No.KOPT/KDS/CIV/T/2402/2695 Date: 11.12.19

CORRIGENDUM-VIII

Ref. Tender Notice No.: KOPT/KDS/CIV /T/2402/64 DT. 16.08.2019
Tender Id No. 2019_KoPT_497965_1

Name of Work :- ThoroughRefurbishment of KoPT Head Office (Main & Annexe) including Interior Beautification, Civil, Sanitary and Plumbing, Electrical, HVAC, Fire Fighting, ELV work at 15, Strand Road, Kolkata-700 001.

Page Ref.	In place of	To be read as
4,10, 11,132,133, Corrigendum-III , Corrigendum-IV, Corrigendum-V , Corrigendum-VI, Corrigendum-VII & wherever applicable.	Date of closing of online e-tender for submission of Techno-Commercial Bid & Price Bid: **16.12.19**. Date & time of opening of Techno-Commercial Bid: **17.12.19**.	Date of closing of online e-tender for submission of Techno-Commercial Bid & Price Bid:**30.12.19**. Date & time of opening of Techno-Commercial Bid: **31.12.19**.

CONTENTS

Superintending Engineer(Contract Cell)
For मुख्य अभियंता / Chief Engineer

CHANGES IN TENDER DOCUMENTS

ITEM REF. NO.	PAGE NO.	IN PLACE OF	TO BE READ AS
D.1.0) i.	391	330 Wp or similar rating PV Modules	PV Modules and the rates shall be in per Wp

D.1.0) iii	391	M.S. Galvanized module mounting structures - 1 Set	M.S. Galvanized module mounting structures - 1 Set
D.1.0) iv.	391	Array Junction Box - As per design	Array Junction Box - As per design
D.1.0) V	391	ACDB (AC Distribution Box) with all protection Equipment - As per Design	ACDB (AC Distribution Box) with all protection Equipment - As per design
I) 1.01	381	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
I) 1.02	381	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
I) 1.03	381	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share	Supply of 55" OLED DISPLAY - Panel depth 3.6mm / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
I)1.04	381	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
I) 2.01	382	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
I) 2.02	382	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC

2.03	382	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share	Supply of 55" OLED DISPLAY - Panel depth 3.6mm / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
2.04	382	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
3.01	382	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
3.02	382	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
3.03	382	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share	Supply of 55" OLED DISPLAY - Panel depth 3.6mm / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
3.04	382	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
4.00	382	Discussion Room 19'10 X 17'	Discussion Room 19'10 X 17'
4.01	382	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
4.02	382	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
4.03	382	75" DISPLAY - 4K wifi Screen Share	Supply of 75" OLED DISPLAY - Panel depth 3.6mm or better / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
4.04	382	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc

5.00	382	Diplay Exhibition - 20'7" x 19'6"	Diplay Exhibition - 20'7" x 19'6"
5.01	382	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
5.02	382	Mixing amplifier 240W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 240 Watt Class-D mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
5.03	382	75" DISPLAY - 4K wifi Screen Share	Supply of 75" OLED DISPLAY - Panel depth 3.6mm or better / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
5.04	382	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
6.00	382	Discussion Room 20' X 20'10"	Discussion Room 20' X 20'10"
6.01	382	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
6.02	382	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
6.03	382	75" DISPLAY - 4K wifi Screen Share	Supply of 75" OLED DISPLAY - Panel depth 3.6mm or better / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony

6.04	382	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
7.00	382		
7.01	382	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
7.02	382	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
7.03	382	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share	Supply of 55" OLED DISPLAY - Panel depth 3.6mm / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
7.04	382	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
8.01	383	8" Driver + Coaxial Polycarbonate HF, 100V Line	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
8.02	383	250 Watts Amplifier	Supply of 240 Watt Class-D mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
8.03	383	75" DISPLAY - 4K wifi Screen Share	Supply of 75" OLED DISPLAY - Panel depth 3.6mm or better / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
8.04	383	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc

9.01	383	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5” or better; HF Woofer 1” or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
9.02	383	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
9.03	383	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share	Supply of 55" OLED DISPLAY - Panel depth 3.6mm / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
9.04	383	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
10.00	383		
10.01	383	Digital desktop chairman microphone unit with chairman control buttons	Supply of Table Top Digital Chairman Unit with Super-cardiod Microphone / array, Gooseneck length minimum 15 inch or more, Dual / Two-way Loudspeaker for better sound reinforcement, Microphone on/off button, Priority switch for temporary muting delegates, RJ-45 daisy chain / star connection complete as required. Approved Makes: Sennheiser, Televic, Beyer Dynamic
10.02	383	Digital desktop delegate microphone unit	Supply of Table Top Digital Delegate Unit with Super-cardiod Microphone / array, Gooseneck length minimum 15 inch or more, Twin / Two-way Loudspeaker for better sound reinforcement, Microphone on/off button, RJ-45 daisy chain / Star connection complete as required. Approved Makes: Sennheiser, Televic, Beyer Dynamic

10.03	383	Central control unit with integrated PC	Supply, Installation, Testing & Commissioning of Digital Audio Conference Control Unit for conference system supplies Power for minimum for 40 units with single controller and controls up to Minimum 300 discussion units with power supply module, built in / External USB Audio Recorder. An Ethernet Port shall be provided for network connection and control units, Option to external PC for diagnostics, pre-installed control software for Microphone management and Audio Recording and controlling conference parameters including equalization, feedback suppression, microphone limiting, and conference modes etc and as required. Approved Makes: Sennheiser, Televic, Beyer Dynamic
10.04	383	CONFERENCE BUS CABLE 3M to be supplied from same OEM as Conference System	CONFERENCE BUS CABLE 3M to be supplied from same OEM as Conference System
10.05	383	CONFERENCE BUS CABLE 20M to be supplied from same OEM as Conference System	CONFERENCE BUS CABLE 20M to be supplied from same OEM as Conference System
10.06	383	Wireless Microphone	Supply of wireless hand held microphone with cardiod polarity pattern, true diversity receiver, Frequency range: 470 - 516 MHz , 516 - 558 MHz , 734 - 776 MHz, THD, total harmonic distortion ≤ 0.9 % or better ; Signal-to-noise ratio ≥ 110 dBA or better ; Switching bandwidth up to 42 MHz or better; Max. 1600 or more receiving frequencies, adjustable in 25 kHz steps 20 frequency banks, each with up to 12 factory-preset channels, Approved Makes: Sennheiser, Clock Audio, Clearone, Rode
10.07	383	Wireless Lapel Set	Supply of wireless head worn microphone of Frequency range: 470 - 937,5 MHz; THD, total harmonic distortion: ≤ 0.9 % or better; Signal-to-noise ratio: ≥ 110 dBA or better; Switching bandwidth: up to 42 MHz or better; Max. 1600 or more receiving frequencies, adjustable in 25 kHz steps 20 frequency banks, each with up to 12 factory-preset channels, Approved Makes: Sennheiser, Clock Audio, Clearone
10.07	383	Wireless Head Set	Supply of wireless lavalier microphone with cardiod polarity pattern Frequency range: 470 - 516 MHz , 516 - 558 MHz , 734 - 776 MHz, THD, total harmonic distortion: ≤ 0.9 % or better ; Signal-to-noise ratio: ≥ 110 dBA or better;Switching bandwidth: up to 42 MHz or better ; Max. 1600 or more receiving frequencies, adjustable in 25 kHz steps 20 frequency banks, each with up to 12 factory-preset channels. Approved Makes: Sennheiser, Clock Audio, Clearone

10.08	383	12 Channel Mixing Console	12 Channel Mixing Console. Approved Makes: Yamaha, Behringer, QSC
10.09	383	6.5" design cabinet loudspeaker, 100v/60Watts or 16 Ω/150Watts	Supply of 2-way wall mount speaker with minimum 1" HF driver and minimum 5" LF driver, rating IP40 or better, 100V Transformer Tappings 40-20-10 W or better, Max. Power 100 W or better, RMS Power 50 W or better, Sensitivity (1W/1m) 87 dB or better, maximum SPL @ 100 V 102 dB or better @ 8 Ω 104 dB or better Speaker type 2-way Dispersion Horizontal / Vertical 110° or better. Approved Makes: Apart Audio, Audac, Bose
10.10	383	Quad Channel Digital Power amplifier 4 x 120Watts @ 100Volts, bridgeable, Class D Amp Topology , Class D Amp Topology, Convection cooled, Hypex inside, 19" rackmount	Supply of Class-D CVT 100 V 4 Channel amplifier with an output power of 4 x 120 Watt, Frequency Response (± 3 dB) 50 Hz - 22 kHz or better, S/N Ratio > 100 dB or better. Approved Makes: Apart Audio, Audac, Bose
10.11	383	75" DISPLAY - 4K wifi Screen Share	Supply of 75" OLED DISPLAY - Panel depth 3.6mm or better / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
10.12	383	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share	Supply of 55" OLED DISPLAY - Panel depth 3.6mm / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
10.13	383	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
11.00		Conference Room	Conference Room
11.01	383	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5" or better; HF Woofer 1" or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
11.02	383	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
11.03	383	75" DISPLAY - 4K wifi Screen Share	Supply of 75" OLED DISPLAY - Panel depth 3.6mm or better / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
11.04	383	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc

12.01	384	Two-way in-ceiling loudspeaker, 6.5" LF & 1" Tweeter, 20 Watts / 100V & 16 Ω/60 Watts, 60Hz - 20KHz , White	Supply of 2 way ceiling speaker with Max. Power 60 W or better; RMS Power 30 W or better; SPL(Max) @ 100 V 102 dB or better; Sensitivity (1W/1m) 87 dB or better; Frequency Response (± 3 dB) 60 Hz - 20 kHz or better; Conical dispersion 145° or better; LF Drivers 5" or better; HF Woofer 1" or better; 100V Transformer Tappings 24 – 12 – 6W or better; Construction type ABS. Approved Makes: Apart Audio, Audac, Bose
12.02	384	Mixing amplifier 120W @ 100V / 70V /4 Ω, 2 mic / line inputs, 4 Music Input, 4-level	Supply of 120 Watt Class-AB mixing amplifier (100 Volt / 4 Ohm) with minimum four balanced microphone inputs, two additional inputs with option for selecting between stereo line or microphone level, minimum 5-zone output selector. Approved Makes: Apart Audio, Audac, QSC
12.03	384	75" DISPLAY - 4K wifi Screen Share	Supply of 75" OLED DISPLAY - Panel depth 3.6mm or better / 4K uhd, wifi Screen Share, audio output 20Wx2. Approved Makes: LG, Samsung, Sony
12.04	384	Interconnects, Connectors & Speaker Cables etc	Interconnects, Connectors & Speaker Cables etc
A) 1.	403.404	Supplying, installing, testing and commissioning of AHRI/EUROVENT Certified **Magnetic Bearing oli free centrifugal turbo core Chiller with mutil compressore Machine,** each complete with **300 TR** actual capacity water cooled condenser, insulated chiller, flow switch at chiller and condenser, vibration isolators, integral refrigerant piping and wiring, BMS interface unit (Tracer / Microgateway / Datalink), grooved couplings for condenser and cooler water in/out connections, complete charge of refrigerant and oil, accessories as required and called for, automatic and safety controls mounted in central micro-processor based console panel and all mounted on a steel frame complete as per specifications. Motor shall be suitable for 400±10% 50 cycles. 3 phase AC supply and motor cable terminal box shall be suitable to connect Aluminium Cabling. Refrigerant used shall be Ozone friendly HFC-134a as detailed in specifications.	Supplying, installing, testing and commissioning of AHRI/EUROVENT Certified Magnetic Bearing oli free centrifugal turbo core Chiller with mutil compressore Machine, each complete with 300 TR actual capacity water cooled condenser, insulated chiller, flow switch at chiller and condenser, vibration isolators, integral refrigerant piping and wiring, BMS interface unit (Tracer / Microgateway / Datalink), grooved couplings for condenser and cooler water in/out connections, complete charge of refrigerant and oil, accessories as required and called for, automatic and safety controls mounted in central micro-processor based console panel and all mounted on a steel frame complete as per specifications. Motor shall be suitable for 400±10% 50 cycles. 3 phase AC supply and motor cable terminal box shall be suitable to connect Aluminium Cabling. Refrigerant used shall be Ozone friendly HFC-134a as detailed in specifications.
		Chiller	Chiller
		Chiller Water IN 54°F	Chiller Water IN 54°F

		Chilled Water OUT 44°F	Chilled Water OUT 44°F
		Fouling factor 0.0005 FPS	Fouling factor 0.0005 FPS
		Chiller Water Flow 720GPM	Chiller Water Flow 720GPM
		Condenser	Condenser
		Condenser Water IN 92°F	Condenser Water IN 92°F
		Condenser Water OUT 102°F	Condenser Water OUT 102°F
		Fouling factor 0.001 FPS	Fouling factor 0.001 FPS
		Chiller Water Flow 775GPM	Chiller Water Flow 1350GPM
		Maximum Power Consumed : Not greater than **0.58**IkW/TR (At Operating Condition)	Maximum Power Consumed : Not greater than **0.58**IkW/TR (At Operating Condition)
		Starting current 2 to 5 Amp	Starting current 2 to 5 Amp
		Minimum COP (At ARI conditions) : **6.4**	Minimum COP (At ARI conditions) : **6.4**
		Minimum NPLV (At design with ARI 550/590 relife) - **0.34**	Minimum NPLV (At design with ARI 550/590 relife) - **0.34**
		1 No. Suitable capacity squirrel cage IP 54 rated TEWAC (Totally Enclosed Water to Air Circuit Cooled type) or TERC (Totally Enclosed Refrigerant Cooled type) induction motor with class 'F' Insulation suitable for operation on 400+10% volts, 50 HZ, A.C. Supply. (for open type compressor motor H.P. Shall be at least 10% higher than the compressor consumed kW requirement at full load at site design conditions as per AHRI certified design conditions Selection sheet.	1 No. Suitable capacity squirrel cage IP 54 rated TEWAC (Totally Enclosed Water to Air Circuit Cooled type) or TERC (Totally Enclosed Refrigerant Cooled type) induction motor with class 'F' Insulation suitable for operation on 400+10% volts, 50 HZ, A.C. Supply. (for open type compressor motor H.P. Shall be at least 10% higher than the compressor consumed kW requirement at full load at site design conditions as per AHRI certified design conditions Selection sheet.
		1 No. factory fitted Variable Frequency drive(VFD) (Make has to be approved by MEP Consultants) suitable for clean motor complete with ammeter with CTs, overload protection ,under voltage protection, protection against phase reversal & independent single phase preventers etc. complete as required. The VFD shall be UL & CE approved. Irrespective to type of VFD cooling method(Aircooled/Watercooled/Refrigerant); VFD Protection rating shall be minimum IP54 or higher to safeguard from surrounded environmental conditions.	1 No. factory fitted Variable Frequency drive(VFD) (Make has to be approved by MEP Consultants) suitable for clean motor complete with ammeter with CTs, overload protection ,under voltage protection, protection against phase reversal & independent single phase preventers etc. complete as required. The VFD shall be UL & CE approved. Irrespective to type of VFD cooling method(Aircooled/Watercooled/Refrigerant); VFD Protection rating shall be minimum IP54 or higher to safeguard from surrounded environmental conditions.

		1 No. - Auto ball tech tube cleaning system complete with injector, ball trap with necessary piping fitted with necessary motorized and manual valves. The quoted price shall be inclusive of PLC programmable control box for auto operation of system FOR 200 TR CHILLER.	1 No. - Auto ball tech tube cleaning system complete with injector, ball trap with necessary piping fitted with necessary motorized and manual valves. The quoted price shall be inclusive of PLC programmable control box for auto operation of system for 300 TR CHILLER.
		1 Set- lubrication device consisting of automatic electric oil pump, oil cooler, oil strainer, automatic pressure regulating valve, oil heater, thermal switch etc. as required for the functioning of complete equipment	1 Set- lubrication device consisting of automatic electric oil pump, oil cooler, oil strainer, automatic pressure regulating valve, oil heater, thermal switch etc. as required for the functioning of complete equipment
		1 No - matching ASME 'U' stamped shell and tube water cooled condenser of Steel shell and integrally fined copper tubes with 2 pass configuration and max pressure drop up to 3.0 meters. Refrigerant sight glass shall be mandatorily provided in the condenser shell for checking moister content and refrigerant level.	1 No - matching ASME 'U' stamped shell and tube water cooled condenser of Steel shell and integrally fined copper tubes with 2 pass configuration and max pressure drop up to 3.0 meters. Refrigerant sight glass shall be mandatorily provided in the condenser shell for checking moister content and refrigerant level.
		1 No - matching ASME U stamped shell and tube water cooled condenser of Steel shell and integrally fined copper tubes with 2 pass configuration and max pressure drop up to 3.0 meters. Refrigerant sight glass shall be mandatorily provided in the condenser shell for checking moister content and refrigerant level.	1 No - matching ASME U stamped shell and tube water cooled condenser of Steel shell and integrally fined copper tubes with 2 pass configuration and max pressure drop up to 3.0 meters. Refrigerant sight glass shall be mandatorily provided in the condenser shell for checking moister content and refrigerant level.
		1 Set - Microprocessor based control panel with minimum 10 inches colored touch screen display complete with accessories. The chiller controller shall be factory wired and unit mounted on the chiller machine. Separate mounting of chiller controller is not acceptable, so that any shifting of the chiller will not necessitate sensor field wiring.	1 Set - Microprocessor based control panel with minimum 10 inches colored touch screen display complete with accessories. The chiller controller shall be factory wired and unit mounted on the chiller machine. Separate mounting of chiller controller is not acceptable, so that any shifting of the chiller will not necessitate sensor field wiring.
		Lot - Refrigerant line accessories comprising of safety valves, angle valves, liquid line indications, liquid level control etc. Liquid line isolation valve shall be provided to isolate refrigerant in condenser for maintenance purposes.	Lot - Refrigerant line accessories comprising of safety valves, angle valves, liquid line indications, liquid level control etc. Liquid line isolation valve shall be provided to isolate refrigerant in condenser for maintenance purposes.
		Lot- Water Differential Pressure switches at inlet and outlet of condenser and chiller, water drain and air purge valves wherever required.	Lot- Water Differential Pressure switches at inlet and outlet of condenser and chiller, water drain and air purge valves wherever required.
		Lot- Victaulic coupling at the inlet and outlet piping connections of	Lot- Victaulic coupling at the inlet and outlet piping connections of evaporator

		evaporator and condenser of chillers.	and condenser of chillers.
		Lot- Suction line and chiller insulation with minimum 19 mm thick polyvinyl nitrile rubber insulation duly insulated at manufacturer works	Lot- Suction line and chiller insulation with minimum 19 mm thick polyvinyl nitrile rubber insulation duly insulated at manufacturer works
		Lot - Frame work for mounting the above condenser, chiller compressor and motor with base plate complete with ant vibration neoprene rubber pads or springs isolator	Lot - Frame work for mounting the above condenser, chiller compressor and motor with base plate complete with ant vibration neoprene rubber pads or springs isolator
		Lot-Factory Charged refrigerant gas and compressor oil.	Lot-Factory Charged refrigerant gas and compressor oil.
		Lot-RCC/Cement concrete foundation for the chilling unit.	Lot-RCC/Cement concrete foundation for the chilling unit.
B) 1.	4,07,408	Supply, installation, testing and commissioning of **Vertical Inline Split Coupled** (with rigid aluminium alloy coupling between pump shaft and motor shaft) **single stage centrifugal pump** each capable of delivering the specified flow rate comprising the following and complete as per specifications. Casing (Volute) - Cast Iron (BS 1452 Grade 220) - PN 16Impeller - Gunmetal Bronze (BS1400LG2C) - Statically and Dynamically BalancedCasing Gasket - Confined Non Asbestos FiberPump Shaft - SS (BS970 416)Flush Line - Braided Stainless SteelMechanical Seal - Outside Balanced (the pump design shall met the requirement of servicing / changing the mechanical seal without disturbing the pump shaft alignment) Motor Type - TEFC Squirrel Cage, Efficiency Class - IE3, Insulation - Class F, 415V ± 10% , 50Hz ± 5%, 3Ø AC Power Supply	Supply, installation, testing and commissioning of Vertical Inline Split Coupled (with rigid aluminium alloy coupling between pump shaft and motor shaft) single stage centrifugal pump each capable of delivering the specified flow rate comprising the following and complete as per specifications. Casing (Volute) - Cast Iron (BS 1452 Grade 220) - PN 16Impeller - Gunmetal Bronze (BS1400LG2C) - Statically and Dynamically BalancedCasing Gasket - Confined Non Asbestos FiberPump Shaft - SS (BS970 416)Flush Line - Braided Stainless SteelMechanical Seal - Outside Balanced (the pump design shall met the requirement of servicing / changing the mechanical seal without disturbing the pump shaft alignment) Motor Type - TEFC Squirrel Cage, Efficiency Class - IE3, Insulation - Class F, 415V ± 10% , 50Hz ± 5%, 3Ø AC Power Supply
		Primary Chilled water pumps	Primary Chilled water pumps
		Water flow rate = 720 USGPM	Water flow rate = 720 USGPM
		Head = 40 Ft. of water	Head = 40 Ft. of water
		Motor KW = 11 kW	Motor KW = 11 kW
		Quantity indicated includes one standby.	Quantity indicated includes one standby.
		Condenser water pumps	Condenser water pumps

		Water flow rate = 900 USGPM	Water flow rate = 1350 USGPM
		Head = 70 Ft. of water	Head = 70 Ft. of water
		Motor KW = 18.5 kW	Motor KW = 18.5 kW
		Quantity indicated includes one standby.	Quantity indicated includes one standby.

TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

CONTENTS	
A.	TECHNICAL SPECIFICATIONS FOR DG SET
B.	TECHNICAL SPECIFICATIONS FOR EXTERNAL ILLUMINATION
C.	TECHNICAL SPECIFICATIONS FOR HT SIDE
D.	TECHNICAL SPECIFICATION FOR LOW SIDE
E.	TECHNICAL SPECIFICATION FOR SOLAR

TECHNICAL SPECIFICATION FOR DG SET
KOLKATA PORT TRUST

SPECIAL CONDITIONS

1. GENERAL

These special conditions are intended to amplify the General Conditions of Contract, and shall be read in conjunction with the same. For any discrepancy between the General Conditions and these Special Conditions, the more stringent shall apply.

2. SCOPE OF WORK

The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the KOPT. The contractor shall furnish all labour, materials and equipment as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation, testing and commissioning of the complete power generating system through Diesel Generator as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The scope of work is as follows but not limited to:

2.1 Radiator cooled Diesel Generator complete with base plate, anti-vibration isolators and all fixing accessories as required.

2.2 DG isolator panels, complete with all accessories.

2.3 Exhaust piping, duly insulated with mineral wool and Copper sheet cladding.

2.4 Residential type silencer, complete with hot dip galvanized supports & brackets, hardware etc.

2.5 Starting battery in non-returnable containers complete with stand and other accessories.

2.6 Day oil tanks, Buffer tank & Over flow tank in the case of diesel generator complete with supporting stand, all accessories, filters, valves, fittings, level indicators, level controllers with contacts.

2.7 Hoisting and handling facilities such as cranes, tools and tackles specially required for this kind of equipment and for lowering equipment in the basement or where ever it is to be installed.

3. ASSOCIATED CIVIL WORKS

Following civil works associated with Power Generating (PG) set installation are excluded from the scope of this tender. These shall be executed by other kopt in accordance with approved shop drawings of, and under direct supervision of the generator contractor.

i. RCC Foundation (Inertia black) with angle iron frame work at the edges as per manufacturer's requirement and rating of generator sets.

ii. Cutout in walls and floors, opening for cable / bus ducts exhaust pipes etc. If any opening is to be made after the floor / slab / wall is built, it shall be the responsibility of the generator contractor to make such openings and make them good after the installation and no extra payment shall be made for such extra works.

iii. Trenches for laying of cables.

4. AWARENESS OF SITE CONDITIONS AND SITE INSPECTION PRIOR TO TENDER SUBMISSION

Prior to the preparation and submission of his tender, the contractor shall make visits to the site and carry out all the necessary inspections and investigations in order to obtain all information and to make his own assessment of the conditions and constraints at site including the means of access to generator room. The contractor shall make himself aware of all the features of the site, working conditions and shall be responsible for obtaining all the necessary required information needed for him to prepare and submit his tender.

5. CO-ORDINATION WITH OTHER CONTRACTORS AND AGENCIES

The contractor during the execution of the works shall co-ordinate with other agencies associated with the project and shall work in harmony with them without causing any hindrance or obstruction on the progress of work in any way.

Other contractors and agencies that the contractor shall be required to coordinate with are :

5.1 Internal / External Electrical Services Contractor

Contractors shall co-ordinate with Electrical services contractor regarding.

Laying of cables on cable trays.

Lighting in the generator area

Interfacing with any works carried out by other electrical services contractor.

5.2 Fire Alarm System Contractor

Co-ordinate with fire alarm system contractor to get the complete information about the facility to be provided in the generator area.

5.3 Civil Works Contractor

To coordinate with civil works contractor to provide foundation, sleeves, insert plates, supports, openings etc., necessary for the power generating sets installation work in compliance with the construction programme.

5.4 HVAC System Contractor

To coordinate bus duct, pipes and ducts crossing.
To coordinate cable tray layout with regard to ducting, piping and ventilation system layout.

5.5 Plumbing& Water Supply Contractor

To collect and coordinate all the relevant information regarding water supply and drainage pipes.

5.6 Fire Protection System Contractor

To collect and coordinate all the relevant information regarding the fire protection system in the Power Generating area.

6. RATING

Rating of all equipment shall be appropriate for the conditions on the location where the equipment will be installed and operate. All the equipment shall be suitable for continuous operation under the most severe conditions of site and shall be rated for the following ambient condition.

Location	:	Kolkata
Altitude	:	6 meters above sea level (approx.)

Ambient Temperature

Maximum	:	42 deg. C
Minimum	:	12 deg. C

7. SHOP DRAWINGS

All shop drawing shall be prepared on computer through Autocad system based on Architectural drawings and site measurement within two weeks of award of work. Contractor shall furnish for the approval of the KOPT, four sets of detailed shop drawings of all equipment and material giving following information.

i. Certified foundation details of DG sets.

ii. Layout of DG set (Sound Attenuated and associated equipments) panels.

iii. Fuel supply system – Day oil tanks layout and piping diagram detailing process and instrument diagram along with pipe sizes, flow rate, in compliance to fire safety / electrical safety measures.

iv. Electrical – Single line diagram of power as well as control schematic showing make / type and description of all components and accessories in compliance to relevant safety norms.

v. Exhaust System – Drawing showing complete insulated exhaust pipes, residential muffler, damper position, common / individual exhaust chimney etc.

7.1 These shop drawings shall contain all information required to complete the Project as per specifications and as required by the KOPT. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other contractors. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings. Minimum 4 sets of drawings shall be submitted after final approval along with soft copy.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in Appendix-III and quoted by the tenderer in technical data part of Appendix - IV.

When the Architect /KOPT makes any amendments in the above shop drawings, the contractor shall supply two fresh sets of drawings with the amendments duly incorporated along with check prints, for approval. The contractor shall submit further six sets of shop drawings to the KOPT for the exclusive use by the KOPT and all other agencies. No material or equipment may be delivered or installed at the job site until the contractor has in his possession, the approved shop drawing for the particular material/equipment/installation.

7.2 Shop drawings shall be submitted for approval two weeks in advance of planned delivery and installation of any material to allow KOPT ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved programme.

7.3 Manufacturers drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labeled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

7.4 Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supercede the contract requirements, nor does it in any way relieve the contractor of the responsibility or requirement to furnish material and perform work as required by the contract.

7.5 Where the contractor proposes to use an item of equipment, other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundation, piping, wiring or any other part of the mechanical, electrical or architectural layouts; all such re-design, and all new drawings and detailing required therefore, shall be prepared by the contractor at his own expense and gotten approved by the KOPT. Any delay on such account shall be at the cost of and consequence of the Contractor.

7.6 Where the work of the contractor has to be installed in close proximity to, or shall interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so directed by the KOPT, the contractor shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Contractor installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the KOPT.

7.7 Within two weeks of approval of all the relevant shop drawings, the contractor shall submit four copies of a comprehensive variation statement in quantity, and itemized price list of recommended (by manufacturers) imported and local spare parts and tools, covering all equipment and materials in this contract. The KOPT shall make recommendation to Owner for acceptance of anticipated variation in contract amounts and also advise Owner to initiate action for procurement of spare parts and tools at the completion of project.

8. COMPLETION DRAWINGS

Contractor shall periodically submit completion drawings as and when work in all respects is completed in a particular area. These drawings shall be submitted in the form of PENDRIVE and four portfolios (300 x 450 mm) each containing complete set of drawings on approved scale indicating the work as - installed. These drawings shall clearly indicate following:

8.1 Location and rating of DG sets.

8.2 Location and details of DG Sync panel, Aux panels, and other particulars including approved fabrication drawings.

8.3 Complete power & control wiring diagram, as installed and scheduled showing all connections in the complete electrical system.

8.4 Routing and particulars of all cables and trays, trenches if required.

8.5 Single line diagram, power schematic, control schematic with detailed bill of materials, showing makes, types and description of all components and accessories.

8.7 Earthing Layout and schematics.

9. OPERATING INSTRUCTION & MAINTENANCE MANUAL

Upon completion and commissioning of Power Generating system the contractor shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer's operating and maintenance manuals. Upon approval of the draft, the contractor shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals; one each for retention by Consultant and Owner's site representative and two for Owners Operating Personnel. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 4 year period of maintenance of each equipment. These manuals shall include:

i. Description of the work carried out / installed.
ii. Operating instructions.
iii. Maintenance instructions including procedures for preventive maintenance.
iv. Manufacturers catalogues.
v. Spare parts list.
vi. Trouble shooting charts.
vii. Drawings
viii. Type and routine test certificates of major items.

10. INSPECTION AND TESTING

The owner / consultant may carry out inspection and testing at manufacturer's works. No equipment shall be delivered without prior written confirmation from KOPT. All expenses relating to test including travelling, boarding & lodging of Three personal ,two from KOPT and one from architect shall be borne by the contractor. Upon completion of work the performance test shall demonstrate the following among other things :

i. Equipment installed complies with specification in all respects and is of the correct rating for the duty and site conditions.

ii. All items operate efficiently and quietly to meet the specified requirements.

iii. All circuits are correctly protected and protective devices are properly coordinated.

iv. All non current carrying metal parts are properly and safely grounded in accordance with the specifications and appropriate codes of practice.

The contractor shall provide all necessary instruments and labour for testing. He shall make adequate records of test procedures and readings and shall repeat any tests requested by the KOPT / Consultant. Test certificate duly signed by a authorized person shall be submitted for scrutiny.

If it is proved that the installation or part thereof is not satisfactorily carried out then the contractor shall be liable for the rectification and retesting of the same as called for by the KOPT / Consultant. All tests shall be carried out in the presence of representative of KOPT / Consultant. The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere. All tests shall be carried out by a test house approved by the KOPT / Consultant. The contractor besides above test shall carry out witness test for performance at full load at PF of 1.0 over at least 12 hrs and 10% additional for an hour.

The DG shall be tested in the presence of Owner's representative at Supplier's works in accordance with latest prevailing standards and codes. The successful passing of any such tests will not however prejudice the right of Purchaser to reject the DG and its accessories, if they do not comply with specifications when erected or perform complete satisfactory operation as intended. Supplier shall provide the test certificate for the bought out items used, if any in the assembly of DG

11. PRE-COMMISSIONING CHECKS

All standards checks including the ones elaborated in the specifications to ensure that the installation of the DG sets and associated systems has been carried out satisfactorily shall be done on completion of installation. These shall include.

11.1 DG sets

- Checking of piping interconnections
- Checking electrical interconnections
- Checking of insulation resistance
- Checking of earthing
- Checking of instruments and controls.
- Checking of alignment
- Checking of vibration transmission to building structure.
- Checking of expansion joints.

11.2 Exhaust system

- Checking of silencer operation
- Checking of surface temperature of exhaust piping

11.3 General

Upon completion of work the performance test shall demonstrate the following among other things:

i. Equipment installed complies with specification in all respects and is of the correct rating for the duty and site conditions.

ii. All items operate efficiently and quietly to meet the specified requirements.

iii. All circuits are correctly protected and protective devices are properly coordinated.

iv. All non current carrying metal parts are properly and safely grounded in accordance with the specifications and appropriate codes of practice.

12. PERFORMANCE TESTING

DG sets shall be tested at varying loads at manufacturers works/site prior to dispatch of the sets to site. The performance tests at the works shall be carried out in presence of authorized representative from the Clients. Due notice for the programme of performance testing at works shall be given to the Clients to enable them to arrange for their representatives for this inspection to be at manufacturers works/site for this inspection and testing.

The performance test on each DG sets shall be of minimum 8 hours duration. It should also include measurement of noise and emission as per standards and CPCB guidelines. Vibration measurement shall also be done as per engine manufacturer's recommendation and ISO – 8528 Part - 9. All instruments, materials, consumables (fuel oil, lube oil etc.) load and labour required for carrying out of the test shall be provided by the Contractor. Following test acceptance criteria shall be applicable.

a. Fuel consumption at 50%, 75%, 100% : + 5% of guaranteed performance. Actual alternator

	and 110% load.		efficiencies as determined in the manufacturers works tests shall be used as the basis of calculation of specific fuel consumption ratio.
b.	Voltage regulation from no load to full load	:	+ 1%
c.	Frequency regulation from no load to full load	:	+ 0.5%
d.	Maximum water temperature	:	+ 5% of guaranteed performance
e.	Maximum lube oil temperature	:	+ 5% of guaranteed performance
f.	Minimum lube oil pressure	:	+ 5% of guaranteed performance
g.	Lub Oil consumption	:	+ 5% of guaranteed performance

13. TYPE TEST

Copies of manufacturers type test for the engine and the alternator of all ratings shall be enclosed along with the dispatch of the DG sets.

The contractor shall provide all necessary instruments and labour for testing. He shall make adequate records of test procedures and readings and shall repeat any tests requested by the Construction Manager/Client's Site Representative / Consultant. Test certificate duly signed by an authorized person shall be submitted for scrutiny.

If it is proved that the installation or part thereof is not satisfactorily carried out then the contractor shall be liable for the rectification and retesting of the same as called for by the Construction Manager/ architect/Consultant/Client's Site Representative. All tests shall be carried out in the presence of representative of Construction Manager/architect/Consultant/Client's site representative.

The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere. All tests shall be carried out by a test house approved by the Construction Manager/Consultant/Client's Site Representative.

The contractor besides above test, shall carry out witness test for performance at full load at PF of 1.0 over atleast 12 hrs and 10% additional for an hour.

14. MATERIALS AND EQUIPMENT

All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved manufacturers as per Appendix - III.

15. COMPLETION CERTIFICATE

On completion of the Generator installation, a certificate shall be furnished by the contractor countersigned by the licensed electrical supervisor under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority.

16. TRAINING OF OWNER'S PERSONNEL FOR OPERATION AND MAINTENANCE

Upon completion of all work and all tests, the Contractor shall furnish necessary operators, labour and helpers for operating the entire installation for a period of fifteen (15) working days of ten (10) hours each, to enable the Owner's staff to get aquainted with the operation of the system. During this period, the contractor shall train the Owner's personnel in the operation, adjustment and maintenance of all equipment installed**.**

17. GUARANTEE

Upon complete of work and before issuance of certificate of virtual completion by the KOPT, the contractor shall furnish written guarantee indemnifying the owner against defective materials and workmanship for a period of one year after acceptance.

The contractor shall hold himself fully responsible for reinstallation and / or replacement, free of cost to Owner the following:

a. Any defective work or material or equipment supplied by the Contractor.

b. Any material or equipment supplied by the Owner which is damaged or destroyed as result of defective workmanship by the contractor.

c. In case of failure of the supplier, to get any defect rectified within forty eight (48) hours, the Owner reserves the right to get necessary repairs done on his own at the supplier cost.

18. UPTIME GUARANTEE

The contractor shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defects liability period, the Defects Liability period shall get extended by a month for every month having shortfall. In case of shortfall beyond the defects liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period.

The Contractor shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all temperatures, pressures, humidity, power consumption. starting and stopping times for various equipment, daily services rendered for the system alarms, maintenance and record of unusual observations etc. Contractor shall also submit preventive maintenance schedule.

Each tenderer shall submit along with the tender, a detailed operation assistance proposal for the Owner's site representatives/Consultant's review. This shall include the type of service planned to be offered during Defects Liability Period and beyond. The operation assistance proposal shall give the details of the proposed monthly reports to the Management.

The tenderer shall include a list of other projects where such an Operation Assistance has been provided.

19. ENGINEER AND FOREMAN

The contractor shall employ a competent, fully licenced, qualified full time electrical / mechanical engineer and foreman to direct the work of installation in accordance with drawings and specifications. The foreman shall be available at all times at site to receive instructions from the KOPT / Consultant for day to day activities throughout the duration of the contract. The foreman shall correlate the progress of the work in conjunction with all relevant requirements of the supply authorities.

20. DEMONSTRATION TO OWNER

Upon completion, devices subject to manual operation shall be operated atleast five times in presence of KOPT Consultants to demonstrate satisfactory operation.

The contractor shall provide performance tests upon completion of the installation. He shall arrange all necessary instruments, tools and tackles to check sound level, vibration and the effectiveness of acoustical treatment and vibration isolator installed.

21. TOOLS AND TACKLES

The Contractor shall provide and install all necessary hoists, ladders, scaffolding, tools, tackles, transportation of labour and materials necessary for the proper execution and completion of the work to the satisfaction of the KOPT / Consultants.

22. OPERATION AND MAINTENANCE

Contractor may be required to carry out the operation of the Power Generating set for the defects liability period. Further, he may also be required to carry out operation and all inclusive maintenance of the entire system for a period of five years beyond the defects liability period**.**

22.1 Operation contract

i. 24 hours a day, year round.
ii. All stand-by equipment to be operated as per mutually agreed programme.
iii. Proper entry and upkeep of relevant log books.
iv. Maintain complaints register. Submit weekly report.
v. Proper housekeeping of all areas under the contract.

vi. Prepare daily consumption report and summary of operation.

22.2 Terms of payment

i. Monthly at the end of each month on pro-rata basis.

23. BUILDING AUTOMATION SYSTEM (BAS)

The scope of Generator Contractor shall include the following for the interface to Building Automation System.

i. Stop/Manual/ Auto switches along with potential free contacts for monitoring the manual operation status (wherever applicable), to be provided for those equipment whose start / stop is controlled by Building Automation System.

ii. Potential free 'NO' contacts for monitoring 'Run' status of equipment wherever required.

iii. The installation of current transformer & Transducer along with wiring between Current Transformer & Transducer up to the terminal block shall be provided by the Electrical contractor. All transducers shall be supplied by BAS contractor.

iv. Provide all necessary relays, contactors, current and potential transformers required by BAS system. CT's for BAS system shall be of 15 VA rating and of metering class. Also, adequate space in the panels shall be provided for mounting of electrical transducers as required.

v. The low voltage BAS cables shall be brought upto AMF panels by BAS contractor and all terminations into AMF shall be made by Generating set contractor after satisfying himself of the wring system. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, lies solely with the Generator Contractors.

The following shall be monitored through BAS:

a. Status monitoring for oil transfer pump

b. Duplicate monitoring of each indication as given in annunciation window of AMF panel.

c. Battery voltage status.

d. Voltage, current, power factor, frequency & power consumption monitoring at each Generating set.

Auto / Manual / Stop changeover switch shall be provided by the Generator supplier for each mechanical equipment related to generating sets with potential free contact. For the temperature monitoring, all nipples / sockets in the pipe shall also be in scope of Generator supplier.

24. APPROVAL & CLEARANCE

All associated activities required for necessary clearances / permissions / approvals / licenses from concerned authorities are in the scope of Generator supplier. Only receipted amounts shall be payable by the KOPT.

A P P E N D I X – I

GUARANTEE PROFORMA

FOR DIESEL GENERATING SET INSTALLATION

We hereby guarantee the year round power generation system which we have installed in the Complex described below :

Building : **KOLKATA PORT TRUST**

Location : **KOLKATA**

For a period of 5 year from the date of acceptance of the total installation, We Agree to repair or replace to the satisfaction of the Owner, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorise the Owner to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation upon completion and ensure that all units are functioning satisfactorily.

SIGNATURE OF CONTRACTOR
for DIESEL GENERATION INSTALLATION

DATE : **SEAL**

A P P E N D I X – II

LIST OF APPROVED MAKES FOR EQUIPMENT & MATERIALS

S. No.	Details of Materials / Equipment	Manufacturer's Name
1.	Diesel Generating Engine	Cummins India MTU Friedrichshaten Caterpillar Mitsubishi
2.	Acoustic Enclosure	Jakson S & W TIL Mitsubishi
3.	Alternator	Stamford Leroy Somer Caterpillar Mitsubishi
4.	DG Synchronizing Panel	Electro Allied Products Sterling Generators Green Galaxy Adroid
5.	Air Circuit Breaker (3/4 Pole)	ABB Larsen & Toubro Schneider Electric Siemens
6.	Moulded Case Circuit Breaker (MCCB)	ABB Larsen & Toubro Schneider Electric Siemens
7.	Miniature Circuit Breakers (MCB)	ABB L&T MDS Legrand Schneider Electric Siemens
8.	Power/Aux. Contactor	Schneider Electric Larsen & Toubro ABB Siemens

S. No.	Details of Materials / Equipment	Manufacturer's Name
9.	Protection Relay	
	a. Numeric Type	ABB Areva Larsen & Toubro Siemens
	b. Electromagnetic Type	ABB Areva Larsen & Toubro
10.	Indicating Lamps LED type and Push Button	Larsen & Toubro (ESBEE) Schneider Electric Siemens Vaishno
11.	Overload relays with built in Single Phase preventer	Schneider Electric Larsen & Toubro ABB Siemens
12.	Electronic Digital Meters (A/V/PF/Hz/KW/ KWH) with LED Display	Conzerv (Schneider Electric) Automatic Electric EI Measure Secure
13.	Static Power Meter & Logger (SPML) With RS 485 port	Conzerv (Schneider Electric) Larsen & Toubro EI Measure
14.	PLC	Allen Bradley Siemens Modicon (Schneider Electric)
15.	PVC insulated XLPE Copper/copper conductor armoured MV Cables upto 1100 V grade	Finolex Gloster KEI Polycab Havells
16.	LT Jointing Kit / Termination	Raychem REPL Safe Kit

S. No.	Details of Materials / Equipment	Manufacturer's Name
17.	Cable Glands Double Compression with earthing links	Baliga Lighting Comet Cosmos
18.	Vibration Isolators	Cori Dunlop Kanwal Industries Corporation Flexionics
19.	Noise Control Silencer / Muffler (Residential Type Silencer)	Intertec Sound Control India
20.	Fiberglass	Owens Corning UP Twiga

21.	Thermometer	Emerald H Guru Taylor
22.	Alarm Annunciator	Advani Oralikon Larsen & Toubro Minilec
23.	Motors (Energy Efficient Class – I)	Kirloskar Bharat Bijlee Siemens ABB
24.	Plug Valve	Audco SKS
25.	GM / Forged brass Ball Valve	RB Italy Zoloto
26.	Check Valve Wafer Type / Dual Plate	Advance Valve Jayhiwa Kirloskar
27.	Flexible Pipe Connections	Flexionics Resistoflex
28.	Pypcoat (AW4) for fuel tank & Burried oil piping	IWL
29.	Oil Flow Meter	Crown Kent Schlumberger
30.	Level Indicator (Oil)	Forbes Marshall
31.	Anchor Fastner	Fisher Hilti Shakti
32.	GI Pipe Fittings	Unik Zoloto M
33.	Welding Rod	ADOR Advani

A P P E N D I X – IV

LIST OF INDIAN STANDARDS (IS)

IS : 694	PVC insulated Electric cable for working voltage upto and including 1100 volts.
IS : 732	Code of practice for electrical wiring and installation
IS : 1554	PVC insulated (Heavy Duty) electric cables for working voltages upto and including 1100 volts.
IS : 1651 & 1652	Stationary cell & batteries, lead acid type.
IS : 1885	Glossary of items for electrical cables and conductors
IS : 2551	Danger notice plates.
IS : 3043	Code of practice for earthing.

IS : 3480	Flexible steel conduits for electrical wiring.
IS : 5133	Boxes for the enclosure of electrical accessories.
IS : 5216	Guide for safety procedures and practices in electrical work.
IS : 5424	Rubber mats for electrical purposes.
IS : 5578	Guide for marking of insulated conductors
IS : 8130	Conductors for insulated electric cables and flexible cords
IS : 8623	Factory built assemblies of switchgear and control gear for voltages upto and including 1000 V AC and 1200 V D C.
IS : 8623	Bus Bar trunking system
IS : 8828	Miniature Circuit Breakers
IS : 9537	Rigid Steel Conduits for electrical wiring (Second Revisions)
IS : 10810	Methods of test for cables.
IS : 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
IS : 12640	Earth Leakage Circuit Breakers
IS : 13947	Air Circuit Breakers
IS : 13947	Moulded Case Circuit Breakers
IS : 13947	Degree of protection provided by enclosures for LV switchgear and control gear.
IS : 13947	General requirement for switchgear and control gear for voltage not exceeding 1000 Volts.

Note *: Latest edition of above mentioned IS shall be referred.*

A P P E N D I X – V

ABBREVIATIONS

The following abbreviations have been used in the accompanying specifications, and schedule of quantities.

DG	stands for Diesel Generator
G I	stands for Galvanized Mild Steel.
Cu	stands for Copper
M S	stands for Mild Steel.
L T	stands for Low Tension.
PVC	stands for Polyvinyl Chloride.
AMP	stands for amperes.
V	stands for Volt
I S	stands for Indian Standards.
IEE	stands for Institution of Electrical Engineers - London.
NEC	stands for National Electrical Code.
ACB	stands for Air Circuit Breaker.
MCCB	stands for Moulded Case Circuit Breaker.
S P	stands for Single Pole.
D P	stands for Double Pole.
TPN	stands for Triple Pole and Neutral.
4 pole	Stands for triple pole and neutral of same size as the phase conductor.

A P P E N D I X – VI

SCHEDULE OF TECHNICAL DATA

1. DG SET **(To be filled by the Bidder)**

a. Engine make

b. Alternator Make

c. Operating Duty

d. KVA Rating

e. KW rating

f. BHP Rating

g. Physical Dimensions

i. Length (mm)
ii. Width (mm)
iii. Height (mm)

h. Shipping Weight (Kg)

j. Engine Lub Capacity (Ltrs)

k. Fuel Consumption at NTP

i. 100% loading (ltrs/hr)
ii. 75% loading (ltrs/hr)
iii. 50% loading (ltrs/hr)

l. No. of Cylinder / Stroke

m. Power Factor

n. Efficiency (%)

o. System back Pressure (KPA)

p. Exhaust Flange

q. Exhaust Gas Flow Rate (CFM)

r. Compression Ratio

s. Heat Rejection to Exhaust System (KW)

t. Heat Rejection to Cooling System (KW)

u. Total Radiated Heat (KW)

v. Exhaust Temperature (°C)

A P P E N D I X – VII

DG SETS – COST OF GENERATION

ITEM	UNIT	DATA SHALL BE FURNISHED BY TENDERER AGAINST EACH ITEM
Make of Engine		
Make of DG set		
Engine Model		
DG set rating	KVA	
DG set rating	Kw	
Average Load factor	%	95%
Units generated per hour	kwh / hour	
Number of hours per year	hours / annum	2400 hours
Number of units generated per year	kwh / annum	
Fuel Cost		
Fuel rate	Rs per litre	
Fuel consumption	Litres/ hour	
Number of units per litre of Diesel	Kwh / litre	
Fuel cost	**Rs per kwh**	
Lub Oil Consumption Cost		
Lub oil consumption	litres / hour	
Cost of Lub oil	Rs per litre	
Lub Oil consumption cost	Rs per hour	
Lub Oil consumption cost	**Rs per kwh**	
Lub Oil Replacement Cost	Rs per litre	
Lub Oil replacement period	Hours	
Lub Oil replacement quantity	Litres	
Lub oil replacement	litres / hour	
Lub oil replacement cost	Rs / hour	
Lub Oil replacement cost	**Rs per kwh**	
Maintenance Cost		
"B Check" maintenance period	Hours	
"B check" maintenance kit cost	Rs	
"B Check" maintenance cost	**Rs per kwh**	
“C Check:” maintenance period	Hours	
“C Check:” maintenance kit cost	Rs.	
"C Check" maintenance cost	**Rs per kwh**	
“D Check:” maintenance period	Hours	
“D Check:” maintenance kit cost	Rs.	
"D Check" maintenance cost	**Rs per kwh**	
Air Cleaner element change period	Hours	
Air Cleaner Element cost	Rs	
Air Cleaner Element replacement cost	**Rs per kwh**	
Total Cost per kwh generated		

Signature of Tenderer

A P P E N D I X – VIII

DG SETS – TEST PROCEDURE

DG Set shall be duly tested at factory as per manufacturer's standards and procedures detailed as under:-

1) Before testing, following details shall be recorded on test report:-

   i) Engine S. No.

   ii) Alternator S. No.

   iii) Engine Model and Make

   iv) Alternator Model and Make

   v) Engine and Alternator Rating

   vi) Date of Testing

   vii) Rated Sped, Voltage & KW Rating

2) Check the tightness of al bolts and necessary connections before starting the DG sets.

3) Start the DG set and run at idle for few minutes. If any leakage occurs, rectify them and note down the parameters on test report.

4) Raise the load gradually and allow the performance parameters to reach steady state conditions and note down the following parameters on test report:

   i) Speed in RPM

   ii) Load in KW

   iii) Current in Amps

   iv) Voltage

   v) Frequency (Hz)

   vi) Lube Oil Pressure

   vii) Water Temperature

   viii) Lube Oil Temperature

   ix) Regulation of Voltage & Speed

   Above parameters shall be recorded at following loads and duration:

Idle Run	-	05 mins
15% Load	-	05 mins
50% Load	-	05 mins
75% Load	-	05 mins
100% Load	-	10 mins
110% Load	-	10 mins

   The DG sets shall be tested with standard test bench facilities as per ISO – 8528 – 6.

A P P E N D I X – IX

TEST REPORT

Description	Engine	Alternator	DG Set	Panel
Make				
Model				
Rating				
S. No.				

Rated Voltage:

Rated Speed:

Load built up test on resistive load bank (unity power factor)

Load %	**Time Min.**	**Start Time**	**Stop Time**	**Volt (Line to Line)**			**Current (Amps)**			**Load (kW)**	**Frequency (Hz)**	**Lube Oil Pr. Bar**	**Lube Oil Temp (°C)**	**Water Temp (°C)**	**Speed RPM**
0															
25															
50															
75															
100															
110															

Volt & RPM at no load
Volt & RPM at full load
Notes:
Date: Tested By: Witnessed By:

TECHNICAL SPECIFICATIONS

A. DIESEL OPERATED GENERATOR SET

1. GENERATORS

1.1 SCOPE

The scope of this section consists of but not necessarily limited to the following:

a. The contractor shall supply, deliver to site, hoisting into position, install, test and commission the standby power generating set together with the necessary controls and switchboards as specified and indicated in the Drawings. Protection circuits, control wiring and interlock circuits not specified or indicated in the Drawings, but deemed necessary for the safe operation of the generating system shall be provided without any additional cost to complete the system.

b. Provide manufacturer's factory representative's services, including coordination, start-up and testing supervision at site.

c. Testing (factory and field), start-up supervision, training and providing necessary documentation and tools for operation.

d. Carry out performance test run at site.

1.2 SUBMISSION

For bidding

The bidder shall submit offer with the following documents in two sets.

- Schedule of deviations from technical specifications.
- List of proposed makes, for the items listed in the tender.
- Technical datasheets indicating overall dimensions & Catalogues of major items, highlighting the offered models.
- Design drawing of residential silencer.
- Day oil tank detailed design drawing.
- Structural support drawings.
- To submit power controller (AMF module) drawings along with operation logic.
- Supporting structure details of chimney e.t.c.
- Other documents and comments, if any.

For approval before construction/erection

The contractor shall submit the following documents.

a) For all the supplies, the contractor shall submit the following documents in 4 sets for approval.

- General arrangement drawings, with all dimensions, showing: space-requirements, weights (for transport and service conditions), requirements of civil works/foundation, fixing and mounting facilities, connection devices, etc..

- Electrical drawings, showing: power and control single line and functional/control multi line diagrams, terminal blocks, components' list with make, type, quantity, etc.

- Quality assurance plan and bar-chart showing manufacturing schedule.

The contractor shall incorporate all comments and submit revised drawings in stipulated time till all drawings are finally approved for manufacturing.

Final

The contractor shall submit the following documents, reflecting the true final as built situation, in 6 sets, and one soft copy in PENDRIVE/SSD/SDCARD.

a) The drawings including wiring diagrams as revised and "as built".

b) Inspection and preliminary testing certificates and reports and shipping release.

c) Test certificates of kWh meters from Government approved Lab or Electric Supply Co. of concerned area.

d) Guarantee certificates.

e) Instruction & maintenance manuals, Cataloguers etc.

f) Any other certificate / report as called for by the Client / Consultant.

1.3 PRODUCT

1.3.1 Capacity

Actual power output shall be as shown in drawings and in schedule of quantities.

Diesel Engine

The diesel engine shall be of the 4 stroke cycle, continuous rating (prime as specified in BOQ), multi-cylinder direct injection, compression ignition type operating at a speed of 1500 rpm and shall be silent, vibration free while in operation and comply Center / State Pollution Control Board and shall conform to BS:649/5514.

The engine shall be complete with water cooled body jacket, water cooled engine, through radiator, fan, lubricating oil pump, lubrication oil pressure gauge, tachometer, digital or electronic type governor, integrated hours-run recorder, over-speed trip and all other necessary auxiliaries.

The brake horse power of the engine with all attached accessories as specified shall not be less than that which is required by the full load rating of the alternator at site operating conditions taking into consideration losses, plus a reserve factor of at least 10%.

1.3.2 Starting

Starting system of the standby generator shall be of a heavy-duty electric motor complete with a 24 VD.C. heavy-duty battery of at least 300 AH. The electric motor shall be capable of cranking the engine to achieve the rated speed in less than 10 seconds from the initiation of the starting process. The electric start battery shall be of adequate capacity for 10 successive starts. Time delay relays shall be incorporated to provide a rest period of 1-5 seconds (adjustable) before each successive start and a time lag period of 19-100 seconds (adjustable) before the system lock out due to failure of the 3rd start to crank up the engine.

The generator set shall be provided with a micro-processor based control system which is manufactured to provide automatic starting, monitoring, and control functions for the generator set. Interface to BMS system according to point schedule on drawings shall be provided.

The control system shall include an engine governor control, which shall function to provide steady state frequency regulation. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting. The governor control shall be suitable for use in paralleling applications without component changes.

1.3.3 Speed Regulation

The governor shall be capable of regulating the speed of the engine within the limits approximately 10% of the rated speed within 4 seconds due to a sudden application or removal of a full load. The steady load speed shall vary within the limits of approximately 1% of the rated speed.

1.3.4 Cooling

The engine cooling system shall be of a closed circuit water recirculating system to cool the engine as well as the body to minimise heat radiated into the generator room. The cooling circuit shall exchange heat through a heat exchanger capable to remove the heat generated under continuous full load operation. Condenser water from cooling tower shall be provided to exchange the heat to external of the building. The cooling system shall include the heat exchanger, fan, pump etc. OEM shall specify the water quality standard of cooling tower.

1.3.5 Lubricator

The lubricating system shall be by a positive displacement oil pump providing a positive force feed to all lubricating points.

1.3.6 Exhaust System

Adequate sized piping and fittings shall be installed to carry the engine exhaust discharge into the atmosphere at a height as indicated in the drawings & as per the requirement of Center / State Pollution Control Board or Pollution Control Committee as the case may be.

Galvanized M.S. structural support and vibration arrestors for D.G. set chimney to specify along with drawing for statutory clearance.

Mufflers shall be installed to reduce the engine exhaust noise to a maximum of 5 dBA above ambient noise level at nearest area accessible to the public within 3m from Generator Room and at least 2m above floor level. Flexible connection shall be provided between the engine and the fixed piping.

1.3.7 Fuel Piping and Fuel Tank Installation

The complete system shall include engineering, supply, installation, testing and commissioning of tank for storage of fuel, pumps, piping, valves and control system.

1.3.8 Instruments

An instrument panel mounted on the engine shall be provided and shall comprise the following flush-mounted instruments and gauges:

Lubricating oil inlet and outlet temperature

Lubricating oil pressure gauge

Tachometer, positive driven

Hour counter.

1.3.9 Protection Devices

Warning indication and automatic shut-down shall be provided for the following:

Low oil pressure shutdown and alarm

Low and high coolant temperature alarm

High coolant temperature shutdown

Fail to crank shutdown

Overcranking shutdown

Overspeed shutdown

Low & high DC voltage alarm

Low battery alarm

Low fuel-day tank alarm

High and Low AC voltage shutdown

Under frequency shutdown

Over current and alarm and shutdown

Short circuit shutdown

Ground fault alarm

Overload alarm

Emergency stop

Failure indication lights and alarm for all fault conditions shall be provided on control panel for restoring the operation to normal.

The starting circuit shall be disconnected in the event of any of the above shutdowns.

1.3.10 Alternator

The alternator shall be brush less synchronous drip proof, self-ventilated and screen-protected and directly coupled on to the diesel engine by flexible coupling and shall be continuously rated for site operating conditions and conform to BS 5000 (part99) or IS 4722..

The full load output voltage shall be 415 volts, 3 phase, 4 wire, 50 Hz at 0.8 power factor with neutral solidly earth with the frequency maintained at 50 Hertz at all time under any load condition including transient overload due to motor starting etc.

The rotor shall consist of the main alternator field poles the brushless exciter and its rectifier module, all bolted on a common alternator shaft. The rotor shall be mechanically and electrically balance up to 135% of the rated speed. The insulation of the alternator shall be non-hygroscopic, Class “H” on the exciter, Class “H” on the stator and Class H on the rotating pole pieces.

The rectifier module of the exciter shall be impregnated with epoxy resin and shall be capable of withstanding without damage or deterioration of the thermal, centrifugal and other stresses that is experienced during normal or short circuit conditions. Rectifiers shall be of silicon type.

The voltage build up shall be of self-excitation using the residual voltage of the alternator through a solid-state voltage regulator. The voltage regulator shall be capable of maintaining the voltage regulation to ± 1% independent of power factor, heating and 5% of speed variation. The voltage output of the alternator shall also be capable of manual adjustable to ± 5% of the rated voltage.

The response of the voltage regulator shall be less than 10 millisecond. The voltage dip shall not exceed 15% when a rated continuous load is supplied to the unloaded alternator and the correction time shall not exceed 200 millisecond. When the rated load is withdrawn, the voltage overshoot shall not exceed 20%.

The automatic voltage regulator and the exciter shall be manufactured to withstand 50% overload at a constant terminal voltage.

A permanent magnet generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a single phase or three phase fault at approximately 300% of motor current for not more than 10 seconds.

1.3.11 Generator Control Panel

The generator control panel shall have all necessary instruments and accessories for operation and control of the generating set. On sensing the utility mains voltage dip to below said voltage, the control panel shall send a signal to start the generator. After 3 successive start and if the diesel generator is not started up, the alarm signal shall be activated.

The generator control panel shall consist of all AMF system, Auto-transfer switch, circuit breakers, protective relays if applicable and accessories required to control the generator operation and shall include but not limited to the following:

Voltmeters

Ammeter

Frequency Meter

Power factor meter

Kilowatt meter with maximum demand indicator

Kilowatt hour meter

Hour run meter

Start-stop and automatic mains monitoring system

Emergency off push button

Manual speed adjusting control reset for overload, alarm muting.

Fully automatic trickle battery charger with voltmeter

Indicating lamps for ‘Mains Available’, ‘Mains on Load’, ‘Standby Available’, ‘Standby on Load’, ‘Alarm’, ‘Mains Fail’, etc.

Audio and visual (flasher) alarm.

The start-stop and automatic mains monitoring system shall be equipped with the following:

Duty selector switch for ‘off-automatic-test-manual’ operation

Manual start-stop push button switch

Manual alternator circuit breaker ‘On-Off’ switch

Cancel alarm switch

Reset switch

Indicating lamps

Battery Status

1.3.12 Interface With Building Automation System

All necessary hardwares/ softwares to integrate the Generator microprocessor panel to BAS system shall be provided free of cost by generator manufacturer / supplier.

For the integration of Microprocessor Panel of the generator with the Building Automation System, an Interface Control Document shall be developed by BAS Contractor. It shall be responsibility of Generator Contractor to provide following to BAS Contractor for preparing the interface.

a. Hardware Protocol of Microprocessor panel.

b. Software Protocol of Microprocessor panel.

c. Communication structure relating to collection of message / event information.

d. Description of the formatted packets / blocks of data which construct controller commands / responses.

e. Written permission to BAS contractor to develop the interface without any financial implication.

1.3.13 Acoustic Treatment

All DG sets up to 1000 kVA shall be provided with it's own outdoor type acoustic enclosure duly tested and approved for 75 dBs as per norms of central / local pollution control board.

A. ACOUSTIC ENCLOSURE FOR DIESEL GENERATOR

Acoustic Enclosure for DG Set shall be as given below:

DG Set Capacities	:	1 No.725 KVA
Structure	:	MS Press bend 3 mm
Panels	:	Steel fabricated double wall insulated panels.
Thickness of panels	:	100 mm thick
Outer sheet	:	2 mm thick CRCA sheet steel
Inner Sheet	:	1.25 mm thick CRCA Perforated sheet steel
Frame & Strainer	:	2 mm thick CRCA sheet steel
Insulation	:	Mineral wool as per IS 8183 - 1993
Thickness	:	100 mm thick (50 mm x 2 slabs)
Density	:	64 Kg / m3
Anti Droning	:	HDPE sheet
Thickness	:	6 mm thick
Air Circulation System	:	Axial flow fans of suitable capacity required for

		each 725 KVA DG Set offered suitable ducted exhaust arrangement for fresh air intake and exhaust shall be made to avoid short cycling.
Finishing	:	Powder coating of colour shade approved by consultant / owner.
Noise Level	:	75 dBA at a distance of 1.0 meter.
Location	:	Outdoor
Δ T Acoustic Enclosure	:	Should not exceed from 7 degree C above ambient temperature.
Painting of Exhaust Piping	:	High temperature Copper paint shall be used (600 – 700 deg C) for painting of uncladed exhaust pipe and top of the chimney
Base frame for canopy	:	Powder coated as per approved colour
Lighting	:	Proper lighting shall be made inside acoustic enclosure for maintenance purpose.

1.3.14 Battery Charger

1.3.14.1 General

The battery charger shall be Float cum Boost type IGBT controlled. The charger shall have selector switch for Auto Float – Boost / Manual Float / Manual Boost Mode of operation. During Auto Float – Boost Mode, Automatic Changeover shall take place from Float Mode to Boost mode and Vice-Versa. This means that when the Batteries are fully charged the charging shall automatically change from Boost charge to trickle charge.

1.3.14.2 Construction Feature

The battery charger shall be housed in sheet steel cubicle of Angle Iron frame work with sheet steel panels of 1.6 mm thickness. Louvers shall be provided in the cabinet for the ventilation. The cubicle shall be painted in Siemens Grey shade RAL7032 of IS-5. Four wheels shall be provided at the base.

1.3.14.3 Performance

The D.C output voltage of Float / Boost charger shall be stabilized within ± 2% for AC input variation of 230 V ± 10%, frequency variation of 50 Hz ± 5% and DC load variation of 0-100%. The voltage regulation shall be achieved by a constant voltage regulator having fast response IGBT control. The ripple content will be within 3% of DC output nominal voltage.

There shall be provision to select Auto Float / Manual Float / Manual Boost modes. During Auto Float Mode the battery charging shall automatically changeover from Boost Mode to Float Mode and Vice Versa. During Manual Float / Boost modes it shall be possible to set the output volts by separate potentiometers.

The battery charger shall have automatic output current limiting feature.

1.3.14.4 Components

The battery charger shall essentially comprise of the following

- 1 No. double pole ON/ OFF MCB at AC input.
- 1 No. pilot lamp to indicate charger ON.

- 1 No. Main Transformer : Double wound, naturally air cooled, having copper winding.
- 1 set single phase full wave bridge rectifier consisting of 4 Nos. IGBTs, liberally rated, mounted on heat sinks and complete with resistor / condensor network for surge suppression.
- 1 No. rotary switch to select auto float / manual float / manual boost. During auto float mode automatic changeover shall take place from float mode to boost mode and vice versa.
- 1 set solid state constant potential controller to stabilize the DC output voltage of the float cum boost charger at ± 2% of time set value for AC input voltage variation of 230 V ± 10%, frequency variation of ± 5% from 50 Hz and simultaneous load variation of 0-100% and also complete with Current Limiting Circuit to drop the Float Charger output voltage upon overloads to enable the battery to take over.
- 1 No. electronic controller to automatically changeover battery charging from boost to float and vice versa.
- 1 No. DC ammeter and toggle switch to read charger output current and battery charge / discharge current.
- 1 No. moving coil DC voltmeter to read the DC output voltage.
- 2 set potentiometer to adjust the output voltage during manual /auto float and boost modes.
- 2 No. double pole ON/ OFF MCB at DC output, 1 No. at charger output and the other at load.
- 2 set DC output terminals. 1 set for the load and the other set for the battery.
- Alarm Annunciation : Visual and audible alarm with manual accept reset facility shall be provided for the following for BMS Connectivity

  a. AC mains fail

  b. Charger Fail

  c. Load / Output overvolt.

1.3.14.5 Rating

AC Input	:	230 V + 10% AC 50 Hz single phase.
DC Output	:	To float / boost charge batteries and also supply a continuous load.
Current Rating	:	30.0 Amps
Float Mode	:	27.0 V nominal (Adjustable) between 24-28.0 V.
Boost Mode	:	29.0 V nominal (Adjustable) between 24-32.0 V.
Voltage Regulation	:	± 2% for AC input variation of 230 V ± 10%. Frequency Variation of 50 Hz ± 5% and DC load variation 0-100%

1.3.14.6 Performance Tests

The schedule of tests to be performed in the Factory Acceptance Test shall include the following:

On each of three separate days and before any other operation of the diesel-alternator on that day three successful manual start-up operations to be accomplished.

Three separate manual start-up operations each within one minute of the diesel-alternator being shut down after running continuously for not less than one hour and attaining normal engine running temperatures.

Three separate automatic start-up operations with simulation of "mains failure". In all or any of these tests the diesel-alternator may be out on load by the automatic closing of the emergency power supply circuit breaker.

Three separate automatic shutdown operations, each initiated by mechanical simulation of a "low pressure" condition.

Three separate automatic shutdown operations, each initiated by manual instigation of an "over-speed" condition.

Three separate abortive start-up operations, each inducing "failure to start" shut-down.

The load tests shall be carried out as follows:

25% of full load at 1.0 pf	For half hour
50% of full load at 1.0 pf	For one hour
100% of full load at 1.0 pf	For two hours
110% of full load at 1.0 of	For one hour

At the completion of the test, readings shall be taken of Voltage, Frequency, Current, Temperature, Vibration, Fuel ratio to Unit produced, Flue analysis and the following:

Insulation resistance – rotor, stator, exciter – to earth;
Insulation resistance – between stator windings;
Alternator rotor and exciter armature temperature

1.3.14.7 Site Test

Upon the delivery to the site and if the generator set is required to re-assemble on site, similar tests shall be carried out by the Contractor to ensure that the performance is not degraded.

The tests, but not limited to are:
Diesel engine-Generator coupling and shafts alignment
On load 'mains failure' simulation test
Safety devices test
Remote monitoring
Auxiliary contacts etc.
Load tests.
BMS interface test

Load tests may be carried out through building load and/or Contractor load bank. Cost to arrange for the load for purpose of testing shall be included in the Tender.

1.3.14.8 Painting of Pipe Work

All pipe work, other than buried pipes, shall be painted immediately after installation with at least one coat of red primer and two (2) finishing coats of best quality aluminum paint. The colour will be determined by the KOPT on site.

1.3.14.9 Vibration Control

The complete generator assembly shall be isolated on static deflection unhoused spring-neoprene in series isolator with non-skid neoprene pads. Start-up and shut down rocking restraint snuffers shall be provided at four corners of base frame.

All fuel line pipes shall be cushioned with a layer of harnesss and neoprene pad at attached points.

All pipe work and engine silencers shall be suspended on static deflection spring-neoprene in-series hangers.

Detail calculation and proposal for justifying the size and provision shall be provided for KOPT review prior to the installation. Emission standards for Diesel Engines (Engine rating upto than 800 KW) for generating sets

Power Category	**Emission Limits (g/kW-hr)**			**SmokeLimit (light absorption coefficient,m^{-1})**
	NOx +HC	**CO**	**PM**	
Upto 19 KW	≤ 7.5	≤ 3.5	≤ 0.3	≤ 0.7
More than 19 KW upto 75 KW	≤ 4.7	≤ 3.5	≤ 0.3	≤ 0.7
More than 75 KW upto 800 KW	≤ 4.0	≤ 3.5	≤ 0.2	≤ 0.7

Acronyms Used

MW	:	Mega (10^6) Watt
NO_x	:	Oxides of Nitrogen
NO_2	:	Nitrogen Dioxide
O_2	:	Oxygen
NMHC	:	Non-Methane Hydrocarbon
C	:	Carbon
PM	:	Particulate Matter
CO	:	Carbon Monoxide
SO_2	:	Sulphur Dioxide
ppmv	:	Part per million (10^6) by volume
FO	:	Furnace Oil
HSD	:	High speed diesel
LDO	:	Light Diesel Oil
LSHS	:	Low Sulphur Heavy Stock
kPa	:	Kilo Pascal
mm	:	Milli (10^3) meter

kg/hr : Kilo (10^3) gram per hour

mg / Nm^3 : Milli (10^3) gram per Normal metre cubic

Area Categories A & B are defined as follows:

Category A : Areas within the municipal limits of towns / cities having population more than 10 lakhs and also upto 5 km beyond the municipal limits of such towns / cities.

Category B : Areas not covered by Category A

The standards shall be regulated by the State Pollution Control Boards or Pollution Control Committees, as the case may be.

1.3.14.10 Limits of Noise for Power Generating Set Manufactured on or after the 1st Jan, 2005

Applicability

These rules apply to Generator sets rated output, installed on or after 1st Jan, 2005.

Requirement of Certification

Every manufacturer or importer of Power Generating set must have valid certificates of Type Approval and also valid certificates of conformity of production for each year, for all the product models being manufactured or imported after 1st Jan, 2005 with the specified noise limit.

All Power Generators shall have a valid Type Approval certificate and conformity of production certificate.

All Power Generator shall have conformance label meeting the requirements.

The conformance label shall contain the following information :

- Name and address of the supplier (if the address is described in the Owner's manual, it may not be included in the label).
- Statement "This product conforms to the Environment (Protection) Rules, 1986"
- Noise limit viz. 75 dB(A) at 1 m.
- Type approval certificate number.
- Date of manufacturer of the product.

Authorized agencies for certification

The following agencies are authorized to carry out such tests as they deem necessary for giving certificates for Type Approval and Conformity of production testing of Generator and to give such certificates :

- Automotive Research Association of India, Pune.
- National Physical Laboratory, New Delhi.
- Naval Science & Technology Laboratory, Palghat
- National Acrospace Laboratory, Bangalore

2. PANELS / BOARDS

Aux. Panels / Synchronizing panel shall be covered under this section. Panels shall be suitable for operation on 3 Phase phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All panels

shall be CPRI tested design and manufactured by a approved manufacturer. **CPRI certificate shall be made available.**

Panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-13947-1993.

2.1 CONSTRUCTION FEATURES

Distribution panels shall be 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be form 3b construction. The panels shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. Panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of Distribution panels shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum **operating** clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest feeder compartment.

Panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Feeders shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

2.2 BUS BAR CONNECTIONS

Bus bar and interconnections shall be of high conductivity electrolytic grade Copper as indicated in the bill of quantities complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / Copper strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars shall be 1A/sq.mm for Copper and **1.4** A/sq.mm for copper busbars.

Maximum allowable temperature for the Bus bar to be restricted to 85 deg C

2.2.1 Temperature - Rise Limit

Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

2.3 CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the Distribution panels for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables.

2.4 AIR CIRCUIT BREAKERS (ACB)

2.4.1 The ACB shall conform to the requirements of IEC 60947-2 / IS 13947-2 and shall be type tested & certified for compliance to standards from–CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V ± 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" “TRIP” indications.

The ACB shall be 3/ 4 pole with modular construction, draw out, electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec.

Circuit breakers shall be designed to ‘close' and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker shall be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts shall be provided on each breaker.

Rated insulation voltage shall be 1000 volts AC.

2.4.2 Cradle

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.
Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.

The following safety features shall be incorporated :

a. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition.

b. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.

c. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

d. All Switchgear module front covers shall have provision for locking.

e. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

2.4.3 Protections

The breaker should be equipped with micro-controller based , communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following four zones :

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

The protection release shall have following features and settings:

a. True RMS Sensing

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

b. Thermal Memory

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics :

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

d. Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

e. Self powered

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation.

f. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault

conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimises the damage to the system.To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.
On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

g. The release shall meet the EMI / EMC requirements.

h. The setting range of release shall be generally as follows :

Type of Protection	**SETTINGRANGE OF RELEASE**	
	PICK-UP CURRENT	**TIME DELAY**
Long Time	0.4 to 1.0 times I_n (I_r) Steps : 0.4, 0.5, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00. Operating Limit : 1.05 to 1.2 times I_r	0.5 to 30 sec at 6 I_r Steps 0.5,1, 2,4, 6, 8,12,18,24 and 30 secs Tolerance : Corresponding to ±10% of current.
Short Time	2 to 10 times I_r Steps : 2,3,4,5,6,7,8,9 & 10 Tolerance : ±10%	20 ms to 600 ms Steps 20,60,100,160,200,260,300 400,500 and 600 ms Tolerance : ±10% or 20ms whichever is higher
Instantaneous	2 to 12 times I_n Steps : 2,3,4,6,8,10,12 Tolerance : ±10%	
Ground Fault	0.2 to 0.6 time I_n Steps : 0.2,0.3,0.4,0.5,0.6 Tolerance : ±10%	100 ms to 400 ms Steps : 100,200,300,400ms Tolerance : ±10% or 20 ms whichever is higher.

All **incomer** ACBs shall have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency
- Restricted Earth Fault protection
- Trip Circuit supervision with PS class CT's.
- Undercurrent, (for DG set only)
- Reverse power (for DG set only)
- Phase sequence reversal (for DG set only)
- Load shedding and reconnection thru programmable contacts.
- Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit.Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

- Phase currents (running, avg & max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.
- Release should be self powered .
- Release should have facility to select different type of IDMTL protection(DT,SIT,VIT,EIT,HVF) for better co-ordination with HT Breaker/Fuse.
- Phase voltages (running, avg & max)
- Energy & power parameters (active, reactive and apparent)
- PF
- Frequency
- Maximum Demand (KVA & KW)
- Total Harmonics distortion

<u>All **O/G** ACBs shall have following functions.</u>

Protection

- The ACB control unit shall offer the following protection functions as standard: Long-time (LT) protection with an adjustable current setting and time delay;
- Short-time (ST) protection with an adjustable pick-up and time delay;
- instantaneous (INST) protection with an adjustable pick-up and an OFF Position.
- Current and time delay setting shall be indicated in amperes and seconds respectively on a digital display.
- Earth-fault protection with an adjustable pick-up and time delay shall be provided if indicated on the appended single-line diagram.

Measurements

- An ammeter with a digital display shall indicate the true rms values of the currents for each phase.Release shall acknowledge the current & time delay settings done by user on the LCD display.
- A LED bargraph shall simultaneously display the load level on the three phases.
- A maximeter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

2.4.4 <u>Safety Features</u>

a. The safety shutter shall prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

b. It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.

c. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

d. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.

e. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

f. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.

g. The insulation material used shall conform to Glow wire test as per IEC60695.

h. The ACB shall provide in built electrical and mechanical anti-pumping.

i. All EDO ACB`s Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

2.5 MOULDED CASE CIRCUIT BREAKER (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles as specified in BOQ. MCCB shall comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab. MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB shall be as specified in the schedule of quantities. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu).MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied with ROM should meet IP54 degree of protection.

2.5.1 Current Limiting & Coordination

- The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. **The manufacturer shall provide both the discrimination tables and let-through energy curves for all.**

Protection Functions

- MCCBs with ratings up to 200 A shall be equipped with Thermal-magnetic (thermal for overload and magnetic for short-circuit protection) trip units
- Microprocessor MCCBs with ratings 250A and above shall be equipped with microprocessor based trip units.
- Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorised access to the settings
- Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.)

- Protection settings shall apply to all poles of circuit breaker.
- All Microprocessor components shall withstand temperatures up to 125 °C

2.5.2 Testing

a) Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 shall be furnished.

b) Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

2.5.3 Interlocking

Moulded, case circuit breakers shall be provided with the following interlocking devices for interlocking the door of a switch board.

a) Handle interlock to prevent unnecessary manipulations of the breaker.

b) Door interlock to prevent the door being opened when the breaker is in ON position.

c) Defeat-interlocking device to open the door even if the breaker is in ON position.

- The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 200 Amps and above shall have adjustable over load & short circuit pick-up both in Thermal magnetic and Microprocessor Trip Units.

- All MCCB with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay.

- The trip command shall override all other commands.

2.6 MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4.MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to satandrd IEC 60947-2 and shall have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom.In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously.The motor circuit breakers shall accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked.The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible.The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC.All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type.The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1.Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory).The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which shall allow the device setting.The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection.In order to ensure safety

and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating.The thermal trips shall be adjustable on the the front by a rotary selector.The adjustment of the protection shall be simultaneous for all poles.Phase unbalance and phase loss detection shall be available.Temperature compensation (-20°C to +60°C)

2.7 MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers shall have a common trip bar independent to the
external operating handle.

Coordination Study in LV Network

LV Switchgear Manufacturer shall submit coordinated & Discriminated solution for LV Network protection devices i.e. **ACB, MCCB, MPCB &**MCB for all Incoming and outgoing devices for all Panels/ DB`s as per BOQ with the help of published discrimination tables. Total discrimination shall be provided up to the short circuit breaking capacity of most down stream circuit Breakers .

2.8 RESIDUAL CURRENT CIRCUIT BREAKER CURRENT OPERATED TYPE (RCCB)

I. System of Operation

Residual Current Circuit Breaker shall confirm to IEC 61008.RCCB shall work on the principle of core balance transformer. The incoming shall pass through the torroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 30 mA at 240/415 volts AC and shall have a minimum of 20,000 electrical operations.

II. Mechanical Operation

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

III. Neutral Advance Feature

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact First before the phases; and at the time of opening, the neutral shall breaks last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

IV. Testing Provision

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB / RCCB and the operating handle shall move to the "OFF" position.

2.9 EARTHING

Earthing shall be provided as per IS:3043-1987.

2.10 PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per BOQ confirming to IS Code No.5.

2.11 LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

2.12 METERS

i. All voltmeters and indicating lamps shall be through MCB's.
ii. Meters and indicating instruments shall be flush type.
iii. All CT's connection for meters shall be through Test Terminal Block (TTB).
iv. CT ratio and burdens shall be as specified on the Single line diagram.

2.13 CURRENT TRANSFORMERS

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class I.

2.14 POTENTIAL FREE CONTACTS

Potential free contacts shall be provided for connection to Building Automation System in panels indicated in Schedule of Quantities.

2.15 INDICATING PANEL

All meters and indicating instruments shall be in accordance with relevant Indian Standards. Meters shall be flush mounted type. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/MPCB as per relevant fault level and toggle switch.

3. AUTO STARTING/ AUTO SYNCHRONIZING/ AUTO LOAD SHARING LT PANEL FOR GENERATORS (725 KVA)

3.1. GENERAL

The auto synchronizing cum LT panel shall have TPN drawout type 3 Pole motor operated spring charged air circuit breaker with 24 volts DC operated trip mechanism of suitable capacity. CT's, PT's, relays meter etc along with a suitable contactor for neutral isolation as incomers from each generators. One 4 pole

motor operated air circuit breaker as bus coupler and TPN bus bars shall be provided as mentioned in schedule of quantities.

3.2 SEQUENCE OF OPERATION

Sequence of Operation in Auto Mode.

On interruption in the grid power the Synchronizing panel after sensing the loss of power shall automatically give command to generator to start through Synchronizing logic. Any generator which starts first shall become the Master Generator (selected by EGCP – 32 relay PCCM - 3100) and shall start feeding power to the Synchronizing Panel when the generator reaches its rated voltage and frequency.

As load increases beyond 75% on the generator which is running, other generator will start and synchronize on the same bus, after verifying the voltage and frequency.

Similarly other generators shall start automatically and synchronize on the same bus. As the load increases or decreases accordingly switching ON and OFF of the generator on the synchronizing bus shall continue with the help of SG 4/ EGCP-32/ PCCM – 3200. If any time only one Generator running and the load is increased suddently more than the available capacity then non critical load shall drop out from the bus automatically through EGCP-32 and same shall come on automatically after other Generator start and synchronize on the same bus.

Auto Synchronizing system shall verify the phase angle of all the sets and also compensate for ACB closing time by initiating closing of the breaker ahead of the actual predictable synchronism hereby ensuring a phase difference of zero degree. The breaker closing command shall not be given at a phase angle difference of ± 4% in any circumstances.

The synchronizing system shall operate the generator ISOCHRONOUS mode. The system shall have a direct analogue interface with the AVR & Governor for direct bias control. No motorized potentiometers shall be acceptable.

- Failure of any synchronizing relay shall not disturb the synchronizing of other generator.
- Failure of EGCP-32 PCCM - 3100 shall not affect the synchronizing system which shall be independent of each other.

System shall also monitor the slip frequency and the Beat Voltage of the machine or system.

NIC of First generator shall remain in Ckt. In the event of shutting OFF of First Set, NIC of any other generator shall close first before tripping NIC of first set. It shall be possible to alter sequence of generator starting through, manual selection.

Active and reactive power shall be made equal on all the machines automatically with the help of ACTIVE LOAD BALANCING System through Governor Control.

In event of set failing to Synchronize, Alarm from annunciator shall invite attention of OPERATOR for manual intervention.

LOAD MANAGEMENT SYSTEM shall have contacts for tripping various loads by field wiring and also trip the ACB of different generator and give ALARM for shutting OFF generator in accordance with predefined parameters to avoid underloading, overloading, cascading effect of tripping and unnecessary FUEL WASTAGE.

On the removal of load, generator ACB's & Bus Coupler ACB's shall be switched OFF in preset sequence with time delays to cover DIPS. Generator shall continue to run for 3 Minutes at reduced speed after generator ACB has been switched OFF.

All auxillaries (pumps supply air fans etc) to come on automatically.

Engine start stop control system shall be mounted on the generator panel.

Sequence of Operation in Manual Mode

- In the manual mode master generator set shall be started by pressing ‘Engine Start’ Push Button (PB)

- When Engine starting push button is pressed cranking relay shall be energized and give starting signal to the engine.

- After full voltage is build up, breaker of the Master generator shall close manually with the help of breaker control switch.

- When breaker Control switch is turned to ‘CLOSE’ position, breaker as per following sequence:

  a. SG 4 / EGPC-32 / PCCM – 3100 Main Selector Switch shall be in Manual Mode.

  b. With the conditions mentioned above fulfilled and breaker control switch in ‘Close’ position, Neutral contactor shall be energized.

  c. Closing command to the generator breaker shall be given.

- IN manual mode care shall be taken, to synchronize the follower generator sets with the 'Master' before closing its breaker.

- During the parallel operation of DG sets in 'Manual Mode', Neutral contact of only master generator shall close. This shall be assured by inter locking the neutral contactors of all the generator.

3.3 SUMMARY OF FUNCTIONS

The following functions shall be required for Synchronizing the generating sets.

- Automatic starting of generating sets.

- Automatic Synchronization of all available generating sets.

- Automatic load sharing between generators, active as well as reactive load sharing.

- Starting & stopping of generators as per load requirement.

- Monitoring of engine & alternator condition and protections.

- Complete load management as per requirement.

3.4 SYNCHRONISING PHILOSOPHY

The system shall be capable of a dynamic synchronization, where the generator frequency is controlled to be slightly higher than the bus bar frequency, when the breaker closes. This ensures that the generator will start to take load in the moment the generator breaker is closed. The frequency difference between generator & bus bar at the moment of synchronization can be programmed. Breaker time shall be adjusted to ensure breaker closure at the exact point of synchronization. System shall control the voltage under synchronization if necessary.

During synchronization system is supervising the frequency of the generator voltage to make sure that the gen-set is not unstable due to a cold fuel / gen-set or an uneven fuel supply. The two frequencies must be within the accepted slip-frequency in 200 mili sec before synchronization.

The system will synchronize the generator to the bus, when all below conditions are fulfilled:

- A control order is given by seting the input “start synchronizing / regulating”
- Feedback signal from breaker “GCB open” is present.
- Bus bar voltage is present

- Generator voltage is present

The frequency regulator in the system shall when the generator voltage and the bus bar voltage are over 50% of nominal voltage (voltage transformer secondary setting). The voltage regulator in the system shall start when the frequency is within 90% of nominal frequency.

System shall close the breaker without synchronization, when all the following conditions are fulfilled:

- Display setting "Black busbar operation is ON.
- A control order is given by setting the input "start synchronizing / regulating"
- Feedback signal from breaker "GCB open" is present.
- Bus bar voltage is not present (Black bus bar)
- Generator voltage is present.

Monitoring

Following electrical parameters shall be monitored by EGCP-32 based system, which shall be connected through set of CT / PT's & shall indicate the following:

i. Voltage – all phases (Line & Phase both)
ii. Current – all phases.
iii. Frequency
iv. Power factor
v. KVAR
vi. KVARH
vii. KW
viii. KWH

All these parameters shall be displayed & shall be used for Load Management & Safety functions. Limits can be assigned to each parameter in the EGCP-32 / PCCM - 3100for alarm & recording / logging purposes.

3.5 ANNUNCIATION ON EGCP-32 FOR AUTO SYNCHRONIZING PANEL

Channel No.	**Inscription**
01	G-1 Fails to Synchronize
02	G-1 Fails to Start
03	G-1 Neutral Discrepancy
04	G-1 ACB Fails to Close
05	G-2 Fails to Synchronize
06	G-2 Fails to Start
07	G-2 Neutral Discrepancy
08	G-2 ACB Fails to Close
09	G-3 Fails to Synchronize
10	G-3 Fails to Start
11	G-3 Neutral Discrepancy
12	G-3 ACB Fails to Close

6 INDICATION : 1 No. Spring charged Indicating Light.
: 1 No. Neutral ON Indicating Light.
: 1 No. Neutral OFF Indicating Light
: 1 No. Trip Indicating Light
: 3 Nos. Ph. Indicating Light
: 1 No. ACB ON Indicating Light
: 1 No. ACB OFF Indicating Light
: 1 Set Control MCB.

3.7 PROTECTION THROUGH RELAYS

3.7.1 Following protection shall be provided through relay both for the stator side and the rotor side:

3.7.1.1 Voltage restrained over current protection (50V/51V)

Normal IDMT O/C shall not work when a over current fault occurs, due to higher current levels. There shall be drop in terminal voltage for the same fault impedance, the fault current shall reduce (with respect to terminal voltage) to a level below the pick-up setting. Consequently, normal IDMT shall not pick-up. It shall be necessary to have a relay whose pick-up setting shall be automatically reduce in proportion to terminal voltage. Hence, the over current protection shall be voltage restrained. Two levels over current protection shall be provided i.e. low set and high set (for short circuit protection)

3.7.1.2 Thermal overload (49)

It shall monitor the thermal status of machine for current between 105% to the low set O/C level (normally 150%).

3.7.1.3 Current unbalance (46)

Generators shall feed power to unbalanced loads whose level shall be monitored. When the unbalance exceeds 20%, it shall cause overheating of the windings. This heating shall not be detected by the thermal overload relay since the phasé currents shall be well within limits. A two level monitoring for unbalance shall be provided first level for alarm, and the second level for trip.

3.7.1.4 Loss of Excitation (40)

When excitation is lost in a running generator, it shall draw reactive power from the bus and get overheated. This condition to be detected from the stator side CT inputs by monitoring the internal impedance level and position of generator.

3.7.1.5 Reverse Power (32)

Generator shall operate in parallel, which may cause reverse power flow at certain times (during synchronization or when there is a PF change due to load fluctuation or when there is a prime mover failure). When reverse power occurs, the generator along with prime mover shall undergo violent mechanical shock. To avoid this reverse lower relay shall be provided.

3.7.1.6 Under Power (37)

It shall be not economical to run generators below a certain load level. This protection shall monitor the forward power delivered by the machine and give alarm when levels, goes below a set point.

3.7.1.7 Under / Over Voltage (27 / 59)

This shall protect the machine from abnormal voltage levels, particularly during synchronization and load throw off conditions.

3.7.1.8 Under / Over Frequency (81)

This shall protect the machine from abnormal frequency levels, particularly during synchronization and load throw of conditions. This shall also help in load shedding scheme for the generator.

3.7.1.9 Breaker Failure Protection

This protection shall detect the failure of breaker to open after receipt of trip signal.

3.7.1.10 <u>Differential Protection (87)</u>

Relay shall be differential relay

3.7.2 In addition to above, following relays to be provided

- Master Trip Relay
- Trip Circuit Supervision Relay
- Engine Cranking Relay

3.8. METERING FOR EACH DG

As mentioned in the Schedule of Quantities.

3.9. ANNUNCIATION

Annunciation with Hooter, Test, Accept and Reset P.B. and Annunciator.

16 WindowSolidState Annunciator for each DG sets.

Channel No.	**Inscription**
01	Set fails to start (only alarm)
02	Over current (breaker trip)
03	Earth Fault (Breaker trip)
04	Excitation Failure (Engine should be stop with breaker trip)
05	Reverse Power (Breaker trip)
06	Emergency Shutdown (Breaker will trip with engine stop command)
07	Over speed (Breaker will trip with engine stop command)
08	High Water Temperature (Breaker will trip with engine stop command
09	Under Voltage (Breaker trip)
10	Over Voltage (Breaker trip)
11	Bearing Temperature high (breaker will trip with engine stop command)
12	Winding Temperature High Breaker with trip with engine stop command)

3.10 COMPONENTS FOR SYNCHRONIZING SYSTEM

Synchronizing Thru PLC :

- Minimum 32 bit CPU
- CPU with Ethernet communication port for PC on LAN
- 3 Nos. Synchronization Modules (No power monitors)
- PLC Rack
- Rack power supply
- Power Supply Cable
- Direct Analogue / PWM (Selectable) command to AVR &
- Governor without using motorized potentio meters
- (DG to be operated isochronous mode)
- 1 No. PLC comprising of Following :

  - Digital input – 16 nos. for each DG sets (24 VDC)
  - Digital output Modules – 16 nos. for each DG set (Relay
  - Memory – 32 KB (min)
  - Man machine interface
  - Software for PLC

- One set of PC to PLC communication card with Communication cable.
- Mod bus communication module for communication on RS 485 port e.g. with RTD scanners, power monitor etc.

- 1 Set Mimic
- 1 set Aux. Relays
- 1 set indicating lights / PB
- 1 set control MCB's
- 1 No. Auto / manual / Test Switch
- 1 No. Annunciator
- 1 No status indicator

4. TESTING

A. GENERATOR

FACTORY TEST SCHEDULE

i. Introduction
ii. Preliminary Information Required
iii. Pre-witnessing Check list
iv. Confirmation of System Parameters
v. System Failure Mode Tests
vi. Equipment and System Operational Tests
vii. System Load Acceptance Tests

I. INTRODUCTION

The primary purpose of the tests scheduled within this document, represents the need for the installed system on site to meet the full expectations of the Specification.

The performed tests shall prove the Automatic and Manual start of the sets and the safe reliable operation of the equipment under Normal site operating conditions: -

- Automatic and Manual start of the sets
- Verification of all safety shutdown circuits and alarms

Note: *All tests conducted shall be conducted using a reactive load bank arrangement at 0.8 lagging p.f.*

The programming of these tests becomes an integral and critical feature for the successful completion of the project; therefore Owners shall require a detailed programme of tests to be submitted in line with the project completion programme.

The co-ordination, documentation & management of the scheduled tests shall be undertaken by the selected suppliers.

II. PRELIMINARY INFORMATION REQUIRED

To allow the scheduled witness tests to proceed, Owners shall require all the information as scheduled below to have been completed in order to meet the Contractual conditions of the Contract works. By conducting and preparing the attached information, Owners expect the tests to be completed expediently and successfully in line with the master Contract programme, this particular element of the project shall also be used to benchmark Contractor performance for selection upon future projects.

Owners expect all the scheduled information to be issued prior to the witnessing team attending the factory.

- Factory test schedules and results
- Record drawings for all equipment and systems
- Completed pre-commissioning and commissioning check lists
- Load bank completion certificate
- Specification compliance sheet to be issued

Note: *All information to be issued in bound format*

III. PRE-WITNESSING CHECKS

- All associated test cabling to be complete
- All ancillary systems within the Generator enclosure to be completed.
- Visual checks to all system components and cabling.
- Automatic and Manual start system verified.
- kW & kVAr sharing proven.
- All set controls circuits checked and operational.
- All emergency shutdown circuits checked and operational
- All interlocks and padlocks are in place.
- All protection devices are operational.
- All recording equipment is in place and functioning.
- Load banks are in place and are operational including load bank panel.

The tests shall be conducted at the full rating of each respective Generator set (i.e. full rating), at design load of each set and under transient step load conditions, all as indicated within this document.

Various recording instruments i.e. Dranetz and multi-meter devices shall be connected into the system at the following locations: -

- Generator Test Synchronisation switchboard : Dranetz multi meter c\w suitable C.T arrangements.

On completion of each test the corresponding signatory shall be included within the test sheets in order to confirm the acceptance of the tests.

IV. CONFIRM SYSTEM PARAMETERS

The Generator equipment shall be confirmed as follows in readiness for the test sequence: -

- Confirm fuel oil transfer rates in l/s
- Confirm battery voltages for starters
- Check alternator output voltage at No load and full load.
- Check current per phase on no load and full load.
- Check Neutral currents on No load and full load.
- Check frequency on no load and full load.
- Confirm Kw & KVA r load sharing at full load.
- Check engine speed

V. FAILURE MODE TESTS

The failure mode tests are to be conducted on successful completion of the system parameter checks and tests.

The tests to be conducted are as follows and shall be carried out on the each generator by the manufacturer at 50% rated load of each set.

- Conduct fail to start test sequence by disabling fuel rack
- While set running fail fuel oil system
- Simulate reverse power and observe set shutdown.
- Fail control power supply and observe set shut down.
- Simulate E.P.O annunciation.
- Prove set shutdown with inlet outlet louvers failed.
- Repeat for all permutations of generators
- Verify all phase failure relay generator start signals.
- Simulate all engine shutdown alarms and observe shutdown
- Simulate specifically, engine over speed alarm and shutdown
- When both sets started under Automatic and Manual start condition, conduct output phase to earth fault.
- Fail one set of starters for each set during start sequence and observe transfer to alternate starter equipment in each case.

VI. OPERATIONAL TESTS

The function of the following test schedule is to confirm the operational abilities of the equipment under all possible scenarios and fault conditions.

The entire test scheduled below shall be conducted on each set and when both sets synchronised with the load bank connected at 100% load N+1.

- With the complete equipment stationary conduct phase failure signals initiation.
- Conduct run down sequence upon reset of phase failure signals.
- Conduct manual start of the sets.
- On completion of heat run, load to be increased to 110% for 1 hr.
- During heat run check all enclosure temperatures
- Check all engine temperatures and alternator readings.

VII. LOAD ACCEPTANCE TESTS

The load acceptance test shall be conducted to confirm the load acceptance of the generator system under varying load steps and in all system configurations.

These tests are required to be conducted individually. The generator load shall be as N+1 design load for all the scheduled tests below. Full recordings of all measurable parameters shall be observed as indicated below.

- Connect generator to load bank and increase load in stages, as the load bank will allow.
- Load the generator/s to 100 % rated load and run for 1 hour.
- Reduce load by 50%.
- Reduce load by a further 50%.
- Apply remaining 25% load step.
- Reduce load by 100%.
- Apply 50% load step.
- Apply remaining 50% load step and run for 1 hour.
- Apply a further 10% load and run for 1 hr.

B. GENERATOR SITE TEST SCHEDULE

Contents

i. Preliminary Information Required
ii. Pre-witnessing Check
iii. Confirm System Parameters
iv. Failure Mode Tests
v. Operational Tests
vi. Load Acceptance Tests
vii. Harmonic Tests

I. PRELIMINARY INFORMATION REQUIRED

To allow the scheduled witness tests to proceed, Owners shall require all the information as scheduled below to have been completed in order to meet the Contractual conditions of the Contract works. By conducting and preparing the attached information, Owners expect the tests to be completed expediently and successfully in line with the master Contract programme, this particular element of the project shall also be used to benchmark Contractor performance for selection upon future projects.

- Factory test schedules and results
- Record drawings for all equipment and systems
- Record drawings of the infrastructure
- Completed pre-commissioning and commissioning check lists
- Fuel system complete and certified
- All relevant snag lists complete

Note:

All information to be issued in bound format As an integral part of the pre-commissioning exercises, it shall also be required to confirm certain conditions and systems within the boundaries of the project are available for use and are fully serviceable. The scope of these pre-commissioning checks shall include the systems, equipment and works that are required to complete the installation and for a complete Normal and Standby system to be available to support the load upon completion of the tests.

Upon completion of the scheduled tests, it is intended that the equipment and systems relevant to the generator system shall be made available to support Owners critical load, therefore, all test documentation, sign off sheets, and O & M manuals shall be presented to OWNERS within 72 hrs following successful completion of the tests.

II. PRE-WITNESSING CHECKS

- All associated infrastructure cabling, BMS and Controls cabling to be completed
- All ancillary systems within the Generator enclosure to be completed.
- All switchgear is completed tested and certified.
- Visual checks to all system components and cabling.
- All infrastructure works to be complete or circuits isolated to allow test to commence.
- All earthing connections completed and tested
- All Builders work to be complete.
- Automatic and Manual start system verified.
- kW & kVAR sharing proven.
- All set controls circuits checked and operational.
- All emergency shutdown circuits checked and operational
- All interlocks and padlocks are in place.
- Generator fuel oil system is complete, certified and functioning.
- All generator supplier site commissioning checks complete and certificates issued.
- All protection devices are operational.
- All recording equipment is in place and functioning.
- All necessary fire precautions have been taken.
- Switchboard/Generator manufacturers to be on site.
- Check all protective devices within the electrical distribution have been set correctly
- All electrical circuit test results issued and approved.
- Confirm all Utility incomers and generator incomers in correct sequence.

Upon issue of the above information and confirmation of the itemised pre-commissioning checks, the Certification tests shall commence as detailed.

III. CONFIRM SYSTEM PARAMETERS

Following commissioning of the relevant electrical infrastructure the Generator system shall be configured as follows in readiness for the test sequence: -

- Verifying alternator star point earth resistance < 1ohm

- Check earth loop impedance on generator configured distribution system.
- Confirm fuel oil transfer rates in l/s
- Confirm battery voltages for starters
- Check alternator output voltage at No load and full load.
- Check current per phase on no load and full load.
- Check Neutral currents on No load and full load.
- Check frequency on no load and full load.
- Confirm voltages at furthest point under UPS test sequence.
- Confirm kW & KVAr at full load.
- Check engine speed
- Confirm all auto-change over time settings.

IV. FAILURE MODE TESTS

The failure mode tests are to be conducted on successful completion of the system parameter checks and tests.

The tests to be conducted are as follows and shall be carried out on the each generator by the manufacturer at 50% design load.

- Conduct fail to start sequence
- While set running fail fuel oil system
- Simulate reverse power and observe set shutdown.
- Fail control power supply and observe set shut down.
- Simulate E.P.O. annunciation.
- Prove set shutdown with inlet outlet louvers failed.
- Test auto-change over system at incoming switchboards.
- Verify all phase failure relay generator start signals.

- Simulate all engine shutdown alarms and observe shutdown
- Simulate specifically, engine over speed alarm and shutdown

V. OPERATIONAL TESTS

The function of the following test schedule is to confirm the operational abilities of the system under all possible scenarios and fault conditions, and will require the whole electrical infrastructure to be complete to enable all the auto change over system to be included within the test.

The entire test scheduled below shall be conducted with the load bank connected via the UPS and all other essential loads connected via their respective distribution switchgear.

With the complete electrical system under Normal mains supply, conduct the following tests: -

- Fail Utility No. 1 input and observe generator start sequence and auto-change over then re-instate.
- Fail Utilitys No.2 input and observe generator start sequence and auto-change over then re-instate.
- Observe priority load scheduling arrangements on mains failure
- Conduct all above tests for each individual generator with 1 No. Generator isolated as if in maintenance.

VI. LOAD ACCEPTANCE TESTS

The load acceptance test shall be conducted to confirm the load acceptance of the generator system under varying load steps and in all system configurations.

These tests are required to be conducted individually. The generator load shall be as N+1 design load for all the scheduled tests below. Full recordings of all measurable parameters shall be observed as indicated below.

VII. HARMONIC TESTS

All measuring devices shall be quality controlled units with current calibration certificates and shall be provided with full functional capability and automatic recording facilities.

Harmonic measuring devices shall be as Dranetz PP1 instruments and shall be located at the following positions: -

- Main incoming switchboards Dranetz
- Generator switchboard Dranetz

C. TESTING OF CABLES

Cables shall be type tested and routine tested in accordance with IS:7098 (Part II).

a. Conductor resistance test.
b. Partial discharge test.
c. High Voltage test

Cables shall be tested at works for the following tests before being dispatched to site.

a) Insulation Resistance Test.
b) Continuity resistance test.
c) Sheathing continuity test.
d) Earth test.(in armoured cables)
e) Hi Pot Test.

Test shall also be conducted at site for insulation between phases and between phase and earth for each length of cable, before and after jointing. On completion of cable laying work, the following tests shall be conducted in the presence of the Owner's site representative.

f) Insulation Resistance Test(Sectional and overall)
g) 1 kV Meggar for LT Cables & 5 kV Meggar for HT Cables
h) Continuity test.
i) Sheathing continuity test.
j) Earth test.

All tests shall be carried out in accordance with relevant Standard Code of Practice and Electricity Rules. The Contractor shall provide necessary instruments, equipment and labour for conducting the above tests and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Owner's site representative.

D. PANELS

Testing of panels shall be as per following codes:

i. IS: 8623 (Part -I) 1977 for factory built assemblies of switch gear for voltages upto and including 1000 VAC.

ii. IS: 13947 : 1993 Degree of protection

iii. IS: 5578 & 11353:1985 Arrangement of bus bars.
Following tests to be done:

a) Insulation Resistance Test with 5000 V Meggar.

b) 500 V Meggar Test for all Control Wiring

c) Relay operation tests by Primary & Secondary Injection kits

d) Functional tests for Inter-locks and other controls

e) Checking all relay settings as per duty requirements.

E. TESTING OF EARTH CONTINUITY PATH

The earth continuity conductor metallic envelopes of cables shall be tested for electric continuity and the electrical resistance of the same, along with the earthing lead but excluding any added resistance or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation, shall not exceed one ohm.

TECHNICAL SPECIFICATION FOR EXRTENAL ILLUMINATION

KOLKATA PORT TRUST

Specifications of Energy Efficient LED Based Luminaries Unit

A. LED MANUFACTURERREQUIREMENTS:

- LED Luminaire manufacture shall have complete in house design, development,

production and testing facility for manufacturing of LEDluminaires.

- LED Manufacturer should have In-House NABL Accredited Photometry Laboratory.
- LED Manufacturer shall have company service network in Kolkata, India to ensure response time is two workingdays.
- LED Manufacturer shall be associated with LED Chip manufacturer for more than two year and shall have confirmation on Luminaire and Drivers design with LEDs for their performance from LEDManufacturer.
- The manufacturer of LED Luminaries should be an ISO 9000:2008/ ISO 9001:2015, ISO 14001:2015 and BS OHSAS 18001:2007 certified organization.
- LED Manufacturer should have separate valid BIS registration number for both luminaries and driver. Driver should have the registration of BIS of the OEM of drivermanufacturer.

B. ENVIRONMENT WITH FACILITIES FOR ASSEMBLY OFLED MODULES ANDPCBs:

- Automatic Pick and Place machine for LEDs and electronic components.
- Temperature controlled automatic wave soldering machine with auto fluxing facility for through holedevices
- Automatic temperature controlled re-flow soldering machine for surface mounted devices.
- Heat / Humidity chamber having minimum range of 0-50ºC with alternate arrangement of standby power supply for carrying out endurance tests.
- Electronic driver testing meter with programmable Input Supply to varyinput voltage. Meter shall be able to report input parameters like wattage, PF, THD, Input Current and Output Voltage, Output Current etc.
- Mirror Type Gonio-Photometer for LM79 / IS16106:2012 testing for Photometric & Electricalparameters.
- Ingress Protection Testing Facility for testing of outdoor products with rating up to IP66 with Dust and Rain JetChamber.
- Impact testingfacility.

C. LED LIGHT LUMINARIESSPECIFICATIONS:

a. <u>LED:</u>

i. LED System Efficacy shall be as per BOQ.

ii. Luminaire system wattage: As per BOQ. It may vary up to +/- 5% as per IS 16107 but shall deliver rated lumen output as declared in the specification.

iii. LED used should be of SMD (Surface Mounted Device) type or COB (Chips On Board)

only. However COB type LED will not be considered only for luminaries for 400W

iv. LM – 80/IS: 16105 Test Reports of specific LED at the soldering point temperature of 85 deg. C for the driving current at which the LEDs shall be driven, shall be submitted along with the material (for SMD typeonly).

v. Rated Minimum life span of LEDs (L70B50) used in the Luminary at the luminary driving current. TM-21 life projection calculation along with LM80 as per applicable standard shall be submitted to substantiate that the life of LED Chip (L70B50).

vi. The LEDs shall comply with Photo biological safety norms as per IEC 62471/ EN 62471/ IS: 16108 and should fall in the exempt or low risk group of outdoor Luminaries.

vii. Beam Angle: As per BOQ.

viii. Secondary Lens/Optics: Luminaire should have secondary optical lens of type PMMA (Poly-Methyl Methacrylate Acrylic)/Borosilicate glass/Polycarbonate.Also the lens shall have maximum temperature withstand capacity of 120 Deg. C.

ix. ColourtemperatureoftheproposedLED luminaries shall be as per BOQ. Colour point should fall within the Step 7 McAdam as per ANSI standard C78.377A.

x. Colour Rendering Index (CRI): Greater than or equal to 70 and should include all colour range of R1 to R15, withR9>0.

xi. Junction temperature of LED Chip shall not exceed 100 Deg. C in case ofSMD.

xii. Make of SMD type Chip: Nichia, Osram, Lumileds (Erstwhile Philips Lumileds), Cree.

xiii. Make of COB: Citizen,Bridgelux.

b. <u>LEDDriver:</u>

i. Input Voltage As per BOQ.

ii. Power factor of complete fitting >=0.9.

iii. Surge Protection: Minimum 4 kV is to be used in series with every driver with fail safe (i.e. without leading to fire hazard) and extra Min 10 kV Surge Protection device, external to the driver circuit, but within the same housing needs to be used. Failed status of surge devices should be clearly visible throughflag/indication.

iv. Total Harmonic Distortion (THD): Less than 20% at fullload.

v. Potted LED Driver: Driver should be half Silicone gel potted driver for better heat dissipation and should be vibration proof for driver circuit component to increase longevity. Destructive test for checking of potted driver needs to bedone.

vi. IP Protection: 65 orabove.

vii. Power Supply shall be connected to the LED PCBs through properconnectors.

viii. Protection:

I. Short CircuitProtection.

II. Open CircuitProtection.

III. Reverse PolarityProtection.

IV. Over Voltage Protection.

ix. Driver shall comply with the safety requirements laid down in IEC: 61347-2-13/EN: 61347-2-13/IS:15885-2-13.

x. Driver shall comply with the performance requirements as per IEC: 62384/IS: 16104.

xi. Driver PCB should be FR4 Grade (Heat Resistive) having min thickness of 1.6 mm.

xii. Junction/channel temperature of switching devices like MOSFET & Transistors are to beprovided.

xiii. Driver should have effective heat sink. Maximum driver case temperature must be declared for theluminaries.

c. <u>LuminarySystem:</u>

i. Housing: Made of pressure die cast extruded Aluminium (LM6/ADC12/LM24) having sufficient area with fins/heat sink for heat dissipation. The temperature should not increase more than 20 degree C above ambient temperature even after 48 hours of continuousoperation.
ii. Cover Type: Heat Resistant Toughened Clear Glass or UV Stabilized Polycarbonate Cover.
iii. Housing Protection: IP 65 or above and IK 07 orabove.
iv. The luminary shall have LM-79/IS: 16106:2012 test report from a NABL accredited lab.
v. Make of luminaries must be embossed/engraved on the luminaryfitting.
vi. Connecting wires used inside the luminaries shall be Low Smoke, Fire retardant (FRLS)cable.
vii. Luminaries should be provided with mounting bracket (GI or StainlessSteel).
viii. Ambient temperature to be considered: 40 degreecentigrade.
ix. Humidity to be considered: 10% to 95%RH.
x. The LED luminaries shall have 60months warranty from the manufacturer from the date ofcommissioning.

RGB LED FLOOD LIGHT LUMINIARE:

LED RGB Flood light for tree lighting application with Housing of Extruded aluminum, wattage not exceeding 50 W with lumen output of note less than 2100. Luminaire has a choice of architectural floodlighting optics with beam angles of 20/40/60/80 degree. Fixture should be with Die Cast Aluminum, powder-coated finish RAL7043.Luminaire should be capable of operating at linevoltage without any separate power supply from 100-240 V AC. Lifetime should be at least 50,000 burning hours at L70 at 25 degree centigrade with total IP66 protection should be provided. Certifications UL / cUL, Temperature Range - 20ºC to 80ºC (-4ºF ~104ºF) start-up temperature, -40ºC to 40ºC (-40ºF ~104ºF) operating temperature. Luminaire should produce sdynamic color changing lightfor large scale facade with millions of colors by DMX/Ethernet based control. Luminaire should have DMX controller, related accessories, cable etc. as per site conditions. Work should be complete with necessary factory made weather proof cable, lenses, and external power cum data supply [if any], wiring, junction boxes, provisioning of power and data cabling etc. as required. All these luminaires has to be individually accessible and can be remotely controlled, also the remote access website needs to be future proof, so that it can be integrated at a later stage with the dashboard

Technical Specifications of LED RGB Facade light

Sr. No.	Criteria	Technical Specification	Offered by bidder (Bidder to specify)
1	Make	Bidder to specify	
2	Make of LED	Cree/Nichia/Osram/Philips (LED shall be of Surface Mounted Design)	
3	Model	Bidder to specify	
4	Luminaire configuration / technical requirement	LED RGB Flood light for external lighting application	
5	Housing / Body of fitting	Die-cast aluminium, dark grey powder-coated finish	
6	Lens	Clear tempered glass	
7	Protection – IP	IP 66	
8	Impact resistance-IK	IK 07	
9	Operating voltage	As per BOQ	

10	Frequency	50/60 Hz	
11	Power factor	> 0.9	
12	Operating temperature	Range -20 to +40-degree C	
13	Working Humidity	0 to 95%, non-condensing	
14	Maintenance factor	0.8	
15	Total Current Harmonic distortion	Total Current Harmonic Distortion should be lesser than 20 %	
16	Total system wattage of Fixture	50 Watt Maximum	
17	Lumens	3000Lumens (All Channels Full On)	
18	Life	As per BOQ.	
19	CRI	As per BOQ	
20	Electrical safety as per IEC.	As per IEC safety standards	
21	Test reports of luminaire	(a) The luminaire should be tested as per IEC 60598-2-3:2002 standards and following test reports should be submitted: Heat Resistance Test, Thermal Test, Ingress Protection Test, Electrical / Insulation Resistance Test,	
		Endurance Test, Humidity Test. The luminaire should be tested for 'Drop test' as per IEC 60068-2-31/IS9000 Part 7 / Sec 3 standards. The luminaire should be tested for 'Vibration test' as per ANSI/IEC 68-2-6 standards.	
		(b) Should be complaint to LM-79 IESNA: approved method for the Electrical and Photometric Measurements of Solid-State Lighting Products LM-79 testing of the complete luminaire.	
		(c) Should be complaint to LM-80 IESNA: Approved Method for Measuring Lumen Maintenance of LED Light Sources and LED lumen depreciation time to L70 based on LM-80 data to estimate lifetime based on performance data collected from IESNA LM-80	
		(d) Required test certifications from NABL accredited laboratory should be submitted for the specification Stipulated in this section.	
		(e) Copy of above test certificates should be submitted with tender.	

		(f) Random samples from supplied lot should be tested at NABL accredited laboratory and report submitted for acceptance.	

TECHNICAL SPECIFICATIONS FOR LED SIGNAGE

i) The Contractor shall be responsible for making the framework for supporting the signage letters and the 3 dimensional Acrylic Letters of the Signage. The Contractor shall be responsible for Supply, Installation, Testing, Commissioning all complete of the LED Signage Board.

ii) The LED Display board/Signage Light for **Head Quarter Building of KOPT** and it should have shall be 4 feet Height and depth to be 14 inches. Signage to read "**KOLKATA PORT TRUST".** The framework of the Signage shall be made of MS Square/Rectangular Hollow Sections of appropriate dimensions which shall be used to frame the support on which three dimensional cutout of letterings made of outdoor Acrylic Sheet is fixed. LED module with control circuit including Power supply system shall be mounted on thepanel.

iii) The dimensions of lettering, spacing and board are to be maintaining with each letter & suitable gap words, but it is to be ensured that the entire alphabets/lines are to be completed within the specified dimension height and width wise. The Back Side of the Character signage board should be covered with GI Sheets in order to protect it from water ingression.

iv) The display board to be hoisted on suitable size MS iron structure and shall be supplied with mounting arrangements frame for easyinstallation.

v) Module connectors shall be supplied for connecting the LED modules. LED module inside the panel will be of red color. For generating brilliant red colors, translucent acrylic sheets having good light diffusion and optimal light transmission have to be used. LED with minimum 50,000 hours shall be used. LED Module with equal fringe and uniform intensity are to be used to ensure that characters to be lit have excellent contrast anduniformity.

vi) All System units should be modular, such that any module (i.e. LED board, LED modules, connector, cable, housing, power supply unit, etc.) can be easily removed when they become defective and a fresh module can be fixed to make the system functional again. The Physical Dimension of the character signage Board should be such that it should be visible at least from a distance of 150 Meters ormore.

vii) Cables provided for each of the display boards shall have sufficient cross-sectional area to withstand power load of the display board. Protection against transients coming in the power supply source or generated by some other source shall beprovided.

viii) All the cards should be suitably protected and mounted in a robust metallic housing so that entire assembly is capable of withstanding shocks, vibrations, electromagnetic induction and electrical surges, etc. The equipment should withstand surges andspikes.

A synopsis of the above is given below:

General Specification:

Front Acrylic sheet thickness	3 mm
Back panel thickness & material	MS Square/ Rectangular Hollow Section
Protection	IP 66

Fronts	As per requirement
Depth of individual character	14 inch or as required
Visibility	100 meter or more
Distance between 2 characters	As per requirement
Mounting Provision	Hanging with clamps or suitable robust Arrangement
Viewing Angle	Minimum 150 degree
Operating Temperature	-40 degree to 60 degree
Alphabets colour	Red
LED module colour	Red

Detailed Dimension & Content of Lettering:

H:4ft”↕ **KOLKATA PORT TRUST**

Overall dimension of the board: 4 ft.”(H) And as per character length.

Electrical Specification:

Nominal Voltage	230 V AC
Operating Voltage range	150 V - 260 V AC
Frequency	50 HZ
Power Factor	0.85-0.90
Input Voltage for LED Module	12 V/24 V DC
Output Voltage Tolerance	10%
LED Type	module
LED wattage	0.47W/module minimum
LEDs/Module	2-3 (Min)
Colour Rendering Index	87
Colour Wavelength	625nm
Protection	IP66

Other specifications:

The tenderer shall provide documentary proof of technical specification of LEDs & power supply used from the concerned LEDmanufacturer.

Cleaning of site:

On completion of works, the contractor shall reinstate and make good at his own expense any property or land which might have been disturbed and/or damaged by his works. Contractor should also clean the site as required during execution and fully clear the site after completion of all the works. Any holes/drillings/openings/damages made on the wall/roof for drawing of cables/installation of equipment shall be made good by the tenderer at his own cost.

LIST OF APPROVED MAKE

Item	Make
Acrylic Lettering	A-Cast, Mitsubishi, Astari
GI sheet for back panel	Tata, Jindal, Bansal
MCB/Timer/DB	ABB/Schenider/C & S/ Havells/L&T/Siemens
LED Module	Cree/Nichia/Osram/Lumiled/GE
PVC Copper wire for internal wiring	KDK-Evershine/ Finolex/ Havells/ Polycab.

TENDER DOCUMENT

FOR

KOLKATA PORT TRUST

HIGH SIDE ELECTRICAL WORKS

SPECIAL CONDITIONS OF CONTRACT

TIME FOR COMPLETION OF WORK

Time allowed for the execution of work in accordance with these conditions shall be the essence of the contract. The time allowed for the completion of work shall be SIX (6) MONTHS from the date of hand over of site from the issue of letter of intent to the successful contractor.

DEFECTS /LIABILITY PERIOD

The contractor shall guarantee that all equipment shall be free from any defective materials and workmanship & that the equipment shall operate satisfactorily. The performance and the efficiency of the equipment shall be not less than the guaranteed values. The guarantee shall be valid for a period of 12 months from the certified date of completion and during this period the contractor shall be responsible to make good and remedy any defect from time to time at his own expense.

The guarantee shall cover all the aspects which in the opinion of the owner / Architect the defects are due to defective material/ workmanship, the contractor shall repair/replace such items and also replace or repair any damage thereby carried to other work.

During this period of guarantee, the contractor shall furnish promptly upon request from the Owner/ Architect all servicing required to maintain the installation and all portions thereof in the operative conditions intended other than the owner's normal operation and maintenance service.

GENERAL

These special conditions shall be read in conjunction with the description of the item of work in the Bill(s) of Quantities, the particular Specifications, Local Statutory Regulations, Indian Standards Specifications/ Codes and the drawings. All the above quoted documents shall be considered supplementary to each other. However, in the case of conflict amongst the various provisions the owner's and the Architect’s opinion will be final and shall be adopted.

If specifications for any item of work are not covered by any of the documents mentioned above, the same shall be decided and conveyed by the KOPT/Architect to the Contractor and shall be binding upon him/them.

The Contractor is advised to inspect the site to ascertain the nature of site, access thereto, local facilities for procurement of materials and working labour rates prevalent in the area, in fact all matters affecting his prices and execution of the work. The tenderer shall be deemed to have full knowledge of the site and drawings whether or not he actually inspects them.

The Contractor shall mobilize and employ sufficient resources to achieve the detailed schedule within the broad frame work of the accepted methods of working and safety. The Contractor shall provide everything necessary for the proper carrying out of the work, including tools, plant and other things.

No additional payment will be made to other Contractor for any multiple shift work or other incentive methods contemplated by him in his work schedules even though the time schedule is approved by the Architect.

RATES

The rates quoted shall be deemed to allow for all minor extras and constructional details which are not specifically shown on drawings or given on the specifications but are essential in the opinion of the Engineer-in-charge to the execution of works to conform to good workmanship and sound engineering practice. The KOPT/Architect reserves the right to make any minor changes during the execution without any extra payment.

The Architects decision to clarify any item under 'minor changes', 'minor extras' and 'constructional details' shall be final, conclusive and binding on the Contractor.

The rates quoted by the Contractor shall be net so as to include all requirements described in the contract agreement and no claim whatsoever due to fluctuations in the price of material and labour will be entertained.

The rates quoted by the Contractor shall include for supplying materials and labour necessary for completing the work in the best and most workmanship like manner to the satisfaction of the KOPT/ Architect and which in the opinion of the KOPT/Architect cannot be made better, and for maintaining the same. The rates shall be complete in all respects also including cost of materials, erection, fabrication, labour, supervision, tools and plant, transport, sales and other taxes royalties, duties and materials, contingencies, breakage, wastage, sundries, scaffoldings, etc., on the basis of works contract. The rates quoted shall include all taxes, duties, transport, insurance, octroi, or any other levies applicable under the `statute'.

In case the rates of identical items under different sub-heads/parts are different, the lowest of these will be taken for the purpose of making the payments.

The rates for different items are for all heights, depths, widths and positions, unless otherwise specified against the item. No claim in respect of any leads/lifts for any item specified in the Schedule of Quantities, for which separate items for lead/lift do not exist in that schedule, will be entertained.

The work shall be executed as per the program drawn or approved by the KOPT / Architect and it shall be so arranged as to have full co-ordination with any other agency employed at site. No claim for idle labour shall be entertained nor shall any claim on account of delay in the completion of the work be tenable except extension of time secured by the Contractor as stated elsewhere.

The Contractor shall permit free access and afford normal facilities and usual convenience to other agencies or departmental workmen to carry out connected work or other services under separate arrangements. The Contractor will not be allowed any extra payment on this account.

The contractor shall provide all equipment, instruments, labour and such other assistance required by the KOPT/Architect for measurement of the works, materials, etc.,

These conditions of contract are meant to amplify the specifications, schedule of quantities and drawings in addition to those conditions specified from time to time as additions or omissions to those said conditions of contract. In case of non-confirmation the latter shall supersede the general conditions of contract.

MATERIALS

The Owner reserves the right to select any of the `Makes' given in the preferred list of Makes.

The Contractor shall ensure to the satisfaction of the KOPT/ Architect that the materials are packed in original sealed containers/packing bearing manufacturer's markings and brands etc., except where the gross quantity required is a fraction of the smallest packing. Materials not complying with this requirement shall be rejected.

The Contractor shall store all materials in a proper manner so as to avoid contamination and deterioration. The places at site where materials are to be stored shall be subject to the approval of the KOPT / Architect. Contractor shall make arrangements to clear the place within such time as may be instructed by the KOPT / Architect. No claim whatsoever will be entertained on this account.

KOPT / Architect shall have the power to cause the Contractor to purchase and use such materials of particular make or from particular source which may in his opinion be necessary for proper and reasonable compliance with the specifications and execution of work.

(a) When required by the KOPT / Architect, the Contractor shall provide all facilities at site or at manufacturer's works or in an approved laboratory for testing the materials and/or workmanship. All the expenditure in respect of this shall be borne by the Contractor unless specified otherwise in the Contract. The Contractor shall, when required to do so by the Architect shall submit at his own cost, manufacturer's certificate of tests, proof sheets, mill sheets etc., showing that the materials have been tested in accordance with requirements of these specifications.

b) Neither the omission by the KOPT / Architect to test the materials nor the production of manufacturer(s) certificate etc., as aforesaid shall affect the right of the Architect to reject, after delivery the materials found unsuitable or not in accordance with the specifications.

DRAWINGS

Clarifications required or discrepancies, if any, noted by the Contractor in the various drawings supplied by the Architect must be obtained well before execution, failing which the decision of the Architect shall be final and binding on the Contractor with regard to detailing and general acceptance of the contract.

Should there by any discrepancy due to incomplete description/ambiguity or omission in the drawings and other documents, whether original or supplementary, forming part of the contract, whether found on completion or during currency of the installation work the Contractor shall immediately on discovering the same, draw the attention of the Architect, and the Architects decision shall be final and binding on the Contractor.

Large scale details shall take precedence over small size drawings. Special dimensions in the specifications or Schedule of Quantities or instruction of the Architect shall supersede the drawings. The Contractor shall verify all dimensions at site.

Detailed working drawings on the basis of which actual construction shall proceed will be furnished to the Contractor by the Architect. Payment will be made on actual measurement of work done, as admissible as per drawings at the rates entered in the Schedule of Quantities forming part of these tender documents.

RECTIFICATION OF DEFECTS

Any defect in the work done or materials used in the works pointed out by the KOPT / Architect shall be rectified within a week or such extended time as may be allowed in this failing which the said defect shall be got rectified by the KOPT / Architect at the risk and cost of the Contractors.

CLARIFICATIONS OF DISCREPANCIES

In case of any discrepancy between specifications, drawings etc., furnished or disputes in respect thereof, the interpretation of the Architect shall be final and binding.

The levels, measurement and other information concerning the existing site as shown on the drawings or as described are deemed to be correct, but the Contractor shall verify them for himself as no extra claim whatsoever shall be entertained on account of the errors or omissions in such matters or on account of the descriptions turning out to be different from what was expected by him.

FEES, PERMITS AND TESTS

The Contractor shall obtain and pay for any and all fees and permits for the installation of the work. On completion of the work, the Contractor shall obtain and deliver to the KOPT certificate of final inspection and approval by the Local Authority. The Engineer-in-Charge shall have full powers to require the materials or work to be tested by an independent agency at the Contractor's expense in order to prove their soundness and adequacy.

SCOPE OF WORK

The work to be carried out under this contract comprises supplying, erection, testing and commissioning of HT side electrical Works for **RENNOVATION OF KOLKATA PORT TRUST HEAD OFFICE.** The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the current rules and regulations of relevant statutory authorities and the local practices, the Bureau of Indian Standards and with the direction of and to the satisfaction of the Architect or by other agencies. The Contractor shall furnish all labour and install all materials, appliances, equipment (expect those items which will be supplied by the Owner to the Contractor at site), necessary for the complete provision and testing of the Installation as specified herein or noted on the drawings. This also includes any material appliances, equipment not specifically mentioned

herein or noted on the drawings as being furnished or installed but which are necessary and customary to make complete installation of electrification works shown on the schedule and described herein, properly connected and in working condition. The work shall include all incidental jobs connected with installation such as excavation of trenches and back filling, cutting/drilling and grouting for fixing of fixtures, equipment etc.

In general the work to be performed under this contract shall comprise the following :

i. Supply, Installation ,testing and commissioning complete works as shown on the drawings and described in this specification and as per the latest ISI specifications including all that which is reasonably inferred.

ii. Complete installation of the works appurtenances internally.

iii. Co-operation with other crafts, in putting the installation in place. Any work done without regard or consultation with other trades, shall be removed by the contractor without additional cost to the owner, to permit the proper installation or all other work, as desired by the Architect

iv. Repair all damages done to the premises as a result of this installation and removal of all debris left by those engaged for this installation.

v. It is the responsibility of the contractor to take care of all the equipment fitted until the time of handing over to the owner.

vi. Touch-up painting of structures and equipment to be carried out after erection.

POSSESSION PRIOR TO COMPLETION AND DEFECTS LIABILITY PERIOD

The KOPT reserves the right to take up erection of plant or any other work during construction for any use completed or partially completed work or part of the work. Such use shall not be deemed to be on acceptance of any work not completed in accordance with the contract agreement. Only if such prior use by the KOPT delays the progress of work then an equitable adjustment in the time of completion only will be made.

The work will not be considered as complete till all the components of the installation provided for in the contract that have been installed at site in all respects have been inspected/ tested by the KOPT / Architect to his entire satisfaction and a completion certificate issued by the Architects.

During the defects liability period the Contractor shall be responsible for any defects in materials or workmanship that may develop in the works and shall remedy the same at his own cost to the entire satisfaction of the KOPT / Architect. The Contractor shall also reinstate any portion of such defective works and/or replace any defective material therein and generally do whatever may be necessary so that the whole of the said works may at the expiration of the said period be in a condition satisfactory to the Architect.

Final security deposit shall not be effected till the final certificate to this effect is issued by the Architect.

WORK AND WORKMANSHIP

The Contractor shall make arrangements for and provide at his own cost all temporary works, if required at site, after obtaining prior approval of the Architect/KOPT.

To determine the acceptable standard of workmanship, the KOPT / Architect may order the Contractor to execute certain portions of works and services under the close supervision of the Architect. On approval, these items shall be labeled by them as guiding samples so that further works are executed to conform to these samples.

All materials, articles and workmanship shall be the best of their respective kind for the class of the work described in the contract documents. The KOPT/ Architect reserves the right to select any of the makes specified in the tender to his choice.

All fittings, fixtures and materials shall be of the best quality and manufactured in India and shall be approved by the KOPT / Architect. The workmanship shall be best quality and decision of the KOPT shall be final and binding as to whether the quality conforms to the standard specified or not.

All items of work under this contract shall be executed strictly in accordance with the relevant specifications read in conjunction with the appropriate Indian Standard Specifications duly modified by special conditions, and particular specifications.

Even though the payment shall be effected under different items in the schedule of quantities, the various items in the schedule of quantities shall be deemed to cover all aspects of the work for the completion of the work as per drawings, from excavation to the finishing not-withstanding any possible omission in the description of the item and specifications thereof regarding incidental items of work, without which the whole work cannot be deemed to have been included under the scope of the

different items of the schedule of quantities. The Contractor is advised to keep this in mind while quoting rates as no claims in this regard shall be entertained.

DRAWINGS & SPECIFICATIONS

The drawings and specifications shall be considered as part of this contract and any work or material shown on drawings and not called for in the specifications or vice versa, shall be executed as if specifically called for in both and are essentially diagrammatic.

The work shall be installed as indicated on the drawings, however any minor changes found essential to co-ordinate, this work with other trades shall be made without any additional cost. The data given herein and on the drawings are not guaranteed. The drawings and specifications are for the assistance and guidance of the contractor's and exact locations and distances and levels will be governed by the building and approval of the KOPT / Architect shall be obtained before the commencement of the work.

SITE ORDER BOOK

The Contractor shall maintain a site order book atthesiteofworks.When necessarytheArchitectwillutilizethebooktoissueinstructionstotheContractor.TheContractorshallfollow theseinstructions in the execution of his work.

COMPLETION DRAWINGS

At the completion of the work and before issuance of certificate of virtual completion the contractor shall submit to the Architect/KOPT layout drawings drawn at approved scale indicating the complete equipments "As Installed"

MANUFACTURER'S INSTRUCTIONS

Where manufacturers have furnished specific instructions, relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.

MATERIALS & EQUIPMENT

All materials and equipment shall conform to the relevant standards and shall be of the approved make and design. Unless otherwise called for only the best quality materials and equipment shall be used. The contractor shall be responsible for the safe custody of all materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with a sample of each shall be submitted to the Architect within 10 days of the award of the Contract. Any item which is proposed as a substitute shall be accompanied by all "Technical Data" giving sizes, particulars of materials and the manufacturer's name. At the time of the submission of proposed substitutes, the Contractor shall state the credit, if any due to the KOPT. In the event the substitutions shall be requested in writing and approvals obtained in writing from the KOPT / Architect. Where no specific make of materials is specified any first class product of a reputed manufacturer may be used, provided it conforms to the requirements of these specifications. The Architect decision in this matter is final.

GUARANTEE

At the close of the work and before issue of certificate of virtual completion by the Architect the contractor shall furnish a written guarantee indemnifying the owner against defective materials and workmanship for a period of one year after completion. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the owner:

i. Any defective work or equipment supplied by the Contractor.

ii. Any material or equipment supplied by the KOPT which is proved to be damaged or destroyed as a result of defective workmanship by the Contractor.

iii. Any material or equipment inside the building damaged or destroyed as a result of defective workmanship by the Contractor.

COMPLETION CERTIFICATE

On completion of the Installation a certificate shall be furnished by the Contractor counter signed by a licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority.

QUALIFIED COMPETENT SUPERVISION

The Contractor shall employ competent fully licensed, qualified full time Engineer to direct the work of complete electrification in accordance with drawings and specifications. The Engineer shall be available at all times on the site to receive instruction from Architect in the day to day activities, throughout the duration of the contract. The foremen shall co-relate the progress of the work in conjunction with all relevant requirements of the supply authorities.

MISCELLANEOUS

Invitation to Tender shall be deemed to be part of these special conditions.

The work will be carried out as per regulations and bylaws of the local authorities. The contractor shall take whatever action is required in getting necessary approvals of plans etc. as well as necessary sanctions for the Installation from the local authorities, wherever required.

ADDITIONAL WORKS

If required, the Contractor shall have to execute additional works within the Project site to the extent of 25% (Twenty five percent) of the total accepted contract sum. No adjustment of rates shall be made up to this limit and the terms and conditions of the contract shall remain unaltered.

The Contractor shall make his own storing arrangement, site offices etc., inside the site, as required. Owner will give only the space (as per availability) inside the building premises.

RESTRICTED AREA

For all purposes of this contract the site is considered as a Restricted Area. The Contractor shall ensure that he obtains entry passes for all his workmen and employees. The Contractor shall obtain special permission in writing from the Owner if he desires to continue working beyond office hours or on Holidays. The Contractor shall also observe and abide by the security regulations applicable during the currency of the contract.

GENERAL

Any clarification / interpretation shall be clarified well in advance without delaying any item of execution.

Any substitution item will have to be approved in writing by Architect / client well in advance.

TECHNICAL SPECIFICATIONS

1. GENERAL:

1.1 The entire electrical installation shall be carried out in accordance with latestIndian Electricity Code and relevant IS/ IEC standards.

1.2 Contractor shall be responsible for obtaining all necessary statutory approvals, clearances and getting actual connections.

1.3 All material, equipment, fixtures used in the installation shall be of approved quality confirming to relevant IS/ IEC specifications.

1.4 Contractor shall submit all necessary drawings for approval by Engineer / Architect prior to commencement of work.

1.5 Contractor shall carry out all necessary tests including Insulation Resistance Test, Earth resistance Test, Continuity of conductors.

1.6 Contractor shall furnish necessary test certificates as required by Clients / Authorities / Architects.

1.7 After completion of Supply of material and installation of wiring system including earthing , if any defect in the workmanship is found or any defect in the material is found by the Engineer / Architect, the contractor shall remove the same and supply approved materials as per instruction by Engineer / Architect and rectify the workmanship at contractor's own cost.

2. PACKAGE SUBSTATION

PACKAGE SUBSTATION WITH BREAKER AS PROTECTION ON HT SIDE

CODE & STANDARDS

All equipment and material shall be designed manufactured and tested in accordance with the latest applicable IEC standards. The 12KV Package Substation Design must be as per IEC 61330/62271-202.

The Package Sub-station offered shall in general comply with the latest issues including amendments of the following standards:

IEC: 61330/ 62271-202	:	High Voltage Low Voltage Pre-Fabricated Substation
IEC 60265	:	High Voltage Switches
IEC 60298/IEC62271-200	:	Metal Enclosed High Voltage Switchgear
IEC 60694	:	High Voltage Switchgear
IEC 60439	:	Low Voltage Switchgear and Control gear
IEC 60076	:	Power Transformers

DESIGN CRITERIA

Package Sub-station consisting of 11KV Non-Extensible SF6 Ring Main Unit with breaker as protection + Transformer + Low Voltage Switchgear +APFC Panel with all connection accessories, fitting & auxiliary equipment in an Enclosure to supply Low-voltage energy from high-voltage system as detailed in this specification.

The complete unit shall be installed on a substation plinth (base) as Outdoor substation located at very congested places. 11KV Isolators controls incoming-outgoing feeder cables of the 11KV distribution systems. The Vacuum Circuit Breaker shall be used to control and isolate the 11kV/433V Distribution transformer. The transformer Low Voltage side shall be connected to Low Voltage switchgear. The connection cables to consumer shall be taken out from the Low Voltage switchgear.
The prefabricated-package substation shall be designed for:
a) Compactness

b) Fast installation

c) Maintenance free operation

d) Safety for worker/operator & public.
The Switchgear and component thereof shall be capable of withstanding the mechanical and thermal stresses of short circuit listed in ratings and requirements clause without any damage or deterioration of the materials.
For continues operation at specified ratings temperature rise of the various switchgear components shall be limited to permissible values stipulated in the relevant standard and / or this specification.

SERVICE CONDITIONS
The Package substation shall be suitable for continuous operation under the basic service conditions indicated below

Ambient Temperature	:	50°C
Relative Humidity	:	upto 95%
Altitude of Installation	:	upto 1000m

The Enclosure of High Voltage switchgear-control gear, Low Voltage switchgear-control gear & Transformer of the package substation shall be designed to be used under normal outdoor service condition as mentioned. The enclosure should take minimum space for the installation including the space required for approaching various doors & equipment inside.
SPECIFIC REQUIREMENT
The main components of a prefabricated- package substation are Transformer, High-voltage switchgear-control gear, Low-voltage switchgear-control gear and corresponding interconnections (cable, flexible , bus bars) & auxiliary equipment. The components shall be enclosed, by either common enclosure or by an assembly of enclosure. All the components shall comply with their relevant IEC standards.
RATINGS

Description	**Unit**	**Value**
Rated Voltage / Operating Voltage	kV rms	11/6.6 (As per the available voltage level of CESC)
Rated frequency & Number	Hz & nos.	50 & 3
Rated maximum power of su	kVA	**630kVA**
Rated Ingress protection clas	IP:	IP-23 for Transformer Compartment and IP-54 for LT & HT Switchgear Compartment.
Rated temp Class of Transfo Compartment		K10 up to 1250kVA K20 from 1500kVA to 2000kVA
HV Insulation Level		
Rated withstand voltage at power frequency of 50 Hz	kV rms	28
Rated Impulse withstand Voltage	kV peak	75
HV Network & Bus bar		
Rated current	Amp	800A
Rated short time withstand current	kA rms / 3 sec	20

Making capacity for switch-disconnectors & earthing switches	kA peak	50kA
Breaking capacity of Isolators (rated full load)	A	630A
LV Network		As shown in SLD.

OUTDOOR ENCLOSURE

The outdoor enclosure shall be made of galvanized Sheet Steel tropicalized to local weather conditions.
The metal base shall ensure rigidity for easy transport & installation.
Substation will be used in outdoor application hence to prevent enclosure from rusting/corrosion, welding should be avoided.
The protection degree of the Enclosure shall be IP54 for LT & HT switchgear compartment & IP23 for Transformer compartment. Proper / adequate ventilation aperture shall be provided for natural ventilation by way of Louvers etc.
To avoid the entry of rodent in the transformer compartment, stainless steel mesh should be provided from inner side of louvers.
Considering the outdoor application of the substation the doors shall be provided with proper interlocking arrangement for safety of operator and to avoid corrosion door should have stainless steel hinges. Door should be provided with stoppers.
Interconnection between HT switchgear and transformer shall be using 1Cx3x185 sq.mm al. armoured XLPE cable and between transformer and LT switchgear shall be using busbar.
Internal Fault: Failure within the package substation due either to a defect, an exceptional service condition or mal-operation may initiate an internal arc. Such an event may lead to the risk of injury, if persons are present. It is desirable that the highest practicable degree of protection to persons shall be provided. The Design shall be tested as per IEC61330/62271-202. **Type test report of arcing due to internal fault should be submitted with the offer.**
Covers & Doors: Covers & doors are part of the enclosure. When they are closed, they shall provide the degree of protection specified for the enclosure. Ventilation openings shall be so arranged or shielded that same degree of protection as specified for enclosure is obtained. Additional wire mesh may be used with proper Danger board for safety of the operator. All covers, doors or roof shall be provided with locking facility or it shall not be possible to open or remove them before doors used for normal operation have been opened. The doors shall open outward at an angle of at least 90^0 & be equipped with a device able to maintain them in an open position.
Earthing: All metallic components shall be earthed to a common earthing point. It shall be terminated by an adequate terminal intended for connection to the earth system of the installation, by way of flexible jumpers/strips & Lug arrangement. The continuity of the earth system shall be ensured taking into account the thermal & mechanical stresses caused by the current it may have to carry. The components to be connected to the earth system shall include:

i. The enclosure of Package substation,

ii. The enclosure of High voltage switchgear & control gear from the terminal provided for the purpose,

iii. The metal screen & the high voltage cable earth conductor,

iv. The transformer tank or metal frame of transformer,

v. The frame &/or enclosure of low voltage switchgear,

There shall be an arrangement for internal lighting activated by associated switch for HV , Transformer & LV compartments separately.
Labels: Labels for warning, manufacturer's operating instructions etc. shall be durable & clearly legible.
Cleaning & Painting: The paints shall be carefully selected to withstand tropical heat and rain. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

3. MV SWITCHGEAR

SCOPE OF WORK

Manufacturing, testing and supplying of integrated cubicle type metal clad, floor mounted and draw out type free standing, front operated indoor type HT switchgear panel up to 33 kV as per specifications given below:

SYSTEM

The switchgear enclosure shall conform to degree of protection IP 4 X.

The switchgear shall be made from MS sheet steel 2 mm thick (CRCA) and shall be folded and braced as necessary to provide a rigid support for all components.

The switchgear assembly shall form a continuous dead front line up of free standing vertical cubicles. Each cubicle shall have a lockable front hinged door and a removable bolted back cover. All covers and doors shall be provided with neoprene gaskets. Suitable arrangement for lifting of each cubicle shall be provided. Design and construction of the switchgear shall be such as to permit extension at either end.

Vacuum Circuit breaker shall be provided with surge arresting device for protection against lightning and switching over voltage. Two separate and distinct connections to earth shall be provided for each surge arrestor.

EQUIPMENTS

Base channel frame of the switchgear with hardware, if required.

Set of accessories.

One set of special tools and tackles.

Mandatory spare parts if required.

Recommended spare parts for three (3) years continuous operation if required.

All relevant drawings, data and instruction manuals.

CODES AND STANDARDS

All equipment and materials shall be designed, manufactured and tested in accordance with the latest applicable Indian Standards (IS) and IEC except where modified and/or supplemented by this specification.

Equipment and material conforming to any other standards, which ensure equal or better quality, may be accepted. In such case, copies of the English version of the standard adopted shall be submitted along with the bid.

The electrical installation shall meet the requirements of Indian Electricity Rules as amended upto date and relevant IS Code of Practice. In addition, other rules and regulations applicable to the work shall be followed.

DESIGN CRITERIA

The switchgear shall be used to supply power to HV transformers and other loads.

The switchgear shall be located in a clean but hot, humid and tropical atmosphere.

Switchgear ratings and quantities are detailed in the annexure. Equipment shall be furnished in strict accordance with the same. For indicative power distribution scheme “Electrical Single Line Diagram” Dwg. No……. shall be referred. Rating shown in the above drawing represents the minimum requirement only; exact rating, number and type of feeders etc. shall be decided by the bidder.

For continuous operation at specified ratings, temperature rise of the various switchgear components shall be limited to the permissible values stipulated in the relevant standards and/or this specification.

The Switchgear and components thereof shall be capable of withstanding the mechanical forces and thermal stresses of the short circuit current listed in the annexure-I without any damage or deterioration of material.

Circuit breaker shall not produce any harmful over-voltage during unloaded lines and unloaded transformers. If required, surge protective device shall be provided in the scope of supply to limit over-voltage.

All vacuum circuit breakers / panels must be manufactured by ISO 9000, ISO 14000, ISO 18001; ISO 50001 certified Organization and shall have been type tested at CPRI / ERDA or any Govt. approved /

international laboratory within Ten years as on the date of bid opening. The Bidder shall demonstrate compliance with this requirement by supplying with the bid, copies of the type test certificates.

Switchgear Manufacturer must have NABL accredited Testing Laboratory for Switchgear in India.

SPECIFIC REQUIREMENT

A. CONSTRUCTION

The switchgear shall be indoor, metal-clad, floor / cassette mounted, draw out type. Design and construction shall be such as to allow extension at either end.

The switchgear enclosure shall conform to the degree of protection IP-4X. The vacuum circuit breaker panels shall be enclosed in sheet steel independent floor mounting cubicle made of 2.0 mm thick CRCA Sheet for outer walls and 1.5 mm thick for partition / inside walls suitable for coupling with identical units on either sides to form switchboard. Alu-zinc coated sheet steel for fabrication is also acceptable.

The switchgear assembly shall comprise a continuous, dead-front, line-up of free standing, vertical cubicles. Each cubicle shall have a front hinged door with latches and a removable back cover. All covers and doors shall be provided with XLPE gaskets.

Switchgear cubicle shall be so sized as to permit closing of the front access door when the breaker is pulled out to TEST position. The working zone shall be restricted within 750 mm to 1950 mm from floor level.

Circuit breakers, instrument transformers, bus-bars, cable compartment etc., shall be housed in separate compartments within the cubicle. The design shall be such that failure of one equipment shall not affect the adjacent units.
All relays, meters, breaker control switches, selector switches and indicating lamps shall be flush mounted on the respective cubicle door or on control cabinet built on the front of the cubicle. AC/DC auxiliary supply switches / isolation switches for cubicle space heater, cubicle lamp, spring charging motor circuit shall be located inside metering compartment.

B. CIRCUIT BREAKER AND BREAKER COMPARTMENT

Vacuum Circuit Breaker shall be mounted in draw out truck with front plate which covers the cubicle when the breaker is in service position. This front plate shall be provided with view glass to facilitate observation of mechanical ON/ OFF indication of Circuit breaker, spring charged / discharged indication and operation counter. Necessary orifice shall be provided for manual charging of the springs. ON/ OFF push button for opening and closing of the circuit breaker shall also be provided. The draw out truck shall have two positions for the circuit breaker VIZ isolated / Test & Service.
Circuit breaker shall be triple pole, single throw and Vacuum type.
Vacuum Interrupters (VI) shall be same make of VCB. Interrupters imported from China/ Chinese make Interrupters are not acceptable.
Vacuum Interrupters must be type tested for 100-shots at rated Short Circuit current.
VCBs must comply with E1 & M2 category as per latest IEC.
Circuit breakers shall be horizontal isolation and horizontal draw out type, having SERVICE, TEST and DISCONNECTED positions with positive indication for each position.
Circuit breakers of identical rating shall be physically and electrically interchangeable.
Circuit breaker shall have motor wound spring charged trip free mechanism with anti pumping-feature and shunt trip. In addition facility for manual charging of spring shall be provided.
For motor wound mechanism, spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor.
Mechanical safety interlock shall be provided to prevent :
The circuit breaker from being racked-in or racked-out of the service position when the breaker is closed.
Racking in the circuit breaker unless the control plug is fully engaged.
Automatic safety shutters shall be provided to fully cover the female primary disconnects when the breaker is withdrawn.
Each breaker shall be provided with an emergency manual trip, mechanical ON-OFF, indication, an operation counter and mechanism charge/discharge indicator.
Each breaker shall be provided with auxiliary switch of 4 NO + 4 NC contacts. Switch contact shall be rated 10A AC /2A DC at their respective operating voltage.

RATINGS: ***Annexure-I***

S.NO.	DESCRIPTION	6.6 KV	11 KV	22 KV	33 KV
A	Rated Current	400 \ 630 A	**400 \ 630 A**	400 \ 630 \ 1250 A	400 \ 630 \ 1250 A
B	Rated Voltage	7.2 KV	**12 KV**	24 KV	36 KV
C	Rated Frequency	50Hz ± 5%	**50Hz ± 5%**	50Hz ± 5%	50Hz ± 5%
D	Rated Short Circuit breaking Current	18.4 KA	**21 KA**	26.3 KA	26.3 KA
E	Rated Short Circuit withstand duration	1 Sec	**1 Sec**	1 Sec	1 Sec
F	Rated short circuit making current (KAP)	50 KA	**50 KA**	65 KA	65 KA
G	Insulation level (KV rms/ KVP)	20 KV / 60 KV	**28KV / 75 KV**	50 KV / 125 KV	70 KV / 170 KV

Note: Rated Short Circuit Breaking Current shall be calculated as per project requirement.

C. BUS BAR COMPARTMENT

The main buses and connections shall be of high conductivity Copper alloy, sized for specified current ratings with maximum temperature limited to as per IEC: 60694, Table – III.
Bus bars shall be of same size for the entire length of the switchgear. Continuous current rating of bus connections shall be same as that of continuous in panel current rating of associated breaker.
All bus connections shall be tin plated. Adequate contact pressure shall be ensured by means of two bolts connection with plain and spring washers and locknuts. Bimetallic connectors shall be furnished for connections between dissimilar metals.
Bus bars and connection shall be fully insulated for working voltage else adequate phase/ground clearances (As per IS) needs to be made for bare busbar.
Bus insulator shall be flame-retardant, track resistant type with creepage distance suitable for heavily polluted atmosphere.
All buses and connections shall be supported and braced to withstand stresses due to maximum short circuit current and also to take care of any thermal expansion.
Bus bars shall be color coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from front of the switch-gear assembly.
Busbar cross-section shall be rectangular type only.

Length & size of each phase of Horizontal Loose Busbars shall be identical to ease of maintenance.

D. CONTROL AND INDICATION

The circuit breaker shall be wired up for local & remote operation. Each breaker cubicle shall be equipped with following :-

One (1) TEST-NORMAL-TRIAL selector switch stay put type with pistol grip handle and key interlock.

One (1) TRIP-NEUTRAL-CLOSE switch spring return type with pistol grip handle.
Three (3) indicating lights on front of compartments :-

GREEN	:	Breaker Open and Spring Charged
RED	:	Breaker Closed
AMBER	:	Trip/Trip circuit trouble

Lamps shall be clustered type LED module pilot lights in thermoplastic enclosure with polycarbonate lens and diffuser. Lamp and lens shall be replaceable from front.

E. CT AND CABLE COMPARTMENT

At the rear of the panel sufficient space shall be available to accommodate three numbers epoxy CT's of dual core and two numbers three core cable termination. The cable entry shall be from the top / bottom.

I. <u>General Requirements</u>

Accommodation shall be provided in the circuit breaker panel, to mount one set of duel ratio CT. Access to the CTS for cleaning, testing or changing shall be from the front, back or top of the panel.

II. Rating

Dual ratio CTS of suitable burden (but each not less than 10 VA) shall be preferred with 5 amps secondary. Instrument Security Factor (ISF) of each CT shall not be more than 10.

The CTs shall conform to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. CT terminals shall be shorting type. Current & voltage circuits shall be laid in separate wire ways. Secondary terminals of CTS shall be brought out to a suitable terminal block which will be easily accessible for terminal connections. Test terminal block shall be provided in the front side of the panel for testing purpose.

CT'S shall have 2 Nos. of cores for following application:

Core -1 for metering

Core -2 for protection.

Class of accuracy of each winding

Metering class 1

Protection class 5P10 / 5P20 / PS

Short Time Current rating shall be same as STC of the system for 1Sec.

F. VOLTAGE TRANSFORMER

The Voltage/ potential transformers (PT) shall be confirming to IS 3156/ IEC 60185.The primary windings of the potential transformers shall be insulated and shall be of the cast rest in type.

Line PTs shall be mounted at the rear side of the Panels. Else separate vertical panel to be provided for Line PTs. Bus PTs shall be mounted in separate Panel. PTs mounted in the cable chamber or PTs mounted below circuit breaker compartment or PTs mounted in the Breaker truck is not acceptable. The PT shall have control fuses on the H.V. side and a miniature circuit breaker on the L.V. side of the windings. HT HRC Control fuses shall be confirming to IS – 9385/ IEC 60282. Miniature Circuit breaker shall comply with IS – 8828/ IEC – 60898.

Padlocking facilities shall be provided for both service and isolated position.

The potential transformer shall be as specified below:

Ratio	:	6600 or 11000 or 22000 or 33000/ √3/ 110/ √3V A Burden
	:	100 VA for 100/√3 and 110 V winding
Class	:	CL –0.5 for both the windings.
Basic Insulation level	:	Same as mentioned for VCB
Over voltage factor	:	1.2 Continuous

Single phase PT'S shall be used and shall be connected in Star/ Star.

G. RELAYS

Multifunction numerical relays shall be selected to provide an integrated protection, continuous measurement and monitoring functions. Features such as self-diagnosis and external testing, disturbance recording, sequence of event recording, time stampings shall be available with the relay. The relay shall have multiple setting groups, optically isolated input / output, front LCD display and menus, fixed function and programmable LEDs, keypad and password protection. All functions including protection, automation, communication, LEDs, input / output shall be programmable and can be modified, if required, using the front panel user interface. Communication port for local and remote (with suitable protocol) communication shall be located in the front and rear part of the relay. The relay shall be housed in dust tight enclosure, suitable for IP 54 degree of protection.

Unless otherwise mentioned in the specification, protective relays shall be multifunction type numerical relays with IEC:61850 protocol of Alstom/Schneider/Siemens/ABB make preferably.Use of any external converter for protocol conversion to IEC:61850 is not acceptable.

The Multi-function relays shall generate GOOSE messages as per IEC: 61850 standards for interlocking / tripping and also to ensure interoperability with third party relays.

Relays shall be of draw-out / semi draw-out design and flush mounted at the front of panel. Auxiliary relays may be in non draw-out execution.

Relays shall be rated for operation on 110V secondary voltage and 1A or 5A secondary current as shown on drawings. Number and rating of relay contacts shall suit the job requirements.

H. METERING INSTRUMENTS AND PANEL ACCESSORIES

METERING

Digital type Load manager of approved make (Smart demand controller) shall be provided on the incomer feeder and shall have communication port for DCS/ PLC interface in MODBUS.

Specification of the meter shall be as follows:

Accuracy : Class 1, compliant to revenue class certification.
: Real time measurement of V, I, PF, KW, KVAR, KVA (per phase & average
: Peak demand, sliding window. Protected.
: V & I unbalance Phase reversal
: Time of Use (TOU)

Power Quality Measurement : Total Harmonics

Logging & recording for all measurements:
: Interval or event-based, 32 channel measurement & recording
: Event logging
: "Bust" data recording
: Min/ Max recording

Alarming : Over & under measurement detection by 24 set point Functions.

Multiport Communication: 1 no. RS 485 and 1 no. RS 232 ports.

INSTRUMENT PANELS

The instrument panel shall be part of the housing. Relays, meters and instruments shall be mounted as per general arrangement drawings to be submitted by the vendors. They shall be of flush mounting type.

INSTRUMENTATIONS

a. Digital type Voltmeter of class 1.0 accuracy and 96 x 96 mm square in size as per IS-1248 shall be provided at incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.

b. Digital type Power factor meter of class of 1.0 accuracy conforming to IS: 1248 shall be provided at incomer panel.

c. Digital type Ammeter of specified range to class 1.0 accuracy and 144 x 144 sq mm in size as per IS - 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.

d. Digital type frequency meter class of 1.0 accuracy conforming to IS: 1248 shall be provided at incomer panel.

The following minimum indication lamps shall be provided in the front of cubicle.

Breaker open / closed / tripped, spring charged trip circuit healthy and control supply healthy. Lamps shall be clustered LED type and trip circuit supervision scheme shall be of continuous supervision type.

After meeting all necessary control and indication requirements 2 nos. NO and 2 nos. NC auxiliary of the breaker shall be made available for the owner, wired up to terminal block for integration with Building Management system.

Separate MCB's shall be provided for lamps, heaters and other instrumentation etc. on each panel.

Anti-condensation space heaters suitable for operation on 240 V single phase, 50 Hz A.C. for each cubicle and with thermostat control one incandescent lamp with switch and 3 pin 5 amps plug socket.

I. PROTECTIONS

Minimum protections to be provided for different type of circuits are listed below:

INCOMER FEEDER

- IDMTL over current (51) for phase fault
- IDMTL over current (51N) for earth fault
- Earth fault (50/50N)

- Under voltage with time delay (27) – voltage input from Line PT
- VT fuse failure
- Circuit breaker failure

AUX. TRANSFORMER FEEDER

- IDMTL over current (50/51) with high set instantaneous units for phase faults
- Definite time O/C (50G) for earth fault
- Under Voltage protection (27) – voltage input from Bus PT / Line PT
- Aux. Relay for indication of Winding temperature Alarm and Trip
- Circuit breaker failure

LINE FEEDER

- IDMTL over current (51) for phase fault
- IDMTL over current (51N) for earth fault
- Earth fault (50/50N)
- Under voltage with time delay (27) – voltage input from Bus PT / Line PT
- Circuit breaker failure

In case any trip function is not available in a single relay, separate numerical relays shall be provided to achieve the requirement.
All protective relays shall be provided with self reset type of contacts.
Apart from protection relays, each breaker shall be provided with separate / discrete auxiliary relays for anti-pumping (94), trip annunciation (30) and lockout (86) functions. Lockout relay shall be hand reset type. However, trip circuit supervision function as an integral feature of the relay is acceptable.
Only VT fuse failure relay shall be provided for Bus VT.
No protection is required for Buscoupler Feeder.

J. CONTROL WIRING

The control wiring shall be carried out with minimum 2.5 sq. mm. PVC insulated copper conductor cables. The wiring shall be securely fixed and neatly arranged to enable easy tracing of wires. Identification PVC ferrules shall be fitted to all wire terminals to render easy identification and facilitate checking in accordance with IS 5578 and 11353.

K. INTERLOCKS

The following interlocks shall be provided:

a. The truck cannot be moved from either test to service position or vice versa, when the circuit breaker is ‘ON’.

b. The circuit breaker cannot be switched ‘ON’ when the truck is in any position between test and service position.

c. Front part of the truck cannot be removed when the breaker in ‘ON’ position.

d. The low voltage plug and socket cannot be disconnected in any position except test/isolated position.

e. The truck cannot be moved inside the panel, when the LT plug and socket is disconnected.

f. Earthing switch cannot be switched ‘ON’ when the truck is inside the panel.

g. The truck cannot be inserted when the earthing switch is ‘ON’.

L. SAFETY DEVICE

The following Safety devices shall be provided for the safety of the operating personnel:

a. Individual explosion vents shall be provided for breaker/bus bar/cable chambers on the top of the panel to let out the gases under pressure generated in case of fault inside the panel.

b. Cubicle with front plate to withstand the pressure for internal arc fault as per PEHLA recommendation.

c. Circuit breaker and sheet metal enclosure shall be fully earthed.

d. Self locking shutters shall be provided which shall close automatically when the truck is withdrawn to 'Test position' and no separate padlocking of the shutter shall be required.

M. GROUND BUS

A ground bus, rated to carry maximum fault current for 1Sec, shall extend for the full length of the switchgear.
The ground bus shall be provided with two-bolt drilling with G.I. bolts and nuts at each end to receive 75 x 10 mm G.I. flat.
Wherever, the schematic diagrams indicate a definite ground at the switchgear, a single wire for each circuit thus grounded shall be run independently to the ground bus and connected thereto.
CT and VT secondary neutrals shall be earthed through removable links so that earth of one circuit may be removed without disturbing other.

N. EARTHING TRUCK

Earthing trucks shall be provided for earthing the switchgear bus bars or outgoing cables. The trucks shall have an interlock to prevent earthing of any live connection. It shall not be possible to use bus-earthing truck for cable earthing & vice versa. Earthing truck shall be non-fault making type. Circuit breakers provided with integral earth switch, as an alternative, is also acceptable.

O. NAMEPLATES

Nameplates of approved design shall be furnished at each cubicle (one no. each at front as well as at backside of cubicle) and at each instruments & device mounted on or inside the cubicle.
The material shall be lamicoid or approved equal, 3 mm thick with white letter on black back ground.
The nameplate shall be held by self-tapping screws. Nameplate size shall be minimum 20 x 75mm for instrument/device and 40 x 150mm for panels.
Caution notice on suitable metal plate shall be affixed at the back of each vertical panel.

P. DRAWINGS AND DOCUMENTS

Following drawings documents shall be submitted by the manufacturer for approval.

a. General arrangement (GA) of equipment layout.

b. Equipment list.

c. Relay and metering system schematics.

d. Supply and erection schedule.

e. Catalogue and specification sheets.

Q. SPACE HEATERS AND PLUG SOCKET

Each cubicle shall be provided with thermostat controlled space heaters and 5A, 3-pin plug socket.
In addition, motor feeder cubicle shall be wired-up for feeding the motor space heater through suitable rated breaker auxiliary NC contact and/or contactor.
Cubicle heater, Motor heater, Plug/socket circuits shall have individual switch fuse units.

R. A.C / D.C POWER SUPPLY

The following power supplies shall be made available to each switchgear:
A.C. supply : 230V Single Feeder
D.C. supply : 110V Double Feeder
Bus-wires of adequate capacity shall be provided to distribute the incoming supplies to different cubicles.
Isolating switch fuse units / MCB shall be provided at each cubicle for A.C/D.C. supplies.

S. PAINTING

All surfaces shall be sand blasted, pickled and grounded as required to produce a smooth, clean surface free of scale, grease and rust. After cleaning, the surfaces shall be given a phosphate coating followed by 2 coats of high quality primer and stoved after each coat. The coating shall be done electro statically followed by stoving. Alternatively, Alu-zinc coated sheet steel for fabrication is also acceptable.
Doors & Covers shall be finished with RAL-7032 powder paint.

T. ACCESSSORIES

Following accessories shall be furnished along with the Switchgear :

Earthing equipment suitable for Earthing the Bus.

Earthing equipment suitable for Earthing the Outgoing Cable.

U. TEST

The switchgear shall be completely assembled, wired, adjusted and tested at the factory as per the relevant IS / IEC standards.
Routine Test shall include but not necessarily limited to the following :-
Operation under simulated service condition to ensure accuracy of wiring, correctness of control scheme & proper functioning of the equipment.
All wiring and current carrying part shall be given appropriate High Voltage test.
Secondary current and voltage shall be applied to all instrument transformers.
Following minimum test certificates shall be submitted alongwith the offer :-
Impulse & Power Frequency withstand Test
a. Temperature rise Test
b. Short circuit Test
Breaker Duty / Mechanical & Electrical Endurance (E1 & M2 category)

V. SPARES

TheThe Bidder shall submit a list of recommended spare parts for three (3) years satisfactory and trouble-free operation, indicating the itemized price of each item of the spares. The final quantity shall be decided during placement of order.

4. DISTRIBUTION TRANSFORMER

A. DRY TYPE CAST RESIN TRANSFORMER

SCOPE OF WORK

Design, manufacture, testing, supplying and commissioning of 11 KV/433 Volt or 6.6KV/433 volts (As per the available voltage level of CESC) step down, transformer complete with all the accessories and fittings for efficient and trouble free operation.
All dry type transformers will be located indoors. Contractor shall provide suitable enclosures with degree of protection of IP-23 for these transformers. These transformer cubicles will be located adjacent to the switchgear cubicles such that 415V switchgear buses in incomer-breaker can be connected to the L.V side (i.e. 433V bus) of transformers. Transformer Manufacturers shall make the required provisions to match with switchgear manufacturer's bus bars in all respects.
All dry type transformers shall be in accordance with the specification and tender drawings.
Contractor to furnish foundation details required for the transformer and cubicle. It should be possible to withdraw transformer after disconnecting roller stopper arrangement, H.T and L.T connections and opening cubicle door.
The contractors will be required to prove that all components are designed to meet requirements of this specification (such as temperature limits, constructional requirements, short circuit withstand & noise level. Contractors should enclose with their offer type test certificates for components that have already been type tested and are known to meet the requirements of this specification.
All material offered shall be new first class in all respects.

CODES AND STANDARDS

The design, manufacture and performance of equipment shall comply with all currently applicable statutes, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be constructed to relieve the VENDOR of this responsibility.
Unless otherwise specified, equipment shall conform to the latest editions of the applicable standards and in particular to following standards. In case of conflict between the applicable standards and this specification, this specification shall govern.

IS: 226	:	Structural Steel.
IS: 1554	:	PVC insulated cables for working voltages up to and including 1100 volts.
IS: 1271-1958	:	Classification of insulating materials for electrical machinery and apparatus in relation to their thermal stability in service.
IS: 2026- 1977	:	Power Transformer.
IS: 11171-1985	:	Dry type power transformers.
IS: 2090-1973	:	Bushings for alternating voltages above 1000V.
IS: 2147-1962	:	Degrees of protection provided by enclosures for low voltage switchgear and control gear.
IS: 2705	:	Current Transformer.
IS: 3114-1981	:	Methods of test for mineral wool thermal insulation materials.
IS: 3639-2966	:	Fittings and accessories for power transformers.
IS: 8183-1976	:	Bonded mineral wool.
IEC: 76 (Part 1 to 5)	:	Power transformers.
IEC: 216 (Part 3)	:	Guide for determination of thermal endurance properties of electrical insulating materials.
IEC: 551	:	Measurement of transformer and reactor sound levels.
IEC: 606	:	Application guide of power transformers.
IEC: 616	:	Terminal and tapping markings for power transformers.
IEC: 726	:	Dry type power transformers.
ECBC 2011	:	Transformer losses.
IS: 7098 (Part 2)	:	Cross linked polyethylene (XLPE) insulated PVC sheathed cables.

GENERAL CONSTRUCTIONAL FEATURES

All material used shall be of best quality and of the class most suitable for working-under the conditions specified and shall withstand the variations of temperature and atmospheric conditions, overloads, over-excitation, short-circuits as per specified standards, without distortion or deterioration or the setting up of undue stresses in any part, and also without affecting the strength and suitability of the various parts for the work which they have to perform.

CORE

The magnetic circuit shall be constructed from high (Prime) grade cold-rolled non-ageing grain oriented low loss silicon steel laminations and shall be of 'core' type. The core shall be insulated on both sides for low losses.

The insulation structure for the core to bolts and core to clamp plates shall be such as to withstand the specified voltage as per relevant standards for minutes.

WINDINGS

High Voltage and Low Voltage windings shall be made of copper and insulation shall be of class F. High voltage and low voltage windings, shall be completely impregnated and cast under vacuum into moulds. This process shall form the insulation system of uniform glass fiber epoxy laminate of highest electrical and mechanical quality, into which windings shall be voidlessly embedded. It should be possible to energize the transformer without pre-drying even after a long period of service interruption. The resin used shall be non-inflammable and self-extinguishing type.

Both the high voltage and low voltage windings of each phase shall be separately cast as one rigid tubular coil.

INTERNAL EARTHING

The framework and clamping arrangements of core and coil shall be securely earthed by copper strip connection to the main frame and enclosure. Two separate earthing terminals shall be available for terminating Purchaser's 10 sq.mm copper conductors through lugs.

ENCLOSURE

The transformer shall be housed in 2 mm thick CRCA sheet steel enclosure mounted on bi-directional rollers. Enclosure shall be provided with metal screen at top and bottom for ventilation. Degree of protection of enclosure shall be IP-28. Transformer enclosure/doors shall be openable type and shall be provided with limit switches and wired accordingly to trip the HT Breaker if the same is opened when the transformer is ON. The enclosure shall be provided with exhaust fans as an additional measure for cooling.

TERMINATIONS

Transformers shall be suitable to receive 11 KV XLPE cables of specified size.

The HV cable termination facility on the transformers shall be designed for connecting Purchaser's aluminium conductor, XLPE cable terminated in crimping type lugs. (cable lugs are to be included in the

scope of supply). The cable entry is from the top. The HV bushings shall be located in the lower half side of the transformer, at a convenient height.

Phase to phase and phase to ground clearance within the enclosure shall be such as enable either the transformer or cable to be subjected separately to H.V tests. Clearances shall be subject to the Purchaser's approval.

L.T side (433V) terminals shall be connected by means of copper (flats/ bus bars) bus to switch gear bus. Prices quoted for the transformers should include the tinned copper clamps required on the LV side for connecting suitably rated bus bars or flexible to the LV bushings. The positions of the LV terminals on the transformer shall be such that horizontal/ vertical connections to switchgear bus bars are straight and without unnecessary joints. Switchgear bus bar details will be furnished after placement of Purchaser's order.

Contractors shall quote unit price for neoprene rubber bellows. The LV terminal flange shall be suitable to terminate 1600A Al bus ducts. The LV terminals and bus-bars shall be located on the side of the transformer towards the switchgear.

The neutral of the star-connected winding shall be in two branches and shall be brought out to two separate bushing terminals. One neutral bushing shall be provided to facilitate leading the earth conductor down to the ground level along with C.T's for earth fault protection. A second bushing shall be provided for connecting neutral bus bar to switchgear. The neutral connections shall be copper.

BUSHINGS

Bushings shall be designed and tested to comply with the applicable standards. If type test certificates are not available, these tests shall also be carried out in addition to the routine tests.

Bushings rated for 400A and above shall have non-ferrous flanges and hardware.

Fittings made of steel or malleable iron shall be galvanized.

All bushings shall be supplied with terminal connector clamp suitable for connecting the bushing terminal to the Purchaser's specified conductor.

MARSHALLING BOX

The contractor shall provide a marshalling box and shall marshal to it all the contacts/ terminals of all electrical devices (such as CTs, winding temperature indicator, thermister electrical circuit etc) required for the transformer. The contractor shall provide the inter-connection cabling between the marshalling box and the devices on the transformer. This interconnection shall be through wires in GI conduits or through armoured cables. The insulation for the wires/cables shall be consistent with the ambient temperature at the location and shall have at least 70 deg C PVC insulation. Compression type brass cable glands required for these inter-connections at the marshalling box shall be included in the scope of supply. Cable glands required for purchaser's external connections are also included in the scope of supply.

The marshalling box shall be mounted in an easily accessible position on the transformer and painted as per clauses 3.19. All doors covers and plates shall be fitted with neoprene gaskets. Bottom shall be at least 600mm from floor level and provided with removable, bolted, undrilled gland plate.

All contacts for alarm, trip and indication circuits shall each be electricity free-wired for auxiliary DC supply as specified and brought out to separate terminals at the terminal blocks in the marshalling box. Terminals shall be rated for 10A. Wiring shall be with stranded copper conductor of sizes not smaller than 1.5 sq.mm for control and 2.5 sq.mm for CT circuits. CT terminals shall be provided with shorting facility. Wiring insulation shall be consistent with the ambient at the location.

All sheet metal work shall be phosphated in accordance with IS: 6005. After phosphating, thorough rinsing shall be carried with clean water, followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed by the application of two coats of ready mixed stoving type primer. The first coat may be flash dried while the second coat shall be stoved. After application of primer, two coats of finishing epoxy paint shall be applied, each coat by stoving. The second finishing coat shall be applied after completion of tests. Each coat of primer and finishing paint be of slightly different shade to enable inspection of the paint. The final finished thickness of paint film on steel shall not be less than 75 microns and shall not be more than 100 microns. Surface treatment procedures not complying with the foregoing requirements are liable to be rejected. A small quantity of finishing paint shall be supplied for minor touching-up required at site after the installation. The colour of finishing paint shall be air craft gray shade No.693 as per IS.

Electrical and Thermal Performance Requirements

Transformers shall be rated to continuously carry the full load current. The maximum temperature rise specified shall not be exceeded when loaded as above with AN cooling.

Transformers shall be designed for 110% continuous over fluxing withstand capability.
The continuous and short time overloading capacities shall be furnished in detail. Terminals, tap changers or other auxiliary equipment shall not limit the over loading specified above.
The neutral terminal of windings with star connection shall be designed for the highest over current that can flow through this winding.
Every care shall be taken to ensure that the design and manufacture of the transformers shall be such as to reduce noise and vibration to the level obtained in good modern practice. The contractor shall ensure that the weighted sound power level of transformer does not exceed 65 dB when measured in accordance with IEC-551.

RATING

Transformer shall be suitable for continuous operation and maximum rating shall be as given in the schedule of quantities.

CONNECTIONS AND VECTOR GROUP

Delta on High Voltage side and star on low voltage side with neutral terminal brought out for solid earthing corresponding to the Vector Symbol Dyn - 11.

SYSTEM OF SUPPLY

3 phase, 50 Cycles, 6.6 / 11 / 22 / 33 KV earthed system.

TAPINGS

Off circuit tap changing links on HV side. The tapingsshall be provided for variation on HV side from +5% to -15% in steps of 1.25% each.

Type

Indoor type.

Cooling

A N Cooled

TEMPERATURE RISE

The maximum temperature rise of the winding shall not exceed the following values as per IEC-726, when measured by the winding resistance method:

Class of Insulation		Maximum Temperature rise in °C
Class B (130°C)	:	70
Class F (155°C)	:	90
Class H (185°C)	:	115
Class C (220°C)	:	140

FITTTINGS AND ACCESSORIES

The following fittings and accessories shall be provided:

i. Terminal complete with connectors for the Purchaser's external conductors as specified.

ii. Neutral bushing terminal complete with connector for earth conductor specified in Section-1.

iii. Neutral bushing terminal with clamp for connection of bus bars to switchgear.

iv. Rating and terminal marking plates.

v. Two earthing terminals for Purchaser's connections.

vi. Lifting lugs for lifting complete transformer (core and coil assembly) and separately for enclosure.

vii. Jacking pads (Transformers weighting above 3000 kg).

viii. The under base provided with channels etc., for fixing rollers.

ix. Four bi-directional rollers in base frame.

x. R.T.D based or thermister based winding temperature indicating and alarm units. (This unit will form the main protection system for the transformer and the conventional, C.T base W.T.I as specified will be used as back up protection). This unit shall have indicating instrument and contacts for "High and Too High" alarms as specified complete details of the thermister based or R.T.D based system offered shall be furnished.

MAXIMUM ALLOWABLE POWER TRANSFORMER LOSSES

Maximum allowable losses for Dry type distribution transformers with highest voltage for equipment up to 22 KV, at 50 % and 100 % of the load.

TRANSFORMER CAPACITY KVA	MAXIMUM ALLOWABLE LOSSES (kW) AT 50% LOADING	MAXIMUM ALLOWABLE LOSSES (kW) AT FULL LOAD
100	0.94	2.4
160	1.29	3.3
200	1.5	3.8
250	1.7	4.32
315	2	5.04
400	2.38	6.04
500	2.8	7.25
630	**3.34**	**8.82**
800	3.88	10.24
1000	4.5	12
1250	5.19	13.87
1500	6.32	16.8
2000	7.5	20
2500	9.25	24.75

MEASUREMENT AND REPORTING OF TRANSFORMER LOSSES
TESTS

- All routine tests including partial discharge test as per IS2026-1977 / IS: 11171-1985 which is applicable shall be carried out at the factory and copies of test reports shall be submitted for approval and records.
- Heat Run Test shall be carried out at an approved test lab as per IS:2026-1977 at no extra cost.
- Impulse test shall be carried out at an approved test lab as per IS:2026-1977
- Measurement of winding resistance.
- Ratio polarity and phase relationship.
- Impedance voltage.
- Load Losses.
- No-Load losses and no-load current.
- Insulation resistance.
- Induced over voltage with-stand.
- Temperature rise.

PENALTY FOR LOSSES

Penalty during evaluation of bids

The offer with the lowest guaranteed losses will be considered as the base value. The losses in other transformers will be compared with the base value. The cost considered for evaluation purposes will be computed as follows :

CE = QP + 54,500 x (DIL +DCL)

Where CE = cost considered for evaluation
QP = Quotation price of offer.
DIL = Difference in iron loss from base value
DCL = Difference in copper loss from base value.

(Rs. 54,500 is the penalty per kW loss, for both iron and copper losses, considered for evaluation of bids).

PENALTY FOR LOSSES AT TESTING:
During testing of the transformers, if the actual losses are found to exceed the guaranteed values, the contractors will be penalized at the rate of Rs.61.30 (Rupees Sixty One and thirty paisa only) per watt of excess loss, per transformer.

REMOTE TAP CHANGER CONTROL PANEL (RTCC)
RTCC panel shall be of sheet steel cabinet for indoor installation, floor mounting type. The RTCC panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket and padlocking arrangement. RTCC panel shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of RTCC panel shall be 14 SWG CRCA sheet steel and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (part-I) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.
All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of RTCC panel. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panel.
The following components shall be provided in the RTCC panel:

- Digital Tap Position Indicating Meter
- Raise/Lower Push Buttons for Remote Control of OLTC
- Tap Change in Progress Signal Lamp.
- Supply on Signal Lamp
- Local / Remote Control Indicating Lamps
- Panel illuminating lamp with door switch.
- Space Heater with Switch and Thermostat.
- Automatic Voltage Relay with Time Delay Element.
- Selectors switch for Auto/Manual Operation.
- Undrilled Gland Plate for Cable entry.
- Earthing Terminal
- Lifting Eyes Bolts.

5. TECHNICAL DATA SHEETS

A. TECHNICAL DATA SHEET FOR MV SWITCHGEAR

Sl. No.	Description	Tender Specification	Confirmation by the bidder
1.0	**Switchgear**		
1.1	General		
	Type	Metal-clad, draw out	
	Service	Indoor	
	Enclosure	IP – 4X	

1.2	System		
	Rated Voltage (KV)	11 kV ± 10% Or 6.6KV ± 10% (As Per available voltage source from CESC)	
	Phase	Three	
	Rated Frequency	50 Hz ± 5%	
	System grounding	Non effectively earthed	
1.3	Design ambient temperature	45ºC	
1.4	Rated Current inside the cubicle and at design ambient temperature of 45ºC		
	Bus bar	As per requirement	
	Circuit breaker	As per requirement	
1.5	Short Circuit Rating		
	Rated short time withstand current	17.5KA	
	Duration	1Sec.	
	Rated peak withstand current :	2.5 times of Breaking Current	
1.6	Insulation level		
	Rated lightning impulse withstand voltage		
	Rated one minute power frequency withstand voltage		
1.7	AC/DC Power Supply		
	Control voltage	110 V DC	
	Service voltage	240V ± 10%, 1 Ph, 50 Hz ± 5%	
1.8	Termination details		
	Incomer/ Tie feeder	Bottom entry cable	
	Outgoing feeder	Bottom entry cable	
1.9	Painting requirement		
	a) Finish paint	Powder coating / Alu-Zinc	
	b) Paint base	Epoxy / Alu-zinc coated	
	c) Paint shade	RAL 7032 (only on Doors & Covers)	
2.0	**CIRCUIT BREAKER**		

2.1	Type	Vaccum	
2.2	No. of poles	Three	
2.3	Rated Voltage (KV rms)	11 KV ± 10% Or 6.6KV ± 10% (As Per available	
2.4	Rated Frequency (Hz)	50 ± 5%	
2.5	Rated normal current at site condition (Amps)	To be decided by the Bidder	
2.6	Reference Standard	IEC-62271-100	
2.7	Rated Making & Breaking Capacity	17.5KA	
2.8	Rated Short-circuit breaking current (Symmetrical)	17.5KA rms	
2.9	Rated short-circuit making current (KA peak)	2.5 times of breaking current	
2.10	Rated Operating Sequence	O - 3m - CO - 3m - CO	
2.11	Operating mechanism	Motor wound Spring charging	
2.12	Operating time		
	Opening time (ms)	Not more than 60ms	
	Closing time (ms)	Not more than 60ms	
2.13	Rated Supply Voltage for		
	Closing	110 V DC, (85% to 110%)	
	Tripping	110 V DC, (70% to 110%)	
2.14	Spring Charge Motor	230 V AC, (85% to 110%)	
2.15	Mechanical Life	10000 (M2 Category)	
2.16	Electrical Life	100 at full short circuit (E1 Category)	
2.17	IAC Classification	25KA for 1.0 Sec A FLR.	

B TECHNICAL DATA SHEET FOR FLOAT CUM BOOST BATTERY CHARGER FOR NICKEL CADMIUM BATTERIES

Sr. No	Description	Tender specifications	Confirmation from Bidder
A.	BATTERY		
1	Battery voltage	110 Volt	
2	Rating	Battery should be adequate to cater to continuous load (annunciation, indicating lamps	

		etc.) as well the maximum momentary load that may arise due to tripping of all HV breakers connected to bus.	
B.	BATTERY CHARGER		
1	AC Input	230 V ± 10% AC 50 Hz single phase.	
2	DC Output	To float / boost charge 110 V	
3	Current Rating	Suitably design for control circuit.	
4	Float Mode	120.0 V nominal (Adjustable) between 110.0 -.144V.	
5	Boost Mode	120.5 V nominal (Adjustable) between 110-155. V.	
6	Voltage Regulation	± 2% for AC input variation of 230 V ± 10%. Frequency Variation of 50 Hz ± 5% and DC load variation 0-100%	
7	Ripple	Less than 1 %	
8	Protection-Alarm and trip against	Phase failure, Wrong phase sequence, Short circuit, overload, under load, Input overvoltage, Input under voltage.	
9	Metering	AC input in put ammeter and voltmeter.	
10	No. of output circuit with protection	Incoming-Incomer breaker to be decide based on battery charging calculation Outgoing-10 Nos. 16 A DP MCB	

C. TECHNICAL DATA SEET FOR FLOAT CUM BOOST BATTERY CHARGER FOR SMF BATTERIES.

Sr. No	Description	Tender specifications	Confirmation from Bidder
A.	BATTERY		
1	Battery voltage	24 Volt	
2	Rating	To be given by bidder based on actual burden of relay and metering load & momentary load that may arise due to tripping of all HV breakers connected to bus.	
B.	BATTERY CHARGER		
1	AC Input	230 V + 10% AC 50 Hz single phase.	
2	DC Output	To float / boost charge 24 V and also supply a continuous load.	
3	Current Rating	suitably design for control circuit burden.	
4	Float Mode	27.0 V nominal (Adjustable) between 24-28.0 V.	
5	Boost Mode	28.2 V nominal (Adjustable) between 24-29.0 V.	
6	Voltage Regulation	+ 2% for AC input variation of 230 V + 10%. Frequency Variation of 50 Hz + 5% and DC load variation 0-100%	
7	Ripple	Less than 1 %	
8	Protection-Alarm and trip against	Phase failure, Wrong phase sequence, Short circuit, overload, under load, Input overvoltage, Input under voltage.	
9	Metering	AC input. input ammeter and voltmeter.	
10	No. of output circuit with protection	Incoming-63 Amps DP MCB Outgoing-10 Nos. 16 A DP MCB	

D TECHNICAL DATA SHEET FOR DISTRIBUTION TRANSFORMER – DRY TYPE
Make -

Sl. No	Description	Unit	Tender specifications	Confirmation from Bidder
1	Rated Capacity (Continuously rated)	kVA	630 kVA	
2	Primary Voltage	Volts	11000	
3	Secondary Voltage	Volts	433	
4	No. of phase		3	

5	Type of cooling		AN	
6	Frequency		50 Hz	
7	Vector Group		DYn 11	
8	Tap changing (To be confirmed based on confirmation form Utility)		On LOAD +5% TO -15% in steps of 1.25%	
9	Reference ambient temperature	˚C	40	
10	Maximum temperature rise (at full load) –	˚C	90 over ambient	
11.	Physical Dimensions (max)			
	Length	mm	To be filled by bidder	
	Width	mm	To be filled by bidder	
	Height	mm	To be filled by bidder	
12	% Impedance	%	5 %	
13	Iron losses at normal voltage ratio (Max.)	kW	Total transformer losses at full load & 50 % loading shall be within ECBC – 2008 recommendations	
14	Copper loss at normal voltage ratio (Max) at full load & 50 % load	kW		
15	Efficiency at unity power factor (Min)			
	Full load	%	To be filled by bidder	
	75% load	%	To be filled by bidder	
	50% load	%	To be filled by bidder	
	25% load	%	To be filled by bidder	
16	Regulation at 75% loading & 0.95 PF	%		
17	Approximate weight	Kgs	To be filled by bidder	

6. LIST OF APPROVED MAKE

SL. NO.	DETAILS OF MATERIAL	NAME OF MANUFACTURERS
1.	Cast resin dry (EPOXY) type transformer :	Intra Vidyut Kirloskar RPG – Raychem SGB, Germany (DTPL, India) Voltamp Schnider ABB

2.	VCB	ABB (up to 11 KV) AREVA Siemens Schneider Electric (Evolis) (Up to 11 kV)
3	Current Transformer (Cast Resin Epoxy Coated)	AE Kappa Matrix Pragati
4	Potential Transformer	AE Kappa Matrix Pragati
5.	Compact substation: 6.6KV/11 KV	ABB AREVA Schneider Electric Siemens
6.	Compact HT Switchgear / RMU:	ABB AREVA C&S L&T Siemens Schneider Electric
7.	Numeric Type Protection Relay	ABB AREVA L & T Schneider Electric Siemens

SL. NO.	**DETAILS OF MATERIAL**	**NAME OF MANUFACTURERS**
10.	Static Power Meter & Logger (Trivector Meters)	AE El Measure Larsen & Toubro Rishabh Secure Schneider Electric(Conzerv) Socomec

11.	Electronic Digital Meter (A/ V/ PF/ HZ/ KWH) with LED Display.	AE El Measure Larsen & Toubro Rishabh Secure Schneider Electric(Conzerv) Socomec
12.	HRC Fuse and Fuse Fitting	GE L & T Siemens
13.	Battery Charger & Batteries	HBL Life AMCO Exide Global (Rocket) Hitachi Max Power Shinkobe
14.	Insulating Mats	Commercial Enterprises DL Miller & Co. Ltd. Premier Polyfilm Ltd. RMG Polyvinyl India Ltd.

Note:

1. ***For any particular projects, the vendor shall put maximum effort to ensure that the makes remain standardized to one type/ make only. In case of any doubt or non availability of standardized makes, the vendor should obtain written clearance from the Architect/ end user within one month of receiving the LOI/ WO.***
2. ***The approved makes for Cables and Wirings listed above are meant for external wiring work like lighting points, power point, telephone systems works etc. and not applicable for panel wiring. The wiring inside panels shall be as per the manufacturers' practice and conforming to the relevant IS and good quality.***
3. ***The Contractors shall clearly mention the actual makes considered against each item in the BOQ while quoting.***

TENDER DOCUMENT

FOR
HEAD OFFICE OF KOPT
LOW SIDE ELECTRICAL WORKS

SPECIAL CONDITIONS OF

CONTRACT TIME FOR COMPLETION OF WORK

Time allowed for the execution of work in accordance with these conditions shall be the essence of the contract. The time allowed for the completion of work shall be SIX (6) MONTHS from the date of hand over of site from the issue of letter of intent to the successful contractor.

DEFECTS /LIABILITY PERIOD

The contractor shall guarantee that all equipment shall be free from any defective materials and workmanship & that the equipment shall operate satisfactorily. The performance and the efficiency of the equipment shall be not less than the guaranteed values. The guarantee shall be valid for a period of 12 months from the certified date of completion and during this period the contractor shall be responsible to make good and remedy any defect from time to time at his own expense.

The guarantee shall cover all the aspects which in the opinion of the owner / Architect the defects are due to defective material/workmanship, the contractor shall repair/replace such items and also replace or repair any damage thereby carried to other work.

During this period of guarantee, the contractor shall furnish promptly upon request from the Owner/ Architect all servicing required to maintain the installation and all portions thereof in the operative conditions intended other than the owner's normal operation and maintenance service.

GENERAL

These special conditions shall be read in conjunction with the description of the item of work in the Bill(s) of Quantities, the particular Specifications, Local Statutory Regulations, Indian Standards Specifications/ Codes and the drawings. All the above quoted documents shall be considered supplementary to each other. However, in the case of conflict amongst the various provisions the owner's and the Architect’s opinion will be final and shall be adopted.

If specifications for any item of work are not covered by any of the documents mentioned above, the same shall be decided and conveyed by the Employer/ Architect to the Contractor and shall be binding upon him/them.

The Contractor is advised to inspect the site to ascertain the nature of site, access thereto, local facilities for procurement of materials and working labour rates prevalent in the area, in fact all matters affecting his prices and execution of the work. The tenderer shall be deemed to have full knowledge of the site and drawings whether or not he actually inspects them.

The Contractor shall mobilize and employ sufficient resources to achieve the detailed schedule within the broad frame work of the accepted methods of working and safety. The Contractor shall provide everything necessary for the proper carrying out of the work, including tools, plant and other things.

No additional payment will be made to other Contractor for any multiple shift work or other incentive methods contemplated by him in his work schedules even though the time schedule is approved by the Architect.

RATES

The rates quoted shall be deemed to allow for all minor extras and constructional details which are not specifically shown on drawings or given on the specifications but are essential in the opinion of the Engineer-in-charge to the execution of works to conform to good workmanship and sound engineering practice. The Employer/Architect reserves the right to make any minor changes during the execution without any extra payment.

The Architects decision to clarify any item under 'minor changes', 'minor extras' and 'constructional details' shall be final, conclusive and binding on the Contractor.

The rates quoted by the Contractor shall be net so as to include all requirements described in the contract agreement and no claim whatsoever due to fluctuations in the price of material and labour will be entertained.

The rates quoted by the Contractor shall include for supplying materials and labour necessary for completing the work in the best and most workmanship like manner to the satisfaction of the Employer/ Architect and which in the opinion of the Employer/Architect cannot be made better, and for maintaining the same. The rates shall be complete in all respects also including cost of materials, erection, fabrication, labour, supervision, tools and plant, transport, sales and other taxes royalties, duties and materials, contingencies, breakage, wastage, sundries, scaffoldings, etc., on the basis of works contract. The rates quoted shall include all taxes, duties, transport, insurance, octroi, or any other levies applicable under the `statute'.

In case the rates of identical items under different sub-heads/parts are different, the lowest of these will be taken for the purpose of making the payments.

The rates for different items are for all heights, depths, widths and positions, unless otherwise specified against the item. No claim in respect of any leads/lifts for any item specified in the Schedule of Quantities, for which separate items for lead/lift do not exist in that schedule, will be entertained.

The work shall be executed as per the program drawn or approved by the Employer / Architect and it shall be so arranged as to have full co-ordination with any other agency employed at site. No claim for idle labour shall be entertained nor shall any claim on account of delay in the completion of the work be tenable except extension of time secured by the Contractor as stated elsewhere.

The Contractor shall permit free access and afford normal facilities and usual convenience to other agencies or departmental workmen to carry out connected work or other services under separate arrangements. The Contractor will not be allowed any extra payment on this account.

The contractor shall provide all equipment, instruments, labour and such other assistance required by the Employer/Architect for measurement of the works, materials, etc.,

These conditions of contract are meant to amplify the specifications, schedule of quantities and drawings in addition to those conditions specified from time to time as additions or omissions to those said conditions of contract. In case of non-confirmation, the latter shall supersede the general conditions of contract.

MATERIALS

The Owner reserves the right to select any of the `Makes' given in the preferred list of Makes.
The Contractor shall ensure to the satisfaction of the Employer/ Architect that the materials are packed in original sealed containers/ packing bearing manufacturer’s markings and brands etc., except where the gross quantity required is a fraction of the smallest packing. Materials not complying with this requirement shall be rejected.

The Contractor shall store all materials in a proper manner so as to avoid contamination and deterioration. The places at site where materials are to be stored shall be subject to the approval of the Employer / Architect. Contractor shall

make arrangements to clear the place within such time as may be instructed by the Employer / Architect. No claim whatsoever will be entertained on this account.

Employer/ Architect shall have the power to cause the Contractor to purchase and use such materials of particular make or from particular source which may in his opinion be necessary for proper and reasonable compliance with the specifications and execution of work.

(a) When required by the Employer / Architect, the Contractor shall provide all facilities at site or at manufacturer's works or in an approved laboratory for testing the materials and/ or workmanship. All the expenditure in respect of this shall be borne by the Contractor unless specified otherwise in the Contract. The Contractor shall, when required to do so by the Architect shall submit at his own cost, manufacturer's certificate of tests, proof sheets, mill sheets etc., showing that the materials have been tested in accordance with requirements of these specifications.

b) Neither the omission by the Employer/ Architect to test the materials nor the production of manufacturer(s) certificate etc., as aforesaid shall affect the right of the Architect to reject, after delivery the materials found unsuitable or not in accordance with the specifications.

DRAWINGS

Clarifications required or discrepancies, if any, noted by the Contractor in the various drawings supplied by the Architect must be obtained well before execution, failing which the decision of the Architect shall be final and binding on the Contractor with regard to detailing and general acceptance of the contract.

Should there be any discrepancy due to incomplete description/ ambiguity or omission in the drawings and other documents, whether original or supplementary, forming part of the contract, whether found on completion or during currency of the installation work the Contractor shall immediately on discovering the same, draw the attention of the Architect, and the Architects decision shall be final and binding on the Contractor.

Large scale details shall take precedence over small size drawings. Special dimensions in the specifications or Schedule of Quantities or instruction of the Architect shall supersede the drawings. The Contractor shall verify all dimensions at site.

Detailed working drawings on the basis of which actual construction shall proceed will be furnished to the Contractor by the Architect. Payment will be made on actual measurement of work done, as admissible as per drawings at the rates entered in the Schedule of Quantities forming part of these tender documents.

RECTIFICATION OF DEFECTS

Any defect in the work done or materials used in the works pointed out by the Employer / Architect shall be rectified within a week or such extended time as may be allowed in this failing

which the said defect shall be got rectified by the Employer / Architect at the risk and cost of the Contractors.

CLARIFICATIONS OF DISCREPANCIES

In case of any discrepancy between specifications, drawings etc., furnished or disputes in respect thereof, the interpretation of the Architect shall be final and binding.

The levels, measurement and other information concerning the existing site as shown on the drawings or as described are deemed to be correct, but the Contractor shall verify them for himself as no extra claim whatsoever shall be entertained on account of the errors or omissions in such matters or on account of the descriptions turning out to be different from what was expected by him.

FEES, PERMITS AND TESTS

The Contractor shall obtain and pay for any and all fees and permits for the installation of the work. On completion of the work, the Contractor shall obtain and deliver to the Employer certificate of final inspection and approval by the Local Authority. The Engineer-in-Charge shall have full powers to require the materials or work to be tested by an independent agency at the Contractor's expense in order to prove their soundness and adequacy.

SCOPE OF WORK

The work to be carried out under this contract comprises Low side Electrical works for the HEAD OFFICE OF KOPT. The Contractor shall carry out and complete the said work under this contract in every respect in conformity with the current rules and regulations of relevant statutory authorities and the local practices, the Bureau of Indian Standards and with the direction of and to the satisfaction of the Architect or by other agencies. The Contractor shall furnish all labour and
install all materials, appliances, equipment (expect those items which will be supplied by the Owner to the Contractor at site), necessary for the complete provision and testing of the Installation as specified herein or noted on the drawings. This also includes any material appliances, equipment not specifically mentioned

herein or noted on the drawings as being furnished or installed but which are necessary and customary to make complete installation of electrification works shown on the schedule and described herein, properly connected and in working condition. The work shall include all incidental jobs connected with installation such as excavation of trenches and back filling, cutting/drilling and grouting for fixing of fixtures, equipment etc.

In general the work to be performed under this contract shall comprise the following:

i. Supply and install complete works as shown on the drawings and described in this specification and as per the latest ISI specifications including all that which is reasonably inferred.

ii. Complete installation of the works appurtenances internally.

iii. Co-operation with other crafts, in putting the installation in place. Any work done without regard or consultation with other trades, shall be removed by the contractor without additional cost to the owner, to permit the proper installation or all other work, as desired by the Architect

iv. Repair all damages done to the premises as a result of this installation and removal of all debris left by those engaged for this installation.

v. It is the responsibility of the contractor to take care of all the equipment fitted until the time of handing over to the owner.

vi. Touch-up painting of structures and equipment to be carried out after erection.

POSSESSION PRIOR TO COMPLETION AND DEFECTS LIABILITY PERIOD

The Employer reserves the right to take up erection of plant or any other work during construction for any use completed or partially completed work or part of the work. Such use shall not be deemed to be on acceptance of any work not completed in accordance with the contract agreement. Only if such prior use by the Employer delays the progress of work then an equitable adjustment in the time of completion only will be made.

The work will not be considered as complete till all the components of the installation provided for in the contract that have been installed at site in all respects have been inspected/ tested by the Employer / Architect to his entire satisfaction and a completion certificate issued by the Architects.

During the defects liability period the Contractor shall be responsible for any defects in materials or workmanship that may develop in the works and shall remedy the same at his own cost to the entire satisfaction of the Employer / Architect. The Contractor shall also reinstate any portion of such defective works and/or replace any defective

material therein and generally do whatever may be necessary so that the whole of the said works may at the expiration of the said period be in a condition satisfactory to the Architect.

Final security deposit shall not be effected till the final certificate to this effect is issued by the Architect.

WORK AND WORKMANSHIP

The Contractor shall make arrangements for and provide at his own cost all temporary works, if required at site, after obtaining prior approval of the Architect/Employer.

To determine the acceptable standard of workmanship, the Employer / Architect may order the Contractor to execute certain portions of works and services under the close supervision of the Architect. On approval, these items shall be labeled by them as guiding samples so that further works are executed to conform to these samples.

All materials, articles and workmanship shall be the best of their respective kind for the class of the work described in the contract documents. The Employer / Architect reserves the right to select any of the makes specified in the tender to his choice.

All fittings, fixtures and materials shall be of the best quality and manufactured in India and shall be approved by the Employer / Architect. The workmanship shall be best quality and decision of the Employer shall be final and binding as to whether the quality conforms to the standard specified or not.

All items of work under this contract shall be executed strictly in accordance with the relevant specifications read in conjunction with the appropriate Indian Standard Specifications duly modified by special conditions, and particular specifications.

Even though the payment shall be effected under different items in the schedule of quantities, the various items in the schedule of quantities shall be deemed to cover all aspects of the work for the completion of the work as per drawings, from excavation to the finishing not-withstanding any possible omission in the description of the item and specifications thereof regarding incidental items of work, without which the whole work cannot be deemed to have been included under the scope of the different items of the schedule of quantities. The Contractor is advised to keep this in mind while quoting rates as no claims in this regard shall be entertained.

DRAWINGS & SPECIFICATIONS

The drawings and specifications shall be considered as part of this contract and any work or material shown on drawings and not called for in the specifications or vice versa, shall be executed as if specifically called for in both and are essentially diagrammatic.

The work shall be installed as indicated on the drawings; however any minor changes found essential to co-ordinate, this work with other trades shall be made without any additional cost. The data given herein and on the drawings are not guaranteed. The drawings and specifications are for the assistance and guidance of the contractor's and exact locations and distances and levels will be governed by the building and approval of the Employer / Architect shall be obtained before the commencement of the work.

SITE ORDER BOOK

The Contractor shall maintain a site order book at the site of works. When necessary the Architect will utilize the book to issue instructions to the Contractor. The Contractor shall follow these instructions in the execution of his work.

COMPLETION DRAWINGS

At the completion of the work and before issuance of certificate of virtual completion the contractor shall submit to the Architect/Employer layout drawings drawn at approved scale indicating the complete equipments "As Installed"

MANUFACTURER'S INSTRUCTIONS

Where manufacturers have furnished specific instructions, relating to the materials used in this job, covering points not specifically mentioned in these documents, these instructions shall be followed in all cases.

MATERIALS & EQUIPMENT

All materials and equipment shall conform to the relevant standards and shall be of the approved make and design. Unless otherwise called for only the best quality materials and equipment shall be used. The contractor shall be responsible for the safe custody of all materials and shall insure them against theft, damage by fire, earthquake etc. A list of items of materials and equipment, together with a sample of each shall be submitted to the Architect within 10 days of the award of the Contract. Any item which is proposed as a substitute shall be accompanied by all "Technical Data" giving sizes, particulars of materials and the manufacturer's name. At the time of the submission of proposed substitutes, the Contractor shall state the credit, if any due to the Employer. In the event the substitutions shall be requested in writing and approvals obtained in writing from the Employer / Architect. Where no specific make of materials is specified any first class product of a reputed manufacturer may be used, provided it conforms to the requirements of these specifications. The Architect decision in this matter is final.

GUARANTEE

At the close of the work and before issue of certificate of virtual completion by the Architect the contractor shall furnish a written guarantee indemnifying the owner against defective materials and workmanship for a period of one year after completion. The contractor shall hold himself fully responsible for reinstallation or replace free of cost to the owner:

ii. Any material or equipment supplied by the Employer which is proved to be damaged or destroyed as a result of defective workmanship by the Contractor.

iii. Any material or equipment inside the building damaged or destroyed as a result of defective workmanship by the Contractor.

COMPLETION CERTIFICATE

On completion of the Installation a certificate shall be furnished by the Contractor counter signed by a licensed supervisor, under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as required by the local supply authority.

QUALIFIED COMPETENT SUPERVISION

The Contractor shall employ competent fully licensed, qualified full time Engineer to direct the work of complete electrification in accordance with drawings and specifications. The Engineer shall be available at all times on the site to receive instruction from Architect in the day to day activities, throughout the duration of the contract. The foremen shall co-relate the progress of the work in conjunction with all relevant requirements of the supply authorities.

MISCELLANEOUS

Invitation to Tender shall be deemed to be part of these special conditions.

The work will be carried out as per regulations and bylaws of the local authorities. The contractor shall take whatever action is required in getting necessary approvals of plans etc. as well as necessary sanctions for the Installation from the local authorities, wherever required.

ADDITIONAL WORKS

If required, the Contractor shall have to execute additional works within the Project site to the extent of 25% (Twenty five percent) of the total accepted contract sum. No adjustment of rates shall be made up to this limit and the terms and conditions of the contract shall remain unaltered.

The Contractor shall make his own storing arrangement, site offices etc., inside the site, as required. Owner will give only the space (as per availability) inside the building premises.

RESTRICTED AREA

For all purposes of this contract the site is considered as a Restricted Area. The Contractor shall ensure that he obtains entry passes for all his workmen and employees. The Contractor shall obtain special permission in writing from the Owner if he desires to continue working beyond office hours or on Holidays. The Contractor shall also observe and abide by the security regulations applicable during the currency of the contract.

GENERAL

Any clarification / interpretation shall be clarified well in advance without delaying any item of execution.

Any substitution item will have to be approved in writing by Architect / client well in advance.

TECHNICAL SPECIFICATIONS

1. GENERAL:

The entire electrical installation shall be carried out in accordance with latest Indian Electricity Code and relevant IS/ IEC standards.

Contractor shall be responsible for obtaining all necessary statutory approvals, clearances and getting actual connections.

All material, equipment, fixtures used in the installation shall be of approved quality confirming to relevant IS/ IEC specifications.

Contractor shall submit all necessary drawings for approval by Engineer / Architect prior to commencement of work.

Contractor shall carry out all necessary tests including Insulation Resistance Test, Earth resistance Test, Continuity of conductors.

Contractor shall furnish necessary test certificates as required by Clients / Authorities / Architects.

After completion of Supply of material and installation of wiring system including earthing , if any defect in the workmanship is found or any defect in the material is found by the Engineer / Architect, the contractor shall remove the same and supply approved materials as per instruction by Engineer / Architect and rectify the workmanship at contractor's own cost.

2. INTERNAL WIRING

SYSTEM SCOPE OF WORK

The scope of work under this section generally covers internal wiring for lights, fans, exhaust fans, call bells, fan coil units, geysers, power sockets etc. The contractor shall provide all materials, labour, equipment, scaffoldings, etc., as required for the completion of wiring installation called for. The wiring shall generally be done using PVC insulated copper conductor flexible FRLS/ ZHLS wires in FRLS PVC (ISI marked, 2mm wall thickness of sizes not less than 20 mm dia.)/ M.S./ G.I conduit as called for including providing switches, sockets, plug tops, fan regulators, outlet boxes etc.

CODES AND STANDARDS

The applicable standards for above work shall be as listed below:

IS: 732 Code of practice for electrical wiring installation (System voltage not exceeding 650 V).

IS: 1646 Code of practice for fire safety of buildings (General Electrical

installation). IS: 2667 Fittings for rigid steel conduits for electrical wiring.

IS: 3480 Flexible steel conduits for Electrical wiring.

IS: 3837 Accessories for rigid steel conduit for electrical wiring.

IS: 694 PVC insulated cables.

IS: 2509 Rigid - non-metallic conduits for electrical wiring.

IS: 6946 Flexible (Pliable) non-metallic conduits for electrical

installation. IS: 1293 Pin plugs and sockets.

IS: 8130 Specifications for conduits for electrical installation.

IS: 3854 Switches for domestic purpose.
IS: 3415 Fittings for rigid non-metallic conduits.
IS: 4648 Guide for electrical layout in residential

building. IS : 9537 Conduits for electrical installation.

IS: 302 General and safety requirements for household and
similar electrical appliances.

IS: 3043 Code of practice for earthing.

IS: 5216 Guide for safety procedures and practices in electrical

work. Indian Electricity Act and Rules.

Regulations for the electrical equipment in buildings issued by the Directorate of Electricity and West Bengal State Electricity Distribution Company Limited.

All standards and codes mean the latest.

SYSTEM OF WIRING

The system of wiring shall consist of single core, PVC insulated, 1100 Volt grade, stranded copper conductor flexible FRLS/ ZHLS wires/cables laid through concealed or exposed FRLS PVC/ GI/ MS conduits as mentioned elsewhere or as directed by owner/ Architect.

GENERAL

Prior to commencement of laying and fixing of conduits and light outlet boxes, contractor shall carefully examine the layout drawings and prepare detailed shop drawings, indicating the exact location of light outlets, with distances marked, conduit routing, with sizes, number of wires run in each conduit, control switch location etc., The contractor shall obtain the approval of all shop drawings by the owner/Architect prior to the installation of conduits. Any discrepancy noticed in the design drawings shall be brought to the notice of the owner/Architect. Any suggestions or modification suggested by the contractor shall have approval of Client/ Architect before execution.

TYPE OF INSTALLATION

Unless otherwise specified all conduits for surface wiring shall be heavy gauge rigid GI/MS conduits and all concealed installation including conduits running above false ceiling shall be heavy gauge rigid PVC.

All conduits buried in grade or in damp wet areas shall be heavy gauge G.I. conduits.

a. Concealed Wiring shall be done using FRLS PVC conduits in the following areas

i. Staircase area lighting.

ii. Wiring inside offices.

iii. Wiring in the false ceiling area.

iv. All other areas where surface conduit is not specifically mentioned.

b. Surface Wiring shall be done using Heavy Gauge G.I/ Black Enamelled M.S. Conduit.

i. Wiring installation in the electrical sub-station room, D.G.room.

ii. Pump room, sewage treatment plant room.

iii. Ventilation fan room, AHU room and electrical room.

c. Conduit Installation in False Ceiling Area

The PVC conduits shall run exposed using above false ceiling.

MATERIALS

CONDUITS

Type of Conduit:

All conduits for fire alarm system irrespective of surface or concealed shall be of G.I/ M.S.

Generally concealed electrical wiring installation shall be in FRLS PVC conduits and surface wiring in G.I/ M.S. conduits.

METALIC CONDUIT AND ACCESSORIES METAL

CONDUITS

Conduits and Accessories shall conform to latest edition of Indian Standards IS-9537 part 1 & 2. 16 gauge up to 32 mm diameter & 14 gauge above 32 mm diameter screwed GI or MS paintedconduits as specified on bill of quantities shall be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 and IS-5133 to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

JOINTS

All jointing shall be subject to the approval of the Owner's site representative. The threads and sockets shall be free from grease and oil. End termination of conduit on GI boxes shall be by means of hexagon check nuts & spring washer on both sides of the conduit. The joints in conduits shall be free of burrs to avoid damage to insulation of conductors while pulling them through the conduits. Rubberized bushes shall be used in the conduit entry and exit from DBs, switch boxes etc, so that wires are protected from damage to insulation of the incoming and outgoing wires.

FLEXIBLE CONDUITS

Flexible conduits wherever necessary shall be made of heavy gauge MS strip galvanized after making the spiral. Both edges of the strip shall have interlocking to avoid opening up. Flexible conduit shall be heat resistant, lead coated steel, water leak, fire and rust proof. The flexible conduit shall be heat resistant on continuous temperature up to 150°C and intermittent temperature up to 200°C. The flexible conduit shall be corrosion resistant as per IS-3480 & BS- 731.

PVC CONDUIT AND ACCESSORIES PVC

CONDUITS

Non-metallic conduits and accessories shall conform to IS 9537 (part 3) - 1983, IS 2509 & IS 3419 and each conduit shall bear ISI Mark. PVC conduits shall be of round, medium gauge Low smoke, Fire Retardant polyvinyl chloride (PVC). The conduit shall be plain end type as specified in IS 2509-1973/ IS 2537-1983. The conduit internal surface shall be smooth. Only approved quality, factory made bends/accessories shall be used. Minimum size of conduits shall

be 20mm diameter. PVC conduits shall be rigid non plasticized, heavy gauge having minimum wall thickness of 2.0mm up to 25mm diameter conduit and 2.5mm wall thickness for all sizes above 25mm diameter.

PVC CONDUIT ACCESSORIES

Accessories used for conduit shall be of an approved brand and type complying with relevant IS code.

All accessories used shall be of standard white or black colour, identical to conduit used.

Plain conduits shall be joined by slip type of couplers with manufacturer's standard sealing cement.

All conduit entries to outlet boxes, trunking and switchgear are to be made with adaptors female thread and screwed male bushes.

PVC-switch and socket boxes with round knockouts are to be used. The colors of these boxes and the conduits shall be the
Standard PVC circular junction boxes are to be used with conduits for intersection, Tee- junction, angle-junction and terminal. For the drawing-in of cables, standard circular through boxes shall be used.

Samples of accessories shall be submitted for approval prior to installation.

All jointing of PVC conduits shall be by means of adhesive jointing. Adequate expansion joints shall be allowed to take up the expansion of PVC conduits.

A. BENDS AND COLLERS

Wherever necessary bends or diversion may be achieved by means of using bends and or circular inspection boxes with adequate and suitable inlet and outlet screwed joints. The PVC conduit bends & collars shall be of heavy duty and preferably of the same make as of conduit. This shall conform to IS 9537/1983 Part III with ISI Mark. In case of recessed installation system, the bends shall be properly secured & flush with the finished wall surface. Elbows shall not be used. No bends shall have radius less than 7.5 cm or 3 times the outside diameter of the conduit. For metallic conduits, bends of defined radius shall be made by compactly filling fine sand inside the conduit length, to avoid non-uniform shape, once the bend is done. Proper jigs shall be used to ensure that the Enameling / Galvanizing of the Conduit is not damaged.

B. PVC/ INSPECTION/ JUNCTION/ PULL BOXES

The Inspection/pull box/junction box, where used, with relevant PVC conduit installation shall be of heavy gauge PVC and conform to IS specification and shall match with the conduit sizes. The box shall be round/square rectangular with conduit stub projection for termination of conduit. The box shall be of minimum 50 mm deep and the size of box shall be suitable to pull/make necessary joints of wires inside the boxes. Extra deep boxes are preferred. The boxes shall have flush type cover. The colour of plate shall match the colour of paint of the surface where installed. The boxes shall have concealed screwed socket for fixing the ceiling rose.

SWITCH OUTLET & SOCKET OUTLET BOXES

CONCEALED TYPE OUTLET BOXES

The concealed outlet boxes for switches, sockets, power outlets, telephone outlet, fan regulator etc., shall be of standard factory made and to match the exact requirement of combination of outlets. The boxes shall be fabricated out of heavy gauge CRCA cold rolled carbon alloy sheet steel with zinc plating (G.I). The size of boxes shall match the type of outlet/ switch plate to be mounted on the box. Adequate No. and size of knockout holes shall be provided to terminate the conduits in the box. These boxes shall be of standard factory made product and of same make as of switch plates and sockets. Separate screwed earth terminal shall be provided in the box for earthing.

The outlet box shall be of minimum depth of 50mm.Boxes shall be suitable for grid mounting type of accessories. Long screw shall be provided to take care of the extra plaster thickness to mount the switch plates. Provision shall be made in the box and switch plate to have the minor adjustment of alignment of switch plate to plumb level.

SURFACE TYPE OUTLET BOXES

The boxes for mounting switches, sockets and other wiring devices shall be either moulded plastic or heavy gauge CRCA sheet steel painted to match the colour of wall. The box shall be suitable to terminate the G.I/ M.S. surface conduit into the box. The size and shape of box shall match the

exact type and combination of switch plates, receptacles and wiring devices.
Deepboxes shall be used to facilitate easy termination of conduit and wires/cables. Separate screwed earth terminal shall be provided in the box for earthing.

LIGHT OUTLET BOXES

For concealed PVC conduit installation the light outlet box shall be of PVC round/square with knock-out holes. Conduit projection shall be suitable to terminate the conduit to the box. The box shall be made of heavy gauge PVC and the sample to have the approval of Construction Manager before use. The boxes shall have concealed screwed socket to fix the ceiling rose. The boxes shall be minimum 50mm deep.

For surface conduit installation the light outlet box shall be of G.I/black enameled M.S. boxes. The boxes shall have threaded stub projection having internal threading to terminate the conduits of different sizes. The boxes shall have concealed screwed socket for fixing the ceiling rose. The boxes shall be minimum 50mm deep.

CEILING FAN HOOK BOXES:

The ceiling fan hook box shall be fabricated of 2mm thick G.I/ M.S. with adequately sized G.I/ M.S. rod/ hook to fix the ceiling fan. The hook shall be concealed within the fan hook box. The side extensions of rod shall be sufficiently long to provide adequate anchorage in the concrete. The size of the box shall be such that it should be totally covered by the plastic canopy of the ceiling fan. The box shall have anticorrosive primer coating.

SWITCHES

Switches shall conform to IS: 3854, and IS: 4615. All switches shall be enclosed type flush mounted suitable for 240 volts AC. All switches shall be fixed inside the switch boxes on adjustable flat M S strips/plates with tapped holes and brass machine screws, leaving ample space at the back and sides for accommodating wires. Switch controlling the light point shall be connected to the phase wire of the circuit and load shall be restricted to maximum 800 watts per switch& maximum 1500 watts per circuit. All wiring accessories shall be BIS approved. Perfect alignment shall be maintained while fixing of the back boxes.

COVER PLATES FOR SWITCHES & OUTLETS

Switches/ sockets/ wiring devices plates shall be of the same make as of switches/ sockets/wiring devices. These shall be of best quality. Moulded plastic grid mounting type device plates/frames shall be used and these shall match with the type of switches/sockets and boxes.

COVER PLATES FOR INSPECTION/JUNCTION/PULL BOXES

The cover plate for PVC boxes shall be with minimum 3mm thick Perspex/ Formica sheet cover and for the G.I/ M.S. boxes shall be of G.I/black enameled M.S. plates. The shape of the plate shall match with that of the box.

RECEPTACLES

The sockets shall conform to IS 1293. Each socket shall be provided with control switch of appropriate rating. The sockets shall be moulded type rated for 250 volts and of 6 A or 16 A capacity as mentioned on the drawings. The 16 Amps sockets shall be multi pin (6 pin) automatic shutter type suitable for plugging 6 A/16 A plugs. The shutter shall open when the earth pin of the plug is inserted in the socket. Where called for, the 16A socket shall have indicating lamp. The socket outlets and switches shall be of grid mounting type. Where called for sockets shall be

make as of socket. The plug shall conform to IS 6538. The socket outlets installed outside the building/ open to sky or in damp/ wet areas shall of weather-proof, water-tight type.

INDUSTRIAL TYPE SOCKETS

The socket outlets single phase or three phase installed in electrical room, D.G room etc., shall be three pin or 5 pin industrial type with MCB (1 phase or 3 phase) control. The socket and MCBs shall be mounted in a sheet steel enclosure and shall be standard factory made product.

CONDUCTORS

All PVC insulated copper conductor flexible FRLS or ZHFR, as specified in BOQ, wires shall conform in all respects to Standards as listed under sub-head Indian Standards and shall be IS approved and ISI marked.

PVC INSULATED WIRES (FOR LIGHT & SMALL POWER WIRING)

The PVC cables shall conform to IS: 696/1977. For all internal wiring PVC insulated cables of 1100V grade, single core shall be used. The wires shall have the approval of Tariff Advisory Committee.

The conductors shall be plain, circular stranded annealed copper conductors complying with BS:
6360.

The minimum number and diameter of wires for circular stranded conductor shall meet the requirements set out in the relevant British Standards.

The insulation shall be PVC compound complying with the requirements of BS: 6746. It shall be applied by an extrusion process and shall form a compact homogeneous body. The PVC compound shall comply with the requirements of IS 5831-84.

The cores of all cables shall be identified by colours in accordance with the following sequence.Single phase
Three phase
Neutral
Earth

- Red
- Red, Yellow, Blue
- Black
- Green or Green/ Yellow.

Manufacturer’s logo shall be embossed throughout the length of cable.

Unless otherwise specified in the drawings, the sizes of the cables/wires used for internal wiring shall be as follows:

In case of circuit wiring for lights, exhaust fans, ceiling fans, bells, convenience socket outlet points:-

2.5 Sq.mm - For Lights/ fans/ 5A socket wiring from DB’s up to the outlet points including control wiring where the circuit length from the DB's to 1st outlet is less than 40 m.

In case of power socket outlet circuit.

6.0 Sq.mm - From DB’s 20/ 32 A Industrial type sockets.

4.0 Sq.mm - From DBs to 16 A sockets.

The earth continuity conductor size as indicated in the drawing/ BOQ shall be drawn through conduit along with other circuit cables/ wires. The size of the earth continuity conductor shall be**UNLESS OTHERWISE SPECIFIED MINIMUM SIZE OF EARTH CONTINUITY CONDUCTOR WIRES NOT FORMING PART OF THE SAME CABLE AS THE ASSOCIATED CIRCUIT CONDUCTOR.**

Nominal cross sectional area of largest associated copper circuit conductor in sq.mm	Nominal cross sectional area of earth continuity conductor in sq.mm (PVC insulated green colour wire)
1.5	2.5
2.5	2.5
4.0	2.5

6.0	4.0
10.0	6.0
16.0	6.0
25.0	10.0
35.0	10.0
50.0	10.0

Separate circuits shall run for each water heater, pantry/ kitchen equipment, window air conditioner, and similar outlets at locations as shown on drawings.

INSTALLATION OF CONDUIT

CONCEALED CONDUIT SYSTEM

Unless otherwise Specified, all wiring shall be in heavy gauge rigid PVC conduit embedded in wall, or ceiling and concealed in the false ceiling. The size of the conduit shall be selected in conformity with I.S. code and as specified in the table given below. Factory made conduit bends and accessories shall be used. PVC Conduit shall be jointed using Solvent Cement as recommended by the conduit supplier. The conduit in ceiling slab shall be straight as far as possible. Before the conduits are laid in the ceiling, the position of the outlet points, controls, junction boxes shall be set out clearly as per the dimensions and to minimize off-sets and bends. Before the reinforcement rods are kept in position electrical contractor shall mark in paint the position of outlet points and conduit drop on the shuttering. When the outlet boxes are kept in position and before pouring the concrete, all outlet boxes shall be filled with paper to avoid entry of concrete into the box. Conduits in ceiling shall be bonded to the reinforcement rods with G.I. bonding wire at intervals not more than 1000mm, to secure them in position. PVC deep light outlet

/ pull boxes shall be provided as required. The conduit in ceiling slab shall be laid above the first layer of reinforcement rods to avoid cracks in the ceiling surface. In general the conduit shall not be laid directly on the shuttering surface to avoid cracks in the ceiling surface.

Conduits concealed in the wall shall be secured rigidly by means of steel hooks/ staples at min. 750 mm intervals. Before conduit is concealed in the walls, all chases, grooves shall be neatly made to proper required dimensions using electrically operated groove cutting tools to accommodate number of conduits. The outlet boxes for control switches, inspection and draw boxes shall be fixed as and when conduits are being fixed. The recessing of conduits in walls shall be so arranged as to allow at least 12mm plaster cover on the same. All grooves, chases etc. shall be refilled with 1:4 cement mortar and finished up to wall surface before plastering of walls is taken up by the general civil contractor. Horizontal chases in walls are not allowed. Where unavoidable, prior permission of owner/ Architect shall be obtained before making any chasing. Where conduits pass through expansion joints in the building, adequate expansion fitting or other approved devices shall be used to take care of the relative movement. Whenever the conduits terminate into control boxes, distribution boards etc. conduits shall be rigidly connected to the boxes/boards with check nuts on either side of the entry. After conduits, junction boxes, outlet boxes etc. are fixed in position, their outlets shall be properly plugged with PVC stoppers or any

foreign materials do not enter into the conduit system. All conduit ends terminating into an outlet shall be provided with bushes of PVC or rubber after the conduit ends are properly filed to remove burrs and sharp edges.

Necessary G.I. pull wires shall be inserted into the conduit for drawing wires before concreting. Insulated earth wires shall be run in each conduit originating from the panel board up to the Light, Socket and Switch boxes. If the Electrical Contractor forgets to install any conduit/boxes etc., before the plastering/ painting work is done by other agencies, he may be permitted to install the same with prior permission of owners/ Architect and he shall be liable to make good the wall, floor, ceiling etc. at his own cost.

Conduits shall be so arranged as to facilitate easy drawing of wires through them. Entire conduit layout shall be done in such a way as to avoid additional junction boxes other than light points. The wiring shall be done in a looping manner. All the looping shall be done in either switch boxes or outlet boxes. Joints in junction or pull boxes are strictly not allowed. Where conduits cross building expansion joints, adequate expansion fittings or other approved devices shall be used to take care of any relative movement.

All conduits shall be installed so as to avoid touching of steam and hot water pipes.

Conduits shall be installed in such a way that the junction and pull boxes shall always be accessible for repairs and maintenance work. The location of junction/pull boxes shall be marked on the shop drawings and approved by the owner/Architect.

A minimum separation of 200mm shall be maintained between electrical conduits and hot water lines in the building.

No run of conduit shall exceed ten meters between adjacent draw-in points nor shall it contain more than two right angle bends, or other deviation from the straight line.

Caution shall be exercised in using the PVC conduits in locations where ambient temperature is
50 degree Celsius or above. Use of PVC conduits in places where ambient temperature is more than 60 degree C is prohibited. The entire conduit system including boxes shall be thoroughly cleaned after completion of installations and before drawing of wires. Conduit system shall be erect and straight as far as possible. Traps where water may accumulate from condensation are to be avoided and if unavoidable, suitable provision for draining the water shall be made.

All jointing methods shall be subject to the approval of the owner/Architect.

Separate conduits shall be provided for the following system.

a. Lighting wiring

b. 16 Amp power outlets.

c. 6 Amp outlets and lighting system.

d. 24 Volt supply system.

e. Telephone/intercom system,

f. Fire Alarm system,

g. Computer data cabling system.

h. Equipment wiring.

CONDUIT JOINTS

Conduits shall be joined by means of plain couplers. Where there are long runs of straight conduits, pull/ inspection boxes shall be provided at intervals, as approved by the owner/ Architect/ construction manager. The conduits shall be

thoroughly cleaned before making the joints. In case of plain coupler joints, proper jointing material like a vinyl solvent cement (gray in color) or any material as recommended by the manufacturer shall be used.

BENDS IN CONDUIT

Wherever necessary, long bends or diversions may be achieved by bending the conduits or by employing normal bends. No bends shall have radius less than 2.5 times outside diameter of the conduit. Heat may be used to soften the PVC conduit for bending, but while applying heat to the conduit, the conduit shall be filled with sand to avoid any damage to the conduit. Kinks in the conduit bends shall not be acceptable.

BUNCHING OF CABLES

Wires carrying current shall be so bunched that the outgoing and return wires are drawn into the same conduit. Wires originating from two different phases shall not run in the same conduit. All wires shall have ferrules for identification. Lighting and power circuits shall be separate. Each Power/ Light Circuit‘s Neutral shall be individual per Circuit and shall not be looped from any other Circuit.

DRAWING OF CONDUCTOR

The drawing and jointing of PVC insulated copper conductor wires shall be executed with due regard to the following precautions. While drawing wires through conduits, care shall be taken to avoid scratches and kinks which may cause breakage of conductors. There shall be no sharp bends. Wire reel stands to be used for pulling of wires to avoid kinks. Care shall be exercised while drawing the wires from reels, by taking appropriate measures to ensure that wires are not spread on ground, causing dust and dirt accumulation on the new wires.

Maximum permissible numbers of 1100 volt grade PVC insulated wires that may be drawn into metallic Conduits are given below:

Size of wires Nominal Cross section Area (Sq. mm.)	**Maximum number of wires within conduit size(mm)**				
	20	**25**	**32**	**40**	**50**
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid nonmetallic or PVC Conduits are given below:

Size of wires Nominal Cross section Area (Sq. mm.)	**Maximum number of wires within conduit size(mm)**				
	20	**25**	**32**	**40**	**50**
1.5	7	12	16	--	--
2.5	5	10	14	--	--
10	--	4	5	6	--
16	--	3	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Insulation shall be removed by insulation stripper only. Few Strands of wires shall not be cut/ reduced for convenience in connecting into terminals. The terminals shall have sufficient cross sectional area to take all strands and its

connecting brass screws shall have flats ends. All looped joints shall be connected through terminal block/connectors. The pressure applied to tighten terminal screws shall be just adequate, neither too much nor too less. All light points shall be terminated through a connector.

Conductors having nominal cross sectional areas exceeding 10sq.mm shall always be provided with cable sockets. At all bolted terminals brass flat washer of large area and approved steel spring washer shall be used. Brass nuts and bolts with brass washers shall be used for all connections.

Only licensed wiremen (Before doing the work or before appointing him on site contractor has to submit his wiring license to Owner) and cable jointers shall be employed to do jointing work. Before entrusting cable jointing work to any technician, or before appointing Cable Jointers or Wiremen on Site, Contractor has to submit such Technicians'/ Wireman's/ Cable Jointer's licensee to Owner.

All wires and cables shall be embossed with the manufacturer's label with ISI mark and shall be brought to site in original packing. For all internal wiring, FRLS or ZHFR PVC insulated wires of 1100 volts grade shall be used.

The sub-circuit wiring for point shall be carried out in loop system and no joints shall be allowed in the length of the conductors. No wire shall be drawn into any conduit until all defective work of conduit installation of any nature that may cause injury to wire is completed. Care shall be taken while pulling out the wires so that no damage occurs to conduits/wire itself, the conduits shall be thoroughly cleaned of moisture, dust, dirt or any other obstruction. The minimum size of PVC insulated copper conductor wires for all sub-circuit wiring for light points shall be minimum 2.5 sq.mm copper or as specified in the schedule of quantity (SOQ). Separate neutral to be pulled for each circuit.

JOINTS

All joints shall be made at main switches, distribution boards, Socket outlets, lighting outlets and switches boxes only. No joints shall be made in conduits and in junction boxes. Conductors shall be continuous from outlet to inlet.

MAINS AND SUBMAINS

Mains and sub-mains cable or wires where called for shall be of the rated capacity and approved make. Every main and sub main wires shall be drawn into an independent adequate size of conduit. Earthing shall be in conformity with relevant IS codes and calculations shall be submitted for verification. An independent earth wire of the proper rating shall be provided for every single phase sub-main. For every 3 -phase sub-main, 2 Nos. earth wires of proper rating shall be provided along with the sub-main. The earth wires shall be drawn along with circuit wires through conduit. Where mains and sub-mains cables are connected to switchgear, sufficient extra lengths of cable shall be provided to facilitate easy connections and maintenance. Where ever necessary,
powder-coated 1.6 mm thick sheet steel covering (also called trunking) shall be provided to cover the group of conduits and cables entering and exiting the Wall mounted/Floor mounted Sub DBs, DBs, and FDBs, so that the Installationlooks neat .The colour of such sheet steel covering (trunking) shall be matching with the colour of the SDBs, DBs and FDBs.65

LOAD BALANCING

Balancing of circuits in three phase installation shall be as planned by the Architects in the tender drawings and shall be verified by the contractor before the commencement of wiring and shall be strictly adhered to.

COLOUR CODE

Colour code shall be maintained for the entire wiring installation: red, yellow, blue for three phases, black for neutral, green/yellow green for earthing.

The control wire from light control switches to the light/ fan points shall be the same colour as that of the phase/ circuit wires feeding that particular loop.

EARTHING

All earthing system shall be in accordance with IS 3043 - 1985 Code of practice for Earthing. The

type and size of earthing wire shall be as specified under the heading of cables.

Each conduit originating from the DB to various outlets shall have one earth wire (PVC insulated green colour wire).

TESTING OF INSTALLATION

Before a completed installation is put into service, the following tests shall be complied with:

INSULATION RESISTANCE

The insulation resistance shall be measured by applying 500 Volt megger with all fuses in place, circuit breaker and all switches closed.

The insulation resistance in mega ohms of an installation measured shall not be less than 50 mega ohms divided by the number of points in the circuit.

The insulation resistance shall be measured between Earth to Phase

Earth to Neutral
Phase to Neutral

EARTH CONTINUITY PATH

The earth continuity conductors shall be tested for electrical continuity and the electrical resistance of the same along with the earthing lead but excluding any added resistance or earth leakage circuit-breaker, measured from the connection, with the earth electrode to any point in the earth continuity conductor in the completed installation and shall not exceed one ohm.

POLARITY OF SINGLE POLE SWITCHES

A test shall be made to verify that every non-linked, single pole switch is connected to one of the phases of the supply system.

COMPLETION CERTIFICATES

All the above tests shall be carried out in presence of Construction Manager and the results shall be recorded in prescribed forms. Any default during the testing shall be immediately rectified and that section of the installation shall be retested. The completed test result forms shall be submitted to the owner/ Architect.

On completion of an electric installation a certificate shall be furnished by the contractor, countersigned by the certified supervisor under whose direct supervision the installation was carried out. This certificate shall be in a prescribed form as required by the local electric supply authority.

3. MV CABLES AND CABLE TRAY WORKS

SCOPE OF WORK

This section covers the supply, installation storing, laying, fixing, jointing / termination, testing and commissioning of Medium Voltage 1.1 kV grade PVC/ XLPE insulated PVC Sheathed armoured aluminium/ copper conductor cables laid in built up trenches, directly buried underground, on cable trays, in pipes, clamped directly to wall or structures etc. as asked for in the BOQ/ drawing. The contractor shall provide all materials, labour, equipments, scaffoldings etc. as required for the completion of M.V. Cables, Cable Trays etc., as called for.

Cables up to 16 sq. mm. shall be with copper conductor and 25 sq. mm. and above shall be with aluminium conductor.

The MV cables 25 sq. mm & above shall be cross linked polyethylene (XLPE) insulated PVC inner sheathed and FRLS PVC outer sheath of 1100 volts grade. Cables below 25 sq. mm. shall be with copper conductor, with HR PVC core insulation and sheathing.

CODES AND STANDARDS

The applicable standards for above work shall be as listed below:

IS 1554-88 PVC insulated (heavy duty) electric cables Part I for working voltages up to and including 1100V.

IS 8130-84 Conductors for insulated electric cables and flexible cords.

IS 3961-67 Recommended current ratings for cables: (Part 2): PVC insulated and PVC sheathed heavy duty cables.

IS 5831-84 PVC insulation and sheath of electric cables.

IS 7098-89 Cross linked polyethylene insulated PVC sheathed cables.

The individual cores shall have continuous numbering of the core all along its length and also be provided with identification ferrules at both ends. Individual control cables shall have 20% spare cores.

FRLS cables shall be used for fire protection system controls to prevent flame propagation, smoke reduction and to avoid toxic gas emission in the event of a fire. FRLS compound shall be tested rigorously for oxygen index as per ASTM D2863, acid gas generation to IEC 754- 1, smoke density to ASTM D 2843 and flammability to SS 424 1475 class F3, IEEE 383 and IEC 332-1.

Manufacturer's name, ISI Mark, cable size and type shall be clearly embossed at regular intervals on all cables.

MATERIAL

TYPE AND QUALITY

Medium voltage cables shall be circular, multi core annealed copper or aluminium conductor, PVC/ XLPE insulated, PVC inner sheathed and steel wire armoured or steel tape armoured construction or unarmoured. The conductors of cable shall be stranded. Sector shaped stranded conductors shall be used for cables of 50 sq. mm. size and above. The cables shall conform to IS: 1554 part-I in all respects.

M.V power cables shall have 3, 3.5 or 4 cores, as required and shall have conductors made from electrical grade high conductivity aluminium for cable sizes 25 sq. mm and above whereas
electrical grade high conductivity copper conductor shall be used for cables below 25 sq. mm.
conforming to IS: 8130 - 84.

Conductors shall be insulated with high quality PVC base compound. Application shall be by extrusion process. Insulation and outer sheathing compounds shall conform to IS 5831 - 84. For XLPE cables the insulation shall be of natural unfilled chemically cross linked polyethylene conforming to IS 7098. The thickness of insulation shall be as per the relevant codes.

A common covering shall be applied over the laid-up cores by a wrapped or an extruded PVC sheath. The thickness of the inner – sheath shall be as per relevant codes.

Insulated conductors of multi core cables shall be with thermoplastic fillers/ plastic fibres in the interstices. The phase identification of cores shall be by coloured strips.

Armouring of galvanized round steel wires or galvanized flat steel strips shall be provided over the inner sheath. Single core cable shall have dia -magnetic armouring. Multi core cables shall have either galvanized round steel wires or flat steel strip armouring. Steel wires and strips for armouring confirm to IS: 3975. The direction of lay of armouring shall be opposite to that of cores.

Outer sheath of FRLS grade PVC shall be extruded over the armouring. Cables shall be manufactured and tested in accordance with IS 1554- 1988. The PVC compound for the outer-sheath shall confirm to Type ST2 of IS 5831. The colour of the outer sheath shall be black with marking at every meter.

Unless otherwise specified, all control cables shall be multi core, 1100V grade FRLS PVC insulated, armoured and overall PVC sheathed with stranded copper conductors of 2.5 sq.mm, conforming to IS 1554. Cores shall be identified by colour scheme of PVC insulation.

RATING

The cables shall be rated for a voltage of 1100 Volts. Current ratings of the cables shall be as per IS: 3961. The Conductor shall be stranded Aluminum/ Copper circular/ sector shaped and compacted. In multi core cables the core shall be identified as per following:

1. Single Core : Green yellow for earthing.
2. Two Cores : Red and Black, Blue & Black, Yellow & Black.
3. Three Cores : Red, Yellow & Blue
4. Four Core : Red, Yellow, Blue & Black Repaired cables

shall not be used.

Cables shall be delivered at site in a non returnable drums to conform to IS: 10418.

The cables shall be suitable for laying in racks, ducts, trenches, conduits and underground buried installation with uncontrolled back fill and chances of flooding by water.

Both ends of the cables shall be properly sealed with PVC/ Rubber caps so as to eliminate ingress of water during transportation, storage and erection.

Progressive automatic in line sequential marking of the length of cables in meters at every one meter shall be provided on the outer sheath of all cables.

NOMENCLATURE

The product should be coded as per IS: 7098 Part-I as follows:

Aluminium Conductor	A
XLPE Insulation	2X
Steel round wire armour	W
Steel strip armour	F
Non-magnetic (Al.) strip armour	Fa
PVC outer sheath	Y

INSPECTION

All cables shall be tested inspected at manufacturer’s works. However upon receipt at site cables shall be checked for physical damages during transit.

JOINTS IN CABLES

The Contractor shall take care to see that all the cables received at site are apportioned to various locations in such a manner as to ensure maximum utilization and avoid cable jointing. This apportioning shall be got approved by the Owner’s site representative before the cables are cut to lengths. Where joints are unavoidable heat shrinkable type

joints shall be made. The location of such joints shall be got approved from the Owner's site representative and shall be identified through a marker.

JOINTING BOX FOR CABLES

Cable joint boxes shall be of appropriate size, with heat shrinkable sleeves, suitable for XLPE/ PVC insulated armoured cables of particular voltage rating.

JOINTING OF CABLES

All cable joints shall be made in suitable, approved cable joint boxes and the filling in of compound shall be done in accordance with manufactures' instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resin.

All cables shall be joined colour to colour and tested for continuity and insulation resistance before jointing commence. The seals of cables must not be removed until preparations for jointing are completed. Joints shall be finished on the same day as commenced and sufficient protection from the weather shall be arranged. The conductors shall be efficiently insulated with high voltage insulating tape and by using of spreaders of approved size and pattern. The joints shall be completely topped up with epoxy compound so as to ensure that the box is properly filled.

NOTE ON FILLING OF EPOXY COMPOUND

Equal quantities of resin and hardener shall be mixed thoroughly by hand until the mixture is free from white patches and has uniform colour. No water, oil or any other liquid shall be added to the mixture to make it soft as is will affect the properties of the compound. The mixture shall be used within 30-40 minutes of mixing. The on which epoxy compound is to be used, shall be free from dust, rust, oil, grease and shall be dry. The joint neither be disturbed nor moved till the epoxy compound is completely hardened. A smooth surface can be made by rubbing a damp cloth smoothly on the compound before it sets. The joints shall be painted after they have completely hardened.

Alternatively, ready mix of epoxy cable jointing compound may also be used. In all cases manufacturer's recommendations shall be strictly adhered to.

CABLE END TERMINATION

Cable termination shall be done in terminal box or cable end box or distribution boards, or apparatus/ equipments. Terminations are to be made with mechanical and glands be tinned/ nickel plated, anti corrosive, three piece improved pattern which is to grip inner and outer PVC sheaths as well as the armour of the cable. The cable ends or the core conductor are to be connected by solder less lugs or sockets using crimping tool of approved make for all cables.

All terminations of cable conductors and base conductors shall be mechanically and electrically sound and shall comply with the requirements of IEEE regulations.

The connectors or connecting sockets are to have such dimensions so as to limit temperature rise.

When required the water tightness of the terminal boxes may be obtained by filling with a compound preferably plastic flame-retarding and non-dripping type within the normal range of temperatures.

When the cable is cut during the course of installation the open ends are to be sealed immediately by means of self-adhesive non-hygroscopic tape over a wax water seal to make an air and water tight joint.

INSTALLATION OF CABLES

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to

avoid forming kinks. The drums shall be unrolled and cables run over wooden rollers, placed at intervals not exceeding two (2) meters.

Generally cables are laid in the following manner:

i. In the underground masonry trench.
ii. On the cable tray/or on cable ladders.
iii. Buried underground.
iv. Through pipe sleeves.

Various installation methods are discussed in the following paragraphs.

GENERAL REQUIREMENTS

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of service.

When cables pass through holes in metal work, precautions shall be taken to prevent abrasion of the cables on any sharp edges.

In every vertical cable ladder, channel, duct, trunking or cable trench containing cables and exceeding three meters in length, internal barriers shall be provided so as to prevent the air at the top of the unit from attaining an excessively high temperature. In every vertical cable shaft, cable trench or any passage of cable through wall, ceiling, floor barriers against spread of fire and smoke shall be provided for compliance with IEE regulations.
Where cable passes through walls, ceiling, floor, it shall run through sleeves of PVC pipes or hume pipes of adequate diameter. After pulling the cable through sleeves, both the ends of the sleeves shall be sealed water tight with fire-resistant material to prevent spread of fire and seepage of water.

Generally along each cable route either in trench or in cable trays/ ladders or in pipe separate Two Nos. of earth strips/ wires shall run exposed.

Where an installation comprises medium voltage cables as well as extra low voltage circuits, precaution shall be taken in accordance with IEE regulations and shall be physically separated by minimum of 300mm distance.

Metal sheaths and armour of all cables, metal conduits, ducts, trunking, and bare earth continuity conductors associated with such cables, which might otherwise come into fortuitous contact with other fixed metal work shall be effectively bonded there to earth so as to prevent appreciable potential difference at such possible points of contact.

If it is necessary to install cables in a situation where flammable and/ or explosive dust, flammable volatile liquid/ vapor/ gas is likely to be present or where explosive materials are handled or stored, the cabling shall be as per IEE regulations.

UNDERGROUND INSTALLATION

The width of trench for laying single cable shall be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench shall be workout by providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum depth of the cable trench shall not be less than 750 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

EXCAVATION OF TRENCHES

The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench

shall be leveled and shall be made free from stone, brick bats etc. The trench shall then be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to lying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum shall be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable shall be removed by `Flaking' i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation shall have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables shall be protected by second class bricks before back filling the trench. The buried depth of upper most layer of cable shall not be less than 750mm.

BACK FILLING

The trenches shall be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

CABLES INSTALLED INSIDE THE BUILDING

The cables inside the building shall be installed in one of the following manner, as indicated in the drawing and approved by the Construction Manager.

INSTALLED IN BUILT-UP TRENCH

The cables laid on the bottom of the structural trenches shall not lie freely upon the trench bottom. They shall be raised to prevent the possibility of their coming into contact with deleterious materials.

The cables laid in the trench shall be laid on angle iron brackets/cable tray/cable ladder/ cable troughs/ cable racks as indicated on the drawings, and as approved by the Construction Manager. Where cables are clamped to the wall a minimum clearance of 100mm shall be maintained between wall and cable and minimum 150mm vertical clearance shall be maintained between two cables. Where cables are laid on brackets the brackets shall not be fixed more than 500mm apart to avoid sag in the cables, where the cables are laid on cable tray/ ladder/ troughs/racks, minimum 300mm distance shall be observed between adjacent tier of tray/ ladder/ troughs/racks, and cable shall be fixed minimum 25mm away from the wall, and minimum of one cable diameter distance shall be observed between two adjacent cables. Cables shall be properly fixed with the tray/ladder/troughs/racks with cable tie or saddles or straps.

INSTALLED ON CABLE TRAYS/ LADDERS

Where cables are installed under/ above suspended ceiling or below ceiling or on wall, they shall be laid on a perforated G.I. cable tray/ladder type cable tray and shall be run in such positions that they are not liable to be damaged by contact with the floor or the ceiling or other fixtures.

The cable tray/ ladder shall be properly fixed with tie rod to the ceiling. The concrete inserts for fixing the tie of shall be put in place while casting the slab. If insert plates are not placed in position, Anchor fasteners shall be fastened to support cable trays. The cable tray route shall be co-ordinated with other services to avoid crisscross of all the services.

While laying the cables on the tray minimum one cable diameter distance shall be observed between two adjacent cables. 25% space shall be kept spare for any future installation.

The trays shall be made of 16 SWG/ 12 SWG G.I. perforated sheet having minimum 50mm depth. The width of perforation shall be maximum 10mm spaced at maximum 20 mm. distance. The width of the cable tray shall be selected so as to accommodate required number of cables to be laid on it, with minimum separation of minimum one cable diameter between two adjacent cables. The cables shall be tied with the cable tray with nylon strip.

CABLE ROUTE MARKERS

Approved CI cable Route marker painted with aluminium paints shall be provided along straight runs of the cables not exceeding 30 meters also for change in the direction of the cable route and underground joints.The size of marker shall be 100 mm dia with “Cable” and voltage grade inscribed on it.

CABLE TRAY/ LADDERS

Ladder and perforated type Cable Trays shall be of Hot dip Galvanized bolted type and factory fabricated out of CRCA sheet with standard accessories like tee, bends, couplers etc. for different loads and number and size of cables. The cable trays / ladders shall be fabricated according to the design specified by IEC 61537, specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

NOTE ON HOT DIP GALVALIZATION OF CABLE TRAY

A. QUALITY OF ZINC

Zinc to be used shall conform to minimum Zn 98 grade as per requirement of IS: 209-1992.

B. COATING REQUIREMENT

Minimum weight of zinc coating for mild steel flats with thickness up to 6 mm in accordance with IS:6745-1972 shall be 400 g/ sq.mtr.

The weight of coating expressed in grams per square meter shall be calculated by dividing the total weight of Zinc by total area (both sides) of the coated surface.

The Zinc coating shall be uniform, smooth and free from imperfections as flux, ash and dross inclusions, bare patches black spots, pimples, lumpiness, runs; rust stains bulky white deposits, blisters.

Mild steel flats / wires shall undergo a process of degreasing pickling in acid, cold rinsing and then galvanizing.

SIZE OF CABLE TRAY

Cable trays for different loads and number and size of cables as given below:

LADDER TYPE

Sl. No.	Size of Cable Tray	Size of Runners	Size of Rungs	Size of Suspenders
1.	1500 mm. wide	25 x 100 x 25 x 3 mm	2# 20 x 40 x 20 x 3 mm 250 mm Center to Center.	2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.
2.	1200 mm. wide	25 x 100 x 25 x 3 mm	2# 20 x 40 x 20 x 3 mm 250 mm Center to Center.	2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

3.	1000 mm. wide	25 x 100 x 25 x 3 mm	2# 20 x 40 x 20 x 3 mm 250 mm Center to Center.	2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

Sl. No.	Size of Cable Tray	Size of Runners	Size of Rungs	Size of Suspenders
4.	750 mm. wide	20 x 75 x 20 x 2.5 mm	20 x 30 x 20 x 2.5 mm 250 mm Center to Center.	2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.
5.	600 mm. wide	20 x 75 x 20 x 2.5 mm	20 x 30 x 20 x 2.5 mm 250 mm Center to Center.	2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.
6.	450 mm. wide	20 x 75 x 20 x 2.5 mm	20 x 30 x 20 x 2.5 mm 250 mm Center to Center.	2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

PERFORATED TYPE

Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.
i. 600 x 40 x 40 x 2 mm thick
ii. 450 x 40 x 40 x 2 mm thick
iii. 300 x 40 x 40 x 2 mm thick
iv. 150 x 40 x 40 x 2 mm thick

Note: Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

Alternatively, Steel wire rope hangers shall be used to suspend the cable trays in place of fabricated support of cable tray. This hanger shall consist of a pre-formed wire rope sling with a range of end fixings to fit various substrates and service fixings. The end fixings and wire must be of the same manufacturer with several options available. The system shall be secured and tensioned with a hanger self locking grip at the other end. Once the grip is locked for safety purpose, unlocking shall only be done by using a separate setting key and shall not be an integral part of the self locking grip. Only wires and/or supports supplied and/or approved shall be used with the system.

ACCESSORIES FOR CABLE TRAYS

i. Following accessories of cable trays, as required, shall be supplied with the cable trays. Coupler plates
90 deg bends - Horizontal and Vertical.

ii. Tees - Horizontal and Vertical.

iii. Reducers

iv. 4-way cross

v. Tray covers

vi. Fasteners.

vii. Accessories also shall be hot dip galvanized, thickness of galvanizing being not less than 110 microns.

TESTING

Prior to laying cables, and prior to energizing the cables, following tests shall be carried out:

i. Insulation Resistance test between phases and phase to neutral and phase to earth.

ii. Continuity test of all the phases, neutral and earth continuity conductor.

iii. Sheathing continuity test.

iv. Earth resistance test of all the phases and neutral.

All tests shall be carried out in accordance with relevant Indian Standard Code of practice and Indian Electricity Rules. The Contractor shall provide necessary instruments, equipments and labour for conducting the above test and shall bear all expenses in connection with such tests. All tests shall be carried out in the presence of the Construction Manager and results shall be recorded in the prescribed forms.

STORING

All the cables shall be supplied in drums. On receipt of cables at site, the cables shall be inspected and stored in drums with flanges of the cable drum in vertical position. The end of the cable shall be sealed for water tightness.

GI/ AL FLOOR TRUNKING SYSTEM GENERAL

REQUIREMENTS

A. Trunking and fittings shall comply with BS 2989 or Indian Standard of IS277 with a GI coating thickness of 275 GSM minimum**.**

B. Trunking shall have top access.

C. All multi-compartment trunking systems shall maintain the stated segregation throughout, including all accessories.

D. Trunking shall be manufactured using pre-galvanized sheet steel. Trunking shall be **spotwelded** & **arc welded** throughout its length for better impact resistant and to prevent seepage ofconcrete during installation. The trunking shall normally be supplied in a standard length of 2500 mm unless otherwise specified and declared by the manufacturer with a material thickness of 1.6mm. Lengths of trunking shall be coupled together by means of joint sleeves, made of pre galvanized GI with 275 GSM GI coating. At each joint in the trunking, continuity shall be maintained by means of copper links, not less than 25 x 3 mm to achieve an acceptable earth loop impedance level in compliance with BS 2989, fixed with brass nuts, bolts and serrated washers. Removal of any lid no matter how it is fitted shall not affect the earth continuity of the trunking. ZHLS copper cable link with cable lugs may be used, if the proper connection method is provided to avoid long term corrosion and electrolytic action. The ZHLS cable shall have an equivalent cross sectional area to the copper links. Bonding link shall be fixed on external surfaces.

E. Manufacturer’s standard fittings shall be used for all connections and changes of

direction. All vertical bends, Crossover boxes, access outlets, and junction boxes shall be of the

same manufacturer as the trunking. Trunking shall not be cut or bent to form bends, flanges or attachments. Gusset bends shall be used wherever necessary to provide sufficient bending radius for the cables. Fabrication at site shall not be accepted.

F. The minimum size shall be 50mm by 40mm with single compartment. The maximum recommended size for the trunking is up to 300mm by 40mm with triple compartments.

G. All inside edges of trunking shall be smooth and provision shall be made to prevent abrasion at bends.

H. Cable retaining straps supplied by the trunking manufacturer shall be fitted at intervals not exceeding 1m. Where trunking passes through walls, floors and ceilings, proprietary fire barriers shall be installed in the trunking. The fire barrier shall have a rating not less than that of the original construction of the opening.

I. Trunking shall be adequately supported throughout its length. Trunking support and channel shall be quick-fixing type and shall be such as to space the trunking a minimum of 13mm from any part of the wall or bulkhead.

J. A minimum of two fixings shall be provided between joints in the trunking except where the distance between is less than the maximum spacing.

K. Where trunking is cut or drilled, the cut edges of the trunking shall be smoothed to prevent abrasion of the cables and shall be painted with anti-corrosion paint like aluminium coating, to the same colour as the adjacent surfaces, such painting to be carried out as the work proceeds. In no circumstances will rough screw edges and nuts be allowed in the interior of the trunking.

L. Flush or buried trunking and under floor metal ducts shall comply with BS 2989.

M. The space factor for cables installed in trunking shall not exceed 35% as per IEE regulations.

N. All lengths of vertical run trunking in excess of 3000mm shall contain cable supports made of insulating, non-hygroscopic, non-combustible material. The spacing between such supports shall not exceed 1800mm. An additional support shall be provided at the top of all vertical runs exceeding 3000mm, to support the weight of the cable and distribute the cables within the trunking to prevent undue compression of the installation.

O. Where trunking crosses expansion joints, a trunking fitting shall be used which shall allow for expansion and maintain earth continuity.

P. Suitable cutout on under floor trunking at ticket barriers shall be provided to suit Automatic Fare Collection System Contractor's requirement. The cutout shall not have a sharp edge or abrasive effect on cables. The location and route for the cutout and under floor trunking shall be according to Working Drawings.

Q. Trunking installed externally shall be manufactured from galvanized sheet steel in accordance with BS 2989 protection Class 3, or other international standards. Trunking installed internally shall be of Class 2.

R. Partitions or dividers shall be of the same material and finish as the trunking. The method of fixing shall not cause any long-term corrosion or electrolytic action.

S. Connections to multiple boxes, switchgear and distribution boards shall be made with

multi compartment vertical access boxes. Expansion joints in long continuous runs shall be provided as recommended by the manufacturer.

T. Junction boxes shall be of GI material and shall be provided with 3mm thick screw mounted covering at the top.

U. For the junction boxes coming in the passages shall have SS cover while junction boxes in the other areas (under work station etc.) shall be provided with finish as per interior requirements.

A. Trunking and fittings shall comply shall be with a 1.6 mm thick Aluminium sheet.

B. Trunking shall have top access.

C. All multi-compartment trunking systems shall maintain the stated segregation throughout, including all accessories.

D. Trunking shall be manufactured using hard anodized aluminium sheet. The trunking shall normally be supplied in a standard length of 2500 mm with a material thickness of at least

1.6 mm. Lengths of trunking, shall be coupled together by means of joint sleeves, made of anodize aluminium. At each joint in the trunking, continuity shall be maintained by means of copper links, not less than 25 x 3 mm to achieve an acceptable earth loop impedance level in compliance with BS 2989, fixed with brass nuts, bolts and serrated washers. ZHLS copper cable link with cable lugs may be used, if the proper connection method is provided to avoid long term corrosion and electrolytic action. The ZHLS cable shall have an equivalent cross sectional area to the copper links. Bonding link shall be fixed on external surfaces.

ACCESS OUTLET

A. Access Outlets are made of high quality materials to withstand heavy load and corrosionmanufactured from high-pressure die cast material for strength & durability.

C. The trap frame & trap are made of FR grade Engineering Plastic for strength & durability.

D. The Trap Frame can be easily removed by pulling either one of the Nylon Bars to detach & remove the unit for servicing or installation of accessories to save installation & servicing time.

E. Patented screw less ratchet bar level adjusting system to match with screed / floor height. The trap lid is self-adjustable to any floor finish thickness.

F. Trap cover must be reinforced with a 2.5mm thick pre-galvanized steel plate to provide rigidity & added strength. Trap lid to have a screw less knob-hinged design for quick mounting on to the frame requiring minimum maintenance.

G. The Trap cover must have 8 mm recessed for installation of carpet and tiles.

H. Trap trim design to protect carpet from damages and give the floor area added aesthetics.

I. Trap lid should be made of Electrostatic Polyester Epoxy Coating to provide excellent and enhanced protection on visible parts against chemical or saline corrosion.

J. Strong and durable trap lifting handle on the trap cover is made of similar color material and has special design for easy lifting, even with large fingers.

K. Cables are guided by Cable Retainers through generous cable outlet which open automatically and lock into position when cables are present.

L. Trap cover of Access box should be retained by Cable Grommets with high quality durable foam to prevent the cable damage from exit position & also prevent ingress of dust when closed.

M. Access Outlet should carry service plates for providing services i.e.: Power, Data & Telecom. The Access outlets must accommodate to have three compartments to run Low Voltage & Extra Low Voltage cables.

N. The system must have Positive Double Earthing connections.

O. Earth wire connector should be provided in all the boxes, and complies with the requirement of current IEE regulation.

P. Access outlets are tested to a load bearing capacity of **2 tons** on the trap lid for heavy traffic areas.

Q. Four side blanks are made with removable perforations to suit ducts installation.

R. Standards & Approvals – The system must comply to the relevant specification & IEC 61084 standards.

JUNCTION BOXES

A. Cross Overs/ Junction boxes are made of high quality materials to withstand heavy load and corrosion manufactured from high-pressure die cast material for strength & durability.

B. The trap lid is self-adjustable to any floor finish thickness using the leveling screws on all the four corners.

C. The Trap cover is made of 2.5mm thick pre-galvanized steel plate to provide rigidity & added strength.

D. The Trap covers to have flexibility for quick mounting on to the base box requiring minimum maintenance.

E. The Trap cover must have 8 mm recessed for installation of carpet and tiles.

F. The Flyover units trap frame and traps should be made of Electrostatic Polyester Epoxy Coating to provide excellent and enhanced protection on visible parts against chemical or saline corrosion.

G. The Cross Overs should carry fly-over made of Electrostatic Polyester Epoxy Coating for cables passage to ensure segregation of service

H. Crossovers are tested to a load bearing capacity of 3.6 tons on the trap lid for heavy traffic areas

I. The Cross Overs should have provision to carry Power, Data & Telecom services.

J. The system must accommodate to run Low Voltage & Extra Low Voltage cables.

K. The trap cover screws must be made from Stainless Steel for extra protection.

L. The system must have Positive Double Earthing connections.

M. Earth wire connector should be provided in all the boxes, and complies with the requirement of current IEE regulation.

N. The complete system must have excellent protection against rust.

O. Four side blanks are made with removable perforations to suit ducts installation of up to 38-mm height.

P. The one-piece base frame design ensures minimum openings to prevent concrete seepage into the box during casting of concrete or screeding.

Q. Standards & Approvals – The system must comply with the relevant specification & IEC 61084 standards.

VERTICAL ACCESS BOXES

A. Vertical access boxes are made of very high quality materials to withstand heavy load and corrosion.

B. Vertical access boxes facilitate the connectivity of floor raceways to the equipments on the wall like the distribution boards, so the product should be designed as “L” shaped

C. The Vertical access boxes should have provision to carry Power, Data & Telecom services.

D. The vertical access boxes should have the duct entry knockouts of upto 38mm and also provision for carrying the conduits to the wall.

E. The vertical access boxes are made of electrostatic polyester epoxy coating to prevent the rusting.

FIRE BARRIER AND FIRE RETARDENT PAINTS

The fire retardant paint / barrier shall be listed by independent test agencies such as UL, FM or OPL and be tested to, and pass the criteria of ASTM E 814 (UL1479) standard test method for fire test through- penetration fire stops and ASTM E 1996 (UL 2079) standard test method for fire resistive joint system.

FIRE BARRIER FOR FLOOR AND WALL SEALING

The framing & fixing part of fire barrier sheet shall be simple & directly fixed around walls & floors by help of anchored bolts & washer. For 2 hour fire rating the fire barrier sheet shall be minimum 7.62 mm thick and shall be cut as per the profile of penetration and opening. The small gap left around the penetration shall be closed with fire rated soft & mouldable putty. Fire barrier must be design on the intumescing technology to seal larger penetration through the fire rated walls & floors. Fire barrier must be a composite construction with the quality incorporated with organic/ inorganic fire resistive elastomeric sheet with specific gravity of 1.6 gm/ cubic centimeter.

FIRE BARRIER FOR FLOOR AND WALL SEALING

The Fire resistant cable coating / painting shall be intumescing / ablative, water based compound. The coating shall expand up to 10 times, supplied in a manufacturer's sealed container indicating manufacturing and expiry dates. The coating material shall be non-toxic, asbestos free, & halogen free and shall have good mechanical strength. The colour of paint shall be white and density of coating shall be 1.3kg/ ltr. Coating shall have a snap time of 30 minutes, the expansion shall begin at 230 deg. C and it shall have a oxygen index of 41%.

Coating shall be applied by ordinary paint brush after cleaning the cables of dust and oil deposition. A minimum textured finish of 3 mm wet film thickness shall be achieved by applying the material in 2-3 layers leaving intervals of 2 to 8 hours depending upon the moisture and thickness, moisture and temperature hours between each coat.

e WIRE MESH CABLE TRAY (PREFERRED FOR HORIZONTAL TRANSFER) GENERAL

Wire Mesh Cable Tray System intended for the support and accommodation of power, Instrumentation, data network, voice, video and other low-voltage cables and possibly other Electrical equipment in Electrical / Communication systems. The SYSTEM shall support commercial, industrial, and utility applications and should be designed, constructed and tested according to IEC 61537.

DESIGN AND FABRICATION OF MESH TRAYS

The wire mesh cable tray shall be manufactured according to the design specified by IEC 61537 and should be tested for Safe Working Load (SWL). The relevant details of SWL and the load chart with respect to SWL, supporting distance and the deflection should be according to the following chart.

Safe Working Load (SWL) with a span length up to 2 meters

Description	Side Height (in mm)	Width (in mm)	Span length (in meters)		
			1m	1.5m	2m
			Permitted Load (in Kg/meter.)		
Mesh cable tray	35	50 - 150	25	11	10
		200	30	14	10
		300	75	22	15
	55	50 - 150	25	12	8
		200 - 400	60	28	25
		500 - 600	75	38	25
		100 – 200	80	55	37

	105	300 – 400	110	75	53
		500 – 600	125	85	60

Each section of mesh tray shall have a length of 3 meter of continuous, rigid, welded steel wire mesh. Consecutive straight length of 3 meter mesh trays shall be connected without couplers or connecting tools

Screwed connections and internal fixing Devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections

Cables shall run in cable tray mounted horizontally or vertically on cable tray support system which in turn shall be supported from floor, ceiling, overhead structures, trestles or other building structures using mounting accessories

SURFACE TREATMENT

Electro Galvanized confirming to DIN E 12329 with minimum 10 microns zinc coating for indoor closed and dry atmospheric application

Hot Dipped Galvanized confirming to ISO 1461 – 1999 with minimum 60 microns zinc coating for outdoor or open area applications

Stainless steel 304 for Food/Beverage/Pharmaceutical and clean room application Stainless steel 316 for highly corrosive atmospheric areas like chemical plant & Offshore platforms

According to area of application, Surface treatment of material can be selected. Eg. Electro Galvanized cable tray and accessories should never be used in outdoor or open areas.

CONSTRUCTION

The Tray shall be constructed using 50 mm x 100 mm grid except for 50mm wide tray to ensure maximum ventilation of cables and dissipation of heat. For 50 mm wide tray, the grid size should be 20 mm x 100 mm. All exposed fabricated edges shall be tapered to ensure safe handling and installation of the product. One end of each straight section of formed wire mesh cable tray shall be of integrated interlocking ends. The diameter of the steel wire shall be minimum 3.5 mm for trays up to 150 mm width and minimum 4.5 mm for trays up to 600 mm width.

Screw less straight connection of mesh cable tray shall be made without couplers and special tools for straight consecutive lengths.

All tray fittings (eg., change in direction) shall be constructed at site by using bolt cutters and fastened using joint connectors, clamps & corner connectors with M6x20 bolt and combination nut. The connectors and clamps should be same or higher corrosion resistance class of the tray.

MOUNTING ACCESSORIES (SUPPORTS AND BRACKETS)

The mounting accessories shall be fabricated from steel and has to be hot dip galvanized against corrosion confirming to ISO 1461-1999 for installations in both indoor and outdoor applications and should be of completely modular type.

All supports and Brackets should be factory made, hot dip galvanized after completing welding, cutting, drilling, other machining operations and tested according to IEC 61537 according to the arrangements in the enclosed drawing. The system shall be designed such that it allows easy assembly at site by using Bolts and Nuts. The main support and brackets shall be fixed at site using necessary brackets, clamps, fittings, bolts, nuts and other hardware etc to form various arrangements required to support the mesh trays. Welding of the components shall not be allowed.

CORROSION PROTECTION TESTING

Sample tray / accessories / mounting accessories and supports should be salt spray tested according to ISO 9227 as below

Sl. No.	Corrosion resistance class	Material Surface Treatment	Salt spray test duration
1	1	Electro Galvanized	24 Hours
2	6	Hot Dip Galvanized	550 hours
3	6	Double Dip Galvanized	550 Hours
4	9 A to 9 D	Stainless Steel	Not applicable

TESTING AND CERTIFICATION

Mesh tray and all mounting supports are to be tested for Safe Working Load (SWL), deflections, Impact resistance, Salt Spray & Electrical continuity test according to IEC 61537. The cable tray should not deflect more than 1/100th of the span length at SWL in Mid span for mesh trays and the transverse deflection of all mounting accessories at SWL shall not exceed 1/20th of the length. The mesh tray should be tested up to 1.7 times SWL at minimum and maximum Temperature. The temperature classification of mesh tray system should be - 5 to + 150°C.

MARKING, DOCUMENTATION, COMPLIANCE AND INSPECTION

The manufacturer or responsible vendor shall provide in his literature all information necessary for the proper and safe installation and use of the mesh tray system. The SWL and impact resistance is valid for the whole temperature classification declared. The information shall include

a. Instructions for the assembly and installation of system components and for the precautions required to avoid excessive transverse deflection, which could cause damage to the cables.

b. Thermal Expansion properties and precautions to be taken, if necessary,

c. Material, Surface Treatment and Salt Spray Test certificate

d. Relative humidity if it affects the material and Surface Treatment

e. Information on devices provided for equipotential bonding or to run Earth Bonding Bar if necessary for routing power cables

f. Product dimensions

g. Torque setting in Nm for screwed connections and internal fixing Devices. These devices should not create any damage to the cable when correctly fixed. Sudden or jerky motions shall not be used to tighten reusable screw connections. To test the screwed connections, it shall be tightened and removed.

h. End Span Distance, Position and type of coupling along the span
SWL in Kg/m for the fittings when not directly supportedFixing method for installing mesh tray or to the supports

l. SWL in Kg/m for the mesh tray lengths or the lengths including joints for various Span Distances. SWL information can be given in the form of a diagram, table or similar. Compliance is checked by inspection

m. SWL in KG for cantilever brackets

n. SWL for pendants as a bending moment in Kg and /or as a force in N

o. The appropriate material specification and environmental conditions, chemical environments or aggressive agents for which the product is suitable

INSTALLATION

Prior to and during installation, refer to SYSTEM layout drawing containing all elements of the SYSTEM. Installer shall comply with manufacturer’s installation procedures. Support and cable loading shall be done in accordance with manufacturer’s load diagram.

4. LIGHTING LUMINAIRES AND

ACCESSORIES SCOPE OF WORK

Scope of work under this section shall include inspection at suppliers/ manufacturer's premises, appropriate, receiving at site, safe storage, transportation from point of storage to point of erection and erection of light fittings, fixtures and accessories including all necessary supports, brackets, down rods and painting as required. The contractor shall supply all materials and accessories (other than those supplied by the owner), labour, tools, transportation, scaffolding etc., required for the completion of above work in all respects.

The light fixtures and fittings shall be assembled and installed in position complete and ready for service, in accordance with details, drawings, manufacturer's instructions and to the satisfaction of the Project Manager.

CODES AND STANDARDS

The lighting and their associated accessories such as lamps, reflectors, housings, ballasts etc., shall comply with the latest applicable standards, more specifically the following :

IS – 1913	Electric light fittings General and safety requirements.
IS – 1777	Industrial lighting fittings with metal reflectors.
IS – 5077	Decorative lighting outposts.
IS – 1947	Flood Lights.
IS – 2149	Luminaries for street lighting. IS
– 1258	Bayonet lamp holders.
IS – 3323	Bi-pin lamp holders for tubular fluorescent lamps.
IS – 1534	Ballasts for use in fluorescent light fittings.
IS – 2215	Starters for fluorescent lamp. IS
– 6616	Ballast for HP MV lamps.
IS – 2215	Capacitors for use in fluorescent, HPMV & LP sodium

Vapor lamps circuits.

IS - 2418 (Part I) Tubular Fluorescent lamps.

IS – 2183	High pressure mercury vapor lamps.
IS – 418	Tungsten filament general electric lamps.

IS - 9974 (Part -I) High pressure sodium vapor lamps.

GENERAL REQUIREMENTS

A. Fittings shall be designed for continuous trouble free operation under atmospheric conditions, reduction in lamp life or without deterioration of materials and internal wiring. Degree of protection of enclosure shall be IP-65 for outdoor fittings except bulkhead fitting. Bulkhead fitting shall be provided with IP-54 protection.

B. Fittings shall be so designed as to facilitate easy maintenance including cleaning, replacement of lamps/ starters etc.

C. All fittings shall be supplied complete with lamps. All mercury vapor and sodium vapor lamp fittings shall be complete with accessories like ballasts, power factor improvement capacitors, starters, etc. Outdoor type fittings shall be provided with weather proof JBs (IP- 55) and control gear boxes (IP- 54). All fluorescent and CFL fittings shall be

provided with electronic ballast (DSI), power factor improvement capacitors and starters capacitors for correction of stroboscopic effect as per schedule of quantities.

D. Metal used in BODY of lighting fixtures shall be not less than 22 SWG or heavier if so required to comply with specification of standards. Sheet steel reflectors shall have a thickness of not less than 20 SWG. The metal parts of the fixtures shall be completely free from burns and tool marks. Solder shall not be used as mechanical fastening device on any part of the fixture.

E. Each fitting shall have a terminal block suitable for loop-out connection by 1100 V PVC insulated copper conductor wires up to 4 sq.mm. the internal wiring should be completed by the manufacturer by means of standard copper wire and terminated on the terminal block.

F. All hardware used in the fitting shall be suitably plated or anodized and passivated.

G. Each light fitting shall be provided with an earthing terminal. All metal or metal enclosed parts of the housing shall be bonded and connected to the earth terminal so as to ensure satisfactory earthing continuity throughout the fixture.

H. All surfaces of the fittings shall be thoroughly cleaned and degreased and the fittings shall be free from scale, rust, sharp-edges, and burrs.

I. The housing shall be stove-enameled or anodized as required. The surface shall be scratch resistant and shall show no sign of cracking or flaking when bent through 90 deg. over 12 mm dia mandrel.

SPECIAL REQUIREMENTS

DECORATIVE TYPE FITTINGS

Decorative fluorescent fittings shall be provided with mounting/ housing channel cum reflectors of CRCA sheet steel. Stove enameled diffusers or louvers shall be translucent white polystyrene.

BOX TYPE INDUSTRIAL FITTINGS

Box type slim line channel must be in screw less construction fabricated from M.S. CRCA sheet steel powder coated with MS CRCA cover, powder coated white. Light reflection surface in Box/ Channel type fittings shall be in polyester pre-coated steel having a reflection factor of not less than 80%. Screw less design and construction Light fixtures shall be preferred due to their ease of maintenance, especially for box/ channel type fixtures.

HIGHBAY TYPE INDUSTRIAL FITTINGS

Industrial High bay luminaries shall be provided with pressure die cast housing along with all accessories, ortho-cyclically wound opine construction ballast, capacitor & semi parallel ignitor connected to terminal block and mounted on the gear plate. The gear shall have side entry for ease in maintenance. The spun aluminium reflector is suitable for narrow as well as wide beam distribution as specified in bill of quantities. The luminaries will be suitable for metal halide lamp HPI BU + 250 W which has 25500 lumens or similar 400W lamp and 2.5 minutes restrike time (when operate with SON control gear).

MOISTURE PROOF INDUSTRIAL FITTINGS

Surface mounted totally enclosed moisture proof fixtures must be in polycarbonate body and diffuser with transparent prismatic interior and smooth exterior and frosted end. Fixture must be completely sealed with polyurethane double gasket to achieve IP 65 protection. Fixture is complete with CRCA steel white powder coated / enameled finish reflector.

FL/ CFL LOW GLARE LIGHT FITTINGS

Recessed mounted, modular fluorescent lighting fixture made of CRCA Sheet steel powder coated (white) housing, electro chemically brightened and anodized reflector, three dimensional cross louvers with concave contours, Fresnel top at louver saddle to increase efficiency. The luminance of <200 cd/ M2 at 63 degree viewing angle in all directions so as to confirm Cat-2 classification of CIBSELG3.

LED DOWN LIGHTER

LED Down Lighter shall be complete with efficient reflector and scientifically designed heat sink for optimum thermal management of LED source ensuring specified life and colour quality. The luminaries shall have IP-20 degree of protection. It shall be suitable for recessed mounting in the false ceiling. The driver shall be provided with the luminaries. LED shall be of high efficiency, long life in warm white or cool day light, as specified in BOQ, with excellent CRI. The LED shall be of 4 watts – equivalent to 18W CFL – or 8W –equivalent to 2x18W CFL lamp. The estimated life time of LED shall be of minimum 50,000 burning hours. THD for any LED light fitting, including driver unit, shall be less than 10%.

ACCESSORIES

REFLECTORS

The reflectors shall be made of CRCA sheet steel/ aluminium/ silvered glass/ Chromium plated sheet copper as called for in the bill of quantity. The thickness of reflectors shall be as per relevant standards. Reflectors made of steel shall have stove enameled/ vitreous enameled/ epoxy coating finish. Aluminium used for reflectors shall be anodized/ epoxy stove enameled/ mirror polished. The finish for the reflector shall be as specified. The reflectors shall be free from scratches/ blisters and shall have a smooth and glossy surface having no premium light reflecting coefficient. Reflectors shall be readily removable from the housing for cleaning and maintenance without use of tools.

LAMP/ STARTER HOLDER

Lamp holders shall have low contact resistance and resistant to wear. They shall hold lamps in position under normal conditions of shock and vibration prevalent in an industrial atmosphere. Lamp holders for fluorescent lamps shall be of spring loaded Bi-pin rotary type. Live parts of the lamp holder shall not be exposed during insertion or removal of the lamp or after the lamp has been taken out.

Lamp holders for incandescent and mercury vapor lamps shall be bayonet type up to 100 W and Edison screw type for higher wattage. Starter holders for fluorescent lamps shall be so designed that they are mechanically robust and shall be capable of withstanding shocks during transit, installation and use.

HF ELECTRONIC BALLAST

High frequency (HF) electronic ballast shall be used with fluorescent / Compact Fluorescent Lamps wherever specified in the schedule of quantities. High frequency electronic ballast shall comply with the following codes and standards

IEC 927, IEC 928 for ≤10% total harmonic distortion.

EMI / RFI – Confirming to FCC / VDE Class A/B.

Line Transient as per IEEE C62.41.

Ballast Crest Factor C1.7%.

No Stroboscopic Effect

Constant Wattage / Light output between 240 V ± 10%.

Circuit protection for surge current and inrush current.

Short circuits, open lamp protection

PF > 0.99 for fluorescent / T5 lamp and 0.95 for CFL.

Deactivated lamp protection

Suitable for use with single and twin lamps

RFI < 30 MHz	EN 55015
Total Harmonic Distortion (THD)	≤10%
Immunity to interference	EN 61547
Safety	EN 60928 / IEC 928 / IS 13021 (Part I)
Performance	EN 60929 / IEC 929 / IS 13021 (Part II)
Vibrations & Bump tests	IEC 68-2-6 FC
	IEC 9001
Quality Standard	ISO 9001
Environmental Standard	ISO 14001
DC Operation	EN 60924
Emergency Lighting Operation	VDE 0108

Total System consumption including lamps and ballast shall be as per the following:

I.	For 1 x 36 W TLD, shall not exceed 36 W
II.	For 1 x 28 W T-5, shall not exceed 28 W
III.	For 1 x 35 W T-5, shall not exceed 35 W
IV.	For 1 x 14 W T-5, shall not exceed 14 W
V.	For 1 x 18 W CFL, shall not exceed 18 W
VI.	For 1 x 36 W CFL, shall not exceed 36 W

Note: For low budget project, clause 4.5.3 above shall be replaced by clause 4.5.3 below.

ELECTRONIC BALLAST

The ballasts shall be designed for long life and low power loss. They shall be mounted using self-locking, anti-vibration fixtures and shall be easy to remove without demounting the fittings. The enclosures shall be dust tight and non-combustible. Ballasts shall be inductive, heavy duty type, filled with thermosetting, insulating, moisture repellent polyester compound filled under pressure or vacuum. Ballasts shall be provided with taps to set the voltage. The ballast wiring shall be of copper and they shall be free from dust.

Separate ballast shall be provided in case of multi-lamp fittings, except in case of 2 x 20 W fittings. Starters shall have bi-metal electrodes of high mechanical strength. Starters shall be replaceable without disturbing the reflector of lamps and without use of any tool. Starters shall have brass contacts and radio interference suppression capacitor.

CAPACITOR

The Capacitors shall have a constant value of capacitance and shall be connected across the supply of individual lamp circuits. The capacitor shall have a value of capacitance so as to correct the power factor of its corresponding lamp circuit to 0.95 lag or better. Capacitor shall be hermetically sealed preferably in a metal enclosure to prevent seepage of impregnated material and ingress of moisture.

LAMPS T-5

T-5 lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 3 mg. lamp should have lowest CO2 emission compared to any other comparable light source (40% less than a TL-D standard lamp, 26% less than TL-D / 80). T-5 lamp shall be 100% lead free. T-5 lamp shall be designed for

operation with electronic gear and well suited for dimming. Maximum lumen output to be reached at approx 35oC in free burning position. T-5 lamp can be ignited from -15°C to + 50°C. Lamp should be fully recyclable and must comply with ROHS (Restriction of Hazardous substances) and shall be covered by WEEE. T-5 shall have 16 mm in diameter service life of TL-5 lamp should be 10% more than TL-D lamps. T-5 lamp shall have lumen efficacy of up to 104 Lumens / W and shall have excellent colour rendering to En 12464 (Ra 80 to 89).

TL-D

Lamp shall be environment friendly low pressure mercury discharge lamp with mercury content less than or equal to 5 mg. The lamp shall have minimum lumen maintenance of 85 and CRI of
85. The lamp must comply with ROHS (Restriction of Hazardous substances) and covered by WEEE. Lamp should be fully recyclable. The lamp should be low on maintenance with life of 40000 burning hours in case of electromagnetic ballast and 65000 burning hours in case of HF ballast up to a maximum declared failure rate of 10%. The discharge glass shall be lead free.

TLD Lamps shall be minimum tri-phosphor type and have bi-pin bases. Lamps shall be “Day light color” type equivalent to “PHILIPS color 84 or color 86 color 82” or “OSRAM color 21 or color 11 or color 41 (as per site requirement)”.

The fluorescent Tubes (TLD) should have cool daylight colour designation. But Architects reserve the right to prescribe either Cool Daylight or Bright White or Incandescent Colour Designations for TLD. NO extra payment will be made over the quoted rate of bidder for this. The 36 W fluorescent tubes will have Nominal Luminous Flux of not less than 3350 lumens whether so mentioned in the Schedule of Quantities or not.

CFL

Compact fluorescent lamp shall have same luminous flux and power consumption as fluorescent tubes but less than half the length and more compact than U-shaped and circulator lamps. CFL shall be suitable for use with conventional control gear & standers and for HF electronic control gear. CFL lamp shall be non integral type of OSRAM / GE / PHILIPS/ Havells (Sylvania only).

LED

LED lamps have a lifespan and electrical efficiency which are several times greater than incandescent lamps, and are significantly more efficient than most fluorescent lamps, which are able to emit more than 150 lumens per watt. The LED lamp market is projected to grow by more than twelve-fold over the next decade. LEDs use only about 10% of the energy an incandescent lamp requires.

The initial cost of LED is usually higher. However, the initial cost is recovered by its shorter payback time.

5. LIGHTING CONTROL SYSTEM*

(OPTIONAL) LIGHT LEVEL SENSOR

The Light Level Sensor shall be capable of measuring ambient light levels in the range of 20 to 3000 lux (40 lux to 1600 lux controllable).

The ambient light level shall be measured by the Light Level Sensor and output devices (such as Dimmer Units) shall be controlled to maintain constant luminance in a given area, under varying conditions.

The target luminance level as well as the Margin shall be set using the control system Installation Software.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The field of View of the light level sensor shall be 180 degrees.

The Supply Voltage to each light level sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required.

The light level sensor shall have an operating temperature range of 0-50 Degree C. **PIR Occupancy**

Sensor

The PIR Occupancy Sensor shall detect passive infrared energy for control of any number of independent electrical loads. The light level shall be adjustable from the front of the unit and shall be used to disable the Occupancy Sensor. Timer settings shall be adjustable from 1 second to 18 hours, in one-second increments. A weatherproof version shall be available for outdoor or industrial use.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Supply Voltage to each PIR Sensor shall be 36VDC @ 18mA. No additional 240V supply shall be required for the unit to operate.

The unit shall have suitable operating temperatures between 0-50 Degree C.

The unit shall be suitable for wall or ceiling mounting, up to mounting heights of 2.4m.

The Indoor unit shall have a field of view of 90 degrees. The outdoor unit shall have a field of view of 110 degrees.

The Indoor unit shall have an effective detection area of 6m x 6m. The outdoor unit shall have an effective detection area of 18m radius x 110 degrees.

The Indoor unit shall have 12 overlapping detection zones. The outdoor unit shall have 18 long range, 16 intermediate range, 10 short range and 4 ultra short-range detection zones.

ULTRASONIC OCCUPANCY SENSOR

The unit shall be an active device utilizing Doppler wave technology as its means of detection.
The unit shall include two air transducers to provide volumetric occupancy detection.

The unit shall be suitable for occupancy detection of larger areas, typically 12m x 12m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit will have easily accessible sensitivity adjustment that can be used to accommodate various room sizes.

The unit will have an indicator LED for walk-testing the unit.

The unit shall be ceiling mounted and a 360-degree field of view. The

unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

Combined Technology Ultrasonic/PIR Occupancy Sensor

The unit shall consist of two air transducers and four PIR detectors with a special lens to provide both volumetric and line of sight detection.

The unit shall be suitable for occupancy detection of larger areas, typically 15m x 15m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit shall be ceiling mounted and a 360-degree field of view.

The unit will have easily accessible sensitivity adjustment that can be used to accommodate various room sizes.

The unit will employ programmable walk-testing LED indicators: Red LED for Passive Infrared and Green LED for Ultrasonic modes.

The unit shall utilize an ultrasonic frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50 Degree C.

Ultrasonic Occupancy Sensor for Corridors and Hallways

The unit shall be suitable for occupancy detection of Corridors and Hallways, typically up to 4.6m x 30m and 2.7m mounting height. The unit shall include its own independent 240V power supply and shall require a socket outlet adjacent to installation point (typically in the lighting wiring loom). To enable the unit to communicate with the control system network, an Auxiliary Switch Input Unit shall be utilized. Each auxiliary unit will allow control of up to four detectors.

The unit shall be ceiling mounted and a 360 degree field of view. The unit will

have an indicator LED for walk-testing the unit. The unit shall utilize an ultrasonic

frequency of 32.7 kHz.

The unit shall have suitable operating temperatures between 0-50° C.

WALL MOUNTED MOTION SENSOR

Sensor angle – 180°, Mounting height ~1.1 m.
Range: frontally up to 12 m, laterally up to 8 m (upon tangential approach). Mounting

height :(1.1-2.5 m), providing a larger detection zone (max. 10 x 15 m).

CEILING MOUNTED PRESENCE DETECTOR

The sensor shall be able to control up to 29 different EIB group addresses Sensor

angle - 360°.

Detection range-	at 2.50 m mounting height: 6
m in dia. at a height of 1 m	
Adjustable brightness-	5 to 1000 Lx
Product standard-	EN 60669-2-1

WALL/ CEILING MOUNTED MOTION SENSOR

Surveillance zone:	220° horizontal
Maximum range:	approximately 16 m (at installation height of 2.5 m and horizontal alignment)

Surveillance density:	92 sectors / 368 switching segments
Dusk brightness sensor:	0.5 – 1000 lux
Delay time:	10 sec – 32 min
Slewing range	
- Horizontal:	+- 30°
- Vertical:	90° upward; 40° downward
Operating temperature range	-25 °C to 55 °C

ROOM TEMPERATURE CONTROL FOR FCU

There shall be a 3-speed fan coil controller which shall regulate the Fan Coil Unit fan speed as required to maintain the guest room temperature at the desired value. The FCU Controller shall be DIN rail mounted device and to be located in the false ceiling .The 3-level fan speed control is operated via a change-over switch. The fan ventilator levels shall be switched depending on the cooling demand. It shall be possible to define the thresh hold values in the parameters settings (between, 0-100%) for the 3 levels fan speed change-over as per the client's requirements.

The Fan Coil Controller shall be capable of controlling thermal On/ Off cooling valves.

END OF PART 5

6. MV PANELS/ DISTRIBUTION

BOARDS SCOPE OF WORK

This section covers the design, manufacture, assembly, testing at manufacturer's works, inspection, packing for transportation, delivery at site, installation, connection, testing and commissioning of 415V switch boards with guarantee of performance for a period of twelve (12) months from the date of commissioning. The contractor shall provide all materials, labour, equipment, scaffolding etc., as required for the completion of the job. Panels/Boards shall be suitable for operation on 3 Phase/single phase, 415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All Distribution panels shall be **CPRI tested design** and manufactured by an approved manufacturer. The manufacturer shall produce the CPRI certificate as and when asked for.

Distribution panels shall comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per latest edition of IS- 8623.Panels for outdoor equipment shall be suitable for outdoor duty application.

CODES AND STANDARDS

The applicable standards for above work shall be as listed below:

IS 4237-83	General requirements for switch gear and control gear for voltages not exceeding 1000V.
IS 5578-85	Guide for marking of insulated conductors.
IS 11353-85	Guide for uniform system of marking and identification of conductors and apparatus terminals.

IS 2147-62 Degree of protection provided by enclosures for low voltage switch gear and control gear.

IS 2675-83 Enclosed distribution fuse boards and cutouts for voltages not exceeding 1000V.

IS 2551-82 Danger notice plates.

IS 2516 Circuit breakers Part 1. Requirements (Part I/Sec 1): and tests: Section 1. Voltages not exceeding 1000V ac or 1200V dc.

IS 4064-78 Air break switches, air break disconnectors, air break switch disconnectors and fuse combination units for voltages not exceeding 1000V ac or 1200V dc.

IS 1818-72 Alternating current isolators (disconnectors) and earthing switches.

IS 8623-77 Factory built assemblies of switchgear and control gear for voltages up to and including 1000V AC & 1200V DC.

IS 8828-78 Miniature air break circuit breakers for voltages not exceeding

1000V. IS 9926-81 Fuse wires used in rewireable type electric fuses up to 650 Volts.

IS 8544-79 Motor starters for voltages not exceeding 1000 Volt A.C. or 1200 Volt

D.C. IS 2959-85 Contactors for voltages not exceeding 1000 Volt A.C or 1200 Volts D.C

IS 9224-79 Low Voltage fuses.

IS 12640-89 Residual current operated circuit breakers.

IS 1248-83 Direct acting indicating analogue (all parts) electrical measuring instruments and their accessories.

IS 2705-81 Current transformers (all parts).

IS 4201-83 Application guide for voltage transformers.

IS 8197-76 Terminal markings for electrical measuring instruments and their accessories. Indian Electricity Act and Rules.

SERVICE CONDITION

Equipment shall be suitable for satisfactory continuous operation under following tropical conditions:

i. Max. Ambient air temperature (deg. C) : 50

ii. Min. Ambient air temperature (deg. C) 5

iii. Max. Relative Humidity (%) 100

iv. Max. Altitude above Sea Level (M) : up to 1000 Mtr. above Mean Sea Level.

CONSTRUCTION

The Distribution panels shall be suitable for use on medium voltage at 415V, 3 phase, 4 wire, 50 Hz AC system. All panels shall be fabricated out of 2 mm thick sheet steel cabinet for indoor installation, dead front, floor mounting/ wall mounting type and shall be form 3b construction. The gland plates shall be 3 mm thick. The Distribution panels shall be totally enclosed, dust and vermin proof and shall be with hinged front/ rear doors and folded covers, Neoprene rubber gasket, padlocking arrangement and bolted back. Distribution panel shall be suitable for the climatic conditions as stipulated in Special Conditions. Steel sheets used in the construction of Distribution panels shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to and including 1100 V AC.

All panels and covers shall be properly fitted with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum operating clearance of 275 mm shall be provided between the floor of Distribution panels and the lowest operating height.

The panels shall have separate modules with doors (for each feeder/ circuit), distinct bus bar chamber, bus-alley, provisions for incoming/ outgoing cables and provision for extension at both ends. Compartments shall have sufficient space for easy maintenance in future.

The front door of each feeder compartment shall be interlocked with respective MCCB/ LBS inside the compartment in such a way that the door can only be opened when the MCCB/ LBS in off position.

Distribution panels shall be of adequate size with a provision of spare switchgear as indicated on the Single Line Diagram. Functional units such as circuit breakers (ACB), fuse switches, MCCBs etc. shall be arranged in multi-tier formation. More than two ACBs shall not be housed in a single vertical section. Knockout holes of appropriate size and number shall be provided in the Distribution panels in conformity with the location of cable/ conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with engraved metal name plates. All panels shall be provided with circuit diagram engraved on PVC sheet. All live accessible connections shall be shrouded and shall be finger touch proof. Minimum clearance between phase and earth shall be 20 mm

and phase to phase shall be 25 mm. Panels with ACB shall necessarily have front and rear access as per requirement whereas panels with all MCCB breaker may be provided with only front access with sufficient clearance.

A continuous earth bus of suitable size shall run along the length of the switchboard. All removable/ hinged doors and covers shall be properly grounded by two distinct and independent flexible stranded connectors.

DIMENTIONAL FEATURES

The preferable and principal dimensions are given below as a general guideline:

i.	Depth of Panels	: 1000/ 1300/ 1600 mm.
ii.	Height of Panels including Base frame	: 2400 mm. (Max.)
iii.	Width of Panel	: As per SLD
iv.	Base Channel	: 75 x 40 x 5 mm.
v.	Min. & Max. operating height	: As per IS
vi.	Type of Panel	: Single front/ Extensible

BUSBAR

Bus bar and interconnections shall be made of high conductivity electrolytic grade aluminium/ copper as indicated in the bill of quantities complying with IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the mechanical force arising

from a possible short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by high tensile bolts. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the bus bars shall be 0.8A/sq.mm for aluminium and 1.4A/sq.mm for copper bus bars.

The continuous current rating and the short circuit values which the main bus bars are able to withstand shall be as follows:

TRANSFORMER RATING	CONTINUOUS CURRENT RATING	SHORT CIRCUIT CURRENT RMS SYMMERICAL
kVA	A	kA
400	630	15
630	1000	21.6
1000	1600	36
1600	2500	36
2000	3200	50

The neutral bus bars shall be designed to carry at least 50 percent continuous current rating of the main bus bars.

Maximum allowable temperature for the Bus bar to be restricted to 85°C.

TEMPERATURE RISE

Maximum temperature rise of 25°C for metal surfaces and 15°C for insulating surfaces above ambience shall be permissible, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation unless specified otherwise.

POWER AND CONTROL WIRING

All power and control wiring of the switchboard to be done by 1100/650V grade single core PVC insulated stranded copper wire of size as below

For Power Circuit

: As per current rating of switchgear

For CT circuit : 2.5 Sq. mm. For

control circuit (except CT) : 2.5 Sq. mm.

Control wiring for analog, digital input/outputs shall be done with 1.5 Sq.mm. screened copper cables.

All power wirings shall be marked/ colour coded for phase identification.

Wherever solid conductors are used for power connection, they should be individually sleeved/ insulated, except for joints and colour coded.

Wiring shall be neatly bunched, adequately supported and properly routed to allow for easy access and maintenance. Wires shall be identified by numbered ferrules at each end.

All wires will be continuous from one terminal to other and also have no tee-junction reroute. The connections shall be securely made with the help of connecting lugs to ensure non- oxidation of the bare conductor.

Whenever control wiring is done between the shipping sections, terminal blocks shall be provided on both sides of shipping sections with TB diagram pasted near the TBs.

Control wiring for analog, digital inputs/outputs shall be done with Screened cables & routed separately to avoid EMI.

FERRULES

Wire number shall be indicated on panel schematic and wiring diagrams and accordingly engraved ferrules, as indicated in the drawing shall be provided on the terminal ends of all wires for easy identification of circuits for inspection and maintenance. The ferrules shall be of ring type and of non-deteriorating material.

TERMINAL BLOCKS

Terminal blocks shall be of 650/ 500 Volts grade and of stud/ screw type.

The terminal blocks for power cables shall be stud type with bolts, nuts and washers. For higher Amp rating, bus-bars to be provided for cable terminations.

The control terminals shall be shrouded and screw type and have current rating of 10 Amps. Provisions shall be made for label inscription. Minimum 20% spare terminals to be provided as spare in each terminal block.

The termination arrangement of multiple cables shall permit connection and disconnection of each individual cable without disturbing the other cables. For termination of cables suitable

lugs of proper size shall be provided. Where armoured cables are to be terminated suitable armour clamps shall be provided.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities with disconnecting type TBs. Current transformer secondary leads shall be provided with terminal block with short circuiting and earthing facilities.

CIRCUIT BREAKERS

A. AIR CIRCUIT BREAKER

The ACB shall be 3/ 4 pole, air- break draw out type with modular construction, manually or electrically operated specified in the BOQ. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (I_{cs}) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(I_{cu}) and short circuit withstand values (I_{cw}) for 1 sec.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided on each pole to protect the main contacts. The arc chutes shall be easily removable for inspection without any hardware and interlocking should be provided to prevent closing of ACB if arc chutes are not mounted properly. The ACB shall have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breakers shall be with electrical motor wound stored energy spring closing mechanism with mechanical flags to indicate ON/ OFF status of the ACB and inbuilt electrical anti-pumping to prevent reclosing of ACB on fault. All electrical accessories should be visible from front fascia without opening panel door.

Circuit breakers shall be designed to ‘close’ and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip & close push button shall be at the front of the breakers panel with suitable cover & pad locking facility. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

The circuit-breaker shunt trip coil provided shall operate satisfactorily with the operating voltage within the range of 70 to 110 per cent of the rated voltage. The shunt trip coil shall be suitable for 240 V AC. No separate control source will be available as such. Capacitor trip Circuit shall be provided where shunt tripping is proposed with protective relay so that ability to trip is not impaired by momentary drop in voltage at the time of a fault.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits shall close before the main contacts have closed. All other contacts shall close simultaneously with the main contacts. The auxiliary contacts in the trip circuits shall open after the main contacts open. Minimum 4 NO and 4 NC spare auxiliary contacts shall be provided on each breaker in addition to the ones already used for various control purposes. All auxiliary contacts shall be wired internally up to the terminal block.

The ACB shall conform to the requirements of IEC 60947-2 / IS 13947-2 / IS/IEC 60947-2 and shall be type tested & certified for compliance to standards from – CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V + 10%, 50 Hz supply system. Air Circuit Breakers shall be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings and bill of quantities with mechanical "ON" "OFF" “TRIP” indications.
The continuous current ratings of ACB units at specified ambient temperature shall be as specified. The RMS Symmetrical breaking capacity of the different air circuit-breakers shall be as follows, unless otherwise specified:

CURRENT RATING OF THE MCCBs/ ACBs	BREAKING CAPACITY RMS SYMMETRICAL AT PF OF 0.2 TO 0.3 IN (kA)
A	A
200	15
400	21
630	36
1000	50
1250	50
1600	65
2500	65
3200	65

Rated insulation voltage (U_i) shall be 1000 volts AC and Impulse Withstand Voltage (U_{imp}) shall be 12 kV peak.

CRADLE

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements shall be free from jerks, easy to operate and shall be on steel balls/rollers and not on flat surfaces.

There shall be 3 distinct and separate position of the circuit breaker on the cradle.

Racking Interlock in Connected/ Test/ Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions. The following safety features shall be incorporated:

i. Withdrawal or engagement of Circuit breaker shall not be possible unless it is in open condition and interlocking should be provided as inbuilt feature.

ii. Operation of Circuit breaker shall not be possible unless it is fully in service, test or drawn out position.

iii. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

iv. All Switchgear module front covers shall have provision for locking.

v. Switchgear operating handles shall be provided with arrangement for locking in

'OFF' position.

PROTECTIONS

The breaker should be equipped with micro-controller based, communicable type release with RS 485 port for communication for metering data, fault history (Optional), event recording, data logger and maintenance related data and should be possible to change protection setting through communication, to offer accurate and versatile protection with complete flexibility and shall offer complete over current protection to the electrical system in the following five zones:

Long time protection (L).
Short time protection with intentional delay (S).
Instantaneous protection (I).
Ground fault protection (G).
Neutral Overload protection (N)

The protection release shall generally have following features and settings. However for exact requirement of protection releases, reference shall be made to BOQ:

a. TRUE RMS SENSING

The release shall sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and shall monitor the true RMS value of the load current. It shall take into account the effect of harmonics also.

b. THERMAL MEMORY

When the breaker shall reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, shall get stored in the memory of the release and this thermal memory shall ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves shall take into account the integrated heating effects to offer closer protection to the system. It should be possible to enable & disable the feature as per system requirement.

c. DEFINED TIME CURRENT CHARACTERISTICS

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve. Each protection should be provided with adjustable pre-trip alarm function.

d. TRIP INDICATION

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis. The release should have separate LED indication for trip & alarm function.

e. SELF POWERED

The release shall draw its power from the main breaker CTs and shall require no external power supply for its operation.

f. ZSI

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions; thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimizes the damage to the system. To implement ZSI manufacturer

should supply all related equipment like power supply, wiring etc. ZSI, wherever specified, shall be used for all incomer as well as outgoing ACBs.

On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

g. It should be possible to measure, monitor and protect (Trip/Alarm mode) the system from Temperature Rise of Bus-Bar beyond recommended limit as per IEC.

h. The release shall meet the EMI / EMC requirements.

i. Two Sets of Protection Settings should be provided in the release for accurate protection as per load profile. Settings would be activated based on Real Time Clock (RTC)

j. The typical setting range of release shall be generally as follows:

	Release setting range	
Type of Protection	Pick- up Current	Time Delay
Long Time (rms)	$I_r = I_n$ x … **Stages: 0.4, 0.5, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 0.98, 1.00.** Tripping Limit : 1.05 to 1.2 x I_r IDMTL setting: SIT, VIT, EIT, HVF and DT	Time Delay: **Stages: 0.5,1, 2, 4, 6, 8, 12, 16, 20 and 24 secs.** Accuracy= 0 to -20% Thermal Memory: 20 minutes before and after tripping
Short Time (rms)	$I_{sd} = I_r$ x … **Stages: 1.5, 2, 2.5, 3, 4, 5, 6, 7, 8, 9 & 10** Tripping Limit : 1.5 to 10 x I_r Double Short Circuit (Hi/Low pick Up) with different delay	At 10 x I_r (I^2t on or I^2t off) **Stages: 20, 60, 100, 160, 200, 260, 300, 400, 500 and 600 ms** Accuracy: ±10% or 20ms whichever is higher
Instantaneous	$I_i = I_n$ x … **Stages: 2, 3, 4, 6, 8, 10, 12, 15 and off** Accuracy= ±10%	
Ground Fault	$I_g = I_n$ x … **Stages: 0.2, 0.3, 0.4, 0.5, 0.6** Tolerance : ±10%	At 0.6 x I_n (I^2t on or I^2t off) **Stages: 100, 200, 300, 400ms** Accuracy: +10% or 100 ms whichever is higher.
Neutral Overload	$I_N = I_n$ x …(50/100%)	Time Delay: **Stages: 0.5,1, 2, 4, 6, 8, 12, 16, 20 and 24 secs.**

k. All ACBs should be provided with Neutral CT as inbuilt in 3P-4W system. In case of 3P ACBs external Neutral CT should be provided separately for accurate G/F protection and Neutral O/L protection.

All incomer ACBs shall have following additional protections other than mentioned above.

Under and over voltage

Under and over frequency (For DG Set)

Restricted Earth Fault protection (For Transformer Cable Protection)

Trip Circuit supervision with PS class CT's.

Undercurrent, (for DG set only)

Reverse power (for DG set only)

Phase sequence reversal (for DG set only)

- Load shedding and reconnection parameters may be set by a supervisor via COM option or through programmable auxiliary contacts.
- Visual inspection of contact wear should be possible or Release should display the Contact wear and operation cycle indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485 port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

- All electrical values in real time (V, A, W, VAR, VA, Wh, VARh, Vah, Hz, Power factor, Energy)
- Release should be able to capture short circuit current on which ACB has tripped. Total fifteen trip, alarm & maintenance record shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.

Release should be self powered.

- Release should have facility to select different type of IDMTL protection (I^2t, I^4t, SI, LI, VI or equivalent) for better co-ordination with HT Breaker/ Fuse.

All outgoing ACBs shall have the protection features as tabulated above. However, for any additional protection which may be required depending upon the merit of the project to be referred from the Bill of Quantity. All outgoing ACBs/ releases shall have the following measurement features:

- An ammeter with a digital display shall indicate the true rms values of the currents for each phase. Release shall acknowledge the current & time delay settings done by user on the LCD display.
- The release should display exact percentage loading in each phase starting from 20% through LED Display or LED bar graph shall simultaneously display the load level on the three phases.
- A maxi meter shall store in memory and display the maximum current value observed since the last reset. The data shall continue to be stored and displayed even after opening of the circuit breaker.

SAFETY FEATURES

- The safety shutter mounted on the cradle, shall automatically prevent access to the isolating contacts when the device is in disconnected or in test position and padlocking should be possible. When the device is removed from the cradle, no live parts shall be accessible.
- The ACB shall provide in built electrical and mechanical anti-pumping. After tripping on fault or intentional opening of contacts, the closing order shall first be discontinued and then reactivated to close the breaker.
- It shall not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement shall be provided to prevent rating mismatch between breaker and cradle.
- There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

Draw out breakers should not close unless in distinct Service/ Test/ Isolated positions.

- The incoming panel accommodating ACB shall be provided with indicating lamps for ON- OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.
- It shall be possible to bolt / lock the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

The insulation material used shall conform to Glow wire test as per IEC 60695.

- All EDO ACB`s Shall have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.
- ACB should be provided with inbuilt Common Fault Indication (CFI) for electrical indication in case of any fault.

B. MOULDED CASE CIRCUIT BREAKER

The MCCB should be current limiting type, i.e. it should have a break time short enough to prevent the short circuit current reaching its otherwise attainable peak value. The tripping time should be less than 10 mili second under short circuit condition. MCCB shall comply with the requirements of the relevant standards as stipulated in IEC 60947-2/ IS13947 – Part 2 and should have test certificates for Breaking capacities from independent test authorities like CPRI / ERDA or any accredited international lab.

MCCB shall comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses.

The breaking capacity of MCCB shall be as per the Single Line Diagram and the bill of quantities. The rated service breaking capacity (I_{cs}) should be equal to rated ultimate breaking capacities (I_{cu}) at all operating voltage levels. MCCBs for motor application should be selected

in line with Type-2 Co-ordination chart published by the manufacturer as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied with ROM should meet IP54 degree of protection.

CURRENT LIMITTING FEATURE

The MCCB shall employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCBs. The manufacturer shall provide both the discrimination tables and let-through energy curves for all ratings.

PROTECTION FEATURES

Protection settings shall apply to all poles of circuit breaker.

MCCBs with ratings 200A and above shall be fitted with microprocessor based trip units. The measurement shall be provided by built-in current sensors linked to an analog- digital converter with a high sampling frequency. The measurement values are continuously compared by the ASIC to the protection settings. When a setting is overrun, the release should trip the MCCB operating mechanism. For all MCCBs with microprocessor based release unit, the protection shall be adjustable Overload, Short circuit and earth fault protection with time delay having minimum 3 time delay steps.

Microprocessor trip units shall comply with appendix F of IEC 60947-2 standard (measurement of rms current values, electromagnetic compatibility, etc.).

All Microprocessor components shall withstand temperatures up to 125 °C.

MCCBs with ratings up to 200 A shall be equipped with Thermal-magnetic (adjustable thermal for overload and fixed magnetic for short-circuit protection) trip units.

Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings.

TESTING

Original test certificate of the MCCB from independent test authorities like CPRI / ERDA or any accredited international lab as per IEC 60947-1 &2 or IS13947 shall be furnished.

Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

SAFETY FEATURES

All MCCB shall be equipped with the following interlocking devices for interlocking the door of a switch board.

i. Handle interlock to prevent unnecessary manipulations of the breaker.

ii. Door interlock to prevent the door being opened when the breaker is in ON position.

iii. Defeat-interlocking device to open the door even if the breaker is in ON position.

C. MOTOR PROTECTION CIRCUIT BREAKER

Motor circuit breakers shall conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4. MPCB shall have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and shall have a rated impulse withstand voltage (U_{imp}) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without derating. Power supply shall be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening and closing with free tripping of the control devices. All the poles shall close, open, and trip simultaneously. The motor circuit breakers shall accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements shall be possible. The front-mounting attachments shall not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers shall have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination shall enable type 1 or type 2 co- ordination of the protective devices conforming to IEC 60947-4-1.Type 2 co-ordination shall be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory).The motor circuit breakers, depending on the type, could be equipped with a door- mounted operator which shall allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) shall be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available.
Temperature compensation (-20°C to +60°C).

REMOTE CONTROL SCHEME FOR BREAKERS

For electrically operated circuit-breakers in addition to ON-OFF control switch provided on the front side of the panel, provision shall be made where required for remote closing and tripping of circuit-breakers from an external control desk with arrangement to prevent closing of the breaker by the control switch mounted on the front of the circuit-breaker cubicle.

ALARM AND INDICATIONS

Each load-centre substation shall be provided with static audible and visible alarm indication with alarm accept and cancellation device. The system shall have arrangement for repeat alarm facilities as well as testing the alarm circuits. The scheme shall be designed to give the following indications:

i. When any circuit-breaker trips on fault only
ii. Temperature rise of winding

iii. Earth fault indication

Provision shall be made for transmitting signals if required to remotely located signaling system to indicate tripping of incoming circuit-breaker on fault and operation of earth fault relay provided in the transformer neutral circuit. Provision shall also be made to transmit the alarm and tripping signals to 33 kV switchboards from which the transformer is fed or to a remote signaling panel.

INSTRUMENTS AND METERS

Instruments, meters and relays shall be of flush-mounted design, housed in dust-proof casing located in an accessible position on the breaker panel. All incoming circuit-breaker units shall be provided with a voltmeter and ammeter complete with C.Ts and selector switches for measuring the voltages and currents in all three phases. All voltmeters shall be backed up with MCB. Ammeters with C.Ts and selector switches shall also be provided for all outgoing feeders. For motor feeders the ammeter shall be provided with a normal scale up to full-load value and a suppressed scale beyond full-load for indication of motor starting current. The accuracy class and burden of C.Ts shall be as per the BOQ and approved Single Line Diagram. Energy meters, Maximum demand indicators shall be provided, wherever specified.

INDICATING LAMPS

All indicating instruments shall be in accordance with relevant Indian Standards. Indicating lamps shall be of low burden, and shall be backed up with 2 amps MCB/ MPCB as per relevant fault level and toggle switch.

CURRENT TRANSFORMERS

Current transformers shall be provided for Distribution panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondary for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast/ Flame Retardant resin filled Nylon type robust to withstand thermal and dynamic stresses during short circuits. Metering CTs, shall have inbuilt bus bar mounting arrangement. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The secondary terminal should be covered with insulation cap/cover so that there should not be any possibility of touching the live terminal. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class 1.

SPACE HEATERS

1 No. 100 W, 240 volts, single phase, 50 Hz AC Anti Condensation space heaters controlled by thermostat and backed up by 6 amps MCB's or MPCB's as per fault level at the panel shall be provided in each vertical section of main LT panel and 1 No. 60 watt Anti Condensation space heater with thermostat shall be provided in each cable alley of main distribution boards and sub distribution boards.

NAME PLATES

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the distribution panels shall be pasted on inside of the panel door and covered with transparent plastic sheet.

PAINTING

All surfaces of steel fabricated panels and framework shall be properly treated by at least seven tank process (degreasing, pickling in acid, cold rinsing, phosphating, passivaiting) to remove

rust, foreign adhering matters, grease etc. A suitable primer shall be applied followed by Epoxy based electrostatic paint (power coating) of shade generally as under or as per choice of client/ Architect conforming to IS- 5:

i. Exterior – Powder Coated, Siemens Grey, RAL 7032
ii. Interior - Powder Coated, White

iii. Base Frame – Stove Enameled, Glossy Black

Colour coding may be used in some panels for easy identification of feeders.

EARTHING

Earthing shall be provided as per IS: 3043-1987.

TESTING

The switchboard/equipment is subject to routine tests at manufacturer's works in presence of the representatives of client/client's Architect according to relevant Indian Standard and to such other tests as may be required to ensure proper functioning of the equipment and its components. The purchaser reserves the right to witness all tests unless waived in writing. Following tests shall be carried out at manufacturer's works after completion of manufacturing.

i. Dimensional check.
ii. Checking of components.
iii. Checking wiring of circuits and their continuity.
iv. Checking of operation of all equipments and modules.
v. Checking of Insulation resistance.
vi. High voltage test.

Inspection call to be issued along with internal test certificate.

SURGE PROTECTION DEVICE

The SPD or Surge Protection Device (also known as TVSS) connected in the mains power supply is meant to protect the electrical and electronic equipment, should be able to withstand at least 100 KA (10/ 350 sec) surges#. Power Line SPD's shall be connected at the main incoming panel after the incoming breaker and in Sub-distribution Panels located more than 15 meters away from the incoming panel. SPDs shall also be installed ignoring the distance from the Main panel in the DB's which are feeding power to critical and sophisticated electronic equipment.

Suitable SPD's shall also be used in all Telecommunication, Signaling, automation and instrumentation equipment according to the Zonal concept as per IEC 62305 for a perfect protection of complete electronic installations.

All SPDs shall be Class B/Class I as per IEC 61643 - 1 and shall be tested and ensure performance requirements as stipulated in IEC 61643

#***As per IEC 62305-1, LPL 1 (Lightning Protection Level) maximum expected lightning current is 200 KA. As explained in IEC 62305,100 KA will be dissipated in earth and the balance 100 KA will reach the electrical supply lines***

MAIN LT PANEL (CLASS B/ CLASS I)

SPD should be connected between Phase and Neutral and between Neutral and Earth with the following ratings:

Parameters	**Specifications**	
	Line t o Neutral	Neutral to Earth
Type	Encapsulated/ Non-exhausting Spark Gap	
Nominal Voltage, Un	230V, 50/60 Hz	
Over Voltage withstanding capacity	400V	

Lightning Impulse Current	40kA (10/350 sec)	125 kA (10/350 sec)
Voltage Protection Level, Up	< 2.5 kV	
Response Time	< 100 nano seconds	
Operating temperature range	-40 C to +85 C	
Mounting on	Din Rail	
Degree of Protection	IP20	
Back-up Fuse / MPCB	Up to 500 amps max. Depending upon panel design & breaking capacity.	

SUB DISTRIBUTION BOARD/ SUB MAIN PANEL (CLASS B+C/ CLASS I+II)

Pluggable type SPD with potential free contact, thermal disconnectors & provision for inbuilt common remote indication for defective arresters shall be connected between Line and Neutral and Spark Gap type SPD shall be connected between Neutral and Earth of following ratings: The SPD shall include base element & pluggable arresters.

Parameters	**Specifications**	
	Line to Neutral	Neutral to Earth
Type	MOV with built in thermal fuse	Spark Gap Encapsulated / Non-exhausting
Nominal Voltage, Un	230V, 50/60 Hz	
Maximum Continuous Operating Voltage, Uc	320 Volts	255 Volts
Nominal Discharge Current I_n	30 kA (8/20 sec)	30 kA

Maximum Discharge Current I_{max}	50 kA (8/20 sec)	
Lightning Impulse Current	7 kA (10/350 sec)	25 kA (10/350 sec)
Voltage Protection Level	< 1.3 kV	< 1.2 kV
Response Time	< 25 nano seconds	< 100 nano seconds
Operating temperature range	-40 C to +80 C	
Mounting on	Din Rail	
Degree of Protection	IP20	
Max. Back-up fuse / MPCB	Up to 160 amps max. Depending up on panel design & breaking capacity.	

VISUAL INDICATION OF FLAG IN SPD

Healthy condition : Green Colour Faulty

condition : Red Colour

EQUIPMENT LEVEL (UPS, SERVER AND MCB DBs), CLASS C/ CLASS II

CLASS C SPD shall be provided at the input side of end equipments for protection of Sensitive Equipments like UPS, VFD's or at Important MCB DB's feeding power to Computer / Server etc.

3 numbers of pluggable type surge arrester with potential free contact, thermal disconnectors & provision for inbuilt common remote indication for defective arresters to connect between Line and Neutral and one number arrester Spark Gap type to connect between Neutral and Earth of following ratings including base element & pluggable arresters.

Parameters	**Specifications**	
	Line to Neutral	Neutral to Earth
Type	MOV with built in thermal fuse	Spark Gap Encapsulated / Non-exhausting
Nominal Voltage, Un	230V, 50/60 Hz	
Maximum Continuous Operating Voltage, Uc	320 Volts	255 Volts
Nominal Discharge Current I_n	20 kA(8/20 sec)	30 kA
Maximum Discharge Current I_{max}	40 kA	50 kA (8/20 sec)
Voltage Protection Level	<1.4 kV	<1.2 kV
Response Time	< 25 nano seconds	< 100 nano seconds
Operating temperature range	-40 C to +80 C	
Mounting on	Din Rail	
Degree of Protection	IP20	
Back-up fuse / MPCB / MCB	Up to 125 amps max. Depending up on panel design & breaking capacity.	

TOTAL TYPE TESTED ASSEMBLY (TTA)

Scope
The scope of supply covers design, manufacture, testing and supply of Type-Tested Assemblies (TTA) as per IS 8623-1 / IEC 60 439-1 for Power & Motor Control Center for Voltages upto 1000 V.

Standards

The equipments covered under this specification shall conform to the latest revisions of relevant Indian and International Standards some of which are listed below.

IEC 61439 2011 : Specification for low voltage switchgear & control gear

assemblies IEC 60439 / 61439 : Specification for low voltage switchgear & control gear

assemblies IS 61641 2008 : Specification for Internal Arc Containment test

IS 13947 1993 : General requirements of Switchgear and Control Gear for Voltage not exceeding 1000V AC or 1200V DC.

IS 11353 1985 : Guide for uniform system of marking Identification of Busbar

and Terminals.

IS 13703	1993	: Low voltage fuses
IS 2705	1992	: Current transformers
IS 694	1990	: PVC insulated cables for voltages including 1100 V with Copper and Aluminum conductor).
IS 1248	1983	: Direct Acting Electrical Indicating Analog
IS 8623	1993	: Low voltage Switch gear & control gear assemblies
IS 5082		: Electrolytic Aluminum & Aluminum busbar, Trunking system, Rod tubes & sections for Electrical purposes.

IS 13779 1999 / : AC Electric Meters / Static Meters.

Site Conditions

Location - West Bengal

Altitude above main sea level - < 1000M above sea level. Maximum

Temperature rise - As per IEC 61 439-1 & 2 Design Ambient Temperature -

40º C

Atmosphere - Dusty

Relative Humidity Max - 95%

Relative Humidity Min - 10%

General Requirement and Selection of Components:

Shall comply with the Technical Data Sheet, SLD, Feeder List. Salient features have been highlighted as under:

1. PMCCs can be of **double Front** and compartmentalized bolted construction.

2. Degree of Protection for the Panels should be IP 40/42/54 in accordance to the location of the panel.

3. All ACB panels shall be preferably **single tier**.

4. Vertical bus bars of MCC panels shall be accessible from side of panel without removing feeder base plate.

5. All Incoming ACB's shall be M / EDO Type.

6. PMCC Incomer shall be Suitable for Top Bus duct entry / Top & Bottom cable connection.

7. All Outgoing Air Circuit Breakers shall be of Manual / Electrical Draw-Out Type as specified in the SLD.

8. All Outgoing MCCB/Motor Feeders shall be Non Draw-out type mounted on a single base plate for ease of removal.

9. All ACBs shall have integral LSIG Protection thro Micro Processor based Release.

10. The ACB & MCCB releases should be detachable & upgradeable at site.

Constructional Features

- The switch board shall be metal clad sheet steel enclosed cubicle, fully compartmentalized, floor mounting type suitable for indoor installations. All the doors and covers shall be fully gasket to prevent any ingress of dust. The enclosure shall be for Indoor type and completely dust, damp and vermin proof. Gasket used for all doors shall be of double lip type.

- The switchboard cubicles shall have structural steel frame work enclosed on all sides and top by CRCA sheet steel of minimum thickness.

The switchboard shall have integral base frame.

Removable undrilled gland plates shall be fitted for bottom cable entry

- All fixing bolts, screws etc. appearing on the panel shall be so arranged as to present a neat appearance.

Door hinges shall be concealed type.

Components shall not be mounded on side, bottom rear side plate in MCC feeder.

- Front access shall be available to all components in each cubicle which require adjustment, maintenance or replacement.

- Switchboard shall be suitable for Seismic zone III / V. The same shall be tested either at ERDA/CPRI only for seismic test. Test Certificate only from ERDA / CPRI acceptable & needs submission at the time of drawing approval.

Panels should be with door locks. Door screws not acceptable

Busbars and insulating materials

- The busbars connections and bus taps to individual feeders shall be by means of electrolyte copper / aluminium bar suitably tested to conform to Type Tested Assemblies (TTA) as per IEC 61439. Busbars shall be color coded for ready identification of phases. The busbar sizes shall be determined taking into consideration the continuous rating and fault level of 65 kA (1 sec) without exceeding the final temperature as per IEC 61439.

Auxiliary busbars each of minimum 25 sq. mm thick electrolytic tough pitch copper shall be provided for following applications. Exact number of busbars shall depend on various controls, metering and auxiliary power distribution requirements.

a) Panel / Motor space heater supply – 230 V AC (2 wires)

b) AC / DC control supply for breaker tripping closing and indication circuits

c) Control supply for breaker spring charging motors, closing coil & indication-

d) Control supply for motor starter control circuits-

Neutral Busbar shall be provided in a separate compartment other then main busbar compartment.

The busbars shall be supported of regular intervals using SMC or DMC insulators It should have Very high Comparative Tracking Index (CTI > 600 as per IS 2824)

Only zinc / blue passivated or cadmium plated high tensile strength steel bolts, nuts & washers etc., shall be used for all busbar joints & supports.

The busbars shall be colour coded using identifying colour rings at regular interval. Red, Yellow & Blue colour shall be used for phases & Black for neutral. The earth busbar shall be identified with Green colour rings at regular intervals.

Minimum clearance between phases / live parts shall be 25 mm and phases / live parts / neutral to ground shall be 19 mm except on the equipment terminals.

Spare contacts shall be wired upto terminal block. Auxiliary contacts in the "trip" circuit shall close before the breaker main contacts close and shall open after the main contacts have opened. All other contacts shall operate simultaneously with the main contacts.

The circuit breakers shall be equipped with Integral Micro Processor based Numerical Relays which shall have current setting, ammeter digital display & bar graph indicating load level.

Earthing

Earthing - Two earth terminal shall be provided on each side of switchboard. An earth bar of at least 50 x 10 mm Aluminium suitable for 30kA for 1 sec. shall be provided. The earth bar shall be electrically continuous and shall run the full extent of each board. This earth bar shall be on the same side as the cable entry. Each unit shall be constructed to ensure satisfactory electrical continuity between all metal parts not intended to be alive and earth terminals of the unit. Suitable holes with bolts and nuts shall be provided at each end of earth bar of switchgear for connection to a main earthing grid. The earth bar shall be accessible in each cable entering

compartment either directly or through a branch extension to ground the cablearmour and shields. 10 mm Ø holes shall be drilled and hardware for connection provided through the earth bus

Internal Wiring :

Minimum size of conductor for power circuits shall be 2.5 sq. mm copper or 6 sq. mm aluminum.

All control wiring except CT secondary wiring shall be carried out with minimum 1.5 sq. mm copper conductor. CT secondary wiring shall be carried out with 2.5 sq. mm copper conductor.

All wiring shall be securely fixed and neatly arranged to enable easy tracing of wires.

All terminal blocks and wires shall be tagged for identification in accordance with IS 11353.

All wiring for external connections shall be brought out to the individual terminals on a readily accessible terminal block; all terminal block shall be shrouded or provided with transparent covers.

Clamp type control terminal blocks shall be provided for outgoing control cables. Minimum 10% spare terminals shall be provided for future use. Control terminal block shall be separated from power terminal blocks by means of an insulating barrier.

Cable Terminations and Marshalling Box:

- Cable entry to switchgear shall be from bottom of the switchgear as specified in the technical particulars.

- Ample space shall be provided in the cable compartment to accommodate XLPE insulated aluminum conductor cable as specified in the technical particulars.

Removable undrilled gland plate shall be provided for termination of Cables. **Painting and Finishing**

All metal works and metal parts of the switchboards shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphatizing, passivation and then sprayed with a high corrosion resistant primer. The finishing treatment shall be by application of synthetic Light Grey Shade RAL7035.

Name Plates & Label

One nameplate giving designation of the switchboard shall be affixed prominently on top. Details of designation shall be specified.

Labels giving following details shall be affixed on each feeder panel:-

Feeder No - As per feeder list

Equipment tag Number and Description

Rating (KW/KVA/AMP)

- All components whether mounted inside the switchboard or on the door shall be permanently and clearly labeled with reference number and/or letter of their function. These labels should be fixed so that they are easily visible.

- Labels for feeder panel designation shall be fixed on the front side of respective panels with Special rivet made of nylon. These labels shall be identical size to permit interchange.

Testing and Inspection

All routine tests specified in relevant Indian Standards and witnessed by buyer.

- Vendor shall submit all following type test report as per IEC 61439-1&2 standards at the time of drawing approval / offer submission:

a. Short Circuit withstand test for main Busbar and neutral Busbar

b. IP test certificate for IP 54 /42 /40

c. Seismic test for Zone III / Zone V as classified on the Seismic graph of India for the project site location.

d. Internal Arc Containment test as per IEC 61641

Operation of all meters.

Secondary wiring continuity test with a low voltage (6 volts) tester.

Insulation test with 1000 volts megger, before and after H. V. test.

H. V. test at 2.5 kV for 1 mte.

Earth continuity test with a low voltage (6 volts) tester.

- Simulating control circuits for various operations of feeders, remote indicating lights and other remote operations, if any.

C. T. Polarity Test

Technical Requirements - PMCC

1. General Requirements

Service	:	Indoor
Enclosure	:	CRCA sheet steel
Min Degree of Protection	:	IP 54 / IP 42 / IP40 dependent on location of panel
Execution	:	Single / Double front both are approved
Incomer ACBs & Bus Couplers	:	Manual / Electrical Operated - Draw out
Outgoing ACBs	:	Manual Operated – Draw Out
Outgoing / Motor Feeders	:	Non Draw-out & Drawout* (*separate specs)
Extensibility	:	Extensible on both sides

2. Enclosure

Sheet steel thickness (mm)	:	Base frame/ Channel – 2.5 mm
Load Bearing member - 2 mm Internal partitions		- 1.6 mm
Surface treatment	:	7 Tank surface treatment.
Painting	:	Epoxy painted.
Paint shade	:	RAL 7035

3. Main Busbar

Material	:	Electrical grade Aluminum
Rated continuous current	:	As per SLD
Maximum operating Temperature	:	As per 61 439-1 & 2.
Rated short time current (KA- RMS)	:	65kA symm for 1 Sec.
Rated dynamic short circuit Withstand current (Peak)	:	105kA peak

Heat shrinkable sleeving	:	Yes with Shrouds for Joints
Current rating of vertical busbar/	:	As per requirement
Droppers in vertical section		
Busbar support	:	SMC/DMC / FRP

4. Earth Bus

Material

Aluminium / GI 50 x 10 Sq.mm size (min.)

Short circuit capacity (KA)

39kA current for 1 Sec.Relay / Protection

ACBs - Incomers	:	LSING.
Outgoings	:	LSIG

Outgoing Distribution feeders : 75KW and above rating shall have Microprocessor Relay with Communication facilities to DCS

6. Indicating Meters

Given below are the functions of metering usually provided by conventional meters. These function are envisaged to be performed by numerical type relays in incomer and there will be a separate ammeter and voltmeter apart from numerical relay. All other feeders shall be having load manager as mentioned in the specification..
The requirements for meters are as follows:

Type	:	Moving Iron type
Size :	96 Sq.mm	
Scale	:	240 Deg.
Input	:	1 A for Ammeter
Type of connection	:	3 Phase, 3 Wire system.
Mounting	:	Flush

7. Wiring

Type of wire	:	1100V grade multistrand copper
Colour coding for		
AC and DC wiring	:	Required
Size :	1.5 sq. mm for control	
2.5 Sq.mm for CT circuits		
Ferruling	:	Cross ferruling required

8. Cables

Power cable entry	:	Bottom
Control cable entry	:	Bottom
Lugs and glands	:	NA for power and control cable
Terminations.		

9. Tranducers

Output Range	:	4-20mA DC Isolated
Input	:	1A, 110V AC / 1A
Accuracy	:	0.5% of full scale
No. of Output	:	2 Channels
Load Resistance	:	600 Maximum
hms)		

Description / Specification for Withdrawable Motor Control Centers

Branded Type Tested Assemblies for switchgear and control gear assemblies designed and manufactured by OEMS or their Authorized Licensed Partners specifically certified forWithdrawable MCCs Technology can only supply.

The low-voltage switchboard must be supplied ready to use as a type-tested assemblies (TTA) for Low voltage switchgear and control-gear assembly in multiple cabinet designs enclosed on all sides by a sheet steel cabinet for

- Side-by-side installation
- Double-fronted installation
- Back-to-back installation
- Corner installation

The following descriptions form part of the calculation and contract. They must be taken into account when describing the individual systems and equipment, even if they are not referred to in more detail

Design

The configuration, the mechanical and electrical assembly, and the tests must be carried out in accordance with the manufacturer's documentation, either by the manufacturer himself or by License partners authorized by the manufacturer.

Structure and enclosure parts

Structural Parts (Busbar Chambers, Cable Alley Chambers) shall be of 3mm / 2.5mm / 2.0mm Hot Rolled, Top / Bottom Sheet 2.0mm Hot Rolled, Doors 1.6mm / 2mm Cold Rolled Covers 1.6mm Cold Rolled Partition Sheets & Barriers 1.0mm Cold Rolled

The doors must be equipped with locks that are resistant to internal arcing faults, and in the case of side-by-side installation of the panels, they must have a door opening angle of 125°(stand-alone installation 180°). The door hinges must be easily changed to adapt to the specified escape route. The top plates of the power distribution board must be provided with pressure relief. The installation must have an earthquake-resistant design.

Cable and busbar connections

It must be possible to insert cables and busbars from above and from below. Clamping rails must be mounted in the panels for securing the cables.

Busbar system

The busbar system must be made of electrolytic copper. All busbar connections must be easily maintainable through the entire service life of the switchboard. The main busbar system is arranged at the back (top and/or bottom) of the panel. The vertical bus bar should be completely enclosed

The neutral conductor and PEN conductor bars are assigned physically to the line conductor bars. The protective conductor bars (PE) must be arranged at the front of the panel for ease of access. The busbars must be identified in each panel in accordance with DIN
EN

60446 (VDE 0198):

Line conductor: L1, L2, L3	Green/yellow
PE/PEN conductor:	100
N conductor:	N

Resistance to internal arcing

Verification of internal arcing limitation must be made in accordance with IEC/TR61641.

Transport units

All panels must be mounted on wooden skids for transport on low-lift platform trucks. The horizontal busbars must be implemented along the entire length of the transport unit. The transport units must be connected to each other at the installation location. The connection points of the main busbars must be made accessible from the front via installation openings, and must be covered after installation so that they are safe-to-touch. The arrangement of the low-voltage panels is independent of the position of the main busbar system and the technical design and can be freely selected.

Labeling

A uniform labeling system must be used for the panels and feeders.

The labeling system must be secured to the doors. The panels are supplied fully installed, including all the required accessory material.

Technical specifications

The power distribution board must meet the following minimum technical

specifications: General

Rated operational voltage Ue:	400 V/50 Hz
Rated insulation voltage Ui:	1000 V AC
Rated impulse withstand voltage:	8 kV
Overvoltage category:	III
Pollution degree:	3
Demand factor:	In accordance with IEC 61439-2 Table 101

Degree of protection:

O IP30 ventilated ..... O
IP31 ventilated
O IP40 ventilated O IP41 ventilated O IP54 ventilated

Installation method: X Side-by-side installation
O Double-fronted installation O Back-to-back O
Corner installation

Installation location above sea level:	Up to 1000 m
Ambient temperature:	35 °C

Surface treatment:

Rack parts: MS Powder coated

Side panels, doors, base: Powder coated

Color: RAL 7035

Color design parts: Blue Green Basic

Control voltage: 230 V

Main busbars:

Busbar system: L1-L3, PE, N

L1-L3, PEN

L1-L3, PEN (insulated), PE L1-L3, PE

Position of the main busbar: Top

Rated operational current of the main busbar: As per SLD.

Resistance to arcing faults in accordance with IEC/TR61641:

The arcing fault limitation function must be verified in accordance with

IEC/TR61641 Specification for all control voltage:

The control voltage is 230 V AC.

Total dimensions:

Switchboard height: 2400 mm (with base 100 mm)

The free space above the distribution board must be at least 400 mm.

Width in mm: 850 mm

Depth in mm: Single-front 560 mm

Double-front 800 mm

Withdrawable trolley :

Withdrawable trolley should have standard operating method. Each module should have positive earthing arrangement. All equipments mounted inside the trolley should be accessible from the front. Gravity operated shutters should ensures positive isolation of module compartment with vertical busbars after the trolley is withdrawn.

The Switch fuse unit upto 125A comes with built in lyra contacts with solid connections between the switch, lyra contact and vertical busbars. The module should have finger touch proof control-gear & auxiliary contacts.

7. FINAL LOW VOLTAGE DISTRIBUTION

Final low voltage distribution system shall comprise of the following:

7.1 FINAL DISTRIBUTION BOARD

Final Distribution Boards shall be fabricated out of 1.6 mm thick CRCA sheet steel pre treated and powder coated by at least seven tank processes. Sheet steel used in the construction of DBs shall be folded and braced as required to provide a rigid support for all component. The DBs shall be suitable for indoor / outdoor installation, wall mounting free standing type, in double door construction. The Final Distribution Boards shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors, Neoprene gasket, padlocking arrangement. All removable/ hinged doors and covers shall be grounded by 4.0 sq.mm tinned stranded copper connectors. Final Distribution Boards shall be suitable for the climatic conditions. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage up to 1100 V.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of the DBs.

Knockout holes of appropriate size and number shall be provided in the FDB's in conformity with the location of cable/conduit connections. Detachable sheet steel gland plates shall be provided at the top / bottom to make holes for additional cable entry at site if required.

Final Distribution Boards shall have the following features:

i. A panel for mounting where appropriate incoming supply circuit breaker & other auxiliaries for Control & distribution as required.

ii. Installations accessories shall be part of the DB for fixing conductor and rails for mounting MCB's and RCCB's etc. Neutral bus bars & earthing bus bars required in the circuit. All bus bars in the FDB shall be insulated type.

iii. Service cable /interconnection shall be part of the Distribution Boards.

iv. The board shall be installed at a height such that the operating is within reach of the normal human height i.e. 1.2 to 1.8 meters from finish floor level.

v. Degree of protection shall be IP-42 for indoor application, IP-55 for kitchen & laundry and IP-65 for outdoor application.

vi. All three phase distribution boards shall have 4 rows and single phase distribution boards shall have single rows for housing of MCB's and RCCB's unless noted otherwise.

vii. Phase segregation to be maintained in all three phase distribution boards.

viii. Earthing shall be provided in each FDB's.

RESIDUAL CURRENT CIRCUIT BREAKER

Residual Current Circuit Breaker shall confirm to IEC 61008.RCCB shall work on the principle of core balance transformer. The incoming shall pass through the torroidal core transformer. As long as the currents in the phase and neutral shall be the same, no electro motive force shall be generated in the secondary winding of the transformer. In the event of a leakage to earth, an unbalance shall be created which shall cause a current to be generated in the secondary winding, this current shall be fed to a highly sensitive miniature relay, which shall trip the circuit if the earth leakage current exceeds a predetermined critical value. RCCB shall be current operated independent of the line voltage, current sensitivity shall be of 30 mA at 240/415 volts AC and shall have a minimum of 10,000 electrical operations.

The moving contacts of the phases shall be mounted on a common bridge, actuated by a rugged toggle mechanism. Hence, the closing /opening of all the three phases shall occur simultaneously. This also shall ensure simultaneous opening of all the contacts under tripping conditions.

The neutral moving contact shall be so mounted on the common bridge that, at the time of closing, the neutral shall make contact first before the phases; and at the time of opening, the neutral shall breaks last after allowing the phases to open first. This is an important safety feature which is also required by regulations.

A test device shall be incorporated to check the integrity of the earth leakage detection system and the tripping mechanism. When the unit is connected to service, pressing the test knob shall trip the ELCB / RCCB and the operating handle shall move to the "OFF" position.

MINIATURE CIRCUIT BREAKER

Miniature Circuit Breaker shall comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/ 415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B, C, D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.MCB shall ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF. MCB should be certified as per BIS standard.

8. POWER FACTOR IMPROVEMENT

SYSTEM SCOPE OF WORK

This section covers the general requirements of Designing, Manufacturing, Supplying, Erecting, testing and commissioning of Indoor type power correction capacitor banks for power factor improvement. The contractor shall provide all materials, labour, equipments, scaffoldings, etc. as required.

CODES AND STANDARDS

Unless otherwise stated below, the APFC system shall comply with the following standards (and their latest amendments):

IS 13340-1993, IS 13341-1992, IEC 60831-1+2 : Capacitors with self healing features

IS 12672 : Capacitors with over pressure disconnectors

IS 13703 : HRC cartridge fuse and links up to 600V

IS 13947 : Circuit breakers & switch gear components

RATING

10 to 50 KVAR (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity.

CONSTRUCTION OF ENCLOSURE

The panel shall be indoor type, free standing, and floor mounting with IP42 degree of protection. The panel shall be fabricated out of 2.0 mm thick CRCA sheet steel. The enclosure shall have sturdy support structure with angle supports as necessary and shall be finished with powder coating in the approved colour shades to match the colour of the other panels. The thickness of powder coating should be minimum 60-80 microns.

The capacitor portion should be modularly separate and segregated from rest of the portion of APFC panel and shall form one vertical portion of the panel, to prevent and contain the damages in case of the unlikely event of capacitors bursting.

Suitable provisions shall be made in the panel for proper heat dissipation. Air aspiration louvers for heat dissipation shall be provided as a necessary.

The panel shall be provided with hinged doors, neoprene gasket fitted with twist type holding down bolts, with concealed hinged construction and flush front with uniform panel depth throughout the length.

An earth bus of size not less than 25 x 6mm aluminium shall be provided on the top with earth studs on either side for safety earthing of the panel.

Each individual module mounting plate, CT's etc., shall be separately grounded to this earth bus using PVC insulated copper flexible wires of 4 Sq.mm (min).

Each door shall be earth bonded to the main-frame by providing braided flexible copper round tails, across the hinged edge of each door. These earth bonds shall be bolted or screw fitted.
The APFC panel construction shall ensure ease of access for maintenance at all times which is most important and shall conform to national/ international standards and good engineering practices.

A tentative G.A drawing of the panel showing the configuration and construction offered by vendors is necessary at the tendering stage to assess the suitability of offer to the site conditions.

All aluminium bus bar joints shall be cleaned with fine emery paper, wiped clean with cloth, and special anti corrosive paste like "Dowels" applied before making joints or tap-off.

Wherever copper to aluminium connections are to be made, copper-aluminium bi-metal spacers shall be used (minimum 2mm thickness). At all electrical connections, proper size plated flat washers of min 2mm thick and flat section plated spring washers shall be used, whether at bus bars or devices.

Further all bolts used in such connections shall be coated with a thin film of petroleum jelly before assembly to prevent seizing and to make effective connections.

All hardware used in the assembly of panels shall be similarly thinly coated with petroleum jelly for ease of removal even after a long period and to prevent corrosive seizing.

The bus-bars shall be PVC sleeved with heat shrinkable tubes with appropriate colour codes as per standards, except at joints and tap off where black non-adhesive PVC tapes shall be used.

All control wires shall be of PVC insulated multi strand copper conductors of 650V grade, ISI approved, ferruled as per IS at both ends with TB’s with termination numbers etc.

15mm thick rubber mat of an approved make shall be provided in front of the full length of the panel.

ANNUNCIATION

The capacitor panel shall have the following annunciation feature all located at the top portion of the panel:

i. Two tone hooter
ii. Fault indication lamp

iii. Capacitor bank "out of Circuit" indication

RELAY / CONTROLLER

Intelligent reactive power controller or Automatic Power Factor Correction relay shall have dual sensing which automatically switch ON/ OFF the capacitor bank to achieve the targeted p.f. and it can be switched to desired p.f. when the system is running on DG. The controller/ relay shall have the following features:

i. Controller shall provide solid state output of 8/12/16 stage suitable for fast switching of capacitor bank controlled by thyristors.
ii. Auto /manual selector switch shall be provided to enable operation of APFC panel in manual mode when required, especially in case of failure of APFC relay.
iii. Controller shall sense three phase three wire voltage and shall have 3 current feedbacks CT sensing for measurement.
iv. Digital settings of parameters like PF, Switching time delay, Step limit etc.
v. LCD Display displaying PF/ V/ I/ KVA/ KW/ KVAR temp./Harmonics (THD for Voltage

and Current and individual odd harmonics up to 15th for phase voltage and current).

The controller shall have the data logging feature for all electrical parameters for at least 30 days.
vi. Indication of PF (up to 3 decimal points), preset parameters, Contactors switching operation and capacitors operating life.
vii. Indication for Failure to achieve the target PF, Harmonic overloading, Step failure etc. online per step health monitoring.
viii. Controller shall maintain PF of 0.8 while system is on DG supply.
ix. Minimum threshold setting of 1% of CT current.
x. Protective shut down in case of harmonic overload i.e. either VTHD or ITHD is higher than 5% (settable up to 25%).

CAPACITOR BANK

The capacitor banks shall be formed out of 50 kVAr (or less) capacitor units as specified in the BOQ shall be used to form a bank of capacitors of desired capacity. The smallest capacitor bank step shall be less than 10 kVAr and the largest capacitor bank step shall not be more than 100 kVAr. Unless otherwise stated, the capacitor bank shall conform to IS: 2834-1986.

For bank formation, Mixed Dielectric Extra Low Loss/ All Poly Propylene (APP)/ Metalized Poly Propylene (MPP)/ MPP Gas Filled (filled with inert gas) capacitor shall be used.

Mixed dielectric capacitors shall be combination of tissue paper and biaxially oriented polypropylene film impregnated with non PCB bio-degradable compound.

APP capacitors shall be combination of multilayer polypropylene film of appropriate microns thickness.

MPP capacitors shall be manufactured using Poly propylene film placed between 2 layers of metal foil and winding or using wave cut MPP film. The MPP Capacitors shall be self-heating type and soft resin or oil impregnated for longer life. The impregnant shall be non-PCB, biodegradable type and must be properly treated and de-gasified so as not to have any degeneration properties and shall be non-oxidizing.

Alternatively, MPP type capacitors filled with inert gas shall be used. The MPP capacitors shall be in cylindrical Aluminium can

For the MDXL or APP capacitors, the elements shall be connected to the external bus bars through the leads in a series- parallel connection to form a three phase unit. These capacitors shall be floor mounting type using minimum floor space. The container of capacitors shall be made out of 2 mm thick M.S sheet steel with polyester paint coated

finish. The design shall be modular for simple mechanical assembly, no extra accessories / metal parts to be required. Unit must be free standing with an IP 41 protection level.

CAPACITOR

Capacitor voltage shall be minimum 440 Volts. However, it shall be derated to give required kVAR output of APFC bank at 415 working voltage. ##

All capacitors shall be ISI marked, 3 phase, 50 Hz., delta connected construction. The

capacitors must be designed to withstand system over voltages.

Over current: 1.5 x I_n

Pick Inrush current withstand: 200 x I_n Operating
temperature: -25°C to +70°C

Watt loss: $\leq$ 0.45W/ KVAr for MPP and $\leq$ 1.5W/ KVAr for APP/ MDXL type

##Note: For Capacitor Bank with Detuned Reactors, the first clause shall be replaced by the following:

Capacitor voltage shall be minimum 440 Volts. It shall be 480V when used with 7% reactors and 525V when used with 14% reactors. However, it shall be derated to give required kVAR output of APFC bank at 415 working voltage.

SWITCHING MODULES

Switching module shall consist of Thyristor switches which shall be capable of switching its rated current suitably cooled by heat sink and forced air cooling.

The rating of individual thyristor modules shall be: dv/dt

device rating of 1000 Volts/micro- sec.

Full rated current should be defined at temperature >75C

Vrrm blocking voltage (forward and reverse) should be of minimum 1600 V

Thyristor switches shall be capable to Turn ON capacitor banks (cold start) at rated current in all phases within 20 milliseconds and reaction time shall be 5 milliseconds. The thyristor switches shall be capable to reswitch and Turn ON same step (hot start) within 2 seconds of Turn OFF without generating transients. During Turn ON, inrush current shall be minimum and should not exceed 210% of rated current peak.

For ease of maintenance the thyristor switches should be able to monitor and indicate faults in thyristor and capacitors by indicating Thyristor short circuits (thyristor failure), under current (capacitor failure), over temperature in heat sink (fan failure) and feedback to the front controller display.

Thyristor shall be protected by thyristor duty fuses and shall be suitable for capacitor switching without generating transients during switch ON or OFF.

Total losses shall not be more than 3 Watts/ KVAr.

Thyristor shall have feature of thermal cutout if temperature exceeds acceptable limits and restarts automatically when temperature comes down.

DETUNED REACTORS

Note: This clause is applicable when capacitor bank with detuned reactor is specified.

Harmonic filters with harmonic filter duty power capacitor to mitigate harmonics improve power factor and avoid electrical resonance in LV electrical networks.

The low voltage filter reactor shall be series type having a three phase, iron core construction suitable for indoor use (IP 00). The reactor shall be air cooled and the layout shall be in accordance with IEC 60289/ IS-5553.

The complete unit shall be impregnated under vacuum and over-pressure in impregnation resin. The insulation shall be Class F/ H with maximum temperature rise limited to equivalent of class B.. The reactor coils shall be wound with high grade aluminum / copper and termination shall be provided with suitably designed copper bars.

The reactor shall be fitted with a temperature sensitive micro-switch in the centre coil (normally open) for connection to trip circuit in case of high winding temperature.

The permitted tolerance of inductance shall be ±5% of rated inductance value.

Reactor tuning factor shall be 7 % (189 Hz) and the current rating of the reactor shall include the effects of harmonics and other possible over-currents.

Reactor losses shall not exceed 0.5% of corresponding step kVAR i.e. for a step of 50 kVAR losses shall not be more than 250W

TERMINALS

Each capacitor bank shall be provided with a terminal chamber and cable glands suitable for PVC insulated aluminum conductor armoured cables as specified. The MPP type capacitor with sigut terminals shall be preferable.

SWITCHGEAR

Incoming breakers to the capacitor panels shall be 3 pole breakers with neutral link of rating minimum 1.8 times the normal current to take care of inrush switching current. The switching of capacitors shall be thyristor based at ‘zero’ cross over to avoid surges in the system. The system will be acceptable subject to demonstration of switching at zero cross over during the inspection.

Bus bars shall be suitably colour coded and must be mounted on appropriate insulator supports.

Power cables used shall have superior mechanical, electrical and thermal properties, and shall have the capability to continuously operate at very high temperatures up to125°C.

Internal wiring between main bus-bars, breaker, thyristors and capacitors shall be made with 1100 V grade, PVC insulated, copper conductor cable of appropriate size, by using suitable copper crimping terminal ends etc.

Suitable bus links for input supply cable termination shall be provided.

EARTHING

Earthing shall be provided as per IS: 3043-1987.

CONTROL CIRCUIT AND INDICATION

The control circuit shall be duly protected by using suitable rating MCB.

An emergency stop push button shall be provided to trip the entire system (22.5 mm dia, mushroom type, press to stop and turn to reset).

Wiring of control circuit of less than 50 V shall be done by using 0.5/1.0 sq.mm, 660 V grade, PVC insulated, copper wire and all other electrical control circuit wiring shall be done by using
2.5 sq.mm, 1100 V grade, PVC insulated, copper wire

Following LEDs /indication shall be provided on the firing card/ controller/ thyristor module for quick fault finding and ease of maintenance:

i. Step ON (Green) - The respective step is ON.
ii. Power ON (Green) - The control power supply is ON.
iii. Current Spike (Red) - Unit tripped due to spike current detection.
iv. Over Current (Red) - Unit tripped due to capacitor over-current.
v. Thyristor Short (Red) - Unit tripped due to thyristor short.
vi. Over Temp. (Red) - Unit tripped due to over temperature at heat sink.
vii. Power Fail (Red) - Power connection failures or Voltage transients high.

Inspection terminal strip, number ferruling, labeling etc. shall be provided.

440 V caution board on the panel shall be provided.

TESTING

The capacitor bank shall be subject to tests as specified in relevant Indian Standards at the factory and the test certificates shall be furnished in quadruplicate. The contractor shall be responsible in getting the approval Certificate from Relay testing division of the relevant Electricity Board.

INSTALLATION

i. ACCP Capacitor banks shall be installed as per installation manual of supplier and shall conform to relevant Indian Standards.

ii. All interconnections in the control panel shall be checked before commissioning.

iv. Cable end cores shall be sealed after cable connections to prevent absorption of moisture.

v. Insulation resistance shall be tested with a 1000 volts megger between phases and phase to earth.

vi. Residual voltage shall be measured after switching off of the capacitors and the same shall not be more than 50 volts after one minute.

vii.

SANDWITCH CONSTRUCTION BUS DUCT AND RISING MAIN
SCOPE OF WORK

This specification covers Design, Manufacture, and Testing at manufacturer's works, delivery at site, erection, testing & commissioning of LV Bus Ducts, suitable for indoor / outdoor installation, with Copper/ Aluminum bus, of the following design:

Conventional, Non –Segregated air insulated factory assembled (Detailed separately)

Sandwich insulated design.

Resin encapsulated.

Bus ducts with protection against fire.

The Bus Ducts shall be for either Rising Mains distribution or Horizontal distribution with different current ratings and bus bar configurations, for use in 3Ph, 4W, 415V, 50Hz, earthed / unearthed AC systems.

The bus duct shall be suitable for operation in a 600/ 1000V system, with frequency of 50 Hz having 100% neutral and internal earth. The bus duct shall be designed for an ambient of 40°C (35°C average over a period of 24 hours) as per IS 8623.

The scope of services shall include preparation of layout drawings in 3-D configuration, co-ordination with other suppliers comprising Switchgear, Distribution Boards, and other Agencies like Structural, HVAC, PHE, IBMS, and Civil Architects associated with the Architects for finalizing of the drawings before commencement of manufacture and installation.

The scope of supply shall include spares, which may be required during installation. Bidder shall make note of this requirement the cost of which has to be borne by the contractor.

CODES AND STANDARDS

The LV Bus Ducts and accessories shall conform to the latest standards and Safety codes in the region where the equipment is to be installed and operated. The specifications are listed below.

IS 8623 - 1& 2 :

IEC 60439 - 1& 2: 1977 & 2000: Particular requirements of bus bar trunking systems BS 5486

Part 2 : Particular requirements of bus bar trunking systems

BIS EN 60439 –1:1977 & 2000

IEC 60529 : Degree of protection

The equipment shall conform to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions, specified therein, for installation and operation of Electrical Plants. The bus duct shall also conform to IEE/ NEMA/ BUI/ JIS for seismic protection certification.

TYPE TESTING REPORTS

The bus bars shall be type tested at a reputed international test laboratory (ASTA or CPRI) for short circuit withstand. The test shall be for a minimum duration of 1 second. Tests shall be performed over a range of current ratings, covering the different frame sizes of the manufacturer.

Degree of ingress protection (IP rating) shall also be tested at any reputed independent laboratory. This test shall be for IP 55 for indoor application and IP 65 for outdoor application for sandwiched bus bars.

DESIGN AND CONSTRUCTION GENERAL

REQUIREMENT

The Bus Duct system is an alternative to conventional cabling system for distribution of electric power within and outside the building. The design shall be simple, compact, easy to install, with provision for dismantling any section without disturbing the adjacent sections. The bus shall be designed to have low reactance, low impedance, low voltage drop and low power loss, apart from temperature rise to be within permissible limits.

The Bus Duct shall be non- ventilated type, natural air cooled, totally enclosed for protection against mechanical damages, offer protection against dust for indoor applications and against seepage of water in the out-door type.

BUS BARS

The bus duct shall consist of three phases and neutral bus bar permanently positioned dust and vermin proof and the degree of enclosure protection shall be IP 54/ IP 55 for indoor installation and shall be IP-65/ IP 68 for outdoor installation as per schedule of quantities. Where an earth conductor is required, it shall be a separate, integral earth conductor, of the same high conductivity material as per clause 7.4.3.1.7 of IS 8623 or IEC 60439. In addition to this, enclosure shall have fixing arrangement to install 2 nos. of external earth strip along the run of the bus duct. It shall be possible to provide a 200% Neutral where specified.

The bus bar conductor material shall be of electrolytic copper as per BIS 613:1984 or aluminium alloy, grade 19501as per BIS: 5082 –1981.The entire surface of bus shall be tin plated whereas the joints shall have silver plating. The tinning throughout the surface shall be minimum 20 microns thick.

The rectangular section, with rounded edges shall be epoxy/ Mylar coated, by extrusion process, to form a well bonded insulated bus with smooth surface, to prevent air corona and cavities during to formation of bends. The insulation shall be of uniform thickness, without voids; the epoxy/ Mylar coating being applied under high pressure, to form a sandwich insulated design.

INSULATION

The bus bars shall be insulated throughout their length by epoxy coating / Mylar. The insulation material used shall be of Class F (155 deg. C) or better for a rated operational voltage/ insulation voltage of 1000V with a rated impulse withstand voltage of 12kV, 1.2/ 50 sec. impulse wave. The insulation must comply with UL 94 V-O. It shall be Halogen Free.

The resin cast design shall have an insulation compound, epoxy resin mix with a high content of inert mineral fillers. The compound shall be halogen free and emit no toxic gases when in flame.

HOUSING

The housing shall be made of extruded Aluminum case duly enameled/ electro-galvanized sheet steel, with an epoxy powder coated paint finish. The housing shall be profiled, to provide higher strength and efficient heat dissipation. The width of the housing shall preferably be the same for all ratings of bus bars, in order to provide interchangeability of tap off boxes.

TEMPERATURE RISE

The maximum temperature rise limits of 40° C above ambient temperature shall be permissible for metal surface and of 50° C above ambient temperature for insulating surfaces as per IS 8623(Part-1) 1993 when carrying the rated current continuously.

JOINTS

Joints shall be such that check for tightness can be carried out without de-energizing the bus bars runs. High tensile steel bolt shall be made use of for fastening the joint; the bolt insulated with high quality insulation material resistant to heat and impact forces. In order to keep the resistance at the joints to a minimum, Belleville washers shall be used for clamping. The joint shall permit safe testing of joints, without de-energizing the bus bar run and possible to remove any one section, without disturbing the sections on either side. The nuts shall be of maintenance free- type, with the outer head twisted-off when the specified torque is reached.

The joint assembly shall comprise mono-block joint, operable by one or two high tensile steel bolts, of proprietary design. The joint construction must allow a +/- 14mm adjustment at the time of installation, for ease of adjusting to site measurement variations.

The joint assembly for vertical bus trunking shall comprise floor flange plate with fire barrier, spring hanger with necessary fastening channel for support as well. Spring hanger assembly shall be provided, per rising main per floor, preceded by one set of rigid hanger per rising main at the start, to prevent expansion of bus in the downward direction.

The bus bar ends shall not have holes or slots at the joints – the electrical continuity shall be through pressure plates, achieving a high area of joint cross section and expansion capability.

NOTE ON BOLTS

The bolts shall be of high tensile steel, electro galvanized or cadmium plated, having standard fine threads with hexagonal heads with typical properties of material as follows.

Tensile strength	:	71 kg / sq.cm
0.2% proof stress (minimum)	:	52 kg / sq.mm
Hardness (minimum)	:	200 Brinell.
Rockwell (minimum)	:	B93

The bolts should be tightened to a desirable minimum of 56kg / sq.cm

The washers to be used at all places shall be min 2.25mm thick with extra large OD of 25mm or 29mm for M10 & M12 bolts respectively. These washers shall be electro galvanized or nickel-plated. In addition, to two plain washers, spring lock washers used shall be cadmium plated.

ACCESSORIES

A full range of accessories like bends, end flanges, end feed units, and support brackets etc. shall be available.

PLUG-IN BOX/ TAP-OFF BOX

Plug-in/ Tap off boxes shall be used, where branch loads are to be fed from rising mains at different floor levels. The tap off locations shall be covered by hinged plates.

Plug-in box shall house Isolator, switch-fuse / fuse switch unit, MCCB or ACB with ratings 125A to 1250A. Plug-in boxes shall be mechanically interlocked with the bus duct housing, to prevent plugging-in / out of the switch units,

when in closed position. Before the plug-in box jaws make contact with the bus bars, the plug-in box enclosure shall make positive ground connection to the bus duct housing. The grounding method shall such that, it is not damaged during future painting or incapacitated due to ware. The Tap off boxes shall have the following additional safety features:

i. The door shall be provided with a lock and keys.

ii. When the lever is in 'on' position, even with the key unlocked, the operator should not be able to remove the box or open the tap off location cover.

iii. The tap off unit handle shall be flexible in the sense that the 'on/off' handle can be attached to the left or right side of the box or in front, depending on the site situation.

iv. When the box is open the live conductors shall be safe guarded by a transparent insulator plate which allows for visible inspection but does not allow touching of the live conductors.

v. For IP 65 bus-trunking, the tap off unit arrangement also must achieve IP65 and for indoor installation IP-52, without requiring any additional sealing at site. The complete arrangement with the tap off unit shall be tested for IP rating by an independent test authority.

INSTALLATION

The Bus Duct shall be suitable for indoor or outdoor installation. Outdoor installation could be either overhead or in trenches with cover.

Further, depending on the trunking system design a number of sets shall be run horizontal or tier formation.

Bus ducts running along the wall shall be supported at intervals not exceeding 1.5 m. In case of branching, there shall be support on all branches at a distance of 300 mm from the point of branching, Support shall not be less than 40 x 40 x 6 mm MS angle secured in an approved manner. Supports may also be provided in the form of brackets fixed to walls where the duct runs along the wall. In case of ceiling suspended bus ducts, supports made out of 40x40x6 mm MS angle iron shall be provided. The horizontal distance between two such supports shall not be more than 1200 mm. The ducts supports shall be suspended from suitable approved suspension devices provided in the ceiling. Fire barrier shall be provided at each floor/ wall crossing as per relevant IS code.

INSPECTION AND TESTING

SHOP FLOOR INSPECTION AND TESTING
VISUAL INSPECTION

i. Measurement of main dimensions of the enclosure, clearance between phases, phases and neutral, phases and earth to be checked. Dimensions of all phases, neutral and earth buses are also to be taken.

ii. Each length of bus bar on either end shall be provided with clear stamped markings identifying the unit to it belongs to and also to match with the mating portions.

SAMPLE TEST AND MEASUREMENT

i. Measurement of tin plate thickness in respect of copper bus and silver plate at joints copper and aluminium bus.

ii. Measurement of galvanizing thickness on sample of enclosure.

iii. Temperature rise measurement on sections of different ratings with mili-volt drop measurement at the joints.

QUALITY ASSURANCE

i. Verification of traceability of the copper bought out and aluminium sections and test reports on the composition.

ii. Galvanizing thickness of bought out GS sheets for fabrication.

iii. Inward test reports on epoxy insulating raw material.

iv. Power frequency test reports on the bus after primary extruded insulation and measurement of insulation test.

v. Verification of stage inspection reports, at random.

SITE INSPECTION AND TESTING

i. Check for transit damage .

ii. Check for secure bolt connections.

iii. Check for hanger supports.

iv. Check for bus bar joint tightening to the recommended torque.

v. Check for end cover fitment.

vi. INSULATION

Insulation measurement check on the entire installation, phase-wise shall be carried out; all connected equipment disconnected either by opening the isolator switch or breakers. In a dry atmosphere the insulation shall be above 100M ohms, with a 500V insulation measuring meter. Insulation measurements are done before and after power frequency withstand test is carried out.**EARTHING SCOPE OF WORK**

This section covers the requirements for providing "Earthing" connection to metal parts of equipment etc. The contractor shall supply all materials, labour, tools, plant etc. and everything necessary for the complete Earthing installation".

The system shall be TNS with four wire supply system (R, Y, B, N and. E) brought from the main LT Panel. All the non-current carrying metal parts of electrical installation and all metal conduits trunking, cable sheaths, switchgear, distribution panels, light fittings and all other parts made of metal shall be bonded together and connected by means of specified earthing conductors to an efficient earthing system. All metal work such as pipe lines, ducts, cable trays, stair case railing etc shall be bonded to earth.

The Contractor shall get the soil resistivity test done at his own cost of the area where earthing pits are to be located and furnish a comprehensive earthing calculation to the client/ Architect before starting the installation.

NEED AND IMPORTANCE OF EARTHING

i. Human and Personnel safety.
ii. Equipment protection.
iii. Provides low impedance path for fault currents.
iv. To ensure good quality power.
v. Protection against lightning and transient currents, noise reductions, Limitation of EMI.

CODES AND STANDARDS

The applicable standards for above work shall be as listed below:

IS 3043-1987 : Code of practice for earthing.

IS 2309 : Code of practice for protection of buildings & allied structures from Lightning.

IEC 60364 : Low Voltage Electrical Installations-Part 5-54: Selection & Erection of Electrical equipment- Earthing arrangement & protective conductors.

IEC 62561	:	Lightning Protection system Components.
IEC 62305	:	Protection Against Lightning–Part 3: Protection of structures & life hazards.
UL 467	:	Grounding and Bonding Equipments.
UL96	:	Lightning Protection System – Components.

DESIRED VALUE OF EARTH RESISTANCE

The resistance of earthing system shall not exceed 1 Ω (One Ohm).

PRECAUTIONS

Earthing system shall be mechanically robust and the joints shall be capable of retaining low resistance even after subjection to fault currents.

The overlapping in strips at joints where required, shall be minimum 75 mm. The joints shall be riveted and brazed in case of copper and by welding/ bolting in case of GI in an approved

manner. All the joints shall be mechanically and electrically continuous and effective. Joints shall be protected against corrosion.

The electrical resistance measured between earth connection at the main LT panel and any other point on the completed installation shall be low enough to permit the passage of current necessary to operate all circuit breakers, and shall not exceed 1 Ω.

Sweated lugs of adequate capacity and size shall be used for termination of all conductor wires above 6 sq.mm size. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substances and properly tinned. Equipotential bonding of all metallic structures shall be done.

All switches carrying medium voltage shall be connected with earth by two separate and distinct connections. The earthing conductors inside the building wherever exposed shall be properly protected from mechanical damage by running the same in GI pipe of adequate size.

Neutral conductor, sprinkler pipes, or pipes conveying gas, water or inflammable liquid, structural steel work, metallic enclosures, metallic conduits and lightning protection system conductors shall not be used as a means of earthing an installation or even as a link in an earthing system.

MAJOR COMPONENTS

i. Earthing Conductor.
ii. Couplers and connectors.
iii. Earth Pits or Chambers.
iv. Earth Electrode.
v. Earth Enhancement Material (Optional).

EARTHING CONDUCTOR

All earthing conductors shall be of high conductivity copper for IT equipment/ Server and hub racks/ EPABX/ special equipments' neutral earthing/ UPS neutral earthing etc. GI earthing conductor shall be used for body earthing of electrical panels and equipments as described in the Bill of Quantities. The connection of earth electrodes shall be strong secure and sound and shall be easily accessible. The earth conductors shall be rigidly fixed to the walls, cable trenches, cable tunnel, conduits and cables by using suitable clamps.

Main earth bus shall be taken from the main medium voltage panel to the earth electrodes. The number of electrodes required shall be arrived at taking into consideration the anticipated fault on the medium voltage net work.

Earthing conductors for equipment shall be run from the exposed metal surface of the equipment and connected to a suitable point on the sub main or main earthing bus. All switch boards, distribution boards and isolators disconnect switches shall be connected to the earth, bus. Earthing conductors shall be terminated at the equipment using suitable lugs, bolts, washers and nuts.

All conduits cable armouring etc. shall be connected to the earth all along their run by earthing conductors of suitable cross sectional area. The electrical resistance of earthing conductors shall be low enough to permit the passage of fault current necessary to operate a fuse/ protective device or a circuit breaker and shall not exceed 2 Ω.

Sizing of earth conductor for receiving substations, HV equipment and main LV panels etc. shall be based on actual fault current calculated.

Earthing grid near substation station & earthing grids for other building shall be connected together at ground floor for equipotential bonding & to minimize overall resistance of earthing path.

Earthing grids of electronic\ IT equipment shall be separate & shall not be connected to general earthing grids with prior consent from user. Electronic\ IT equipment earthing grids for various buildings can be interconnected for equipotential bonding & to minimize overall resistance of earthing path

For lighting & power circuits cross sectional area of earthing conductor shall not be smaller than half of the largest current carrying conductor subject to an upper limit of 80 Sq.mm. If the area of the largest current carrying conductor or bus bar exceeds 160 sq.mm then two or more earthing conductors shall be used in parallel, to provide at least half the cross sectional area of the current carrying conductor or bus bars. All fixtures, outlet boxes, junction boxes and power circuits up to 15 amps shall be earthed with PVC insulated copper wire.

EARTH ELECTRODE GI PIPE

EARTHING

Electrodes shall be made of G.I. pipe of internal diameter of 100mm dia. The pipe electrode shall be as far as practicable embedded below permanent moisture level. The length of the pipe electrode shall not be less than 2.5 mtr except where rock is encountered; pipes shall be driven to a depth of at least 2.5 mtr where rock is encountered at a depth of less than 2.5mtr. The electrode may be buried inclined to the vertical and the inclinations not more than 30°C from the vertical. The pipe electrode shall be made of one piece. Earth leads to the electrode shall be laid in a heavy duty GI pipe and connected to the pipe electrode with brass bolts, nuts and washers. GI pipe shall be terminated in a wire meshed funnel. The funnel shall be enclosed in a masonry chamber of 450mm x 450mm dimensions. The chamber shall be provided with

C.I. frame and CI inspection cover. The earth station shall also be provided with a suitable permanent identifications label tag. The earth electrode shall conform to IS: 3043 latest edition. The soil around the earthing electrode shall be treated to reduce the resistivity of the soil by filling the complete depth of electrode with alternative layers of charcoal and salt.

GI PLATE EARTHING

Earthing electrode shall be 600 x 600 x 6.3 mm thick GI plate electrode, with 2 nos. 50 X 6 mm GI strips from earth plate electrode to inspection chamber, 50 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh, masonry chamber 1000 X 500 mm with concrete base as per IS3043 with CI manhole cover with frame painted with bitumastic paint and packing with mixture of charcoal and common salt around plate electrode including digging of pit up to permanent moisture level but not less than 3 meters and back filling as required.

COPPER PLATE EARTHING

Earthing electrode shall be 600 x 600 x 3.15 mm thick tined copper plate electrode, with 2 Nos 50 x 6 mm copper strips from earth plate electrode to inspection chamber, 50 mm dia medium class GI pipe, CI funnel with 20 gauge GI wire mesh, masonry chamber 1000 x 500 mm with concrete base as per IS: 3043 with CI heavy duty/ chequered plate manhole cover with frame painted with bitumastic paint and packing with mixture of charcoal and common salt around plate electrode including digging of pit up to permanent moisture level and as per soil condition but not less than 3 meters and back filling as required.

MAINTENANCE FREE EARTH ELECTRODE/ CHEMICAL EARTHING

EARTH ELECTRODE

The earth electrode shall be copper coated Solid steel Rods fabricated out of high tensile low carbon steel rod, molecularly bonded with 99.9% electrolytic copper. Minimum 0.25 mm thickness of copper shall be deposited over the steel core as per BS 7430/ UL 467. Average life of the ground rod shall be 30 years in most soil.

The minimum length of a single earth rod shall be 3 meters which can go up to 9 meters in dry areas. The vendor should quote price of the rod in length of 3 meters. Earth rod offered shall have passed the test required of BS7430/ ANSI/ UL467 and confirm to the adhesion of the copper coating to the steel core (Design feature that prevents the ingress of moister and subsequently the integrity of the rod.

For Lightning protection application rods should have a diameter of 14.2 mm or 17.2 mm. In order to carry fault current, earth rods used in Power networks should be of diameter 20 mm or 25 mm. In case of applications more than 3 meters, diameter of the rod should be 20 or 25 mm. These rods also should have facility to drive with an electric/ hydraulic hammer.

EARTHING CONDUCTORS

Copper coated steel strips / tapes shall be used to interconnect different earthing rods as well as horizontal earthing (Ring earthing). These strips should have a coating thickness of minimum 70 microns and have minimum cross sectional area of 90 Sq. mm. (Eg 30 X 3 strip).

COUPLERS/ CONNECTING CLAMPS

Couplers for interconnecting rods should be made of Brass or any other copper alloy, which is resistant to corrosion. For rods with diameters larger than 20 mm self-locking arrangements are preferable instead of couplers. Connectors for connecting Electrode with Earthing conductor/ strip should be of Brass/ copper alloy or copper coated steel. Fasteners should be made of Stainless steel. Size should be selected according to the electrode and earthing conductor dimensions. Different arrangements should be as per the below fig.

EARTHING PITS/ INSPECTION CHAMBERS

The inspection chambers shall have an inner dimension of 250 mm X 250 mm X 250 mm made of FRP material. Flush Mounted, removable and lockable cover of the earth pit should be able to withstand 15kN. The area inside the inspection chamber should be such that, the UNIVERSAL CLAMP/ EBB/ Bus bars not too deep inside the inspection chamber or projecting out of inspection chamber. The chamber should have facility for marking earth resistance and latest testing date by paint at the cover and previous recorded values inside the cover.

EARTH ENHANCEMENT MATERIAL

Ground enhancement material shall be as per IEEE-80 clause 14.5d with a resistivity of less than 0.12 ohm-meters. The ground enhancement material shall be permanent and not leach any chemicals in to the ground. The pH value of the ground enhancement material shall be 6.9 to 7.2 of 100 gm/ lit @ 20°C.

Minimum 30 Kg of ground enhancement material shall be provided for each earth electrode.

INSTALATION

Normal soil in Marsh land: Electrodes can be hand driven or hammered into earth for the required length.

Semi Hard Soil: Electrodes can be hammered electrically or hydraulically for the required length.

Hard Soil: Bore a hole with a minimum diameter of 100 MM with at a depth of up to 3 meters. Place the electrode at the center of the hole in such a way that bottom 100 mm of the electrode is in bond with the mother soil. For deep driven rods with depth more than 3 meters, remaining length of the rod should be driven into the mother soil. (Ref fig)Fill the hole with earth enhancement compound.

11. EXTERNAL LIGHTNING PROTECTION

SYSTEM 11.1 SCOPE OF WORK

The section Involves supply, installation, testing and commissioning of External Lightning Protection system works consisting of Air Terminations, Air Termination supports, down conductors, earthing, performance recording equipment etc., as required complete.

CODES AND STANDARD

Complete installation shall be engineering and constructed in accordance with the latest revision of the following:

i. NFC-17-102

ii. IEC 61204

The details of the lightning protection system shall also confirm to the requirements of all relevant local codes, as applicable, together with the additional requirements referred to in this specification and drawings, whichever is more stringent and acceptable to the engineer.

AIR TERMINAL

The air termination shall be of the type that responds dynamically to the appearance of a lightning down leader by creating free electrons between outer surfaces and an earthed central finial rod.

The Air terminal shall work under **Early Streamer Emission (ESE) Technology** and the attractive radius of the air termination shall be traceable to known and acceptable lightning research and statistics.

The Lightning conductor shall deliver a unique gain time in efficiency, anticipating the natural formation of an upward leader. The Air terminal generates a leader that propagates rapidly to capture the Lighting stroke and conduct it towards the ground.

Arcing is not to be continuous and shall only occur during the progress of the lightning leader.

The air termination shall not cause high frequency radio interference except during the millisecond intervals associated with the progress of the lightning leader and during the main return strike of lightning events in the region.

The materials of the air termination shall be non-corroding in normal atmosphere.

The air termination shall not be dependent upon batteries or external power supplies for any part of its operation.

The Height of the air terminal support mast shall be minimum 2mts and the height will be increased as per the coverage design.

The support shall be securely installed and guy wires shall be used where necessary to enable the air termination and mast system to withstand maximum locally recorded wind velocities.

DOWN CONDUCTOR

In order to reduce probability of damage it is often necessary to have several parallel current

paths. As recommended by IEC 62305 & IS 2309 equal spacing of down conductors , 25 x 3 mm Copper \ AL \ GI external strip, is preferred around the building perimeter or 1C x copper conductor special cable offered by LA supplier (recommended when laid in shaft within building). Two down conductors shall be used in case of the structure height is above 28mts and both shall be connected with maintenance-free Grounding system down conductor shall be connected directly to the air termination.

The down conductor shall be installed in accordance with the manufacturer's instructions and shall not be subject to sharper bends.

The down conductor must be kept in constant physical contact with the structure via conductive mounting clamps.

Each down conductor shall be directly connected at the dedicated earthing pit and the dedicated earth pit shall be connected to the other earth pits in the earthing grid.

ALTERNATE- STEEL REINFORCEMENT USED AS DOWN CONDUCTOR AS PER IEC 62305 & IS 2309

Steelwork within reinforced concrete structures is considered to be electrically continous, provided that major part of interconnections of vertical & horizontal bars are welded, clamped or overlapped a minimum of 20 times their diameter and bound or otherwise securely connected.

While using structural reinforcement as down conductor,

1. Preferably outer columns which are straight from terrace up to the ground floor shall be used as down conductor. Steel bars in this column should be welded \ bolted with proper overlapping at every floor to ensure, proper continuity throughout.
2. At ground level steel bars shall be taken out & welded \ bolted to the GI tape, and the tape will be carried out till the earthing pit at ground
3. Also at terrace level steel bars will be taken out & to the connected to the Air terminal

Note: This method is allowed by IS\ IEC, however requires close coordination with structural agency & monitoring during construction work to ensure proper bonding of steel bars at every level.

In this case responsibility matrix, may be worked out as under –

Sr	Description	Responsibility
	Design stage	
1	System proposal with details like, identification of column, recommended overlapping to ensure continuity, typical details for taking out reinforcement at various levels, bonding details etc,	MEP Architect
2	Integration of all above details in the arch & GFC structural design to be followed for construction.	Arch & structural Architect
	Construction Stage	
3	Direct Supervision on site to ensure proper overlapping, workman ship to ensure continuity. Proper log of continuity at every floor level before & after pouring of concrete	Project manager \ Electrical Contractor
4	Ensure proper method to take out reinforcement at various levels for connection with AT & EP network & bonding with structure of curtain wall.	Project manager \ Electrical Contractor

For buildings utilizing steel reinforcement as down conductor, the electrical continuity if reinforcing bars shall be determined by electrical testing between uppermost part & ground level. The overall electrical resistance should not be greater than 0.2 ohms measured using test equipment suitable for this purpose.

For high rise building more than 60 Mtr height, horizontal conductors at every 20 Mtr for top 20 % of building height is recommended to take care of side flashes

Conductive components of building cladding shall be bonded to the down-conductor at the top and bottom ends & every 20 m (for top 20 % of building height, in case of high rise building)

DATA LOGGER/ LIGHTNING EVENT COUNTER/ LIGHTNING FLASH COUNTER

i. Each protection system shall be supplied with a lightning event counter. The lightning event counter shall have an register that activates one count for every discharge where the peak current exceeds 1500A. The test wave shape shall be the 8/20us standard as defined by ANSI C62.41.

ii. The lightning event counter shall be robust, easy to install and housed in a IP67 rated enclosure. The counter shall operate from the energy of the lightning discharge and not depend on external or battery power to operate.

iii. The lightning event counter shall be installed to the manufacturer's instructions in a readily accessible manner so that readings can be taken at regular intervals. It shall be positioned such that its operating temperature is within the range -20 C to +60 C.

GROUNDING

i. The grounding system reading shall not exceed 10 ohms static impedance except with prior approval by the EB or manufacturer of the Advanced Lightning protection system.

ii. Grounding shall be affected by copper wire or tape buried below the frost line (or to approximately 600mm deep in non freezing locations) or by deep driven UL listed copper bonded steel core ground rods with at least 10mil copper thickness.

iii. Bonding of the grounding system to all metallic parts of the building, including structural reinforcing steel is preferred. The resistance should be measured and the 10-ohm requirements achieved before such bonding is affected.

iv. Electrically conductive Ground Enhancing Materials may be used to achieve low ground resistance provided the materials are mixed and strictly in accordance with the manufacturer's instructions.

12. STREET LIGHTING/ AREA LIGHTING

POLES M.S. TUBULAR POLES

A. 3 Meter Poles (As per BOQ)

3 meter high shall be suitable dia, 3.25 mm wall thickness MS tubular straight pole with a cast aluminium adaptor for post top mounting. Pole shall be provided with 300 mm x 300 mm x 6 mm thick MS base plate. Foundation for the pole shall be of cement concrete in 1:2:4 rates (1 part cement, 2 parts coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including 2.5 sq.mm PVC insulated copper conductor wires from the terminal block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

B. 7 METER POLES WITH LADDER BAR

7 meter high (5.75 meters above and 1.25 meters below ground shall be M.S.step tubular pole in 3 steps (bottom part shall be 4 meters high, 114.3 mm outer dia and 3.65 mm walll thickness, middle part shall be 1.5 meter high, 88.9 mm outer dia and 3.25 mm wall thickness, top part shall be 1.5 meters high, 76.1 mm outer dia and 3.25 mm wall thickness) with 300 mm x 300 mm x 6 mm thick base plate. Foundation for the pole shall be of cement concrete in 1:2:4 ratio. (1 part cement, 2 parts, coarse sand and 4 parts stone aggregate) IP-55 weather proof junction box shall also be provided to accommodate 1 No. 3 phase and neutral terminal block and 1 No. 6 amps SP MCB including

2.5sq.mm PVC insulated copper conductor wire from the terminals block to the fixture and 2 Nos. 32 mm dia GI sleeves of suitable length shall be provided to the junction box.

DIE CAST ALUMINIUM POLES

Ornamental die cast aluminum pole shall be made out of cast aluminum as per requirements of IS:202 (1993). Casting of all pole Sections shall be accurately done from permanent moulds and cores of the design submitted to Achieve uniformity in all design aspects in internal and external shape of the unit. All sections shall be free from defects like blow holes, porosity, hard spots, cracks, hot tears, cold shuts, distortion, sand and slag inclusion and other harmful defects. All the casted sections used in the pole shall be free from welding of any kind used to repair it. The casted sections shall be machined from all the locations used to insert the pieces into one another using either threading or socket method. Accuracy of all machined parts shall be maintained throughout a lot for random replacements of sections if and when required. All the threaded joints shall be mechanically tightened and sealed using industrial tools to make the entire unit vandal resistant.

MATERIAL

Cast aluminum material used for casting pole unit shall be Grade FG-220 type, as described in IS:
202 and shall have minimum tensile strength of the order of 200 N/mm. sq.

PRE TREATMENT

Each and every casted piece shall be subject to Sand blasting at a pressure of 10-15 kgf to remove all its external dirt and sand remains etc.

PAINTING AND FINISHING

Entire unit shall be given an extensive three stage treatment with PU based two pack Zn-Ph primer

and paint prescribed for CI surfaces to make it absolutely rust and corrosion proof, as well as giving it a pleasing appearance. PU based paint shall be MRF make or equivalent.

THICKNESS OF COATING

A minimum of 80 microns of coating thickness shall be achieved on the final piece.

MOUNTING ARRANGEMENT

Pole unit shall be grouted using 4 nos. anchor bolts of size M-16x450 mm confirming to 6.8 Gr. as per IS 2062. Pole unit shall be grouted on a foundation made out of concrete (1:3:6) cement after excavating the earth with proper cable sleeves etc. laid in the foundation itself.

DIMENSIONS

Total height:	3000 mm
Dia of base plate:	380 mm
Pitch Circle Dia:	335 mm

TOP BRACKET/ ARMS

Single double decorative arm shall be provided on the pole (as asked for in B.O.Q.), secured with the help of two nos. bolts outreach not less than 400 mm.

MAINTENANCE CUTOUT

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc.

ELECTRICAL CONNECTIONS

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps SP MCB including 2.5 sq. mm. PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided up to the service window. An earth boss is provided on the control plate along with connectors and interrupters.

GALVANIZED OCTAGONAL POLES DESIGN

The Octagonal poles shall be designed to withstand the maximum wind speed of 169 KM / Hr. as per IS 875. The top loading i.e. area and the weight of fixtures are to be considered to calculate maximum deflection of the pole and the same shall meet the requirement of BS : 5649 Part VI 1982.

POLE SHAFT

The pole shaft shall have octagonal cross section and shall be continuously tapered with single longitudinal welding. There shall not be any circumferential welding. The welding of pole shaft shall be done by submerged Arc Welding (SAW) process.

All octagonal pole shafts shall be provided with the rigid flange plate of suitable thickness with provision for fixing 4 foundation bolts. This base plate shall be fillet welded to the pole shaft at two locations i.e. from inside and outside. The welding shall be done as per qualified MMAW process approved by Third Party Inspection agency.

DOOR OPENING

The octagonal poles shall have door of approximate 500 mm length at the elevation of 500 mm from the Base plate. The door shall be vandal resistance and shall be weather proof to ensure safety of inside connections. The door shall be flush with the exterior surface and shall have suitable locking arrangement. There shall also be suitable arrangement for the purpose of earthing.

The pole shall be adequately strengthened at the location of the door to compensate for the loss in section.

MATERIAL

Octagonal Poles:	HT Steel Conforming to grade S355JO
Base Plate:	Fe 410 conforming to IS 226 / IS 2062
Foundation Bolts:	**EN.8 grade**

procedures duly qualified by third party inspection agency. The welders shall also be qualified for welding the octagonal shafts.

POLE SELECTIONS

The Octagonal Poles shall be in single section (up to 11 Mtr). There shall not be any circumferential weld joint.

GALVANIZATION

The poles shall be hot dip galvanized as per IS 2629 / IS 2633 / IS 4759 standards with average coating thickness of 70 micron. The galvanizing shall be done in single dipping.

XING TYPE

The Octagonal Poles shall be bolted on a pre-cast foundation with a set of four foundation bolts for greater rigidity.

TOP MOUNTINGS

The galvanized mounting bracket shall be supplied along with the Octagonal Poles for Installation of the luminaries.

MANUFACTURING

The pole manufacturing & galvanizing unit shall be ISO 9001: 2000 & ISO 14001 certified to ensure consistent quality & environmental protection.

MAINTENANCE CUTOUT

A service window of the size 150 mm x 100 mm shall be provided in the base of the pole to allow access to electrical connections and terminations. It shall be covered with MS plate and proper rubber gaskets shall be provided to prevent any ingress of water etc..

ELECTRICAL CONNECTIONS

Four way connectors shall be provided along with Slide lock and 1 no. 6 amps Sp MCB including 2.5sq.mm. PVC insulated copper conductor wires from the terminal block to the fixture and 2 nos. 32 mm dia GI sleeves of suitable length shall be provided up to the service window. An earth boss is provided on the control plate along with connectors and interrupters.

DIMENSIONS

HEIGHT	TOP	BOTTOM	SHEET	BASE PLATE	FOUNDATION BOLT

	DIA (A/F)	DIA (A/F)	THICK NESS	DIMENSIONS (L x B x T)	BOLT SIZE (NO. x DIA)	PITCH CIRCLE DIA (PCD)	BOLT LENGTH (MM)	PROJECTED BOLT LENGTH
(Mtr)	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**	**(mm)**
3	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
4	70	130	3	200 x 200 x 12	4 x 16 Dia	200	450	80
5	70	130	3	200 x 200 x 12	4 x 16 Dia	200	600	80
6	70	130	3	220 x 220 x 12	4 x 20 Dia	205	600	100
7	70	130	3	220 x 220 x 12	4 x 20 Dia	205	700	100
8	70	135	3	225 x 225 x 16	4 x 20 Dia	210	750	100
9	70	155	3	260 x 260 x 16	4 x 24 Dia	250	750	125
10	70	175	3	275 x 275 x 16	4 x 24 Dia	270	750	125
11	90	210	3	300 x 300 x 20	4 x 24 Dia	300	750	125
12	90	240	3	320 x 320 x 20	4 x 24 Dia	325	850	125

13. UPS/ INVERTER

SYSTEM SCOPE OF WORK

The scope of work for supply and installation of UPS system shall include design manufacture, supply, installation, testing and commissioning of all related equipments together with all accessories and auxiliaries as per specifications.

The system shall be fully operational and shall comply with the specified codes and standards.

The contractor shall be responsible for providing all materials, equipments and engineering services specified or which are required to fulfill the intent of ensuring reliability of the total work covered under these specifications within his quoted price.

CODES AND STANDARDS

The applicable standards for above work shall be as listed below:

IEC 62040-3-2011 /IS 16242: Part-3 Methods of specifying the performance and test requirements of UPS

IEC 60146-5 Switches for UPS.

IEC 60439 Low voltage switchgear and control gear assembly.

IEC 60801 Electromagnetic compatibility for industrial process

measurements. IEC 60950 Safety of IT equipments including electrical business

equipments.

IEC 61000-2-2 Electromagnetic compatibility – Compatible levels for low frequency conducted disturbances and signaling in public low voltage power supply system.

IEC 1000-4 Electromagnetic compatibility – Testing and measurement techniques.

The equipment shall also conform to the latest issues of Indian Standards, prevailing Indian Electricity rules and other statutory regulations effecting in force from time to time.

GENERAL REQUIREMENTS

The contractor shall submit his offer for UPS systems as indicated in the tender document.

All components of the UPS equipment shall have Surge Withstand Capability (SWC) to meet the requirements of ANSI C62.41-1980, ANSI C 37.90a and IEEE Standard 472-1974.

All components of UPS system shall withstand short circuit current without any damage.

Following general requirements shall be met for ensuring proper circuit protection.

a. Fuses shall not be larger than 125% of the transformer primary circuit current where the secondary circuit fuse protection has not been provided.

b. Where the secondary fuses are sized not larger than 125% of the secondary current of the transformer, fuses shall not be required in the primary circuit, provided the primary feeder fuses are not larger than 250% of the transformer primary current.

c. All the neutral conductors in three phase UPS systems shall be sized equal to at least

200% of the maximum phase current. In addition, all the isolators and circuit breakers used in three phase UPS system shall also to be rated such that the neutral poles shall take at least 200% of the maximum phase current.

d. All control shall be designed and positioned such that possibility of inadvertent or accidental operations are eliminated.

e. All UPS system cabinets, frames and power equipment shall be double earthed.

f. For modular system, to achieve higher reliability and availability of the system Individual battery bank and individual static bypasses per UPS or per Module shall be preferred within the architecture of the UPS.

The UPS design shall ensure that a single component/ device failure shall not result in failure of the entire UPS system. The design of UPS System shall be modular rack mountable, compact having all cabling internal and from the front without any need to access other sites to permit easy maintenance.

The various overload capacities of inverters, static switch, and step down transformer / voltage stabilizer as specified herein are the minimum requirements. However, if the Contractor's offered system has better overload capacities for the above devices, the same shall be highlighted by the Bidder in his bid.

The UPS system offered by the contractor shall be suitable for operating continuously at the rated capacity indicated in tender with in ambient temperature 0-40°C and relative humidity of 0 to 95% non condensing. Also the UPS system shall be suitable for operation as per full rating up to 1000 meters above mean sea level without derating. The Contractor shall furnish a certificate towards compliance on ambient conditions permissible.

The UPS system to be supplied by the contractor shall have maximum humming noise level of 65 DB one meter away from the UPS cabinets. .

Suppression of Radio Interference shall be provided to meet statutory requirements. Detailed

literature should be provided showing Quality Assurance Procedure adhered to.

The contractor shall submit detailed item by item compliance statement along with the tender.

FUNCTIONAL REQUIREMENTS

Contractor shall furnish On-Line Uninterruptible Power Supply (UPS) system of continuous duty of the ratings mentioned in Bill of Quantities. Each UPS shall give regulated filtered & uninterruptible power supply as described in the specifications.

Contractor shall note that the KVA ratings of the UPS systems shall be guaranteed at 40°C ambient temperature. In case contractor's standard UPS KVA rating are based at a lower temperature, the contractor must consider a derating factor of at least 1.5% per deg. C for arriving at the specified UPS capacity at 40°C ambient temperature.

In case the calculated /specified UPS capacity is not the same as one of the standard KVA ratings of the UPS manufacturer, the next higher standard KVA rating shall be selected. UPS of non standard rating shall not be acceptable.

UPS system supplied by the contractor shall be the latest state of the art technology system fully digitalized using microprocessor controlled full wave rectification and IGBT inverter.

Batteries shall be valve regulated lead acid specially meant for UPS application. UPS shall be able to charge VRLA and Ni-Ca batteries too

Monitoring and control system shall also be state of the art technology LCD touch panel type providing all relevant data described in this document.

The monitoring and control system shall be capable of RS485 with MODBUS protocol input software for connecting to customer's computer system for data display and monitoring.

All necessary components required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Contractor as an integral part of the UPS system.

The control logic power supply shall have redundant power supply AC input and the system battery as power sources.

The UPS systems shall include but not be limited to the following equipment:

a. UPS system including 100% capacity float-cum-boost charger with 100% sealed valve regulated lead acid batteries with guaranteed battery life of 5 years.

b. Suitable factory built battery cabinet or shelf for housing the batteries, including terminal isolator / breaker and power disconnect device. The enclosure shall conform to IP 20 as minimum.

c. All cables, connectors, accessories like trunking, cable trays, conduits etc. required for connection between battery and the UPS unit.

In case of modular UPS design, each UPS module shall have hot-swappable capability. In a parallel redundant system, if one UPS module fails, the UPS system shall have the capability to replace the faulty UPS module ON LINE without transfer the load on by-pass.

STATIC CONVERTER

A. GENERAL CHARACTERISTICS

The static converter (rectifier) shall be a multi-functional converter providing functions of power conversion, battery charging and shall have the additional functions of input power factor improvement and current harmonics reduction. The converter equipment shall include all necessary independent decentralized control circuitry and device to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The converter shall be a solid state static PWM converter using Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) transistors and shall include intelligent features like the drive circuitry, over current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching at 6 KHz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The PWM converter shall be used to achieve unity power factor and reduce input current harmonics at full load independent of the load and thus improve the overall input power factor of the converter achieving input KVA savings.

The converter (rectifier) shall accept a wide range of input voltage and frequency tolerances without using the batteries to supply the inverter.

During any step inverter load change (0-100%) the converter shall only supply 100% current to the inverter. The battery shall not be cycled at any time during this step load changes.

B. INPUT CURRENT LIMIT

The converter logic shall provide input current limiting by limiting the DC output current. Two (2) line-side current transformers shall be employed as a means of sensing the current amplitude. The converter logic shall also be capable of providing auxiliary current limited when the logic is signaled to do so via an external dry

contact closure (e.g. UPS fed from generator). The converter shall be capable of supplying overload current in excess to the full load rating. It shall also have sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 95% of full capacity within 10 times the discharge time. The DC output current limit values shall be as follows:

Rectifier output current (maximum) 100%.

Rectifier output current (aux.) 25% - 100% variable.

Note: 100% current shall be under the battery recharging mode.

C. BATTERY CHARGING CURRENT

Battery charging shall work with a min. DC- voltage ripple (e.g. smaller 2 % or ripple free)

The battery charger shall have the possibility to charge the battery depending of their temperature. The converter logic shall provide current limiting function of battery charging to prevent the battery from damage. The following battery current limit and protection shall be provided.

Battery charge current limit 10% of battery Ah rate.

Over-current protection at 120% of above item.

D. VOLTAGE REGULATION

The rectifier / charger output voltage including variation effects of input voltage does not deviate by more than +/- 1% of the nominal output voltage, due to the following conditions:

From 0 to 100% loading.

Rectifier input variations of voltage and frequency within the limitations set in above sections.

Environmental condition variations within the limitations set in above sections.

E. AUTO I/P CURRENT WALK-IN

The converter logic shall employ circuitry to allow a delayed and timed ramping of input current. Subsequent to energizing the converter input, the ramping of current shall be delayed by a maximum of 3to 5 seconds. Upon starting the walk-in process, the ramping of current is timed to assume the load gradually within 1 through 60 seconds (every 1 second selectable).

F. I/P OVERLOAD PROTECTION

The A/C input fuses shall be provided at the converter input as a means of overload protection.

The AC maximum current shall be controlled by the Converter.

G. EQUALIZING CHARGE TIMER

The UPS logic shall provide an electronic automatic equalize charge timer which shall be selectable 24 hours for Lead Acid type or 8 hour for Alkaline type batteries. The charger shall be limiting the battery ripple < 2 %. The timer circuit, once activated shall provide a high rate equalizing charge voltage to the system battery for the selected time. The circuit shall also be capable of manual activation via the LCD touch panel mounted on the front door. The level of equalizing voltage shall be equal to that stated by the battery manufacturer. Upon completion of the timer count, the converter output voltage shall automatically return to the specified float voltage.

H. STEP LOAD CHANGE

During any step inverter load change (0-100%), only the converter shall supply 100% current to the inverter. The batteries SHALL NOT be cycled at any time during these step load changes.

I. I/P SOURCE

The converter shall be fed from the Normal Power Supply source.

Note: The converter shall meet the specifications given in data sheets in addition to other requirements stated above

STATIC INVERTER

A. GENERAL CHARACTERISTICS

The static inverter shall be of solid state type using proven Pulse Width Modulation (PWM) technique. The inverter equipment shall include all necessary control circuitry and devices to conform requirements like voltage regulation, current limiting, wave shaping, transient recovery, automatic synchronization etc. as given below.

The inverter shall utilize Insulated Gate Bipolar Transistors (IGBT) or Intelligent Power Module (IPM) Transistors which shall provide intelligent features like the drive circuitry, over- current protection, over temperature protection, control power failure protection and short circuit protection.

The IGBT / IPM transistors shall enable high speed switching of 6 Khz thus reducing the heat dissipation in the UPS and thereby providing high efficiency.

The UPS shall utilize both Voltage and Current feedback control circuits so that the inverter shall act not only as a constant voltage source but also as a load required current source. This shall enable the inverter to quickly adapt to the changing load current value and wave shape.

B. VOLTAGE REGULATION

The inverter output voltage shall not deviate by more than + 1% RMS due to the following steady state conditions:

From 0 to 100% loading
Inverter DC input voltage varies from maximum to minimum.
Environmental conditions variations within the limitations set in the above sections.

C. FREQUENCY CONTROL

The inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g. the bypass source or another UPS module) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set hereunder. The inverter shall operate on self run mode without synchronism if the bypass frequency exceeds the set value. The oscillator, while running asynchronously, shall maintain the frequency as 50 Hz + 0.01% (or + 0.005 Hz). Automatic adjustment of phase relationship between inverter output and standby bypass source shall be gradual at a controlled slew rate which shall be adjustable at the rate of 0.5, 1.0, 2.0, 3.0 Hz / second. (Default 2.0 Hz / second).

The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

From 0 to 100% loading.
Inverter DC input varies from maximum to minimum.

Environmental condition variations within the limitations set in the above sections..

D. O/P VOLTAGE HARMONIC DISTORTION

The inverter output shall limit the amount of harmonic content to the values stated in the above sections. The use of excessive or additional filtering shall not be required to limit the harmonic content thus maintaining a high level of efficiency, reliability and original equipment footprint.

E. O/P OVERLOAD CAPABILITY

The inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated in section 4.8. An LED indicator shall be located on the control panel to identify this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load shall be transferred to the bypass source without interruption.

F. INVERTER CURRENT LIMIT

The inverter output shall be limited to 150% of rated load current. The two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, preventing unnecessary damage to power transistor components / fuses. Load current above 150% shall cause an immediate transfer of the load to the bypass source for fault clearing.

G. INVERTER OVERLOAD PROTECTION

The AC output from the inverter shall utilize fuses for overload protection. The inverter shall utilize a contactor to isolate the inverter output from the critical bus.

The inverter fuses shall be the fast acting semiconductor type.

The inverter output isolation contactor shall be located in the UPS module and shall be controlled by the internal UPS module system logic.

H. BUILT-IN ISOLATION TRANSFORMER

When UPS system design has a built-in isolation transformer it shall provide neutral separation which shall mean that output neutral will be independent of incoming neutral,

hence critical load shall be isolated from the problems like incoming neutral open or, short or, variations in neutral to earth voltage due to sudden loading in neighboring installation. Whenever isolation transformer is provided, it shall have K factor as given in the enclosed data sheet and shall have galvanic isolation of more than 1000 mega ohms to affect common mode noise rejection of : upto 10 kHz >120 dbs, 10 to 50 kHz > 90 dbs, and 50kHz to 1 MHz > 50 dbs.

However, in case of transformer less UPS design, necessary protection system like Electronic DC Protection System (EDCP) shall be incorporated at the output of UPS to prevent DC component, arising out of fault of inverter IGBT, to enter into supply system on load side. In such cases, separate Isolation transformer shall be provided externally.

I. REVERSE PHASE SEQUENCE PROTECTION

In the event of Phase sequence reversal at the input, UPS system shall continue to work on the main power supply, or UPS systems shall go into battery mode, and shall not trip the UPS system. Wrong phase rotation on the input of the converter (rectifier) shall not stop the inverter neither switching the UPS into battery mode.

Note: The converter shall meet the specifications given in data sheets in addition to other requirements stated above

BYPASS AND STATIC TRANSFER SWITCH

A. A bypass circuit shall be provided as an alternate source of power other than the inveter. A high speed switch shall be used for the critical load during automatic transfers to the bypass circuit. The static switch shall be fully sized to conduct the full nominal current as well the full overload capability of the UPS. There shall not be any wrap around contactors parallel to the static switch. The static switch shall drive power from an upstream bypass feed circuit breaker internal to the UPS module provided for overload protection. . The bypass circuit shall be capable of supplying the UPS rated load current and also provide fault clearing current. The UPS system logic shall employ sensing which shall cause the static switch to energize within 150 microseconds thus providing an uninterrupted transfer to the bypass source when any of the following limitations shall exceed:

Inverter output under voltage or over voltage.
Overload beyond the capability of the inverter
DC circuit under voltage or over voltage
Final end voltage of system battery is reached.
Bypass source present and available
System failure (eg. Logic fail, fuse blown, etc.)

B. Keeping the above requirements in view, the static switch shall have the following minimum rating:

Capacity continuous equal to 100% of continuous rating of the inverter.
Capacity overload equivalent to overload characteristics specified for UPS.

C. AUTOMATIC RE-TRANSFER

In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic monitors the overload condition and, upon the overload being cleared, performs an automatic re-transfer back to the inverter output. The UPS system logic shall only

allow a re-transfer to occur three times within a ten minute period. Re-transfer shall be inhibited on the fourth transfer due to the likelihood of a recurring problem at the UPS loaddistribution. The re-transfer a load to the inverter shall also be inhibited due to the limitations set in section 5.3.

D. MANUAL TRANSFER

The UPS shall be capable of transferring the critical load to / from the bypass source via LCD touch panel. When performing manual transfer to inverter or automatic re-transfers, the UPS system logic shall force the inverter output voltage to match the bypass input voltage and then parallel the inverter and bypass source providing a make-before-break transition allowing a controlled walk-in of load current to the inverter.

E. MAINTENANCE BY-PASS

The UPS shall include as standard equipment, a zero energy maintenance bypass switch. Full UPS wrap-around enables personnel to do work inside the UPS module or maintenance bypass switchboard without danger fro high voltage conditions.

UPS BATTERY SYSTEM

a. The UPS system shall, as an integral part, provide battery system for backup time as specified in the Schedule (Full Load) standby capacity.

b. The latest state of the art Valve Regulated Sealed Maintenance Free Lead Acid Batteries shall be used with a 20 hours discharge rating.

c. The battery system shall be sized to provide back up time as specified in the schedule of quantity when the UPS is supplying 100% rated load at 0.8 load power factor.

d. An ageing factor of 15% shall be applied to the capacity arrived at, to allow for compensation against capacity loss during float operation.

e. The battery system design shall be provided with necessary devices to prevent deep discharge beyond recommended limits to prevent the batteries discharging beyond end cell voltage specified by the battery maker. The connections from battery to battery shall be by using copper bus bar strips and the entire battery system shall be used in IP20 steel cabinet enclosure or on shelves and shall be similar to the UPS enclosure.

f. All batteries shall be clearly identified and identification numbers marked on the batteries and a schematic diagram along with the complete calculations, including manufacturers supporting curves, shall be submitted with the tender.

g. The UPS shall have a properly rated and sized circuit breaker to isolate it from the battery

h. In modular system, The battery system shall be able to be individual per modules as well be able to be configured as a common battery for a whole n+1 system . Individual battery per module shall be preferred

OPERATION

The UPS shall be designed to operate as a true on-line, double conversion Voltage and Frequency Independent (VFI) system in the following modes:

a. Under normal operation, the UPS load will be fed from the Inverter with the bypass

switch inhibited. The Converter, apart from providing DC power to the Inverter, also charges the battery under the float charge mode. The battery charge system shall have float charge, equalizing charge and recovery charge modes, to replenish thebatteries self-discharging part while the battery is fully charged, equalizing the battery cell voltage to a constant value forcibly, and recharging the battery system to the required values when the batteries have been used, respectively.

b. The Inverter shall constantly monitor the AC source frequency and shall be in synchronization with the AC input source till the frequency of the AC input source is within synchronizing limit and if the frequency of the standby source exceeds the synchronizing limit the Inverter will work on its own internal oscillator maintaining an output frequency of 50 Hz +/- 0.01% under all conditions of load. When the Inverter operates on its internal oscillator, it shall continuously monitor the frequency of the input source and when the input source frequency returns to within synchronization limit, the Inverter shall automatically synchronize itself with the input A/C source frequency and use it as a signal for Inverter output frequency control.

c. Battery Operation:

i. When the A/C input voltage drops below specified limits or in case of a power failure the Inverter continues to supply AC power of constant voltage and constant frequency utilizing the battery system as a power source until the input voltage returns to normal requirement. When the power supply is resumed or the input voltage returns to limits, the Converter shall automatically start and the load fed for normal operation status.

ii. If the power failure continues beyond battery backup time or the battery voltage drops to the final discharge voltage, the Inverter should automatically stop and at the same time transferring the load to the bypass circuit. On resumption of power supply, the Converter shall automatically re-start the operations and charge the batteries with minimized AC ripple whereas the Inverter should inhibit automatic start and should be started manually.

d. Bypass Operation:

When power is supplied from the Inverter in synchronization with the bypass, it shall accomplish the following:

i. When the UPS output current reaches overload status it shall automatically transfer the load to bypass circuit with no interruption and when the overload status is cleared it automatically re-transfers the load to Inverter.

ii. When the battery final discharge condition is reached, the load shall automatically be transferred to the bypass circuit without interruption.

iii. In case of failure of the UPS, the load shall be automatically transferred to the bypass circuit with no interruption and when the failure is cleared, re-transfer the load to the Inverter shall be done manually.

iv. There should be provision made in the system to prevent, when necessary, asynchronous transfer.

v. When the UPS goes on bypass mode in any of the conditions described above and if at that time there is no bypass power supply available due to power failure, the UPS shall remain in standby mode and as soon as the bypass power supply is available will transfer the load to bypass.

vi. A maintenance bypass transfer switch shall be provided with lock and key arrangement and should be manually done by authorized personnel only.

ADDITIONAL REQUIREMENTS FOR MODULAR SYSTEM

Whenever modular system is specified in a BOQ, UPS system shall conform to following additional requirements.

1. Non-redundant system.

All the UPS units connected in parallel are required to supply the full rated load within the same cabinet. If a UPS unit power or control module should malfunction, the load shall be transferred automatically to the bypass line via each of the UPS units with their static bypass switches being triggered simultaneously. The battery set shall consist of at least two strings so that in the event of a battery malfunction the affected string is automatically isolated from the system thereby ensuring battery autonomy is retained, albeit of a shorter duration.

2. Redundant operation

The UPS system shall operate in an N+n configuration where N is the number of UPS units connected in parallel to support the load and n is the number of UPS units connected in parallel to provide the co-efficiency of redundancy. The value of n is generally 1. However this may be higher than 1 in particular requirements, as specified in BOQ.

3. The parallel UPS units shall be capable of operation from a common DC bus or with a separate DC supply for each UPS unit. In either case the batteries shall be configured so that the failure of one battery string (common DC. bus) or the failure of one battery set (separate DC supply for each UPS) provides battery redundancy whereby the specified autonomy at full load is maintained.

4. The malfunction of one of the UPS unit's power or control modules shall cause that particular UPS unit to be automatically isolated from the system and the remaining UPS units shall continue to support the load. Replacement or repair of a faulty UPS unit shall be achieved ON LINE without disturbance to the connected load or necessity to switch off the load.

BATTERY MONITORING SYSTEM

a. The Battery Monitoring System shall provide for the automatic acquisition, trending, alarming and storage of information from every cell or jar in a battery bank. It will have the interactive ability to first identify and then provide an isolated equalizing charge current to any individual cell or jar that deviates below a user-specified set point, from the cell average, within the same string or bank.

b. The Battery Monitoring System shall test the relative charge state and health of each individual cell or jar by injecting a DC current, recording the magnitude of this current & comparing it to previous benchmark values. Systems that require battery discharge for testing are not acceptable. The system shall provide estimated backup time remaining during an actual discharge.

c. The Battery Monitoring System shall monitor and maintain historical files for:

Individual cell or jar voltage
Total bank voltage
Discharge current
Ambient and pilot cell temperature
Relative current response value

d. Display shall be via local LCD display, with capability for viewing at a remote terminal. All files shall be written to a fixed solid state disk within the enclosure. All functions shall be accessible via modem using common communications software.

e. The system shall operate a “form C” relay contact when any parameter is in alarm.
Alarm data shall be written to a file in ASCII format for future retrieval.

f. The system shall be capable of remote communications for remote access to all functions via modem or ANSI terminal.

g. The Battery Monitoring System shall be capable of monitoring a minimum 264 jars per string, 9 parallel strings per system, 6 cells per jar.

h. Resolution shall be 12 bit accuracy, with up to 10 per second channel test rate.

i. Cell voltage measurements must be made to within plus or minus 5 milli volts over the entire operating and temperature range.

j. Documentation. Manuals and installation documentation for the equipment shall be provided which lists block diagrams, schematics parts list and theory of operating for each unique component of the system. Installation drawings and documentation shall be site specific for each string at this facility. Marked up building drawings shall be provided to show any changes to building wiring including power wiring and communications cables.

k. The system shall be factory tested fully and completely before shipment.

CABINET AND ENCLOSURES

a. The entire UPS system, including all components like inverter, static switch, maintenance bypass, shall be housed in free-standing steel type factory-finished enclosures complying with the protection standards of IP20. For modular system, the housing shall include all wires to able the rack mountable modules to be hot swapped without any need to disconnect power cabling or without any need to put the load on bypass during swap operations . The enclosure shall be open able using a special tool for internal access. The color shall be light grey. All parts for maintenance requirement shall be front accessible

b. Ventilation

Forced air-cooling shall be provided to allow components to operate within their rated temperature specified. The cooling fans shall have thermal relays protection using a latched cut fire re-setting, as a protection for the cooling fans.

c. Similarly, the backup battery system shall also be housed as described earlier in an IP20 cabinet.

CONTROL AND MONITORING

a. The UPS shall utilize state of the art full DDC control software driven Control and Monitoring System.

b. It shall be provided with LED displays.

c. The UPS logic should provide one set of normally open dry contact / relay output to allow interfacing of UPS operating status to an external system and should be capable of providing, as a minimum, 10 numbers status and, should the UPS manufacturer's

standard product does not provide such software, the bidder must add additional equipment and cost for the same.

d. The UPS shall also have an RS485 port with MODBUS interface card if required for interfacing to BAS system or client's centralized computer network.

LCD TOUCH PANEL (OPTIONAL)

a. The UPS shall be provided with an operator friendly large scale LCD touch panel.

b. The LCD touch panel shall also include graphic measurement display, operational procedures of each activity, fault status display and also have capability to record at least 50 faults.

c. The touch screen panel shall clearly define specified areas for operational function, execution and message display.

d. It should be possible to operate the entire UPS system and its components and obtain all measurements and data through the touch screen operation. The measurement software should provide capability to measure phase voltage, current in each phase, frequency, power factor, available battery time etc.

e. Under all operating conditions, the system software should have capability for displaying fault alarm automatically. The tenderer should describe in detail the faults that would be displayed under this mode.

UPS TESTING

a. The Contractor shall perform the following tests, as a minimum, at site prior to handing over, to confirm the functional and the performance specification of the UPS as specified. All required test equipment like Digital Oscilloscope, Voltage Regulator, Measurement Meters etc. shall be the responsibility of the Contractor without any additional cost.

b. The Contractor shall demonstrate as a minimum the following features on site by providing all required test equipment, such as power factor improvement, input current THD, output voltage THD, output frequency and all other performance monitoring requirements detailed before as required by the Owner.

Notes for preparation of specification of UPS

i. When any project requires very critical loads to be fed by an uninterrupted as well as clean regulated power irrespective of whatever occurs on the upstream side of UPS, fully galvanic protection has to be provided. This is achieved by providing isolation transformer with specific characteristics as specified under Inverter section above. If isolation transformer is not provided as

built-in feature of UPS after bypass terminals, such transformer need to be provided outside UPS, may be as a part of UPS system or as a part of electrical distribution system. Generally, for normal offices loads and general purpose usage such galvanic isolation is not found necessary

ii. When any project requires UPS for very critical loads like Data center, IT industries etc. then, distance of load to UPS shall be minimal. (Typically 30-40M for data centres and 70-80 M for IT work stations) otherwise there will be chance of neutral shift due to unbalance nature of load. To avoid this, isolation transformer with delta-star winding, star point being grounded shall be provided. For transformer less UPS design this may be external to UPS and part of distribution system.

iii. Whenever isolation transformer is provided, either part of UPS or external, it shall be ensured to have proper K factor given in a data sheet of isolation transformer and as per galvanic isolation characteristic given under Inverter section.

14. OLAR PV

SYSTEM SCOPE OF WORK

The vendor shall supply and install Roof integrated grid connected photovoltaic power system.
Contractor shall ensure proper integration of the system as per site constraints/ requirements.

CODES AND STANDARDS

All equipment will comply with IS codes and standards, and other national and international codes of practice as listed below.

IEC 61215 : Crystalline silicon Terrestrial Photovoltaic (PV) Modules– Design Qualification and Type Approval.

IEC 61730-2 : Photovoltaic module safety qualification Part

The Inverter shall be designed to accept the PV array output and shall be listed to UL1741, IEEE 1547, IEEE 929 standards.

GENERAL REQUIREMENT

All PV Panels and materials shall of a quality accepted by the Client without any damage or breakage during transportation or installation. All metal parts shall be protected on site from rust, corrosion and dirt by properly storing, packing and covering.

The primary components of the PV System shall include rooftop integrated PV Array with auto tracking system, DC source circuit combiner boxes (outdoor duty – IP 65),DC disconnects (IP 65), electrical room disconnects and combiner, DC-AC inverter, necessary cabling, conduiting, panels etc

Solar panels shall be installed in shadow free area.

SYSTEM REQUIREMENTS

Photo voltaic panels shall be mono/polycrystalline silicon technology. Solar Panels shall be efficient & of suitable capacity to form a array of required capacity. Each module will be rated for maximum system voltage up to 1000VDC.

Solar panels shall be extremely light weight. Each solar module shall be provided with Anodized Aluminium frame to protect the module. The back of the module will be covered with a layer of mylar.

PV module Terminal box shall be IP65 with four terminal connection blocks.

PV module shall be suitable for roof temperature up to 85°C & shall be suitable for installation on roof having slope between 3° and 60°.

Each of PV circuit combiners will be designed and rated to combine series strings of Photo voltaic panels, as required. PV circuit shall be protected by DC MCBs of suitable rating. Each Circuit combiner will be provided with surge suppression device.

DC disconnects shall be designed and rated for DC power disconnecting under load. Each DC disconnect will be provided with surge suppression device.

Exterior and interior conduit associated with the PV system shall be of appropriate Diameter. Exposed PV module wiring shall be kept to a minimum, will be properly rated for sunlight & hot temperatures associated with the PV array.

All cables shall be 1.1 KV, stranded copper, HR PVC insulation and continuous Power cables will be sized for a voltage drop of 1 % or less between PV modules and inverter.

The DC to AC Power Inverter shall be 3-phase, 50Hz, 415VAC.The inverter shall be a grid-interactive, non battery-based, IP65, operating temperature range – 40 deg C above ambient . The inverter peak efficiency shall not be less than 95%.

The inverter shall start, synchronize, operate, and disconnect automatically without the need for user action or intervention.

The inverter shall be protected for AC over/ under voltage, AC under/over frequency, over temperature, AC and DC over current, DC over voltage etc

Inverter will be provided with LCD display, RS485 communication.

The PV system shall have dedicated meter that records only the AC Output from the inverter of the PV system. All system components, including meters, shall comply with all applicable codes& standards.

15. TECHNICAL DATA SHEETS TO BE SUBMITTED BY THE BIDDERS

A. TECHNICAL DATA SHEET FOR LV BUS DUCT

Sl. No	Item	Unit	Description	Remarks
1.0	Bus Duct			
1.1	Air Insulated / Sandwich Insulated / Resin Cast / Flame Resistant			
1.2	Outdoor / Indoor			
1.3	If Outdoor whether run in trenches or Overhead racks			
1.3	Degree of Protection offered by Enclosure: IP 65 /68/ IP 54/ 55			
1.4	Whether the offer is for: Rising Main / Horizontal Distribution			
1.5	Bus Configuration Offered: 3P + N + PE			

	3P + N + PE + Ext. Earth 3P + N + PE + Internal Earth 3P + 2N + PE 3P + 2N + PE + Ext. Earth			
1.6	Standards to which Bus Ducts are Manufactured:			
1.6.1				
1.6.2				
1.6.3				
1.6.4				
2.0	Voltage level & Insulation			
2.1	Nominal Voltage / Rated Insulation Voltage & Frequency	V/V Hz		

Sl. No	Item	Unit	Description	Remarks
2.2	Rated Impulse Voltage (1.2 / 50 sec) impulse wave	kV		
2.3	Bus Insulation Class / Temperature Rise Limited to Class	F		
2.4	Insulation Material; i) Epoxy /cast Resin, ii) Air Insulated with / without PVC Sleeve			
2.5	For Air Insulated Bus, Ph to Ph / Ph to N/ Ph to E Clearance	mm		
3.0	Bus Material & Current Rating			
3.1	Material: Copper / Al alloy			
3.2	SC Current withstand 1.0 sec required for different Current Ratings Current Rating;	KA / 1.0s		

	125A 250A 400A 630A 1250A 1600A 2000A 2500A 3200A 4000A 5000A 6400A or as furnished in the layout drawing			

Sl. No	Item	Unit	Description	Remarks
3.3	Voltage Drop from Transformer LV terminals to the further point in the bus	%		
3.3	Dynamic Rating.	KAp		
3.4	Disposition			
3.4.1	Edgewise / flat wise			
3.4.2	Horizontal vertical			
3.5	Feeder Bus Trunking			
3.5.1	Transformer 415V terminals to 415V Main Switchgear			
3.5.2	Main Switchgear to Switchgear			
3.5.3	Switchgear to DB			
3.5.4	Gen to 415V Gen Switchgear			
3.5.5	Gen Switchgear to 415V			

	Switchgear			
3.5.6	Gen Switchgear to Rising mains			
3.5.7	Mai 415V Switchgear to Rising mains			
3.5.8	Switchgear to Rising Mains			
4.0	List of Components Offered (Quantity & Current Rating to be Furnished)			
4.1	Joint			
4.2	Spring Hanger			

Sl. No	Item	Unit	Description	Remarks
4.3	Horizontal elbow			
4.4	Horizontal Tee Section			
4.5	Vertical Elbow			

4.6 Vertical offset Elbow

4.7 Vertical Tee Section

Sl. No	Item	Unit	Description	Remarks
4.8	Plug-in Boxes			
4.9	Flanged Ends (Box/Adapter Box)			

4.10 Reducer

Sl. No	Item	Unit	Description	Remarks
4.11	Expansion Unit			
4.12	Isolator for Sectionalizing			

4.13 Tap- Off Points

4.14 Feed End Box / Adopter

4.15 End Cover

4.16 Wall / Floor Flange

4.17 Vertical support

Sl. No	Item	Unit	Description	Remarks
5.0	Type Test Reports Enclosed			
5.1				
5.2				
5.3				
6.0	List of Routine Test that are included in the Price offered for witnessing.			
6.1				
6.2				
6.2				
7.0	Quality Assurance Plan Enclosed			

Sl. No	Item	Unit	Description	Remarks
8.0	Submittals			
8.1	Whether agreeable to furnish			
	documents as called for in Cl.6.0			
	of Part-1			
	With the Offer			
	After award of Contract			
	After completion of the Contract			
9.0	List of drawings with the offer			
	Proposed Layout			
	Layout 3D drawing			
	Layout for Alt. Proposal			
	List of Component drawings			

B TECHNICAL DATA SHEET FOR UPS TO BE SUBMITTED BY THE BIDDERS

Sr. No.	Parameters	Requirements as per specification	Confirmation by Bidder
1	Make	As per approved list of the specification	
2	Model	As per bidder's standard	
3	Capacity	As per bill of materials	
4	Input short circuit level	As per bill of materials	
5	Rating	Continuous	
6	Ambient	40 deg C	
7	Overload capacity at full voltage : 120% of normal rating 150% of normal rating	 10 minutes 10 seconds	
8	**Converter**		
8.1	Nominal Voltage	415V, 3 Phase, 4 Wire	
8.2	Voltage Range.	+ 15% / - 20% AC	
8.3	Normal Frequency	50 Hz ± 8 %	
8.4	Frequency Range	± 8% (± 4 Hz)	
8.5	Input Power Factor	0.95 lagging or more at full load (PF improvement)	
8.6	Input terminal Harmonic Current THD at complete non linear load	3% typical at 100% load 6% maximum at 50% load Both can be complete non-linear	
8.7	Duty	Continuous at 40°C	

Sr. No.	Parameters	Requirements as per specification	Confirmation by Bidder
8.8	Cooling	Forced cooling using fans with	

		thermal relays using a latched cut out for re-setting as protection for cooling fans. Each individual fan shall have its own thermal relay.	
8.9	Ambient operating temperature range	Operating - 0 to 40°C maximum. Storage & Transport -20 C to 70 C	
8.10	Operating Relative Humidity	0-95% non-condensing.	
8.11	Operating Altitude	Altitude Operating: to 3,000 ft. (1,000 meters) above Mean Sea Level. Derated for higher altitude applications. Storage/Transport: to 40,000 ft. (12 200 meters) above Mean Sea Level	
8.12	Magnetized sub-cycle in rush current	Typically 8 times normal full load current	
8.13	Converter Walk-in time	1 through 60 seconds (every 1 second selectable, (0 to 100% rated load)	
8.14	Input terminals	Suitable terminals shall be provided for termination of cables from the AC distribution board.	
9.0	**INVERTER**		
9.1	Voltage Input	Three Phase UPS : Nominal 360 V DC (Range 290 V to 414 V DC to maximum DC bus voltage during charging the batteries).	
9.2	Nominal Voltage Output	415 V ± 1% AC 3 Phase, 4 Wire	
9.3	Inverter Capacity	To be given by bidder	
9.4	Voltage Regulation		

Sr. No.	**Parameters**	**Requirements as per specification**	**Confirmation by Bidder**
	a. For 0 to 100% loading	< ± 1%	
	b. Inverter DC input		

	voltage vary from maximum to minimum	< ± 1%	
	c. Environmental conditions give n below	< ± 1%	
9.5	Transient Voltag e Regulation		
	a. AT 100% step load change	< ± 3%	
	b. At loss or return of AC input	< ± 1%	
	c. At load transfer from bypass to inverter	< ± 3%	
9.6	Time to recover from transient tonormal voltage	20 milli seconds	
9.7	Wave form		
	a. Normal frequency	50 Hz	
	b. Frequency regulation for all conditions of input supplies, loads and temperatur e occurring simultaneously or in any combinatio n (automatically controlled)	± 0.01%	
	c. Synchronization limits for synchronis m between the inverter and standby AC source.	49 Hz to 51 Hz.	
	d. Field Adjustmet range for above	50 ± 1 Hz to 50 ± 2 Hz	

Sr. No.	Parameters	Requirements as per specification	Confirmation by Bidder
9.8	Total harmonic voltage distortion	< 2% THD for 100% linear load < 4% THD for 100% non-linear load	
9.9	Output power factor	0.9 or better	
9.9	Duty	Continuous	
9.10	Cooling	Forced cooling using fans.	
9.11	Ambient operating temperature range	0 to 40deg.C maximum continuous.	
9.12	Operating relative humidity	0-95% non-condensing.	
9.13	Operating altitude.	Sea level to 1000 meters.	
9.14	Output Terminals	Suitable terminals are provided for termination of cables for connecting inverter output to AC distribution board.	
10	**BY PASS**		
10.1	Nominal bypass input voltage	415 V / 240 V, 3 phase, 4 wire	
10.2	Voltage Range	± 10% of nominal	
10.3	Nominal Frequency	50 Hz	
10.4	Frequency range	± 2% Please refer to selectable range of Inverter given in point 4.3 & 4.8	

Sr. No.	Parameters	Requirements as per specification	Confirmation by Bidder

10.5	Output Fault Clearing :		
	Current	1000%	
	Duration	10-250 milli seconds	
10.6	Ambient operating temperature	0 to +40 degree C continuous	
10.7	Operating relative humidity	0-95% non-condensing	
10.8	Operating altitude	Sea level to 1000 meters	
10.9	Cooling	Natural Convection	
10.10	Duty	Continuous	
11	**Metering Parameters on Control panel**		
11.1	Input AC voltage line-to-line and line-to-neutral for each phase	To be provided	
11.2	Input AC current for each phase	To be provided	
11.3	Input frequency	To be provided	
11.4	Battery voltage	To be provided	
11.5	Battery charge/discharge current	To be provided	
11.6	Output voltage A and C line-to-line for each line-to-neutral phase	To be provided	
11.7	Output AC current for each phase	To be provided	

Sr. No.	**Parameters**	**Requirements as per specification**	**Confirmation by Bidder**
11.8	Output frequency	To be provided	

11.9	Percent of rated load being supplied by the UPS	To be provided	
11.10	Battery time left during battery operation	To be provided	
11.11	Bypass power available	To be provided	
12	**Alarms / Indications on Control panel**		
12.1	Input power out of tolerance	To be provided	
12.2	Input phase rotation incorrect	To be provided	
12.3	Incorrect input frequency	To be provided	
12.4	Charger in reduced current mode	To be provided	
12.5	Battery Charger Problem	To be provided	
12.6	Battery failed	To be provided	
12.7	Low battery warning (adjustable 1 to 99 minutes)	To be provided	
12.8	Low battery shutdown	To be provided	
12.9	DC bus overvoltage	To be provided	
12.10	Bypass frequency out of range	To be provided	
12.11	Load transferred to bypass	To be provided	
12.12	Excessive retransfers attempted	To be provided	
12.13	Static switch failure	To be provided	
12.14	UPS output not synchronized to input Power	To be provided	
12.15	Input power single phased	To be provided	

Sr. No.	Parameters	Requirements as per specification	Confirmation by Bidder	
12.16	Input voltage sensor failed	To be provided		

12.17	Inverter leg over current	To be provided		
	in X-phase			
12.18	Output under voltage	To be provided		
12.19	Output overvoltage	To be provided		
12.20	Output overcurrent	To be provided		
12.21	System output	To be provided		
	overloaded			
12.22	Load transferred	To be provided		
	to bypass due			
	to overload			
12.23	Overload shutdown	To be provided		
12.24	Control Error	To be provided		
12.25	Critical power	To be provided		
	supply failure			
12.26	Load transferred due to	To be provided		
	internal protection			
12.27	External	To be provided		
	shutdow			
	n (remote EPO			
	activated)			
12.28	Fan failure	To be provided		
12.29	Over	To be provided		
	temperatu			
	re shutdown impending			
12.30	Over	To be provided		
	temperatu			
	re shutdown			
12.31	Lamp test	To be provided		

13	**GENERAL**		
13.1	Noise	Max. 65 dBA at 1 M *(to be ascertained based on project requirements)*	

13.2	Data communication interface with PC	To be provided	
13.3	Clearance required at rear and on both sides	To be given by bidder	

Sr. No.	Parameters	Requirements as per specification	Confirmation by Bidder
13.4	Overall dimensions	To be given by bidder	
13.5	Total weight in kgs.	To be given by bidder	
13.6	Overall Efficiency at, 100% load 50% load	To be given by bidder	
13.7	Heat Dissipation a)UPS system at		

	100% load 75% load 50% load b) Batteries	To be given by bidder To be given by bidder To be given by bidder To be given by bidder	
13.8	BMS Compatibility - Type of Protocol	To be given by bidder	
13.9	Additional features : Battery Management System - Battery Monitoring System – SMS/ Email alerts – Bypass Enable \ Disable – Static Switch Enable \ Disable-	To be given by bidder To be given by bidder To be given by bidder To be given by bidder To be given by bidder	

C TECHNICAL DATA SHEET FOR BATTERIES

Sr. No.	Parameters	Requirement as per specification	Confirmation by Bidder
1	Make	As per approved list	
2	Model	To be given by bidder	
3	Capacity (15% ageing factor)	**30 min (*To be selected for the project)*** at full load and at rated voltage.	
4	Type	SMF	

5	Cell voltage	To be given by bidder	
6	PF considered for battery calculation	To be given by bidder	
7	Lead content in battery	To be given by bidder	
8	Overall dimensions of battery rack / panel	To be given by bidder	
9	Total weight	To be given by bidder	

D. TECHNICAL DATA SEET FOR FLOAT CUM BOOST BATTERY CHARGER FOR NICKEL CADMIUM BATTERIES

Sr. No	**Description**	**Tender specifications**	**Confirmation from Bidder**
A.	BATTERY		
1	Battery voltage	110 Volt	
2	Rating	Battery should be adequate to cater to continuous load (annunciation, indicating lamps etc.) as well the maximum momentary load that may arise due to	

		tripping of all HV breakers connected to bus.	
B.	BATTERY CHARGER		
1	AC Input	230 V ± 10% AC 50 Hz single phase.	
2	DC Output	To float / boost charge 110 V	
3	Current Rating	Suitably design for control circuit.	
4	Float Mode	120.0 V nominal (Adjustable) between 110.0 -.144V.	
5	Boost Mode	120.5 V nominal (Adjustable) between 110-155. V.	
6	Voltage Regulation	± 2% for AC input variation of 230 V ± 10%. Frequency Variation of 50 Hz + 5% and DC load variation 0-100%	
7	Ripple	Less than 1 %	
8	Protection-Alarm and trip against	Phase failure, Wrong phase sequence, Short circuit, overload, under load, Input overvoltage, Input under voltage.	
9	Metering	AC input in put ammeter and voltmeter.	
10	No. of output circuit with protection	Incoming-Incomer breaker to be decide based on battery charging calculation Outgoing-10 Nos. 16 A DP MCB	

E. TECHNICAL DATA SEET FOR FLOAT CUM BOOST BATTERY CHARGER FOR SMF BATTRIES

Sr. No	**Description**	**Tender specifications**	**Confirmation from Bidder**
A.	BATTERY		
1	Battery voltage	24 Volt	
2	Rating	To be given by bidder based on actual burden of relay and metering load & momentary load that may arise due to tripping of all HV breakers connected to bus.	
B.	BATTERY CHARGER		
1	AC Input	230 V + 10% AC 50 Hz single phase.	

2	DC Output	To float / boost charge 24 V and also supply a continuous load.	
3	Current Rating	suitably design for control circuit burden.	
4	Float Mode	27.0 V nominal (Adjustable) between 24-28.0 V.	
5	Boost Mode	28.2 V nominal (Adjustable) between 24-29.0 V.	
6	Voltage Regulation	+ 2% for AC input variation of 230 V + 10%. Frequency Variation of 50 Hz + 5% and DC load variation 0-100%	
7	Ripple	Less than 1 %	
8	Protection-Alarm and trip against	Phase failure, Wrong phase sequence, Short circuit, overload, under load, Input overvoltage, Input under voltage.	
9	Metering	AC input. input ammeter and voltmeter.	
10	No. of output circuit with protection	Incoming-63 Amps DP MCB Outgoing-10 Nos. 16 A DP MCB	

END OF PART 15

16. LIST OF APPROVED MAKES FOR LOW VOLTAGE EQUIPMENT

SL. NO.	DETAILS OF MATERIAL	NAME OF MANUFACTURERS
1.	Power Distribution Panel and Motor Control Centre & Air Insulated Bus ducts	Adlec Control System Advance Panels & Switchgear Green Galaxy Electrotech Pvt Ltd Electro Allied Products
2.	Sandwiched Construction Bus ducts	EAE Schneider Electric Zucchini (Legrand)
3.	Air Circuit Breaker (3/4 Pole)	Schneider Electric Siemens ABB
4.	Moulded Case Circuit Breaker (MCCB)	Schneider Electric Siemens ABB
5.	Motor Protection Circuit Breaker(MPCB)	ABB

		Schneider Electric Siemens
6.	Automatic Transfer Switch (ATS)	ASCO Cummins
7.	Final distribution board / Miniature Circuit breakers (MCB)/ Residual Current Circuit Breakers (RCCB)	ABB Schneider Electric Hager Siemens
8.	Power/Aux. Contactor / Capacitor Duty Contactor	Schneider Electric Siemens
9.	Change Over Switch	Elcon Socomec
10.	Control Transformer/Potential Transformers	Indcoil Matrix Kappa Pragati
11.	Current Transformer (Epoxy Cast Resin)	Indcoil Matrix Kappa Pragati
12.	Indicating Lamps LED type and Push Button	Altos Schneider Electric Siemens

SL. NO.	**DETAILS OF MATERIAL**	**NAME OF MANUFACTURERS**
13.	Protection Relay	
	a. Numeric Type	ABB Areva Schneider Siemens
	b. Electromagnetic Type	ABB Areva
14.	Overload relays with built in Single Phase preventer	ABB Schneider Electric Siemens
15.	a. Electronic Digital Meters (A/V/PF/Hz/KW/KWH) with LED/ Display / Dual Energy Meter/ Static Meter	Automatic Electric El Measure Schneider Electric Secure Socomec
	b. Prepaid Meters & accessories	Actaris HPL Schneider Electric Secure

		Socomec
	d. Electromagnetic Meters	Automatic Electric Rishabh
16.	Power Capacitor	EPCOS GE Neptune Ducati Schneider Electric Unistar
17.	Automatic Power Factor Correction Relay (Numeric Type)	BELUK (Germany) Conzerv Neptune Ducati
17.1	Thyristerised APFC Control Panel	ABB Neel Controls Power Matrix Schneider Electric
17.2	Detuned Reactor	EPCOS Neel Controls Nepune Ducati Schneider Electric
17.3	Thyristor Fuse	Cooper Bussman Ferraz Shawmut Siemens

SL. NO.	DETAILS OF MATERIAL	NAME OF MANUFACTURERS
18.	PVC insulated XLPE aluminium/ copper conductor armoured MV Cables up to 1100 V grade	CCI Finolex Gloster Havells
19.	LT Jointing Kit / Termination	-3M Raychem REPL
20.1	Cable Glands Double Compression with earthing links	Baliga Lighting Comet Cosmos
20.2	PVC Glands	Control Well Lapp
21.	Bimetallic Cable Lug	Comet Cosmos Dowell's (Biller India) Hax Brass (Copper Alloy India)
22.	PVC insulated copper conductor stranded flexible wires	Finolex R R Kabel Batra Hanley Polycab
23.1	Mettalic / GI Conduit (ISI approved)	AKG BEC
23.2	Lead Coated Flexible GI Conduit	Flexicon PLICA India Pvt. Ltd.
24.	PVC Conduit & Accessories (ISI approved)	AKG BEC D Plast Precision
25.	Switch & Socket	Crabtree ABB – Lumina/ Classic Clipsal (Opal Series) Legrand (Arteor) Wipro (North West)
26.	Terminal Blocks	Connect Well Elmex Wago
27.	Industrial Socket	
	a. Splash Proof	Clipsal ELCON-PCE Gewiss MDS Legrand Schneider Electric
	b. Metal Clad	BCH HANSEL MDS

SL.	DETAILS OF MATERIAL	NAME OF MANUFACTURERS

NO.		
28.	Ceiling Fan	Anchor Crompton Greaves Havells Orient Usha
29.	Lighting Fixture	
	a. Incandescent / Halogen / PL / Metal Halide) / Fluorescente/ CFL/ LED	Philips Havells Wipro Crompton
	b. External Lighting Fixture	Philips Crompton Trilux K lite
	c. Aviation Obstruction Light (LED Type)	Actos Bajaj Binay Havells
30.	Electronic Ballast for Fluorescent (To be selected as per fixtures' manufacturer)	GE Osram Philips Thorn Wipro (APF)
31.	Lighting Control Equipments/ Dimmers	ABB MK (Honeywell) Schneider Electric Wipro
32.	Occupancy sensors	L&T MK (Honeywell) Philips Schneider (Clipsal) Wipro
33.	Selector Switch, Toggle switch	Kaycee Salzer (Larsen & Toubro)
34.	Timer	Larsen & Toubro ABB BCH Legrand Schneider Electric Siemens
35.	50 W Halogen Light Transformer (Encapsulated Transformer)	Gemini Global Opal Philips Reiz
36.	Batteries with battery charger	Amar Raja Exide Global (Rocket) Hitachi Shinkobe

SL. NO.	DETAILS OF MATERIAL	NAME OF MANUFACTURERS

37.	LT Automatic Servo Voltage stabilizer	Automatic Electric Neel Controls Recon
38.	K rated Isolation Transformers	Datson Numaric Emerson
39.	Inverter	Autopro (Professional Lighting) Luminous Megatech
40.	UPS	RESQ Emerson Network Power Merlin Gerin HITACHI
41.	Power Distribution Units	APC Merlin Gerin Delta Power Solutions Emerson Network Power GE Power Mitsubishi
42.	Cable Trays (Factory Fabricated) / Raceways	OBO Bettermann Legrand Profab MK - Raceways
43.	Cable tray supporting system	Gripple
44.	Anchor Fastener	Fischer Hilti
45.	Lighting Poles	Bombay Tubes and Poles Bajaj Electricals Keselec K-Lite
46.	Fire Sealant & Fire Retardant Paint	OBO Bettermann 3 M India Ltd. HILTI
47.	Lighting & Surge Voltage Protection	Indelec OBO Bettermann Schneider Electric ASCO Hager
48.	230/12 V Step Down Transformer with BUILTIN Isolation Transformer	Talema Volstat
49.	Lightning Protection System	Erico LPI
50.	HDPE underground cable duct	Rex Polyextrusion Tirupati Plasomatics Duraline
51	Earthing Enhancement Material	Ashlock Galaxy Indelec Forend

SL. NO.	DETAILS OF MATERIAL	NAME OF MANUFACTURERS

52	Exit Signage	Legrand MK PHILIPS Prolite Thorn
53	SOLAR System	Pulse power Technologies pvt ltd Chloride solar National Solar

Note:

1. For any particular projects, the vendor shall put maximum effort to ensure that the makes remain standardized to one type/ make only. In case of any doubt or non availability of standardized makes, the ven dor should obtain written clearance from the Architect/ end user within one month of receiving the LOI/ WO.

2. The approved makes for Cables and Wirings listed above are meant for external wiring work like lighting points, power point, telephone systems works etc. and not applicable for panel wiring. The wiring inside panels shall be as per the manufacturers' practice and conforming to the relevant IS and good quality.

TECHNICAL SPECIFICATIONS FOR 50 kWp GRID CONNECTED SOLAR POWER PLANT

OVERALL SCCHEMEME OF THE PROJECT:

The array capacity of the PV Power plant will be **50 kWp for power plant at KOPT Head Office Building.**

The PV array is to be installed at the available space earmarked at project site. The power from PV array is to be feed into grid through one or more than one number grid Connected string inverter. The capacity of 2+1 inverter or the cumulative capacity of the inverters should be minimum nominal capacity of 50 kVA 3Ø 415 V 50Hz AC for KOPT Head Quarter Outputs of the grid-tied string inverter will be terminated to an Inverter LT Panel to be located close to the inverters at both the locations.

The output of the Inverter LT Panel is to be terminated and connected with supply mains through a Grid interfacing LT Panel.

An Export Import Energy Meter is to be installed nearer to the Grid interfacing Panel before connecting to the mains to measure the energy produced from the PV Power Plant.

The Grid connected string Inverter, Inverter LT Panel is to be installed in suitable kiosk with proper security and protection with arrangement of proper shed (if required).

The SPV power plant is to be installed at both the sites should be Robust, Economic, Efficient and Time tested and having a good aesthetic view matched with the Building.

Note: The contractor/contractors have to submit the Design of the Power plant as per site for approval.

1. **Bidder Eligibility:**

Sl	Eligibility Criterion	Supporting Document Required	Complied (Yes / No)
1	The Bidder must have their own office in the state of West Bengal	Trade License Copy Along with - Complete Name and Address - Contact Numbers	
2	The Bidder must have executed at capacity & cumulative 250kWp in WB under the net metering scheme in this Financial year 2018-19.	Work Completion Certificate from the End Customer Copy of the Electricity Bill of the End Customer showing net metering benefits	

2. **The system will consist of the following components:**

1. Crystalline Silicone PV Modules minimum 50 kWp Capacity

2. PV Module Mounting Structure suitable for above PV Modules

3. DC Array Junction Box– Per inverter there will be 1 no. either external or internal with inbuilt SPD of minimum 25kA capacity.

4. Transformer less Three Phase String Inverters – 2 Nos of minimum 20 Kw and 1 No of 10kW Capacity with inbuilt string monitoring box.

5. Inverter Interfacing ACDB – An Inverter Interfacing ACDB with 2 nos. of MCB for individual inverter & 1 No. of main MCCB for the total output power is to be placed within a distance of maximum 8 metre from the inverters.

6. SFU for Grid Connectivity – 1 Nos
7. Earthing System

8. Lightning Rod – 1 Nos

9. All Electrical AC and DC cables including Conduits

10. Remote monitoring System – 1 Set

Detailed Technical Specifications

Crystalline Silicone PV Modules

a. Modules must be indigenously manufactured in India
b. Only Mono / Poly Crystalline Modules are acceptable
c. Modules must have IEC 61215 and IEC 61730 as per MNRE requirements from any NABL / IECQ accredited laboratory
d. PV Modules of 72 cells – 290-330Wp and above are acceptable. No other configuration is acceptable
e. Total PV Yard Capacity should be 50000 Wp minimum
f. Warranty - The warranty should have 5 Years ComprehensiveWarranty, 10 years 90% power output guarantee and 25 Years 80% Power Output Guarantee.

g. Please clearly mention the following

i. Make of the PV Module
ii. Model Number of the PV Module
iii. Voc (Open Circuit Voltage of the PV Module)
iv. Isc (Short Circuit Current of the PV Module)
v. Vmpp (MPP Voltage of the PV Module)
vi. Impp (MPP Current of the PV Module)
vii. Dimensions in mm
viii. Temperature Coefficients of Voltage, Power and Current
ix. Wp Rating of the PV Modules
x. Total number of PV Modules Offered

The PV modules must qualify the relevant **IEC 61215 or IS 14286 and IEC 61730.** The proposed PV Module must have the Test Certificate issued from accredited test laboratories of MNRE Government of India under JNNSM programme. The test certificates issued from IEC accredited laboratories will also be acceptable.

Each PV module used in this solar power project must use an RF identification tag. The information must be mentioned in the RFID used on each module as per guideline of MNRE Government of India (This can be inside or outside the laminate, but must be able to withstand harsh environmental condition).Manufacturer of proposed PV modules must have the ISO 9001:2008 or ISO 14001Certification for their manufacturing unit for their said manufacturing item.

Warranty:

A. l Warranty: The manufacturer should warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than five (05) years from the date of commissioning of the PV Power Plant.

i. Defects and/or failures due to manufacturing
ii. Defects and/or failures due to quality of materials
iii. Non c onf or mi t y t o specifications due to faulty manufacturing and/or inspection processes.

If the solar Module(s) fails to conform to this warranty, the manufacturer will repair or replace the solar module(s), at the contractor's cost & risk.

The contractor shall be responsible to contact with the manufacturer if any of the above mentioned cases occurred.

B. Performance Warranty:

The manufacturer should warrant the output of Solar Module(s) for at least 90% of its rated power after initial 10 years & 80% of its rated power after 25 years from the completion of trial run at site/date of final commissioning. The contractor shall collect the Warranty Certificate for performance of the modules from the manufacturer and submit the same to KoPT after getting the necessary documents vetted from the Consultant.

If, Module(s) fail(s) to exhibit such power output in prescribed time span, the Contractor will bound to either deliver additional PV Module(s) to replace the missing power output with no change in area of site used or replace the PV Module(s) with no extra cost with in the contact period claimed at Owner's sole option.

Manufacturer of proposed PV modules must have the ISO 9001:2008 or ISO 14001Certification for their manufacturing unit for their said manufacturing item.

Note: Only indigenously manufactured PV cells & modules should be used in Grid Connected Rooftop Solar PV Power Plants under this scheme. However, other imported components can be used, subject to adequate disclosure and compliance to specified quality norms and standards.

Desired specification of the PV Module will include but not limited to the following:

Sl No	Item	Description
1.0	Certification	i)IEC 61215 or IS 14286 ii) IEC 61730
1.1	Type Test certificate issuing authority.	NABL/ IEC Accredited Testing Laboratories or MNRE accredited test centers.
2.0	PV Cell	
2.1	Type	Crystalline Silicon preferably Poly-crystalline Silicon
2.2	Indigenous Indentification	Manufacture Indentification mark on each cell
3.0	PV Module	

3.1	Rating at STC	i)290 Wp -330Wp, 72 cells (without any negative tolerance)
3.2	Efficiency	minimum15%
3.3	Fill factor	Minimum 70%
3.4	Withstanding voltage	1000V DC
3.5	Glass	
3.5.1	Thickness	3.2 mm (minimum)
3.5.2	Type	High transmission, low iron, tempered & textured glass.
3.6	PV Module Junction Box	
3.6.1	Protection level	IP 65 or above
3.7	Bypass Diode	
3.7.1	System Voltage (V sys)	1000 V dc
3.7.2	Number	3 numbers (minimum)
3.8	Module Frame	
3.8.1	Type	Anodized aluminum frame

MANDATORY ENCLOSURES

1. Brochure of the Offered PV Module
2. IEC 61215 certificate of the PV Modules
3. IEC 61730 certificate of the PV Modules

2. Power Conditioning Unit (PCU)

a. The Power Conditioning Unit will be a grid connected string inverter. This will convert the DC Power generated from the PV Array Yard to Pure Sine wave AC Output and feed into the grid.

b. Rating – The System should be capable of handling upto 33 kWp of PV modules. The Output AC shall not be less than 30000 W.

c. The Output Voltage of the Inverter should be 400 VAC and should be capable of syncing to the grid within a range of +/- 20%. The Output will be 3 Phase 4 Wire.

d. The Output frequency should be minimum 47-52 Hz in sync with the grid frequency.

e. The PCU should be transformerless and in minimum IP 65 enclosure for outdoor use if required The Inverter Selected should have at least 3 Channels of MPPT. Each Channel of MPPT Should be able to support atleast 12 kW of DC Power. The MPPTs should be capable of symmetric as well as asymmetric loading and should also be capable of paralleling.

g. The inverter must have the inbuilt feature of string level monitoring.

h. The MPPT Tracking range should be 500V – 850 V.

i. Please mention the following parameters about the Inverter:

i. Make of the Inverter.
ii. Model Number of the Inverter.
iii. Please mention maximum Input voltage from PV modules allowed on the inverter.
iv. Please mention Input MPP Range of the Inverter.
v. Please mention night Consumption of the Inverter.
j. The Inverter should have a peak efficiency not less than 98%.
k. The Inverter should have IEC 61683 and IEC 60068-2 (1,2,14,30).
l. The Inverter should have RS 485 over Modbus for upgrading firmware.

m. For remote monitoring the inverter must be compatible to both GPRS & WIFI through RS 232 port.
n. For Local monitoring the inverter must have inbuilt Bluetooth facility through which software upgradation will also happen. The Bluetooth facility must have the feature of extracting generation data.

MANDATORY ENCLOSURES

1. Brochure of the Offered Inverter
2. IEC 61683 of the offered Inverter
3. IEC 60068-2 (1,2,14,30) of the offered inverter

3. Remote Monitoring System

The Remote monitoring system will consist of an inbuilt Data Logger. The data after being stored locally will be transferred to the remote portal in the internet cloud which will keep a backup of the data. Anyone can logon to the remote portal and access the generation data using a predefined username and password.

Apart from monitoring of the inverter remotely through web portal there must be facility to monitor the inverter through mobile app also. The mobile app should be available in both IOS & Android operating system.

Upto minimum 5 inverters of same make but different capacities should be connected in daisy chain formation for the purpose of plant monitoring for providing a single internet connection.

4. Module Mounting Structure

The Solar PV mounting structure should be Mild Steel Galvanized to minimum 80 microns. The structure should be suitably built at an angle of 23-25 deg and will be placed at Roof top of a Building in shadow free area for maximum output from PV array. The structure should be built to accommodate the PV Modules in Section 1 above for KOLKATA region . The structure should be so designed as to withstand wind speeds upto 150 km / hr. The successful bidder

will have to have the module mountingstructure design vetted and approved by a Civil Engineer.

5. DC Array Junction Box (AJB)

The Array Junction Box must confirm to the following specifications

1. It should be made of Fire Proof, UV protected Poly Carbonate and should be IP 65 enclosure protection if external
2. The AJB should have suitable rated 25 kA SPD Type II inbuilt in the system. 1 SPD should be provided for each MPPT Tracker of the Inverter.
3. For 3 Inverter 3 AJBs will be required.

Sl No	Item Description	Desired Data
1.0	**Enclosure**	
1.1	Degree of Protection	IP65 with UV Protected
1.2	Material	Polycarbonate.
1.3	Withstanding voltage	1000V DC
1.4	Withstanding Temperature	100 ^{0}C
1.5	Accessories mounting arrangement	DIN Rail or as suitable
1.6	Front cover	Transparent
1.7	Number of Strings entry	As may be required
2.0	Cable Entry and Exit	
2.1	Position	Bottom at cable entry and exit
2.2	Cable Entry and Exit connector type	MC 4 / Tyco Connector (PV Array String cable)
2.3	Cable gland	Earthing cable entry
3.0	Surge Protecting Device (SPD)	
3.1	Type	DC
3.2	Protection class	Type 2
3.3	Rating (8/20)	20 kA
3.4	Number of set	As may be required as per string Design (minimum 1 set against each MPPT Chanel)
4.0	Fuse with fuse holder	
4.1	Position	Positive and negative terminal for each series string
4.2	Type	Glass fuse, for PV Use only
4.3	Rating	Current: Minimum **1.25** times the rated short circuit current of the series string
4.4	Approved make	***(as peracceptabilityof KDS –KoPT)***
5.0	Earthing Provision	Terminal blocks will have to be provided for Earthing
6.0	Terminals, lugs and bus bar	Tinned copper

6. Inverter Interfacing LT Panel

The Inverter Interfacing LT Panel should have the following

1. It should be made of Fire Proof, UV protected Poly Carbonate and should be IP 65 enclosure protection
2. It should have suitably rated MCB for each Inverter Input of 10 kA fault current
3. It should have Grid side MCCB of suitable rating of 25 kA fault current
4. It should have Type II SPD, 25 kA Fault Current Three Phase type. Please enclose the catalogue of the SPD being used.
5. The Inverter Interfacing LT Panel should have a Class 1 accuracy import export energy meter.

Desired specification of each string inverter will include but not limited to the following:

Sl. No.	Operating Parameter	Desired specification
1.0	Type	Grid Connected String Inverter
2.0	Usage	Specially used for PV system
3.0	Standards	
3.1	Efficiency Measurement	**IEC 61683/ Equivalent BIS Std.**
3.2	Environmental testing	**IEC 60068-2 (1,2,14,30) / Equivalent BIS Std.**
3.3	Interfacing with utility grid	**IEC 61727 or Equivalent**
3.4	Islanding Prevention Measurement	**IEC 62116 or Equivalent**
3.5	Type Test certificate issuing authority **(for item no 3.1 , 3.2)**	Accredited Testing Laboratories.
4.0	**Input (DC)**	
4.1	Aggregated PV array connectivity capacity	Total individual/ cumulative capacity 50 kWp
4.2	MPPT Voltage range	Compatible with the array voltage
4.3	Total number of MPPT	two or more
5.0	Output (AC)	
5.1	AC Active Power	Total individual/ cumulative 50 kW at unity pf respectively
5.2	AC Grid Connection	3Ø , 415 V & N, 50Hz
5.3	Adjustable AC voltage range	As per prevailing Grid code.
5.5	Frequency range	As per prevailing grid code
5.6	AC wave form	Pure Sine wave
5.7	THD	As per prevailing Grid code.
6.0	General Electrical data	
6.1	Efficiency	minimum 95 %
6.2	Sleep mode consumption	Less than 10 W
7.0	**Protection**	

7.1	DC Side	Reverse-polarity protection Reverse current to PV array protection, over voltage, Under voltage protection Over current
7.2	AC side	DC inject protection to grid Over voltage and Under voltage Over current Over and under grid frequency protection, Anti Islanding protection
7.3	Isolation Switch	PV array Isolation switch (DC) (If DC isolating Switch is not provided in the inverter it will be provided by the contractor separately nearer to the inverter
7.4	Ground fault detection device (RCD) which can detect changes in ground current. Rating will be as suitable for inverter	To be provided for transformer-less inverter.
8.0	Display	
8.1	Display type	LCD /LED Display
8.2	Display parameter	
8.2.1	DC	Voltage Current Power
8.2.2	On grid connected mode	Line status Grid voltage Grid frequency Export Power Cumulative Export Energy
9.0	Interface (Communication protocol)	Suitable port must be provided in the inverter for i) On site upgrade of Software, ii) Instant on site data dumping facility, iii) Compatible to Web based remote monitoring system
10.0	Web monitoring	Matched with the monitoring and data logging system
11.0	Mechanical Data	
11.1	Protection Class	IP 65(Outdoor type)
11.2	Temperature	$0\ ^{0}$ C to 55^{0}C
11.3	Cooling	Natural / forced cooling
11.4	Type of Fixing	Wall Mounted / floor mounted

6. Switch Fuse Unit

A Suitably rated Switch Fuse Unit will have to be provided at the input to the grid. The SFU will be Four Pole Type with metal enclosure and suitable handle. SFU make will be Siemens / ABB / Schneider.

7. Earthing System

A minimum of 4 Nos of Earthing Pits of Chemical gel type will have to be erected at the site. 2 Nos Interconnected earth pits will be used for system and earthing and 2 Nos interconnected earth pits will be used for the lightning arrestors. All the chemical gel earth pits will have copper electrodes. The system has to be designed using Copper Cables / Copper strips for interconnection and termination. Suitable Tinned copper earth busbars are to be placed for termination.

9.0 Lightning Arrestors

The lightning system should be so designed as to cover the whole array yard. A suitable number of Franklin rods are to be placed for protection against lightning and subsequent over voltages.

10.0 Electrical Cabling

10.1 **DC Cabling** – All DC Cabling will be done with Double Insulated, weather proof, UV protected, cross linked polymer cables of suitable cross section should be used. Cable make will be Solar as from list of approved makes.

10.2 **AC Cables** – Exposed cables shall be XLPE armoured cables of requisite dimension. Indoor cables will be PVC insulated cables suitable for carrying the requisite currents. When PVC cables are used it should be put through suitable ducts / conduits, no cables should be exposed. Cable make will be as from list of approved makes.

This is a turn key project irrespective of any items not specifically mentioned but required for proper functioning of the equipment and the Power Plant the same shall be within the scope of this tender.

List of approve make		
Sl	**Item Description**	**Make**
1	330 Wp or similar rating PV Modules	Maker enlisted under MNRE website
2	Solar mounting stucture	Fabricated

3	Grid Connected Solar Inverters	KACO/abb/sma/ge/seimens
4	ACDB	Ensto
5	Array Junction Boxes	Hensel/Spelsberg/abb/Ensto
6	AC Cables	Polycab /Havellsl/Gloster/
7	DC Cables	Lapp/Leoni/Polycab/Top solar/Schneider
8	Earthiing Protection	OBO Betterman
9	Fuse with fuse holder	Cooper Bussman/Ferazz Shamut
10	Surge Protection Device	OBO Betterman/Dehn/Citel
11	Export import Meter	L&T/Secure/hpl/

TENDER DOCUMENT FOR EXTRA LOW VOLTAGE SYSTEM

FOR

PROPOSED RENOVATION WORK FOR KoPT

1. BUILDING MANAGEMENT SYSTEM

1 System description

1.1 General

1.1.1 Building automation and control system requirements

System requirements

General requirement: - Include a digital (DDC) building technology control system to operate technical equipment in buildings. The system must be able to carry out comprehensive measuring, control, optimization, and monitoring functions. All applications deployed are tested, documented, and used multiple times. The possibility for free programming of individual system components should be available to individually modify customer-specific requests. The software shall be capable of doing Online engineering i.e. Zero Downtime of software during any modification of Graphics.

System up-to-datedness

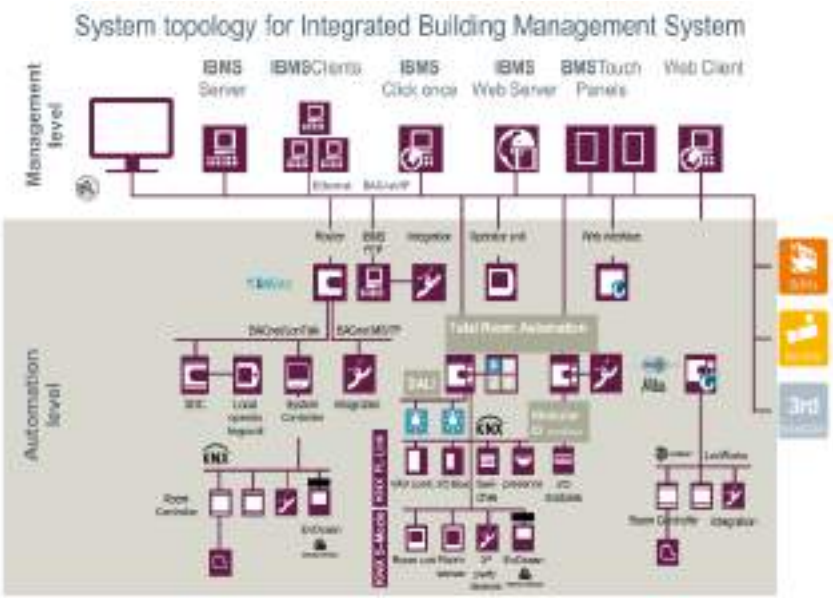
Product lifecycle: - The system provider must offer a transparent product lifecycle to ensure the required consistency. All equipment offered for this project must be contained in the current product portfolio. The existing system environment must allow for easy and smooth integration of devices and extensions.

System continuity: - Products employed must be labeled with a brand for a global standard that secures the interaction of products from various manufacturers. Products bearing these brands can also be employed together when manufactured at an interval of more than 10 years.

Architecture

Three system levels:- A building automation and control system featuring system architecture as per ISO EN 16484-3 is required. The three system levels must be interconnected via communications.

- Management level
- Automation level (automation stations/individual room control)
- Field level (field devices)



Automation stations: - The system offered must provide largely decentralized intelligence to achieve high operational and plant availability. The devices are autonomous components that can independently execute assigned automation and control.

Implement third-party systems: - Third-party systems must be able to be integrated on both management and automation levels to ensure full system consistency. Default interfaces must be provided. Third-party protocol implementation must be possible and require little effort. To do this, all hardware and software required for integration, all required services, clarifications with other technical and mechanical building installations, interface testing, data transmission testing, data point generation/integration as well as plant picture creation,

backup, test protocol generation and specific documentation must be included in total costs.

Location-independent operation: - The building automation and control system technology must allow for location-independent operation and management of all messages and trends on all available types and views for the entire building automation and control system.

Consistency

Uniform system:- The supplier must prove that the required functions originate from a single manufacturer and using one automation and control system, where the hardware and software are developed in a manner that allow for simply modification while operational for subsequent function extensions or changes.

Implement new data points: -Building automation and control must be coherent to ensure possibility of future extensions and changes. This means that data points must be acquired once only, and then be provided automatically as needed to operator units and management level.

Integration of open standards

General

Interfaces: -The building automation and control system must be extendible to ensure long-term operation and provide all standard interfaces commonly available on today's market.

Implement via BACnet: -Default protocols and suitable physical communications media must guarantee interoperability (ISO standard). Use only listed protocols and communications media. Third-party systems are integrated via BACnet. Provide only data required to efficiently and economically operate building services plants.

Integrate fire detection systems: - Fire detection system BACnet-based.

BACnet-based fire detection systems supporting BACnet BIBB AE-LS-B as well as objects LifeSafetyPoint and LifeSafetyZone as per the PICS (Protocol Implementation Conformance Statement) document must be able to be integrated for best deployment of a building automation and control system. The following functions must be supported:

- Alarms and events from the fire detection system must be identified clearly and unambiguously.
- Signaling device states must be displayed as per the BACnet standard.
- Instruction texts must be able to be added to detectors and zones.
- Situational and floor plans as well as dynamic symbols must be able to be used for visualization.
- A technical hierarchy, e.g. building, building part, zone, detector, must be provided to the operator for ease of operation.

Integrate Modbus devices: - Decentralized integration of third-party devices via Modbus.

Modbus-capable devices must be able to be connected to a BACnet-capable automation station via decentralized interface module for bidirectional data exchange. The automation station provides the following functions:

- Event-oriented communication
- Peer-to-Peer (cross communication)
- Alarm and message processing, distribution to local operator units and building automation and control system.
- Scheduler program with weekdays
- Calendar function
- Local trend recording in device buffer (long-term trend).

Integrate via OPC: -Integrate third-party devices via OPC

OPC servers must be able to be connected to a BACnet network for bidirectional data exchange.
The integration required must form a high-performance link between OPC and BACnet via presentation as OPC client in OPC and BACnet server in BACnet. The function extends far beyond simple mapping and transfer of OPC items to BACnet. The following functions must be ensured to achieve the required openness.

- Direct mapping of OPC items to BACnet objects, for display and operation by BACnet clients.
- Grouping of OPC items to create standard integrated BACnet objects.
- Event-driven transfer of alarms in the BACnet network
- Trend server with its own data maintenance for trendlog objects.
- Cross communications (peer-to-peer) with other BACnet servers

Integrate third-party devices via OPC: -The system must be OPC Foundation tested and certified and must be able

to integrate and process, but also to provide real-time data as OPC data points. The System processing must include Alarming, Trending, Scheduling, and Reporting and allow cross communication with other integrated devices.

The System must be support the OPC specification:

- OPC Data Access

Power failure

Data backup: - The data must be saved for extended periods of time until next data input in case of power failure or extensions or removal of automation stations. The applications and all vital operating parameters (including set points, scheduler values, etc.) must not be lost due to a power outage. Other operating values such as alarms, trend data, etc. must be capable of being saved locally on the automation station.

System time

Time format:- Time synchronization in BACnet: UTC time (coordinated universal time). The building automation and control system must have a uniform system time. To this end, a time master supporting BACnet BIBB DM-UTC-A as per the PICS document must be defined. The time master must receive the DCF77, GPS or Internet NTP signal and provide it synchronized to all remaining system devices.

Subsystem autonomy: -The automation stations must autonomously run their own time if the time master fails. The building automation and control time must be resynchronized automatically after the time master becomes available again.

Self monitoring and self diagnosis

Watchdog: - The building automation and control system must monitor itself to always know its latest and current status. A watchdog function helps detect and signal failed system devices and restarts them in a defined mode.

Self diagnosis: -Self diagnosis must be available to quickly detect errors. It must provide information on system function and load. E.g. CPU and memory load must be displayed.

General plant operating states

Overview of operating modes

There are five higher operating modes for all plants:

- Local emergency operation without automation station functionality (direct via I/O module or directly on the control panel as agreed to with owner).
- Local manual operation with automation station functionality (control panel in the control panel).
- Local - manual operation via visualization on the management level (all functions on the local automation station are set to Auto).
- Scheduler program under the condition that all plants are enabled for automatic operation.
- Automatic detection.

All control functions of the automation stations must be set to and remain on automatic for highest plant availability, if a plant or aggregate is switched to MANUAL. In individual cases, automatic mode must change over to this unit in case of redundancies when a plant or aggregate is switched off locally.All safety and interlocking functions must take highest priority for operation independent of operating mode.

Automatic detection: -The plants of the building automation and control system are switched on and off either automatic or dependent on time or event. The following functions apply to the actual plant descriptions. All control loops, safety and interlocking functions must be guaranteed to work regardless of operating mode.

Controlled via scheduler program:- All plants must be set to automatic for this operating mode. The plants of the building automation and control system must be switched on and off by individual use via a day, week, month, or annual scheduler program.

Manual operation: - Different options are required for manual operation.

- Manual operation via management level (remote operation)
- Manual operation via local operator unit or laptop directly at the control panel.
- Manual operation via operator unit or directly at the control panel.

Manual operation generally is possible only if the corresponding automation station is running. Manual operation allows for manually overriding scheduled plant switchings. Plants switched off by schedule can be

switched on via plant switching command. Manual control of the plant switching command is equal to automatic control, i.e. the scheduled control is retained for as long as the scheduler remains active. Search & Replace function must allow for Mass Changes in parameters can be done across the entire installed system (eg. Operating hours change, set point etc)

Energy efficiency & references to applicable standards.

General: - The building is constructed under strict energy guidelines. The control technology deployed must contain all functions required to efficiently consume energy.

Energy efficiency class "C" as per EN 15232:- Standard EN15232 serves as the basis for energy efficiency functions. The system supplier must prove that the functions are as described by the standard. This tender was established based on Class C criteria.

Requirements from EN 50001 placed on building automation and control system.The processes defined in standard ISO 50001 to improve energy efficiency must be supported by the data from the building automation and control system. In other words, all required data and information, measurement and analysis functions as well as outputs and display must be provided in accordance with this standard.

Energy efficiency monitoring and Evaluation.

Support of eu.bac guidelines, part 4.Energy monitoring and evaluation is required for the entire building automation and control system. The basis forms the eu.bac guidelines - EEBACS Certification Scheme, Certifying Energy Efficiency of Building Automation and Control Systems, at first delivery and during the lifetime, Part 4: Specification of Key Performance Indicators.

Management level: - Visualize quality state.A violation of the energy efficiency limits values for monitored measured values on the management level must be displayed using colors or symbols. Easy to interpret symbols provide the operator with a quick overview on the state of monitored plants, components, etc. Bar charts or pie charts or similar are still required for display of the overall state of monitored plants or the entire building. The operator must recognize how many (in percentages) of the total number of monitored measured values are in the quality state "good" or "bad", or, however, monitoring and evaluation is disabled. The quality state indicates whether the monitored measured value is within or outside the energy-efficient range. Violations of monitored limit values are displayed on the one hand through the quality state "bad" and, on the other, assessed as an indication that resulted through a fault operation, manual intervention, error or false or incorrect parameterization, in non-energy-efficient operation of components, aggregate or plants, ultimately resulting increased consumption (electricity, water, natural gas, etc.). An individual weighting of the calculation of resulting quality states must be possible since multiple measured values can be evaluated within a building or plant. The parameters for weighting, monitoring, evaluating and forming the quality state can be set based on read and write access rights. As an alternative: Make possible the simple navigation to an appropriate user program.

Automation level: - Key performance indicators on the automation level.Monitoring and evaluation of measured values for primary plants (components and plant parts, software/program/system functions, setpoints, et.) must occur directly on the automation level. Monitoring and evaluation is intended to recognize unfavorable operations of plants/components early on and thus lower or optimize energy consumption and wear and tear.

Monitoring and evaluating analog measured values.The following monitoring and evaluation must be able to be implemented for analog measured values (sensors, setpoint, modulating control of valves, dampers, variable speed drives, etc.):

- Determine the minimum value (lowest value) within a defined timeframe.
- Determine the maximum value (lowest value) within a defined timeframe.
- Determine the average value (lowest value) within a defined timeframe.
- Determine the linger period (in hours) during which the measured value moves between freely definable limit values.
- Determine deviation that the measured value deviated from the upper and lower setpoint within a defined timeframe.

The determined value is monitored to a minimum and maximum and displayed as quality state for breach and/or exceeding thereof. The value from the current timeframe is displayed; the value from the previous timeframe is also displayed and made available to the trend data. The evaluation ceases for a fault to the measured value (sensor interrupt, module fault, etc.), until the measured value once again assumes a reliable state. This fact must also be recognizable in the trend data.

Monitoring and evaluation of digital and multi-stage measured values. Digital measured values (messages,

switching commands, operating modes, etc.) must be definable as key performance indicators and make possible the following evaluation and monitoring:

- Determine the runtime (operating hours) within a defined timeframe.
- Determine the switch-on frequency within a defined timeframe.
- Determine the runtime (operating hours) for each stage within a defined timeframe.
- Determine the switch-on frequency for each stage within a defined timeframe.

The determined value is monitored to a minimum and maximum and displayed as quality state for breach and/or exceeding thereof. The value from the current timeframe is displayed; the value from the previous timeframe is also displayed and made available to the trend data. The evaluation ceases for a fault to the measured value (sensor interrupt, module fault, etc.), until the value once again assumes a reliable state. This fact must also be recognizable in the trend data.

Monitoring and evaluating metered values: - Metered values (consumption meters, pulse meters, etc) must be definable as key performance indicators and make possible the following evaluation and monitoring. Determine the difference value (consumption value within a defined timeframe.The determined value is monitored to a minimum and maximum and displayed as quality state for breach and/or exceeding thereof. The value from the current timeframe is displayed; the value from the previous timeframe is also displayed and made available to the trend data. The evaluation ceases for a fault to the measured value (sensor interrupt, module fault, etc.), until the value once again assumes a reliable state. This fact must also be recognizable in the trend data.

Evaluation over different timeframes:- Monitoring and evaluation must be able to occur over definable timeframes (annually, monthly, weekly, daily, hourly, 15-minutes).

Weighting of monitoring and evaluation criteria:- Since an aggregate or component may include multiple evaluations, it is required to be able to weigh them so that they are included differently in the calculation of the resulting quality state.

1.1.2 Engineering tools and engineering efficiency

Engineering efficiency

System and tool platform:- Creating solutions must be as efficient as possible, i.e. programming on construction sites; use of pre-defined application blocks, fast exchange of standard functions, etc. The goal is to achieve the maximum required level of flexibility at as little expense as possible.

Preloaded application on devices.

Applications portfolio.Prefabricated and tested must be loaded in a fix manner on the devices prior to commissioning. They can be used in the basic functions without the use of additional engineering tools.

Harmonized tools and workflows.

Consistent tools:- Uniform data and functions must be used by the building automation and control system in a consistent manner throughout all tools to achieve a high level of data consistency. In other words, all data is only entered once in the system. Consistent tool processes avoid a manual exchange of data (Import/Export).

Transparency for customers.

Data backup for minimum 30 day's: - A data backup concept must be presented that provides the current state of a project in a form that is useable and complete to the customer. In includes raw data from plants, applications, engineering data (e.g. DP, labeling, links, and parameters), documentation.

Customer changes

The technical operator at the customer be able independently make simple changes to the project. Potential training proposals must be appended to the bid.

1.1.3 Corporate performance.

Performance for implementation.

Performance on communication network.

Establish communications network: - The required communications network is part of the building automation and control system's scope of delivery. All control, monitoring, and communications tasks must run on this network. The communications network comprises all three system levels.

- Management level
- Automation level.
- Field level.

The approved network concept must be documented in full and handed over operational.

Supplier support: - The supplier must have all expertise and capacity required to support and advise the expert planner on hardware and network structure definition in dependence of the selected operating concept.

Engineering offerings

Offerings on programming: - The contractor provides all services to successfully operate the specified plants and systems. This includes:

- General review and detailed requirements listing by the expert planner.
- Detailed listing of the functions and specifications listed in this document.
- Present a detailed communications concept.
- Work required to engineer or parameterizes the building automation and control system.
- Edit and program all required control, operating, signaling and logging functions including system-related programming.
- Create data point list featuring all entries required by standards.
- Review and implement the described measuring concept.
- Set switching times, setpoints, and control parameters as per the targets defined and agreed to with the expert planner.
- Review the device application with regard to adherence to targets, especially regarding the described energy efficiency.
- Document the project concerning functions, communications, system topology, and control panels/panels.

Offerings on commissioning

The contractor provides all services to successfully commission the specified plants and systems. This includes:

- Create configuration and parameterization lists.
- Review and ensure working communications across the entire building automation and control system including all devices on the network.
- Check network load and resulting reaction times.
- Test the modules and automation stations, all inputs and outputs including associated documentation (cold commissioning).
- Test the safety functions for control and processing algorithms (e.g. with regard to technical and mechanical installations interaction and simulated operating failure or faults).
- Unambiguous labeling of all network components, user address, and/or operating materials.
- Comprehensive data point test including review of all connected sensors and actuators.
- Check all cabling in the building for adherence to installation guidelines.
- Check all bus terminators and voltage supply.
- Setting of required configuration parameters.
- Commission the connected sensors and/or actuators together with the other mechanical and electrical installations.
- Review of planned automation functions as per specifications.
- Log set and measured values.

- Log required function for energy efficiency.

Final documentation: - A final, comprehensive documentation must be provided following building automation and control system acceptance. To create such documentation, the system must allow for complete and current data export. As a result, the complete data set must be able to be exported any time featuring up-to-date data.

Offerings for training: - The contractor provides all services to train maintenance staff. This includes the following topics.

- Structure, properties, and functions of the installed building automation and control system.
- Training on all operating options. (Room operation, emergency switch, control switch, operator units, management level, etc.).
- Detailed operation of all management station functions. (Reports, analyses, trends, interpretation of alarms, alarm handling, data backup, etc.).
- Troubleshooting and diagnosis on system and plants.
- Adapt simple functions, implementation of updates, etc.

Service offerings: - Service covering all electrical and mechanical installations. This project contains several, individual electrical and mechanical installations. The supplier must therefore be able to offer a comprehensive service concept covering all types of building installations. Possible service offerings must be documented and submitted together with the bid.

1.2 Management level

1.2.1 Management level requirements

General

General: - All information comes together at the management level. The management level is the graphical, interactive interface for the operator to the automation station and the integrated plants and plant parts. The operator can display, query, process, save, or print any plant information via the peripheral units at the management level. System operation must be simple, i.e. dialog-driven. The plants are displayed in synoptic images and the values and states are presented and displayed dynamically. Special programs are used for higher control, optimization functions, and maintenance and energy management.

Operating system for building automation and control system: - All data servers, operator workspaces etc. for the building automation and control system must be compatible with the current, common 64-bit Windows operating system. As a result, the current Windows version (at least 6 months after release by Microsoft) must be supported as well as the previous version as a minimum. Adjustment to the customer network is targeted. The building automation and control system must thus be able to be installed on any commonly available PC environment.

Data exchange via various subsystems: - If several subsystems are used, various data must be exchanged between the automation stations (outside temperature, demand and coordination signals, etc.).

Automate recurring tasks: - The building automation and control system must take care of recurring tasks to lower the operator's workload. This includes, for example, cyclical report generation triggering, plant release at various conditions, or automatic adjustment of setpoints or alarm limits.

Designed for use with fire life safety systems (UL certified): - The management station must have passed performance and environmental tests by the Underwriters Laboratories (UL). To combine the comfort and fire life syfe system, the management station must provide all the relevant functions:

- Visualize and treat events
- Graphically monitor and control the life safety system
- Know where to start as highest priority events are highlighted.
- Directly navigate to the triggering element of an event.
- Quickly navigate to custom operator instructions and graphical display of event locations.
- Store and retrieve fire alarm system activity data.
- Distribute fire monitoring and control capabilities across the network of the management stations.
- Provide Operating Procedure checklists to guide the operator, under stress conditions, during the treatment of life safety events.
- Send out automatic remote notification of responders through email.
- View and schedule automatic history reports.

SCADA platform: The management station must be based on a SCADA plattform, which must be fully compliant with the BACnet B-AWS profile. It must enable the integration of any type of building equipment, such as HVAC and lighting.

Help functions: The software shall provide an online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.

Single Client License concept: Easy configurable client as the same can be used as Desktop or Web client in Floating configuration.

Hardware requirements

Minimum hardware requirement (Plants from +/- 2’000 up to +/- 20'000 data points)

A client / server system for large sites is required. The hardware and software environment must fulfill the the folowoing definition:

- Type: Server 19” Rack
- Processor:
- 1x Xeon E5-2690 or
- 2x Xeon E5-2690 (Verssion-4)
- HDD: 4x Seagate Constellation 2 SAS 2000GB 7.2k Hot Plug SED
- Graphic Card:
- On-board video graphics or
- AMD Radeon 7750 1GB or
- Nvidia GeForce GT 610 1GB
- RAM: 32GB DDR4, 4x 8GB

Recommendet software environment

- Windows Server 2019 , 64bit Edition
- MS SQL 2019 Standard or
- MS SQL 2019 Enterprise

Network requirements

- Local Network
- 1000 Mbps up/down
- Latency <lt/>10ms

Range defined

- 1 server
- Max 50 clients (10 Installed + 40 Remote/Web)
- Max 4 drivers

Additional: System must be to extent with a dedicated SQL server if a high data throughput is required.

Minimum hardware requirements (plants with greater safety requirements)

Hardware requirements as redundant server system

The PC at the management level as a redundant server system must have hardware satisfying the described requirements.

- 5 GB of available RAM.
- 8 GB RAM.
- Windows 2019 Server.
- Dual Xenon (or equivalent) at 2.8 GHz.
- NVR or SAN.
- VMware ESX 3.5.
-

Multi-Monitor Support-(Max 4 Nos):- 4 Simultaneous views of critical systems , Reduction of client workstation licensing & hardware cost.

1.2.2 User profiles

Plant overview

Individual view: - Individual, specific, or own views must be able to be set up to broaden plant overview. These views must cover various electrical and mechanical installations or follow geographic or organizational criteria and must allow personalized hierarchical “tree” views that represent the workstation, control systems, geographical facility layouts, and mechanical equipment relationships.

User privileges: - The building automation and control system must allow users to define, change, or delete predefined reactions as per their user privileges.

Multi language possibility: - The user interface must be able to support minimal three languages simultaneously in one system.

Related Items:- Information of any data point available in multiple pages, Access to trend, scheduler, reports, data sheets"

1.2.3 Graphics

General

Operator interface to CAD system: - The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, and point alarm association. Graphics software shall permit the importing of CAD symbol, or scanned pictures for use in the system.

Operating messages: - Operating messages must be able to be displayed and evaluated at the management level. Graphics shall be capable of displaying the status of points that have been overridden by a local priority switch, for points that have been designed to provide a field local priority override capability.

Full graphics mode: - A fully graphic management level featuring ergonomic images must be available. The system must be designed for operation, monitoring, optimization, and logging of all connected automation stations in real-time.

Graphics creation: - User shall be able to add/delete/modify system graphics and state text for digital points, from standard user interface without the need of any external or specialized tools.

Navigation: - The navigation through various graphic screens shall be optionally achieved through a hierarchical “tree” structure. Graphics viewing shall also include dynamic pan zoom capabilities and include the ability to switch between multiple layers with different information on each layer.

Vector Graphics & Multi-layer with Depth support: - The system must support for Autocad import of plan with Zoom In & Zoom Out facility through scroll mouse feature & must Enable simplified and un-cluttered view of all utilities (FAS, ACS, CCTV etc) on any typical floor plan.

Dynamic 3D & HD Graphics: - Must support for Dynamic 3D & HD Graphics symbols for better clarity, aesthetics, effective use of change in display technology

Pictures: - Graphic symbols and standard: - The plant pictures must satisfy ergonomic needs of operators. The displayed graphic symbols must correspond to the generally valid standard for HVAC symbols (DIN 19227) and ASHRAE guidelines. Symbols must be supported as two or three dimensional graphics. Capability to create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including, but not limited to, air handling units, chilled water systems, hot water boiler systems, and room level terminal units. Associated prints of standard plant pictures must thus be added to the bid.

Object-oriented graphics: - The building automation and control system must offer dynamic, high-resolution graphics. The graphics must be object-oriented. Each symbol must be able to display several states in the same, consistent format. At the same time, several views must be able to be open concurrently, and all views must be updated dynamically.

Continuous update and display: - Measured values, setpoints, user settings, and alarms must be displayed immediately and continuously. State changes must be indicated via symbol, e.g. using animation or changing the color, in general, however, graphic presentation, or text.

1.2.4 Energy management

Energy measuring functions

Energy and quantity measurements: - The management level must allow for carrying out various evaluations and analyses of energy consumption in the building. After reviewing the data, aggregates not working efficiently or

rooms not operated optimally must be easily identified. To this end, the system must be able to process and calculate the listed measurement units.

Examples:
Energy:

- Instantaneous value of output in: kW
- Metered value in energy in: kWh

Volumes:

- Volume flow values in: m3
- Instantaneous volume flow values in: l/s.
- Instantaneous volume flow values in: m3/h.

Operating and consumption data reports: - Complete processing and presentation of operating and consumption data in the form of a graphical report is required for the highest possible availability and optimal use of technical installations in buildings. The following reports and functions must be created and supported:

- Energy consumption reports.
- Energy cost reports.
- Weigthed consumption report.
- Adjusted heating degree day report.
- Energy efficiency report.
- CO2 emissions report.
- Display format (line, steps, 3D line, and 3D steps, various colors, automatic or set scaling of y-axis, zoom).
- The generated reports must be printable.
- The operating and consumption data must be recorded autonomously in the automation station using BACnet trendlog objects. This data may not be lost due to short-term management station failure.

In addition, it must be possible to evaluate reports and data generated by comparing the data to previous years. Several reports (with max. 10 data series) must be able to be created and saved for each of the above report templates. Operators must be able to manually start reports, add a scheduler program or create new reports based on templates regardless of their user rights.

1.2.5 Scheduler programs

General

Scheduler programs: - At least eight switching times (On/Off) per day must be possible via operator units (local or management level) to achieve reasonable plant control. The following schedules must be supported:

- Binary: e.g. on/off.
- Analog: e.g. setpoint profile.
- Multistate: e.g. room operating modes Protection/Economy/Comfort.

Special days must be able to be edited at the management level via two different ways:

- Via calendar.
- Via direct special day entry in scheduler program.

Navigation from plant picture to scheduler program: - Every currently used plant picture must offer user-friendly scheduler program operation.

Management via central scheduler programs: - Operate all scheduler programs online from the management level to achieve consistent, transparent operation of all integrated systems and subsystems.

Scheduler program types

Customized scheduler program: - The user can customize the schedule defining the operating mode for each plant. Switching times are defined via weekly schedule. Overriding recurring weekly schedules via local or global exceptions as well as operation via any operator unit must be possible.

Customized calendar: - Local or global calendar exceptions must be able to override the plant-specific weekly scheduler program. Equal calendars must be assigned priority over each other. Calendar operation must be possible via all operator units.

1.2.6 Building automation and control system operation

Multiuser-System with online services

Create calendar online: - Calendar programs must be able to be remotely created online to provide service personnel a high level of flexibility.

Create scheduler online: - Scheduler programs must be able to be remotely created online to provide service personnel a high level of flexibility.

Online creation of offline trends: - Trends, that also trend offline, must be able to be remotely created online to provide service personnel a high level of flexibility.

Multiple, concurrent users: - Multiple users must be able to work concurrently on various workspaces on the building automation and control system for efficient and comprehensive work. Plants must simultaneously be analyzed and e.g. monitored or operated via a remote station.

Security

Access protection: - Different persons maintain and operate the plant. For this reason, passwords must be assigned to authorized persons to guarantee transparency for tracking or authorization purposes. A minimum of four different rights must be assignable.

- Administrator.
- Program and graphics creation
- Operation to change or adjust setpoints.
- Guest.

Windows authentication: - The building automation and control system's password administration must be consistent with the customer's IT guidelines. In other words, corporate customer guidelines must also apply to the building automation and control system. As a result, password administration and related properties must be equal to standard Windows login and shall "follow" the operator to any workstation logged onto.

Closed Mode Operations: - The software should have an option to disable to use other windows applications such as Microoft Office tools, access to local drives ets to ensure Secure operations - The BMS server/PC must be prevented to be used as a general purpose PC by the users.

Operating functions

Central setpoint shift: - The setpoints in the rooms must be adjustable and shiftable for effective and clear room operation for the rooms as a whole and individually via the building automation and control system.

1.2.7 Alarm handling

General

Alarm function: - The automation station contains an image of the physical data points. Each data point must be alarmable. Parameterization via operator units must be possible. The alarms either do not require acknowledgement, i.e. they come and go without acknowledgement, or must be acknowledged or reset and acknowledged.

Alarm message: - Alarms from the automation station must be displayed on the operator units within 1 second. Alarms must be acknowledged or acknowledged and reset dependent on access rights. Delay times (e.g. feedback supervision, triggering of differential pressure monitor, filter) must be changeable via operator units.

Alarm suppression: - Lower priority messages, undesired reactions from objects or entire plants must be capable of being suppressed during commissioning, plant servicing or automation station start up.

System safety

High availability: - High availability is required of the building automation and control system. Data availability must be increased and any fail times massively reduced.

Alarm generation

Message handling:- Both types of alarm management (Intrinsic Reporting/Algorithmic Reporting) are supported as recipients. Alarms from automation stations are received at the management level, but not generated based on a change to Present_Value or Status_Flags in the automation station. All alarms are displayed when the management level is started.

- Intrinsic: Each BACnet object is alarmable.
- Algorithmic: Limit value supervision.

Management Station Alarms: - Must be possible to create Alarms for third party systems.

Alarm routing

Media, independence, formats: - Current alarms may need to be routed independent of media at certain times to a central service (Printer, email). To do this, various formats must be available (CSV, XLS, PDF). There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.

Alarm message escalation list: - System must be configurable to send messages to an individual person or group of people and shall be configurable to send different messages to different remote devices based on alarm message priority level.It must be able to send also to an escalation list so that if the first device does not respond, the message is sent on to a second device after a configurable time has elapsed.

Acknowledgment

Operator units for acknowledgement: - After user rights are assigned, all alarms (alarms and faults, errors) must be acknowledgeable from all operator units. This helps to trace alarms. A time stamp and assignment (based on user account) is required. This includes:

- Local acknowledgement (control panel, automation station).
- Management level.
- Remote operating equipment.

Alarm management strategy: - The software shall allow the user to configure the alarm management strategy for each point. The editor shall provide the ability for editing the point database directly online with the Building Controllers. The operator interface software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points.

Assisted treatment of alarms: - The system should support for Guided operations for any event so as to reduce the human error while handling the alarms must be possible to configure Predefined & fast intervention steps for faster response.

Alarm display

Color display: - Incoming alarms must be colored for quick and easy interpretation. Both order and state as well as alarm priority must be recognizable. The alarm window must be displayed as per operator needs. Alarm window displays must be added to the bid.

Alarm message content: - The message texts must contain all information necessary to allocate and resolve the error. This includes at least the following attributes:

- Clear text.
- Control panel name
- Plant name
- Priority (min. 16 different priorities).
- Time.
- Status (acknowledged, unacknowledged).
- Instructions on how to resolve the problem must be available in the background.

Filter alarms: - The building automation and control system must offer alarm filtering. Filtering must be possible by alarm lists or priorities. Alarms are displayed in popup windows. Step-by-step instructions on handling each alarm help the building automation and control system operator to find a solution.

1.2.8 Event management

Event Routing and sorting: - Event Routing shall allow the user to send event notification to selected printers or workstation location(s) based on event severity, or point type. The List must have the ability to list and sort the events based on event status, point name, ascending or descending activation time.

Event Notification: - Event Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each event: name, value, event time and date, event status, priority, acknowledgement information, and alarm count. Each event shall have the ability to sound an audible notification based on the category of the event.

Event acknowledge: - Directly from the Event List, the user shall have the ability to acknowledge, silence the event sound, print, or erase each event. The interface shall also have the option to inhibit the erasing of active acknowledged events, until they have returned to normal status. The user shall also have the ability to navigate to all information related to a selected point in order to command, launch an associated graphic or trended graphical plot, or run a report on a selected point directly from the Event List.

1.2.9 Report generation

Reports

Report generation: - The system must spontaneously (snapshot) generate predefined reports (real-time and historical data) to provide vital plant data at any time. These reports must be printable or exported to third-party spreadsheet software and as PDF file. The data must be editable in other programs (Microsoft Excel, or Microsoft Access) for further analysis.

Standard report templates: - Templates help generate comprehensive reports without much effort. At least three different report templates must be available.

- Reports to record alarm and fault states.
- Reports to record logbook entries.
- Reports to record plant and building panels states
- List of all points currently in override status
- List of all disabled points
- List of alarm strategy definitions
- Point tantalization report

- Point Trend data listings
- Initial Values report
- User activity report
- Event history reports

Customized report templates: - The system must allow for creating specific report templates to meet individual report generation requirements, which also may include plant and trend graphics.

1.2.10 Remote operation

Operating options

Internet access: - The building automation and control system must offer an Internet solution via Microsoft IIS (Internet Information Server). The management level programs must be mapped to APS (Active Server Pages) and optimized for Microsoft Internet Explorer.

Terminal server: - Users must be able to remotely operate and engineer plants regardless of location via a terminal server function. This openness, of course, may in now way impact plant safety.

General requirement for operating: - The Web based interface shall provide the same functionalities as those available at any other workstation, including operation and configuration capabilities. All operator interface functions must be available in clients running in a browser, installed client console, or Windows desktop app.

Via web browser: - Users must be able to remotely operate and engineer plants regardless of location with the same user interface. This openness, of course, may in no way impact plant safety. The client must run in a browser as a Full Trust client application

Dedicated Desktop Installed client: - Users must be able to remotely operate and engineer plants regardless of location. This openness, of course, may in now way impact plant safety. The client must run as a fully installed software installation that can lockdown desktop space and prevent the ability for the software to be minimized or covered by other applications.

Windows Desktop APP: - Users must be able to remotely operate and engineer plants regardless of location with the same user interface. This openness, of course, may in no way impact plant safety. An app must be downloaded to the client from the server PC that runs like an installed application, and must be automatically updated whenever new apps are available at the server.

1.2.11 Trend data

Analyses

Simultaneous, multiple trends: - Multiple trend views must be possible simultaneously to provide a comprehensive plant overview. Standard plants from medium to higher complexity (as in this project) require a simultaneous display of up to 10 trend curves on the current page view to assess the plants. Multiple trend curves must thus be recorded at the same time.

Freely assign trend data: - For greatest possible flexibility, operators must be able to assign and thus record max 4 additional data points individually for each plant. The assignment must be carried out from the management station.

Decentralized data storage: - None of the trend data may be lost during communications failure to achieve gap-free trend documentation. For this reason, all trend data must be created and saved to the automation station. After communications are restored, all values saved on the management station must be updated automatically.

Intermediate storage of history data: - Trend data are collected in the automation station and transferred to the management level after a specific time has expired or specific number of data has been recorded. Trend data may not be lost if the management station is unavailable temporarily.

Trend comparison: - To make analysis of changed conditions in different times, the system must provide a time shifted trend view.

1.3 Automation level

1.3.1 Requirements at the automation level

General

Automation station standard: - Automation stations must be intelligent. They must be autonomous. They must be

built to go from high decentralization into small units (DDC). Automation stations must be freely programmable and feature graphical programming optimized for building automation and control. The following functions must be available: Control, measure, signal at various priorities and by event, monitor, alarm, count, calculate, schedule, save trend values, and log as per DIN EN ISO 16484-5. BACnet server (automation stations) certificates must be added to the bid.

System design: - Manufacturer must prove that they have various scalable automation stations to ensure optimal automation station design. Associated system documentation must be added to the bid and included in system evaluation. Documentation must show that the hardware (DDC and I/O modules) is designed optimally for the number of the required data points.

Delineation, automation to management level: - All management level functions must be fully engineered in the automation station to increase plant availability. Delineation is defined to ensure that no additional engineering is required at the management level (BACnet client).

Delineation,Room automation to management level: - All management level functions must be fully engineered in the room automation station to increase plant availability. Delineation is defined to ensure that no additional engineering is required at the management level (BACnet client).

Specifications: - The DDC controller to be 32 bit controller with BTL certification. The decentralized small units (DDC) to have UIO concept for configuration of inputs & outputs to suite the project specific requirement and the last minute changes at site.

The CPU frequency of 100 for controller up to 22 IO's & 133 MHz for 36 IO's and above with RTC & having Bacnet/LON OR Bacnet/Ethernet IP having SDRAM of16MB to 64MB & Flash Memory for 22 IO's & 36 IO's respectively. 8 MB to 16MB for 22 IO's & 36 IO's respectively. Maximum IO for small units to support up to 36 IO's.

The DDC to be capable of accepting inputs of 0-10 VDC; PT1000; NTC 10K; LG-Ni1000. The same to have agency compliances like EN 60730-1; EN 50491-x; EN 60730-5-2/-5-3; CE 2004/108/EC; CE 2006/95/EC; UL916; FC PART15, CLASS B; ISO 14001; ISO 9001 .Each decentralised small units (DDC) should be capable of being operated through room units to a maximum of 5 nos via PPS2 inertface for various operations aprat from portable operating terminal(POT).

1.3.2 Operation concept at automation level

Local operation

General: - Local operation with access for the corresponding automation station, or network operation via BACnet to all or selected automation stations, or simple room operation must be available.

Operator and monitoring units

Local operator and monitoring unit: - Local operation must be possible via a locally usable operator unit. All vital operating parameters of the automation station must be displayed in clear text. All current plant values, setpoints, and parameters must be displayed on the operator units. All operator units must be configured to allow for acknowledging maintenance and fault messages.

Networkable operator and monitoring unit: - Plant operation must be possible both locally and via management level. Local operation must be location-independent and allow for maintenance staff work from any automation station or be integrated in the control panel door. Operation must allow for access to all values (current values, setpoints, parameters, maintenance and fault messages) without special engineering as well as plant-specific composition of vital values. Operation must allow for graphic display of weekday and exception programs, heating curves and trends set up individually.

Graphical plant operation via network-capable touch panel: - A network touch panel operates the building management system. They must inform the operator without log on using plant graphics on the present state of the plant. Multiple plants must be able to be operate via touch panel. Is must be capable of displaying and acknowledging alarms. The operator should be informed about faults directly by a common alarm display via faults even when the display is switched off. At the same time, functions to control the plant must be supported, so that plants must be able to be graphically operated and displayed using select data points, schedulers as well as trend views. A capacitive display is used to operate. The touch panel as be added as an integral component of the overall system via a scalable web interface as well as a pleasant form of polished aluminum frames. User name and password is required to run functions that can change to plant settings in order to protect the plant.

Web operation independent of hardware: - A web interface, independent of hardware, operates the building

management system. The entire user interface must be optimized for finger operation. To ensure operation not tied to a location, web operation must also support, for example, off-the-shelf tables (Android, i OS App, Microsoft) or notebooks. It must be capable of operating multiple plants as well as display and acknowledge alarms. At the same time, functions to control the plant must be supported, so that plants must be able to be graphically operated and displayed using select data points, schedulers as well as trend views. User name and password is required to run functions that can change to plant settings in order to protect the plant. Existing, system touch panels must be able to be integrated, or devices able to use standard web browser functions without further upgrades.

Operation via web browser or mobile clients: - Vital functions must be viewable regardless of plant location. To this end, access is required via mobile clients (mobile phone, pocket PC, PDA, etc.) to all actual values and setpoints, plants and operating states.

Online trends: - Local operator units must support temporary recording of trend data to allow local operators to record a trend at the control panel for diagnostic purposes.

1.3.3 I/O modules

General

Construction: - As highly flexible I/O modules are needed for complex and large technical equipment in buildings, they must be composed individually for each plant. To this end, modules must be configurable for various signal types, grouped, labeled per channel with clear text, two-sided readable, and distributed or set across several control panels/panels.The entire module electronics must be protected by a stable plastic housing against touch and soiling.

Diagnostic function: - A status diagnosis for each channel is required to quickly locate installation or plant errors. The status is displayed by LED or on the module.

LED display: - The color of the status LED must be configurable to correspond with message type to provide and easy overview in the control panel. Feedback: green, maintenance: yellow, warning: red.

Remote I/O modules: - Remote I/O modules must be able to be used for small plants or parts thereof to keep the size and number of control panels/panels as low as possible. The modules must be able to be as far as 200 m from the automation station. The maximum number of data points edited this way may only be limited by the maximum capacity of the automation station.

Isolating terminal functionality: - The electronic modules must have isolating terminals to simplify hardware tests and commissioning. As a result, connected field devices can be measured at the test plug sockets without module electronics influence. At the same time, the connection terminals must act as cabinet/panel terminal strips. If the bidder cannot provide proof for this function, all inputs and outputs must be run via separate isolating terminals. The resulting costs must be included in the unit prices.

Connection

Short-circuit proof: - Field devices and motors must be connected directly without requiring coupling relays or other proprietary hardware. All terminals are protected against short circuit and incorrect wiring using AC/DC 24 V. Field device errors must be recognized and displayed reliably to retain high plant availability.

Broken wire interlock: - Interlocks (hardware) and fault messages must be designed for possible wire breaks or loose terminals under closed-loop rules, i.e. the automation station then has status "1" OK (closed monitoring loop) or no fault, and status "0" (interrupted monitoring loop) or fault.

Connect field devices

Field device standards: - The automation stations or I/O modules must support all common sensors (e.g. temperature, humidity) and actuators (valves, damper actuators) without requiring additional conversion hardware. The bidder must provide proof that the field devices used for the project were tested under the entire system and documented accordingly.

Use of I/O modules on the automation level: - Functionality for the I/O system must be implemented on the automation level.

1.3.4 Updates and adaptations

Updates

Changes during operation: - Customer-specific plant programs must allow for minor adjustments without having to switch off unrelated plants and without changing set parameters and setpoints.

Changes to applications during operation: - Minor program changes must be able to be introduced without operational interruptions.

Adaptations

Access via system network: - Operators must be able to enter adapted parameters, setpoints, times etc. in each automation station via the system network under their password.

1.4 Communication

1.4.1 Standard BACnet / AMEV

DIN EN ISO 16484-5 / AMEV

BACnet conformance and BTL logo: - The BACnet servers (automation stations) used must support at least BACnet standard Version 1, Revision 10 (1.10) or higher. In addition, a test must be carried out successfully in a neutral testing laboratory (conformance testing) and the automation stations must have the BTL logo.

B-AWS (management station): - Management stations must match the BACnet Profile B-AWS (Advanced workstation) as per the BTL Listing.

B-BC (automation station): - Automation stations must match the BACnet Profile B-BC (Building Controller) as per the BTL Listing.

AMEV AS-A and AS-B (automation station): - Automation stations must meet the AMEV profile AS-A and AS-B as per AMEV guidelines "Bacnet 2011"

B-AWS (management station): - Management stations must match the BACnet Profile B-AWS (Advanced workstation) as per the BTL Listing and also specified in ANSI / ASHRE 135 guidline. It must also support the BACnet Life Safety Points and BACnet Life Safety Zones functionality

ONVIF video standard: - The system must be able to implement Video streams of IP cameras. The presentation in “video wall” modus must be supported.

Conformance declaration

Protocol implementation and conformance declaration (PICS): - Manufacturer self-declaration PICS is required prior to executing work to gain information on the type of communication for the building automaton and control system.

Communication via LonTalk

BACnet over LonTalk: - The automation stations must allow for communication via LonTalk and work on simple two-wire cabling in a freely selectable bus topology with a total possible length of 900 m. Ethernet/IP must serve as the backbone.

Communication via BACnet / IP

BACnet/IP: - The automation stations (room automation stations as well) must support BACnet/IP communication (as per the standards described previously) for later system-independent plant extensions.

BACnet/IP(v4-v6) to BACnet/MS/TP: - The automation station must be able to integrate, using a router manufactured by the same vendor, the MS/TP protocol via BACnet/IP.

BACnet/IP(v4-v6) to BACnet/MS/TP or BACnet/LonTalk: - The automation station must be able to integrate, using a router manufactured by the same vendor, the BACnet/MS/TP protocol via BACnet/IP as well as BACnet/LonTalk.

BACnet/IPv4 to BACnet/IPv6: - The building management system must be able to connected the BACnet/IPv4 protocol with BACnet/IPv6 protocol using a router manufactured by the same vendor.

BACnet LonTalk to BACnet MS/TP: - The building management system must be able to connected the BACnet/LonTalk with BACnet/MS/TP protocol using a router manufactured by the same vendor.

1.4.2 Physical structure

Network structure

Structure: - The offered network must be flexible and allow for all types of networks (line, star, ring, tree, etc.) to satisfy all owner/operator needs.

Cable types: - The manufacturer must add to the bid any requirements for specific types of cable, cable

installation, or diameters etc., if the manufacturer or offered bus topology require them.

1.4.3 Building automation and control system - Automation stations

Openness

Extendibility: - Integrating existing technical equipment without additional conversion hardware (existing, open system, or other standardized bus systems such as BACnet or third-party) in the new environment is a vital task. The same applies to LonTalk, DALI, or KNX integration.

Integration of third-party systems: - If possible, the same communication protocol must be used as for the existing technical equipment in the building to integrate third-party systems (refrigeration machines, lighting and building automation and control systems, etc.). Building automation and control systems not offering this integration as specified must include and clearly declare any additional conversion hardware (gateways) in their price.

Open and neutral communication via BACnet: - Automation stations are connected to the management level via communication bus. System structure must allow open, neutral and manufacturer-independent communication. Communications must take place in principle via BACnet even if proprietary communications would be possible based on the automation stations used. Intermediate OPC servers are not allowed.

Engineering interface via the network or remote: - Access over the network, VPN, or modem is required for maintenance and diagnostics purposes.

1.4.4 Automation station - Automation station

Standard protocol

Uniform protocol: - Communication must also be standardized even between individual modules and automation stations. All devices must communicate on the same protocol on the entire room level.

1.4.5 Automation station - Field level

Field device connection.

Connect field devices: - The automation stations or I/O modules must support all common sensors (e.g. temperature, humidity) and actuators (valves, damper actuators, lighting control, blinds drives) without requiring additional conversion hardware. The bidder must provide proof that the field devices used for the project were tested under the entire system and documented accordingly.

Use of communicative field devices: - Communicative field devices are required to achieve simple cabling and consistent communication structures.

Connect communicating field devices: - Common manufacturers must be integratable to connect third-party devices and subsystems. (E.g. communicating pumps, Modbus subsystems, M-bus capable heat meters, etc.)

Third-party system connection: - A interface is required to connect various devices that supports communication protocols such as Modbus, M-Bus, Genibus and USS.

Support of Plug&Play commissioning: - The communications protocol used on the field level must support "Plug&Play", i.e. commissioning must be able to be conducted by a person without tools other than a PC/notebook without expensive software tools.

Number of supported communicative field devices: - The communications protocol used on the field level must support at least 30 communicative field devices for each controller with the use of gateways.

1.5 Field level

1.5.1 Requirements at the field level

Product range

Field level contents: -

The field level comprises all measuring sensors, actuators, transmitters and energy measuring devices used to control, regulate, monitor, and optimize plants. The bidder is expected to provide all required field devices from own production to the installer to provide a harmonized plant image. The associated field device product range overview must be added to the bid.

1.5.2 Actuators for ventilation and air conditioning plants

General

Mechanical strength: - Robust and long-lived actuators are required for reliable operation of ventilating plants.

Connecting cable: - Actuators are required to have color and number-coded connecting cables to prevent wiring mistakes.

Axis attachment: - The actuators must allow for fast mounting to maintain ventilation plants optimally at reasonable costs.

Damper positioning display: - Damper actuators must be equipped with an easily visible optical position indication for clear and visual check of the damper position.

Auxiliary functions: - Auxiliary functions such as auxiliary switches, position feedback, etc., are supplied mounted in the housing.

Disposal: - Actuators must be easily disposable.

Manual adjustment

Actuators are equipped with manual adjustor or disengagement function.

1.5.3 Actuators for fire dampers

Security

Demand: - Fire dampers are intended to provide protection against plant damage and/or personal injury. Periodic function checks guarantee highest safety. Motorization and position feedback is therefore a must. Fire dampers must guarantee secure closure in emergencies for the entire product life. All fire damper actuators as a rule must have a spring return actuator.

1.5.4 Sensors

General

Product line consistency: - As part of uniform plant design, all sensors must originate from the same manufacturer with recognizable, consistent appearance. All sensors must be CE-approved. For the final documentation, data sheets must be provided for all sensors used.

Reverse voltage protection: - The sensors must have reverse voltage protection to reduce error sources during electrical connection of the sensors.

Test functions: - The sensors must have a test function to ensure commissioning on a tight construction schedule. Allowing errors and faults to be recognized during point test or for analytic purposes during operation

Environmental declaration: - Proof for the materials used in the sensors must be provided if requested by the building owner. In addition, packing materials must be disposed of in an environmentally compatible manner.

Sensor connection: - For cabling, it must be noted in principle that disturbances occur the longer the wiring runs in parallel and the smaller the distance between lines. Use shielded cabling in environments subject to strong EMC. Use twist pair wiring for customer power lines as well as signal lines.

Sensor types:-

Temperature sensor

Outside air sensor: - Outside air sensors must allow for high-quality temperature measurements to promote efficient and ecologically meaningful control. A temperature measuring concept including wind and solar radiation is required.

Duct sensor: - Sensors acquiring temperature values via mean value acquisition are required to retain the necessary flexibility for sensor integration in air ducts.

Humidity sensor

Outside sensor: - Only maintenance-free sensors are used. The supplier must provide proof that the offered sensors feature compensation of inherent temperature. The sensor build must ensure protection against dust.

Duct sensor: - Only maintenance-free sensors are used. The supplier must provide proof that the offered sensors feature compensation of inherent temperature. The sensor build must ensure protection against dust.

Air quality sensor

Duct sensor: - Duct sensors may not feature additional duct mounting housings or other sealing masses for exchange during operation. Installation depth must be seamlessly adjustable to achieve a small product range. The sensor's design does not require sophisticated orientation to the flow direction in the duct.

Pressure sensor

Absolute pressure sensor: - Robust sensors ideal for measuring static and dynamic overpressure at intensive load changes are required for pressure control of liquids and gases. The related sensor build must ensure that the sensors are immune against humidity and temperature deviations in the long term.

Differential pressure sensor: - Sensor with highly stable membrane are required to monitor differential pressure of air and non-aggressive gases. Robust sensors ideal for measuring static and dynamic overpressure at intensive load changes are required for pressure control of liquids and gases. The related sensor build must ensure that the sensors are immune against humidity and temperature deviations in the long term.

Flow sensor

Flow monitor: - For flow monitoring of liquids, sensors of fiberglass reinforced plastic or in robust gun metal. The sensors must be constructed to be insensitive to contamination and have a high level of media resistance. Multiple configurations for the output signal must be possible to permit matching to a specific application.

Flow switch: - Maintenance-free sensors with reed contact are specified to monitor the flow of liquids. The sensors must be deployable to a wide nominal range to optimize application. The reed contact must be a proximity switch. The set switching point must be stable and independent of pressure.

Air velocity sensor: - The sensor used must be immune to contamination regardless of the flow direction. However, these sensors must be able to be adapted to various velocity measuring ranges without auxiliary tools to avoid measuring accuracy disadvantages. Multiple configurations for the output signal must be possible to permit matching to a specific application.

1.5.5 Valves and actuators

General

Own development and assembly competence: - The bidder provides proof that owns development competence is available to quickly and comprehensively adapt to new market requirements.It is important that both development and manufacture are from one bidder to ensure fast and consistent advanced development of the products.

CAD / CAE symbols: - The manufacturer must provide 2D and/or 3D CAD models in a standardized format for all valve-actuator combinations to ensure efficient pipe planning.

Backward compatibility between actuator and valve: - The valve and actuator supplier must ensure 100% backward compatibility for valve and actuator to simplify service planning and warehousing and ensure trouble free, future exchange.

VDI3805 symbols: - The manufacturer must provide the data sets under VDI 3805 for all valve-actuator combinations to ensure efficient pipe planning.

Requirements for valves and actuators

Mechanical requirements

Robust actuators: - Overload-proof actuators with robust components and easy-to-operate manual adjustment must be used for reliable operation.

Documentation: - Documentation for mounting and commissioning staff in the respective country's language must be added to the product to ensure smooth mounting and plant commissioning.

Manual adjustment: - The actuators must be equipped with tool-free manual adjustment for efficient service and secure emergency operation during plant faults.

Maintenance: - Robust and long-lived actuators are a must to ensure maintenance-free operation.

Electrical requirements

Energy consumption: - Actuators with the lowest possible power consumption should be used to achieve environmentally-friendly and energy-efficient plant operations. (The power consumption data must be documented),

The following upper limits are defined for electromotive and electro-hydraulic actuators:
Actuators for valves up to DN50: 20 VA.
Actuators for valves up to DN65 to DN150: 25 VA.Declarations

European standards: - The supplier must provide proof for adherence to the specific European standards for valves and actuators. (EMC Guideline)

RoHS / environmental declaration: - Only actuating devices conformant to RoHS and with an environmental declaration provided by the manufacturer may be used to ensure environmentally-compatible plant design.

Combination valves

Automatic differential pressure controller: - Valves must have differential pressure control to simplify installation and hydraulic balancing.

Treatment and primary distribution

Direct-mounted rotary actuators

General: - Use only direct-mounted actuators with integrated console for globe valves and butterfly valves to ensure efficient, trouble-free mounting.Thanks to the integrated console, there are not too many parts at the mounting location and errors due to wrong consoles are avoided.

Product range accessories: - The bidder provides proof of the fact that he/she has a comprehensive range of accessories allowing for flexible functional extensions any time.This aims at keeping the actuator range manageable for users, and ensures that standard functionality is not influenced by unused functionality. At the same time, the standard product does not include extra costs for other functions.

Kvs value gradation: - The bidder must offer a valve product range that ensures high efficiency in hydraulic circuits based on highly incremented kvs values. Optimal valve gradation is required based on exact adjustment of the volume flow at lowest possible pressure drop. In addition to operating energy savings for the hydraulic circuit, exact sizing must also ensure energy efficiency for hot and cold water generation by reaching optimized operating points more quickly.

Nominal widths: - The following valve-actuator combinations with the following runtime/nominal width gradations must be used for control tasks to optimize energy efficiency.Actuators for valves up to DN50: Actuators for valves from DN65 to DN150: 120 sec

Nominal pressure levels: - The bidder must offer a large range of valves for various nominal pressure levels in his/her own product range, and be able to mix the products without problems.

Operating and status indications: - The actuators used must have easy to understand visual operating and status indications. The movement of an actuator must be possible as well as from a certain distance (some meters) to

simplify function checks. Operating state of continuous actuators must displayed externally via Leeds, to allow less training personnel to quickly localize a plant or actuator error.

Direct-mounted rotary actuators ISO5211: - For efficient, trouble-fee mounting and compact installation, use only direct-mounted rotary actuators with connection as per ISO 5211. Thanks to the integrated console, there are not too many parts at the mounting location and errors due to wrong consoles are avoided.

Uniform valve interface: - The must document that it has a defined valve actuator interface to protect the investment in the plant.

Electrical requirements

Flexible voltage supply: - All actuators can be operated on both 24 VAC and VDC to achieve flexible application of actuators in the plant and to avoid double actuator warehousing.

Real electric positioning feedback messages: - Valves must offer real feedback to ensure reliable position indication/plant monitoring.

Position signal provisioning: - The selected actuators must be able to be operated on 0-10 V or 4-20 mA for the positioning signal even under critical EMC conditions.

Position indication / operating state indication: - Actuators offering possible position feedback for efficient plant monitoring and quick troubleshooting from the management level must be provided.

Mechanical requirements

Runtimes: - Actuators with very short positioning times, preferably faster than 5 seconds, must be used to optimize energy efficiency in very fast control paths.

Drinking water conformance: - Only DVGW (German Technical and Scientific Association for Gas and Water) certified valves may be used for valves in drinking water plants.

Connection types: - For optimal selection, various mechanical connection types are required for flexible installation. The valves must be delivered with flanges, external or internal threads (external threaded valves including screwed fittings) and comprehensive recommendations and instructions for various mounting systems.

Operation & mounting: - Uniform operation of all actuators: - rouble-free commissioning and efficient operation is guaranteed through uniform and user-friendly operation of all rotary and stroke actuators.

Tool-free manual adjustment: - The actuators must be equipped with tool-free manual adjustment for efficient service and secure emergency operation during plant faults

Manual adjustment with two operating modes: - Manual adjustment must be both temporary (reset to automatic occurs automatically) as well as permanent (reset to automatic only upon user request) to allow for optimum use during each project phase (commissioning and service).

Robust manual adjustment: - Manual adjustment must be designed to preclude damage to the actuator and activated valve, even for unintended operation.

Integrated actuator bracket for quick mounting: - Use only stroke actuators with integrated brackets for efficient and trouble-free mounting; for quick mounting using one tool. Mechanical adjustments, that cause an error, are not allowed.

Easy extension of functionality with a comprehensive offering of accessories:- The bidder provides proof of the fact that he/she has a comprehensive range of accessories for actuators allowing for flexible functional extensions any time. This aims at keeping the actuator range manageable for users, and ensures that standard functionality is not influenced by unused functionality. At the same time, the standard product does not include extra costs for other functions.

Easy-to-handle actuator accessories: - Accessories should be designed to simplify mounting and planning/logistics so they can be used on all actuators in the product range requiring as few parts as necessary for mounting.

Protection functions

Fail-safe function (safety of persons): - The bidder must guarantee fail-safe functionality for the entire valve-actuator range. The valve must mechanically move to the defined fail-safe position in the event of a power failure. The bidder must provide proof that the valves used are certified accordingly as part of the final project documentation.

Fail-safe function (safety of assets):- The bidder must guarantee fail-safe functionality for the entire valve-actuator range. The valve must mechanically or electrically move to the defined fail-safe position in the event of a power failure.

1) Room Temperature Sensor:

Sensing Element : Pt1000
Range of Use : 0...50 °C
Degree of protection : IP 30 to IEC 529
Output Signal : Resistive Output
Environmental conditions :
Temperature : 0...50 °C
Humidity : <85 % r. h.

2) Room Temperature & RH Sensor:

Sensing Element : NTC 10k (Temperature), capacitive sensing element (Humidity)
Range Of Use : 0...50 °C/ - 35...+ 35 °C / - 40. . +70 °C (Temperature), 0... 100 % relative humidity
Degree of protection : IP 30 as per IEC 60529
Output Signal : DC 0...10 V for both (Temperature and Humidity)
Power supply : AC 24 V ± 20 %, 50/60 Hz
Accuracy : ±0.8 K (15...35 °C), ± 3 % r. h. (30...70 % r. h.)
Approval : CE, UL 873, and C-Tick
Environmental conditions : Température: -15...50 °C; Humidity: <95 % r. h.

3) Duct Temperature Sensor:

Sensing Element : Pt1000
Range of Use : - 50...+ 80 °C
Degree of protection : IP 42 to IEC 529
Output Signal : Resistive Output
Probe Length : 400mm
Environmental conditions : Temperature: - 40...+ 70 °C; Humidity: 5...95 % r. h.

4) Duct Temperature & RH Sensor:

Sensing Element : NTC 10k (Temp), capacitive sensing element (Humidity)
Range of Use : 0...50°C/ -35...+35 °C /- 40...+70°C (Temperature),0..100% r. h.
Degree of protection : IP 54 as per IEC 60 529
Output Signal : DC 0...10 V for both (Temperature and Humidity)
Power supply : AC 24 V ± 20 %, 50/60 Hz
Accuracy : ± 0.8 K (15...35 °C), ± 3 % r.h (30...70 % r.h.)
Approval : CE, UL 873, and C-Tick
Environmental conditions : Température: -25...70°C; Humidity: <95 % r. h.

5) Water Temperature Sensor:

Sensing Element : Pt1000/LG-Ni1000
Range of Use : -30...+130 °C
Degree of protection : IP 42
Output Signal : Resistive Output
Thermo well : 100/150mm Length
Time constant : approx. 30s (With Protection Pocket)
Immersion rod : Stainless steel
Environmental conditions : Temperature: -40...70°C; Humidity: <5...95 % r.h.

6) Duct Differential Pressure Sensor (Air)

Sensing Element : Piezo-resistive
Range of use : 0...200 Pa/ 0...250 Pa/ 0...500 Pa
Degree of protection : IP 42 as per IEC 60 529
Power supply : AC 24 V ± 15 %, 50/60 Hz
Output Signal : DC 0...10 V
Accuracy : <± 0.1 % FS / °C (at 20°Ambient, TC zero point)
Overload Pressure : 5,000 Pa
Medium temperature : 0...70 °C
Pressure connection : PVC nipples □ 6.2 mm
Approval : CE, C-Tick, ROHS

Accessories : consisting of 2 m plastic tubes, 2 air duct probes
Environmental conditions : Temp: -25...70°C; Humidity: <90 % r.h. (without condensation)

7) Room Differential Pressure Sensor (Air)
Sensing Element : Piezo-resistive
Range of Use : ±50 Pa/ ±100 Pa
Degree of protection : IP 42 as per IEC 60 529
Output Signal : DC 0...10 V
Power supply : AC 24 V ± 15 %, 50/60 Hz
Accuracy : <±0.1 % FS / °C (at 20°Ambient, TC zero point)
Overload Pressure : 5,000 Pa
Medium temperature : 0...70 °C
Pressure connection : PVC nipples □ 6.2 mm
Approval : CE, C-Tick, ROHS
Accessories : consisting of 2 m plastic tubes, 2 air duct probes
Environmental conditions : Temp: -25...70°C; Humidity: <90 % r. h. (without condensation)

8) Air Differential Pressure Switch (Air):
Sensing Element : spring-loaded diaphragm
Range of Use : 50...500 Pa
Degree of protection : IP 54 as per IEC 60 529
Output Signal : Single-pole change-over, multi-layer contact (AC 250 V, max. 5 A res.)
Overload Pressure : 7500 Pa
Cycle Time : > 1 micro switching cycle
Approval : CE, UL94, C-Tick, DVGW approval
Accessories : consisting of 2 m plastic tubes, 2 air duct probes
Environmental conditions : Temp: -30...85 °C; Humidity: <90 % r.h.(without condensation)

9) **Water Pressure Sensor:**
Sensing Element : Piezo-resistive
Range of Use : 0...10 bar
Degree of protection : IP 65 to EN 60 529
Output Signal : DC 0 ...10 V
Power supply : AC 24 V ±15 %, 50/60 Hz
Rupture Pressure : 3 x scale end value of measuring range (FS)
Medium Temperature : - 40...+ 80 °C
Accuracy : <± 0.6 % FS
Approval : CE, C-Tick
Accessories : Mounting kit 1 m copper capillary line, both ends prefabricated ready for connection Thread adapters and terminal nuts.
Pressure connection : G1/ 8“ or G1/2“ outer threading.
Environmental conditions : Temperature: -40...80 °C; Humidity: insensitive to condensation

10) Water Differential Pressure Sensor:
Sensing Element : ceramic sensor
Range of Use : 0...10 bar
Degree of protection : IP 65 to IEC 60 529
Output Signal : DC 0 ...10 V
Power supply : AC 24 V ± 15 %, 50/60 Hz
Overload Pressure : 8 bars
Medium Temperature : - 15...+ 85 °C
Accuracy : <± 0.4 % FS
Approval : CE, C-Tick
Accessories : Mounting kit 1 m copper capillary line, both ends prefabricated ready for connection Thread adapters and terminal nuts
Pressure connection : G1/ 8“ or G1 /2“ outer threading.
Environmental conditions : Température:-15...85°C; Humidity:<90% r. h. (non-condensing)

11) Water Flow Switch:

Suitable media : All liquids (not suitable for ammonia)
Pipe Diameter : DN 20….200
Switching capacity : max. AC 230 V, 1A, 26 VA
Degree of protection : IP 65 per EN 60 529
Output Signal : Reed contact
Nominal pressure : 25 bars
Medium Temperature : -20. ..110 °C
Approval : CE
Environmental conditions : Température : -20...80 °C; Humidity: <95 % r. h

12) Air Velocity Sensor:

The sensor measures a point, i.e., it measures the values at a specific location in the flow profile.
Principle : Anemometric measurement
Range Of use : 0.5 m/s, 0...10 m/s, and 0...15 m/s
Output Signal : DC 0...10 V or 4.. .20 mA
Operating Voltage : AC/DC 24 V ± 20 %, 50/60 Hz
Degree of protection : IP 42
Medium Temperature : -20...110 °C
Approval : CE
Environmental conditions : Temp: -10...+45 °C; Humidity: <95 % r.h.

13) Modulating Valves:

Threaded : Up to 40mm
Flanged : > or Equal 50mm
PN Rating : PN16
Valve Body : bronze up to 4omm, Grey cast iron for 5omm & above
Δp max across the valve : Minimum 175Kpa
Two Way/ 3-Way : As per BOQ
Stem : Stainless steel
Medium temperature : +1 . . .95 °C
Environmental conditions : Temperature: -10...55 °C; Humidity: 5...95% r.h.

14) Valve Actuator:

Type : Electromotoric up to 65mm, Electrohydraulic for 8omm and above
Operating voltage: AC 24 V ± 20 % 50 or 60 Hz
IP Rating : IP54
Type of Signal : Modulating DC 0.10V
Nominal stroke : **5.5mm** upto 40mm dia;**20mm** for 50,65,80mm Dia; **40mm** for 100,125,150mm Dia.valves
Manual Override : YES
Approval : CE
Environmental conditions : Temperature: -5. . .50 °C; Humidity: 5...95% r.h.

15) Damper Actuator (FireDamper Actuator On/Off)

Type : Rotary version with spring return
Operating voltage : AC 24 V ± 20 % 50 or 60 Hz
IP Rating : IP54
Type of Signal : Two-position control
Torque : 7NM (1.5SQM damper Area) or 18NM, (3SQM Damper Area)
Runtime for rotary angle 90° : 90s
Closing time with return spring : 15s
Manual Override : YES
Round / square shaft : 6.4...20.5 / 6.4...13 mm (7NM)
Round / square shaft : 8...25.6 /6...18 mm (18NM)
Approval : CE, C-Tick

Environmental conditions : Temperature: -32…+70°C; Humidity: <95 % r.h.

16) Damper Actuator (Modulating)

Type : Rotary version without spring return
Operating voltage : AC 24 V ± 20 % 50 or 60 Hz
IP Rating : IP54
Type of Signal : DC 0...10V
Torque : 5NM (0.8SQM damper Area); 10NM,(1.5SQM Damper Area);15 NM (3SQM Damper Area)
Runtime for rotary angle 90° : 150s
Manual Override : YES
Round / square shaft : 6.4...20.5 mm /6.4...13 mm (I5NM)
Approval : CE, C-Tick
Environmental conditions : Temperature: -32...+70 °C; Humidity: <95 % r.h.

17) Butterfly Valves:

Valve Body : Grey cast iron
PN Rating : PN 16 to EN1333
Permissible operating pressure : 1600 kPa (16 bar)
Angle of rotation : 90° (to end stop)
Medium temperature : -10. . . 120 °C
Permissible media : chilled water, low temp hot water, high temp hot water, Brine
Approval : CE

18) Butterfly Valve Actuator:

Type : Electromotoric rotary actuators
Type of Signal : 3-position
Operating voltage : AC 230 V ± 15%(3-position)
Operating voltage : AC 24 V ± 20% (DC 0.10V, Modulating) if included in BOQ
Type of Signal : DC 0...10V if included in BOQ
IP Rating : IP54 as per EN 60529
Positioning times : 120s
Manual Override : YES
Approval : CE, UL
Environmental conditions : Temperature: -15...+55 °C; Humidity: 5.95 % r.h

19) BTU Meter:

- Meter to be tampering-proof with Single button design. No tampering through the keypad. Parameters of the meter can be changed through software only.
- All meters need to be wet calibrated (temperature sensor and flow meter need to be calibrated together) and calibration certificate to be provided for the BTU meters.
- Meters need to have an inbuilt Lithium battery backup - guaranteed for a min. of 6 years.
- No reflector used for detection of flow. This ensures that meters are very robust and efficient and maintenance free for years of operation.
- The flow sensor to be a high capacity flow meter, to take velocities as high as 10 m/s.
- Meters need to be CE certified and needs to have IP65 Protection.
- Meter should have the facility to be used as a hot meter as well as a cold meter without any modifications. The meter should have auto switching of Hot/ Cold meters.
- The enclosure protection needs to be IP65 and environment class A.
- The temperature sensor should be matched pair with Pt1000 type. The measuring range should be -20 to +95 deg C.
- The BTU meter shall provide the following points both at the integral LCD and as outputs to the building control system: Energy Total, Energy Rate, Flow Rate,

Supply Temperature and Return Temperature. Output signals shall have protocol conforming to BACnet/IP, LONWORKS®, MODBUS RTU or MODBUS TCP.

- The entire Energy Measurement System shall be built and calibrated by a single manufacturer, Each Btu meter shall be factory programmed for its specific application.
- The BTU meter system shall consist of a flow meter, two temperature sensors, a Btu meter, temperature thermowells.
- The installation of flow meter and the thermowells of temperature sensors shall be HVAC.

1.5.6 Installation:

System shall be installed by the controls supplier. BACS vendor shall submit their system architecture schematic with necessary cabling/conduiting drawings for this specific project with the data sheets of the individual components that has been taken into account in the design.

1.5.7 Programming, testing and commissioning:

The entire system shall be programmed, tested and commissioned by the BACS vendor using qualified and trained personnel with necessary service tools/software that has been provided by the factory/principal manufacturer. They shall co-ordinate as necessary with the other equipment supplier, wherever 3rd party integrations are required to successfully bring their data to the BACS Workstation.

1.5.8 Training

Necessary training shall be conducted by the BACS contractor and shall utilize IOM manuals, data sheets and as-built drawings and necessary documentation; Operator training shall be carried out for a minimum period of six hours including a site familiarization of the facility, various critical functioning of the BACS, data recovery, transfer & storage, text editing and graphics, review of sequence of operation.

BACS Specifications

Preparation of reports and modifying the same for presentation to management, trouble shooting of various important functions, password control; the training shall be done immediately upon system completion and handing over.

One copy of the draft O & M manual shall be submitted for review that will have all the necessary data sheets and drawings (in A3 sizes) immediately upon the commissioning of the project; copies of O&M manual shall be submitted after review and finalization with all the necessary data sheets of the equipment and components supplied and installed with as-built drawings and commissioning data sheets.

1.5.9 Warranty

All component, system software, parts and assemblies supplied by the BACS contractor shall be guaranteed against defects in materials and workmanship for a period of one year from the owner's acceptance date. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

Labour to troubleshoot, repair, reprogram, or replace system components including all the cost of the components (landed at site) shall be furnished by the BACS contractor at no extra charge at site to the owner during the warranty period.

1.5.10 Drawings:

BACS vendor shall submit working drawings for all their works at site including conduiting, cable layouts, cable schedule and DDC panel details; contractor shall also submit all data

sheets, graphics layout of the screen for approval; Submittal shall be done within a week of the award of contract with all the necessary details like system architecture, conduiting & cable routing, DDC enclosure panel drawings with all necessary wiring terminations etc., necessary co-ordination shall be done along with other vendors for smooth execution of the project.

MODE OF MEASUREMENT

Signal Cable

The cabling running between DDC controller to the field devices shall be termed as signal cabling. This cabling along with conduits shall be payable on per I/O point Basis.

Communication Cable

The cabling running between the system integration units to the DDC controllers shall be defined as communication cable. This cable along with conduits shall also be measured on per I/O point Basis.

LAN Cable

The cable connecting various system integration units to the control station shall be termed as LAN cable. This cable alongwith conduits shall be measurable on unit length Basis.

Q. SIGNAL CABLING & COMMUNICATION CABLING

The signal cable shall be of the following specifications :

a.	Wire	:	Annealed Tinned Copper
b.	Size	:	Minimum 1.5 sq. mm, 7 strands
c.	No. of conductors	:	Two (One pair)
d.	Shielding	:	Overall beld foil Aluminum polyester shield.
e.	Jacket	:	Chrome PVC
f.	Nominal DCR	:	17.6 ohm/km for conductor 57.0 ohm/km for shield
g.	Nominal OD	:	8.5 mm
h.	Nominal capacitance at 1 KHz	:	130 pF/m between conductors 180 pF/m between one conductor and other conductors connected to shield.
i.	Colour	:	Black and Red
j.	Armoured	:	yes

Communication Cable

The communication cable shall be of the following specifications :

a.	Wire	:	Annealed Tinned Copper
b.	Size	:	Minimum 24 AWG stranded
c.	No. of conductors:	:	Two pair (4 conductor)
d.	Shielding	:	Overall beld foil Aluminum polyester shield.
e.	Jacket	:	Chrome PVC
f.	Nominal DCR	:	78.7 ohm/km for conductor 55.8 ohm/km for shield

g.	Nominal OD	:	5.64 mm
h.	Nominal capacitance at 1 KHz	:	131 pF/m between conductors 243 pF/m between one conductor and other conductors connected to shield.
i.	Colour	:	Black and Red, Black and White
j.	Armoured	:	yes

LOCAL AREA NETWORK CABLE

Depending on the type of LAN system being used by the contractor, standard, manufacturer's specification shall apply for CAT 5 / CAT 6 cable.

1. FIRE DETECTION & ALARM SYSTEM

A. GENERAL

This performance specification provides the minimum requirements for the fire detection & alarm system. The system shall include, but not limited to all equipment, materials, labor, documentation and services necessary to furnish and install a complete, operational system to include but not limited to the following operations and controls:

- Smoke and fire detection.
- Sprinkler suppression system monitoring and control.
- Off-premise notification.
- Smoke control.
- Releasing Service
- Two-way voice communication system.

Materials & Equipment

All equipment and components shall be the approved manufacturer's current model. The materials, appliances, equipment and devices shall be listed by a nationally recognized approvals agency like UL864/EN54/VDS for use as part of a protected premises protective signaling (fire alarm) system and smoke control system. The authorized representative of the manufacturer, to be designated as the contractor, shall be responsible for the satisfactory installation of the complete system. The contractor shall provide, from the acceptable manufacturer's current product lines, equipment and components, which comply, with the requirements of these specifications. Equipment or components, which do not provide the performance and features, required by these specifications are not acceptable, regardless of manufacturer. Strict conformance to this specification is required to ensure that the installed and programmed system will function as designed, and will accommodate the future requirements and operations of the building owner. All specified operational features must be met without exception. All equipment and components shall be the manufacturer's current model. The contractor shall be responsible for the satisfactory installation of the complete system. All control panel assemblies and connected field appliances shall be provided by the same system supplier, and shall be designed and tested to ensure that the system operates as specified. The system shall utilize electronically addressable, microprocessor-Based detectors as described in this specification. The equipment to be supplied will be considered only if it meets all sections of the performance specification.

The supplier shall submit a point-by-point statement of compliance for all sections in this specification. The statement of compliance shall consist of a list of all paragraphs within these sections. Where the proposed system complies fully with the paragraph, as written, placing the word "comply" opposite the paragraph number shall indicate such. Where the proposed system does not comply with the paragraph as written, and the supplier feels the proposed system will accomplish the intent of the paragraph, a full description of the function as well as a full narrative description of how its proposal will meet its intent shall be provided. Any submission that does not include a point-by-point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed system does not comply. The Contractor shall furnish all labor, services and materials necessary to furnish and install a complete, functional FIRE DETECTION & ALARM SYSTEM (System). The System shall comply in respects with all pertinent codes, rules, regulations and laws of the Authority, and local jurisdiction. The System shall comply in all respects with the requirements of the specifications, manufacturer's recommendations and UL864/EN54/VDS listings.

It is further intended that upon completion of this work, the Owner/Consultant be provided with:

a. Complete information and drawings describing and depicting the entire system(s) as installed, including all information necessary for maintaining, troubleshooting, and/or expanding the system(s) at a future date.

b. Complete documentation of system(s) testing.

c. Certification that the entire system(s)

CODES & LISTING:

The equipment and installation shall comply with the current and latest edition of the following codes and listing:

A) National Fire Protection Association (NFPA) - USA:

NFPA 13	Sprinkler Systems
NFPA 16	Foam/Water Deluge and Spray Systems
NFPA 17	Dry Chemical Extinguishing Systems
NFPA 17A	Wet Chemical Extinguishing Systems
NFPA 2001	Clean Agent Extinguishing Systems
NFPA 72	National Fire Alarm Code
NFPA 76	Telecommunication Facilities
NFPA 318	Clean Room Applications
NFPA 101	Life Safety Code
NFPA 90A	Air conditioning & ventilation system

Listed

B). Underwriters Laboratories Inc. (UL) - USA:

UL 268 Smoke Detectors for Fire Protective Signaling Systems
UL 864 Control Units for Fire Protective Signaling Systems **9th Edition**

UL 268A Smoke Detectors for Duct Applications
UL 521 Heat Detectors for Fire Protective Signaling Systems
UL 464 Audible Signaling Appliances
UL 38 Manually Actuated Signaling Boxes
UL 346 Water flow Indicators for Fire Protective Signaling Systems
UL 1971 Visual Notification Appliances
UL 228 Door Holders
UL 1481 Power Supply for fire protective signaling system.
UL 1711 Amplifiers for Fire Protective Signaling Systems.
UL 1635 Digital Alarm Communicator System Units

ADDENDUMS thereafter in UL Code for Fire Detection(2007).
UL 9th Schedule Certification
International Standards Organization (ISO)
ISO-9000
ISO-9001
European Union (EU)
EMC Directive 89/336/ EEC
Electromagnetic Compatibility Requirements
EN 54 / VDS

C) LOCAL FIRE NORM **NATIONAL BUILDING CODES IS-2189**

D). European Standards

EN54

E). German Standards

VDS

B. PANEL COMPONENTS & OPERATIONS AND CONTROLS

The control panel(s) shall be a multi-processor Based networked system designed specifically for fire, one-way and two-way emergency audio communications, smoke control, extinguishing agent releasing system if necessitated, with integration modules for BMS or any third party control/annunciation. The

control panel shall be UL/EN 54/VDS listed The control panel shall include all required hardware, software and site specific system programming to provide a complete and operational system. The control panel(s) shall be designed such that interactions between any applications can be configured, and modified . The control panel(s) operational priority shall assure that life safety takes precedence among the activities coordinated by the control panel.

The control panel shall include the following capacities:

- The Control Panel shall have processor redundancy or shall perform all operations and controls through loop cards in case of processor failure including receipt of signals and activation of life safety services associated with loop card.
- Support up to minimum 125 detectors / 125 Devices per Loop
- Support up to minimum 2500 analog/addressable points per panel
- Support network connections up to minimum 64 or other control panels and annunciator.
- Support multiple digital dialers and modems
- Support multiple communication ports and protocols
- Support up to a minimum of 1740 chronological events.

The network of control panels shall include the following features:

- Ability to download all network applications and firmware from the configuration computer from a single location on the system.
- Addressing of detectors and devices by means of electronic way / dip switches / rotatory switches.

- Provide an operator interface control/display that shall annunciate, command and control system operations and controls.

- Provide an internal audible signal with different programmable patters to distinguish between alarm, supervisory, trouble and monitor conditions.

- Provide a discreet system control switch provided for reset, alarm silence, panel silence, drill switch, previous message switch, next message switch and details switch.

- Provide system reports that provide detailed description of the status of system parameters for corrective action or for preventative maintenance programs. Reports shall be displayed by the operator interface or capable of being printed on a printer.

The control panel shall contain a standby power supply that automatically supplies electrical energy to the system upon primary power supply failure. The system shall include a charging circuit to automatically maintain the electrical charge of the battery.

Operator's Interface

The system shall be designed and equipped to receive, monitor, and annunciate signals from devices and circuits installed throughout the building. Standard LED annunciator may be combined in common enclosures provided that the groups of LED's comprising each of the required annunciator are separated from one another (Detection, Supervisory, Status, and Security) and clearly labeled. A minimum 120-character LCD display shall be part of the main control panel for easy alarm reading and understanding. Receipt of alarm, trouble, and supervisory signals shall activate integral audible devices at the control panel(s) and at each remote annunciation device. The integral audible devices shall produce a sound output upon activation of not less than 65 dB (A) and not more than 105 dB (A) when measured at distance of 1.5 meters.

The annunciator shall contain the following system status indicators:

- LCD character Backlit Liquid Crystal Display
- System Normal Indicator
- System Common Alarm Indicator
- System Common Trouble Indicator
- System Common Supervisory Indicator
- System Ground Fault Indicator
- System Common Security Indicator
- System Disabled Point(s) Indicator
- System Reset Switch with Indicator
- System Alarm Silence Switch with Indicator
- System Trouble Silence Switch with Indicator
- System Message Queue Scroll Switches.
- Digit Keypad to Enable/Disable System and Operations and controls.

Audio

The system shall be capable of delivering multi-channel audio messages simultaneously over copper and/or fiber media. All audio messages and live pages shall originate at the one-way audio control unit. The one-way audio control unit shall store pre-recorded audio messages digitally. These messages shall be automatically directed to various areas in a facility under program control. The system shall support remote cabinets with zoned amplifiers to receive, amplify and send messages through speakers over supervised circuits. The one-way emergency audio control shall provide control switches to direct paging messages as follows:

"All Call" to direct the page messages to all areas in the facility, overriding all other messages and tones.

"Page to Evacuation Area" to direct the message to the evacuation area(s), overriding all other messages and tones.

"Page to Alert Area" to direct page messages to the area(s) receiving the alert message and tones, overriding all other messages and tones..

"Page to Balance Building" to direct page messages to the areas) in the facility NOT receiving either the evacuation area or alert area messages.

"Page by Phone" switch to select the firefighters telephone system as the source for paging.

The system shall be capable of delivering multiple audio messages simultaneously over copper and / or fiber media. All audio messages and live pages shall originate at the one-way emergency audio control unit. The one-way emergency audio control unit shall store pre-recorded audio messages digitally. These messages shall automatically direct to various areas in a facility under program control. The system shall support remote panels with zoned amplifiers to receive, amplify and distribute messages through speakers over supervised circuits. The two-way voice communications control unit shall provide two-way communications between remotely located phones and the command center. The control unit shall provide the ability to individually select and display each two-way voice communication circuit support up to five (5) remote telephones in simultaneous two-way voice communications.

Audio Amplifiers (Multi-Channel)

Provide as minimum one twenty (20) watt (Maximum capacity should be decided as per site requirement). audio amplifier per paging zone. The system software shall be capable of selecting the required audio source signal for amplification. . Audio amplifiers shall be power limited and protected from short circuits conditions on the audio circuit wiring. Each amplifier output shall include a dedicated, selectable 25/70 Vrms output. Provide a standby audio amplifier that will automatically sense the failure of a primary amplifier, and replace the function of the failed amplifier.

DACT Dialer

The system shall provide off premise communications capability using a digital alarm communications transmitter (DACT) for sending system events to multiple central monitoring station (CMS) receivers. The system shall provide the CMS(s) with point identification of system events using Contact ID or SIA DCS protocols. In the event of a panel CPU failure during a fire alarm condition, the DACT degrade mode shall transmit a general fire alarm signal to the CMS.

Power Supply

System power supply(s) shall provide multiple powers limited 24 VDC output circuits as required by the panel. Upon failure of normal (AC) power, the affected portion(s) of the system shall automatically switch over to secondary power without losing any system operations and controls. Each system power supply shall be individually supervised. Power supply trouble signals shall identify the specific supply and the nature of the trouble condition.

All standby batteries shall be continuously monitored by the power supply. Low battery and disconnection of battery power supply conditions shall immediately annunciated as battery trouble and identify the specific power supply affected. All system power supplies shall be capable of recharging their associated batteries, from a fully discharged condition to a capacity sufficient to allow the system to perform consistent with the requirements of this section, in 48 hours maximum.

All AC power connections shall be to the building's designated emergency electrical power circuit and shall meet the requirements of NFPA 72 - The AC power circuit shall be installed in raceway. The power circuit disconnect means shall be clearly labeled FIRE ALARM CIRCUIT CONTROL and shall have a red marking. The location of the circuit disconnect shall be labeled permanently inside the each control panel the disconnect serves.

Power supply for all input & output devices to be driven from main Fire Alarm Panel.

Reports

The system shall provide the operator with system reports that give detailed description of the status of system parameters for corrective action, or for preventative maintenance programs. The system shall provide these reports via the main LCD, and shall be capable of being printed on any system printer.

The system shall provide a report that gives a sensitivity listing of all detectors that have less than 75% environmental compensation remaining. The system shall provide a report that provides a sensitivity (% Obscuration per foot) listing of any particular detector.

The system shall provide a report that gives a listing of the sensitivity of all of the detectors on any given panel in the system, or any given analog/addressable device loop within any given panel.

The system shall provide a report that gives a chronological listing of up to the last 1740 system events.

The system shall provide a listing of all of the firmware revision listings for all of the installed network components in the system.

Graphic Command Workstation

The command center shall function as the center point for all operational and administration operations and controls required for the systems provided within the specification. The command center shall contain a console that will display and house any equipment necessary for system operation. Console space shall be provided for other equipment provided under other sections of the specifications. A single graphical workstation shall be provided that will enable primary control of the systems provided by this specification. An operator shall not have to operate multiple workstations to receive, view, process and record system events for each system provided. The graphical command workstation(s) shall display a different color text for each message type and color graphic diagrams/floor plans. Each detector has to be mapped in graphical workstation diagrams/floor plans. The graphical workstation diagrams/floor plans should have the each detector mapped. The graphical command workstation shall simultaneously display the following system event views; system event display, graphical diagram display, detailed event message/instructions, and user event log. The workstation shall be an latest

personal computer which can support the all software& have enough memory to handle the data. The makes will be as per attached list. The workstation(s) shall be capable of annunciation and control of all fire detection and smoke control points. The computer shall be minimum of an Pentium Grade Pentium Processor 2.4 Ghz or higher with a 533Mhz front side bus or higher, 512 MB RAM or higher, 320 GB Hard Drive, and 21" LCD monitor. Installation of the computer or monitor can be either desktop or floor mounting or rack/panel mounting.

The workstation (software) shall be capable of storing over 100,000 network events in a history file. The history buffer allows the operator to view events in a chronological order. A filter shall be available for displaying chronological events by operator, date, time, fire alarms, troubles (including security, supervisory and system/device), disabled points/zones, system programming, operator response and operator log in/log out.

The software shall include the ability to display system information in a graphical (floor plan) form. Each view, created using standard Windows bitmap files, shall include icons created for intelligent devices. These icons shall blink and change to the appropriate programmed icon when an event occurs. When the device has been acknowledged, the icon shall become steady. Once the point has returned to normal, the normal icon is displayed. In addition to the graphical representation of the device, the user shall be able to link pictures, documents and sound files to the device.

The software shall have a flexible way of assigning operator passwords. There shall be an unlimited number of possible operators, each with specific levels of control. Each operator shall have his/her own password. Operator password and control selection shall be available to a high level "administrator" who shall have complete control over levels of control.

The software shall provide multitasking type environment that allows the user to run several applications simultaneously. The operating program shall run within a 32-bit operating system such as Windows® XP or equivalent. These Windows applications shall run simultaneously with other programs. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel and other Windows Based software packages, while concurrently annunciating on-line alarms and monitoring operations and controls.

Equipment included in the command center shall include:

- System annunciation and controls for.
- Fire detection.
- Fire suppression.
- Fire pump status
- Firefighters smoke control.
- Emergency one-way voice communications.
- Standby generator status indication and controls.
- Automatic transfer switch status indication and controls
- Radio communications
- Public intercom
- Public telephone
- Elevator monitor, status and controls

The graphic display screen shall organize and structure system events for easy user comprehension. The workstation display shall use four relational quadrants. When any event occurs:

The "list of events area" shall display the address of the alarm or off-normal point with type and description and time of the event in a prioritized color-coded event list. Highlighting an event in the event list area shall automatically cause the display of a graphical map and other three areas (described below) to display information relating to the highlighted event. The "map area" shall display color graphical representation of the area location in which the alarm or off-normal device is located. It shall be possible for the operator to manually zoom down to any portion of a vector-Based graphic without aliasing, artifacting, or pixilation of the image. Preset zoom levels shall not be considered equal. The "event action area" shall display a customized set of written operator instructions for every state (alarm, trouble, restore, etc.) of each point. An event log shall record all events and operator actions to history

for future review. An operator's log shall record operator's comments for each event in system history with time and date. The "image area" shall display a stored image of the device relating to the event highlighted in the event list area.

When processing fire alarm events the graphic workstation:

- Shall be capable of acknowledging, silencing, and resetting all fire alarm operations and controls.

- Shall be capable of manually activating, deactivating, enabling, and disabling individual fire alarm points.

- Shall be capable of generating status, maintenance and sensitivity reports for fire alarm components.

- Receipt of a fire alarm shall activate an audio WAV file over the workstation speakers alerting the operator

Field Mounted System Components

Intelligent Detectors:

General

The smoke detector shall have inbuilt microprocessor and shall be capable of taking an independent alarm decision. Minimum to 250 intelligent smoke detectors should connect to one loop. Each intelligent addressable smoke detector's sensitivity shall be capable of being programmed electronically from Control Panel without any extra tools as most sensitive, more sensitive, normal, less sensitive or least sensitive. In addition to the five sensitivity levels the detector shall provide a pre-alarm sensitivity setting, which shall be settable in 5% increments of the detector's alarm sensitivity value. The detector should continue to give TRUE alarms even if the loop controller on the main panel fails.

Each detector shall incorporate indicator “LED” at the detector which shall blink during normal condition and light up on actuation of the detector to locate the detector which is operated. The detector shall not be affected by the failure of the response indicator lamp. The LED shall be give 360 degree view from all possible points.

The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

An alternate alarm sensitivity level shall be provided for each detector, which can be set to any of the five (5) sensitivity settings manually or automatically using a time of day event. In addition to the five alternate sensitivity levels the detector shall provide an alternate pre-alarm sensitivity setting, which shall be settable in 5% increments of the detector's alternate alarm sensitivity value The detector shall be able to differentiate between a long drift above the pre-alarm threshold and FDAt rise above the threshold.

The detector's sensing element reference point shall automatically adjust, compensating for background environmental conditions such as dust, temperature, and pressure. Periodically, the sensing element real-time analog value shall be compared against its reference value. The detector shall provide a maintenance alert signal that 75% to 99% compensation has been used. The detector shall provide a dirty fault signal that 100% or greater compensation has been used.

The system shall allow for changing of detector types for service replacement purposes without the need to reprogram the system. The replacement detector type shall automatically continue to operate with the same programmed sensitivity levels and operations and controls as the detector it replaced. System shall display an off-normal condition until the proper detector type has been installed or change in the application program profile has been made.

Multi Criteria Detector:

The multi-sensor or multi-tech smoke detector which will have both photoelectric as well as thermal detection elements shall have inbuilt microprocessor, and shall be capable of taking an independent alarm decision. The scattering of smoke particles shall activate the photo sensor. Each intelligent addressable smoke detector's sensitivity shall be capable of being programmed electronically from Control Panel without any extra tools as: most sensitive, more sensitive, normal, less sensitive or least sensitive. In addition to the five sensitivity levels the detector shall provide a pre-alarm sensitivity setting, which shall be settable in 5% increments of the detector's alarm sensitivity value. The detector should continue to give TRUE alarms even if the loop controller on the main panel fails.. Alarm condition shall be Based upon the combined input from the photoelectric, and thermal detection elements. Each detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient "environmental thresholds approximately six times an hour.. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 75% and 100% of the allowable environmental compensation value. The sensitivity range shall be 1-4% per feet. The detector shall be capable of work in Heat only alarm mode and ignore smoke alarm when given a command from control panel. The detector shall support the use of a relay, or LED remote indicator.

4D/Laser Photo Detector.

The 4D/Laser/equivalent detector shall have the ability to have the sensitivity of 0.08 OBS / FTor better. The detector shall have inbuilt microprocessor and shall be capable of taking an independent alarm decision. The intelligent 4D / laser photo smoke detector shall be spot type detector that incorporates extremely bright laser diode, combined with special lens and mirror optic that focuses the light beam to a very small volume near a receiving photo sensor. The tightly focused light beam, combined with intelligent sensing algorithms, allows the system to differentiate between dust and smoke particles, rejecting false signals caused by larger airborne particles such as dust, lint and small insects. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 75% and 100% of the allowable environmental compensation value. The laser photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required. The laser photo detector shall include two bicolor LEDs that flash green in normal operation and turn on steady red in alarm.

INTELLEGENT THERMAL DETECTOR:

The heat detector shall have a thermal sensing element /circuit. The detector shall have inbuilt microprocessor, not microcontroller and shall be capable of taking an independent alarm decision. Detectors shall be rated at 15°F (9°C) per minute rate-of-rise and 135°F (57°C) fixed temperature The detector shall be capable of being addressed electronically from control panel without any extra tool. The choice of alarm reporting as a fixed temperature detector or a combination of fixed and rate-of-rise shall be made in system software and be changeable at any time without the necessity of hardware replacement.

ADRESSABLE BEAM DETECTOR:

The addressable optical beam detector or projected beam smoke detector shall be used for detection in large volumes and double heights. The set shall consist of a transmitter, receiver and control

electronics. The transmitter shall project a modulated infrared light beam to the receiver. If there is smoke in the beam path, the receivers signal shall be reduced by the value proportional to the density of the smoke. If the signal is reduced to a level between the obscuration threshold and 93% for 8-10 seconds, the fire alarm relay shall be activated. The alarm obscuration threshold shall be set at 25%, 35% or 50% obscuration depending on the application. The typical coverage shall be equal or more than 100 m x 15.25 m.

INTELLEGENT DUCT SMOKE DETECTOR

The Smoke Detector housing shall accommodate intelligent photoelectric detector.

The housing shall also protect the measuring chamber from damage and insects. The housing shall utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to ten feet. Drilling templates and gaskets to facilitate locating and mounting the housing shall also be provided. The housing shall be finished in baked red enamel. Remote alarm LED indicators and remote test stations shall be provided.

When sufficient smoke is sensed, an alarm signal to be initiated and appropriate action taken to change over air handling system to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The detector assembly shall be suitable for working in air velocity range of 150 to 1200 mtrs / min.

SMOKE DETECTOR – PHOTOELECTRIC

The detectors shall be use the photo electric (light scattering) principal to measure smoke density. Provide analog/addressable photoelectric smoke detectors at the locations shown on the drawings. The detector shall have the ability to set the sensitivity and alarm verification of each of the individual detectors on the circuit. It shall be possible to automatically change the sensitivity of individual analog/addressable detectors for the day and night periods. Each smoke detector shall be capable of transmitting pre-alarm and alarm signals in addition to the normal, trouble and need cleaning information. It shall be possible to program control panel activity to each level. Each smoke detector may be individually programmed to operate at any one of five (5) sensitivity settings. Each detector microprocessor shall contain an environmental compensation algorithm that identifies and sets ambient environmental thresholds approximately six times an hour. The microprocessor shall monitor the environmental compensation value and alert the system operator when the detector approaches 75% and 100% of the allowable environmental compensation value.

Detector Bases:

The Bases shall be easy to install and mount and shall be of standard type or isolator Base type or sounder Base type. The sounder Base shall be used where local or group alarm signaling is required. The sounder Base emits an audible alarm when there is fire. The Base shall, contain no electronics and support all series detector types.

C. MANUAL STATIONS

The fire alarm station shall be of polycarbonate construction and incorporate an internal toggle switch. A locked test feature shall be provided. The station shall be finished in red with silver "PULL IN CASE OF FIRE" lettering. The addressable MCP shall be double action type and use a key operated test-reset lock which shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

Speakers

Low Profile Speaker

The low profile speaker shall not extend more than (2.5cm) past the finished wall surface, and provide a switch selectable audible output of 2W (90dBA), 1W (87dBA), 1/2W (84dBA), or 1/4W (81dBA) at 10 ft. Wattage setting shall be visible with the cover installed. When the cover is installed, no mounting hardware shall be visible. In and out screw terminals shall be provided for all wiring.

Speaker-Strobes

Low Profile Addressable Speaker-Strobe
The low profile speaker/strobe shall not extend more than (2.5cm) past the finished wall surface, and provide a switch selectable audible output of 2W (90dBA), 1W (87dBA), 1/2W (84dBA), or 1/4W (81dBA) at 10 ft

Strobes shall provide flash output that shall be switch selectable for output values of 15cd, 30cd, 75cd & 110cd. Wattage and candela settings shall be visible with the cover installed. When the cover is installed, no mounting hardware shall be visible. In and out screw terminals shall be provided for all wiring.

Programmable Electronic Exit Point Addressable Directional Sounders/Hooters:

Electronic sounders shall operate on 24 VDC nominal. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 90 dB(A) measured at 10 feet from the device and shall be flush or surface mounted as shown on plans. Theyshall produce broad band directional sound to guide occupants to safe exists even in complete darkness. It shall consist of inbuilt amplifier which will produce a sound consisting of Low-Mid-High range of sounds in particular pattern. The noise pattern shall be such that it will be possible for occupants to find out from where the sound is coming.Equivalent alternate type will be also acceptable

Horns

Explosion proof - Class I

The horns shall provide 109 dBA output, and be polarized for supervised operation. The horns shall be UL /VDS/ EN 54 listed for Class I Division 1 and 2, Groups B, C, D hazardous locations.

Explosion proof - Class I, II, III

The horns shall provide 109 dBA output, and be polarized for supervised operation. The horns shall be UL /VDS/ EN 54 listed for Class I Division 1 and 2, Groups C, D; Class II Division 1 and 2, Groups E, F, G; Class III Division 1 and 2 hazardous locations.

Vibrating Bell-Explosion proof

The bells shall provide 83 dBA output and be polarized for supervised operation. The bells shall be UL listed for Class I Groups B, C, D; Class II Groups E, F, G; Class III Division 1 and 2 hazardous locations.

Intelligent Modules

The personality of multifunction modules shall be programmable at site to suit conditions and may be changed at any time using a personality code downloaded from the Analog Loop Controller. The modules shall have a minimum of 2 diagnostic LEDs mounted behind a finished cover plate. A green LED shall flash to confirm communication with the loop controller. A red LED shall flash to display alarm status. The module shall be capable of storing up to 24 diagnostic codes, which can be retrieved for troubleshooting assistance. Input and output circuit wiring shall be supervised for open and ground faults.

Control Relay Module:

The Control Relay Module shall provide one form "C" dry relay contact rated at 2 amps @ 24 Vdc to control external appliances or equipment shutdown. The control relay shall be rated for pilot duty and releasing systems. The position of the relay contact shall be confirmed by the system firmware.

If any external relay or contact required for any remote tripping is in vendor scope.

Dual Input Module:

The Dual Input Module shall provide two (2) supervised Class B input circuits each capable of a minimum of 4 personalities, each with a distinct operation. The dual input module shall support the following circuit types:

- Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
- Normally-Open Alarm Delayed Latching (Water flow Switches)
- Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
- Normally-Open Active Latching (Supervisory, Tamper Switches)

Dual Input Signal Module:

The Dual Input (Dual Riser Select) Signal Module shall provide a means to selectively connect one of two (2) signaling circuit power risers to one (1) supervised output circuit. The dual input signal module shall support the following operation:

Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25 Vrms @ 50w or 70 Vrms @ 35w of Audio)

Isolator Module:

Provide intelligent fault isolators modules. The Isolator Module shall be capable of isolating a fault from a class A data circuit while allowing the remaining data loop to continue operating. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC loop segment or branch. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section. The isolator module shall not require address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

Monitor Module:

The Monitor Module shall be factory set to support one (1) supervised Class B Normally-Open Active Non-Latching Monitor circuit.

Single Input Module:

The Single Input Module shall provide one (1) supervised Class B input circuit capable of a minimum of 4 personalities, each with a distinct operation. . The single input module shall support the following circuit types:

- Normally-Open Alarm Latching (Manual Stations, Heat Detectors, etc.)
- Normally-Open Alarm Delayed Latching (Water flow Switches)
- Normally-Open Active Non-Latching (Monitor, Fans, Dampers, Doors, etc.)
- Normally-Open Active Latching (Supervisory, Tamper Switches)

Single Input Signal Module :

The Single Input (Single Riser Select) Signal Module shall provide one (1) supervised Class B output circuit capable of a minimum of 2 personalities, each with a distinct operation. When selected as a telephone power selector, the module shall be capable of generating its own "ring tone". The single

input signal module shall support the following operations:

- Audible/Visible Signal Power Selector (Polarized 24 Vdc @ 2A, 25Vrms @50w or 70 Vrms @ 35 Watts of Audio)
- Telephone Power Selector with Ring Tone (Fire Fighter's Telephone)

Waterflow-Tamper Module:

The Waterflow/Tamper Module shall be factory set to support two (2) supervised Class B input circuits. Channel A shall support a Normally-Open Alarm Delayed Latching Water flow Switch circuit. Channel B shall support a Normally-Open Active Latching Tamper Switch.

Telephone Handsets

The contractor shall Provide firefighter's telephone handsets for use with the firefighter's telephone jack stations. The telephone handsets shall be red in color and have a 5 ft (1.3m) coiled cord.

Addressable Telephone Jacks

The contractor shall provide stainless steel firefighter's telephone jack stations at the locations shown on the drawings. The jack station shall be clearly identified with the words "FIRE FIGHTER'S TELEPHONE" for use with portable fire fighter telephone handsets.

Power Supply

Standby power supply shall be an electrical battery with capacity to operate the system under maximum supervisory load for 48 hours and capable of operating the system for thirty (30) minutes of evacuation alarm on all devices, operating at maximum load. The system shall include a charging circuit to automatically maintain the electrical charge of the battery. The system shall automatically adjust the charging of the battery to compensate for temperature.

Sequence of Operations

General – Audio (Fire Condition)

Upon alarm activation of any area smoke detector, heat detector, manual pull station, sprinkler water flow, the following operations and controls shall automatically occur:

The internal audible device shall sound at the control panel or command center.

Display the alarm event on the graphical workstation. The LCD Display shall indicate all applicable information associated with the alarm condition including: zone, device type, device location and time/date. All system activity/events shall be documented on the system printer. Any remote or local annunciator LCD/LED's associated with the alarm zone shall be illuminated.

The following audio messages and actions shall occur simultaneously:

An evacuation message shall be displayed in risk area and adjacent zones as per cause & Effect Matrix, approved by consultant / client. The intent of message is to advise occupants hearing this message that they are near danger and should leave the building via the stairs (nearest exit) immediately.

Activate visual strobes on the fire floors (zones) immediately above and below (adjacent to) the fire floor (zone), as per approved cause & effect matrix. The visual strobe shall continue to flash until the system has been reset. The visual strobe shall not stop operating when the "Alarm Silence" is pressed. An alert message shall be sounded on the remainder of building. It is the intent of this message to advise occupants to prepare for evacuation if necessary. An instructional message shall be sounded in the stairwells instructing occupants to move carefully and quickly down the stairs to exit the building and to exit to a safe floor if you encounter smoke in the stairwell.

An instructional message shall be sounded in the elevator cabs. It is the intent of this message to advise elevator occupants that an emergency exists, the elevator has been directed to the ground floor, and that occupants should quickly exit the building. An instructional message shall be sounded in the lobby. It is the intent of this message to advise lobby occupants to leave the lobby and clear the area for arriving firefighters. An instructional message shall be sounded in the concourses connected to the building's lobby. It is the intent of this message to prevent new entries into the lobby by advising occupants not to attempt to enter the lobby of the affected building.

Provide selective paging to each individual floor (zone). In addition to the message/channels detailed above, a dedicated page channel shall be capable of simultaneously providing live voice instructions without interrupting any of the messages listed above shall be provided.

Transmit signal to the building Management system.
Transmit signal to the central station with point identification.
Activate automatic smoke control sequences.
All automatic events programmed to the alarm point shall be executed and the associated outputs activated.
All stairwell/exit doors shall unlock throughout the building.
All self-closing fire/smoke doors held open shall be released.
Direct the closed circuit TV cameras to the alarm event and start video recording

The system shall be double knock alarm system. The system shall provide default time to allow investigation to be undertaken. The default time shall be adjustable. The default time shall be overridden in case of activation of second device. There shall be no provision for investigation on actuation of manual call point and system shall go directly in alarm mode, when MCP is activated.

In Fire alarm and detection system BOQ, item no 1.12 must be read as Lot instead of nos. and maximum four (4) numbers of Manual call point is to be considered in one lot

The maximum elapsed time between actuation of any initiating device and its indication on FACP shall not be more than 10 seconds.

Supervisory Operation

Upon supervisory activation of any sprinkler valve supervisory switch, fire pump off-normal, clean agent fire suppression system trouble, the following operations and controls shall automatically occur:

Visible and audible indication of self-restoring supervisory signals and visible indication to their restoration to normal shall be automatically indicated within 90 seconds.

The internal audible device shall sound at the control panel or command center.
Display the event on the graphical workstation and display a pictorial image.

The LCD display shall indicate all applicable information associated with the supervisory condition including; zone, device type, device location and time/date. All system activity/events shall be documented on the system printer.

Any remote or local annunciator LCD/LED's associated with the supervisory zone shall be illuminated.
Transmit signal to the central station PC with point identification.

Trouble Operation

Upon activation of a trouble condition or signal from any device on the system, the following operations and controls shall automatically occur:

Trouble signal and their restoration to normal shall be indicated with in 200 seconds.

The internal audible device shall sound at the control panel or command center.

Display the event on the graphical workstation and display a pictorial image.

The LCD keypad display shall indicate all applicable information associated with the trouble condition including; zone, device type, device location and time/date. All system activity/events shall be documented on the system printer.

Any remote or local annunciator LCD/LED's associated with the trouble zone shall be illuminated. Transmit signal to the central station PC with point identification.

D. NOTIFICATION APPLIANCE CIRCUITS

All notification appliance circuits shall have a minimum circuit output rating of: 2 amps @ 24 vdc; 50 watts @ 25V audio, and 35 watts @ 70V audio. The notification circuits shall be power limited. Non-power limited circuits are not acceptable

Network Wiring

The system supplied under this specification shall utilize node-to-node, direct-wired multi-priority peer-to-peer network operations. The backbone shall be multi-core wiring or commercial CAT5/6 cable or Single mode, multimode fiber cable depending on application. A Minimum of 64 ten loop panels shall be capable of being networked together and each panel shall have capability of addressing 2000 points .The system shall utilize independently addressed, smoke detectors, heat detectors and input/output modules as described in this specification. The peer-to-peer network shall contain multiple nodes consisting of the command center, main controller, remote control panels, LCD/LED annunciation nodes, and workstations. Each node is an equal, active functional node of the network, which is capable of making all local decisions and generating network tasks to other nodes in the event of node failure or communications failure between a nodes. When a network is wired in a Class B configuration, a single break or short on the network wiring isolates the system into two groups of panels. Each group continues to function as a peer-to-peer network working with their combined data bases. When wired using a Class A configuration, a single break or short on the network wiring causes the system to isolate the fault, and network communication continues uninterrupted, without any loss of function. Should multiple wiring faults occur, the network re-configures into many sub-networks and continues to respond to alarm events from every panel that can transmit and receive network messages The remote control panel/network nodes shall meet the same requirements as described in control panel section and shall contain Common control switches with minimum 120 character LCD display, as required with Integral power supply(s) with secondary stand-by power. It shall also have signaling line circuits for communications with analog/addressable devices, as required, Audio amplification, as required, Notification appliance circuits, as required and Auxiliary function circuits and operations, as required.

The network communication shall be Based on a Local Area Network (LAN). The network shall use a deterministic token-passing method. Collision detection and recovery type protocols are not acceptable substitutes due to life safety requirements. In addition, there shall be no master, polling computer, central file computer, display controller or other central element (weak link) in the network which, on failure, may cause complete loss of network communications or cause major degradation of network capability. There shall be no cascading of CPUs or master-slave relationships at the network level to facilitate network communications. Failure of any node shall not cause failure or communication degradation of any other node or change the network communication protocol among surviving nodes located within distance limitations. Each node/panel shall communicate on the network as per the NFPA response requirement (10 second).

Network Remote Monitoring:

The system shall provide off premise or remote communications capability for transmitting system events to multiple Central Monitoring Station using web servers or Netcom cards on main panel using the open TCP/IP protocol The system shall provide the remote location with point identification of system events.

Submittals

It is the responsibility of the contractor to meet the entire intent and functional performance detailed in

these specifications. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications. The contractor shall submit three (3) complete sets of documentation within 30 calendar days after award of purchase order. Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the contract documents. In addition the Contractor shall provide specific notation on each shop drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation. All drawings and diagrams shall include the contractor's title block, complete with drawing title, contractor's name, address, date including revisions, and preparer's and reviewer's initials

Product Data

Data sheets with the printed logo or trademark of the manufacturer for all equipment. Indicated in the documentation will be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of the Architect/Engineer.

System Calculations

Complete calculations shall be provided which show the electrical load on the following system components:

Each system power supply, including stand alone booster supplies.
Each standby power supply (batteries).
Each notification appliance circuit.
Each auxiliary control circuit that draws power from any system power supply.

Quality Assurance

The contractor shall have successfully installed similar system fire detection, evacuation voice and visual signaling control components on a previous project of comparable size and complexity. The owner reserves the right to reject any control components for which evidence of a successful prior installation performed by the contractor cannot be provided.

The contractor shall have in-house engineering and project management capability consistent with the requirements of this project. Qualified and approved representatives of the system manufacturer shall perform the detailed engineering design of central and remote control equipment. Qualified and approved representatives of the system manufacturer shall produce all panel and equipment drawings and submittals, operating manuals. The contractor is responsible for retaining qualified and approved representative(s) of those system manufacturers specified for detailed system design and documentation, coordination of system installation requirements, and final system testing and commissioning in accordance with these specifications.

Pre-Installation Requirements

The provider shall submit a detailed project plan that will describe in detail how the provider will approach the project, from inception to finalization. The plan must include at a minimum the following information:

Project Staging
Project Management
Equipment Schedules
Installation Time Lines
Other Trade Requirements
Final Acceptance Testing
Personnel Resumes
Progress Report Sample

All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics,

physical equipment sizes, etc. before beginning system installation. Refer to the manufacturers riser/connection diagram and details for all specific system installation/termination/wiring data.

Start and Completion Dates

The starting and completion dates for this work will be established at the pre-bid meeting.

Training

The System Supplier shall schedule and present a minimum of 8 hours of documented formalized instruction for the building owner, detailing the proper operation of the installed System.The instruction shall be presented in an organized and professional manner by a person trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the Installation. The instruction shall cover the schedule of maintenance required by NFPA 72 and any additional maintenance recommended by the system manufacturer.

E. SYSTEM OPERATION – FUNCTIONAL SPECIFICATIONS & PRODUCTS

General: The system shall be integrated into a comprehensive system, to provide the functional performance described as follows:

Fire Detection and Alarm System

The fire detection and alarm system shall monitor and display the activation of each device in the system, such as heat detector, smoke detector, manual break-glass unit, sprinkler water flow switch, sprinkler valve tamper switch, hose reel water flow switch and hose reel valve tamper switch or any other input device which may be required.

The system shall initiate output operations and controls such as automatic alarm annunciation via speakers, fans shutdown, automatic notification to the Fire main control PC and activation of audible hooters/directional sounders/strobes.

The system shall be of the addressable intelligent type, completely supervised, such that a break in any wire (loop) shall not prevent any device from operating. The system shall be of the type such that each device connected to the system shall be provided with unique address and separately identified at the Main control panel (MCP).

The wiring shall be monitored against faults such as opens, shorts, earth's or data transmission failure. Detection addressable loops, capable of handling minimum of 250 addressable points shall return to the control panel.

Emergency Paging And Voice Alarm

The system shall permit communication in the form of paging from the main control panel and telephone switchboard to any floor or group of floors simultaneously. The system shall be capable of manual operation or automatic operation initiated by the FIRE DETECTION & ALARM SYSTEM. Speakers shall be located as required to achieve acceptable audibility in all Communication addressable loops will be supervisedand therefore return to the control panel.

Emergency Telephone

The emergency telephone system shall provide two way communications capability between the main control panel and jacks for emergency telephone handsets. The emergency telephone handsets shall be furnished as part of the overall system.

Scope

The Main control panel shall be located in the main control room now called the Fire Command Centre (FCC) as located in the drawings. The appropriate authorities shall approve the exact location.

A active & networkable remote repeater panel shall also be installed at designated places and shall repeat all alarm operations and controls displayed at the main control panel.

Graphics software shall be loaded on the PC in the FCC and capable of displaying all information graphically. It shall be capable of uploading drawings in the AutoCAD format and pop up alarms or silence them.

Photoelectric type smoke detector shall be with integral microprocessor and shall be capable of taking an independent alarm decision. In case of the failure of the main loop controller the detector shall be capable of operating in standalone mode or degrade mode and continue to take decisions

Heat detectors of the fixed temperature (57 deg.C) type or rate of rise of temperature type shall be used in areas environmentally unsuited for smoke detectors such Kitchens, Valet Laundries, Emergency Generator rooms,

Each fan system shall be provided with a duct-mounted smoke detector, which utilizes full width sensing probes and is suitable for the air velocities to which it is subjected. Duct mounted smoke detectors concealed from view shall be supplied with a remote indicator, located near the location of the hidden detector, appropriately labeled as to the detector's location.

Pull in type manual fire alarm stations shall be located on the occupied side of the door to each exit stair and at intermediate locations as required (Maximum distance between pull stations shall not exceed 60 m). .

Sprinkler, Hose reel water flow switch and valve tamper switch shall be provided at each sprinkler system valve location (the flow and tamper switches shall be generally furnished and mounted by the sprinkler system installer and wired by the fire detection alarm system installer).

Magnetic hold open devices shall be provided where required for the automatic release of smoke / fire doors.

System Operation

The system shall be arranged for categories of alarm inputs and provide output operations and controls appropriate to each of the categories;

Supervisory Monitor input: The following inputs shall be considered supervisory monitoring operations and controls:

a. Sprinkler system shut off valve tamper switch.

b. Hose Reel cabinet tamper switch

c. Removal of a smoke detector from its Base.

d. Fire / Sprinkler pump status (i.e. power available, malfunction).

e. Wiring faults.

Activation of a supervisory monitoring device shall provide the following indications:

a. The Main Control Panel and remote annunciators shall indicate shall indicate an audible and visual "SUPERVISORY" condition. In addition, the "Supervisory alarm" shall be displayed on the graphic display unit for the type of alarm.

b. Printer shall print clear next message on the event log indication the device, which initiated a trouble alarm.

c. An alarm signal shall be automatically sent to the local control room as well as REMOTE control room if designed This may be accomplished by means of an web server /Netcom/ digital dialer.

In case of fire all lift call and door buttons and signals shall become inoperative, lifts serving that floor shall be signaled to immediately return to the ground floor or as designated by the local Fire department and be held for the exclusive use of the Fire Brigade. Should such an alarm occur on the ground floor / designated floor, the lifts shall be signaled to return to an alternate floor which is not in alarm.

Signals shall be sent directly to heating, ventilating and air conditioning fan motor controllers for status monitoring circuits to confirm the operation of the fan systems.

The details of the fan control sequence shall be as follows (in compliance with approved cause & effective matrix):

All fans serving the areas affected by the alarm condition shall shutdown.

Smoke extraction fan system shall have to be started

Stair pressurization fans shall be started.

Signals shall be transmitted to the paging system to display zone in alarm.

The printer shall print a clear text message on the event log printer The printer shall print the device information indicating clearly in plain language which device is in alarm, the time, and the date associated with the alarm. The printer shall print all follow-up information regarding this alarm, such as acknowledge, reset etc.

All access control doors shall be released in case of fire conditionshall allow graphics for more than one floor at a time to be displayed on the screen.

The automatic voice evacuation alarm shall be initiated from the fire detection & alarm system upon activation of an alarm. The alarm shall consist of a “slow whoop” alarm tone for a maximum of fifteen (15) seconds followed by an automatic preselected voice evacuation message. At the end of each message the ‘slow whoop’ shall continue for fifteen (15) seconds followed again by the automatic voice evacuation signal. This sequence of alarm shall sound until the signal silence switch is operated at the main fire alarm control panel or the fire alarm has been reset as described previously. The voice evacuation signal shall be distinct, authoritative without any inflection and shall be repeated in several languages as agreed with the fire brigade.

The alert tone shall consist of an introductory pulse tone for fifteen (15) seconds followed by an alert message to advise that this floor is not in alarm but the floors that are in alarm shall be stated. The message shall also state that the occupants shall be prepared to evacuate the building when the evacuation alarm is given. The alert tone shall be distinctly different from that of the evacuation alarm.

Each stairwell shall receive a voice message without a fire alarm tone. The message shall state that there is an emergency in the building anyone presently in the stairwell shall not re-enter any floors but should proceed immediately to the ground floor exit level. Zone circuits shall be designed for this activity

During the automatic transmission of the fire alarm and alert tones, it shall be possible at the main fire alarm panel to permit selective voice paging. Upon activation of manual controls switches and the microphone push-to-talk switch, it shall be possible to transmit a message to the selected areas. The activation of any such switches and microphone switch shall initiate the “slow whoop’ alarm tone for fifteen (15) seconds followed by an announcement or message. The message shall follow the ‘slow whoop and the person making the announcement be cued when to start the announcement by a red

indicator located adjacent to the microphone. When the microphone button is released, the “slow whoop’ shall sound for fifteen (15) seconds, after which the system shall return to the automatic voice evacuation or alert mode until reset as mentioned above.

It shall be possible to load a variety of prerecorded message plus combinations of floor fire alarms prerecorded message, which shall all be selected by the system software. Amendments to the prerecorded message and any reprogramming of the operating system shall be accomplished by front panel operated push buttons, selector switches and a keypad.

It shall be possible to transmit an alarm tone to speakers in one zone while sending a voice message to another zone while the rest of the building is receiving alert tone, all at the same time.

Each speaker zone (with dual circuits) shall be connected to its own amplifier. It shall therefore be possible to have as many channels as there are speaker zone. A minimum of three (3) channels shall be supplied; an ALERT channel, an EVAC channel and a PAGE channel.

Zoning of speaker circuit shall be as indicated in the drawings.
Each level should have minimum two zone. One for common areas and one for other area.

The emergency evacuation and voice alarm system amplification equipment shall be sized to accommodate the total quantity of speakers for each channel (total of three) plus 25% spare reserve capacity in each channel.

The system shall be provided with redundant amplifiers arrange in such a manner that failure of an amplifier shall not result in loss of acceptable audibility in any area of the building.

Emergency Telephone System: All remote emergency telephones will communicate with the emergency telephone control panel at the main control room:

The insertion of any telephone handset into its jack will cause the appropriate phone location indicator to flash and a distinctive audible pulsing sound to be heard in the fire command centre. The subsequent picking-up of the master phone and operation of that phone selector switch will silence the pulsing tone, cause the phone location.

The emergency telephone system will provide the capacity to handle simultaneous use of multiple remote phones (minimum five). All phone jacks will be annunciated and monitored against fault or tampering (i.e. supervised).

The removal of all remote telephone handsets from their jacks will cause the restoration of all normal supervisory operations and controls. If any remote phone is not removed, then the appropriate phone zone indicator will flash and the pulsing tone will resume in the fire command centre.

Co-ordinationwith Other Systems

The fire detection and alarms system shall have interface with other building systems, which are described under other sections of the report, as follows:

Heating, Ventilating and Air Conditioning (HVAC)

Building Management System (BMS)

Sprinkler / Pumps system

The life safety system is required to monitor fire hydrant / sprinkler pump status. The pump controllers shall have the necessary volt free output signals available.

Cables

Cabling for FIRE DETECTION & ALARM SYSTEM shall be FRLS armoured / un-armoured . Un-armoured cables should be laid thru metal conduits. Unarmored cables will be confirm by consultant /

client. All wiring for FIRE DETECTION & ALARM SYSTEM shall be copper conductor armored and/or un-armored cable of 600/1000V (for armored) and 300/500V (for un-armored). The armored cable shall be in compliance with BS: 7846 (latest edition) and un-armored cable shall be in compliance with BS: 7629-1(latest edition).

The cable (armored / unarmored) should meet enhanced Fire resistance/survival test as per clause of BS 5839-1(26.2e) for Enhanced Fire Resisting cables when tested in accordance to BS 8434-2

The cables used shall be exclusively for Fire Detection System. The multi-core cables shall not be shared for other low voltage or high voltage circuits.

The cables connected to detectors shall be given S –loop on both the sides of the detectors which shall be properly clamped to the ceiling. Loop shall also be left where cables connects sounders, panels, dampers etc. Appropriate glands shall be provided where the cables enters the junction box.

Cables shall be laid by skilled and experienced workmen. Care shall be taken while laying cables to avoid kinks. At all the changes in direction (vertical and horizontal planes) the cables shall be bent smooth with a radius as recommended by the manufacturers.

No joints shall be allowed between two points. The sleeve at joints shall be shaved off like a pencil and shall not be cut square to avoid cutting of conductors.

Cabling scope shall be supply and laying of cables of core sizes minimum size 2 core x 1.5 sq mm copper conductor FRLS Cables. Depends on the length of the loop, contractor has to select the core sizes. However the core sizes should not be less than 1.5 Sq.mm dia.

All cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system. Loop wiring shall be of 1.5 sq mm 500 Volts.

All initiating, and supervisory circuit wiring shall be not less than $1.5mm^2$ (500V for un-armored and 1100V for armored).

FIRE DETECTION & ALARM SYSTEM and PA speaker cables should not have the same color code. Both should have separate colors to identify easily.

All field wiring shall be completely supervised. No cables more than two nos. should be saddled directly in to wall /ceiling. Contractor should use cable tray/trunking for wherever more than two cables are to be layed.

All speaker and telephone circuits shall be not less than $2.5mm^2$, 500 / 1100 volts copper conductor FRLS cables.

Cabling shall be completely installed, field connections made and tested for stray voltage, short circuits, and ground faults prior to connection to the intelligent modules.

All loop cabling shall be identified by ins and outs. It is defined as coming from the panel.

Red and Black must be used for 24 VDC panel power circuit. Audio visual indicating circuits shall be colour coded. Colour code shall not be duplicated in the same panel.

No voltage supply from any other source than the primary power 230 VAC and the panel 24 VDC power supply shall be utilized.

Intelligent loop circuits shall be labeled at all junction locations by the panel number and loop number.

Intelligent loop circuits shall be provided with adequate junction boxes be expandable and provide a means for connecting to the loop in the junction box.

Control and other panels shall be mounted with sufficient clearance for observation and testing. Fire alarm junction boxes shall be clearly marked for distinct identification..

All fire alarm junction boxes should be mounted in approved locations for ease of maintenance from floor level.

All junction boxes shall be made up in a uniformly and orderly manner.

Fire Alarm Control Panels and GA (GRPAHICS node) – OPERATIONAL SPECS

Each network FIRE ALARM CONTROL PANLEL now called FACP shall contain a microprocessor-Based central processing unit (CPU). The FACP shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, local and remote operator terminals, printers, annunciators, emergency voice communication systems, public address system, building management system, and other system controlled devices. The FIRE DETECTION & ALARM SYSTEM shall include all required hardware and system programming to provide a complete and operational system, capable of providing the protected premises with the following operations and controls.

Modular systems manufacture with a layered application concept, including an “operational layer” and a “human interface layer”, to allow maximum flexibility at the system with a minimum physical size requirement.

All system operational software is to be stored in FLASH memory.

System response to any alarm condition must occur within 3 seconds, regardless of the size and the complexity of the installed system.

Each FACP on the network shall perform the following operations and controls:

Supervise and monitor all intelligent/addressable detectors and modules connected to the system for normal, trouble and alarm conditions.

Supervise all initiating signaling and notification circuits throughout the facility. Voice evacuation speakers to be monitored by the public address system.

Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.

Visually and audibly annunciate any trouble, supervisory or alarm, condition on operator's terminal, panel display, and annunciators.

Visually display sprinkler valve and water flow detectors.

Visually display status of emergency power.

Shall have controls for unlocking stairway doors.

Graphically display all zones.

Trouble alarm for public address system.

Trouble Alarm for Building Management System.

System status LEDs for Test status, CPU Fail status, Ground Fault status, Disable status

Common control switches for reset, Alarm silence, panel silence, drill silence.

Other operator control switches such as previous message switch. Next message switch, and more details switch.

Each FACP node shall include a full featured operator interface control and annunciation panel which shall include individual, colour coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.

All programming or editing of the existing programming in the system shall be achieved without special equipment or interrupting the alarm monitoring operations and controls of the fire alarm control panel.

Each FACP node shall be capable of providing the following features:

Block Acknowledge for Trouble Conditions

Rate Charger Control

Control-By-Time (Delay, Pulse, time of day, etc.)

Automatic Day/Night Sensitivity Adjust (high/low)

Environmental Drift Compensation (selectable ON or OFF)

Smoke Detector Pre-alarm Indication at Control Panel

NFPA 72 Smoke Detector Sensitivity Test

System Status Reports

Alarm Verification, by device, with tally

Multiple Printer Interface

Multiple CRT Display Interface

Non-Fire Alarm Module Reporting

Automatic NFPA 72 Detector Test

Programmable Trouble Reminder

Upload/Download System Data base to PC Computer

One-Man Walk Test

Smoke Detector Maintenance Alert

Security Monitor Points

Alpha-numeric Pager Interface

On-line or Off-line programming

Interface with security system, Building Management System public address system.

Ground fault detection.

Fire Alarm Central Processing Unit

"The proposed fire detection & alarm system shall be from a single UL listed manufacturer for complete compatibility of the proposed large peer-to-peer networked system. Master-Slave network will not be acceptable. Each occupant shall have its own Fire Alarm Control Panel as a Node in the Network complete with its own Network Control Annunciator, Web Server, Graphics Control Station and BACnet Gateway for integration with the individual Occupants Building Management System.

The fire detection & alarm system for the areas which Occupants share with other Occupants due to the lack of Fire Compartmentalization in the common area shall be controlled by the Network Control By Event Equations, as this area is treated as a Life Safety Risk by all the Occupants. When the fire is sensed by any one Node in the Network for the Shared Area shall be annunciated at the Network Control Annunciator of all the other Occupants. All the Outputs associated with the Fire Alarm Event in the Shared Area shall be actuated / triggered automatically like activation of Pressurization Fans, Fire Dampers to close, Sounder / Strobes to be activated, Ventilation Fans to be run on double speed etc. in the Shared Area, as if the Fire Alarm Event has occurred in all the Nodes which share the Common Area. The Alarmed System for the Shared Area shall only be Controlled and Reset by a separate Network Control Annunciator dedicated for the Shared Area, after due investigation by the authorities concerned."

Peer-to-Peer Fire Alarm Network

Peer-to-Peer Fire Alarm Network is the interface with allows intelligent Fire Alarm Control Panels to form a network. Each local control panel (network node) maintains its own area of protection, while monitoring and controlling other areas (other network nodes).

Local information shall be displayed at each network node. In areas such as a security office, where the entire network must be monitored, network annunciators shall be required.

NCS Network Control Station

The NCS shall Based on a UL 864 recognized computer. Special hardware and software are to be added by manufacturer to make the NCS operate as a Command Center.

Network Graphics Control Station

The Network Control Station (NCS) is a high performance desktop computer with text and color graphics display capability of all network events and points. The NCS runs under the user-friendly Windows® environment.

NCS Software Features**:**

- Windows® 2000 operating system
- As built location of all devices and detectors on the loop.
- Mouse control with extensive use of Windows-type “point and click” operation.
- Vectors to a screen displaying an alarm with or without operator intervention.
- Cursor changes automatically to indicate on-screen action areas.
- New and Acknowledged Event boxes display all off-normal status simultaneously with graphic screens.
- Operator log-on with response tracking.
- History Manager records operator, event, and response with time-and-date stamp to hard drive.
- Multiple search filters make History Manager a power management tool.
- An unlimited number of events can be stored in the history manager. A warning is generated every 100 events after 100,000 events are stored.
- A complete library of device icons is included.

- Custom device icons can be created in the field.
- Add, edit, and delete devices and screens in the field.
- Link devices or system events to voice (*.wav), text, or bitmap files.
- All software backed up on CD-RW.
- Read Status/Program/Edit window – network points (online).
- Walk-test over the network
- Up to five states can be visually represented for each input device: Normal, Trouble, Alarm, Pre-Alarm (detectors), Disabled.
- Up to two states can be visually represented for each system Trouble: Normal, Trouble.
- Off-Normal Event window (color coded).
- Network-wide Disabled Device window.
- Mini-History viewer, last 1,000 events (color coded).
- Programmable access per feature, per node, per user matrix.
- Logs in history any programming changes.
- GSP (Graphic Setup Program) imports DWG-formatted (AutoCAD®) files to BMP.
- Graphic Editing and Navigation aids (on-site modifiable).
- SVGA 1024 x 768 color graphics.
- Programmable Alarm and Trouble tones (variable frequency).
- Control ON/OFF (DI/DO) all networked panels
- Archived history files.

Network Control Annunciator (Repeater Panel)

The Network Control Annunciator (NCA) shall be a 168 or higher- character backlit LCD display with operator keypad for the network. As a remote node on a network, it provides both system control and display capabilities for all network nodes.

The NCA shall have optional display for the fire control panels. When mounted in the control cabinet and connected to a stand-alone panel, it provides system control and display capabilities for a stand-alone panel. When connected to a networked panel as a primary display, it can provide network control and status/history display capabilities.

Hardware Features:

- Full supervision of all inputs and network integrity.
- Enhanced-format 168 or higher -character LCD display with backlighting.
- Keyboard interface (EIA-232)
- Ten LED status indicators:
- Power, Fire Alarm, Pre-Alarm, Security Alert, Supervisory, Trouble, Signal Silence, CPU failure, Point Disabled, Other Event.
- Alphanumeric keypad with tactile and audible feedback.
- Four status relays: Alarm, Trouble, Supervisory, Security (Form-C).

- Nonvolatile real-time clock can be synchronized with network by master node.
- Optional Security Key switch enable to NCA.
- Optional Security Tamper switch.
- Individual Enable / Disable or Group Enable/Disable local and networked zones.
- Control ON/OFF of local (the panel in the same cabinet and networked control points.
- Read Status of local (the panel in the same cabinet) and networked points and zones.
- Network event display and optional CRT with keyboard.
- Network master fire phone, paging control, HVAC control.
- Network-wide: Acknowledge, Silence, Reset.
- Lamp Test (local to NCA).
- History Buffer (1,000 System events).
- Report status of networked panels and their respective field devices to a central station.
- One master level and nine user level passwords. The Master can assign each User access levels (programming, alter status).
- Interactive Summary Event Count display, event handling package.
- Online programming and alter-status programs.
- Intuitive user guidance program including interactive soft keys.
- Enhanced Read Status / Alter Status displays.
- New history filters for report displaying and printing: All Events, Only Alarms, Only Troubles, Only Supervisory, Only Security, Time Interval, Point Range.
- Fully programmable node-mapping subsystem.
- New Advanced / Basic Walk-test program.
- Timer control for Auto Silence, AC Fail Delay.

Web Server

The Web Server or equivalent Network card with TCPIP connectivity shall be a web-Based device that acts as an HTML server, allowing remote access to the network via the internet or an intranet. With the NWS interface, users can view fire alarm control panel (FACP) event history, event status, device properties and other information Based on access permissions defined by the system administrator.
Features: For the Web Server and Serial Configuration Tool:

- Access network device statuses and properties remotely via the Internet or an Intranet.
- Standard Ethernet over IP connection.
- Supports up to 64 operator and 64 administrator accounts.
- Online Authorization log keeps a record of the username, time and date of the last 50 users to access the system.
- Built-in password security and user-access record.

- Multiple users can access the web server at the same time.
- Supports standard Microsoft® Internet Explorer 5.0 or higher.
- Intuitive Explorer-style user interface.

BACnet/MODBUS/LONWORKS Gateway

The BACnet/eqv Gateway shall provides an interface between fire panel network and a network using the BACnet/IP/eqv communication protocol. BACnet protocol is an American National Standard (ANSI/ASHRAE 135-1995). With the Gateway interface, devices on fire alarm control panels are represented as BACnet objects to the BACnet client. The user subscribes to Event Notification objects per FACP, and the BACnet device receives events from objects on the FACP as a result of this subscription.

Loop Controller (LC)

Loop Control boards shall be provided to monitor and control each of the Signaling Line Circuit (SLC) loops in the network node. The loop Control board shall contain its own microprocessor and shall be capable of operating in local mode in the case of a failure in the main CPU of the control panel. In local mode, the loop interface board shall detect alarms and activate output devices on its own SLC loop.

The LIB shall not require any jumper cuts or address switch settings to initialize SLC Loop operations.

The loop interface board shall provide power to, and communicate with, all of the intelligent detectors and addressable modules connected to its SLC Loop over a single pair of wires. This SLC Loop shall be capable of operation as **NFPA Style 7.**

The loop interface board shall receive information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular detector. The loop interface board software shall include software to automatically adjust and compensate for dust accumulation to maintain detector performance as it is affected by environmental factors. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

The LCB shall communicate with each intelligent addressable detector and addressable module on its SLC loop and verify proper device function and status.

Enclosures

Control panels shall be housed in FM/UL-listed or BS/IEC Standards cabinets suitable for surface or semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and the manufacturer's standard finish. The back box and door shall be constructed of 1.5mm steel with provisions for electrical cable connections into the sides and bottom. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

Field Programming

The system shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.

All local FACP node programming shall be accomplished through the FACP keyboard or through a portable laptop.

All field defined programs shall be stored in non-volatile memory.

The programming function shall be enabled with a password that may be defined specifically for the system when it is installed. Multi-levels of password protection shall be provided in addition to a key-lock cabinet. One level is used for status level changes such as zone disable or manual ON/OFF commands. A second (higher-level) is used for actual change of program information.

Specific System Operations

Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all intelligent detectors in the FACP node from each system keypad or from the keyboard of the video terminal. Sensitivity range shall be within allowed UL limits.

. Alarm Verification: Each of the intelligent addressable detectors in the system may be independently selected and enabled for alarm verification. Each FACP shall keep a count of the number of times each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

System Point Operations

All devices in the FACP node may be enabled or disabled through the local keypad or video terminal.

Any FACP node output point may be turned on or off from the local system keypad or the video terminal.

Point Read: The FACP node shall be able to display the following point status diagnostic operations and controls without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

Automatic Detector Maintenance Alert: Each FACP node shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.

If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system shall enter the trouble mode, and the particular intelligent detector shall be annunciated on the system display, network display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

Conventional Heat Detectors (For Parking Area)

Conventional heat detectors shall have a combination rate of rise and fixed temperature rated at 57°C for areas where ambient temperatures do not exceed 38°C, and 93°C for areas where the temperature does not exceed 65°C.

Conventional heat detectors shall be a low profile, ceiling mount type with positive indication of activation.

The rate of rise element shall consist of an air chamber, a flexible metal diaphragm, and a factory calibrated, moisture-proof, trouble free vent, and shall operate when the rate of temperature rise exceeds 15 °C per minute.

The fixed temperature element shall consist of a fusible alloy retainer and actuator shaft.

Conventional heat detectors shall have a smooth ceiling rating of 250 square meter.

Addressable Dry Contact Monitor Module

Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.

The monitor module shall mount in a 100 mm square, 100 mm deep electrical box.

The IDC zone shall be suitable for Style D operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 60 mm x 30 mm x 13 mm.

Batteries and External Charger

Battery
Batteries shall be 12 volt, Cd type or better and shall not be hazardous to humans or environment

The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills and leakage shall not be required.

Battery shall be heavy duty type of life span of minimum 5 years.

Uninterruptable Power System

The Contractor shall furnish and install an Uninterruptible Power System (UPS) with the following features:

Voltage:

Input – 240 Volts, single phase, two wire plus ground

Output – 240 Volts, single phase, two wire plus ground.

Output load capacity – to be designed by the contractor as per load.

Surge protection

Overload capacity – 200% for 60 seconds in normal operation.

Monitoring and control

Installation

Installation shall be in accordance with the IFC, NEC, NFPA 72, local codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

All cables ,junction boxes, cable supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

Manual Pull Stations shall be suitable for surface mounting or semi flush mounting as shown on the plans, and shall be installed not less than 1 m nor more than 1.2 m above the finished floor.

Typical Operation

Actuation of any manual station, smoke detector, heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

. Activate all programmed speaker circuits in a zone or throughout.

Actuate strobe units until the panel is reset in a zone or throughout.

. Light the associated indicators corresponding to active speaker circuits.

Release all magnetic door holders to doors to adjacent zones on the floor from which the alarm was initiated.

Where required, return all elevators to the primary or alternate floor of egress.

A smoke detector in any elevator lobby shall, in addition to the above operations and controls, return all elevators to the primary or alternate floor of egress.

Smoke detectors in the elevator machine room shall return all elevators in to the primary floor. Heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical installation. Smoke detectors at the primary level elevator lobby shall return elevation to an alternate level.

Duct type smoke detectors shall, in addition to the above operations and controls, shut down the ventilation system or close associated control dampers as appropriate.

. Activation of any sprinkler system low pressure switch, on valve tamper switch, shall cause a system supervisory alarm indication.

Commissioning

Commissioning shall include pre-testing, troubleshooting, acceptance testing, and punch list.

The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. The Contractor shall pre-test the system before the final acceptance testing and shall submit a pretest report to the Engineer:

Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.

Verify activation of all flow switches.

. Open initiating device circuits and verify that the trouble signal actuates.

Open signaling line circuits and verify that the trouble signal actuates.

Open and short notification appliance circuits and verify that trouble signal actuates.

Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.

Ground initiating device circuits and verify response of trouble signals.

Ground signaling line circuits and verify response of trouble signals.

Ground notification appliance circuits and verify response of trouble signals.

Check alert tone and prerecorded voice message to all alarm notification devices.

. Check installation, supervision, and operation of all intelligent smoke detectors using smoke test.

Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.

When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

. Check each zone smoke control sequence under “automatic,” “on” and “off” operation.
Perform the following tests for the public address/FIRE DETECTION & ALARM SYSTEM:

Simulate a fire condition using each of the following initiating devices in each zone: 1) manual pull station – waterflow switch 2) area smoke detector - projected beam smoke 3) heat detector - detector 4) duct smoke detector

After alarm verification time has exceeded ensure that proper voice institution messages are transmitted to the proper zone.

Simulate live voice announcements in all zones using All Call, All Call Minus, Page to Evac., and Page to Alert operations and controls to ensure that proper voice instruction messages are transmitted to the proper zones. Stairways shall be on an independent zone separate from all other zones.

Test & Inspection

All intelligent analog addressable devices shall be tested for current address, sensitivity, and user defined message. All wiring shall be tested for continuity, shorts, and grounds before the system is activated. All test equipment, the installing contractor, shall make instruments, tools and labor required to conduct the tests available.

The system including all its sequence of operations shall be demonstrated to the Owner, his representative, and the local fire inspector. In the event the system does not operate properly, the test shall be terminated. Corrections shall be made and the testing procedure shall be repeated until it is acceptable to the Owner, his representatives and the fire inspector.

At the final test and inspection, a factory-trained representative of the system manufacturer shall demonstrate that the system operations and controls properly in accordance with these specifications. The representative shall provide technical supervision, and participate during all of the testing for the system.

A letter from the Contractor certifying that the system is installed entirely in accordance with the system manufacturer's recommendations and that the system is in proper working order.

3. <u>TWO WAY COMMUNICATION SYSTEM</u>

A. GENERAL

Two-way communication systems for fire evacuation system shall be provided. The system shall be used for providing emergency communication in case of fire. There shall be one main console located on Ground floor in the Fire Control Room. All communication units provided on floor shall be able to transmit & receive voice signals to main console. However, communication between two floor units shall not be required.

A. COMPONENTS

The system shall include the following:

- Amplifier
- Talk Back Console & Microphone
- Talk Back Speakers with push button or pressing device (talk switch)

B. TALK BACK PAGING AMPLIFIER

The amplifier, necessary rack, talk back console and microphone are located at the ControlCenter location (Master's desk). The talk back speakers with "press to talk" switches shall be at individual locations.
Each such individual location stated above should be wired to the talk back console with 2 No. Twin twisted 32/0.2 tinned copper music wires.

The talk back amplifier (paging amplifier) shall be suitable for 230 V, 50 Hz A/c supply with rated RMS output to match the number of individual talk back speakers located in different locations. Maximum RMS output should be 150 % of rated RMS output, with a distortion of less than 3 % and frequency response of 80 Hz to 20,000 Hz. The amplifier shall have a minimum of two auxiliary inputs and a minimum of five Microphone inputs. Bass and Treble Control of 100 Hz (+) or (-) 10 dB, and 10 kHz of (-) 10 dB respectively. The S/N Ratio shall be better than 60 dB.

C. TALK BACK CONSOLE

The talk back console shall comprise Zone Selector switches with "Press to Page" / "Release To Listen" switch. In addition there shall be an "All Call switch" for paging all the talk back speakers. The console shall also have a monitoring amplifier of appropriate output capacity and a monitoring speaker with volume control. Frequency response shall be 300 Hz to 4.5 kHz (+) or (-) 3 % with distortion less than 2 %. All control relays shall be rated 230 V (+) or (-) 10 % at 50 Hz.

D. TALK BACK SPEAKERS

The talk back speakers shall be rated 6 W each with tappings of 6 W, 3 W & 1 W. Input 100 V and effective frequency range of 200 Hz to 15,000 Hz and a rated impedance of 1667 ohms.

E. CALL MASTER SWITCH

Call master switch shall be the micro – type and all cabling shall be with 2 pair twin twisted 32/0.2 tinned copper wire of approved make.

F. MODE OF WORKING

a) Call Originated from Talk Back Speaker:

- Press Call Master Switch at Talk Back Speaker till Master responds.
- LED and the buzzer glows on the Talk Back Console indicating from which floor the call is originated.
- The Master at the console will observe the Audio – Visual indication and attend the call request.
- Master will select the zone selector switch from where the call is originated.
- The Buzzer will get cut off but the LED still continues to glow.
- Master will acknowledge by holding " Press to Talk " switch and speaking in to the MIC connected to Talk Back amplifier.
- The announcement is heard in the selected talk back speaker.
- After the announcement is over, Release the " Press To Talk " Switch and listen to the Talk Back Speaker.
- Communication between Master and Talk back speaker goes on till Master switches off the zone selector switch.

b) Mater Talk Back Console Operation

- Observe for buzzer sound and led glow at the console.
- Acknowledge to the called zone by selecting the zone selector switch.
- Buzzer cuts off and led continues to glow.
- Press the ‘ press to talk switch ’ and speak into the ‘ mic ‘ connected to amplifier.
- After announcement advise the called zone talk back speaker to ‘ talk ‘ and Release press to talk switch.
- Listen to the talk back speaker.
- After his talk is over again press the ‘press to talk switch and speak in to ‘mic ’.
- Continue the communication in simplex mode by ‘ press to talk and release to Listen ’.
- On completion of communication release the zone selector switch to reset the System.

c) Talk Back Speaker Location Operation.

- Press call master switch till master responds.
- Listen to master’s voice.
- On advice from master, speak in to the talk back speaker from a distance of one foot.
- After giving information wait for master to respond.
- Continue the communication in simplex mode.

Note: Listening from talk back speakers is only one zone at a time. Ensure proper grounding of the system is provided. Ensure no talk back speaker is left open. It has to be terminated to Speaker or a dummy load. If not noise will be generated.
When Master is in communication with one Zone Talk back speaker, the other zone Talk back can also call Master, by pressing the ‘Call Master Switch ’ at his talk back speaker.
The LED glows at the Master indicating the calling zone. Buzzer will not be on.
Master can disconnect the zone that is in communication after advising him and attend to the other zone and get back to the first caller.

d) Call Originated from master Console.

- Select the required zone speaker by selecting the required zone selector switch.
- Press the ‘ Press to talk switch ’ and speak in to the Microphone. This is heard loud and clear, in talk back speaker.
- Release the ‘ Press to talk switch ’ and listen to the called party when he responds.
- The Communication on simplex continues on ‘ Press to Talk and Release to Listen ’.
- Master can broadcast to all zones from the Talk Back Console by selecting the ‘ ALL CALL ’ switch

4. PUBLIC ADRESS SYSTEM (P.A)

1. GENERAL DESCRIPTION:

The objective is to have an effective public address and evacuation system for the entire area. The system will combine all the essential EVAC functionality- such as zone wise paging & voice evacuation, event logging, digital mixing & feedback cancellation, digital message management and a relay Based fire alarm panel interfacing. The system shall monitor all the peripherals such as speakers & speaker circuits, amplifiers, battery, voice messages, microphones etc. The system shall fully comply with IEC / EN60849 and BS5839 part 8 standards . The same also should be comply NFPA 72 codes and Indian Standard IS 2189.

2. SCOPE :

The contractor shall supply, install, test, connect and commission a high quality FDAt-acting Public Address and Voice Alarm System and Professional Audio System complying strictly as per the standards.

The system shall provide Paging announcements from microphone stations, emergency message from the in-built memory & simultaneous background music from CD/DVD/PC player in different zones. The system shall consist of minimum 8-button Paging security microphone (PSM) working on RS-485 protocol & balanced audio line transmission. The PSM will have built-in pre-amplifier & will be connected to Distributed amplifier unit (DAU) using CAT 5 or CAT 6 cable crimped by RJ 45 connector on both the sides.

The Public Address and Voice Evacuation System shall comprise of Audio Matrix Units, High quality speakers, Power Supplies, Side Lobe Free Line Array DSP “Digital Signal Processor” Speakers, Musical Horn Speakers, Wall Mounted Speakers, Pro-Audio Input Plates, Automatic Gain Control Microphones, Audio rack all mounted on a suitable Rack and fully connected and integrated on the fire alarm loop as per the project requirement.

Prior to placing order for any equipment, the contractor shall submit comprehensive document comprising working drawings, catalogues and descriptive literature of components, acoustic calculation to meet with all relevant codes . The contractor shall be required to train and instruct client's personnel in the correct use, operation and supervision of the system, preferably prior to the handing over of the project. In order to ensure whole site integration capability, the fire and voice alarm system will be awarded to a single specialist local System Integrator who will be responsible for the design, global operation, management and interfacing of the system as defined in BS5839 part 1.

The contractor shall make sure that all power tapping of the speakers must be carried out as specified, even if the acoustic calculations indicates less power tapings. The back ground noise of the project shall be considered 80dBA. The contactor must endure minimum of 10dB above noise levels are achieved.

The system shall be fully programmed to accommodate fire alarm and voice communication zones as indicated on the drawings and schematics. 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 the buildings.

The System shall be capable of identifying the Evacuation Zones via Software, and shall be able to Page, Evacuate, Alert zones as required by the Cause and Effect of the Fire Alarm without any limitation to the number of zones.

3. SYSTEM DESCRIPTION:

3.1 PAVA DSP MATRIX UNIT (PDMU)

The PDMU shall be a central control unit for PAVA system & shall be capable of being used for everyday background music and public announcement duties; with the fire alarm initiated emergency announcements overriding all other facilities.

Each PDMU shall be 4 IN & 4 OUT matrix & will cater to 4 zones. (Number of Zones shall be designed as per the site requirements) PDMU shall have a staking capability for expansion of zones upto 256 by stacking 64 PDMUs together.

The PDMU Shall have a GUI "Graphical User Interface" shall be the latest technology in routing music with all the Professional Audio Library Operations and controls of windows drag and drop such as Equalizers, Mixers, Auto Mixers, Fillers, Compressors, Crossovers, Feedback Killer, Gates, Delays. All these blocks shall come part of the GUI. The system shall be able to provide the AutoCAD of the building, and shall be easily able to drag and drop any of the controls, Mute Buttons, Volume Controls or any other control on the software to enable the user to easily control and route the 48 audio channels to any selected location as per the building map.

The PDMU along with entire Voice Evacuation and Public Address System shall be integrated with the FIRE DETECTION & ALARM SYSTEM and shall be sitting on the same Fire Alarm Loop. The PDMU along with amplifiers (system) shall be capable of sending messages automatically to any zone at any time interval, without affecting the music in the other areas.

The PDMU shall utilize the latest DSP (Digital Signal Processing) capabilities in order to perform high quality and site programming flexibility, as well providing high fidelity music over 32 audio channels

The PDMU shall play background / Foreground music and in case of Fire Alarm / Paging announcement, the system shall go to full power as programmed to provide the enough SPL levels to comply with BS5839 part8, with minimum of 10dB above the noise levels.

All system components shall be digitally monitored including and not limited to, Messages, Amplifiers, and back up amplifiers, Speaker Circuits, Audio Matrix units, Paging Microphone, Battery Charger and the 230VAC line. Each amplifier / line circuit shall be monitored individually and shall report any faults back to the Master Audio Matrix Unit as well as the CFM.

Each Zone and circuit speaker shall have separate amplifier, system sharing two amplifiers to multiple circuit speakers are not acceptable. There shall be one back up amplifier for every four amplifiers, the system shall automatically change over to the backup in case of any amplifier failure, and the backup amplifiers shall be monitored as well.

The PDMU can provide any Cause & Effect programs after integrating with the FIRE DETECTION & ALARM SYSTEM, thus Alert/Evacuate messages can be programmed and delayed as well as played on any zone / floor as per the Cause & Effect approved by the Engineer.

The Battery Back up shall provide 24 hours of back up and 30 min of alarm operation. The power supply / charger must comply with EN54 part 4 and shall be 19" rack mounted. Battery calculation must strictly comply with BS5839 part 8 and shall be Based on the amplifier size and not the speaker circuit load.

PDMU will ensure the Initiation of voice alarm shall take immediate priority and shall cancel all other PA operations in that particular fire zone and shall not affect the music in other zones.The voice alarm system shall be capable of broadcasting pre-recorded emergency alarm messages and live speech in the event of fire detection system activating for up to 32 audio channels simultaneously. The systems shall be capable of broadcasting up to twelve different pre-recorded messages to different zones or group of zones simultaneously.

In addition a FIRE DRILL, BOMB ALERT, EARTHQUAKE ALERT and an ALL CLEAR message shall be incorporated into the operation. If required the messages shall be recorded in the local languages e.g. Hindi, Marathi, Gujrati, Tamil Telgu etc. for making voice evacuation more efficient & user friendly.

Technical Specifications

0dB input / outputs	4 Nos per PDMU
Audio input impedance:	10K Ohms
Input sensitivity:	0dB
Audio output impedance:	50Ohms
Output levels	0dB
Max input/output level	+14 dBv
Pass-band	10 Hz to 22KHz
Sampling	48 kHz 24bit
Distortion	0.02% to 1 KHz
Output noise	<84 dBu Lin, <88 dBu A-weighted
Output dynamic	>98dBu Lin, >102dBu A-weighted
100V Inputs/Outputs	4
Max power per Channel	500W, and four channel per AMS
Amplifier gain measurement	1 kHz, 18 kHz
Line impedance measurement 100V	1kHz, 18kHz
Ground fault measurement Yes	

3.2 Central Fire Microphone (CFM)

The Central Fire Microphone “CFM” shall be of touch screen type and connected back to the control room, to monitor and control the entire PAVA system, as well to start/stop any music programs, page any zone via touch screen buttons, route any message to any zone as required. The CFM must be provided for redundancy. If the master fails, the other redundant microphone shall take over automatically and without any manual interference. The secondary CFM shall indicate the fault on the LCD of the microphone. Any button paging microphones or PC Based paging console does not comply with the above and hence deemed rejected.

CFM shall be configured either using a PC computer, or by using control keys and the front LCD screen of thePDMU module to which it is connected. Access can be password-protected. All parameters needed for site operating shall be programmed: zones assigned to the different buttons, name of zones, zone groups, priorities, access to different messages, levels adjustments, pre-call chime, press-to-talk, music ON/OFF (DI/DO) and music routing.The LCD screen shall provides an overall view of busy zones and active sources. A VU meter controls the microphone presence and modulation level.

A CFM shall have a built-in loudspeaker makes it possible to listen to all system-generated messages and announcements. The CFM shall have fully monitored (microphone capsule, power supply, touchscreen, audio and RS485 connections). Any system faults are detected, located and indicated clearly on the screen of CFM.

In case of any system component failure, the CFM shall override any defective unit and provide paging to the required zone.

When a touch screen CFM is operated, this shall override any automatic voice alarm signal being transmitted to the zone selected. The Alert and Evacuate pre-recorded messages will be maintained in other zones while live voice fire announcements are being broadcast to selected loudspeaker zones.

3.3. Paging Security Microphone console (PSM)

The PSM shall consist of Unidirectional Condenser Addressable Microphone, compatible with UAPdevices via RS485 protocol over a single CAT6 cable connection to transport both Audio and Power to the PSM from the UAP system. The unit comprise of 8 zones / 8 buttons with sleek Condenser Goose Neck Microphone, and spring metal protection, providingdurability and excellent aesthetic look.

The PSM unit is fully addressable; each button can be assigned to different zone and up to 256 zones expansion via the additional Key-pad easy extension station. The buttons can be represent a single zone or group of zones and easily defined via the GUI of the UAP system via simple Matrix selection IN Windows Based configuration software.

The Unit shall comprise its own Pre-amplifier and 128kB audio storage memory inside, allowing the unit to store Pre / Post Chime tones. These Wave Files Tones can be easily stored and downloaded via the UAP GUI (Graphic User Interface) software directly to the PSM.

The Unit comprise as well “Hold” and “Busy” LED signals apart from the zone LED’s, these shall allow the identification of selection / Busy signals for the user notification. All buttons shall be programmed with Drag & Drop features from the UAP GUI software and each button can be programmed for Push to Talk or Latch functionality.

The Unidirectional Condenser Microphone shall provide high quality directive pick up from the user and hence less interference from the surroundings.

The UAP system shall accommodate up to 32 PSM microphone on one UAP and up to 256 zones in total, the RS485 communication protocol will facilitate daisy chain of up to 1000m on a simple CAT6 cable, and yet making outlets easy to connect via a universally accepted standard RJ45 connectors.

3.4. Paging Microphone IP Based console (PMIP)

The PMIP console will be directly fitted on the TCP/IP network either connected to switch or router. It shall bear its own static (manually configured) IP Address. The IP Based PA system will use a Virtual LAN with static addresses for communication with amplifiers & microphone control consoled. The PMIP shall be used as a microphone directly communicating over IP -Ethernet interface including POE (Power On Ethernet). PMIP will consist of monitored high quality gooseneck microphone, Automatic gain control on microphone input. A Monitored built in loudspeaker for listening to transmission of audio messages to remote locations. The console will use SPEEX/MP3 audio encoding/decoding protocol for TCP/IP audio & data transmission. It shall have a Memory space for pre-recorded messages & a RJ9 plug for optional headset

Technical Specifications

Speaker: Power	4 Wrms, Bandwidth 200 Hz-10 kHz
Microphone	Length 250 mms, bandwith 100 Hz-10 kHz
Contact inputs	Active to ground, voltage 3.3 VDC
Relay outputs	48 VDC / 2A
Housing	Polystyrene shock, UL94 self extinguishable,
Color	White / Grey / as per site requirement
Serigraphy	Yellow pantone 143C
Power consumption (24 VDC)	1.7 W standby, 8 W max

3.5. TCP/IP Ethernet Interface

The TCP/IP Ethernet interface unit shall be a core component in Audio IP Transmission & will be used as a bridge for IP integration Use of IP Based PA system shall save a wiring as the IT infrastructure will be shared on the same backbone.

Technical Specifications

Power supply	24 VDC
Audio Inputs	2 balanced audio 0 dB to -60 dB inputs
Audio Outputs	2 balanced audio 0 dB outputs
Audio Compression	SPEEX/MP3 audio encoding/decoding
Contacts	2 output contacts NO/NC
Data	RS232 interface (TX/RX/GND)
Audio inputs	max level +18 dB bandwidth 20 Hz-20 kHz
Audio outputs	max level +18 dBU bandwidth 20 Hz-20 kHz
Contact inputs	Active to ground, voltage 3.3 VDC
Relay outputs	48 VDC/2 A
Housing	Polystyrene shock, UL94 self-extinguishable,
Color	White / as per site requirement
Serigraphy	White / as per site requirement
/Power consumption	(24VDC): 1.7 W

3.6. Watt Metal ceiling speakers

The ceiling mounted 6 W speakers shall be installed as depicted in the drawing. The speakers are finished in RAL 9016 color in stylish metal chassis. The speakers shall have terminals to allow selection of nominal full power, half power & quarter power. Assembly shall comprise of a twin cone loudspeaker and shall be fitted with a 6Watt / 100volt transformer. The loudspeaker baffle shall be a round two part bezel comprising an inner metal mesh grille, and chassis with integral loudspeaker having no visible fixings. Installation shall be by pre-mounted torsion-springs for False ceiling mounting. Loudspeaker shall have wide angle dispersion of Cone shall be a damped, high compliance type with a smooth extended frequency response of 100Hz~17.5 KHz. The speakers shall be very easy to install with mounting clamps . It shall have excellent frequency response with wide opening angle & inbuilt 100V line matching transformer. It should blend aesthetically with interiors**.**

Technical Specifications

Rated power	6 W
Tappings 100V line	6/3/1.5/0.75/0.25W
Effective frequency range	70 ~ 17.5Khz
SPL @ 1w/m (test signal 100Hz~10kHz)	90 dB
S.P.L. ,@Full power/ 1m, dB	97 dB
Axial Q Factor at 1k/2kHz	2.3/4.6
Colour	White / as per site requirement
Ceiling Cut-out	155 mm
Dimensions	180 mm x 70 mm

3.7. Moulded cabinet wall-mount loudspeakers

The enclosure shall be ported and treated with UV inhibitors. The bowed grille will be manufactured from mild steel construction with an epoxy coated finish. The assembly of the speaker shall comprise of a 160mm diameter BMSs/midrange treated coned loudspeaker. It shall have in addition a 25mm Mylar dome tweeter complete with neodymium magnet and a factory fitted 6watt / 100 volt line transformer. The loudspeaker shall have wide-angle dispersion of 160° and a smooth extended

frequency response of 160Hz ~20kHz. Sensitivity shall be a minimum of 96dB @ 1metre, 1watt test signal bandwidth 100Hz ~10kHz. Transformer shall be 100 volt line with 3dB power taps of 6, 3, 1.5, 0.75 and 0.25watts to be clearly marked on the assembly. The speaker shall be compliant to BS5839 part 8 (Voice Alarm Standard) to include all the above features with the addition of thermal fuse and ceramic terminals to take 2 x2.5mm² cables. Fire Rated cable tail must be fitted for full compliance to BS5839 Part 8. All units to be tested to BS6840 Part 5.

Technical Specifications

Rated power	6 W
Tappings 100v line	6/3/1.5/0.75/0.25 W
Effective frequency range	160 ~18Khz
SPL @ 1w/m (test signal 100Hz~10kHz)	96dB
Dispersion at 1k/2kHz	180/120
Axial Q Factor at 1k/2kHz	3.6/5.8
Colour	White / as per site requirement

3.8. W Horn Type Speakers

The Horn speaker unit shall have a 100-volt transformer sealed inside its high-strength, lightweight, ABS housing that is protected against the elements by molded-in UV inhibitors. Its wire enters the housing through a gland nut designed to keep the moisture out. Horns must have lightweight high-density, phenolic-resin diaphragms and ceramic magnets.

Mounting shall be using epoxy-coated, stainless steel U bracket held in place by stainless steel hardware allowing its position to be maintained despite unusually high wind velocity.

The Horn speaker should be tested in accordance to IEC60268 Part 5 for high quality intelligibility & shall comply to BS5839 part 8, hence fitted with ceramic terminals and thermal fuse. Unit shall consist of a weather-resistant ABS housing, high density phenolic resindiaphragm, internal 100-volt transformer, epoxy coated stainless steel mounting bracket, stainless steel hardware and 17 inches five conductor wire.

Technical Specifications

Rated power, Watts	10 W
Tappings 100 volt line	10/5/2.5/1.25 W
Transformer Impedance, Ohms, 100V	1k/2k/4k/8k
Effective frequency range, Hz (BS6840)	400–8,000
S.P.L. @ 1m, 1 watt, dB, Test Signal Bandwidth	97dB
S.P.L. @ Full power Octave Bandwidth, dB	107dB
Dispersion at 1k/2kHz, Degrees	160 / 110
Directivity Axial Q factor, 1 k/2kHz	2.80 / 6.60
Dimensions, front & depth, mm	Ø138 x 200
Colour/Finish	Grey RAL7035
Material	ABS plastic housing with UV inhibitors
Mounting	Stainless Steel U Bracket
IP Rating	66

3.9. Amplifiers

The power amplifier shall be of high quality, suitable for the most demanding PA installations and applications. The unit shall have a frequency response of no less than 50Hz - 15kHz (±3dB). Distortion at 1kHz shall not exceed 0.5%. The Signal to Noise ratio shall be -82dB or greater. The amplifier shall have two transformer balanced XLR inputs, one of which can be used to feed additional power amplifiers. The amplifier shall be capable of delivering 120/240/480 watts RMS into 100 & 70 Volt or 4 ohm loads. Speaker connection shall be via a rear panel barrier strip. The unit shall operate from both AC mains power or from a 24V DC battery supply. The

amplifier shall include a built-in trickle charge circuit. The amplifier shall feature overload and overdrive protection and shall also include cooling fans, which should only be active if the operating temperature exceeds a factory preset level. The unit shall be packaged in a rugged 2 RU metal chassis suitable for desk or rack mounting.

Rated Output Voltage(RMS)		120/240/480W
Battery Voltage		24VDC(max 10% déviation)
Frequency Response	:	50Hz to 15KHz
Impedance	:	10KOhm
S/N Ratio	:	>82 dB
Sensitivity	:	Max 300mV(set at 1V)
Total Harmonic Distortion	:	Less than0.5% @ 1kHz

3.10. Entertainment Rack

The equipment panel shall consist of 1 no. CD player & 1 no. AM/FM tuner. All music transmitted from this position will be routed through the Central Equipment rack to the zone / zones selected though complete windows Based programming.

The equipment components shall comply with the following requirements:

3.10.1 FM/AM tuner

The tuner shall contain provision for up to six preset stations, two of which shall be dedicated to MW or LW. It shall have the following characteristics:

Sensitivity	:	3uV for FM channels
	:	20uV for 26dBSNR for AM section
Distortion	:	1% THD
IF rejection	:	70db
Nominal output	:	100mV
Antenna Impedance	:	75 ohms
Tuning method	:	Electronic, onsite adjustable with LED on station Indicator

3.10.2 CD/DVD Player

The CD player shall be capable of loading up to six discs into a magazine to provide many hours of repeated play. All discs could be played sequentially or randomly by the use of a remote signal.

Frequency response	:	20 Hz to 20,000 Hz
Signal to Noise Ratio	:	90dB
Distortion	:	0.008 % THD @ 1 kHz
Channel Separation	:	82dB
Quantization	:	16-bit twin DAC

3.10.3. Equipment Rack

The equipment shall be housed in a standard rack of suitable height, with Plexiglas door or metal mesh and lock. Ventilation panels of 1U height shall be provided between each item of equipment.

Details of the proposed equipment shall be forwarded to the Consultant with performance specifications, dimensions, construction and finish for approval.

The site shall be fitted with man / machine interface terminal facilities, which shall allow live speech broadcasts to be addressed to selected areas of the site. The unit shall also allow initiation of stored messages and alarm signals.

3.11. Speaker Cables

All cables associated with PA System shall be of following specifications :

The 2 core speaker cable will be connected to the speakers by screw terminals before which it shall be crimped using 1.5 sq. mm. bootlace lugs. Care has to be taken for avoiding any single strand of wire shall not come out of Lug & screw terminals to avoid noise & leakage.

Flexible Copper Conductor of cross section 1.5 Sq. mm / 2.5 Sq.mm PVC insulated,PVCFRLS sheathed control Cable as per IS 694.

These Cables shall be laid in G.I. Conduits concealed/surface.

4. APPLICABLE STANDARDS

BS 5839 part 8: Code of Practice for the design, installation and servicing of voice alarm systems
EN60849: International Standards Sound Systems for Emergency Purposes
BS 6259: Reinforcement of Pro-Audio Systems with Voice Evacuation.
IEC60268 Part 5: speaker rated power in compliance
BS6840 Part 5: Speaker tested in accordance with.
Speakers EASE, CATT and ULYSSES models for acoustical studies.

5. INSTALLATION:

Installation shall be as shown on the drawings, and as recommended by the major equipment manufacturer.

All cables, junction boxes, cables supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas

TESTING:

Sr. No.	Description	Visual	Test Readings	Documentation
1	All cables are tested for continuity, insulation, resistance etc.			√
2	System installation proper as per drawing	√		
3	Carry out visual checks on all speakers & Processors are free from any mechanical damage, cables, inter phase modules etc.to ensure they are properly installed.	√		
4	Check for proper termination of bootlace lugs & feruling	√		
5	Check Input A/C Supply Voltage		√	
6	Check location / spacing of loudspeakers as in drawing.	√		√
7	Check Distribution of Zones as per Drawing.	√		√
8	Check full load speaker sound quality & measure Sound pressure level (SPL) in dB.	√	√	
9	Check if local loudspeakers overrides by voice messages in case of emergency evacuation .	√		√
10	If power fails, whether Voice evacuation system is working on battery supply if yes for what time		√	

11	Check if recorder messages are CLEAR, free from any noise distortion & easy to understand with Room acoustic speech transmission Index (RaSTI) value >0.5.	√	√	
12	Processor LED's and all keys are working properly	√		
13	Check for Microphone locations & the sensitivity by paging	√		√
14	Play a soft music & check sound quality	√		

6. COMMISSIONING :

At final commissioning of each system, the Contractor shall confirm that:

All devices, control panels are tested and operate correctly .

The standby batteries are adequately sized. (Measurements of the quiescent and full loads shall be taken and compared to calculated values used at the design stage.) Calculations and measurements shall be submitted to the Engineer.

Commissioning shall be fully documented and the documentation submitted to the Engineer.

The Contractor shall demonstrate each zone and main panel to the satisfaction of the Engineer by conducting a series of witnessed acceptance tests as directed by the Engineer. This shall take place after the above final commissioning and following receipt of the commissioning documentation by the Engineer.

Both the installation and the commissioning activities shall be undertaken as a single continuous operation.

Upon completion of the installation activity, the contractor shall Test, Start-up, Commission and Handover the system to the customer.

The contractor shall make use of the following documents to record test results and details of commissioning tests:

- Cable Test Sheets
- Installation Check Report
- System Layout Drawing(s)
- System Schematic Diagram(s)

The contractor shall be responsible for inspecting and testing the complete system.

The contractor shall present an Acceptance Certificate for signature by the customer.

8. DOCUMENTATION :

The contractor, upon completion of the commissioning activity, shall hand over the system to the customer.

At the time of hand over, the contractor shall provide the customer with the following documentation:

1. Copy of detailed report
2. Component and equipment list
3. Product description sheets

4. System design drawing(s)
6. System schematic diagram(s)
7. System operating manuals

9. HANDOVER :

Prior to final acceptance, the installing contractor shall provide complete operation and maintenance instruction manuals to the owner. All aspects of system operation and maintenance shall be detailed, including wiring diagrams of all circuits, a written description of the system design, sequence of operation and drawing(s), illustrating control logic and equipment used in the system. Checklists and procedures for emergency situations, maintenance operations and procedures shall be included in the manual.

10. TRAINING :

General

The contractor shall provide the customer with details of the training required by personnel to operate and maintain the PA System.

The Contractor and the customer shall jointly agree the number of staff to attend the training courses.

11. MAINTENANCE :

Routine maintenance should be carried out in accordance with relevant customers requirements.
All performance checks undertaken should be recorded in the system log book.

As a minimum, the following performance checks must be undertaken on each maintenance visit. Carry out verification checks as detailed in the commissioning instructions.

Remove dust and dirt from the Control Panels/speakers using a soft brush or a lint cloth. A solvent which is harmless to the finishes of metal and plastic may be applied to more stubborn stains.

Examine the exterior of the enclosure for any signs of damage or loose cable glands and rectify any faults found.

Examine the printed circuit boards for signs of over heating, dry joints and/or damaged tracks.

Examine the battery terminals for secure connection and for any signs of corrosion. Replace or repair as required

5. SECURITY SYSTEM

CLOSE CIRCUIT TELEVISION SYSTEM (CCTV IP SOLUTION)

1. HARDWARE MPEG4 ENCODER

The Encoder should convert Analog Composite / S-Video input into good quality MPEG4 stream and able to transmit as Unicast / Multicast IP packet with low latency. The Encoder should have the following specifications or should match with the requirement.

Encoder with

Video Input - Four composites, 1Vpp into 75 ohms (NTSC/PAL)
Resolution Scalable from CIF to 4CIF 352x240 to 704x480 NTSC, 352x288 to 704x576 PAL ,$ CIF per channel
Compression - Dual stream MPEG-4/FHD/ H.264 (at 25 FPS each) per channel
Frame Rate 1-30 FPS Programmable NTSC (full motion) - CIF, 2CIF and 4CIF 1-25 FPS Programmable PAL (full motion) - CIF, 2CIF and 4CIF
Interface Ethernet 10/100Base-T Connector RJ-45
IGMP Multicast network protocol enabled
Protocols Transport: RTP/IP, UDP/IP, TCP/IP with full multicast support. DNS and DHCP
Security SSL-Based authentication
Bandwidth Each stream is configurable between 30 Kbps and 4 Mbps for a total of 6 Mbps per cam-era (dual streaming - viewing and recording combined)
Input 12 dry contacts, Output 3 Relay Contact, 48V AC/DC at 100 mA max.
Bi-directional Audio (EA) Input: -46 to -3 dBV into 1 kOhm, Output: -46 to -3 dBV into 16 ohms minimum, Connectors: One set of 0.14 in. (3.5 mm) input and output stereo jacks
Communication Protocols Port 1: RS-232 (maximum 230 Kbps) Port 2: RS-422/485 2/4 Wires (maximum of 230 Kbps)
Configuration Remote: Via Video management software and standard web browser Local: Telnet via the serial port using any ASCII Terminal
Firmware Upgrade - Flash memory for upgrade of encoders and application firmware over the network
Power - 12VDC , 25W
19” 1U (1.75”) high rack mount enclosure
Operating Temp: 32° F to 122° F (0° C to 50° C)
Humidity : 95% (Non-condensing)

4. NETWORK VIDEO RECORDER (NVR)

NVR box should be used to record the video streams which are viewed and monitored. The video streams should be recorded Based on the control settings assigned by the administrator using video Surveillance control software. Control Room and other clients should be able to access the recorded video streams. The NVR should support simultaneous play back and recording at full duplex operation

It shall provide a high quality recording storage and play back of images. It should support integration with LAN to provide Centralized Management and shall operate on Windows/ Linux O/S. Support of user management for security level control and

authentication required. This NVR boxes should have the following features and specifications.

Network Storage Device for CCTV	
Processor	it shall offer 64-bit Embedded multi-core processor with 32GB high-speed buffer.
Video input for CCTV recording	it shall support 32-channel concurrent writing at 3Mbps
	it shall be connectable to encoding devices (IPC/DVR/encoder/NVR) using standard stream media protocol such as RTSP, ONVIF, PSIA, etc.
HDD slot	it shall support up to 24 SATA HDD and up to 144TB capacity for each device
Hot-swap disk	Supported
RAID level	it shall support RAID 0,1,3,5,6,10,50, JBOD and hot spare to enhance the storage reliability.
Recording type	it shall support multiple recording types, including continuous recording, manual recording, main and sub stream recording; motion recording, etc.
Recording backup	it shall support data backup to increase data security.
	it shall support Local backup; Remote backup
	it shall support SAS cascade extension.
Recording protection	it shall support ANR technology to ensure data integrity when the network disconnected.
Search mode	By time / type
Alarm type	Sound, Flash LED, Email, Warning
Log download	Auto-down load by USB flash drive, Remote backup via web browsing
Protocol	RTSP / ONVIF / PSIA / iSCSI
Data port	it shall offer 2 Gigabit Ethernet ports supporting network interface bonding.
Management port	1×100M self-adaptive Ethernet interface
COM interface	should support
USB interface	Min. 2 x USB
Power supply	Redundant Power supply required
Temperature	Operating: 5℃ ~ 35℃ ;
Chassis	4U (19-inch)
Humidity	Operating: 20%-80% RH(non-freezing, non-condensing); Storage: 5%-90% RH(non-freezing, non-condensing)
Certification	CE, FCC, UL
Power supply	100 to 240 VAC (Redundant power supply required)
Consumption (without hard disk)	≤30 W
Working temperature	-10 to +55ºC (14 to 131ºF)
Working humidity	10 to 90 %
Certification	CE, FCC, UL

Basic OEM Guideline	OEM should have more than 10 year's existence in India and OEM should have own office in West Bengal.

STORAGE EXPANSION ENCLOSURE
it shall provide high reliability feature, including hot swap HDD, redundant power supply, redundant fan.
it shall support Mini SAS .
it shall support cascading expansion.
it shall Support 24-port SATA HDD interfaces.

Sl No	Camera resolution	Required Bandwidth (Kbps) in H.264	No of Camera	Total Bandwidth (Kbps)	Storage Space @ 24hrs (GB)	No of days	Total Storage (GB)	Total Storage (TB)	For RAID 5 (TB)
1	3 MP (1920*1080)	4096	83	339968	3,501.56	30	1,05,046.88	102.58	137.4636841

Note: If camera considered by the bidder are higher capacity than Specified resolution then NVR storage capacity must be re-calculated by the contractor and NVR capacity has to be considered and quoted as per the camera consideration by the contractor.

Video Management Software	
1	It should be a flexible, scalable, high reliable and powerful central video system. Integrating with multiple surveillance systems.
2	It should be capable of managing devices, live view, storage and playback, VCA search, alarm linkage, etc.
3	Access to the CMS via IP address or domain name.
4	Support accessing by HTTPS to ensure high security.

5	Multiple device can be added : IP cameras, encoders, DVRs, NVRs, alarm input /output etc.
6	Provide the centralized management for the users, roles, permissions, surveillance devices, alarm device and servers.
7	Provide the log management and statistics function.
8	Scalable for medium and large-size projects.
9	**Live View :** View real-time video from the cameras. Can control PTZ. Manual recording, Capture, custom window division, instant playback, digital zoom, two-way audio, auto-switch.
10	**Playback :** Playback recording files/ timeline, search by date / storage mode, download the recordings for backup, slow forward / fast forward, turn on/off the audio in playback, video clipping, capture.
	Smart playback based on motion analysis / intrusion / line crossing events. Normal playback for continuous recordings, Event playback for recordings triggered by events such as motion detection, video loss, video tampering, etc.
11	**Alarm :** Display event alarm info including time, alarm name, alarm status, etc. Display system alarm info including time & description.
	View the live video or pictures from the related camera.
	add the mark to the alarm information. acknowledge the event alarm with text description.
	Arming control for event alarm. clear the alarm manually. Enable / disable the alarm audio. Enable / disable alarm triggered pop-up image.
12	can be set the network transmission settings as per network performance.
13	**E-map :** Support load local map file (*.png / *.jpg / *.bmp / *.svg), support Main maps and sub maps for the areas.
	Permits users to add various points on the map to provide a convenient, efficient way for live viewing and handling the alarm information via the map system events. This operation provides instant notification and verification and optimizes the overall event handling process.
14	The system should have feature of recording at different frame rates.
15	VMS shall support windows and open source DBMS(PostgreSQL/ MySQL/MS SQL)
16	The VMS should be able to run on a hardware server of a reputable brand supporting Microsoft windows operating system.
17	VMS should support remote access for live viewing and archive search using any standard browser.
18	software licenses to view all camera i.e minimum 240 numbers are to be provided by the bidder
19	it shall support Video wall configuration. Add, edit and delete scenes. Set window division for the selected window. Click-and-drag the camera on the signal source panel to the display window of video wall

5. PCs FOR VIDEO SURVEILLANCE ADMINISTRATION / CLIENT SOFTWARE

FEATURES	DESCRIPTION
Processor	Intel i7 Processor 3.6 GHz with EM 64 Technology, 9th gen
Memory	16 GB (2 x 8Gb) memory, Up to 32 GB Max.-memory expandable through four DIMM slots
Cache (External)	2 x 1 GB L2 Cache
ROM	1 GB Flash ROM, Can be upgraded from a diskette
Expansion Bus	2nos PCI Express (x1), 4nos 32 bit PCI slots, 33 MHz PCI 2.2 slots, 1-graphics slot
Graphic Accelerator	N-vidia Quadra FX 4400(DVI/VGA/HDMI)with 1 GB Memory with dual monitor capable graphics card
Hard Disk	1 TB 7.2K rpm SATA hard disk
Power Supply	375 W switchable/50 Hz with dual power supply provisions
Keyboard	Cordless 104 keys window 8 keyboard, PS/2 Compatible
Operating System	Supports Windows 8, 7 or 10
Software	Windows Professional 8, 7 or 10
Power Management	EPA compliant
Desktop Manager	Based on SNMP protocol
Antivirus Software	PC-Cillin or equivalent pre-loaded
Diagnostic Software	PAQ 95 or equivalent pre-loaded
Network	Broad cam 10/100/1000 Mbps Ethernet adapter Network Interface Card with wake on LAN support
Interfaces	1 parallel, 8 USB 2.0, 1 serial, 2 Ultra ATA/100,2 optional IEEE1394, 1 PS/2 Keyboard, 1 PS/2 Mouse, 1 video, 1 Microphone jack, 1 Line-in jack, 1 RJ-45, 1 Headphone jack & 1 line-out jack (analog/SPDIF digital
Audio Card	Integrated AC 97/16 bit Stereo full-duplex and integrated speaker
Mouse	Cordless Mouse
Monitor	Monitors shall be with a minimum 19 inch color LED flat panel display.
CD DVD Writer	DVD/CD-RW Combo Drive with speakers
Printer	Laser Jet 20 ppm, A3 paper size.

6. PC FOR VIDEO WALL DISPLAY

CPU	Pentium® 4 Dual Processor 3.2 GHz, 800FSB, 512KC
Mother Board	Intel Original Mother Board
Memory	1 GB DDR RAM
Hard Drives	80 GB IDE @ 7200RPM
CD-Rom Drive	52x
AGP slot	1

Network Adapter (NIC)	Integrated 10/100/1000 Base –T
Sound Card	In- Built
PCI slots	Min 6 nos. on mother board
USB	2 nos. at front panel
Keyboards	Cordless Keyboard
Mouse	Cordless Mouse
Operating system	Windows 2000/XP

+7. L ED MONITORS for VIDEO WALL

Picture tube	55” Flat Screen Colour
Aspect ratio	16:9
Resolution	4K
System	PAL
Input	VGA port/HDMI/SDI/HD-SDI/display board
Operating voltage	AC 180-230 V, 50 Hz

8. DIGITAL VIDEO SURVIELLANCE SERVER CONTROL SOFTWARE

A GENERAL

1 The Network Video Management System shall be a software Based solution running on standard off-the-shelf computer server and communicating over Ethernet network using the TCP/IP network protocol.

2 The proposed solution shall not require proprietary computer hardware.

3 The proposed solution shall be Based on Windows™ 2019 Server Operating System or higher.

4 The NVMS shall be designed as a distributed architecture for a fully redundant operation. The following redundancies shall be Basic features of NVMS.

a) Redundant recording shall be a Basic feature of the NVMS

b) Failover recording capabilities shall be a Basic feature of the NVMS

c) Distributed recording capabilities shall be a Basic feature of the system

d) Distributed main Data base shall be a Basic feature of the system. The system shall not be Based on a single data base and rather on a data base failover architecture.

5 The NVMS system shall be Based on the latest in software programming technology and shall be Based on Microsoft .NET frame work.

6 The NVMS system shall support both analog and IP cameras

7 Support of analog cameras shall be done using Camera Encoder Video Servers and shall not require the installation of video capture cards

a) The NVMS shall support both NTSC and PAL video formats

b) The NVMS shall support video from IP fixed color/B&W cameras, PTZ/Dome cameras, infrared cameras, X-Ray cameras, low light/IR cameras, and any other camera that provides a composite NTSC/PAL 1v p-p video signal.

8 The NVMS shall support multiple Video Servers (Encoders) and Monitor Decoders technologies to interface with analog cameras and PTZ domes.

a) The NVMS shall support the MPEG-4 / H 264 Baseline and H 264 high profile video format/H.264 HIGH PROFILE AND BASELINE PROFILE

b) The NVMS shall support the MPEG-4 / H 264 Baseline and H 264 high profile video format

c) The NVMS shall support the MPEG-4 / H 264 Baseline and H 264 high profile video format

d) The NVMS shall support the MPEG-4 / H 264 Baseline and H 264 high profile video format

e) The NVMS shall support all the above video compressions simultaneously.

9 The NVMS shall sustain full operation using CIF, 2CIF, VGA, 4CIF 800 x 600 (0.5 m pixel) and Megapixel video resolutions (HD Resolutions)

a) The NVMS shall be able to support all cameras at the maximum frame rate and the maximum resolution while maintaining less than 80% load on the Server

10 The NVMS in addition to Video shall provide full Audio monitoring and recording functionality

11 The NVMS shall allow for 2-way audio communication using the audio interface

a) The NVMS shall provide the ability to communicate back to an audio enabled Encoder, Decoder or IP camera and provide an IP Based Intercom

12 The NVMS Audio function shall be available as independent sources and/or synchronized with video

a) The NVMS shall allow the use of audio inputs for Audio recording of telephone lines, microphones, radio systems or any other analog audio interface.

b) The NVMS shall allow for audio search by date, time and alarm event with or without association to video.

13 The NVMS video storage shall be capable of storing 100 cameras on each of the video archive servers each at 30 images per second NTSC/ 25 PAL, at 704x480 NTSC and 704x576 PAL video resolution.

14 The NVMS shall be Based on the TCP/IP communication protocol between all IP cameras, camera Encoders, monitor Decoders, Network Video Management Software and Media Storage Servers

a) The NVMS shall also support the UDP/IP network protocol.

15 The NVMS storage system shall be Based on advanced recording methods and shall not rely on the Windows Operating System to manage the storage.

16 The NVMS shall provide the coactivity to an external storage system

17 The NVMS storage option as a minimum shall provide RAID-10 redundancy

18 All storage redundancy and mirroring capabilities shall be done using hardware interface and shall not rely on the Windows Operating System to perform these operations and controls

19 The network Based video recorder server (Media Storage Server) shall as a minimum provide multi-video compression support in addition to the Base MPEG-4 and shall simultaneously record video from MPEG-4 / H.264/ H.265 Baseline and H 264 high profile video and H.264/ H.265 Baseline and H.264/ H.265 high profile image compression algorithm standards.

20 The NVMS shall allow for specific cameras to be set at the most optimized recording technique, MPEG-4 / H.264/ H.265 Baseline & H.264/ H.265 high profile and should be available for live monitoring and recording signals.

21 The system shall be flexible and as a minimum the compression scheme shall be able to run in one of several bandwidth selections. Bandwidth options shall include but not be limited to:

b. 64 Kb;

c. 128 Kb;

d. 256 Kb;

e. 384 Kb;

f. 512 Kb;

g. 786 Kb;

h. 1.5 Mb;

i. 2MB;

j. 3MB; and

k. 4MB.

22 The system shall allow the recording, live monitoring, playback of archived video audio, and data simultaneously

23 The NVMS shall allow the user to view live video at 30 fps NTSC/ 25 PAL /Higher while recording at a lower frame rate for more efficient video storage.

24 The NVMS shall allow the user to view live video at High resolution 4CIF /FHD while recording at a lower CIF or 2CIF for more efficient video storage.

25 The NVMS client application shall support multiple flat panel monitors to be connected to a single computer.

a) Each monitor shall have independent controls and shall support multi views up to 16 real time camera views.

26 The NVMS client application shall allow each user with the ability to view 32 cameras on a single PC all at 30fps NTSC/ 25 PAL

a) The system shall maintain the capability to add additional flat panel monitors for other applications.

27 The NVMS shall provide unlimited IP video outputs through the IP monitor Decoders.

28 The NVMS shall provide the user with the ability to fully control the system using PC Based keyboard or mouse.

29 The NVMS shall offer a plug and play type hardware discovery service with the following operations and controls:

a) Automatically discover devices as they are attached to the network

b) Discover devices on different network segments including the Internet and across routers.

30 The NVMS shall provide a reporting utility for tracking but not limited to the following options. Video and images shall be stored with reports for documenting events.

a) Alarms

b) Incidents

c) Operator logs

d) Service requests

31 The IP Based NVMS shall provide file export tool for export of single frames of video in J-PEG and BMP file formats and for export of motion video files in MPEG4/H.264/H.265 file format for transport and playback on computers utilizing a Windows environment

32 The NVMS shall allow for each of the system Media Storage Servers to be set for fail over recording or redundant recording independently.

33 The NVMS data base and video storage shall be Based on SQL Server 2000 or better

34 The NVMS data base shall be design as a distributed architecture and shall not introduce a single point of failure.

a) All data base information shall be stored in multiple locations simultaneously and shall not require manual or automated synchronization.

35 The IP Based NVMS shall allow for installation of Anti-Virus and network security Software

36 The NVMS shall be Based on a client – server architecture.

B **<u>NVMS SERVER SOFTWARE</u>**

1 The NVMS software shall consist of an MS-SQL Based Main Server Data base Server, Media Storage Server (audio and video storage), Digital Virtual Matrix, Internet Video Broadcasting Server, Incident Reports, Alarm Management, Network Management System and Watchdog modules

2 The NVMS SQL Based Data base Server shall offer the capability to be installed on multiple servers to enable distributed architecture on the LAN or WAN

3 The NVMS Data base Servers shall not limit the number of Media Storage Servers which can be networked together to form a distributed video management and recording system

4 The NVMS Data base Server shall maintain a catalog of settings for all the clients, servers, encoders, decoders and IP cameras in the system

a) The Server shall enable the client to dynamically create connections between Encoders and Decoders and view live or recorded video on

the digital VGA/HDMI/SDI/HD-SDI monitors (audio, video, serial ports and digital I/Os)

b) The Server shall provide the client seamless operation of all Encoders and Decoders available in the system regardless of the actual connection to different archive servers.

c) The Server shall detect signal loss and have the capability to alert the systems administrator

d) The Server shall receive all incoming events (motion detection and triggered digital input and relay output) in the system and take appropriate actions Based on user-defined event/action relationships.

e) The Server shall create an audit trail of all events and user activities.

f) The Server shall perform dynamic bandwidth management.

g) The Server shall authenticate users and give access to the NVMS Monitor Client application Based on predefined user access rights.

5 The NVMS Media Storage Server shall offer the capability to be installed multiple servers software on multiple Computer Servers to enable distributed archiving architecture on the LAN or WAN

6 The NVMS shall provide a Failover Server Data base Server module for system redundancy

a) The Failover Server shall synchronize its configuration data base with the main Server data base.

b) The Failover Server shall take over the NVMS main Server operations in the event there is network or main Server failure.

c) The NVMS shall support multiple Server failovers.

d) The NVMS shall allow for each of the system Failover Directories to operate independently.

7 The NVMS Media Storage Server shall support all camera connections indicated in BOQ, through video Encoders or IP cameras, all recording at 30fps NTSC/ 25PAL/Higher

8 The NVMS shall record all video from all cameras, Encoders and IP cameras, in the native video format of each (e.g. Mpeg-4, H 264 Baseline and H.264/H.265 high profile video compressions)

9 The NVMS shall record all video in real time simultaneously at bandwidth ranging from 8 Kb/sec to 4 Mb/sec, frame rates ranging from 1fps to 30fps NTSC/25PAL and resolution ranging from CIF (352X240 NTSC, 352x288PAL) to 4CIF (704X480 NTSC, 704x576PAL) and HD Resolutions.(25FPS-FHD)

10 The NVMS shall be able to set each camera frame rate, bit rate and resolution independently from other cameras in the system, and altering these settings shall not affect the recording and display settings of other cameras.

a) The NVMS shall utilize multicast network communication for video monitoring.

i Unicast Based equipment will not be considered as an approved equal for alternate system

11 The NVMS shall require no proprietary hardware for video and audio recording servers.

12. The NVMS shall not utilize any hardware or software multiplexer or time-division technology for video or audio recording and monitoring.

The NVMS shall provide a Failover Media Storage Server module for system redundancy

a) The Failover Archive Server shall synchronize its configuration data base with the Server Data base Server.

b) The Failover Archive Server shall take over the NVMS Archive Server operations in the event there is any system Archive failure.

c) The NVMS shall support multiple Media Storage Server failovers.

d) The NVMS shall allow for each of the system Failover Archive Server to operate independently.

14 The NVMS shall provide a Redundant recording module for system redundancy

a) The redundant recording shall record all video in multiple server, mirroring recording, and shall synchronize all setup and configuration data bases with the mirrored server(s).

b) The NVMS shall support multiple redundant recording servers.

c) The NVMS shall allow for each of the system Media Storage Server to be set for redundant recording independently.

15 The NVMS shall support a built-in Digital Video Matrix Switcher

a) The Virtual Matrix Switch shall provide a full matrix operation of IP video to analog output.

b) The Virtual Matrix Switch shall provide a full matrix operation of IP video to digital monitors.

c) The Virtual Matrix Switch shall have the capability of creating camera sequences with the following functionalities:

i Each Sequence shall have capability upto 500 cameras.

ii Each camera in the sequence shall have its own individual dwell time, from 1 to 60 seconds.

iii Each entry in a sequence shall have the capacity to trigger PTZ camera presets, patterns or auxiliaries.

iv Multiple users shall be able to view the same camera sequence simultaneously, not necessarily synchronized one with the other

d) The NVMS Virtual Matrix Switch shall have the capability to create and execute Visual Basic (VB) or .NET scripts on events or on schedules.

e) The NVMS Virtual Matrix Switch Macros shall give the Server Services the capacity to perform the following:

i Interface with Access Control Systems

ii Interface with Point of Sale Systems

iii Interface with Alarm Systems

iv Interface with Process Control Systems

v Interface with Building Management Systems

vi Automate user/client operations

f) The Virtual Matrix Switch shall have the capacity to interface with legacy video walls via a CCTV keyboard connected to Encoder, Decoder or the client PC

16 The NVMS shall support an Internet Video Broadcast server (IVB)

a) The IVB shall act as a proxy for NVMS client, Media Storage Servers and web Based clients connecting to the NVMS system via the Internet.

b) The IVB shall act as a Gateway for network topologies that restrict a client from receiving the multicast UDP video and audio streams directly from the Encoder/Decoder,

i The IVB shall communicate the streams via a unicast, UDP or TCP transmission protocol.

17 The NVMS shall support video motion detection module

a) The NVMS Media Storage Server shall perform Video Motion detection on each individual camera Based on a grid of 1320 motion detection blocks.

b) The NVMS Media Storage Server motion detection shall allow for multi zone masking.

i It shall either be set to full screen, one zone (all 1320 block activated), or a custom motion mask can be configured with multiple zones by selecting any number of available blocks.

c) The NVMS Media Storage Server motion detection sensitivity shall be adjusted by configuring the amount of motion required to trigger an alarm and the amount of time that the motion is present.

d) The NVMS Media Storage Server motion detection sensitivity shall be adjusted by configuring the amount of motion after trigger is required to stop the alarm and the amount of time that the motion is present.

e) The NVMS Media Storage Server motion detection shall provide a learning mode allowing the system to automatically learn the motion in the selected detection zone and subsequently use motion in the “learned” area to trigger motion alarm

18 The NVMS shall support a built-in Watchdog module

a) The Watchdog shall monitor operation of all services and automatically restart them if they are malfunctioning.

b) The Watchdog shall be responsible for restarting the application or in a last resort restart the server in case of malfunction of software components

19 The NVMS shall provide a full interconnectivity between analog matrix operations and IP video to analog and digital outputs.

20 The NVMS shall have the capacity for unlimited analog video inputs and outputs.

21 The NVMS shall have the capability to program each IP viewing station to view and control selected cameras only.

22 The NVMS shall provide a Windows Based GUI (Graphical User Interface)

23 The NVMS shall provide operation on multiple VGA/HDMI/SDI monitors connected to a single PC using standard hardware and software.

24 The NVMS shall be Based on a true open architecture that allow for use of non-proprietary PC and storage hardware that shall not limit the storage capacity and shall allow for gradual upgrades of recording capacity

25 The NVMS shall digitally sign recorded video using 248-bit RSA public/private key encryption.

26 The NVMS shall allow for changing the encryption key.

27 The NVMS Shall support management and control over unlimited satellite sites.

28 The NVMS shall provide alarm dry contact interfaces to allow for any alarm input initiating any action in the NVMS system.

a) The NVMS shall transmit dry contact information over the IP Digital Transmission Network.

29 The NVMS shall provide a serial interface for alarm input to allow for any alarm input initiating any action in the NVMS system.

a) The NVMS shall transmit alarm serial information over the IP Digital Transmission Network.

30 The NVMS Shall support full duplex audio communication and transmission signals over the IP Digital Transmission Network.

31 The NVMS shall provide alarm management module.

a) The alarm management shall be able to set any monitor or groups of monitors to automatically display cameras in response to alarm inputs.

b) The alarm management shall be able to reset automatically or manually alarmed video.

c) The alarm management shall allow for multiple modes of alarm handling capability, these modes to be programmed within the same system.

9. DIGITAL VIDEO SURVIELLANCE CLIENT CONTROL SOFTWARE

32 The NVMS client shall consist of Administrator Tool application, a Monitoring application, an Archive Player application, a Web Monitoring access, a Web Archive Player access and a Mobile Monitor application.

33 The NVMS client shall perform the following applications simultaneously without interfering with any of the Storage Server operations (Recording, Alarms, etc.):

a) Live display of cameras

b) Live display of camera sequences

c) Control of PTZ cameras

d) Playback of archived video

e) Retrieval of archived video

f) Instant Replay of live video

g) Use of graphical controls (maps)

h) Use of procedures (Macros)

i) Configuration of system settings

j) Execution of system macros

k) Events Back-ups

34 The NVMS client applications shall support any form of IP network connectivity, including: LAN, WAN, VPN, Internet, and Wireless (WiFi and Cellular) technologies.

35 The NVMS client applications shall support IP Multicast (UDP) and Unicast (TCP or UDP) video streaming.

36 The NVMS client applications shall automatically adapt to the network topology and use the best available method to receive streaming video.

37 The NVMS client applications shall provide an authentication mechanism, which verifies the validity of the user.

38 NMRS Client MONITOR Application

a) The Client Monitor application shall allow for live monitoring of video and audio.

i The Monitor shall enable view of 1 to 4 video tiles simultaneously on a single SVGA/HDMI/SDI monitor at 30fps per camera.

ii The Monitor shall enable view of up to 8 video tiles simultaneously on a computer supporting dual SVGA/HDMI/SDI (1024x768) monitor outputs at 30fps per camera.

iii The IP Based NVMS Shall provide on each of the VGA /HDMI/SDI monitors independently the following tile views:

1) Full screen

2) Quad

3) 3x3 (9-view)

4) 4x4 (16-view)

5) 1 + 9 (One large and 9 small view)

6) 1+11 (One large and 11 small view)

7) 1+12 (One large center tile and 12 small view)

8) 1+15 (One large and 15 small view)

b) The NVMS Monitor application shall allow operators to view an instant replay of any camera.

i The operator shall be able to define the amount of time he wishes to go back from a predefine list or through a custom setup period.

ii The operator shall be able to control the playback with play, pause, forward, and speed buttons.

c) The NVMS Monitor application shall allow operators to add bookmarks or to switch their instant replay view into the Archive Player application, for advanced operations, by clicking on a single button in the Instant Replay tab.

d) The operator shall be able to choose and trigger an action from a list of available actions included but are not limited to:

   i View camera in a video tile

   ii View camera on a Decoder (analog monitor)

   iii View Map or procedure in a video tile

   iv Starting/stopping PTZ pattern

   v Go to PTZ Preset

   vi Sending alert messages

   vii Sending e-mails

   viii Send/receive messages through a serial data stream

   ix Executing a macro

e) The NVMS Monitor application shall provide management and control over the system using a standard PC mouse, keyboard.

f) The NVMS Monitor application shall display all cameras attached to the system regardless of their physical location on the network.

g) The NVMS Monitor application shall display all camera sequences created in the system.

h) The NVMS Monitor application shall allow for unlimited cameras sequences, which can be run independently of each other on either digital VGA/HDMI/SDI monitor tiles or IP CCTV monitors.

i) The NVMS Monitor application shall allow operators to control (Pause/Play, skip forwards, skip backwards) Camera Sequences, without affecting other operators' ability to view and control the same sequence.

j) The NVMS Monitor application shall display all cameras, sequences and analog monitors in a logical tree.

k) The NVMS Monitor application operator shall be able to drag and drop a camera from a tree of available cameras into any video tile or an analog monitor icon for live viewing.

l) The NVMS Monitor application operator shall be able to drag and drop a camera sequence from a tree of cameras into any video tile or an analog monitor icon for live viewing.

m) The NVMS Monitor application shall support Graphical Site Representation (Maps) functionality, where digital maps are used to represent the physical location of cameras and other devices throughout facility.

   i The NVMS Maps shall have the ability to contain hyperlinks to create a hierarchy of interlinked maps.

   ii The NVMS Maps shall be able to import maps from any graphical software supporting BMP, JPEG and/or GIF image formats.

n) The NVMS Monitor application operator shall be able to drag and drop a camera from a map into a video tile for live viewing.

i The operator shall be able to click on an icon in a map to initiate PTZ camera preset, run PTZ pattern, view camera in an analog monitor or send an I/O stream.

o) The NVMS Monitor application shall support the procedure functionality, where procedures can be triggered to appear during a certain event and can be used to provide detail written or verbal instructions to the operator as to the actions to be taken.

p) The NVMS Monitor application shall support touch screen technology

i The operator shall be able to optimize the monitor for touch screen technology

q) The NVMS Monitor application shall support digital zoom on a fixed camera's live video streams

r) The NVMS Monitor application shall support digital zoom on a PTZ camera's live video streams

39 Each workstation running the IP Based NVMS client application shall be able to use a CCTV keyboard that can control the entire set of cameras throughout the system, even if the system consists of motorized cameras produced by different manufacturers.

a) The NVMS client shall be able to use multiple CCTV keyboards to operate the entire set of cameras throughout the system, including cameras of various manufacturers' brands, including their PTZ functionalities (i.e.: one keyboard manufacturer controls other manufacturer's dome or vice-versa).

b) The NVMS client shall allow for a CCTV keyboard to be attachable directly to a encoder/decoder via its serial port.

c) The NVMS client shall allow for a CCTV keyboard to be attachable directly to the PC runing the NVMS client application via its serial port.

d) The NVMS client CCTV Keyboard Interface shall provide full PTZ control.

i The operator shall be able to control pan-tilt-zoom, iris, focus, dome relays and dome patterns

ii The NVMS client software shall allow the operator to access the PTZ configuration menus with no need of additional hardware.

iii The NVMS client software shall allow for operator PTZ priority ranging from 1 to 255

1) This shall prioritize which operator has control over a camera vs. another operator trying to control the same camera at the same time.

e) The NVMS client CCTV Keyboard Interface shall provide full video matrix operations

40 The NVMS shall support full control for PTZ (Pan Tilt and Zoom) cameras.

UNINTERRUPTED POWER SUPPLY:

A. Features

On Line

- Built in protection against over voltage, overload, spikes transients and battery discharge.
- Alarm for battery operation.
- Rating of 5 KVA
- 15 Minutes SMF battery backup at full load operations.

INPUT

- Input 230 V AC single phase.
- Frequency: 50 Hz ± 5 %

OUTPUT

- KVA : 15 KVA
- Voltage : 230 V AC
- Voltage Regulation : 0.5 %
- Freq. Regulation : 50 Hz ± 5 %
- Overload : 150 % for 10 seconds

10. ACCESSORIES

A. Weather proof housing for outdoor application

The Housing should be made of extruded aluminum and should be weather proof. The minimum internal dimensions of the housing should be capable of housing the camera and the Verifocal lens.

The camera housing should be:

- Compatible to camera
- Suitable for the make and model no of cameras offered and as specified by the manufacturer
- Should be compact and indoor / outdoor type as required.
- Suitable for operation in upright and inverted position'
- Should be weather proof in case of outdoor mounting.
- Should be Vandal proof

B. Camera mount

The camera mount should be:

- Of the same make as that of camera and suitable for the model number offered as specified by the manufacturer.
- Should be compact and indoor / outdoor type as required.
- Should support the weight of camera. Camera accessories such as housing pan & tilt head in any vertical or horizontal position.
- Should be weatherproof in case of outdoor mounting.

C. Speed dome controller/PTZ controller

Speed Dome Controller should have variable speed joystick, LCD for programming and it should be able to control the Encoders as well as speed dome for PAN / TILT / Zoom operations and controls.

D. Video Wall Rack

The video wall mountings should be of powder coated MS frames/supports and should be strong enough to take care weight of all Monitors. It should be suitably fabricated in such a way that only screens of monitors should be visible outside. Power supply wiring with suitable capacity sockets /earthing should be neatly installed on the rack. Video wall computers should also be enclosed in the rack. The supporting frames of monitors should not sag due to its weight.

SPECIFICATION FOR IP BASED CAMERA

III. Fixed Camera Specifications :

A GENERAL

1 The network (IP) camera shall be with 1/3-inch high resolution color camera, high resolution digital video of 4CIF (704x480 NTSC / 704x576 PAL) using the MPEG-4 / H.264 / H.265 compression algorithm and TCP/IP transmission.

3 Mega Pixel Fixed Network Dome Camera or better	
Camera Model	To be mentioned by the Bidder …..
Camera OEM	To be mentioned by the Bidder …..
Camera Specification	
Image Sensor	1/3" Progressive Scan CMOS or better
Min. illumination	Color: 0.005 Lux (AGC ON), 0 Lux with IR
Lens	4mm or better
Image resolution	1920 x 1080
Shutter time	1/3 s to 1/100,000 s,
Streaming type	Camera shall offer three video streams (it shall be supported with independent resolution, bit rate and frame rates)
Compression format	camera shall offer video compression of H.265, H.264, MPEG4
Day &Night	camera shall provide true & day night (ICR) low-light capabilities.
Digital Noise Reduction	3D DNR
BLC features	should support
Wide Dynamic Range	120dB True WDR
ROI	should support
Privacy Mask	should support
Image Settings	image rotation, Saturation, Brightness, Contrast, Sharpness, White Balance.
Ethernet port	1 - RJ45 10M/100M Ethernet interface, PoE Supported
Protocols	TCP/IP,ICMP,HTTP,HTTPS,FTP,DHCP,DNS,DDNS,RTP ,RTSP, PPPoE,NTP,UPnP,SMTP,SNMP

Smart analytics features	Intrusion detection, Line crossing detection, Motion detection, unattended baggage detection, object removal detection, Face detection
On-board storage	Micro SD/SDHC/SDXC card slot
Network Storage	NVR (Support NFS, SMB/CIFS)
API	ONVIF standards.
IR range	min. 30m
Protection Level	IP 67, IK 10
Power Supply	12 V DC , PoE (802.3af/at)
Operating condition	-30 °C ~ 60 °C , Humidity 95% or less (non-condensing)
Certificates	CE, FCC, UL
Basic OEM Guideline	OEM should have more than 10 year's existence in India. (Any Govt. Order or Import Document etc needs to be submitted) and OEM should have own office in West Bengal.

3 MP Fixed Bullet Camera or better	
Camera Model	To be mentioned by the Bidder …..
Camera OEM	To be mentioned by the Bidder …..
<u>Camera Specification</u>	
Image Sensor	1/3" Progressive Scan COMS
Min. illumination	Color: 0.005 lux @(F1.2, AGC ON), 0 lux with inbuilt IR
Lens	4 mm or Better
Image resolution	1920 × 1080
Shutter time	1/3s to 1/100,000 s
Streaming type	Camera shall offer three video streams (it shall be supported with independent resolution, bit rate and frame rates)
Compression format	camera shall offer video compression of H.265, H.264, MJPEG
Day &Night	camera shall provide true & day night (ICR) low-light capabilities.
Digital Noise Reduction	3D DNR
BLC features	should support
Wide Dynamic Range	Support WDR: 120 dB
ROI	should support
Privacy Mask	should support
Image Settings	image rotation, Saturation, Brightness, Contrast, Sharpness, White Balance.
Ethernet port	1 - RJ45 10M/100M Ethernet interface, PoE supported
Protocols	TCP/IP,ICMP,HTTP,HTTPS,FTP,DHCP,DNS,DDNS,RTP ,RTSP, PPPoE,NTP,UPnP,SMTP,SNMP,IPv6
Smart analytics features	Intrusion detection, Line crossing detection, Motion detection, unattended baggage detection, object removal detection, Face detection
On-board storage	Micro SD/SDHC/SDXC card slot
Network Storage	NVR (Support NFS, SMB/CIFS)

API	ONVIF standards.
IR range	IR range min 50 Meter
Protection Level	IP 67
Power Supply	12 V DC , PoE (802.3af/at)
Operating condition	-30 °C ~ 60 °C , Humidity 95% or less (non-condensing)
Certificates	CE, FCC, UL
Basic OEM Guideline	OEM should have more than 10 year's existence in India. (Any Govt. Order or Import Document etc needs to be submitted) and OEM should have own office in West Bengal.

3 Mega Pixel Varifocal Network Bullet Camera or better	
Camera Model	To be mentioned by the Bidder …..
Camera OEM	To be mentioned by the Bidder …..
<u>Camera Specification</u>	
Image Sensor	1/3" Progressive Scan CMOS or better
Min. illumination	Color: 0.005 Lux (AGC ON), 0 Lux with inbuilt IR
Lens	2.8~12mm or better
Image resolution	1920 x 1080
Shutter time	1/3 s to 1/100,000 s,
Streaming type	Camera shall offer three video streams (it shall be supported with independent resolution, bit rate and frame rates)
Compression format	camera shall offer video compression of H.265, H.264, MJPEG
Day &Night	camera shall provide true & day night (ICR) low-light capabilities.
Digital Noise Reduction	3D DNR
BLC features	should support
Wide Dynamic Range	120dB True WDR
ROI	should support
Privacy Mask	should support
Image Settings	image rotation, Saturation, Brightness, Contrast, Sharpness, White Balance.
Ethernet port	1 - RJ45 10M/100M Ethernet interface, PoE supported
Protocols	TCP/IP,ICMP,HTTP,HTTPS,FTP,DHCP,DNS,DDNS,RTP ,RTSP, PPPoE,NTP,UPnP,SMTP,SNMP,IPv6
Smart analytics features	Intrusion detection, Line crossing detection, Motion detection, unattended baggage detection, object removal detection, Face detection
On-board storage	Micro SD/SDHC/SDXC card slot
Network Storage	NVR (Support NFS, SMB/CIFS)
API	ONVIF standards.
IR range	min. 50m
Protection Level	IP 67 , IK 10

Power Supply	12 V DC , PoE (802.3af/at)
Operating condition	-30 °C ~ 60 °C , Humidity 95% or less (non-condensing)
Mounting Arrangement	Should have compatibility to mount on the Pole with suitable accessories
Certificates	CE, FCC, UL
Basic OEM Guideline	OEM should have more than 10 year's existence in India. (Any Govt. Order or Import Document etc needs to be submitted) and OEM should have own office in West Bengal.

3 Mega Pixel Varifocal Network wireless Camera or better	
Camera Model	To be mentioned by the Bidder …..
Camera OEM	To be mentioned by the Bidder …..
Camera Specification	
Image Sensor	1/3" Progressive Scan CMOS or better
Min. illumination	Color: 0.005 Lux (AGC ON), 0 Lux with inbuilt IR
Lens	2.8~12mm or better
Image resolution	1920 x 1080
Shutter time	1/3 s to 1/100,000 s,
Streaming type	Camera shall offer three video streams (it shall be supported with indep resolution, bit rate and frame rates)
Compression format	camera shall offer video compression of H.265, H.264, MJPEG
Day &Night	camera shall provide true & day night (ICR) low-light capabilities.
Digital Noise Reduction	3D DNR
BLC features	should support
Wide Dynamic Range	120dB True WDR
ROI	should support
Privacy Mask	should support
Image Settings	image rotation, Saturation, Brightness, Contrast, Sharpness, White Bala
Ethernet port	1 - RJ45 10M/100M Ethernet interface, PoE supported
Protocols	TCP/IP,ICMP,HTTP,HTTPS,FTP,DHCP,DNS,DDNS,RTP ,RTSP, PPPoE,NTP,UPnP,SMTP,SNMP,IPv6
Smart analytics features	Intrusion detection, Line crossing detection, Motion detection, unattend detection, object removal detection, Face detection
On-board storage	Micro SD/SDHC/SDXC card slot
Network Storage	NVR (Support NFS, SMB/CIFS)

API	ONVIF standards.
IR range	min. 50m
Protection Level	IP 67 , IK 10
Power Supply	12 V DC , PoE (802.3af/at)
Operating condition	-30 °C ~ 60 °C , Humidity 95% or less (non-condensing)
Mounting Arrangement	Should have compatibility to mount on the Pole with suitable accessori
Certificates	CE, FCC, UL
Basic OEM Guideline	OEM should have more than 10 year's existence in India. (Any Govt. C Document etc needs to be submitted) and OEM should have own office Bengal.

Wireless Transmitter:

The wireless transmitter should have the following characteristics:-

Sl. No.	Features	Description
1	Frequency	Same Radio should operate in India ISM Band (preferably 5.8GHz) as per WPC Regulation
2	Topology	System should be able to perform as Point-to-Point and Point Multipoint without changing Hardware
3	Channel Bandwidth	System must support t 5MHz / 10 MHz / 20MHz / 40 MHz Channel Bandwidth
4	Channel Spacing	Configurable on 5MHz increments
5	Modulation	QPSK, 16-QAM, 64-QAM, MIMO, OFDM with Forward Er Correction (FEC), Should support automatic adaptive modula Should support automatic adaptive modulation
6	Transmit Power	System must support Automatic Transmit Power Control (ATPC) to limit the CPE unwanted power
7	Distance Coverage	System must support at least for 500 Ms
8	Vlan Support	VLAN support based on IEEE 802.1Q with 802.1p priority
9	Encryption	128 bit AES
10	Throughput	System must deliver actual/usable aggregate throughput of at least 100 Mbps in 20 MHz Channel Width
11	Encryption effect on throughput	Throughput capacity should not be reduced when using AES encryption
12	LAN Interface	System must support 100/1000Base(T) half/full duplex, rate a negotiated

13	Management	System should have support of Network Management with HTTPs, SSH, SNMPv2c. System should have support of IPv4 IP, ICMP, SSH, SNMPv2c, HTTPs, STP
14	Quality of Service	Three level priority (Voice, High, Low) with packet classifica by DSCP, COS, VLAN ID, IP & MAC Address, Broadcast, Multicast and Station Priority
15	Classification	System must provide the provision to configure rules to classi High Priority Packets
16	MAC (Media Access Control) Layer	System must support scheduled access rather than CSMA Technology
17	Anti Cloning	system must supports Anticoding Hardware for better security
18	Bandwidth	System should be able to configure symmetric & asymmetric bandwidth. Also should support flexible dynamic Upload and download percentage should be user configurable.
19	Identity-based user accounts	System must support minimum of four user with four possible user role as Administrator, Installer, User and Read only
20	DHCP	System must be able to receive the IP Address from DHCP Se
21	Spectrum Analyser	System must support Spectrum analyser tool to find the best available frequency to be used.
22	Performance Statistic	System must be able to provide detail statistic of Wireless and LAN Interface including Received packets, error, multicast , broadcast packet received
23	Ethernet Port	system must also support Secondary Ethernet Port which can directly connected to IP Camera
24	Protection	Shall support IP 55
25	WPC Approved	System must be approved from WPC

ACCESS POINT ANTENAS:

The anteeas to have the following features.
Frequency Range 5150 – 5875 MHz
Gain 23 dBi
VSWR 1.6:1 max
Maximum Input Power 50 Ohms
Cross Polarization >18 dB
Wind Survival 190 km/h (118 mph)

EARTHING REQUIREMENT

Protective (loop earthing) conductor (s) shall be laid along the runs the conduit between the metallic switch boxes and the distribution boards/switch boards, terminated thereto. These conductors shall be of such size and material as specified. Depending upon their size and material, the protective earth conductors shall be either drawn inside the conduits. When laid external to the conduits, this shall be properly clamped with the conduit at regular intervals.

The protective conductors shall be terminated properly using earth studs, earth terminal block etc. as the case may be.

Jointing of wires is not permissible, however looping may be done from point (same circuit) or using a terminal strip in junction box where site condition warrants, prior permission from Engineer-in-Charge shall be obtained.

19. SPECIFICATIONS TO BE FILLED BY VENDOR

Following data sheets to be filled and submitted by vendor during the submission of tender. The data shall strictly meet the specification given above.

Fixed Dome type Indoor Cameras		
Sl. No	**Technical specification**	**Supplier equipment specification**
1	Make	
2	Model Number	
3	Type	
4	Backlight compensation available	
5	Power Supply	
6	Resolution	
7	1/3" CCD conformity	
8	Lens specifications	
9	Lux Sensitivity	
Outdoor type PTZ Cameras		
Sl. No	**Technical specification**	**Supplier equipment specification**
1	Make	
2	Model Number	
3	Type	
4	Backlight compensation available	
5	Power Supply	
6	Resolution	
7	1/4" CCD conformity	
8	Lens specifications	
9	Lux Sensitivity	
10	Signal Format	
11	Construction	
12	Operating Temperature	
13	Pan Movement	
14	Pan/Tilt Speed	
Indoor type PTZ Cameras		

Sl. No	Technical specification	Supplier equipment specification
1	Make	
2	Model Number	
3	Type	
4	Backlight compensation available	
5	Power Supply	
6	Resolution	
7	1/4" CCD conformity	
8	Lens specifications	
9	Lux Sensitivity	
10	Signal Format	
11	Construction	
12	Operating Temperature	
13	Pan Movement	
14	Pan/Tilt Speed	
Digital Video Recorders		
Sl. No	**Technical specification**	**Supplier equipment specification**
1	Make	
2	Model Number	
3	Maximum image display	
4	Maximum recording speed	
5	Resolution	
6	Image compression method	
7	Remote communication	
8	Camera Inputs	
9	External sensor inputs	
10	Remote control available	
Color Monitor		
Sl. No	**Technical specification**	**Supplier equipment specification**
1	Make	
2	Type	

3	Resolution	
4	Front panel controls	
5	Screen size	
6	Internal Comb filter available	
SPECIFICATION FOR CCTV CABLE		
Sl. No	**Technical specification**	**Supplier equipment specification**
	CCTV System - Power Cabling	
a	Manufacturer	
b	Country of Origin	
c	No. of Cores	
d	Area	
e	Type	
f	Characteristics	
g	Standards	
h	Application	
	CCTV System - Video Signal Cabling	
a	Manufacturer	
b	Country of Origin	
c	Type	
f	Characteristics	
g	Standards	
h	Application	
	CCTV System - Control Cabling	
a	Manufacturer	
b	Country of Origin	
c	Type	
f	Characteristics	
g	Standards	
h	Application	

5.2 ACCESS CONTROL SYSTEM

1. SYSTEM DESCRIPTION

The Security Management System (SMS) specified shall be fully integrated and installed as a complete package by the Access/Security Control Contractor. The SMS / ACS shall be able to provide for and integrate (as required) the following subsystems:

- Integrated Access Control
- Alarm Monitoring
- Integrated Digital Video Management
- Interactive Alarm/Facility Graphics Display
- Wireless Alarm and Video Transmission
- Associated Access Control and Alarm Equipment Control
- Multiple Language Operation
- Multiple Tenant Operation
- Access Initiated and Event Initiated Control
- Elevator Control
- Workstation and associated equipment, as required.

The SMS shall be Based upon a distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on a true peer-to-peer, token passing Local Area Network (LAN). The SMS shall be capable of monitoring, recording, and displaying card access activity and supervised alarm inputs/outputs on a continuous, real time Basis. Each installation shall comply with local, state, and federal code requirements as applicable. The system shall be user friendly, providing a user interface that allows for training of non- technical personnel to effectively operate and administer the system.

The ACS shall be designed to provide a centralized location with the ability to monitor, control, view, and communicate from a secure location within a facility or within the facilities or systems network.

System expansion capability: Minimum 100% over specified requirements with no additional software or required software upgrades.

2. SYSTEM CAPACITIES

Total minimum number of Hosts: 1
Total number of concurrent hosts: 48
Total number of optional Backup Workstations: = total number of connected workstations
Support for up to 633,000 readers using either magnetic-strip, Wiegand, proximity, Biometrics, Pinpad technologies or user definable custom card formats.
Support for up to 6,120,000 unique ID records.
Support alarm monitoring of up to 1,638,400 supervised digital input points.
Support for 1,638,400 output control points
Support for 5,000,000 on-line transaction history records
Archive history limited only to hard disk space (Bidders to specify the hard disc capacity requirement)
Support for up to 1100 system passwords
Support for up to 10,000 unique graphics pages
Support for Ethernet Lan: TP (10 Base-T) Twisted pair, AUI (10 Bases) Thicknet, BNC (10 Base-2-default) Thinnet.

3 SYSTEM CAPABILITIES

The following functional capabilities are considered essential for the Security Management System (SMS) described in this specification:

A. Integrated Access Control
B. Intrusion Detection
C. Door Control
D. First Key Auto Unlock
E. Anti-Passback control
F. Alarm Assessment (Instructions)
G. Data base Security And Encryption
H. Dynamic Maps Displaying Alarm Points
I. If/Then/and/or/not operations and controls
J. Time Scheduled Events
K. Access Control initiated events
L. Windows Based, Mouse oriented operations
M. Dial – Up Alarm processing from remote locations
N. Dial – Up processing of Access Control operations and controls for remote locations
O. Ability to Import and Export cardholder data
P. Comprehensive User Definable Reports
Q. Comprehensive User Definable Archiving
R. Integrated Digital Video Management
S. Integrated Video Badging
T. Visitor Management Module
U. Two Man Rule
V. Escort Privileges
W. Support for OPC, DDE and ODBC technologies
X. Ability to be WEB enabled

4. RELATED WORK

4.1 DOOR HARDWARE

Not specifically covered under this specification. It will be the responsibility of the individual bidder/contractor to provide and install all electric locking equipment including but not limited to electro-magnetic door locks, egress equipment, door status/alarm switches, and related power supplies. All electronic door hardware provided shall meet the local authority having jurisdiction for its intended use. Any code deficiencies associated with the system once installed will be left to the installing contractor to be replaced with the appropriate equipment.

4.2 WIRING / CABLE SPECIFICATIONS

All wiring for Distributed Control Unit communications and all wiring for related sub-LAN controller communications shall be Belden 9184 or equivalent. Belden 9841 or equivalent may be used for LAN lengths not exceeding 5000 ft. (1220m).

All other cable is to meet the following requirements as outlined below:

- All cabling shall be shielded unless specified otherwise by a card access manufacturer.
- As a minimum, standard 18 AWG cable shall be installed unless in direct conflict with manufacturers specifications
- All cabling used in the implementation of systems integration shall be in accordance with the

recommendations of the manufacturer.

Provide specialist personnel for the complete wiring installation. Provide cables, conduits, cable tray and ancillary equipment necessary to complete the installation.

4.3 GROUNDING

Take particular attention to the grounding of equipment cases and shielded cables to eliminate noise interference and avoid electrical loops. Provide shielded cable for all communications cabling. Correctly terminate shields at ground bars and connect to the main building ground or as specified by the manufacturer.

- Insulate all incoming or outgoing shielded cables from control cabinet casings.
- Provide suitable terminals, where grounding of cable shields is required.
- Make provision of a through connection of cable shields for through connected communications cables.

4.4 SYSTEM SUPPORT

Provide a guarantee, in writing, of system support for a minimum period of six years after final completion, including provision for technical support, hardware, and spare parts. Demonstrate that the manufacturer's previous systems have not been made obsolete and that the manufacturer is committed to total and complete backward compatibility. System support shall include all aspects of the originally installed system as well as system training.

4.5 SUBMITTALS

Provide a submittal for approval prior to commencement of installation and training to include:

- English language description of system operation
- Single line diagrams
- Building floor plans indicating all related equipment and their termination point
- Input/output point schedules
- A copy of the data base put into logical groups that represent how information will be displayed to the user
- Sample graphics pages
- Floor plans showing location of all controllers and sensors
- Co-ordination drawings showing interface terminal numbers and cross-referenced wire numbers for all connections between the SMS and other equipment
- Details of all related equipment
- Full details of each control station including equipment and wiring diagrams and terminal layouts
- Fully detailed wiring diagrams for the entire security control, monitoring and electrical cabling installation

4.6 MATERIALS

Furnish and install at locations shown, the specified the following equipment to provide a completely operational Security Management System.

A. Door hardware and accessories
B. Card Readers
C. Monitors
D. PC Workstations
E. Network Interface Boards
F. Distributed Control Units
G. Security Control Units
H. Printers
I. Alarm relays
J. Miscellaneous cable, wire, associated connectors, and hardware
K. Power supplies

All materials and equipment shall be standard, regularly manufactured equipment.
All systems and components shall be thoroughly tested and proven in actual field use.
All system main control components shall be from one manufacturer.

4.7 EXTRA MATERIALS

Based upon the contractor's and the manufacturer's experience with the equipment's performance history, the contractor shall submit a final spares list for all operations and controls for this system. This list shall be Based upon a philosophy of maintaining a central system operation with a simple remove/replace capability. The final spares list shall be developed as a result of a joint customer/contractor review of the recommended list during the installation phase. Submit this final recommended spares list for approval prior to system completion, so that spares are available upon activation.

4.8 Definitions

LAN: Local area network.
UPS: Uninterruptible power supply.
SMS: Security Management System.
SCU: Security Control Unit
DIO: Discrete Input/Output Unit
READER: Selected card reader technology.

5. SECURITY MANAGEMENT SYSTEMS

5.1 GENERAL REQUIREMENTS

System administration shall be available from any workstation in the system. The system specifically must have the capability to support not less than 48 concurrent workstations connected on the network at the same time manipulating and modifying the same data base. The Security Management System shall support distributed processing such that all connected workstations function in a true multi-user, multi-tasking environment. The system shall not be dependent on a Server therefore fully Client / Server Based systems are unacceptable.

The system architecture shall be capable of supporting single sites and/or campuses as well as multiple sites located in different geographical locations. Any additional software options needed to support a multi-site or multi-campus system shall be included in the Base bid. Connection to remote facilities shall be handled through a TCP/IP connection.

The Operating System shall be Based upon a Microsoft Windows 2000, XP Professional, or Windows Server 2003 platform. Unacceptable operating systems include Windows 95, Windows 98, Windows ME, Windows NT4, Windows NT5, OS/2 and UNIX operating systems.

The system shall co-exist with the Microsoft Office Suite of applications.

The system shall support web Based viewing and control.

The system shall employ a non-proprietary, open, highly scalable data base Based on Microsoft SQL.

The system shall have the capability, as originally bid, to transmit alarm and video information to remote and wireless operator terminals. From these terminals, operators of the system shall be able to:

- Individually call up cameras from multiple locations at the same time.
- Individually call up pre-recorded video footage.
- Take control of the facilities electric locking equipment in order to perform an emergency lock down.

It is the intend of the customer to utilize as much of the existing hardware and communications infrastructure as possible to minimize the installation costs. Any associated integration with the existing system or systems should be considered.

5.2 SOFTWARE

A. GENERAL

The Contractor shall provide all software required for efficient operation of all the automatic system operations and controls required by this specification. Software shall be modular in design for flexibility in expansion or revision of the system. It is the intent of this specification to require provisions of a system that can be fully utilized by individuals with no, or limited, previous exposure to PC's and programming techniques and languages The software shall include a general-purpose operating system, as well as access control system application software. All available vendor workstation application software shall be provided with the system, and shall reside in each and every PC. Unbundled software packages where the vendor can charge the user extra fees, require dedicated workstations, require annual software renewal licenses or require systems rebooting for access are unacceptable.

The software in the system shall consist of both "firmware" resident in the controllers / card reader cum controllers and "software" resident in the operator workstations. The architecture of the system, and the application software/firmware shall be distributed with no single-system component responsible for a control function for the entire sub controller LAN. Each controller resident on the system shall contain the necessary firmware and I/O capability to function independently in case of a network failure. No active control sequences shall be resident in the PC workstations. All PC workstations shall be removable from the system without loss of control function -- only alarm monitoring, long-term history collection, data base additions/deletions, and operator monitor/command/edit operations and controls would be lost.

The primary operator interface to the system shall be through a graphical, “object oriented”, interactive presentation using a mouse and cursor for object selection and commands. The SMS contractor shall work with the customer to complete fully integrated graphics pages allowing operators of the system to manipulate controlled points using only a mouse. The system shall not be limited to only one type of operator interface at a time.

The system software shall support an operator definable “default” system page. The default system page shall be displayed upon system start-up, operator activity time-outs, and when the system is not in use. This default system page may be any one of the standard dynamic graphic pages or a custom display developed for this purpose. The operator shall be able to display their corporate logo, emergency information, etc. as the default system page.

The system software shall support "pop-up" windows for point commands. On selecting an object with the cursor, a window shall open up to present the operator with choices corresponding to the operator's

password authorizations. These point commands shall include state changes, manual override of application software, test mode activation and test value entry. This window shall include, for reference, the point's descriptor (name), the point's hardware address, and alarm status.

The system software shall support "pop-up" windows for point editing. On selecting an object with the cursor, a window shall open up to present the operator with a list of active point data base editors, if permitted by the operator's password level. Selecting one of these editors shall allow the operator to modify the Basic parameters associated with a point, as well as access any programs assigned to the point (such as time schedules, calculations, events, etc.).

The system software shall be Based upon interactive prompts and choices using "dialog boxes," as opposed to memorization of commands, "syntax", exact spellings, etc. This interactive prompt and choices approach shall be used in monitoring, issuing commands, and editing. Command choices shall be as simple as "clicking" the cursor over the correct word choice prompts (i.e., SECURE, RELEASE, UNLOCK), without typing in the letters.

The system software shall support a "zoom" function. It shall be possible for an operator to locate any system point to monitor status, issue commands, or edit associated data base without knowledge of the point's name, address, or associated controller, and without having to refer to a "tree" directory. The operator shall be able to zoom in on a building in a campus graphic, zoom in on a floor in a building graphic, zoom in on a door in a floor plan graphic, etc.

The system software shall be compiled for FDAter execution speeds and shall offer all of the following features and capabilities:

- Input / Output Capabilities: From any local PC workstation or any remotely connected PC workstation, the system operator shall have the capabilities through the keyboard/mouse to request dynamic displays of current values or status using a tabular or graphic format. A global data base sort utility shall allow an expanded tabular display of only the points on the current graphic display. This expanded tabular display shall list point name, hardware address, dynamic state or value, alarm status, override status, and test mode status.
- Obtain a summary of all access control doors with status (under access control, access control disabled, or access control ignored) and allow issuing commands to the access control doors to manually force the door to one of the above states, or provide a momentary release (act as a valid key/card access), or return to automatic control (remove manual state).
- Add, delete, or change points within each Controller or application routine while on-line.
- Change point I/O descriptors, status, and alarm descriptors and engineering unit descriptors while the system is on-line.
- Add new Controllers and sub-controllers to the system while the system is on-line.
- Develop, modify, delete or display full range of color graphic displays providing dynamic, animated displays. All development, editing and display work shall be capable of being performed with the system fully on-line and in full communications with the Controllers and sub-controllers.
- To enhance system response the data base shall be distributed with up to 96,000 ID records residing in each door-processing unit. Each DCU (distributed control unit) shall support a combination of up to 64 sub LAN controllers consisting of DPU's (Door processing unit), DIU's (digital input units), DIO's (digital input/output units). Each DPU and DCU shall be capable of providing full access control decision capabilities and monitoring of assigned input/output alarm points whether on or off-line with host computer.

5.3 DATA BASE CREATION AND SUPPORT

A. GENERAL

The intent of this specification is to provide an SMS system that will allow the owner to independently perform his or her own modifications to the system from any operator workstation. All changes shall be done utilizing standard procedures, and must be capable of being done while the system is fully on-line and operational.

The DCU on the Controller LAN shall automatically check a PC workstation's data base files upon connection to verify a current data base match. A utility shall inform the operator if the DCU's data base files do not match the backup files stored on the PC workstation, along with the date of the last DCU modification and date of the last backup. The owner must have, as a minimum, the on-line capability to:

- Add, Delete and Modify and points and parameters.
- Determine which PC workstation(s) will receive alarms, messages & transactions on a point by point / door-by-door Basis.
- Change, add, or delete English language descriptors (i.e., name). System I/O points may be identified either by name or by it's logical address. Up to 16 characters shall be available for the English language descriptor, which shall be used in all control sequences. Use of a second abbreviated point "name" for control sequences is unacceptable complexity.
- Add, modify, or delete alarm limits.
- Add, modify, or delete individual records.
- Add, modify, or delete points in start/stop programs, trend logs, etc.
- Create and/or modify override parameters.
- Add, modify, and delete any applications program.
- Create custom relationship between points. A general-purpose user utility shall be provided, such that the user can implement software interlocks, calculations, etc.
- Assign application programs to points (as opposed to assigning points to programs).
- Obtain an "audit trail" of which application programs are controlling an individual point, on a point-by-point Basis.

5.4 DOOR PARAMETERS

Provide a door parameters editor, which shall include the following options:

- Reader technology selected.
- User definable Wiegand reader formats between 26 and 64 bit.
- If the reader is for the cab of an elevator (lift).
- If the reader is used for “exit” (pushbutton exit being the default), and if so, whether the exit reader is used for continuous egress or is linked to the Mode Schedule of an “entry” reader.
- The minimum time (in seconds) allowed between successive “reads”. Used to adjust traffic flow rates through portals such as turnstiles.
- The polarity of the reader’s LED used to indicate a good read, etc.
- Whether anti-passback (APB) is implemented or not.
- What the entry zone number is (APB).
- What the exit zone number is (APB).
- Escort required criteria.
- Anti-passback criteria
- Customizable reader buzzer control per event type.
- Whether the door sense switch is used, and if so whether it is a normally open (NO) or normally closed (NC) contact.
- Whether the Request to Exit (RTE) is used, and if so whether it is a normally open (NO) or normally closed (NC) contact.
- Whether a shunt function is used.
- Whether the door-locking device (e.g., an electric strike) is used, and if so, whether it is activated for entry requests, exit requests, or both.
- How long the locking device will be unlocked after an authorized read or RTE pushbutton operation. The unlock interval shall be adjustable from 1 to 255 seconds.
- “First Key Auto-Unlock” shall be available to provide additional security for doors that implement access control after hours and automatically unlock the doors on a time schedule during the day. This feature does not unlock the door until an authorized key is read after the scheduled unlock time. If this feature is not used, the door is unlocked per the Door Mode Schedule, regardless of key activity.
- “Door Prop” alarm timer setting. This setting shall ignore the door monitor switch input for alarming during the timer interval. The timer shall be adjustable (operator selectable) from 1 to 7200 seconds.
- Individual door configuration for 2-man rule.
- The polarity control of the reader audible device to be configured for individual sounds Based upon the door event (forded door, valid card read, denied card read, door open to long).

5.5 SYSTEM PASSWORDS

To limit control by the system operators, the SMS shall support system passwords at both the host level and controller level.

- The host passwords shall limit user access and privileges to provide system level security. A password shall be required to "log on" to the system. The SMS host shall support up to 1,100 passwords. It shall be possible to enable or disable each and every individual function of the SMS on a password-by-password Basis using a simple point and click operation. Each password shall allow a 30-character operator name, a 10-character alphanumeric password, and 4 characters for the operator initials.
- System passwords time out after a user-defined period of time.
- The SMS System shall also be capable in utilizing the customers' pre-issued network ID and password to automatically log them into the SMS system.
- Logon passwords shall allow for any number of limited views
- Automatic expiration of passwords as set by system administrator.
- Non re-use of system passwords
- Screen settings and system configurations are remembered Based on password log in.
- User configurable ID card log on in lieu of keyboard log on.
- Separate from the SMS logon an additional layer of passwords shall limit operators from gaining access to certain control panel operations and controls. The controller passwords shall restrict user access and privileges to system controllers. The controller passwords shall support 4 levels:
- Level 1 – Display only access
- Level 2 – Display controller data, issue commands, acknowledge alarms.
- Level 3 – Display data, issue commands, acknowledge alarms and edit all operations and controls except the DCU password function.
- Level 4 - Display data, issue commands, acknowledge alarms and edit all operations and controls, including the DCU password function.

5.6 SYSTEM RESPONSE TIMES

Any state change or alarm condition shall be communicated to the SMS system immediately and without delays. The times listed below shall serve as the SMS systems maximum times for doing automatic refreshes and point polling.

- Change of State: Time for a change of state or value of a field point to register an alarm or update at the workstation: 3 seconds.
- Manual Command: Time for a manual command from the workstation to override a field device: 1 seconds.
- Graphics Display: Time to display a full graphic with current parameter values: 8 seconds.
- System Logs: Time to display a system log or report: 1 seconds.
- Global Data Transfer: Time for data to travel between standalone controllers: 3 seconds.
- Local Control Event: Time for standalone controller to initiate an output action after a change of input: 2 seconds.

5.7 ALARM /MESSAGES/EVENT SIGNALING AND ARCHIVING

A. ALARMS

The SMS shall provide for user definable alarm summary screens. As a minimum the SMS shall support critical alarms, priority alarms and routine alarms. The user definable alarms summary screens shall support four states as follows:

- Point in alarm (Un-Acknowledged)
- Point in alarm (Acknowledged)
- Point returned to normal (Un-Acknowledged)
- Point returned to normal (Acknowledged)

The system shall support operations and controls such that either of the two acknowledgement operations and controls can be disabled so that they are not required.

For a low priority informational alarm - acknowledgements would be configured as not required and the sequence in the alarm window would be such that the alarm would appear when it enters it's alarm state and automatically clear from the alarm window when it returns to normal. The operator is still given the ability to acknowledge the alarm and append text etc but this is not enforced.

For a medium priority alarm - "point in alarm acknowledgement" is required and regardless of whether the alarm returns too normal or not, the alarm will remain in the alarm window until it is

acknowledged. If the acknowledgement is prior to the return to normal then the alarm stays in the alarm window until the return to normal is received at which point it automatically clears down.
If the acknowledgement is after the return to normal then the alarm clears down once the acknowledgement process is completed.
For the highest category of alarms the return to normal message also requires to be acknowledged. This alarm cannot clear down until both acknowledgements have been given.

The system shall support user selectable colors by alarm category. The status colors shall indicate the following:

- Alarm – The point is currently in alarm, and the alarm has not yet been acknowledged.
- Alarm Acknowledged – The point is currently in alarm, and has already been acknowledged.
- Return to normal – The point went into alarm, but has since returned to normal without being acknowledged.

The configurable summary screens will display the date/time that each alarm occurred, the number of times the point has go into alarm, the point address, the name assigned to the point, the current status of the point, and the system graphic page the point can be found on. The Access Control System shall provide a means for storing all alarms, messages, and events for an indefinite period and allow for quick retrieval at any time. The Alarms data base shall be an open format. The Access Control System shall maintain as, a minimum, the latest 10,000 alarms for quick review or display. In the event of an alarm condition occurring, the Access Control System shall display a message on the operator workstation, print on the printer, sound an audible alarm, optionally display the graphic page the alarm point has been assigned, and optionally set off a visual annunciation (i.e. flashing lights).

The Access Control System shall have the following alarm processing features, all of which shall be user definable:

- Allow the user to add “wav” files to alarms Based on alarm category
- Incorporate an icon on the banner which shows the number of unacknowledged alarms
- Print of the alarm screen currently being viewed
- Define multiple filters on any alarm window
- Sort the alarms contained in any window
- Alter the display preferences for any window
- Remember preferences and filters by user login
- Send alarms to pagers, beepers, mobile phones, PDA’s, and e-mail
- Escalate alarms to other destinations Based on user definable parameters
- Provide for user selectable Image Verification Based on card access control alarms.
- Each off normal condition shall cause an alarm and an appropriate message, including the time of the alarm, system and point descriptor, and alarm condition. The operator shall have the capability to select, at any time, which state/value shall be considered alarms and which alarms shall cause automatic dial-out to occur.
- Each critical alarm or change-of-state message shall be displayed. All Controller LAN network alarm messages shall be stored on disk and may be reviewed on the CRT and/or printed on operator selected printers at any time. It shall be possible to sort this alarm/change-of-state data base by date, time and/or item fields.
- Provide an automatic page selection option for alarms. This feature (operator activated and selectable) automatically selects and displays the designated “best” graphic page for each alarm, even when the operator is signed off. In the event of multiple alarms, the page associated with the most recent highest priority alarm is displayed.
- Automatic user defined time delay of alarms during equipment start-up or shutdown shall be provided to prevent nuisance and false alarms.
- Unique alarm delays on analog and discrete input points to prevent "flutter" alarms.
- The operator shall have the capability to route specific alarms to specific workstations, and/or to specific pagers.
- Each operator workstation (user configurable) will have the ability to notify an operator of an alarm condition anywhere in the system. Alarm notification shall consist of:
- Automatic print of the alarm condition.
- Display of an icon indicating an alarm condition, including while in a third party program.
- Operator selectable audible alarm indication. The audible alarm will be user configurable.
- Relay operation at the PC workstation, used to activate notification devices where the operator will be too far from the PC to see visual indication, or the environment is too noisy to hear the PC's audible

alarm.

- Automatic alarm/message redirection of unattended workstations connected on a WAN.

B. EVENTS

The SMS software shall have the ability to automatically initiate commands, user-defined messages, take specific control actions, or change control strategy and application programs as a result of an event condition.

- An event condition may be an operator defined limit, a change-of-state, a specified state, or alarm occurrence, a return to normal or logical combinations of the above. Events shall not be limited to alarm occurrences only but shall also include time, dates, as specified system results. All event assignments or modifications shall be owner defined through the input keyboard.

C. MESSAGES

The system shall be capable of automatically displaying or printing a user-defined message subsequent to the occurrence of selected events. Events shall not be limited to alarm occurrences. It shall be possible for the owner to construct independent messages for each DCU, each with as many as 64 characters. The operator shall be able to:

- Compose, change, or delete any message
- Display or log any message at any time
- Assign any message to any event

The Messages data base shall be an open format or provide a means to export the messages information for use in other third party programs.

D. ARCHIVING

The system shall be capable of automatically archiving. Based on user configurable options the system shall be capable of:

- Automatic or manual archiving.
- The overall size must be fully configurable up to 5 million records. 3 millions records shall be stored online with no archiving.
- Start archiving Based on Time, Size, Operator or any combination.
- Decide where the archive will go.
- Archived items will be accessible directly from the access control systems alarm-handling screen.

5.8 TRANSACTIONS

Transactions Summary: Provide password-protected access to historical files containing Access Control related transactions. The Transactions Summaries shall be Based upon user defined “filters” to the Access Control data base. The filters shall operate over user defined time ranges for time and date, using a two entry (earliest, latest) selection for both time and date to support multiple days, each with a time slice, versus a continuous duration between two days. The operator shall be able to establish an unlimited quantity of custom “filters”, on-line. In addition to providing an “all transactions” filter, provide an operator definable custom filter template with the following entries:

- Filter Name
- Point Address - Doors shall be points in the system. Provide two Door Points which define the low and high end of a range of Doors
- Tenant - Provide two Tenant numbers which define the low and high end of a range of Tenants (1-255)
- Key/Card - Provide two ID numbers which define the low and high end of a range of ID numbers
- Zone - Provide anti-passback zones which define the low and high end of a range of anti-passback zones (0-64)
- Records Display type: Permanent/Temporary/Both as defined in the Individuals Editor.
- Device Name: 16-character Door or Elevator cab name. May be used as an alternative to the Point address range above, for operator convenience.
- Group Name
- Last Name

- First Name
- Field Names: Provide a separate entry for each of the 1 to 16 user-defined fields. These fields may have from 1 to 16 ASCII text characters, as well as the wild card? And * symbols for matching and sorting on subsets of a field.
- Transaction Selection: Operator shall be able to select from any or all of the following: Reader entry, Reader entry-elevator, Reader exit, Denied - schedule, Denied - APB, Denied - tenant, and denied -Issue, Denied - selection.

Provide a print utility for the transactions summary, which includes the following statistics:

- Reader entries for selected readers (excludes elevators)
- Elevator entries for selected readers
- Elevator floor selection
- Reader exits for selected readers
- Reader denials (Based upon Tenant, issue, selection, schedule, or APB)

5.9 ACCESS CONTROL PERSONNEL DATA BASE

A. GENERAL

Provide a personnel data base that shall reside in the PC workstation in a SQL format, and have access control operations and controls downloaded to the Controller and DPU for remote, standalone operation. Where the system consists of multiple PCs on a Commercial LAN, changes to the Personnel Data base in one PC workstation shall be equalized among all SMS workstations, automatically. All changes shall be done utilizing standard procedures and must be capable of being done while the system is on-line and operational. The SMS system shall employ a user-friendly "re-cycle bin" feature which is intended to protect the owner from accidental or incidental deletions of the cardholder or personnel data base.

The owner must have as a minimum, the on-line capability to:

- Add, delete, modify and copy new ID devices (keys, cards, templates) and link these to the Personnel Data base.
- Assign information to the Personnel Data base including the ID #, Last Name, First name, Group Name, and other user defined fields. The user shall be able to define the Field Name for the user-defined fields and field data base entries of 16 alphanumeric characters. In a multi-tenant system, individual authorized tenants shall be able to assign different field names to their respective Personnel Data bases.
- Video badging images
- Assign status to a card, which may be permanent (not a visitor), temporary (a visitor), or disabled (entered into the data base, but not enabled). For cards designated as temporary, allow the operator to pre-determine the activation schedule Based upon the following entries:
- Begin date (MM/DD/YY)
- Begin time (HH:MM)
- End date (MM/DD/YY)
- End time (HH:MM)

Provide a means for the user to define the content and order of data presented in the Personnel Data base editor specifically, provide the ability to set the sort order on any field and filter and sort the data within any field. The following options shall be available to the operator:

- Permanent records - include/exclude
- Temporary records - include/exclude
- Disabled records - include/exclude
- Display Order - allows the operator to select from key/card #, Last name, First name, Group, or any of the user defined 16 fields as the Basis for the primary ordering of the presentation display. For instance if the custom field "Social Security #" were selected, the individuals would be presented in order of the alphanumeric sort of the Social Security #.
- Key/card range - Displays only ID #'s between the low and high values entered.
- ASCII text parameters - For each of the custom fields, allows the entry of up to 16 characters for matching and sorting, including the wild card characters of? and *. * shall be the default and support all entries (a wide open filter)
- Anti-passback options whether hard, soft, or graced.

Provide a means to assign doors to designated tenants, groups, and individuals. Assign individuals to doors associated with the tenant that the individual is a part of and the group that individual is apart of.

Provide a means to assign Mode Schedules to doors, that determine when the door is under access control, when the door is unlocked, and when the door is locked (even against authorized access control devices). Also, an Anti-Passback reset trigger may be assigned to the door mode schedule to cancel and purge anti-passback "flags" set previously (i.e., the previous day).

Provide a means to assign Personnel Schedules to doors, that determine when (date and time) authorized personnel are permitted access to designated doors. Each personnel schedule shall support seven access intervals, each with a start and stop time (time slice). Provide a seven-day week plus

seven “special” days and two temporary days for each personnel schedule. Provide the ability to assign up to 31 personnel schedules per door.

Provide a means to assign personnel to "Groups" which consist of a combination of doors and associated personnel schedules. The system shall also be capable of issuing multiple groups to an individual cardholder. The user shall be able to assign individuals to groups to save keystrokes and manages organizational changes. Different tenants shall be able to assign different groups to their respective access control data bases.

5.10 REPORTS

A comprehensive report writer capability Based on Crystal Reports from Seagate shall be provided in each workstation. The report writer shall have design capability built in as well as provide report templates and report wizards. The report writer shall have the capability to sort and extract data from the on line open data base as well as from archived files and be able to generate finished custom reports. Reports shall be capable of manual initiation and/or printout as well as automatic printout. The system will have the capability to print reports on a daily, weekly, monthly, yearly, or automatically generate reports Based upon a set scheduled. The system will have the capability to print reports as a result of an “event”. This report writer shall provide the capability for statistical data manipulation and extraction. As a minimum, the custom report writer must provide the capability to generate four types of reports: statistical detail reports, summary reports, trend graphic plots for up to four variables, and x-y graphic plots.

Prepared Historical Report: Provide an on-line, historical, data base sort report utility, with the following features:

- Prompts to select data base sort by time, by date, by point (or range of points) with system supplied default values of 24 hours, today, all Controller LAN points, respectively.
- Prompts for activating conditional sorts, including: changes-of-state, alarms, returns to normal, operator sign ON/OFF (DI/DO), operator acknowledgments, command errors, program control of a point, test ON/OFF (DI/DO), manual ON/OFF (DI/DO), program control (AIC, Event) override, power restore, LAN reconfiguration, controller off-line, time/date modifications, and archive disk memory 90% full, 95% full, and full.
- Provide audit trail messages of operator edits of access control, specifically editing the data bases for individuals, groups, tenants, transactions, doors, personnel schedules, access-initiated control, and elevator control. Also, include door prop alarms, forced door alarms, and failure of the data base to download to field controllers.
- Single keystroke retrieval resulting in a report listing the most recent condition first, along with the time, date, address, name, condition type, and value.

The System shall provide the operator with a set of “canned” reports. The “canned” reports shall include but not be limited to the following:

- Alarms Door-Individual Field Roster
- AMT Archive Performance Report
- Analog Sample Report
- Archives Analog Sample Report
- Archive Consumption Sample Report
- Archive Demand Sample Report
- Archive Discrete Sample Report
- Archive Override Billing Sample Report
- Archive Runtime Sample Report
- Audit Trail Report
- Door-Group Roster Report
- Door-Individual Roster Report
- Door-Tenant Roster
- Group-Door Roster Report
- Group-Individual Field Roster
- Group-Individual Roster
- Messages Report

- Network Configuration
- Tenant-Door Roster
- Tenant-Group Roster
- Tenant-Individual Field Roster
- Tenant-Individual Roster
- Transactions - Doors Report
- Transactions - Individuals Report
- Zone Census Report

Free Form Historical Reports: An operator shall be able to manually request reports from a console keyboard. All reports shall have time and date and shall not be limited to "canned" or "standard" format. Data shall be gathered from the field LAN's automatically, and archived on owner-selected workstations. The systems shall include a report writer function that supports as a minimum, the following operations and controls:

- Long term data archiving to hard disk
- Automatic directives to download to transportable media such as floppy diskettes or tapes for storage
- Data selection methods to include data base searches, sorts, and manipulation
- Data extraction shall support mathematical manipulation
- Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed Based plots with not less than four (4) variables displayed.
- Generating reports either normally at operator direction, or automatically under PC directions. Both Events driven and scheduled automatic reports shall be supported.

Archiving to disk shall automatically occur as long as the PC workstation is ON and physically capable of communicating with the Controller LAN(s), regardless of what programs are currently being executed at the time data is needed to be stored to disk (i.e., an operator can be developing a financial spread sheet in Microsoft Excel when the SMS stores field trending information to disk -- the current Excel program shall not be interrupted or halted) for archiving.

Proprietary reporting packages will not be acceptable.

Provide facility to extract data from archived files and generate custom reports.
Automatically generate reports through user or fixed time schedules, or on demand.
Provide facility to generate reports in a user-defined format.
Provide facility to export (as a whole or individually) the following data to be used in some other common data base software package:

- Tenants
- Floors
- Doors
- Transactions
- Messages
- Passwords
- Individuals
- Groups
- Field Names
- Alarms (sorted by priority)

Support two printer operations. The alarm printer will print all alarm annunciations and return to normal, operator acknowledgments, action messages, system alarms, operator sign-on and sign-off. All operator control activities shall include the operator's initials in the printed and disk record.
The data printer will be reserved for printing reports, graphical page prints, and data base prints. Both printer operations and controls shall be available from any PC workstation.

5.11 HELP SCREENS

Context Sensitive Help Screens: Provide context sensitive help screen associated with the current keyboard/mouse input.

Application Sensitive Help Screens: Provide the capability to develop help screens tailored to job specific applications. These screens shall be displayed by selecting an icon from an associated graphic display. These help screens will be intuitive in nature and provide the operator the ability to perform the task at hand without any help from outside individuals. The help screens will automatically prompt the operator to enter relevant information in to specific areas of the system.In addition to the help screens, the SMS system will provide the operators of the system with administrative Wizards designed to aid in the training of operational personnel. These Wizards will also set operators through the process of modifying the cardholder data base. As operators are editing the cardholder data base through the Wizards, the information shall also automatically be added to the system with no additional editors being opened.

5.12 OPERATOR WORKSTATIONS

General

If required, provide an on-site operator workstation to provide user friendly, operator interface with the complete system.
If required, provide an off-site operator workstation to provide user friendly, operator interface with the complete system. Provide all operator interface software and commissioning.

A. Hardware specifications

Provide workstation equipment, conforming to the specified requirements. (Refer to the project requirements schedule).

Pentium IIII – 1.2GHZ or the latest configuration
512 MB Ram - File Master
256 MB Ram - workstation (equalization station)
40 gig. Hard Drive
DVD - RW Drive for data archiving
17 /21" Video Monitor w/display 800 X 600 – TFT screen
Windows Based operating System
Sound card/speakers for audible alarms

5.12.1 SOFTWARE GENERALLY

The Access Control System shall allow all connected workstations to function in a true multi-user, multi-tasking environment such that:

- All terminals can access the same network and data base at the same time.
- All terminals can access and/or control the same control unit at the same time
- All terminals can access and/or modify the same control unit data base at the same time
- All terminals shall be able to archive data, alarms, access transactions, and network actions to hard disk regardless of what application programs are being currently executed (i.e., LAN operating system, spreadsheets, word processing, etc.). All archiving disk traffic shall be accomplished on-line without affecting the operation of the current programs.
- An operating system to control all support operations and controls including memory allocation, disk access and external devices.
- An application package specific to the manufacturer's SMS, operating in a Microsoft Windows 2000, Server 2003, or XP Professional environment.
- Any other required proprietary programs for operations and controls such as graphics, reports etc.
- Latest revisions of all programs at time of practical completion.
- Licensing of software at time of practical completion.
- The software shall include all available software licenses for a fully integrated Security/Access Control and Lighting Control system.

Operator Workstation: Any operator workstation shall:

- Accept data from the Controller LAN on an as needed Basis without having to scan the entire network of DCU's for updated point data.
- Interrogate the Controller LAN for updated point data when requested by the system operator.
- Allow operator command of equipment connected to DCU's .
- Allow operator to place specific DCU's in or out of service.
- Allow parameter editing of DCU's, and "gateway" nodes (limited only by an individual operator's

password assignments).

- Store duplicate data base on file for every DCU and allow this data base to be downloaded to the remote panel while the system is on-line.
- Control or modify specific programs on a DCU Basis.
- Develop, store and modify dynamic color graphics utilizing system supplied mouse and mouse-supported software. It shall be possible for both mouse-supported workstations and non-mouse supported workstations to coexist on the same Controller LAN.
- Provide data archiving of assigned points throughout the system and to support overlaid graphing of this data utilizing up to four variables.
- To maintain system integrity, the operator shall have available an automatic DCU save utility. The data base of the DCU's shall be automatically uploaded to a workstation at 02:00 AM, for backup purposes. This utility will function for both direct connect and dial-up workstations.
- The operator will have the option of selecting daily, weekly or monthly as a scheduled frequency to synchronize time and date in DCU's from the PC workstation. This function will be performed for dial- up as well as direct connected locations. This program shall accommodate automatic daylight savings time adjustments.
- The SMS shall support not less than 48 operator workstations, each with simultaneous access to the Local Area Network. Regardless of how the operator workstations are connected to the Controller LAN (i.e., hardwired or via modem), the network shall support all specified operations and controls.
- The operator may print a selected DCU data base whenever desired. The operator shall be able to select any or all control parameters as needed. A "bind able" printout of the data base of each DCU , with a floppy disk backup shall be submitted with "as-builts" as part of the final acceptance procedure.
- The CRT shall have a feature to indicate audibly and visually, Off-Normal conditions and messages pending, whether in SMS operating mode or third party software mode.

5.12.2 GRAPHICS

The system shall support an operator definable "default" system page. The default system page shall be displayed upon system start-up, operator activity time-outs, and when the system is not in use. This default system page may be any one of the standard dynamic graphic pages, or may be a custom display developed for this purpose. Tiered graphics pages will be usable through the system allowing the operator the ability to penetrate further into the system to gain more detail on any given graphical point. The operator shall be able to display their corporate logo, emergency information, an index of all graphic pages, etc. as the default system page.

The graphics system employed by the SMS system will allow for the addition of "single button control" points to be located on any/all system graphics pages. These "single button control" points will perform a customer defined sequence of events such as:

- Automatically run and print reports.
- Secure all pre-defined doors.
- Unlock all pre-defined doors.
- Control 3rd party devices such as DVR's.
- Launch 3rd party applications
- Turn point's ON/OFF (DI/DO).
- Launch 3rd party applications such as:

1. Windows Media Player.
2. AutoCAD.
3. Microsoft Word/Excel.
4. Any Windows compatible application

6. DYNAMIC GRAPHIC PROGRAMMING

Shall be part of the ACS system and not considered as an add on feature.

The operator shall have the ability to create, construct, and modify existing "dynamic" graphics pages for monitoring and system control without the need of outside assistance. This graphics utility shall be

usable both for on-line control such as override and alarm acknowledgment, and for display of system status and alarm activity.The graphics program shall have the following features:

- Microsoft Windows-Based “Integrated” graphic package. A separate or optional graphics generation program or package is unacceptable.
- Minimum of one second updating of real time data.
- Page summary feature for all graphic pages.
- Operator modification of set points and adjustable parameters.
- User-friendly operator development of graphics.
- Comprehensive library of symbols.
- Ability to create user defined symbols.
- Provide an automatic page selection option for alarms. This feature (operator activated) automatically selects and displays designated “best” graphic page for each alarm, even when the operator is signed off. In the event of multiple alarms, the page associated with the most recent highest priority alarm is displayed.
- On-line graphic development shall be supported on all workstations connected to the LAN either as "hard-wired" direct connect or via remote dial-in.
- Provide for import of .BMP file format graphics developed in third party programs such as Paintbrush. Such imported graphics shall be used as a "backdrop", so that all other dynamic and animated system features may be superimposed on this graphic. Similarly, it shall be possible to import CAD type drawings, by first converting the CAD drawing from .DXF format to .BMP format.
- Add, delete, develop and/or modify custom dynamic color graphic displays utilizing either custom symbols or system-supported library of symbols. Graphics shall support at least 16 colors and not less than 60 outputs of real time, live dynamic data per graphic. The system shall allow this dynamic graphic data to be displayed as an animated symbol (i.e., when a door opens the door on a floor plan moves to the open position), an ASCII set (i.e., on-off), or as an analog bar graph. Each operator workstation shall support not less than 10,000 separate graphic pages.
- The contractor shall include 15 developed graphics as approved by the owner's representative for this project. The following graphic pages shall be provided As a minimum:
- Index page of all graphics, with direct selection.
- Floor plan of each floor with door status with point control.

System graphics: Provide the following graphic displays:

- Master graphic from which other graphics may be selected.
- Building elevations and plans: A number of graphics indicating position of security operations centers, plant rooms and major items of equipment and providing access to other graphics.
- A series of graphics (e.g. building sections) showing all equipment operational during fire mode.
- A series of floor plans showing all secured portals and sensor locations.
- System configuration: Indicating relationship of workstation, controllers, printers etc.
- Building single line electrical diagram: Graphic showing status and values of all monitored electrical equipment.
- Include graphics for the required spare points.
- Tenancy fit out: Allow for graphics associated with tenancy fit out.

During and/or after completing construction of the dynamic graphic flow chart, the cursor may be placed on the icon, and by "clicking" the mouse; the icon may be expanded into the associated data base editor for adding, deleting, or modifying the point, module, or application program. Similarly, the point may have its "pop-up" window called up to issue point commands, or overrides. Systems requiring graphic programming languages which are off-line, or require time delays for compiling, or which are not integrated into the primary operator workstation are not acceptable.

Select a graphic screen refresh rate between one-second refresh and 60 second refresh rate.

Graphic Display: On-line graphic development shall be supported on all workstations connected to the LAN either as "hard-wired" direct connect or via remote dial-in. The system shall support any mix of mouse-supported workstations or non-mouse workstations.

The systems graphic software shall provide the following minimum features:

- "Page Linking" such that it is possible to "zoom" into a specific door or any other page through a sequence of graphics without using anything but the system mouse.
- Generate, store, and retrieve library symbols for use in generating graphic pages.
- Single or double height characters.
- 60+ dynamic points of data per graphic page.
- “Hot Buttons” that are customer programmed to perform any number of sequences.
- Pixel level resolution. Graphics will be displayed on VGA monitors with a 640 X 480 resolution, minimum.
- Animated objects for discrete points (i.e., doors open and close on authorized access or when a parking gate opens it goes up on the screen).
- CCTV icons providing direct links to the device for full control.

7. SYSTEM CONTROLLERS

A. GENERAL

All points in the system shall be monitored and/or controlled through "intelligent" Distributed Control Units / card reader cum controllers. Each control unit in the system shall contain its own microprocessor and memory with a minimum 300 hours battery backup. Each control unit shall be a completely independent stand-alone "master" with its own hardware clock calendar and all firmware and software to maintain complete control on an independent Basis. Control Units generally shall:

Release all access doors in case of fire /fire related conditions.

- Acquire, process, and transfer information to the PC operator workstations or other control units on the network.
- Accept, process, and execute commands from the other control units or other input devices, or multiple PC workstations.
- Allow access to both data base and control operations and controls by multiple workstations at the same time.
- Record, evaluate, and report the changes of state and/or value that occur among points associated with the control unit. If any operator workstation or transmission network fails, but the power to the control unit does not, the control unit shall continue to perform all control operations and controls associated with the points connected to that control unit.
- Control Unit Upload/Download Capability: Each control unit shall be able to download from or upload to any PC operator's workstation. All point data shall be modifiable from any authorized PC operator's workstation and downloaded to the control unit over the Control Unit LAN. This upload/download shall be readily performed on a regular Basis without interrupting the control operations and controls in the control unit. All upload/downloads shall be performed without the operator workstation being taken "off-line. Additionally, all Control Unit upgrading shall be performed via a download from any workstation on the system; i.e. it shall not be necessary to replace e-proms to perform a system revision upgrade.
- The system controllers must provide an integral time clock and have the capability to synchronize time with operator workstation.
- The system controllers must provide a dedicated port for communication link between panels as well as a redundant communications port for backup communications and have the ability to auto-detect breaks in the network.
- The system controllers must provide a separate RS232 communications port for connection of portable operator's terminal (laptop PC and/or a hand held controlling device).
- Provide sufficient input/output modules to achieve the required control operations and controls, including the required spare points.
- Modules: Removable without having to disconnect field cabling.
- Control Unit Point Scanning: It shall be possible to independently set the scan or execution speed for each point in the control unit to an operator selected time from 1 to 254 seconds.
- Field door controllers will have the ability to store within their own memory the last card transaction.

7.1 CONTROLLER SOFTWARE/FIRMWARE

Provide the following features:

- Real time, day of the week and calendar.
- Automatic clock synchronization from operator workstation.

- Time schedules.
- Holiday schedules.
- Temporary schedule overrides
- Automatic Daylight Savings Time Switcher
- Software timers with one-second resolution.
- User-defined alphanumeric software and hardware point descriptors.
- Resident diagnostics, which continuously monitor the operation of the unit, enunciate faults (including continuous looping of control loops, unreliable data) and provide continuous operation using the last reliable data.
- Test mode to drive a selected point (not the physical service) to a selected value and observe the consequential effect.
- Password protection.
- Alarm processing program including the ability to redirect alarms according to alarm priority and time schedules.
- Flash downloadable.
- Individually addressed
- Spare points: Allow for all software associated with the required spare points.

Program loading: On-line, either from a personal computer directly into the Control panel or through the operator workstation network.

7.2 CONTROLLER APPLICATION ROUTINES

Automatic Time Scheduling (ATS):
Each Control Unit shall provide self-contained ATS programs for automatic start/stop/scheduling of devices. Each ATS program shall support up to seven normal day schedules, seven "special day" schedules and two temporary day schedules. The special days schedule shall support up to 30 unique date/duration combinations. Each load shall support an individual time program, as a minimum.

Each load shall be able to be assigned at least 17 control actions per day with one-minute resolution. Operator selectable time schedule operation choices shall include the following: Start, Optimized Start, Stop, Optimized Stop, Cycle, and Optimized Cycle.

A minimum of 30 holiday periods up to 99 days in length may be specified for the year.

It shall be possible to create "temporary" schedules up to a week in advance that will be in operation only on the day or days specified.

Support a temporary "special day" date and duration to be broadcast to selected or all sites to account for unusual situations Such as temporary operating hours or "snow days".

Support control actions to be performed at any operator selectable time of day as well as at "sunrise" and "sunset". Sunrise and sunset parameters shall be selectable Based upon time zone, latitude, and longitude.

In additional to individual load scheduling, provide for group scheduling by designating equipment to be linked to a “master” time schedule, for quick schedule changes of large groups of equipment which follow a common schedule. The master schedule shall provide a choice of fixed start and stop times by day, or a plus and minus adjustments to the existing schedule, in minutes. Master schedules shall provide a choice of immediate activation or activation at a later date and time.

Event Initiated Programming (EIP):
Each Control Unit shall provide event-initiated programs. An event may be initiated by any data point. Triggering an EIP shall cause a series of control actions in a sequence, i.e., if point A reaches an alarm condition, start points 1 through 12. Up to 64 sequences can be defined per Control Unit. Each sequence may cause up to 16 control actions. Sequences may be chained together.

Access Initiated Control (AIC)
An AIC is an automatically generated control action initiated in response to an access transaction for a selected tenant, group, or individual.

As a minimum, each Control Unit shall supply support for up to 64 AIC's regardless of the number of tenants assigned. If an AIC is directed to a single output the capability to initiate additional actions through Event Sequences and Event Action editors must exist. The capability must exist to cause control actions on a system wide Basis from a single AIC (i.e. turn on Air Conditioning, lights etc.). The capability must exist to assign a minimum of 24,000 users to a single AIC. As a minimum, the following access transactions shall be capable of generating an AIC:

- Reader entry
- Reader entry - elevator
- Reader exit
- Denied entry - schedule
- Denied exit - schedule
- Denied exit - schedule
- Denied entry - PIN
- Denied exit - PIN
- Denied entry - anti-passback
- Denied entry - issue #
- Denied exit - issue #
- Denied entry - selection
- Denied exit - selection

7.3 HARDWARE SPECIFICATIONS - DOOR CONTROLLERS

The quantities and types of door controllers shall be determined by the contractor Based upon the requirement to provide a fully operational system, as per the intent of the specification, as shown on the drawings and recommended by the manufacturer. As a minimum, the following features shall be supported in each Door Processing Unit:

Resident card holders. (Minimum 10,000 or depends on population)
Support for maximum 4 doors per SCU
Standalone Access Control Logic
Real Time Clock/Calendar
Resident Day & Date Based Logic
Central Control and Monitoring
First Entry Auto Unlock
Zoned Anti-Passback (Local DPU level & Global across LAN)
Elevators: one or two cabs, each with one reader.
2-Man Rule
Multi-drop RS485 communications
Fiber optic compatible
On-board battery charger
Optical tamper switches
switch addressable (0-31)
Supervised inputs
Flash downloadable
Supported readers technologies:

- I/DISC Touch Memory
- Magnetic Key & Card
- ABA (Track 2)
- Wiegand (26 & 32 bit)

- Proximity
- Watermark Magnetics
- Biometrics

7.4 CONTROLLER OPERATION

Distributed Access Control downloads all “local” access control parameters from the Host PC to the Door Processing Interface (DPI) and then to the Door Processing Unit, so that it may operate in a standalone Basis. This ensures rapid access processing and minimal dependence on a single point of failure. As a standalone controller, the DPU provides access to one or two doors. Support for a door monitor input, locking mechanism output, secondary alarm bypass output, and a request to exit input are provided for each door. Optionally, the second reader may be used for door exiting. When the door is controlled by two readers, anti-passback operation is available. As a distributed network controller the DPU allows centralized alarm monitoring, historical data collection, zoned anti-passback,

First Entry Auto Unlock allows the door to automatically unlock during the day Based upon a time and day schedule (Modes) in the DPU. However, this feature ensures that the door is not unlocked until at least one “authorized” person has arrived, following occupancy time.

7.5 DATA COMMUNICATIONS

NETWORK: RS-485
DATA RATE: 9600 BPS
CABLE SUPPORTED: 22 AWG twisted pair, shielded (low capacitance, eg. Belden 9184 or 9855)
CABLE LENGTH: 5000 ft (1500 m) maximum
LED's are provided to indicate data transmission, receiving data,
Normal power mode, standby power operation, RAM error,

7.6 ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE: 32° to 122°F (0°C to 50°C) without battery backup; 50° to 100°F (10° to 38°C) with lead-acid battery backup
OPERATING HUMIDITY: 10% to 80% RH, non condensing

7.7 HARDWARE SPECIFICATIONS - DIGITAL INPUT CONTROLLER

The quantities and types of controllers shall be determined by the contractor Based upon the requirement to provide a fully operational system, as per the intent of the specification, as shown on the drawings and recommended by the manufacturer. As a minimum, the following features shall be supported in each Digital Input Unit:

RS-485 Communications – Multi-Drop
Remote Operation Over Dial-Up Phone Lines
"Point" Based
Central Control and Monitoring
16 Supervised Alarm Inputs – Standard
4 States of Fault Supervision

- Cut
- Short
- Open
- Closed

Alarm Input Shunting Support

- Via DPI or MCI
- Centralized – Manual Overrides

Fiber Optic Compatible
On-Board Battery Charger
Tamper Input

7.8 DATA COMMUNICATIONS

NETWORK: RS-485
DATA RATE: 9600 BPS
NETWORK WIRING REQUIREMENTS:
CABLE SUPPORTED: 18 – 22 AWG twisted pair, shielded (low capacitance, eg: Belden 8760) CABLE LENGTH: 5000 ft (1200 m) maximumLED's are provided to indicate data transmission, receiving data, normal power mode.
TERMINAL BLOCKS: Removable screw terminal connectors

7.9 ELECTRICAL SPECIFICATIONS (As per manufacture's standards)

CONTROLLER: 24V (±10%) DC or AC (50/60Hz),
BATTERY CHARGE CURRENT: 2 Amps maximum (short circuit), 0.6 Amps typical
POWER SUPPLY: 115Vac or 250Vac transformer (50/60 Hz ±15%), 40VA, maximum
POWER FAILURE NOTIFICATION: Standard, using internal detection logic

7.10 ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE: 32° to 122°F (0° to 50°C) without battery backup; 50° to100°F (10° to 38°C) with lead-acid battery backup
OPERATING HUMIDITY: 0% to 80% RH, non condensing

8. HARDWARE SPECIFICATIONS - DIGITAL INPUT/OUTPUT CONTROLLER

The quantities and types of controllers shall be determined by the contractor Based upon the requirement to provide a fully operational system, as per the intent of the specification, as shown on the drawings and recommended by the manufacturer. As a minimum, the following features shall be supported in each Digital Input/Output Unit:

RS-485 Communications – Multi-Drop
Remote Operation Over Dial-Up Phone Lines
"Point" Based
Central Control and Monitoring
12 Supervised Alarm Inputs – Standard
4 States of Fault Supervision

- Cut
- Short
- Open
- Closed

8 Multi-Mode Form "C" Outputs

- Pulsed
- Tracking
- Latched

Alarm Input Shunting Support – VIA DPI or MCI

- Centralized – Manual Overrides

Fiber Optic Compatible
On-Board battery charger
Tamper input

8.1 DATA COMMUNICATIONS

NETWORK: RS-485
DATA RATE: 9600 BPS
NETWORK WIRING REQUIREMENTS:
CABLE SUPPORTED: 18 – 22 AWG twisted pair, shielded (low capacitance, eg: Belden 8760)
CABLE LENGTH: 5000 ft (1200 m) maximum
LED's are provided to indicate data transmission, receiving data, normal power mode.
TERMINAL BLOCKS: Removable screw terminal connectors

8.2 ENVIRONMENTAL SPECIFICATIONS

OPERATING TEMPERATURE: 32° to 122°F (0° to 50°C) without battery backup; 50° to 100°F (10° to 38°C) with lead-acid battery backup
OPERATING HUMIDITY: 0% to 80% RH, non condensing

9. PROXIMITY READERS

The reader shall be proximity type with Smart Card chips. It shall read the ID number of the card or tag when presented to the surface of the reader without physical contact. Read range shall be nominally 4 inches from the rear surface when used with a card. Maximum dimensions shall be 4.6 inches (11.7 cm) high x 5.5 inches (14 cm) wide x 1.4 inches (3.5 cm) thick. The reader may be mounted directly on any material including metal without the use of standoffs, or concealed behind any building material except metal.

An LED on the front surface of the reader shall indicate to the user that the card or tag presented to the reader has been read. An audio beep tone to indicate that the card has been read shall be available as an option.

Electrical connections from the reader assembly to the system interface or CPU shall be via color-coded, five conductor, #18 AWG shielded cable (six conductor optional audio tone).

Wiring from the reader assembly to the system interface or CPU may be run inside metal conduit or EMT, as may be required by electrical codes.

Any of the readers shall be capable of being powered by a 1.2 amp-hour battery for at least five hours.

Accidental or intentional transmission of radio frequency signals into the reader shall not compromise the system.

The reader shall function in the access control system's normal or anti-passback mode without changes to the reader.

The reader shall contain no internal code matching or memory devices to operate with a group of ID numbers.

The access control system readers shall have the capability to accept codes from any of the following proximity devices:

- The presence of small metal objects such as keys or coins near the card or tag shall not alter the code read by the reader or prevent the code form being read by the reader.
- The individual card or tag shall be derived from a population of at least 134 million unique codes.
- Cards or tags shall be sequentially numbered. The user may specify codes or numbers. Exact replacements for cards or tags, which may be lost, damaged, or stolen shall be available upon request. Cards and tags having the same number shall also be available upon request.
- Cards, key ring tags, or badge tags may be used interchangeably and shall be compatible with all readers in the system, regardless of the reader's physical size or style, and without any code matching or memory devices in the reader.

10. FIELD HARDWARE

A. **DOOR CONTACT / STATUS SWITCH**

UL Listed
¾" diameter recessed magnetic contacts with factory installed wire leads, minimum 1 ft. long – 22AWG.
Installation shall include the application of mounting compound for added adhesive strength.
Where field conditions prohibit the use of a recessed magnetic contact, surface mounted switch shall be used.
Type: Interior/Exterior,

B. **REQUEST TO EXIT SWITCH**

1 3/4" diameter opaque colored mushroom cap push button
Operation: Momentary N.O. and N.C. DPDB Circuits

C. **PROXIMITY CARDS**

Dimensions: 3.38" x 2.12" x 0.03"
Material: PVC
Slot Punch: Vertical/Horizontal
Permanent Marking: Includes P/N code, date code and ID number matching internal ID

E. **GLASS BREAKAGE DETECTOR**

UL Listed
FCC Certified
Detection range 25' minimum
Mounting locations at the wall or ceiling.
Recessed or Flush Mount, Tamper available
Operation: 25', 360° opposed.

F. **PASSIVE INFRARED SENSOR**

UL Listed
FCC Certified
Available in various designs to provide coverage of 30 ft. to 200 ft. depending upon the area of protection
Combination heat and motion sensitive detection technologies, both needed to verify alarm condition (dual- technology).
Ability to disable LED for Stealth mode
Sequential Logic Input

Automatic PIR temperature compensation
Catch sensitivity: 1ft. per second
Trouble output supervisory feature
Phase sensitive PIR processing
Ceiling, wall, corner, flush, and swivel mountable brackets to be available.

G. **LOCKING DEVICES**

All locking devices providing access are to be of the electromagnetic type to meet the following requirements as outlined below:

- Approved by the authority having jurisdiction, including local fire authorities to provide free egress at all times.
- Type: Electrified handsets, electric strikes
- UL listed
- Each door to be provide with an integral door status switch and magnetic bond sensor
- It will be up to the individual security contractor to provide the proper door locking equipment for each individual controlled door.
- All locking devices utilized on passages providing a main means of egress out of a protected space are to meet fire code and approved by the authority having jurisdiction, including local fire authorities
- Shall meet NFPA 101 Life Safety Code requirements
- UL listed
- Shall receive power from the lock power supply

J. POWER SUPPLY

Provide:

- Power supply rated for the total load of the control station for all input and output modules energized, without diversity.
- Protection against power surges and over voltages.
- Battery backup to support panel memory for a minimum of 72 hours.
- Battery backup to support electric locks for a minimum of 4 hours.
- Individually fused outputs.
- 24-volt AC/DC control circuits throughout.
- The same type and manufactured power supplies shall be used for ACS .

H. BOOM BARRIER: The boom barrier shall be either 3m or 4.5 m or 6 m as per site, with opening time of not more than 2 seconds, with loop controllers, boom controller, weatherproof exteriors armed with
20” long range readers and manual override switch for VIP movement. The boom shall be seamlessly connected to the nearest access controller and reports of IN/OUT movement to be recorded on the access management software.

11. INSTALLATION

Install all devices in locations as shown on the drawings in accordance with standard industry practice.

Install and adequately support fixed wiring throughout the installation. For cabling routes not specified in detail, submit a proposed route layout.

Handling cables: Handle cables to avoid damage to insulation and sheathing. Report any damage and replace or repair-damaged cable as directed.

Straight-through joints: Unless unavoidable due to length or difficult installation conditions, run cables for their entire route length without intermediate straight-through joints. Where straight-through joints are used contain within a junction box arranged so that they are accessible after installation.

Tagging: Identify all cables at each end and at crowded intermediate points by means of stamped, non-ferrous tags, clipped around each cable.

Fire Caulking: Provide the appropriate penetration caulking.

Cables in false ceilings: Secure from building structure, not from other services.

Cables in conduits: Feed cables into conduits in such a way as to prevent twisting and crossing. Do not use inspection fittings for drawing in cables.

Cables on trays and ladders: Fix cables neatly to trays and ladders in single layers and parallel to the tray edge to avoid unnecessary crossovers. Fix cables at intervals not exceeding 48” by means of non-corrosive FDAtening materials.

Segregation: Physically segregate data cabling from power and SMS input/out cabling and mains cabling from all other cabling.

PANELS
Install panels and controllers within a dedicated metal enclosure.
Documentation: Provide plastic fade-free points list in a pocket. Include terminal numbers, point addresses and short and long descriptions.

Small point controllers: Install adjacent to the controlled device, accessible for maintenance. Provide suitable enclosure.

11.1 TRANSMISSION SYSTEMS

The ACS shall utilize the above LAN architecture to allow all of the Control Units to share data as well as to globalize alarms. The Controller LAN shall be Based upon a peer-to-peer, token passing technique with a data speed of not less than 19.2 KB.
Each individual ACS control panel shall have the ability to maintain 100% of the information needed for it to operate in the event it is disconnected from the rest of the system. Systems that require a "master" communications controller or network manager for the data base storage and alarmed and activity buffering or operate in a degraded site-code mode are not acceptable.

11.2 COMMUNICATIONS

Utilize an established LAN or other communication standard to link all SMS equipment.

Technique: Token Passing network for Controller LAN, Polled for Small Point & Application Specific Controllers.

Configuration: A break in the communication path of the Controller LAN shall be announced as an alarm and shall automatically initiate a Controller LAN reconfiguration such that the resulting sections of the Controller LAN continue to function as separate LANs. No loss of control shall result from such a break in the Controller LAN.

Commercial LAN: Workstations on the Controller LAN may also reside on a higher tier "commercial" LAN. This "commercial" LAN shall be Based upon Ethernet, and comply with IEEE 802.3 standards. Where a "commercial" LAN is implemented, it shall be possible to connect multiple Controller LANs together, with global data sharing across this commercial LAN.

Alarms and special event notices shall be routed to different workstations on the "commercial" LAN-Based upon time of day, and day of the week.

Operator password assignment shall be available on both a system-wide Basis and a workstation-by-workstation Basis.

11.3 TESTING AND COMMISSIONING

A. General

The contractor shall perform all tests submitted in the “Test Procedure” section as outlined in the specification.

Provide a program for the testing and commissioning procedure. Use a qualified representative of the ACS supplier to co-ordinate testing and present at all tests and training courses and remain on-site until the ACS is fully operational.

B. Factory testing

Procedure: Submit procedure for factory test at least two weeks prior to the test.

After test: Submit summary of results and necessary modifications.

C. Site testing and commissioning

Carry out the following:

- Attendance at the testing of all equipment that interfaces to the ACS and confirmation of the operation of such equipment from the ACS interface terminals.
- Testing of all field wiring from terminals to field interface terminal strips.
- Testing and commissioning of all power supplies and batteries.
- Verification of communication to remote systems.
- Testing of the operation of each control point from the operator's workstation (if supplied) and verification of the status of all points and alarm operations and controls on graphic displays.

Demonstrate the following:

- Operation of each control loop.
- Globally transferred information such as alarms.
- Detection and action of all alarm conditions.
- Communications with PC workstations.
- Time schedules and after-hours operation.
- Mapping of system points to operator's workstation(s).
- Operator's workstation software.
- Power fail re-starts.
- Essential power mode operation.
- Fire mode of operation.

B. Final acceptance Test:

After the testing report and as built drawings have been approved by the customer's representative, the completed system shall be tested in the presence of the customer's representative.

Acceptance of the system shall require a demonstration of the stability of the system. Should major equipment failure occur, the contractor shall replace or repair component (s).

11.4 NOTICE OF COMPLETION

When the final acceptance test described above has been satisfactorily completed, the contractor shall issue a letter of completion to the customer indicating the date of such completion. The notice of completion shall be recorded by the contractor upon receipt of the customer completion letter. This date of record shall be the start of the one-year guarantee period.

12. SPECIFICATION FOR CABLES

12.1- 8 CONDUCTOR, 18-24 AWG, OVERALL SHIELDED, PVC/PVC FOR CARD READERS

Description : Shielded multi conductor control cable

Conductors : 18/22 AWG 7/32 Strand Tinned Copper, 6 conductors

Insulation : Colour coded PVC 0.010"

Colour Code : Black, white, red, green, blue, brown

Shielding : 100% aluminum Mylar foil shield overall with a 24 AWG 7/32 strand tinned copper drain wire.

Jacket : Gray flame retardant PVC 0.032"

Nominal OD : 0.205"

Capacitance : 33 pF/Ft between conductors

Ratings : Manufactured in accordance with UL subject 13, type CM

Passed UL VW-1 Flame Test
UL CM approved

12.2- 2 PAIR, 18 AWG, INDIVIDUALLY SHIELDED, POLYPROPYLENE INSULATED SIGNAL CABLE FOR INTELLIGENT CONTROLLER COMMUNICATION.

Description : 2 pair individually shielded cable

Conductors : 18 AWG 7/30 Strand tinned copper, twisted into 2 pairs

Insulation : Colour coded polypropylene, 0.008"

Colour Code : Black with red, Green with white

Shielding : Each pair individually shielded with 100% aluminumMylar foiled shield plus 22 AWG 7/30 strand tinned copper drain wire.

Jacket : Gray flame retardant PVC

Nominal OD : 0.170"

Capacitance : 35 pF/Ft

Voltage : UL rated 300 Volts

Ratings : Manufactured in accordance with UL subject 13, type CM

Passed UL VW-1 Flame Test

UL CM approved

12.3- 2 PAIR, 20 AWG, SHIELDED, MULTI-PAIR, SIGNAL CABLE FOR ELECTRICAL BOLT RELEASE.

Description : 3 pair over-al l shielded cable

Conductors : 20 AWG 7/28 Strand tinned copper, twisted into 3 pairs

Insulation : Colour coded polypropylene, 0.010"

Colour Code : Black with red, Black with white, Black with Green

Shielding : 100% aluminumMylar foiled shield overall with 22 AWG 7/30 strand tinned copper drain wire.

Jacket : Gray flame retardant PVC 0.020”

Nominal OD : 0.251”

Capacitance : 45 pF/Ft between conductors

Voltage : UL rated 300 Volts

Ratings : Manufactured in accordance with UL subject 13, type CM

Passed UL VW-1 Flame Test

UL CM approved

13. PEDESTRIAN FLAP BARRIER

1. GENERAL

A pedestrian flap barrier shall mean a barrier with two flaps made out of Soft Material, that shall open in case of an impulse from a valid card or any other type of access control system used/adopted for validation of pedestrians. The barrier shall close only after the validated pedestrian has passed and in the event the pedestrian chooses not to pass- the barrier shall close after a specified time. The barrier shall be operable in Normally Closed Mode also referred to as N/C Mode in which the flaps will remain Closed under normal circumstances. The Drive System shall be maintenance-free & almost noise-less providing 100% duty cycle. The High Torque Motor shall be free of any mechanical gears or gear box so as to avoid maintenance & shall come with a built-in mechanism for precise position feedback but not using limit switches. The design lifetime of the drives shall be at least 30 Million cycles or 10 years. The movements of flaps shall be smooth with minimal noise. The barrier shall avoid tailgating under normal circumstances. Appropriate sensors are used for this purpose. The barrier shall have dynamic braking for smooth resting of flaps. The barrier shall be controlled by a microprocessor Based controller. The barrier flaps shall be made of soft rubber/Polyurethane or a suitable material for enhanced pedestrian safety with internal metal reinforcement for stability. The barrier flaps shall be lockable at both the end positions in the event of power failure. The Barrier housing shall either be made out of Stainless steel or Mild Steel Powder Coated in Structured Finish.

2. TECHNICAL DETAIL:

S.No	Item	Description
1	Application	Indoor
2	Drive Technology	The Combination of a Brush-less DC Motor with in-built resolver shall make it a Drive with no wear & tear components. Additionally the absence of limit Switches & Slip Clutches shall provide trouble free operation w/o the need for constant maintenance.
3	Gate/Barrier Controller	Micro Processor Based Motor Controller shall have in-built Speed control and Dynamic Braking Features. Micro Processor Based Barrier Controller with Logic for Motor, Safety Sensors and Lane Indicators.
4	Throughput	25 to 30 persons per minute (excluding card validation time)
5	Operation	Bi-directional

6	Housing Dimension	Regular Lane : L 1300mm x W 250mm x H 1035mm Wide Lane : L 1300mm x W 280mm x H 1035mm with Telescopic Flap
7	Lane Width	Regular Lane : 520mm Wide Lane : 900mm
8	Flaps	Regular Lane: Soft Wing with metal reinforcement Wide Lane: Telescopic Soft Wing with metal reinforcement
9	Power Supply	230+/- 10% VAC, 50 Hz.
10	Finish	Mild Steel Powder Coated in Structured Finish / Stainless Steel finished to Grade 4 also known as Satin Finish.
11	Protection	All Housing and internal parts will be rust & corrosion free metals or alloys of high strength or with suitable epoxy coating
12	Power–Off / Emergency	Fail Safe Mode - Flaps shall Automatically Open during Power Failure. Also can be configured for Flaps to remain closed during power failure.
13	Safety	Soft flaps & the use of Brush-less DC motor for very quick reversibility and enhanced pedestrian safety
14	Duty Cycle	100%
15	Ingress Protection	IP 44
16	Braking	Dynamic Braking for smooth resting of flaps.
17	MTBF–Mean Time Between Failure	2 Million Cycles
18	Integration	Shall function in integration with Smart cards, proximity reader Based access control systems, Bio-metric systems etc.

TechnicalSpecifications - 100100 X-RAY Baggage Scanner

1. Tunnel Size - Minimum 100 cm W (width) x Minimum 100 cm H (Height)
2. Conveyor belt speed should be between 0.2 and 0.3 meter per second. Conveyor movement bi-directional
3. All machines should should operate on 230 VAC, 50 Hz power supply
4. Conveyor Capacity - 200 kg evenly distributed
5. Through put should be 300 bags per hour
6. Sensors > 1000 diodes, L-shaped detector (folded array type), In case of defective diode arrays, scanning should be disabled and error message should be displayed on the screen
7. Tube Voltage : 100 KVA to 160 KVA (Must be Adjustable)
8. Tube Current 0.3 to 1.2 mA (Must be Adjustable)
9. Duty Cycle - 100%
10. The X-ray beam divergence should be such that the complete image at maximum size of bag is displayed without corner cuts.
11. The radiation level should not exceed accepted health standard (0.1m R/Hr at a distance of 5 CM from external housing). Relevant certificate from AERB.
12. The operating temperature should be -5° to 50° C

13. Storage temperature - 20° to 60° C
14. Relative Humidity- 10 to 95% non-condensing
15. Resolution: The machine should be able to display single un-insulated tinned copper wire of 40-SWG or 36-AWG
16. Steel penetration: 28 mm guaranteed; 30 mm typical
17. Detector : 2048 channels in a L Shaped array
18. Video display - 17" or better LCD Monitor SVGA High resolution, low radiation, flicker free, resolution at least 1280x1024, 24 bit true color real time processing
19. X ray direction : Downward with Beam Launch Angle: 80°
20. **Health & Safety -** The machine must comply with requirements of health and safety regulations with regards to mechanical, Electrical and radiation hazards. The supplier/manufactures should furnish Test Certificate from Atomic Energy Regulatory Board of India regarding radiation safety.

21. **Computer Specifications -**

- Processor: Intel Core 2 Duo
- Memory: 2GB RAM
- Storage: 160GB HDD
- Video Card: 512MB Graphic card
- Platform: LINUX
- Backup: UPS (10 Min) for Computer

22. Other Features

- Multi energy imaging (4 color palette)
- Crystal clear images
- Black & white viewing
- Organic/ inorganic stripping
- Indigenous Design
- High penetration
- Variable edge enhancement
- Zoom 32 X or more

- Facility to view previous bag
- Manual image archive
- Configurable image processing keys
- Facility to count baggage
- Date /time display
- Have search indicator
- Have facility of high density alert (HDA)
- Manual Scan facility
- Automatic image archiving
- Image Printing Facility

23. XBIS should be Indigenous make and factory should be in India and its original equipment manufacturer (OEM) should be Indian, ISO-9001 certified company.

24. Production license from AERB should be submitted.

25. **Film Safety:** Guaranteed safety for high-speed films up to ISO1600. The machines should be film safe. In other words photographic films must not be damaged due to x-ray examination

26. Preference for equipment manufactured by MSME registered OEM.

27. **Optional Features**

- Threat image projection (TIP)
- Network Supervisory workstation (optional), capable of connecting multiple machines to one supervisory console.
- The X-Ray Baggage Scanner should have two small CCTV cameras to image the person who has kept the bag and the bag video. This video should be recorded and should be available for post event analysis.
- Conveyor Accessories (Input/ Output Rollers) - 1 mtr length SS

28. **Warranty -** 12 Months from the date of dispatch.

29. OEM should be Make in India.

30. OEM Service center should be in Kolkata.

31. OEM must have supplied the quoted machine in any Port Trust in India.

TECHNICAL SPECIFICATIONS FOR DOOR FRAME METAL DETECTOR:

1. It should be capable to detect both ferrous and nonferrous metals including 9 mm live cartridge, stainless steel knife.

2. Passage Dimensions
Height - 200 cm approx., Breadth - 76 cm approx., Width - 58 cm approx.

3. Weight: 90 Kg maximum

4. Construction of Door Frame: Light weight, rigid, laminated side panels with ABS plastic boots for panel protection. Also, the cross piece and control unit should be of Heavy duty aluminium.

5. Control Unit: LCD Display, alarm lights, LED bar graphs and control touchpads plus all wiring, connections and electronics are integrated into a single, lockable overhead compartment which eliminates exposure of wires and external control box and any tampering.

6. Power Supply: 220+/-10 VAC, 50Hz, 12-24 VDC, should be provided with internal battery backup for 6 hours minimum and the internal battery backup should be completely inside the control panel.

7. Alarm Acoustic and Optical alarm with alphanumeric display, height on person bar display (Metal locator), Low Battery Indication.

8. Sensitivity: Wide range of sensitivity setting and fine tuning from 1 to 200, Zone wise sensitivity setting required (to be shown at the time of demonstration).

9. Frequency: There should be minimum 100 frequencies which should be user selectable to configure the DFMD for placing adjacent to each other (to be shown at the time of demonstration).

10. Zones: Not less than 33 zones covering full height of the Instrument.

11. Calibrations: Manual and automatic by built in key pad. All Functions should be programmable & controlled by a microprocessor.

12. Counter: Intelligent Traffic counter for transit with option of counting either forward, reverse, subtraction reverse and bi-directional.

13. Detection: Uniform from top to bottom.

14. Throughput rate: 30 people per minute.

15. Multiple Metal Detection: Should be able to detect multiple metal objects of various size in all the zones simultaneously.

16. Protection Conform to relevant electric safety standard (Supported by Test Certificate from NABL (India) or other accredited labs from the country of origin of the equipment).

17. Other Features:

a. High discrimination between small masses and personal metallic objects.
b. Automatic synchronization for DFMD's located close to each other up to a distance of one feet side by side.
c. Programming protected by password.
d. Magnetic field should be harmless to magnetic media, electronic devices i.e. users of heart pacemakers etc. of pregnant women. (Supported by Test Certificated from NABL (India) or other accredited labs from the country of origin of the equipment), and (By a Govt. recognized Medical Institute).
e. Should not be effected by opening / closing of a metallic gate in vicinity.
f. Should not effected by heavily reinforced floors.
g. Should not be effected by external RF transmission and EMI (Supported by Test Certificated from NABL (India) or other accredited labs from the country of origin of the equipment).

18. Environmental Protection Standard: Confirming to IP55 standard (Test Report to be provided).

6. GAS SUPPRESSION SYSTEM

1. SCOPE OF WORK

Supply, Installation, testing and commissioning of Gas Suppression & Smoke Aspiration System consists of the following systems:
A. Gas Suppression System (FK-5-1-12 / Novec 1230 or equivalent)
B. Aspirating Smoke detection system.

2. CODES

Following codes shall be referred while finalizing & executing the scheme :

A. National Fire Protection Association (NFPA) - USA :

1. No. 70-90 or 70-93 National Electric Code (NEC)
2. No. 72-1993 National Fire Alarm Code
3. No. 101-91 Life Safety Code
4. NFPA 2001 Clean Agent Fire Extinguishing Systems
5. NFPA 70 National Electric Code
6. NFPA 72 National Fire Alarm Code

B. Underwriters laboratories Inc. (UL) - USA :

1. UL 50 Cabinets and Boxes
2. UL 268 Smoke Detectors for Fire Protective Signaling Systems
3. UL 864 Control Units for Fire Protective Signaling Systems
4. UL 268A Smoke Detectors for Duct Applications
5. UL 521 Thermal Detectors for Fire Protective Signaling Systems
6. UL 228 Door Closers-Holders for Fire Protective Signaling Systems
7. UL 464 Audible Signaling Appliances
8. UL 38 Manually Activated Signaling Boxes
9. UL 346 Water flow Indicators for Fire Protective Signaling Systems
10. UL 1481 Power Supplies for Fire Protective Signaling
11. UL 1076 Proprietary Burglar Alarm Units and Systems
12. UL 1971 Visual Notification Appliances

C. Factory Mutual Systems (FM) Publications

Factory Mutual Approval Guide

D. National Electrical Manufacturers Association (NEMA) Publication

Enclosures for Industrial Controls and Systems

E. U.S. Environmental Protection Agency, Protection of Stratospheric Ozone 59 FR 13044 (SNAP).

Equivalent European standards shall be acceptable in lieu of UL standards.

F. ANSI A17.1 Safety Code for Elevators and Escalators

National Building Code

3. PERFORMANCE GUARANTEE

The contractor shall be fully and solely responsible for proper , safe and efficient design and performance of the system installation , in conformity with drawings and parameters and specifications stipulated in the contract documents.
Incase the Contractor finds that anything contained in the drawings, specifications or given parameters will not ensure such performance and compliance with best trade practices and codes, rules and regulations laid down by Authorities, he shall bring such matters to the attention of the Consultant /CFO and shall follow their instructions. The contractor shall indemnify and save harmless the consultant and the employer in consequence of the design , manufacturing defects, construction defects, found in the executed work at any time in a period commencing with the grant of completion certificate by the employer / consultant to the contractor in accordance with and subject to the provisions of the said contract.
The contractor shall also guarantee that the performance of the various equipment individually shall not be less than specified ratings when working under operating conditions given for the respective items in the finally accepted "schedule of equipment."
GAS SUPPRESSION SYSTEM. (FK-5-1-12 / Novec 1230 or equivalent)

3.1. SCOPE OF TENDER

Fire suppression system is fire detection and quenching system. This is proposed for Server room at second floor where data or digital information is stored / processed. Any small quantity of Fire can lead to high loss of data/information. All accessories used for this system including Gas, Cylinder etc. shall be UL and FM approved. Additionally all cylinders should be CCoE/PESO approved.
FK-5-1-12 / Novec 1230 or equivalent system is proposed in the Data Center.
a. FK-5-1-12 / Novec 1230 or equivalent system shall have 25 Bar pressure and shall activate by detecting smoke using high sensitive LASER-Based Smoke Detectors in the Server Room.
b. Once smoke is detected a Basic alarm (strobe/hooter) is annunciated called as 1st stage alarm. This alarm states, that the area is under fire state & necessary action to be taken. If the alarm is not reset by the set time another alarm called as 2nd stage alarm is annunciated.
c. 2nd stage alarm is an audible voice alarm stating people, to vacate the Server room. In between both these, alarms the security manager or the IBMS controller can reset the panel electronically from his PC.
d. If the panel is not reset after the 2nd Stage alarm a solenoid valve switch activates the FK-5-1-12 / Novec 1230 or equivalent cylinder, allowing the high-pressure gas to flow out & quench the fire in the Server room . Alarm cannot be reset / aborted from P.C. person has to physically go to location of fire to reset / abort the gas release.
3.2. The contractor shall supply, install, test and put in operation an FK-5-1-12 / Novec 1230 or equivalent Based fire suppression system. The fire suppression system shall include and not be limited to gas release control panel, seamless cylinders, discharge valve (with solenoid or pneumatic actuator) as the case may be, discharge pipe, non-return valve and all other accessories required to provide a complete operation system meeting applicable requirements of NFPA 2001 or ISO standards and installed in compliance with all applicable requirements of the local codes and standards.
The system design should be Based on the specifications contained herein, NFPA 2001 & in accordance with the requirements specified in the design manual of the agent.
The bidder shall confirm compliance to the above along with their bid.
3.3 Design and Engineering
Systems shall be designed taking the extinguishing concentration and a minimum design concentration of as applicable to class 'A' and class 'C' risks.
The system design must consider the limitations caused by the void height. It should also consider temperature in the void and leakage factor of about 10% to determine the appropriate quantity of agent required. The contractor shall indicate the percentage of leakage factor considered in the design. The vendor should clearly indicate the qty. of the gas in Kgs. to be used for the system. All voids within each hazard shall be discharged simultaneously. Each hazard shall have an independent system, unless otherwise specifically stated, when a centralized system with directional valves can be used.

Fill density should be considered for the agent to be discharged within the specified time of 10 seconds.
The system engineering company should carry out the piping Isometric design and validate the same with a hydraulic flow calculation generated by using the agent's design software. The appropriate fill density to be arrived at Based on the same.
The design & calculation shall be checked & certified by the supplier of gas from where it is being sourced outside India. The contractor has to take into consideration the routing available while designing the pipe network.

3.4. Gas Authentication

A certification (from the manufacturer of the agent or their direct distributor) on the genuinity and quality of the agent filled in the system procured should be submitted by the System Engineering Company. Gas procured from China / Korea is not acceptable.

3.5. Filling, Refilling and Maintenance

The cylinders to be filled in India only, preferably from UL listed filling centre. In case of any leakage or accidental discharge of the agent, it should be possible to refill the cylinders in India itself. The contractor should indicate the source of refilling and time that will be taken for refilling and replacement.

3.6. Discharge Time

As gas has to be fully discharged within 10 seconds for effective quenching of fire as per the relevant standards, the contractor has to ensure that the design meets this requirement. Once the discharge takes place there should be warning signs restricting personal from entering the protected area until the gas has been cleared from the area.

4. MATERIALS AND EQUIPMENTS

4.1 All materials and equipments shall be from approved manufacturers and shall be suitable for the performance of their respective operations and controls.
The cylinders should be complete with all accessories. The contractor shall indicate the dimensions of the cylinders required for each area while quoting.
The number of nozzles and their positions must be chosen so that the design concentration is established everywhere in the enclosure.
The gas release panel should have manual override and manual discharge keys/lever.

4.2 Cylinder

The cylinder shall be high pressure, seamless steel gas cylinder, flat type, concave bottom as per IS 7285 complete with neck ring.
Appropriate fill density shall be chosen Based on the cylinder location and piping retrofit. The hydraulic calculations should prove that the fill density is appropriate and total discharge will take place within 10 seconds.
The cylinders shall be super-pressurized with dry nitrogen to 25 bars at 20°C. The cylinder shall be capable of withstanding any temperature between -30° C and 70°C.
Cylinder shall be mounted according to manufacturer recommendations.
The cylinder shall withstand Hydrostatic test pressure up to 250 bars and maximum working pressure at 15°C shall be 150 bars.

4.3 Valves

The discharge valve shall be UL listed for use with gas. All the gaskets, O-ring, sealant and other valve component shall be constructed of materials compatible with the clean agent.
The system should be engineered using hardware approved for use with gas systems. This would include main discharge valve, solenoid, check valve / non-return valve and pneumatic actuators.

4.4 Pipes and Fittings

All Pipes shall be of ASTM - A-106, Gr: B, schedule - 40 seamless Mild Steel Pipes and fittings shall be as per ASTM-A-105 standard.

4.5 Discharge Nozzle

Nozzle shall control the flow of gas to ensure high velocity, proper mixing in the surrounding air and uniform distribution of the agent throughout the enclosure. The number of nozzles and their positions must be chosen so that the design concentration is maintained everywhere in the enclosure. Nozzle shall be located where they can be adequately supported on walls, ceiling or structural members. Software generated calculation supporting the nozzle design shall be submitted by the successful bidder before signing of contract.

5. TESTING AND DOCUMENTATION

I. SYSTEM INSPECTION and CHECKOUT

After the system installation has been completed, the entire system shall be checked out, inspected, and functionally tested by qualified, trained personnel, in accordance with the manufacturer's recommended procedures and NFPA standards.

A. All containers and distribution piping shall be checked for proper mounting and installation.

B. All electrical wiring shall be tested for proper connection, continuity and resistance to earth.

C. The complete system shall be functionally tested, in the presence of the owner or his representative, and all operations and controls, including system and equipment interlocks, must be operational at least five (5) days prior to the final acceptance tests.

D. Each detector shall be tested in accordance with the manufacturer's recommended procedures and test values recorded.

E. All system and equipment interlocks, such as door release devices, audible and visual devices, equipment shutdowns, local and remote alarms, etc. shall function as required and designed.

F. Each control panel circuit shall be tested for trouble by inducing a trouble condition into the system.

II. DOCUMENTATION

The bidder should be one of the authorized systems engineering companies of the gas supplier or should have a back up letter of support from one of the authorized system engineering companies of supplier of gas from abroad from where gas is being sourced. A copy of the same shall be submitted along with the bid documents.

The system engineering company should prepare & submit along with the bid documents, the piping Isometric drawing and support the same with a hydraulic flow calculation generated by using the agent's design software. The calculations shall validate the fill density assumed by the bidder.

The bidder shall submit copies of the datasheets of the hardware used in the system.

The System Company should provide, as part of handing over, the as-built drawing, operation manual and maintenance manual. The as-built drawing shall exactly match the Isometric drawing submitted with the flow calculation prior to commencement of work.

6. AUTHORIZED GAS PROCUREMENT AGENCIES IN INDIA

Gas shall be procured from only following agencies in India and contractor shall furnish certification at the time of supply.

6.1 FK-5-1-12 / Novec 1230 or equivalent

The FK-5-1-12 / Novec 1230 or equivalent system should be procured directly from the principles/authorized distributors or agents in India. While dispatching the material for this project, the contractor should enclose the quantity and quality verification certificate for the gas or reagent along with their provisional certificate for the installation / scheme. The quantity and quality certification format should be as per NFPA or any other reputed international standard. The installation certificate should be as per standard guidelines of NFPA or should meet UL standards in full. Principles / Authorized agents / distributors would only be supporting this project for installation, commissioning and post warranty support. Refills beyond the commissioning period should be also directly procured from them through the process as described above. No gas procured from China / Korea shall be accepted.

6. PARKING MANAGMENT SYSTEM

MOTORISED BOOM BARRIER

S No.	Parameters	Technical Specification	Compliance	
			YES / NO	Deviation
1	Boom length (mt)	upto 6 mtrs		
2	Height of boom from ground (mm)	min 900		
3	Housing dimension (mm)	min 450x280x1000		

4	Protecting rating	IP54		
5	Type of Boom	Cylindrical		
6	Boom Dia (mm)	min 100		
7	Control panel power supply(V)	230 A.C.50/60Hz		
8	Motor power supply(V)	24 D.C		
9	Max power(W)	300		
10	Torque(Nm)	600		
11	Opening time (sec)	3 to 6		
12	Duty cycle	Intensive use		
13	Operating temp(degree C)	-20 to +55		
14	Operation	Smooth operation of Boom Barrier while open and close without bounce/jerks at end positions. Stand alone with push button switch and can also shall be integrated with Access Control system.		
15	Safety	Optical beam sensor to detect presence of vehicles and inversion of boom movement.		
16	On power failure mode	Barrier can be raised or lowered by releasing the boom lock with key type mechanism.		
17	Warranty	2 yr		
18	Execution of similar jobs	Vendor should have executed similar jobs in last two years and should submit satisfactory performance reports.		
19	Availablity of service center	The bidder must have a local branch or authorized service center in the city of the installation.		
20	Certification	The bidder should be an ISO 9001: 2000 & ISO 14001 and OHSAS 18001:1999 firm.		

SPECIFICATION FOR PASSIVE NETWORKING:

Eligibility Criteria for Passive OEM:

Sr #	Eligibility Criteria	Compliance with Document
1	**Passive OEM** offered must be in steady profitable business in India for more than at-least 15 years.	
2	OEM should have members participating in Telecommunications Industry Association (TIA) committee. Membership shall be available for validation at www.tiaonline.org	
3	OEM shall have RCDD certified technical staff based out of India and local technical manpower in the region of supply.	
4	OEM must have ISO 9001:2015 and ISO 14001 certified manufacturing unit in India, functioning for min. 5 years.	
5	The Cat6A SCS must be tested by an accredited 3rd Party test facility to the following standards: - ANSI/TIA 568-C.2: Category 6A Channel – 4 connector 3rd Party verification for both 100m Long channel & Short Channel (15m) testing must be provided as part of the bid response. Copies	

	of test reports should be appended to this RFP.	
6	OEM shall provide min 25 years of warranty on performance for all the offered products	
7	All offered components must be ROHS compliant. ROHS compliance shall be mentioned in datasheets.	

TECHNICAL SPECIFICATION FOR UTP CABLING SYSTEM

1. Specification for CAT 6A LSZH U/UTP Cable

Standard Compliance	**Compliance (Yes/No)**	**Remarks**
Channel Performance		
The Category 6A/ Class EA UTP SCS shall comply with the following standards a) ISO/IEC 11801:2010 b) EN 50173 Part 1 through Part 5:2010 and 2011 c) ANSI/TIA-568-C d) IEC 60603-7-4		
The Category 6A/ Class EA UTP system should support the following IEEE Ethernet applications -		
a) 802.3ab - 1000BASE-T b) 802.3af - Power Over Ethernet (15.4W) c) 802.3at - Power Over Ethernet Enhancements (25.5W) d) 802.3az - Energy Efficient Ethernet		
The proposed Category 6A UTP SCS, when configured as a worst-case 100 metre channel shall provide performance headroom over limits specified by Cat6A for below parameters -		
NEXT - Minimum 3 db above the standards; Should support a minimum of 4 connector Channel with a minimum 3 db guaranteed NEXT		
Insertion Loss - 3%		
Return Loss - 1.0 db		
The SCS must be tested by 3rd Party test facility to EIA/TIA 568C, ISO/IEC 11801 Amendment 1 and for the channel testing must be provided as part of the bid response.		
The Category 6A system should support channels that are shorter than 15 meters for 4 connector channel without any minimum length requirements.		
CAT 6A UTP Horizontal Cable		
The Cable should meet ANSI/TIA 568C.2 Category 6A Specifications		
The cable should consist of Eight 23 AWG copper conductors. Copper Clad Aluminum or any other combinations are not allowed		
The weight of the cable box of 1000 Feet should not be less than 34.7 lb		
The nominal Outside diameter should not be more than 0.285 inches (7.28mm)		

The cable should support the installation temperature: 0 to 60 ^{0}C It should support Operating temperature of -20 to 60 ^{0}C		
The cable shall be available in Low-Smoke, Zero Halogen (LSZH) and must comply with the following Fire Safety standards: 1) ISO/IEC 60332-3-22: Vertical Flame Spread 2) ISO/IEC 60754-2: Acidity 3) ISO/IEC 61034-2: Smoke Density		
Factory test reports for CAT6A cable must be available for verification of authenticity, at OEM website with unique print string on individual cable jacket.		

2. Specification for Category 6A U/UTP Information Outlets

Standard Compliance	**Compliance (Yes/No)**	**Remarks**
The 8-pin modular (RJ-45) jacks shall comply with IEC 60603-7-4		
The Category 6A outlets shall be backward compatible with Category 6 and 5E cords and cables.		
The Category 6A outlets shall be of a universal design supporting T568 A & B wiring.		
The information outlet shall have a Current Rating of 1.5 A at 20°C		
The information outlet must support 90 degree cable termination. As some mounting hardware does not allow for cable entry directly from the rear, this capability is necessary		
3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 Amendment 2 testing for Cat 6A components.		
The information outlet will have insertion life of 750 cycles minimum. Must be available in multiple colors for better administration.		

3. Specification for CAT 6A LSZH U/UTP RJ45 Patch Cords

Standard Compliance	**Compliance (Yes/No)**	**Remarks**
CAT6A U/UTP Patch Cord, 23 AWG solid construction, 4 pair		
SCS must support patch cord lengths of 1 meter minimum and equipment cords of 2 meter.		
Cords shall be equipped with 8-pin modular plugs on each end.		
Plugs shall be designed with an anti-snag latch to facilitate easy removal during move, add and change processes.		
The LSZH version must comply with the following Fire Safety standards: ISO/IEC 60332-3-22: Vertical Flame Spread ISO/IEC 60754-2: Acidity ISO/IEC 61034-2: Smoke Density		
The cordage shall be UTP components that do not include internal or external shields, screened components or drain wires.		
The patch cords will have insertion life of 750 cycles minimum. Shall be available in multiple colors.		

4. Specification for CAT 6A Jack Panel

Standard Compliance	Compliance (Yes/No)	Remarks
24 Port Patch Panel		
The ganged adapter style patch panel will utilize increments of six RJ-45 style jacks in a common moulded component.		
The ganged adapters shall have RJ45 jack in the front and Insulation Displacement Connector (IDC) at the rear of the module.		
The panel must be capable of supporting an upgrade to an intelligent system without any interruption to service due to patch cord removal or terminal block re-termination.		
3rd Party Verification test certificates shall be provided to show compliance to ISO/IEC 11801 Amendment 2 testing for Cat 6A components.		
When configured in worst-case 100 meter channels with full cross-connects and consolidation points with the other products proposed in this tender, the panel shall be capable of delivering the minimum guaranteed channel performance		
The patch panel type shall be a 1U (24 port) or 2U (48 port) panel capable of supporting 24 or 48 unshielded modular 8-pin connectors compliant with IEC 60603-7-4 while meeting the Channel Performance as specified in Amendment 1 to ISO/IEC 11801:2002		
The panel shall be available in 24-port and 48-port configurations, both straight and angled, with universal A/B labeling and 110 connector terminations on rear of panel allowing for quick and easy installation of 22 to 24 AWG cable		
The panel shall be equipped with a removable rear mounted cable management bar and labels		
The panel shall be UL and cUL Listed		
Operating Temperature Range = 14°F to 140°F (-10°C to 60°C)		
Humidity = 95% (noncondensing)		
Insertion Life = 750 minimum insertions of an FCC 8-Position Telecommunications Plug		

5. Ceiling connectors – CAT6A

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be compliant to ANSI/TIA 568-C.2 CAT6A requirement		
Shall use 110 based termination of cable without any RJ45 mating		
Shall be available as connector only and connector with factory terminated singe ended patch cord		
Shall be UL 94 V-0 rated and ETL certified.		
Current rating shall be 1.5A @ 20^0 C		
Insulation Resistance, minimum: 500 MOhm		

6. 2 & 4 Port Shuttered Face Plate

Standard Compliance	Compliance (Yes/No)	Remarks
Shall be available in 2 port and 4 port square versions.		
General Specifications a) Color: White		

b) Width: 86.36 mm (3.4 in) c) Height: 86.36 mm (3.4 in) d) Depth: 13.72 mm (0.54 in)		
Material shall be high impact, flame retardant, UL-rated 94 V-0, thermoplastic.		
Shall have inbuilt shutters to prevent dust to accumulate on the information outlets which are not in use.		

SPECIFICATION FOR SINGLEMODE FIBER COMPONENTS
6 CORES - OUTSIDE PLANT FIBER CABLE

Standard Compliance	**Compliance (Yes/No)**	**Remarks**
Shall be Multimode (OM4), Indoor / Outdoor, Single Jacket, All di-electric armor, Gel-free, Stranded Loose tube Fiber.		
Qualification Standards: ANSI/ICEA S-104-696, EN 187105, Telcordia GR-20, Telcordia GR-409. Compliance: IEC 60793-2-10 (type A1a.3a), IEC 60793-2-10 (type A1a.3b), TIA-492AAAD (OM4)		
Regulatory Compliance: RoHS 2011/65/EU compliant		
Construction Materials a) Jacket Material: LSZH b) Safety compliance: IEC 60332-3, IEC 61034-2, IEC 60754-2, UL 1685. c) Strength member: Di-electric strength member d) Number of fibers per tube: 6 e) Jacket Color: Black f) Jacket UV Resistance: UV Stabilized g) Subunit Type: 2.5mm Gel-free buffer tubes h) No. of Rip cords: 1 i) Water Swellable Tape: Yes j) Central non-metallic strength member		
Dimensions a) Cable Diameter: Not more than 12.00 mm b) Cable Weight: Not more than120 - 130 kg/km		
Physical Specifications a) Minimum Bend Radius, loaded: 17.5 cm b) Minimum Bend Radius, unloaded: 11.7 cm c) Tensile Load, long term, Max: 800 N or better d) Tensile Load, short term, Max: 2700 N or better e) Vertical Rise: upto 650 mtr		
Environmental Specifications a) Operating Temperature: -40 degree Celsius to +70 degree Celsius b) Flame test: listed for NEC OFN-LS (ETL) and c(ETL)		
Mechanical Test Specifications a) Compression: 22 N/mm (as per IEC 60794-1 E3) b) Flex: 35 Cycles (as per IEC 60794-1 E6) c) Impact: 2.94 N-m (as per IEC 60794-1 E4) d) Water Penetration Test Method: 24 h (as per IEC 60794-1 F5)		
Optical Specifications Attenuation, Maximum a) 0.22 dB/km @ 1550 nm b) 0.27 dB/km @ 1490 nm		

c) 0.31 dB/km @ 1385 nm d) 0.34 dB/km @ 1310 nm		
Factory Test report: Shall be available publicly against unique tracking ID on cable, at OEM website.		

5. Rackmount Sliding Fiber Shelf

Specifications	**Compliance (Yes/No)**	**Remarks**
Shall accommodate 4 coupler plates or 4 pigtail cassettes for a total of 48 fiber terminations.		
The width shall be 19 inches and height of 1U (1.75 inches), with a maximum of 18 inch depth.		
The shelf/LIU shall be sliding.		
The Fiber shelf must be intelligent ready and must support field upgrade to intelligent fiber panels without removal of existing patch cords and without disruption of network services.		
Shall have splice trays to splice minimum 32 fibers.		

6. 12F LC OM4 cassette assembly with pigtails

Specifications	**Compliance (Yes/No)**	**Remarks**
Factory fitted fiber cassette assembly loaded with 6 duplex LC OM4 adapters and 12xLC OM4 pigtails		
Pigtail 900 micron tight buffered OM4 as per 1.5 mtr		
Pigtails on each port shall be color coded as per TIA for identification		
LC ports should be supplied with integrated hinged shutters		
Insertion loss: 0.27dB or less		
Return Loss: 20 dB or higher		
Fiber Cassette shall be intelligent ready and should be upgradable to intelligent system without any patch cord removal.		
Safety: UL listed		

7. Multimode Fiber Optic Patch Cords

Specifications	**Compliance (Yes/No)**	**Remarks**
LC-LC Multimode OM4 duplex Patch Cord, bend insensitive, 10 feet		
1.6 mm duplex cord		
Operating Temperature: -10 to 60 ºC		
Insertion Loss, typical: 0.17 dB		
Return Loss, minimum: 25.0 dB		
Optical Components Standard ANSI/TIA-568-C.3		
Flame Test Listing as per NEC OFNR (ETL) and c(ETL)		

TECHICAL SPECIFICATION FOR ACTIVE NETWORK

Sl. No.	Description	Parameters (48 Port switch)	Compliance (Yes/No)
	Make		
	Model		
1	**General Features for Access switch**		
1.1	Form Factor	19 Inch Rack mountable Ethernet switch.	
1.2	Architecture	Non-Blocking architecture. Must have EAL3 /NDcPP or above common criteria certification. All the switches should be on the same IOS. The switches, Modules should be from the same OEM. The OEM should be present in the latest Gartner magic quadrant for Wired and wireless, Data center segment for leader/challenger quadrant. The OEM should be present in latest Gartner Magic quadrant for wired and wireless segment for leader /Challenger quadrant .The OEM should be present in Latest Gartner Quadrant for Data center segment as well for leader/challenger segment .	
1.3	IPV6 Compliance	All Functionalities of Switch shall be IPv6 compliant and it should work on IPv6 Platform without any additional hardware/ software.	
1.4	End of sale	OEM End-of-sale declaration shall not have been released for the quoted model at the time of the bid submission.	
1.5	Latest OS version	The switch shall be supplied with the latest OS version and all the proposed switch should be of same IOS.	
1.6	Feature Availability	All the specified features/parameters/certifications must be available on the Technical Bid opening date. Features /parameters /certifications proposed to be available in near future / on roadmap shall not be considered.	
1.7	Basic Layer-3 Support	Switches must be managed Basic layer-3 type for better broadcast segmentation.	
1.8	Interface Specifications:	Non-blocking architecture	
1.9	Ports	Should support at least 48 x10/100/1000T port with min 8 x100/1000SFP ports. Min 2 Stacking port should be ready from day 1 (40 Gbps stacking bandwidth). Geographically stacking should be achieved if required for ease of management. In future it should have option to offer min 2x 10 G copper port in the same hardware.	

1.10	SFP Transceivers	All the Transceivers/Modules used to connect the Switches should be from the same OEM/make of the switches only	
1.12	Port status display	Each port must have a dedicated LED for status display.	
2	**Hardware Specifications:**		
2.1	Back Plane Bandwidth	At least 176Gbps switching bandwidth	
2.2	Packet throughput	130 Mpps or more for each member switch.	
2.3	MAC Addresses and MTBF	16 K or more,	
2.4	VLANs (802.1q tagged VLAN)	4000 or more Concurrent	
3	**Standards and Protocols**		
3.1	L2 Loop Protection	IEEE 802.1d Spanning tree protocol	
		802.1s MSTP (Multiple instances of STP)	
		802.1w RSTP (Rapid spanning tree),), Should support less than 50 Millisecond convergence .	
3.2	Link Aggregation	802.3ad Link Aggregation	
3.3	QOS Support	At least 8 nos of 802.1p Priority Queues per port.	
3.4	IP Multicast	IGMP Snooping	
3.4	Port Mirroring / Span port	Port mirroring must be available.	
4	**Routing Features**		
4.1	Routing Protocols:	The switch shall have hardware based forwarding for IPv4 & IPv6. Following protocols shall be supported with IPV4: Static routing, PBR, RIPv2, OSPFv2 IPV6: PBR, Static routing, RIPng, OSPFv3 The switch shall have Dual stack mode to run both IPv4 & IPv6 RIP and RIPng ready from day 1.	
4.2	Router redundancy	Shall support VRRP for IPV4 and IPV6.	
4.3	Security Features		
4.4	Network Login	MAC and 802.1 X based Login must be available	
4.5	Port Security	MAC Address based Lockdown and Limited Learning	
4.6	Access Control Lists:	L2/L3/L4 IP based, Source port, destination port, MAC based, Time based	
4.7	AAA (authentication, authorization and accounting)	AAA using RADIUS must be available	
5.	**Management and Monitoring:**		
5.1	Management	Following in-band management methods shall be available:	
		Secure Web based management (On https)	

		SSH based management (SSH v2).	
5.2	Out-of-band management	Following out-of-band management methods shall be available:	
		Serial console port	
		Management ethernet port .Dedicated OOB port	
5.3	Role based Administration	The switch shall support multiple administrator accounts. Each administrator account shall be configurable with the desired level of management privileges.	
5.4	Remote Monitoring	RMON Support RFC 5357 for measuring round-trip performance between two devices	
5.5	Network Management	The switch should support SNMP V2c and V3, XML api and SDN with Openflow	
5.6	Log Management	Syslog shall be supported with multiple syslog destinations.	
5.7	Flow export	Shall support Netflow/IPFIX/sflow for flow exports.	
5.8	Time synchronization	Time synchronization using Network time protocol must be available.	
5.9	Configuration backup & restore	The switch shall have feature of backing up the configuration & restoring a backed- up configuration. Multiple Configuration files must be supported.	
5.10	TFTP/FTP upload and download	Config/image upload and download from TFTP/FTP server shall be available.	
6.	**Other Requirements:**		
6.1	Interface cables and other features	Console cable and power cable (As per Indian standards) to be provided. All Cables shall be factory-terminated. The Switch Operating System (OS) should mandatorily support individual process (eg ssh , snmp, telnet, dhcp etc) restart to prevent reboot in case of Software Process Crash by running processes on top of Kernel. Should support AVB to ensure set of standards that provide the means for highly reliable delivery of low-latency, time-synchronized AV streaming services through Layer 2 Ethernet networks	
6.2	Power Supply & FAN	Each switch should be populated with 1 PSU, should have option for RPS.	
6.3	Safety certification	The switch shall conform to IEC-60950/CSA-60950/EN-60950/UL-60950 standard for safety requirements of information technology equipment.	
6.4	Environmental conditions	The offered equipment must be able to operate in the following environmental conditions	
		¨ Operating temperature: 0°C to 50°C	
		¨ Relative Humidity: 10% to 95% Non-condensing	
6.5	Electromagnetic interference	The Offered equipment shall have FCC certification.	

Sl. No.	Description	Parameters(24 Port Switch)	Compliance (Yes/No)
	Make		
	Model		
1.1	Form Factor	19 Inch Rack mountable Ethernet switch.	
1.2	Architecture	Non-Blocking architecture. Must have EAL3 /NDcPP or above common criteria certification. All the switches should be on the same IOS . The switches, Modules should be from the same OEM . The OEM should be present in the latest Gartner magic quadrant for Wired and wireless, Data center segment fro leader/challenger quadrant.	
1.3	IPV6 Compliance	All Functionalities of Switch shall be IPv6 compliant and it should work on IPv6 Platform without any additional hardware/ software.	
1.4	End of sale	OEM End-of-sale declaration shall not have been released for the quoted model at the time of the bid submission.	
1.5	Latest OS version	The switch shall be supplied with the latest OS version and all the proposed switch should be of same IOS.	
1.6	Feature Availability	All the specified features/parameters/certifications must be available on the Technical Bid opening date. Features /parameters /certifications proposed to be available in near future / on roadmap shall not be considered.	
1.7	Basic Layer-3 Support	Switches must be managed Basic layer-3 type for better broadcast segmentation.	
1.8	Interface Specifications:	Non-blocking architecture	
1.9	Ports	Should support at least 24 x10/100/1000T port with min 8 x100/1000SFP ports. Min 2x SFP+(10) port should ready from day 1. . Min 4Stacking port should be ready from day 1 (40 Gbps stacking bandwidth) . Geographically stacking should be achieved if required for ease of management.	
1.10	SFP Transceivers	All the Transceivers/Modules used to connect the Switches should be from the same OEM/make of the switches only	
1.12	Port status display	Each port must have a dedicated LED for status display.	
2	**Hardware Specifications:**		
2.1	Back Plane Bandwidth	At least 128Gbps switching bandwidth	
2.2	Packet throughput	95 Mpps or more for each member switch.	
2.3	MAC Addresses and MTBF	16 K or more,	

2.4	VLANs (802.1q tagged VLAN)	4000 or more Concurrent	
3	**Standards and Protocols**		
3.1	L2 Loop Protection	IEEE 802.1d Spanning tree protocol	
		802.1s MSTP (Multiple instances of STP)	
		802.1w RSTP (Rapid spanning tree),), Should support less than 50 Millisecond convergence .	
3.2	Link Aggregation	802.3ad Link Aggregation	
3.3	QOS Support	At least 8 nos of 802.1p Priority Queues per port.	
3.4	IP Multicast	IGMP Snooping	
3.4	Port Mirroring / Span port	Port mirroring must be available.	
4	**Routing Features**		
4.1	Routing Protocols:	The switch shall have hardware based forwarding for IPv4 & IPv6. Following protocols shall be supported with IPV4: Static routing, PBR, RIPv2, OSPFv2 IPV6: PBR, Static routing, RIPng, OSPFv3 The switch shall have Dual stack mode to run both IPv4 & IPv6 RIP and RIPng ready from day 1.	
4.2	Router redundancy	Shall support VRRP for IPV4 and IPV6.	
4.3	Security Features		
4.4	Network Login	MAC and 802.1 X based Login must be available	
4.5	Port Security	MAC Address based Lockdown and Limited Learning	
4.6	Access Control Lists:	L2/L3/L4 IP based, Source port, destination port, MAC based, Time based	
4.7	AAA (authentication, authorization and accounting)	AAA using RADIUS must be available	
5.	**Management and Monitoring:**		
5.1	Management	Following in-band management methods shall be available:	
		Secure Web based management (On https)	
		SSH based management (SSH v2).	
5.2	Out-of-band management	Following out-of-band management methods shall be available:	
		Serial console port	
		Management ethernet port .Dedicated OOB port	
5.3	Role based Administration	The switch shall support multiple administrator accounts. Each administrator account shall be configurable with the desired level of management privileges.	
5.4	Remote Monitoring	RMON Support RFC 5357 for measuring round-trip performance between two devices	

5.5	Network Management	The switch should support SNMP V2c and V3, XML api and SDN with Openflow	
5.6	Log Management	Syslog shall be supported with multiple syslog destinations.	
5.7	Flow export	Shall support Netflow/IPFIX/sflow for flow exports.	
5.8	Time synchronization	Time synchronization using Network time protocol must be available.	
5.9	Configuration backup & restore	The switch shall have feature of backing up the configuration & restoring a backed- up configuration. Multiple Configuration files must be supported.	
5.10	TFTP/FTP upload and download	Config/image upload and download from TFTP/FTP server shall be available.	
6.	**Other Requirements:**		
6.1	Interface cables and other features	Console cable and power cable (As per Indian standards) to be provided. All Cables shall be factory-terminated. The Switch Operating System (OS) should mandatorily support individual process (eg ssh , snmp, telnet, dhcp etc) restart to prevent reboot in case of Software Process Crash by running processes on top of Kernel. Should support AVB to ensure set of standards that provide the means for highly reliable delivery of low-latency, time-synchronized AV streaming services through Layer 2 Ethernet networks	
6.2	Power Supply & FAN	Each switch should be populated with 1 PSU, should have option for RPS.	
6.3	Safety certification	The switch shall conform to IEC-60950/CSA-60950/EN-60950/UL-60950 standard for safety requirements of information technology equipment.	
6.4	Environmental conditions	The offered equipment must be able to operate in the following environmental conditions	
		¨ Operating temperature: 0°C to 50°C	
		¨ Relative Humidity: 10% to 95% Non-condensing	
6.5	Electromagnetic interference	The Offered equipment shall have FCC certification.	

Sl. No.	Description	Parameters (Core switch)	Compliance (Yes/No)
	Make		
	Model		
1.1	Form Factor	19 Inch Rack mountable Ethernet switch.	
1.2	Architecture	Non-Blocking architecture. Must have EAL3 /NDcPP or above common criteria certification. All the switches should be on the same IOS. The switches, Modules	

		should be from the same OEM. The OEM should be present in the latest Gartner magic quadrant for Wired and wireless, Data center segment for leader/challenger quadrant.	
1.3	IPV6 Compliance	All Functionalities of Switch shall be IPv6 compliant and it should work on IPv6 Platform without any additional hardware/ software.	
1.4	End of sale	OEM End-of-sale declaration shall not have been released for the quoted model at the time of the bid submission.	
1.5	Latest OS version	The switch shall be supplied with the latest OS version and all the proposed switch should be of same IOS.	
1.6	Feature Availability	All the specified features/parameters/certifications must be available on the Technical Bid opening date. Features /parameters /certifications proposed to be available in near future / on roadmap shall not be considered.	
1.7	Basic Layer-3 Support	Switches must be managed Basic layer-3 type for better broadcast segmentation.	
1.8	Interface Specifications:	Non-blocking architecture	
1.9	Ports	Should support at least 12 SFP+ 10 G port to support both 1 G and 10 G module. Min 2 x 100 Gbps QSP28 port for flexibility to choose .Should have min 400 Gbps stacking bandwidth .	
1.10	SFP Transceivers	All the Transceivers/Modules used to connect the Switches should be from the same OEM/make of the switches only	
1.12	Port status display	Each port must have a dedicated LED for status display.	
2	**Hardware Specifications:**		
2.1	Back Plane Bandwidth	At least 296Gbps switching bandwidth	
2.2	Packet throughput	220 Mpps or more for each member switch.	
2.3	MAC Addresses and MTBF	96 K or more	
2.4	VLANs (802.1q tagged VLAN)	4000 or more Concurrent	
3	**Standards and Protocols**		
3.1	L2 Loop Protection	IEEE 802.1d Spanning tree protocol	
		802.1s MSTP (Multiple instances of STP)	
		802.1w RSTP (Rapid spanning tree),), Should support less than 50 Millisecond convergence .	
3.2	Link Aggregation	802.3ad Link Aggregation	
3.3	QOS Support	At least 8 nos of 802.1p Priority Queues per port.	
3.4	IP Multicast	IGMP Snooping	

3.4	Port Mirroring / Span port	Port mirroring must be available.	
4	**Routing Features**		
4.1	Routing Protocols:	The switch shall have hardware based forwarding for IPv4 & IPv6. Following protocols shall be supported with IPV4: Static routing, PBR, RIPv2, OSPFv2 IPV6: PBR, Static routing, RIPng, OSPFv3 The switch shall have Dual stack mode to run both IPv4 & IPv6 RIP and RIPng ready from day 1.Should support MPLS , 1588v2.	
4.2	Router redundancy	Shall support VRRP for IPV4 and IPV6.	
4.3	Security Features		
4.4	Network Login	MAC and 802.1 X based Login must be available	
4.5	Port Security	MAC Address based Lockdown and Limited Learning	
4.6	Access Control Lists:	L2/L3/L4 IP based, Source port, destination port, MAC based, Time based	
4.7	AAA (authentication, authorization and accounting)	AAA using RADIUS must be available	
5.	**Management and Monitoring:**		
5.1	Management	Following in-band management methods shall be available:	
		Secure Web based management (On https)	
		SSH based management (SSH v2).	
5.2	Out-of-band management	Following out-of-band management methods shall be available:	
		Serial console port	
		Management ethernet port .Dedicated OOB port	
5.3	Role based Administration	The switch shall support multiple administrator accounts. Each administrator account shall be configurable with the desired level of management privileges.	
5.4	Remote Monitoring	RMON Support RFC 5357 for measuring round-trip performance between two devices	
5.5	Network Management	The switch should support SNMP V2c and V3, XML api and SDN with Openflow	
5.6	Log Management	Syslog shall be supported with multiple syslog destinations.	
5.7	Flow export	Shall support Netflow/IPFIX/sflow for flow exports.	
5.8	Time synchronization	Time synchronization using Network time protocol must be available.	
5.9	Configuration backup & restore	The switch shall have feature of backing up the configuration & restoring a backed- up configuration. Multiple Configuration files must be supported.	
5.10	TFTP/FTP upload and	Config/image upload and download from TFTP/FTP server shall be available.	

	download		
6.	**Other Requirements:**		
6.1	Interface cables and other features	Console cable and power cable (As per Indian standards) to be provided. All Cables shall be factory-terminated. The Switch Operating System (OS) should mandatorily support individual process (eg ssh , snmp, telnet, dhcp etc) restart to prevent reboot in case of Software Process Crash by running processes on top of Kernel. Should support AVB to ensure set of standards that provide the means for highly reliable delivery of low-latency, time-synchronized AV streaming services through Layer 2 Ethernet networks	
6.2	Power Supply & FAN	Each switch should be populated with 1 PSU, should have option for RPS. The PSU and FAN module should be hot swappable.	
6.3	Safety certification	The switch shall conform to IEC-60950/CSA-60950/EN-60950/UL-60950 standard for safety requirements of information technology equipment.	
6.4	Environmental conditions	The offered equipment must be able to operate in the following environmental conditions	
		¨ Operating temperature: 0°C to 50°C	
		¨ Relative Humidity: 10% to 95% Non-condensing	
6.5	Electromagnetic interference	The Offered equipment shall have FCC certification.	

Sl. No.	**Description**	**Parameters (Distribution switch)**	**Compliance (Yes/No)**
	Make		
	Model		
1	**General Features for Access switch**		
1.1	Form Factor	19 Inch Rack mountable Ethernet switch.	
1.2	Architecture	Non-Blocking architecture. Must have EAL3 /NDcPP or above common criteria certification. All the switches should be on the same IOS. The switches, Modules should be from the same OEM. The OEM should be present in the latest Gartner magic quadrant for Wired and wireless, Data center segment for leader/challenger quadrant.	
1.3	IPV6 Compliance	All Functionalities of Switch shall be IPv6 compliant and it should work on IPv6	

		Platform without any additional hardware/ software.	
1.4	End of sale	OEM End-of-sale declaration shall not have been released for the quoted model at the time of the bid submission.	
1.5	Latest OS version	The switch shall be supplied with the latest OS version and all the proposed switch should be of same IOS.	
1.6	Feature Availability	All the specified features/parameters/certifications must be available on the Technical Bid opening date. Features /parameters /certifications proposed to be available in near future / on roadmap shall not be considered.	
1.7	Basic Layer-3 Support	Switches must be managed Basic layer-3 type for better broadcast segmentation.	
1.8	Interface Specifications:	Non-blocking architecture	
1.9	Ports	Should support at least 12 x100/1000X port with min 8 x100/1000SFP ports. Min 2 Stacking port should be ready from day 1 (40 Gbps stacking bandwidth). Geographically stacking should be achieved if required for ease of management. In future it should have option to offer min 2x 10 SFP+ port in the same hardware.	
1.10	SFP Transceivers	All the Transceivers/Modules used to connect the Switches should be from the same OEM/make of the switches only	
1.12	Port status display	Each port must have a dedicated LED for status display.	
2	**Hardware Specifications:**		
2.1	Back Plane Bandwidth	At least 296Gbps switching bandwidth	
2.2	Packet throughput	220 Mpps or more for each member switch.	
2.3	MAC Addresses and MTBF	16 K or more,	
2.4	VLANs (802.1q tagged VLAN)	4000 or more Concurrent	
3	**Standards and Protocols**		
3.1	L2 Loop Protection	IEEE 802.1d Spanning tree protocol	
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3.2	Link Aggregation	802.3ad Link Aggregation	
3.3	QOS Support	At least 8 nos of 802.1p Priority Queues per port.	
3.4	IP Multicast	IGMP Snooping	
3.4	Port Mirroring / Span port	Port mirroring must be available.	
4	**Routing Features**		

4.1	Routing Protocols:	The switch shall have hardware based forwarding for IPv4 & IPv6. Following protocols shall be supported with IPV4: Static routing, PBR, RIPv2, OSPFv2 IPV6: PBR, Static routing, RIPng, OSPFv3 The switch shall have Dual stack mode to run both IPv4 & IPv6 RIP and RIPng ready from day 1.	
4.2	Router redundancy	Shall support VRRP for IPV4 and IPV6.	
4.3	Security Features		
4.4	Network Login	MAC and 802.1 X based Login must be available	
4.5	Port Security	MAC Address based Lockdown and Limited Learning	
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5.	**Management and Monitoring:**		
5.1	Management	Following in-band management methods shall be available:	
		Secure Web based management (On https)	
		SSH based management (SSH v2).	
5.2	Out-of-band management	Following out-of-band management methods shall be available:	
		Serial console port	
		Management ethernet port .Dedicated OOB port	
5.3	Role based Administration	The switch shall support multiple administrator accounts. Each administrator account shall be configurable with the desired level of management privileges.	
5.4	Remote Monitoring	RMON Support RFC 5357 for measuring round-trip performance between two devices	
5.5	Network Management	The switch should support SNMP V2c and V3, XML api and SDN with Openflow	
5.6	Log Management	Syslog shall be supported with multiple syslog destinations.	
5.7	Flow export	Shall support Netflow/IPFIX/sflow for flow exports.	
5.8	Time synchronization	Time synchronization using Network time protocol must be available.	
5.9	Configuration backup & restore	The switch shall have feature of backing up the configuration & restoring a backed- up configuration. Multiple Configuration files must be supported.	
5.10	TFTP/FTP upload and download	Config/image upload and download from TFTP/FTP server shall be available.	
6.	**Other Requirements:**		
6.1	Interface cables and other	Console cable and power cable (As per Indian standards) to be provided. All Cables	

	features	shall be factory-terminated. The Switch Operating System (OS) should mandatorily support individual process (eg ssh , snmp, telnet, dhcp etc) restart to prevent reboot in case of Software Process Crash by running processes on top of Kernel. Should support AVB to ensure set of standards that provide the means for highly reliable delivery of low-latency, time-synchronized AV streaming services through Layer 2 Ethernet networks	
6.2	Power Supply & FAN	Each switch should be populated with 1 PSU, should have option for internal Hot swappable RPS and field replaceable Fan module .	
6.3	Safety certification	The switch shall conform to IEC-60950/CSA-60950/EN-60950/UL-60950 standard for safety requirements of information technology equipment.	
6.4	Environmental conditions	The offered equipment must be able to operate in the following environmental conditions	
		¨ Operating temperature: 0°C to 50°C	
		¨ Relative Humidity: 10% to 95% Non-condensing	
6.5	Electromagnetic interference	The Offered equipment shall have FCC certification.	

LIGHTING AUTOMATION:

The Lighting Automation System should be based on KNX which is an open standard (see EN 50090, ISO/IEC 14543) for commercial and domestic building automation. Proprietary Lighting Automation Protocols are not acceptable. This specification document should be considered as binding where ever there is a conflict with the BOQ / BOM of the Tender.

1.0 Lighting Control Equipment

1.1.1 General

The lighting control system shall be decentralized based on a project requirement every device should be microprocessor based, individually addressable entity.

1.1.2 Control System Bus Protocol

The control system protocol shall be KNX only as per ISO/IEC 14543 , EN50090 Approved & implement the International Standards Organization (ISO) 'Open Systems Interconnection' seven-layer reference model for communication protocol.

There shall be no visible delay between command being issued and action executed. It shall typically be less than 2mS.
The system protocol shall be available to third party companies to develop interfaces to the installed system.

The system shall be capable of 'high-level' integration to Building Management Systems and other proprietary control systems over LON , BACnet & Mod Bus.

1.1.3 Addressing Capabilities

The entire system shall consist of bus lines each consisting of up to 254 devices over 4000 mts line . System should be capable of connecting much more than 254 devices on a single network further by using repeaters and shall have a topology supporting more than 58000 devices.

1.1.4 Interfacing to the Control System

The system shall allow USB access points in a networkl, to perform control, maintenance or reprogramming on the network,

1.1.5 System Control Requirements

The system shall be able to perform control in all of the following ways.

- Centralized control from a PC enabling over-ride control of individual units, groups, zones, buildings, sites.
- Any input device shall be able to be programmed as a master /slave . Master over-rides shall be able to positioned anywhere in the network, and control any other unit or units on any connected network.
- The system shall allow unlimited switching, dimming configurations. Any number of switches shall be able to program for a common load or loads (i.e. multi-way switching) and all switches shall indicate the load status.
- Over-rides shall be able to be re-programmed at any time without any wiring changes.
- All Out put devices shall be DIN Rail mounted in standard Distribution Board with manual over ride on every switching, dimming & DALI modules.

1.1.6 Distributed Intelligence

The system shall operate without a computer connected, including the operation of all manual switches, detectors, photoelectric cells, etc. For the logical relationship between input devices and output loads to be fully reliant on a computer being connected shall not be acceptable.

All devices shall be able to communicate directly with each other without the need for a computer or a centrally based processor to receive and transmit signals.

1.1.7 Safety requirements

The network bus shall be Safety Extra Low Voltage (SELV).The bus shall be short circuit protected to ensure that accidental short circuit will not damage any system components.

The system shall have a fail-safe default mode.

The failure of a module on the system shall not affect any other module.

Modules shall be able to be programmed to re-start to 'on', 'off', or resume in previous state after a power failure.

2.1.1 Networking and Expansion Capabilities

The system shall have a software controlled network structure. Any input device shall be able to control any output device, or any group of devices. The devices shall be able to be located anywhere on the network without a direct connection. The relationship shall be able to be changed at any time without re-wiring.

There shall be no requirements for end-of-line bus terminations for impedance matching.

The System shall be able to be easily expanded. Additional units shall be able to be added at any time at any point without re-configuration of any other component or the control devices. An existing system shall not need to be powered down if expansion is being carried out in the future.

The system shall be capable of operating on a bus voltage of 21-30V dc.

System modules (input and output devices) shall be able to be located up to 1000m apart on the bus cable. Only one control bus cable shall be required to link any number of rooms, buildings, projects or sites. Localized input devices (e.g., switches or PIR Sensors) shall be able to be added at any time, and shall be able to be programmed to perform any function.

Output relay units shall be able to be connected to different phases or voltage sources, yet be controlled from any location on the network & mounted in a standard distribution board.

The system shall have distributed intelligence to allow full control over any module even if on another electrical sub-system.

2.1.2 Input and output Configurations

It shall be possible to provide input control of the system via the following system devices.

- 0-1V, 0-5V, 0-10V and 4-20mA analogue & binary contacts
- Digital Contact Closures (programmable functions)
- Occupancy Sensors
- Switches / Keypads with inbuilt Temperature sensors
- Electronic Delay Time switches (software imbedded)
- Light Level - analogue and digital

It shall be possible to provide output control of the system via the following system devices.

- 0-10V dc analogue outputs with manual override
- DALI Outputs with Manual Override
- Relay switch Actuators with manual override
- Phase control Universal dimmer outputs (incandescent and 12V ELV lighting) with manual override.

The commissioning tool software will be used to:

- Individually address all control units on an installed system.
- Set the required control relationships between input and output devices.
- Define the Functional Control
- Set dimmer unit fade rates.
- Set photocell unit control points.
- Set temperature sensor unit control points.
- Set Power-Up status of Loads

All the above parameters will be set from within a graphical user interface, with separate configuration templates being provided for each type of control unit.

The software shall have the ability to export and import complete databases from within the software interface.

There shall be the ability to automatically detect and resolve address conflicts between any control units in an installation.

The software shall allow project names, system topology, application names and address names to be setup.

The software shall allow for real-time interrogation of sensor readings from the network, for example light level readings (in lux).

2.2 Lighting Control Equipment Product Specifications

2.2.1 Key Input Units (Keypads for User Controlling)

Wall mount, programmable 'Key Input Units', designed to control lighting applications and other electrical services shall be available from the manufacturer of the overall control system. The units shall be able to control any system output device including relays, dimmers, and analogue output units to switch or dim loads.

The units shall be available with one, two or four tactile switches.

The unit functions shall be customizable at any time before or after installation. Each key shall be capable of being programmed to achieve various functions including, toggle switch, dimmer control, timer or pre-set. In the event of power failure, a non-volatile memory (NVM) shall retain all programmed information relating to each unit's current operating status.

Key Input Units shall communicate with all other system units and obtain power via the Communication Bus cable.

A Key Input Switch shall be suitable for more than 100,000 operations.

A Key Input Switch shall have an on-board Timer The Timer resolution shall be 1 second – 120 mins

A Key Input Switch shall be capable of dimmer control of about 255 possible levels.

The unit shall have inbuilt room thermostat control, be suitable for operating temperatures between 0-50 Degree C.

2.2.2 Multigang Key Input Units Panels

A Multigang Key Input Units Panel, as a standard item from the system manufacturer, shall consist of multiples of four positive feel tactile switches, starting at eight switches, mounted to either a stainless steel or polished and lacquered brass fascia. Each switch shall contain a red light emitting diode and shall be programmed to provide on/off, dimmer or timer functions. Custom variations of multi-gang panels shall be detailed in drawings with respect to layout and functionality.

Specifications for a Multigang Key Input Units Panel shall be as per a Four Key Input Module for each four switch multiple incorporated within the panel.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

2.2.3 365 Day Cycle Clock

The clock module shall consist of a 365-day real time controller with two channels of output for control of up to four group addresses. The 7-day timer shall be able to be programmed from the front of the clock (independent of the installation software) whilst the outputs are configured in software (as per other system components).

The unit shall be capable of issuing on, off, dimming and delay-off timer commands.

The clock shall sustain its settings for 24 hours in the event of loss of supply.

Daylight savings, Holiday and Random modes shall be incorporated on the front of the clock.

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The 365 Clock shall be having a suitable Operating Temperature range of 0-50 Degree C.

2.2.4 Touch Screen

The touch screen shall provide a touch sensitive LCD screen that displays pages of graphical items to perform a particular function when pressed.

The touch screen shall be programmed via a software based configuration tool. This Configuration Software shall be Microsoft Windows based and shall provide the ability to program the appearance and operation of the touch screen.

The touch screen shall have the ability for the following components to be placed on a touch screen page:

i. Buttons (keys) with text and/or images
ii. Text
iii. Images
iv. Shapes (rectangles, triangles, ellipses)

v. Sliders
vi. Clocks
vii. Percent Indicator
viii. Backlight control
ix. Contrast control
x. JPEG Images
xi. GIF Images
xii. Auto Cadd Layout

The touch screen shall have the ability to action a complete scene. Scenes shall be able to be setup as follows:
i. Up to 254 system addresses controlled per scene
ii. Level and ramp rate shall be selectable
iii. Activated by a particular system Address/Level combination.

The touch screen shall have the ability to action Schedules. Schedule details shall be able to be setup as follows:
i. Command (on / off / ramp & ramp rate, pulse or set scene)
ii. Time of event
iii. Repeat cycle of event (once / daily / weekly / week days / weekends / monthly and complex combinations)
iv. A list of scheduled events shall be displayed in the configuration software.

The configuration software shall support a "simulation mode" where clicking on components on the screen will execute the programmed actions.

2.2.5 USB Interface

The USB Interface shall provide the medium for an external PC to communicate with the control system network, including monitor and control functions. It shall also be used to program all other system units and generate the system clock for synchronized data communications.

2.2.6 Power Supply

The Power Supply shall provide safe extra low voltage (30V DC or as per requirement of supplier) to the control system bus.

The Power Supply shall be capable of supporting about 64 control system units (Key inputs, Relay Units, Dimmer Units etc.). Multiple Power Supplies shall be paralleled to support any system load.

The output current of the Power Supply shall be 640mA (nominal).

2.2.7 Single Channel DALI Gateway – 64 Devices

The DALI gateway connects the KNX with digital electronic ballasts equipped with a DALI interface. The gateway is the DALI master and power supply for the electronic ballasts. It supports the switching and dimming of up to 64 electronic ballasts in 16 groups and the control of 16 scenes. In addition, the 64 electronic ballasts can be individually activated via KNX or compiled via KNX group addresses.
Error messages of individual electronic ballasts or each connected lamp can be transmitted to the KNX and visualised on display devices. DALI commissioning and configuration, as well as group assignment and scene setting can be carried out using:
■ the device (display and operating buttons)
■ a software tool (free of cost)
■ the integrated Web server. The RJ45 connection is used for connection to a PC (with standard browser).
■ a portable Web panel or a PDA (optional)
The device may have 2 inputs for connecting push-buttons (building site operation), for example. For installation on DIN rails TH35 according to EN 60715. The bus is connected using a bus connecting terminal; a data rail is not necessary. The network and the DALI cable as well as the switch inputs are connected via screw terminals on the device.
Supply voltage: AC 110 - 240 V, 50 - 60 Hz
Inputs: 2, passive DC 9 - 36 V or AC 9 - 24 V
Outputs: DALI D+, D- in line with DALI specification DC 16 - 18 V, 150 mA, short circuit-proof
Interfaces: 1xRJ45
Connecting cable: 1.5 - 2.5 mm2
Type of protection: IP 20
Device width: 6 modules = approx. 108 mm
Contents: With bus connecting terminal.

2.2.8 One\Two\Four \Eight\ Twelve Channel Relay with 10 / 16 / 20 A Voltage Free Contacts

This unit shall allow control of One\Two\Four \Eight\ Twelve Channel Relay independent loads, with a load capacity A multiplied by no of channels for ex 12 Channel 10 A Realy will be of 120 A rated. The individual channel load shall be rated at 10/16/20 A (inductive and resistive).

In the event of power cycling, a non-volatile memory (NVM) shall be incorporated to retain all address and switching information.

The Relay Unit shall have the facility to program (via the software) a minimum threshold setting.

The unit shall have an input voltage operating frequency range of 47-53Hz and 57-63Hz.

The units' mains voltage terminals shall be suitable to accommodate 4 x 2.5mm square cable.

The unit shall have suitable operating temperatures between 0-50 Degree C.
The Unit Shall be DIN Rail Standard Distribution board mounted.

2.2.9 Scene Controller Specification

All Input Switches will support minimum 8 max 16 scenes per unit, to allow the user of the lighting system to access the lighting in the area, switch the lighting on and off, ramp the lighting up and down and manually save lighting scenes as required.

The only cable termination requirements shall be a twisted pair communication cable. There shall be no additional requirements to terminate 240V or extra low voltage cabling at the Scene Controller

For ease of maintenance, the lighting outputs (dimmers, relays, etc) controlled by the unit shall be mounted remotely. Output devices mounted in the wall (either as an integral part of the Lighting Controller or as a separate unit) will not be accepted.

The Lighting Controller shall form an integral part of the lighting system and shall have the capabilities to communicate with other input and output devices attached directly to the systems communication bus, including (but not limited to) Relay Units, Dimmer Units, Wall mounted Switches, Light Level Sensors and Passive Infrared Movement Detectors.

Output Load Control

The controlled lighting loads shall be dependent on the output devices connected to the system, rather than being dependent on the load capacity of the Scene Controller itself. Thus, the scene controller should be able to control various load types including incandescent, Extra Low Voltage Tungsten Halogen Dichroic, Fluorescent (via High Frequency Electronic 0-10V or Digital Ballast's) on the same group address.

User Interface/Control

The wall-mounted controller shall include separate buttons to allow the user to individually dim up or dim down eight separate groups of output loads. A series of LED's shall be associated with the group to indicate the current lighting ramp level for that group. The controlled output groups shall be programmable via a software assignable addressing system and shall not be limited to any hardwired groups of outputs.

Lighting Preset Scenes

The Lighting Controller shall incorporate a minimum of eight / sixteen programmable scene buttons and associated LED's. The LED's shall indicate which lighting scene is active or inactive. The user shall be able to assign and recall a preset lighting scene directly from the unit. Whilst acceptable for testing and commissioning proposes, Controllers that require the user to attach a separate device (e.g. a PC) to program and re-program scenes on an ongoing basis will not be accepted.

Power-up

If power to the unit is lost, the lighting shall automatically return to a preset level. All scenes, fade rates, etc shall be stored in non-volatile memory.

Master OFF

A 'Master Off' button shall be available on the Switch / Keypad. This Master Off button shall be programmable to allow the user to select controlled output groups. Pressing the Master Off button shall turn off all the lighting loads.

Night Light function

There shall be a "night light scene programmed on the Scene controller. This shall be programmable via the installation software to be enabled or disabled. When enabled, if no indicator other than the fade rate is active on the Lighting Controller (all primary groups are off), then all eight scene indicators will be dimly lit.

Infra-red Interface

The hand held Remote control Scene buttons (10 Buttons) shall function as the scene buttons on the Lighting Controller. The IR controller shall effectively mimic the press scene buttons on the unit.

The Remote control 'All Off' button shall function exactly the same as the master off button on the Lighting Controller.

All the scene button indicators shall flash when the scene controller is receiving valid data from the remote control Lighting Controller.

PIR Occupancy Sensor

The PIR Occupancy Sensor shall detect passive infrared energy for control of any number of independent electrical loads. The light level shall be adjustable from the front of the unit and shall be used to disable the Occupancy Sensor. Timer settings shall be adjustable from 1 second to 18 hours, in one-second increments. A weatherproof version shall be available for outdoor or industrial use.

The unit shall have suitable operating temperatures between 0-50 Degree C.

The unit shall be suitable for ceiling mounting, up to mounting heights of 2.8m.

i. Provide ceiling mount PIR occupancy sensor as shown on the drawings.
ii. The motion sensor shall be KNX presence detector for interior ceiling mounting.
iii. The unit shall have a 360° detection pattern, a diameter of 14 m at 2.5 metres mounted above floor-level. Sensor should have lux adjustable from 10 to 2000.

3.0 RECOMMENDED MAKES FOR KNX LIGHTING AUTOMATION SYSTEM :

1. KNX KEY INPUT UNITS – SCHNEIDER / BERKER / CRESTRON
2. KNX TOUCH SCREEN – SCHNEIDER / BERKER / TCS
3. KNX POWER SUPPLY - – SCHNEIDER / BERKER / ABB
4. KNX 12 CHANNEY RELAY UNIT - – SCHNEIDER / BERKER / CRESTRON
5. KNX BASED DALI GATEWAY (SINGLE CHANNEL) – SCHNEIDER / BERKER / CRESTRON
6. KNX MULTI CHANNEL CURTAIN MOTOR CONTROLLER - – SCHNEIDER / BERKER / CRESTRON
7. KNX PROGRAMMING GATEWAY - – SCHNEIDER / BERKER / CRESTRON
8. IR TRANSMITTER - – SCHNEIDER / BERKER / CRESTRON / ANY REPUTED MAKE.
9. KNX LOGIC AUTOMATION MODULE - – SCHNEIDER / BERKER / CRESTRON
10. DISTRIBUTION BOARD / MCB'S / SURGE PROTECTION DEVICE ACCESSORIES – LEGRAND / HAGER / SCHNEIDER
11. KNX EIB CABLE – LAPP / REPUTED MAKE.

Compliance/ Technical Specification for 75" UHD Industrial Display				
Sl. No.	**Section**	**Item Description**	**Detailed Specification**	**Complied Yes/No**
1	**Warranty**	3 years		
2	**Panel**	Screen Size	75" or higher	
3		Panel Technology	IPS	
4		Aspect Ratio	16:09	
5		Native Resolution	3,840 x 2,160 (UHD)	
6		Brightness	500cd/m2 or higher	
7		Contrast Ratio	1,200:1	
8		Dynamic CR	4,000,000:1 (DTV Label only)	
9		Viewing Angle (H x V)	178 x 178	

10		Response Time	6ms (G to G)	
11		Surface Treatment	Low Haze 3%	
12		Life time (Min.)	30,000 Hrs	
13		Guaranteed Operation Hours	24 Hrs	
14		Orientation	Portrait & Landscape	
15	**Connectivity**	Inputs	HDMI(3), DP, DVI-D, Audio, USB 3.0, SD Card	
16		Outputs	DP, Audio	
17		External Control	RS232C, RJ45, IR Receiver, Pixel Sensor	
18	**Special**	Features	Temperature Sensor, Auto Brightness Sensor, Tile Mode (up to 15x15), Natural Mode@Tile Mode, ISM Method, Internal Memory, Wi-Fi built-in, USB Cloning, Contents Scheduling, Sync mode, PM mode, Fail Over, Wake on LAN, BEACON (On/Off), Embedded Template	
19	**Environment Conditions**	Operation Temperature	0 °C to 40 °C	
20		Operation Humidity	10 % to 80 %	
21	**Power**	Power Supply	100-240V~, 50/60Hz	
22		Power Type	Built-In Power	
23		Power Consumption	Typ.240W , Smart Energy Saving 170W or better	
24	**Industrial Grade/ Certification**	Safety	UL / cUL / CB / TUV / KC	
25		EMC	FCC Class "A" / CE / KC	

Compliance/ Technical Specification for 86" UHD Industrial Display				
Sl. No.	**Section**	**Item Description**	**Detailed Specification**	**Complied Yes/No**
1	**Warranty**	3 years		
2	**Panel**	Screen Size	86" or higher	
3		Panel Technology	IPS	
4		Aspect Ratio	16:09	
5		Native Resolution	3,840 x 2,160 (UHD)	
6		Brightness	500cd/m2 or higher	
7		Contrast Ratio	1,200:1	
8		Dynamic CR	4,000,000:1 (DTV Label only)	
9		Viewing Angle (H x V)	178 x 178	
10		Response Time	6ms (G to G)	
11		Surface Treatment	Low Haze 3%	
12		Life time (Min.)	30,000 Hrs	
13		Guaranteed Operation Hours	24 Hrs	
14		Orientation	Portrait & Landscape	
15	**Connectivity**	Inputs	HDMI(3), DP, DVI-D, Audio, USB 3.0, SD Card	
16		Outputs	DP, Audio	
17		External Control	RS232C, RJ45, IR Receiver, Pixel Sensor	
18	**Special**	Features	Temperature Sensor, Auto Brightness Sensor, Tile Mode (up to 15x15), Natural Mode@Tile Mode, ISM Method, Internal Memory, Wi-Fi built-in, USB Cloning, Contents Scheduling, Sync mode, PM mode, Fail Over, Wake on LAN, BEACON (On/Off), Embedded Template	

19	**Environment Conditions**	Operation Temperature	0 °C to 40 °C	
20		Operation Humidity	10 % to 80 %	
21	**Power**	Power Supply	100-240V~, 50/60Hz	
22		Power Type	Built-In Power	
23		Power Consumption	Typ.275W , Smart Energy Saving 200W or better	
24	**Industrial Grade/ Certification**	Safety	UL / cUL / CB / TUV / KC	
25		EMC	FCC Class "A" / CE / KC	

	Technical Specification for 55" LED DISPLAY
1	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share
2	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share
3	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share
4	75" DISPLAY - 4K wifi Screen Share
5	75" DISPLAY - 4K wifi Screen Share
6	75" DISPLAY - 4K wifi Screen Share
7	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share
8	75" DISPLAY - 4K wifi Screen Share
9	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share
10	75" DISPLAY - 4K wifi Screen Share
11	55" OLED DISPLAY - Panel depth 3.6mm / 4K wifi Screen Share
12	75" DISPLAY - 4K wifi Screen Share
13	75" DISPLAY - 4K wifi Screen Share

LIST OF APPROVED MAKES

Sl.No.	**Details of Materials / Equipment**	**Manufacturer's Name**
Building Automation system		
1	Software	SIEMENS Johnson Controls

		Schnider Trane
2	DDC Controllers	Siemens Johnson Controls Schnider Trane
3	System Integration Units	Siemens Johnson Controls Schnider Trane
4	Immersion Temperature Sensor	Siemens Johnson Schnider Trane
5	Duct Temperature Sensor	Siemens Johnson Schnider Trane
6	Outside temperature Sensor	Siemens Johnson Schnider Trane
7	BTU Meter	Belimo Schnider Siemens Trane
8	Duct Humidity Sensor	Siemens Johnson Schnider Trane
9	Room Humidity Sensor	Siemens Johnson Schnider Trane
10	Pressure Transmitters	Siemens Johnson Schnider Trane
11	Flow Meter (Ultrasonic)	Siemens Johnson Schnider Trane
12	Differential Pressure Switches	Siemens Schnider Trane
13	Water Flow Switches	Siemens

		Siemens Schnider
14	Level Switches	Trane Siemens
15	Level Transmitters	Schnider Siemens Trane
16	Load ManaSchniderr	ABB Conzerve L & T Trane
18	2/3 way Modulating / ON/OFF valves with Actuators	Siemens Siemens Trane
19	Butterfly valve with Actuator	Siemens Siemens Trane
20	Damper Actuators ON/OFF , Modulating Type	Siemens Trane
21	DDC Controller Enclosure	Adlec Control System Advance Panels & SwitchSchniderar Milestone Engg. Tricolite
22	Water Hardness Analyser	HACH Siemens Thermo
23	P.H./ Chlorine Analyser	HACH Siemens Thermo
24	TDS Meter	HACH Siemens Thermo
25	CO Sensor/CO2 sensor	HACH Siemens Trane
26	Conductivity Meter	HACH Siemens Thermo
27	Communication Cables / Signal Cable/ Control/power Cable (indiSchnidernous)	Batra Henlay Finolex Neolex

29	Metallic Conduits	AKG BEC NIC Vimco
30	PVC Conduits	AKG BEC D plast Duraline

Central Control Station		
1	Personal Computer	DELL Hewlett Packard HP Wipro
2	Colour Monitor	L.G. Philips Samtron Samsung
3	Printer	Hewlett Packard HP
4	Mouse	Dell Logitech Microtek

S.No.	**Items**	***Makes***
	FIRE ALARM SYSTEM	
1	Fire Sensors & module	Schrack Seconet Simplex (Tyco) Siemenss Notifier(Honey well)
2	Main Control Panel (Including the emerSchnidernc y voice evacuation, Repeater panel Graphic Display software)	Schrack Seconet Simplex (Tyco) Siemenss Notifier(Honey well)
3	Manual call stations/ Hooters/IO modules/ Strobes Multi tap speaker	Schrack Seconet Simplex (Tyco) Siemenss Notifier(Honey well)
4	Conventional Fire Alarm System	Cooper Rawal Morly
5	Public Address / Sound System & Accessories	Ateis - Switzerland Sennheiser Siemens (US or European manufacturing product only)

6	Sealed maintenance free batteries	Exide GS Batteries (Japan StoraSchnider Co Ltd.) HiTranehi
7	Communication Cable - IndeSchnidernous	Batra Henlay Caliplast Finolex Neolex
8	Auto Dialer	Securico
9	Response Indicator	Agni System Sensor

S.No.	Items	*Makes*
	CCTV SYSTEM- IP	
1	NVR & Accessories including software	Pelco Bosch Schnider Hikvision
2	CCTV- Cameras	Pelco Bosch Schnider Hikvision
3	Monitor	Sony Sumsung LG Tosiba
4	Lenses	Pelco Axis Schnider Hikvision
5	Weatherproof Housing	Pelco Bosch Schnider Hikvision
6	L2 & L3 Switches	cisco Juniper Extrem

	ACCESS CONTROL SYSTEM	
1	Door Controller &Software	Hikvision DDS Schnider - Casirusco Siemens – Prowatch Series
2	Electric Door Strikes	Hikvision Lock netics Miwa Lock

		Rutherford
3	Electric Door Lock	Hikvision Bell Ebelco
4	Cards and Card Readers	Hikvision DDS Schnider HID
5	Boom Barriers	Automatic Systems (Belgium) Hikvision Ravel Magnetic
6	Half Height Swing /Retractable /Flap type Barriers (Imported)	Automatic Systems (Belgium) Hikvision FAAC(ITALY) Gunnebo
7	Half Height Swing /Retractable / Flap type Barriers (IndeSchnidernous)	Shivananda Technomat Magnetic
8	Full Height Turnstiles	Automatic Systems (Belgium) FAAC(ITALY) Gunnebo Magnetic Schniderrmany
9	Door Frame Metal Detectors	Metor Garett Godrej
10	Perimeter Fencing	Siemens IBEX Gallaghar
11	Vehicle Under Scanning System	KritikalSecurescan
12	L2 & L3 Switches	Extrem Cisco Juniper
13	Metallic Conduits (MS/GI)	AKG BEC NIC Wimco
	OTHER ELV SYSTEM	
1	Gas Supression System	VESDA Siemens ESSER ANSUL
2	Smoke Aspiration System	VESDA HART Siemens ESSER
3	Lighting Automation	Creston Legrand (Arteor-My home)

		Indo Simon Schnider (Clipsal)
4	Integration ManaSchniderrs	N G Solutions (India PvtLtd) H M A consultingDubai internet city
5	UPS	APC EMERSEN HITraneHI
6	Pasive Componant for Voice & Data	Belden Commscope Scheneider
7	Active Componant for Voice & Data	Cisco Juniper Extrem
8	RODENT	Star Mase
9	LIGHTING AUTOMATION SYSTEM	SCHENEIDER HAVELS

TECHNICAL SPECIFICATIONS
FIRE PROTECTION SYSTEM
FOR KOLKATA PORT TRUST, KOLKATA

1. GENERAL

All materials shall be of the best-approved quality obtainable and unless otherwise specified they shall confirm to the respective Bureau of Indian Standard specifications.

Samples of all materials shall be got approved before placing order and the approved samples shall be deposited with the Employer.

In case of non – availability of materials in metric size, the nearest size in FPS units shall be provided with prior approval of the Employer / Consultants for which neither extra will be paid nor shall any rebate be recovered.

If directed / found necessary, materials shall be tested in any testing laboratory selected by the Employer and the Contractor shall produce the test results to the Consultant for his scrutiny and approval. The entire charges for original as well as repeated tests shall be borne by the Contractor. If required, the Contractor shall arrange to test portion of work at his own cost in order to prove the soundness of the same, to the Employer/Consultant or their representatives. The work or portion of work if found to be not satisfactory in the opinion of the Employer / Consultant or their representatives. Contractor shall pull down and re – do the same at his own cost. All defective materials shall be removed from the site immediately as ordered.

It shall be obligatory for the contractor to furnish certificates, if so demanded by the Employer / Consultant from manufacturer or the material supplier, that the work has been carried out by using their material and installed / fixed as per their recommendations.

2. SCOPE OF WORK

The general character and the scope of work to be carried out under this contract is illustrated in Drawings, Specifications and Schedule of Quantities. The Tenderer shall carry out and complete the said work under this contract in every respect in conformity with the contract documents and with the direction of and to the satisfaction of the OWNER's site representative. The tenderer shall furnish all labour, materials and equipment (except those to be supplied by the OWNER) as listed under Schedule of Quantities and specified otherwise, transportation and incidental necessary for supply, installation,

testing and commissioning of the complete Fire Fighting system as described in the Specifications and as shown on the drawings. This also includes any material, equipment, appliances and incidental work not specifically mentioned herein or noted on the Drawings/Documents as being furnished or installed, but which are necessary and customary to be performed under this contract. The Fire Fighting System shall comprise of following:

a. Fire fighting pumps, equipment and electrical panel including connection to various equipment.

b. Fire Hydrant System

c. Sprinkler System

d. Hand Held Fire Extinguishing System

e. Approval from Local Authorities

f. Wiring & earthing from MCC panels to various fire fighting system, control wiring & interlocking.

g. Cutting holes, chases & like through all types of walls /floors and finishing for all services crossings, including sealing, frame woriks, fire proofing, providing sleeve, cover plates, making good structure and finishes to an approved standard.

h. Balancing, testing & commissioning of the entire fire fighting system.

i. Test reports, list of recommended spares, as-installed drawings, operation & maintenance manual for the entire fire fighting system.

j. Training of Owner's staff.

3. ASSOCIATED CIVIL WORKS

Following civil works associated with Fire Fighting installation are excluded from the scope of this contract. These shall be executed by other agencies in accordance with approved shop drawings and under direct supervision of the Fire Fighting tenderer.

a. RCC foundation for machines, pumps & large equipment with angle iron frame work at the edges to protect these from damage.

b. RCC work for water tanks

c. PCC foundation blocks with angle iron frame work edging for all motor control centre.

d. Water proofing of floors.

e. Masonry drains channels and sumps in plant room.

4. ASSOCIATED SERVICES WORKS

4.1 **AllELECTRICAL WORKS** are excluded from the scope of this contract. However, the fire fighting contractor for connections to be provided for motors.

a. The fire fighting contractor within 10 days of issue of LOI shall furnish an electrical load diagram showing the position of the fire loads.

5. BUILDING AUTOMATION SYSTEM

(No additional cost shall be paid for providing the interfacing).

The scope of Fire Fighting Tenderer shall include the following for the interface to Building Automation System.

a. Sockets /Nipples including shut-off valve for mounting sensors/transmitters on pipe lines.

b. It is to be clearly understood that the final responsibility for the sufficiency, adequacy and conformity to the contract requirements, of the Fire Fighting system, lies solely with the tenderer.

6. PROJECT EXECUTION AND MANAGEMENT

The Tenderer shall ensure that senior planning and erection personnel from his organisation are assigned exclusively for this project. They shall have minimum 10 years experience in this type of installation. The Tenderer shall appoint one Project Director holding senior management position in the organisation. He shall be assisted on full time basis by a minimum of two erection engineers & two senior supervisors. The entire staff shall be posted at site on full time basis.

The project management shall be through modern technique. Erection engineer and supervisors shall be provided with mobile communication system so that they can always be reached.

For quality control & monitoring of workmanship, tenderer shall assign at least one full-time engineer who would be exclusively responsible for ensuring strict quality control, adherance to specifications and ensuring top class workmanship for the installation.

The Tenderer shall arrange to have mechanised & modern facilities of transporting material to place of installation for speedy execution of work.

7. INSPECTION AND TESTING

The owner shall carry out inspection and testing at manufacturer's works for items such as water treatment plant & pumps covered under this contract. No equipment shall be delivered without prior written confirmation from Project Manager. In case factory inspection is carried out then all travelling and lodging expenses shall be borne by OWNER for maximum two persons. All expenses related to testing shall be to Contractor account. Tests on site of completed works shall demonstrate the following, among other things.

That the equipment installed complies with specification in all respects and is of the correct rating for the duty and site conditions.

That all items operate efficiently and quietly to meet the specified requirements

The contractor shall provide all necessary instruments and labour for testing, shall make adequate records of test procedures and readings, shall repeat any tests requested by the Project Manager and shall provide test certificate signed by a properly authorized person Such test shall be conducted on all materials and equipments and tests on completed work as called for by the Project Manager at contractor’s expenses unless otherwise called for.

If it is proved that the installation or part thereof is not satisfactorily carried out, then the contractor shall be liable for the rectification and retesting of the same as called for by the Project Manager whose decision as to what constitutes a satisfactory test shall be final.

The above general requirements as to testing shall be read in conjunction with any particular requirements specified elsewhere. All tests shall be carried out by a test house approved by the Project Manager.

8. BYE-LAWS AND REGULATIONS

The installation shall be in conformity with the Bye-laws, Regulations and Standards of the local authorities concerned, in so far as these become applicable to the installation. But if these Specifications and Drawings call for a higher standard of materials and / or workmanship than those required by any of the above regulations and standards, then these Specifications and Drawings shall take precedence over the said regulations and standards. However, if the Drawings and specifications require something which violates the Bye-laws and Regulations, then the Bye-laws and Regulations shall govern the requirement of this installation.

9. FEES AND PERMITS

The tenderer shall obtain all permits/ licenses and pay for any and all fees required for the inspection, approval and commissioning of their installation. However, all receipted amount shall be reimbursed on production of proof of payment.

10. DRAWINGS

The Fire Fighting Drawings listed under **Appendix-I**, issued with tenders are diagrammatic only and indicate arrangement of various systems and the extent of work covered in the contract. These Drawings indicate the points of supply and of termination of services and broadly suggest the routes to be followed. Under no circumstances shall dimensions be scaled from these Drawings. The architectural/interiors drawings and details shall be examined for exact location of sprinklers, hydrants, equipments and water supply / drainage piping etc.

The tenderer shall follow the tender drawings in preparation of his shop drawings, and for subsequent installation work. He shall check the drawings of other trades to verify spaces in which his work will be installed.

Maximum headroom and space shall be maintained at all points. Where headroom appears inadequate, the tenderer shall notify the Architect/Consultant/OWNER's site representative before proceeding with the installation. In case installation is carried out without notifying, the work shall be rejected and tenderer shall rectify the same at his own cost.

The tenderer shall examine all architectural, structural, plumbing, electrical and other services drawings and check the as-built works before starting the work, report to the OWNER's site representative any discrepancies and obtain clarification. Any changes found essential to coordinate installation of his work with other services and trades, shall be made with prior approval of the Architect/Consultant/ OWNER's site representative without additional cost to the OWNER. The data given in the Drawings and Specifications is as exact as could be procured, but its accuracy is not guaranteed.

1. TECHNICAL DATA

Each tenderer shall submit alongwith his tender, the technical data for all items listed in Appendix-IV in the indicated format. Failure to furnish complete technical data with tenders may result in summary rejection of the tender.

12. SHOP DRAWINGS

All the shop drawings shall be prepared on computer through Autocad System based on Architectural Drawings, site measurements and Interior Designer's Drawings. Within four weeks of the award of the contract, tenderer shall furnish, for the approval of the Architect/Consultant, two sets of detailed shop drawings of all equipment and materials including layouts for Plant room, Pump room, showing exact location of supports, flanges, bends, tee connections, reducers, detailed piping drawings showing exact location and type of supports, valves, fittings etc; external insulation details for pipe insulation etc; electrical panels inside/outside views, power and control wiring schematics, cable trays, supports and terminations.

These shop drawings shall contain all information required to complete the Project as per specifications and as required by the Architect/Consultant/OWNER's site representative. These Drawings shall contain details of construction, size, arrangement, operating clearances, performance characteristics and capacity of all items of equipment, also the details of all related items of work by other tenderers. Each shop drawing shall contain tabulation of all measurable items of equipment/materials/works and progressive cumulative totals from other related drawings to arrive at a variation-in-quantity statement at the completion of all shop drawings. Minimum 12 sets of drawings shall be submitted after final approval along with CD.

Each item of equipment/material proposed shall be a standard catalogue product of an established manufacturer strictly from the manufacturers listed in Appendix-III and quoted by the tenderer in technical data part of Appendix - IV.

When the Architect/Consultant makes any amendments in the above drawings, the tenderer shall supply two fresh sets of drawings with the amendments duly incorporated alongwith check prints, for approval. The tenderer shall submit further twelve sets of shop drawings to the OWNER's site representative for the exclusive use by the OWNER's site representative and all other agencies. No material or equipment may be delivered or installed at the job site until the tenderer has in his possession, the approved shop drawing for the particular material/equipment/installation.

Shop drawings shall be submitted for approval four weeks in advance of planned delivery and installation of any material to allow Architect/Consultant ample time for scrutiny. No claims for extension of time shall be entertained because of any delay in the work due to his failure to produce shop drawings at the right time, in accordance with the approved programme.

Manufacturers' drawings, catalogues, pamphlets and other documents submitted for approval shall be in four sets. Each item in each set shall be properly labelled, indicating the specific services for which material or equipment is to be used, giving reference to the governing section and clause number and clearly identifying in ink the items and the operating characteristics. Data of general nature shall not be accepted.

Samples of all materials like valves, pipes etc. shall be submitted to the OWNER's site representative prior to procurement. These will be submitted in two sets for approval and retention by OWNER's site representative and shall be kept in their site office for reference and verification till the completion of the Project. Wherever directed a mockup or sample installation shall be carried out for approval before proceeding for further installation.

Approval of shop drawings shall not be considered as a guarantee of measurements or of building dimensions. Where drawings are approved, said approval does not mean that the drawings supercede the contract requirements,

nor does it in any way relieve the tenderer of the responsibility or requirement to furnish material and perform work as required by the contract.

Where the tenderer proposes to use an item of equipment, other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundation, piping, wiring or any other part of the mechanical, electrical or architectural layouts; all such re-design, and all new drawings and detailing required therefore, shall be prepared by the tenderer at his own expense and gotten approved by the Architect/Consultant/ OWNER's site representative. Any delay on such account shall be at the cost of and consequence of the Tenderer.

Fire Fighting Tenderer shall prepare coordinated services shop drawings based on the drawings prepared by Electrical, HVAC & Low Voltage Tenderers to ensure adequate clearances are available for installation of services for each trade.

Where the work of the tenderer has to be installed in close proximity to, or will interfere with work of other trades, he shall assist in working out space conditions to make a satisfactory adjustment. If so, directed by the OWNER's site representative, the tenderer shall prepare composite working drawings and sections at a suitable scale, not less than 1:50, clearly showing how his work is to be installed in relation to the work of other trades. If the Tenderer installs his work before coordinating with other trades, or so as to cause any interference with work of other trades, he shall make all the necessary changes without extra cost to the OWNER.

Within two weeks of approval of all the relevant shop drawings, the tenderer shall submit four copies of a comprehensive variation in quantity statement, and itemized price list of recommended (by manufacturers') imported and local spare parts and tools, covering all equipment and materials in this contract. The Project Manager shall make recommendation to OWNER for acceptance of anticipated variation in contract amounts and also advise OWNER to initiate action for procurement of spare parts and tools at the completion of project.

13. QUIET OPERATION AND VIBRATION ISOLATION

All equipment shall operate under all conditions of load without any sound or vibration which is objectionable in the opinion of the OWNER's site representative. In case of rotating machinery sound or vibration noticeable outside the room in which it is installed, or annoyingly noticeable inside its own room, shall be considered objectionable. Such conditions shall be corrected by the Tenderer at his own expense. The tenderer shall guarantee that the equipment installed shall maintain the desired NC levels.

14. ACCESSIBILITY

The Tenderer shall verify the sufficiency of the size of the shaft openings, clearances in cavity walls and suspended ceilings for proper installation of his

piping and other ancillaries. His failure to communicate insufficiency of any of the above, shall constitute his acceptance of sufficiency of the same**.** The Tenderer shall locate all equipment which must be serviced, operated or maintained in fully accessible positions. The exact location and size of all access panels, required for each concealed valve or other devices requiring attendance, shall be finalized and communicated in sufficient time, to be provided in the normal course of work. Failing this, the Tenderer shall make all the necessary repairs and changes at his own expense. Access panel shall be standardised for each piece of equipment / device / accessory and shall be clearly nomenclatured / marked.

15. MATERIALS AND EQUIPMENT

All materials and equipment shall conform to the relevant Indian Standards and shall be of the approved make and design. Makes shall be strictly in conformity with list of approved manufacturers as per Appendix - III.

16. MANUFACTURERS INSTRUCTIONS

Where manufacturer has furnished specific instructions, relating to the material and equipment used in this project, covering points not specifically mentioned in these documents, such instructions shall be followed in all cases.

17. ELECTRICAL INSTALLATION

The electrical work related to Fire Fighting services is excluded from the scope of the tenderer. The termination of the cable to the various motors shall be carried out by the contractor.

18. BALANCING, TESTING AND COMMISSIONING

Balancing of all water systems and all tests as called for the Specifications shall be carried out by the tenderer through a specialist group, in accordance with the Specifications and Standards. Performance test shall consist of three days of 10 hour each operation of system for each season. Cost of performance witness test of major equipment such as pumps etc. at factory with two personnel from OWNERs / Consultant shall be included.

The installation shall be tested again after removal of defects and shall be commissioned only after approval by the OWNER’s site representative. All tests shall be carried out in the presence of the representatives of the Architect/Consultant and OWNER’s site representative.

19. COMPLETION DRAWINGS

Tenderer shall periodically submitt completion drawings as and when work in all respects is completed in a particular area. These drawings shall be submitted in the form of two sets of CDs' and four portfolios (300 x 450 mm) each containing complete set of drawings on approved scale indicating the work as - installed. These drawings shall clearly indicate complete plant room layouts, piping layouts, location of wiring and sequencing ofautomatic controls, location of all concealed piping, valves, controls, wiring and other services. Each portfolio shall also contain consolidated control diagrams and technical literature on all controls. The tenderer shall frame under glass, in the plant room, one set of these consolidated control diagrams.

20. OPERATING INSTRUCTION & MAINTENANCE MANUAL

Upon completion and commissioning of part Fire Fighting system **t**he tenderer shall submit a draft copy of comprehensive operating instructions, maintenance schedule and log sheets for all systems and equipment included in this contract. This shall be supplementary to manufacturer's operating and maintenance manuals. Upon approval of the draft, the tenderer shall submit four (4) complete bound sets of typewritten operating instructions and maintenance manuals; one each for retention by Consultant and OWNER's site representative and two for OWNERs Operating Personnel. These manuals shall also include basis of design, detailed technical data for each piece of equipment as installed, spare parts manual and recommended spares for 4-year period of maintenance of each equipment.

"*Preventive Maintenance Schedule for each equipment / panel shall be submitted along with Operation and Maintenance Manual".*

21. ON SITE TRAINING

Upon completion of all work and all tests, the Tenderer shall provide necessary operators, labour and helpers for operating the entire installation for a period of fifteen (15) working days of ten (10) hours each, to enable the OWNER's staff to get aquainted with the operation of the system. During this period, the tenderer shall train the OWNER's personnel in the operation, adjustment and maintenance of all equipment installed**.**

22. MAINTENANCE DURING DEFECTS LIABILITY PERIOD

22.1 Complaints

The Tenderer shall receive calls for any and all problems experienced in the operation of the system under this contract, attend to these within 10 hours of receiving the complaints and shall take steps to immediately correct any deficiencies that may exist.

22.2 Repairs

All equipment that requires repairing shall be immediately serviced and repaired. Since the period of Mechanical Maintenance runs for one year

concurrently with the defect's liability period, all replacement parts and labour shall be supplied promptly free-of-charge to the OWNER.

23. UPTIME GUARANTEE

The tenderer shall guarantee for the installed system an uptime of 98%. In case of shortfall in any month during the defect's liability period, the Defects Liability period shall be extended by a month for every month having shortfall. In case of shortfall beyond the defect's liability period, the contract for Operation and Maintenance shall get extended by a month for every month having the shortfall and no reimbursement shall be made for the extended period.

The Tenderer shall provide log in the form of diskettes and bound printed comprehensive log book containing tables for daily record of all pressures, power consumption. Starting and stopping times forvarious equipment, daily services rendered for the system alarms, maintenance and record of unusual observations etc. Tenderer shall also submit preventive maintenance schedule.

Each tenderer shall submit along with the tender, a detailed operation assistance proposal for the OWNER's site representatives/Consultant's review. This shall include the type of service planned to be offered during Defects Liability Period and beyond. The operation assistance proposal shall give the details of the proposed monthly reports to the Management.

The tenderer shall include a list of other projects where such an Operation Assistance has been provided.

24. OPERATION AND MAINTENANCE

Tenderer may be required to carry out the operation of the FIRE FIGHTING installation for a period of one year from the date of commissioning and handing over of the entire system. Further, he may also be required to carry out operation and all-inclusive maintenance of the entire system for a period of four years beyond the defects liability period**.**

24.1 Operation contract (Fire Fighting)

i. 16 hours a day, year-round.

ii. All stand-by equipment to be operated as per mutually agreed programme.

iii. Proper entry and unkeep of relevant log books.

iv. Maintain complaints register. Submit weekly report.

v. Proper housekeeping of all areas under the contract.

vi. Prepare daily consumption report and summary of operation.

24.2 Terms of payment

i. Monthly at the end of each month on pro-rata basis.

24.3 All Inclusive Maintenance Contract

a. Routine Preventive Maintenance Schedule to be submitted

i. Schedule to cover manufacturer's recommendation and / or common engineering practice (for all plant and machinery under contract).

ii. Plant and machinery history card giving full details of equipment and frequency of checks and overhaul.

iii. Monthly status report.

iv. Entire Fire Fighting installation to be painted in fourth year (from end of defects and liability period) before the expiry of operation and maintenance contract.

b. Uptime during maintenance contract

i. 98% uptime of all systems under contract.

ii. Up time shall be assessed every month and in case of shortfall during any month the contract shall be extended by a month.

iii. There shall be no reimbursement for the extended period.

iv. Break-downs shall be attended to within ten hours of reporting.

v. Spare motor assembly to be made available within seven calendar days in case of total breakdown/burnout.

c. Manpower

i. Adequate number of persons to the satisfaction of the OWNER's site representative shall be provided including relievers.

ii. Statutory requirements of EPF, ESIC and other applicable labour legislations to be complied with; and monthly certification to that effect to be submitted.

iii. Duty allocation and Roaster control shall be tenderer's responsibility.

d. Shut Downs

i. Routine shut downs shall be permitted only during winter season.

ii. Tenderer shall be at liberty to carry out routine maintenance as and when required but with prior permission of the OWNER.

e. Payment Terms

i. Monthly payment at the end of each month on pro-rata basis**.**

25. PARTIAL ORDERING

OWNER through the Architect/Consultant/ OWNER's site representative reserves the right to order equipment and material from any and all alternates, and /or to order high side and /or low side equipment and materials or parts thereof from one or more tenderers**.**

A P P E N D I X – II

GUARANTEE PROFORMA

GUARANTEE FOR

FIRE FIGHTING SYSTEM INSTALLATION

We hereby guarantee the year-round Fire Fighting System Installation Which We Have Installed in The Complex Described Below:

Project Name: **HO, KOLKATA PORT TRUST, KOLKATA**

Clients Name: **KOLKATA PORT TRUST**

For a period of one year from the date of acceptance of the total installation, WE AGREE TO repair or replace to the satisfaction of the Owner, any or all such work that may prove defective in workmanship, equipment or materials within that period, ordinary wear and tear and unusual abuse or neglect excluded, together with any other work, which may be damaged or displaced in so doing. In the event of our failure to comply with the above-mentioned conditions within a reasonable time, after being notified in writing, we collectively and separately, do hereby authorise the Owner to proceed to have the defects repaired and made good at our expense, and we shall pay the cost and charges thereof, immediately upon demand.

WE ALSO HEREBY UNDERTAKE to test the entire installation in first SUMMER, WINTER AND MONSOON on following the completion of the installation, to check and do everything necessary to ensure that the specified design conditions and functional requirement are met, that all water, sewage, air pollution control systems are properly balanced, that all controls are calibrated accurately, and that all units are functioning satisfactorily.

SIGNATURE

OF TENDERER

for FIRE

FIGHTING SYSTEM

DATE: **SEAL**

APPENDIX-III

LIST OF APPROVED MAKES OF EQUIPMENT & MATERIALS FOR FIRE FIGHTING SYSTEM

S.No.	Details of Materials / Equipment		Manufacturer's Name
1.	Fire / Sprinkler Main Pump / Jockey		Willo - Mather & Platt GrundfosS / Lubi
2.	Diesel Engine		Cummins Crompton Greaves KOEL / Willo - Mather & Platt
3.	Motor		ABB Kirloskar Siemens Crompton Greaves
4.	G.I. / M.S. Pipes (IS: 1239 / IS: 3589)		Jindal (Hissar)/ Tata
5.	Standard M.S. Fittings		Seamless Fittings Pipeline Products
6.	DI / CI / Forged Steel Fittings		Bharat Forge Jainsons Industries VS
7.	RCC Pipe		PRECAST QUALITY INDIAN HUME PIPE CALCUTTA HUME PIPE
8.	RCPC MH Cover & Frame		OM CONCRETE NECO Raj Iron Foundry, Agra
9.	FRP / GRP Manhole Covers		Everlast Thermoset

S.No.	Details of Materials / Equipment		Manufacturer's Name
10.	Paints		Asian Paints Berger ICI
12.	Double / Single Headed Landing Valve		Fire Shield Newage Safeguard
13.	Controlled pressure landing valve		Fire Shield Newage Safeguard
14.	Siamese breaching connection/Fire service inlet dragged out connection		Fire Shield Newage Safeguard
15.	Fire Hose		Fire Shield Newage Safeguard
16.	Hose Box (ISI marked)		Fire Shield Newage Safeguard
17.	Photo Luminous Signages		Autolite Legrand
18.	First Aid Hose Reel (LPCB Approved)		Fire Shield Newage Safeguard
19.	Hose Reel Drum (ISI marked)		Fire Shield Newage Safeguard
20.	Gun Metal / SS Branch Pipe		Fire Shield Newage Safeguard

S.No.	Details of Materials / Equipment		Manufacturer's Name
21.	Fireman Axe		Fire Shield Newage Safeguard
22.	Installation Control Valve		HD Tyco Viking
23.	Sprinkler Heads		HD Tyco Viking
24.	Water curtain nozzles		HD Fire Viking
25.	Electrical Panel Detection & Suppression System		TRICOLIGHT/ EQUIVALENT
26.	Fire Extinguishers		Fire Shield Newage Safeguard
27.	Water Flow Switch		Gem Honeywell Rapid Control System Sensor
28.	Pipe Protection Wrapping & Coating		IWL - Pypkote Rustech - Coatek STP Ltd.
29.	Pipe clamp & supports		Chilly Euroclamp Gripple
30.	GM / Forged Brass Valves		Kitz Itap Leader Zoloto
31.	Cast Iron Sluice (Gate) Valves		Indian Valve Company Kirloskar Sarkar

32.	Butterfly Valve	Autco Kitz/Zoloto Sant
33.	Check Valve – Wafer Type	Autco Kitz Zoloto Sant
34.	Check Valve – Dual Plate	Sarkar Subhas Kirloskar Zoloto
35.	Pressure Switch	Danfoss Infoss
36.	Tamper switch	Danfoss Infoss Rapid Control Viking
37.	Foot valve	Kirloskar Normex
38.	Deluge valve	HD Fire Tyco
39.	Solenoid valve	Avcon Danfoss Viking
40.	Emergency shower and Eye wash	Conforming to ANSI Z358.1 and complying with OSHA standards
41.	Pressure Reducing Valve (Listed)	Honey well Zoloto Leader Itap
42.	Air Release Valve	Advance Sant ITAP Leader
43.	Ball Float Valve	Prayag Kitz Autco Sant

44.	CI Y Strainer	Sarkar Advance Autco Kitz
45.	Mechanical Seal	Burgmann Sealol
46.	Couplings	Lovejoy
47.	Anti Vibration Mounting & Flexible Connections	Dunlop Easy flex Flexionics Resistoflex
48.	Spring Load Pressure Relief Valve	Honeywell Sant Advance Kitz Autco
49.	Pressure Gauge	Emerald Fiebig H Guru
50.	Level Controller & Indicator (Water)	Auto Pump Cirrus Engineering Technika Techtrol Pumptrol
51.	Paints	Asian Paints Berger ICI Shalimar Paints Johnson & Nicolas
52.	Fastener	Fisher Hilti
53.	Fire Sealant	Birla 3 M Hilti Promat STI (USA)/ Fire master
54.	Power Distribution Panel and Motor Control Centre & Air Insulated Bus ducts	Adlec Control System, Delhi Fluid Control, Kolkata

Electro Allied Products, Kolkata

A P P E N D I X – IV

SCHEDULE OF TECHNICAL DATA

1. FIRE PROTECTION SYSTEM

1.1 **FIRE PUMPS & MOTOR**

1.1.1 **Electrical Driven Main Fire & Sprinkler Pumps**

Make / Manufacturer	:
Quantity	:
Liquid Handed	:
Liquid Temp deg.C	:
Special Gravity of Liquid	:
Suction	:
Rated Discharge and Head	:
Actual Discharge and Head	:
Model	:
Horizontal / Design	:
Speed / No. of Stages	:

Impeller Dia (Maximum)	:
Suction / Delivery Size	:
Efficiency at Rated Capacity & Head	:
kW required at rated capacity & head	:
Shut Off Head	:
Material of Construction	
Pump Casing	:
Impeller	:
Pump Shaft	:
Shaft Sleeve	:
Casing Wearing Ring	:
Base Plate	:
Mechanical Seal	:
Make of Mechanical Seal	:
Wheather pumps are capable of discharging 150% of rated capacity at a head not less than 65% of rated head.	:
Whether automatic priming arrangement included.	:

<u>Description of Motors</u>

Make	:
Model No.	:
Type	:
Frame size	:
Speed (RPM)	:
Rated Capacity (Power)	:

Full load current :

Enclosure :

Coupling / Pulley :

Class of Insulation

Size of Foundation
For complete coupled set mounted over MS base frame :

1.1.2 **DIESEL ENGINE DRIVEN PUMP**

Make / Manufacturer :

Quantity :

Liquid Handed :

Liquid Temp deg.C :

Special Gravity of Liquid :

Suction :

Rated Discharge and Head :

Actual Discharge at Low Zone Head :

Model :

Horizontal / Design :

Speed / No. of Stages :

Impeller Dia (Maximum) :

Suction / Delivery Size :

Efficiency at Rated Capacity & Head :

kW required at rated capacity & head :
Shut Off Head :

Material of Construction

Pump Casing :

Impeller :

Pump Shaft	:
Shaft Sleeve	:
Casing Wearing Ring	:
Base Plate	:
Mechanical Seal	:
Make of Mechanical Seal	:
Wheather pumps are capable of discharging 150% of rated capacity at a head not less than 65% of rated head.	:
Whether automatic priming arrangement included	:

<u>Description of Engine</u>

Make	:
Model No.	:
Type	:
Frame size	:
Speed (RPM)	:
Rated Capacity (Power)	:
Full load current	:
Enclosure	:
Coupling / Pulley	:
No of Cylinder	:
Fuel Pump & Water pump detail	:
Engine Cooling & Oil System	:
Diesel Oil tank capacity	:
Fuel Oil storage shall ensure working of pump for number of hours	:

Size of Foundation
For complete coupled set mounted over MS base frame :

1.1.3 **JOCKEY PUMP**
(Please submit separate data sheet for each type of pump)

Liquid Handed :

Liquid Temp deg.C :

Special Gravity of Liquid :

Suction :

Rated Discharge and Head :

Actual Discharge and Head :

Model :

Horizontal / Design :

Speed / No. of Stages :

Impeller Dia (Maximum) :

Suction / Delivery Size :

Efficiency at Rated Capacity & Head :

kW required at rated capacity & head :

Shut Off Head :

Material of Construction

Pump Casing :

Impeller :

Pump Shaft :

Shaft Sleeve :

Casing Wearing Ring :

	Base Plate	:
	Mechanical Seal	:
	Make of Mechanical Seal	:
	<u>Description of Motor</u>	
	Make	:
	Model No.	:
	Type	:
	Frame size	:
	Speed (RPM)	:
	Rated Capacity (Power)	:
	Full load current	:
	Enclosure	:
	Coupling / Pulley	:
	<u>Size of Foundation</u> For complete coupled set mounted over MS base frame	:
1.2	**PIPING**	
	15 NB TO 50 NB	:
	15 TO 50 NB Fittings	:
	65 NB TO 150 NB Pipes	
	65 NB TO 150 NB Fittings	
	200 NB ONWARDS Pipes	
	200 NB ONWARDS Fittings	
	Flanges	
	Gaskets	
1.3	**HYDRANT VALVES**	

1.3.1 **Technical Specifications:**

Item :

Working Pressure :

Code for Design Mft. :

1.3.2 **Construction Features**

Type of Stem

Type of Inlet

Type of Outlet

Flange Drilling

1.3.3 **Material of Construction**

Body and Bonnet :

Stop Valve, Valve Seat :

Check nut & gland nut :

1.4. **PRESSURE GAUGE**

1.4.1 **Technical Specifications:**

Working Pressure :

Code for Design Mft. :

Scale range :

1.4.2 **Construction Features**

Case :

Pointer :

Dial Size :

Dial Lettering :

Process Connection :

1.4.3 **Material of Construction**

Case :

Movement :

Block :

1.5 **PRESSURE SWITCHES**

1.5.1 **Technical Specifications:**

Item :

Working Pressure :

Scale range :

1.5.2 **Construction Features**

Protection :

Cable Entry :

Process Connection :

Repeatability :

Switch
Type :
No. of contacts :
Contact Rating :

1.5.3 **Material of Construction**

Enclosure :

Pressure element :

Wetted Parts :

A P P E N D I X – V

LIST OF BUREAUS OF INDIAN STANDARDS CODES

All equipment supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below upto 30th April, 2003 and amended thereafter till date. All equipment and material being supplied by the tenderer shall meet the requirements of IS. Tarrif advisory committee's regulation (fire insurance), electrical inspectorate and Indian Electricity rules and other Codes / Publications as given below:

1. **GENERAL:**

SP: 6 (1)	Structural Steel Sections
IS: 27	Pig Lead
IS: 325	Three Phase Induction Motors
IS: 554	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS: 694	PVC insulated cables for working voltages upto & including 1100 V.
IS: 779	Specification for water meters (domestic type).
IS: 782	Specification for caulking load.
IS: 800	Code of practice for general construction in steel
IS: 1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.
IS: 1172	Code of Basic requirements for water supply drainage and sanitation.
IS: 1367 (Part 1)	Technical supply conditions for threaded steel fasteners: Part 1 introduction and general information.
IS: 1367 (Part 2)	Technical supply conditions for threaded steel fasteners: Part 2 product grades and tolerances.
IS: 1554 (Part 1)	PVC insulated (heavy duty) electric cables: Part 1 for working voltages upto and including 1100 V.
IS: 1554 (Part 2)	PVC insulated (heavy duty) electric cables: Part 2 for working voltages from 3.3 KV upto and including 11 KV.
IS: 1726	Specification for cast iron manhole covers and frames.
IS: 1742	Code of practice for building drainage.
IS: 2064	Selection, installation and maintenance of sanitary appliance code

	of practice.
IS: 2065	Code of practice for water supply in buildings.
IS: 2104	Specification for water meter for boxes (domestic type)
IS: 2373	Specification for eater meter (bulk type)
IS: 2379	Colour code for identification of pipe lines.
IS: 2629	Recommended practice for hot dip galvanizing on iron and Steel.
IS: 3114	Code of practice for laying of cast iron pipes
IS: 4111 (Part 1)	Code of practice for ancillary structures in sewerage system: Part 1 manholes.
IS: 4127	Code of practice for laying glazed stoneware pipes.
IS: 4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes.
IS: 5329	Code of practice for sanitary pipe work above ground for buildings.
IS: 5455	Cast iron steps for manholes.
IS: 6159	Recommended practice for design and fabrication of material, prior to galvanizing.
IS: 7558	Code of practice for domestic hot water installations.
IS: 8321	Glossary of terms applicable to plumbing work.
IS: 8419 (Part 1)	Requirements for water filtration equipment: Part 1 Filteration medium sand and gravel.
IS: 8419 (Part 2)	Requirements for water filtration equipment: Part 2 under drainage system.
IS: 9668	Code of practice for provision and maintenance of water supplies and fire fighting.
IS: 9842	Preformed fibrous pipe insulation.
IS: 9912	Coal tar-based coating materials and suitable primers for protecting iron and steel pipe lines.
IS: 10221	Code of practice for coating and wrapping of underground mild steel pipelines.

IS: 11149	Rubber Gaskets
IS: 11790	Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings.

2. **PIPES AND FITTINGS**

IS: 1239 (Part 1)	Mild steel, tubes, tubulars and other wrought steel fittings : Part 1 Mild Steel tubes.
IS: 1239 (Part 2)	Mild Steel tubes, tubulars and other wrought steel fittings: Part 2 Mild Steel tubulars and other wrought steel pipe fittings.
IS: 1879	Malleable cast iron pipe fittings.
IS: 1978	Line pipe
IS: 1979	High test line pipe.
IS: 2501	Copper tubes for general engineering purposes
IS: 2643 (Part 1)	Dimensions for pipe threads for fasterning purposes: Part 1 Basic profile and dimensions.
IS: 2643 (Part 2)	Dimensions for pipe threads for fastening purposes: Part 2 Tolerances.
IS: 2643 (Part 3)	Dimensions for pipe threads for fastening purposes: Part 3 Limits of sizes.
IS: 3468	Pipe nuts.
IS: 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS: 3989	Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS: 4346	Specifications for washers for use with fittings for water services.
IS: 4711	Methods for sampling steel pipes, tubes and fittings.
IS: 6392	Steel pipe flanges
IS: 6418	Cast iron and malleable cast iron flanges for general engineering purposes.

IS: 7181	Specification for horizontally cast iron double flanged pipe for water, gas and sewage.

3. **VALVES**

IS: 778	Specification for copper alloy gage, globe and check valves for water works purposes.
IS: 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS: 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS: 2906	Specification for sluice valves for water works purposes (350 mm to 1200 mm size)
IS: 3950	Specification for surface boxes for sluice valves.
IS: 5312 (Part 1)	Specification for swing check type reflux (non-return) valves: part 2 Multi door pattern.
IS: 5312 (Part 2)	Specification for swing check type reflux (non-return) valves: part 2 Multi door pattern.
IS: 12992 (Part 1)	Safety relief valves, spring loaded: Design
IS: 13095	Butterfly valves for general purposes.

4. **FIRE FIGHTING EQUIPMENT**

TAC	Tariff Advisory Committee fire protection manual Part-I.
TAC	Rules of Tariff Advisory Committee for automatic sprinkler system.
NFPA: 13	Installation of Sprinkler System
NFPA: 14	Installation of Standpipe & Hose System
NFPA: 20	Installation of Stationary pump for Fire Protection
IS: 636	Non-percolating flexible fire fighting delivery hose.
IS: 884	Specification for first aid hose reel for fire fighting.
IS: 901	Specification for couplings, double male and double female, instantaneous pattern for fire fighting.

IS: 902	Suction hose couplings for fire fighting purposes.
IS: 903	Specification for fire hose delivery couplings, branch pipe, nozzles and nozzle spanner.
IS: 904	Specification for 2-way and 3-way suction collecting heads for fire fighting purposes.
IS: 907	Specification for suction strainers, cylindrical type for fire fighting purposes.
IS: 908	Specification for fire hydrant, stand post type.
IS: 909	Specification for underground fire hydrant, sluice valve type.
IS: 910	Specification for portable chemical foam fire extinusiher.
IS: 933	Specification for portable chemical foam fire extinguisher.
IS: 1648	Code of practice for fire safety of building (general): Fire fighting equipment and its maintenance.
IS: 2171	Specification for portable fire extinguishers dry powder (catridge type)
IS: 2190	Selection, installation and maintenance of first aid fire extinguishers – Code of practice.
IS: 2871	Specification for branch pipe, universal, for fire fighting purposes.
IS: 2878	Specification for fire extinguishers, carbon dioxide type (portable and trolley mounted).
IS: 3844	Code of practice for installation and maintenance of internal fire hydrants and hose reel on premises.
IS: 5290	Specification for landing valves.
IS 5714	Specification for coupling, branch pipe, nozzle, used in hose reel tubing for fire fighting.
IS: 8423	Specification for controlled percolation type hose for fire fighting.
IS: 10658	Specification for higher capacity dry powder fire extinguisher (trolley mounted).
IS: 11460	Code of practice for fire safety of libraries and archives

	buildings.
IS: 1309	External hydrant systems – Provision and maintenance – Code of practice.
IS: 5514 (1 to 7)	Reciprocating internal combustion engines Performance. :

TECHNICAL SPECIFICATIONS

BASIS OF DESIGN

SECTION-:1 FIRE PROTECTION SYSTEM

1. SCOPE:

The scope of this section consists of but is not necessarily limited to supply, installation, testing and commissioning of the fire protection system. The philosophy of the system is as follows:

a. The Fire Suppression System shall comprise the Fire Hydrants System, the Sprinkler System (Wet type) and Hand Appliances.

b. Water from the underground RCC Fire Water Storage Tanks, shall be supplied for the uses listed below.

   i. Fire Hydrant System (Pressurised) both for the external hydrants, the internal landing valves and the hose reels at landings.

   ii. Sprinkler System (Wet Type)

c. The Hydrant System and the Sprinkler System, under normal conditions, shall be lowest pressurized by means of the electric motor driven Jockey Pump.

d. The Hydrant System shall be provided with two pump sets, one of which will be diesel engine driven and the other electric motor driven.

e. The Sprinkler System shall be provided with an electric motor driven pump set.

f. The piping and valve connections shall be done so that the water from the discharge of the Hydrant Pump sets is able to supply water, automatically to the Sprinkler System whenever, the Sprinkler Pump is unable to maintain the pressure or fails and not vice versa.

g. The starting and stopping of the Jockey pump shall be automatic based on the pressure switches at preset low and high pressure.

h. The electric motor driven Hydrant Pump starts automatically at a preset pressure by means of a pressure switch. As soon as the Hydrant Pump starts, the Jockey Pump Stops. If for any reason the electric motor driven Hydrant Pump does not start at the preset pressure or is unable to maintain the pressure, the diesel engine driven Hydrant Pump starts at the preset pressure.

i. The Hydrant Pump, whether electric motor driven or the diesel engine driven shall be stopped only manually.

j. The Sprinkler Pump shall be started automatically at a preset pressure but shall be stopped only manually.

k. Contractor shall ensure that all false ceiling voids generator than 800 mm are provided with sprinkler.

l. Tenderer shall ensure Hydro Testing for the complete system.

m The Tenderer shall obtain the necessary approval of the drawings and the schemes from the local authority / TAC as called for. The tenderer shall also take care of any other requirement so that insurance cover can be obtained, if required at minimum premium at a later date.

n. The tenderer shall design and after approval of Project Manager display near each staircase landing at floor levels, a glass covered framed floor plan clearly showing the locations of all landing valves, hose reels, hand appliances, as well as the DO's and DON'T's for the personnel and the exit direction in case of an emergency. The dimensions of the floor plan, its scale, lettering size, colour scheme etc shall be as directed by the Project Manager.

2. PIPE WORK

2.1 GENERAL REQUIREMENTS:

All materials shall be of the best quality conforming to the specifications and subject to the approval of the Consultants.

Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

Pipes shall be securely fixed to walls and ceilings by suitable clamps and supports (galvanised after fabrication) at intervals specified. Only approved type of anchor fasteners shall be used for RCC slabs and walls / floors etc.

Valves and other appurtenances shall be so located that they are easily accessible for operations, repairs and maintenance.

Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.

Pipe accessories such as gauges, meters, control devices, etc. shall have the same working pressure rating as the associated pipework. All pipework shall be free from burrs, rust and scale and shall be cleaned before installation. All personnel engaged on welding operations must possess a certificate of competence issued by an acceptable / recognized authority.

2.2 PIPING:

Pipes of following types are to be used:

Mild steel black pipes as per IS:1239 heavy grade for pipes of sizes 150 mm N.B. and below and IS: 3589 from 200mm dia and above with 6.35 mm wall thickness suitably lagged on the outside to prevent soil corrosion. Pipes shall be embedded all around 150mm thick compacted silver sand and providing protection to embedded MS pipes and fittings by applying pype kote primer (@ 100 gm/sqm) thereafter wrapping 4 mm thick pyp kote (AW 4 mm) protection coating by thermo fusion process. Overlap shall be maintained at 20 mm.

All pipe clamps and supports shall be fabricated from MS steel sections and shall be factory galvanised before use at site. Welding of galvanised clamps and supports shall not be permitted.

Pipes shall be hung by means of expandable anchor fastener of approved make and design. The hangers and clamps shall be fastened by means of galvanised nuts and bolts. The size/diameter of the anchor fastener and the clamps shall be suitable to carry the weight of water filled pipe and dead load normally encountered.

Hangers and supports shall be throughly galvanised after fabrication. The selection and design of the hanger & support shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchor braces, dampener, expansion joint and structural steel to be attached to the building/structure trenches etc. shall be provided. Hangers and components for all piping shall be approved by the Consultants.

The piping system shall be tested for leakages at 2 times the operating pressure or 1.5 time shut-off pressure, which ever is highest including testing for water hammer effects.

Flanged joints shall be used for connections for vessels, equipment, flanged valves and also on two straight lengths of pipelines of strategic points to facilitate erection and subsequent maintenance work.
For pipes under ground installation the pipes shall be buried at least one meter below ground level and shall have 230 mm x 230 mm masonry or concrete supports at least 300 mm high at 3m intervals. Masonry work to have plain cement concrete foundation (1 cement: 4 coarse sand: 8 stone aggregate) of size 380x380x75 thick resting on firm soil.

Mains below ground level shall be supported at regular intervals not exceeding 3.0 metres and shall be laid at least 2.0 metre away from the building.

2.3 PIPING INSTALLATION & SUPPORT:

Tender drawings indicate schematically the size and location of pipes. The Tenderer, on the award of the work, shall prepare detailed working drawings,

showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Piping shall be properly supported on, or suspended from, on stands, clamps, hangers as specified and as required. The Tenderer shall adequately design all the brackets, saddles, anchor, clamps and hangers, and be responsible for their structural stability.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. Risers shall be supported at each floor with Galvanised steel clamps. To permit free movement of common piping support shall be from a common hanger bar fabricated from Galvanised steel sections.

Pipe hangers shall be provided at the following maximum spacings:

Pipe Dia (mm)	**Hanger Rod Dia (mm)**	**Spacing between Supports (m)**
Up to 25	8	2
32 to 50	8	2.7
80 to 100	10	2.7
	MS Angle Support	
125 to 150	50 x 50 x 6 mm thick	3.0
200 to 300	50 x 50 x 6 mm thick	3.6

The end of the steel rods shall be threaded and not welded to the threaded bolt.

All pipe work shall be carried out in a proper workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation with other agencies work, so that area can be carried out in one stretch.

Cut-outs in the floor slab for installing the various pipes area are indicated in the drawings. Tenderer shall carefully examine the cut-outs provided and clearly point out wherever the cut-outs shown in the drawings, do not meet with the requirements.

Pipe sleeves, larger diameter than pipes, shall be provided wherever pipes pass through walls and slab and annular space filled with fibreglass and finished with retainer rings.

The tenderer shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by

Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before lying. 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, concentric reduces shall be used for the piping to drain freely. Ecentric reduces may be used at pump suction.

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size gate valves. Automatic air valves shall be provided on hot water risers.

Discharge from the air valves shall be piped through a pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

Pressure gauges shall be provided as shown on the approved drawings. Care shall be taken to protect pressure gauges during pressure testing.

2.4 PIPE FITTINGS:

Pipe fittings mean tees, elbows, couplings, unions, flanges, reducers etc and all such connecting devices that are needed to complete the piping work in its totality.

Forged steel fittings of approved type with “V” groove for welded joints. Forged steel fittings shall be screwed type/socket welded only and shall be used for pipes of 50 mm dia & below.

Fabricated fittings shall not be permitted for pipes diameters 50mm and below.

When fabricated fittings are used, they shall be fabricated, welded in workshops. They shall be inspected by Project Manager before dispatch from the workshop. The welding procedures of the workshop should have been approved by the rules for sprinkler system and applicable to hydrant and sprinkler system. For “T” connection, pipes shall be cutting by gas. Pipes cutting by electrical welding shall not be permitted.

2.5 JOINTING:

2.5.1 WELDED JOINTS:

Joints between MS pipes and fittings shall be made with the pipes and fittings having “V” groove and welded with electrical resistance welding in an approved manner. But welding without “V” groove shall not be permitted.

All joints in the pipe line with screwed fittings shall be seal welded after testing and the weld plus the adjoining portion shall be given two coats of zinc rich primer.

Pipes up to 50 mm dia, standard threaded forged fittings (MS/GI) shall be used and 65 mm and above standard MS but welded fittings shall be used as per IS: 15105.

2.5.2 Flanged Joints (50 Mm Dia and Above)

Flanged joints with flanges conforming to IS: 6392 shall be provided on

a. For jointing all types of valves, appurtenances, pumps, connections with other type of pipes, to water tanks and other places necessary and as required for good engineering practice and as shown/noted on the drawings.

b. Flanges shall be with GI bolts and nuts and 3mm insertion gasket of natural rubber conforming to IS: 11149.

3. AIR VESSEL:

The air vessel shall be provided to compensate for slight loss of pressure in the system and to provide an air cushion for counter-acting pressure, surges, whenever the pumping sets come into operation. Air vessel shall conform to IS: 3844. It shall be normally half full of water, when the system is in normal operation. Air vessel shall be fabricated with 8 mm thick M.S. plate with dished ends and suitable supporting legs. It shall be provided with one 100 mm dia flanged connection from pump, one 25 mm drain with valve, one water level gauge and 25 mm sockets for pressure switches. The air vessel shall be tested to pressure for 12 hours at 2 times the operating pressure or 1.5 times the shut-off.

4. FIRE BRIGADE CONNECTION:

The storage tank shall be provided with a 150-mm fire brigade pumping connection to discharge at least 2275 litres /minimum into it. This connection shall not be taken directly into the side of the storage tank but arranged to discharge not less than 150 mm above the top edge of the tank such that the water flow can be seen. The connection shall be fitted with stop valve in a position approved by the Project Manager. An overflow connection discharging to a drain point shall be provided from the storage tank.

The fire brigade connection shall be fitted with four numbers of 63mm instantaneous inlets in a glass fronted wall box at a suitable position at street level, so located as to make the inlets accessible from the outside of the building. The size of the wall box shall be adequate to allow hose to be connected to the inlets, even if the door cannot be opened and the glass has to be broken. Each box shall have fall of 25mm towards the front at its base and shall be glassed with wired glass with” FIRE BRIGADE INLET” painted on the inner face of the

glass in 50 mm size block letter. Each such box shall be provided with a steel hammer with chain for breaking the glass.

In addition to the emergency fire brigade connection to the storage tank, a 150mm common connection shall be taken from the four 63mm instantaneous inlets direct to hydrant main so that the fire brigade may pump to the hydrants in the even of the hydrant pumps being out of commission. The connection shall be fitted with a sluice valve and reflux valve. Location of these valve shall be as per the approval of the Project Manager.

Two way collecting head with two numbers 63 mm instantaneous type inlets shall be connected to the sprinkler header. All other details shall be as described above.

5. SYSTEM DRAINAGE:

The system shall be provided with suitable drainage arrangement with drain valves complete with all accessories.

6. VALVE CHAMBERS:

Provision of suitable brick masonary chambers in cement mortar 1:5 (1 cement: 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement: 5 fine sand: 10 graded stone aggregate 20 mm nominal size) with 15 mm thick cement plaster inside and outside finished with a plaster inside and outside finished with a floated coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back-filling complete shall be made.

7. VALVES

7.1 **SLUICE VALVES:**

Sluice valves shall be double flanged valves with cast iron body. The spindle, wall seat and wedge nuts shall be of bronze. They shall generally have non-rising spindle and shall be of the particular duty and design called for.

The valves shall be supplied with suitable flanges, non- corrosive bolts and asbestos fibre gaskets. Sluice valves shall conform to Indian Standard IS: 780-1969 and IS: 2906.

7.2 **BUTTERFLY VALVE:**

The butterfly valve shall be suitable for waterworks and rated for 300 P.S.I

The body shall be of cast iron to IS:210 in circular shape and of high strength to take the water pressure. The disc shall be heavy duty cast iron with anti corrosive epoxy or nickel coating.

The valve seat shall be of high-grade elastomer or nitrile rubber. The valve is closed position shall have complete contact between the seat and the disc

throughout the perimeter. The elastomer rubber shall have a long life and shall not give away on continuous applied water pressure. The shaft shall be EN 8 grade carbon steel.

The valve shall be fitted between two flanges on either side of pipe flanges. The valve edge rubber shall be projected outside such that they are wedged within the pipe flanges to prevent leakages.

7.3 BALL VALVE:

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon.

The handle shall be provided with PVC jacket. The handle shall also indicate the direction of ‘open’ and ‘closed’ situations. The gap between the ball and the Teflon packing shall be sealed to prevent water seeping.
The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

7.4 GUN METAL VALVES:

Gun metal Valves shall be used for smaller dia pipes, and for threaded connections. The Valves shall bear certification as per IS: 778

The body and bonnet shall be of gun metal to IS: 318. The stem gland and gland nut shall be of forged brass to IS: 6912. The hand wheel shall be of cast iron to IS: 210.

The Hand wheel shall be of high-quality finish to avoid hand abrasions. Movement shall also be easy. The spindle shall be non-rising type.

7.5 NON-RETURN VALVE:

Non-Return valves shall be cast iron double flanged with cast iron body and gunmetal internal parts conforming to IS: 5312.

7.6 PRESSURE RELIEF VALVE:

Each System shall be provided with a Pressure Relief Valves. The Valve shall be spring actuated and set to operate as per field requirement. The Valve shall be

constructed of bronze and provided with an open discharge orifice for releasing the water. The Valve shall be open lift type.

8. PRESSURE SWITCH:

The pressure switches shall be employed for starting and shutting down operation of pumps automatically, dictated by line pressure. The Pressure Switch shall be diaphragm type. The housing shall be died cast aluminium, with SS 316 movement, pressure element and socket. The set pressure shall be adjustable.

The Switch shall be suitable for consistent and repeated operations without change in values. It shall be provided with IP:55 water and environment protection.

9. PRESSURE GAUGE:

The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainles steel Bourden tube type pressure gauge with a scale range from 0 to 16 Kg / cm square with a dial size of minimum 100 mm dia. and shall be constructed as per IS:3524. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.

10. PAINTING:

All Hydrant and Sprinkler pipes shall be painted with post office red colour paint. All M S pipes shall first be cleaned thoroughly before application of primer coat. After application of primer coat two coats of enamel paint shall be applied. Each coat shall be given minimum 24 hours drying time. No thinners shall be used. Wherever required all pipe headers shall be worded indicating the direction of the pipe and its purpose such as "TO RISER NO.1" etc.

Painting shall be expertly applied, the paint shall not over run on surfaces not requiring painting such as walls, surfaces etc. Nuts and bolts shall be painted black, while valves shall be painted blue.

11. EXCAVATION:

Excavation for pipe lines shall be in open trenches to levels and grades shown on the drawings or as required at site. Pipe lines shall be burried with a minimum cover of 1 meter or as shown on drawings.

Wherever required Tenderer shall support all trenches or adjoining structures with adequate timber supports, shoring and strutting.

On completion of testing in the presence of the Project Manager and pipe protection, trenches shall be backfilled in 150 mm layers and consolidated.

Tenderer shall dispose off all surplus earth as directed by the Project Manager.

12. ANCHOR / THRUST BLOCK:

Tenderer shall provide suitably designed anchor blocks in cement concrete/steel support to cater to the excess thrust due to work hammer and high pressure

Thrust blocks shall be provided at all bends, tees and such other location as determined by the Project Manager.

Exact location, design, size and mix of the concrete blocks/steel support shall be as shown on the drawings or as directed by the Project Manager prior to execution of work.

143. FIRE HYDRANTS

14.1 EXTERNAL HYDRANTS:

a. Tenderer shall provide external hydrants. The hydrants shall be controlled by a cast iron sluice valve/Butter Fly Valve. Hydrants shall have instantaneous type 63mm dia outlets. The hydrants shall be single outlet conforming to IS: 908 with CI duck foot bend and flanged riser or required height to bring the hydrant to correct level above ground.

b. Tenderer shall provide for each external fire hydrant two numbers of 63mm dia. 15 m long controlled percolation hose pipe with gunmetal male and female instantaneous type couplings machine wound with GI wire (hose to IS: 8423 type certification), SS branch pipe with nozzle to IS:903. This shall be measured and paid for separately.

c. Each external hydrant hose cabinet shall be provided with a drain in the bottom plate.

d. Each external hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman's Axe. This shall be measured and paid for separately.

e. Each hose cabinet shall be conspicuously painted with the letters "FIRE HOSE".

14.2 INTERNAL HYDRANTS:

a. Tenderer shall provide on each landing and other locations as shown on the drawings single / double headed SS landing valve with 80 mm dia inlet as per IS:5290, with shut off valves having cast iron wheels as shown on the drawings. Landing valve shall have flanged inlet and instantaneous type outlets as shown on the drawings.

b. Instantaneous outlets for fire hydrants shall be standard pattern and suitable for fire hoses.

c. Tenderer shall provide for each internal fire hydrant station two numbers of 63 mm dia. 15 m long ruberized fabric lined hose pipes with gunmetal male and female instantaneous type coupling machine wound with GI wire (hose to IS: 8423 type 2 and couplings to IS: 903 with IS certification), fire hose reel, SS branch pipe with nozzle to IS: 903. This shall be measured and paid for separately.

d. Tenderer shall provide standard fire hose reels of 20mm dia high pressure Dunlop rubber hose 36.5 m long with gunmetal nozzle, all mounted on a circular hose reel of heavy duty mild steel construction having cast iron brackets. Hose reel shall be connected directly to the wet riser with an isolating valve. Hose reel shall conform to IS: 884 and shall be mounted vertically. This shall be measured and paid for separately.

e. Each internal hydrant hose cabinet shall be provided with a drain in the bottom plate. The drain point shall be lead away to the nearest general drain.

f. Each internal hydrant hose cabinet containing items as above shall also be provided with a nozzle spanner and a Fireman's Axe. The cabinet shall be recessed in the wall as directed. This shall be measured and paid for separately.

g. Each hose cabinet shall be conspicuously painted with the letters "FIRE HOSE".

14.3 **HOSE REEL:**

Hosereel shall conform to IS: 884, heavy duty, 20 mm dia length shall be 36-metre-long fitted with gun metal chromium plated nozzle, mild steel pressed reel drum which can swing upto 170 degree with wall brackets of cast iron finished with red and black enamel complete.

14.4 **FIRE HOSE:**

All hose pipes shall be of 63 mm diameter RRL/ CP as required, conforming to IS: 8423. The hose shall be provided with copper alloy delivery coupling. The hose shall be capable of withstanding a bursting pressure of 35.7 Kg/Sq.cm without undue leakage or sweating. Hose shall be provided with instantaneous spring-lock, type couplings.

14.5 **BRANCH PIPE, NOZZLE:**

Branch pipes shall be of SS with loaded tin bronze ring at the discharge and to receive the nozzle and provided at the other with a leaded tin bronze ring to fit into the instantaneous coupling. Nozzle shall be of spray type of diameter of not less than 16 mm and not more than 25 mm. Nozzle shall be of loaded tin bronze branch pipe and nozzle shall be of instantaneous pattern conforming to Indian Standard - 903.

14.6 HOSE CABINET:

Hose cabinet shall be provided for all internal and external fire hydrants. Hose cabinets shall be fabricated from 16-gauge MS powder coated sheet of fully welded constrcution with hinged double front door partially glazed (3 mm glass panel) with locking arrangement, stove enamelled fire red paint (shade No. 536 of IS:5) with “FIRE HOSE” written on it prominently (size as given in the schedule of quantities). Cabinet surfaces in contact with the walls shall not be powder coated but instead given two coats of anti-corrosive bitumastic paint.

14.7 INTERNAL HOSE CABINET:

Hose cabinet shall be of glass fronted with hinged door & lock. The cabinet shall be made of 16-gauge thick MS sheet and spray painted to shade No. 536 of IS: 5. the hose cabinet shall be of size to accommodate the following:

i. Landing Valves (Single/double headed)
ii. Hose pipe (2/4 length of 15 m)
iii. Hose reel (36.5 mtr.)
iv. Branch pipes, nozzles (1/2 sets)
v. Fire man's axe and hand appliances

14.8 EXTERNAL HOSE CABINET

The hose cabinet shall be of size to accommodate the following:

i. Single headed yard hydrant valve
ii. Hose pipe (2 length of 15 m)
iii. Branch pipes, nozzles (1 set)

15. SPRINKLER SYSTEM

15.1 GENERAL SPECIFICATION:

The scope of work shall include supply, commissioning, testing of the system as a whole. The pendant upright, side wall and concealed types of sprinkler heads are to be fixed into heavy quality black steel pipes, conforming to IS 1239 along with a clamp / bracket or any other approved specifications. The size of pipe will vary from 25 mm to 150mm to suit the hydraulics of the system. The System shall conform to CFO Rules for the installation of sprinkler systems in general for 'Ordinary Hazard' category-in respect of design, density and spacing of sprinkler heads.

Reduction in pipe sizes shall not be made by use of bushings. All piping shall be done by means of welding, screwed & flanged jointing as per codes.

Due care shall be taken that sprinklers are not applied with paint at the time of applying paint to piping and fittings.

All control, drain, test and alarm valves shall be provided with signs to identify their purposes, functions, direction of flow the satisfaction of the Consultants.

15.2. QUARTZOID BULB AUTOMATIC SPRINKLER:

Sprinkler heads shall be made of brass/quartzoid bulb sufficiently strong, in compression to withstand any pressure, surge or hammer likely to occur in the system. The yoke & body shall be made of high-quality gun metal brass with arms streamlined to ensure minimum interference with the spread of water. The deflector of suitable design shall be fitted to give even distribution of water over the area commanded by the sprinkler.

The bulb shall contain a liquid having a freezing point below any natural climatic figure and a high coefficient of expansion. The temperature rating of the sprinkler shall be stamped on the deflector & the colour of the liquid filled in the bulb shall be according to the temperature rating as per HFPA standard. The sprinkler heads shall be of type & quality approved by the local fire brigade authority. The inlet shall be screwed.

The sprinklers shall have 15mm nominal size of the orifice for ordinary hazard.

The orifice size shall be marked on the body or the deflector of the sprinkler.

Metal guards for protection of sprinkler against accidental or mechanical damage shall be provided as desired by the Project Manager.

Tenderer shall submit detailed submittal and discharge spray pattern for the Sprinkler for the approval of consultant.

15.2.1 OPERATING TEMPERATURE:

The Operating temperature at which the quartzoid bulb of the sprinkler head shall actuate, shall be 68-degree C or as specifically mentioned.

15.2.2 SPRINKLER INSTALLATION:

Sprinkler heads shall be located in positions shown on the drawings. While slight relocation may result from building construction features or interference

from other services, the maximum spacing between sprinkler heads and coverage area shall not exceed those stipulated in the TAC regulations and the NFPA 13-1994 Rules.

Allowance shall be made for such relocations within a radius of 1500 mm of the indicated positions without additional cost. The Fire Protection Services Trade shall co-ordinate with the ceiling Trade to set out the sprinkler locations to suit the site location of the unit grid. In general, all sprinklers shall be located at the centre of the ceiling unit and a provision of about 10% more sprinklers and pipework than required in TAC and NFPA Rules shall be included in this sub-contract. Chrome plated wire mesh guards shall be used to protect the sprinkler heads which are liable to accidental or mechanical **(at no extra cost)** damage.

15.3. **FLOW REQUIREMENTS:**

The flow requirement for sprinkler heads shall be specifically approved for the designated area of installation.

15.4. **ORIFICE PLATES:**

For restricting pressure at lower levels in the sprinkler system, orifice plates of appropriate sizes shall be fitted at different floor levels, at the branching points from Riser Main.

The Diameter of such orifice shall not be less than 50% of the dia of pipe into which it is to be fitted, which shall not be less than 50mm dia. These orifice plates must be of stainless steel with plain central hole without burrs, and the thickness shall be 3mm for pipe size upto 80 mm, 6 mm for pipes from 80 to 125 mm dia and 9 mm for pipes greater than 125 mm dia. Such orifice plate must have a projecting identification tag.

The orifice plate shall have fitted not less than two pipe internal diameters down stream of the outlet from any elbow or brand.

Tenderer shall submit the design and identify location on drawing before installation.

15.5 **INSTALLATION CONTROL VALVES:**

Each installation shall be provided with a set of installation control valves comprising: -

a. An Alarm Valve.

b. A Water Motor Alarm & Gong.

c. Installation valves shall be installed on the sprinkler circuits as shown on the drawings.

d. Tenderer shall submit detailed shop drawings showing the exact location, details of installation of the valves/alarm in all respects.

e. Installation valve shall comprise of a cast iron body with gunmetal trim, and double seated clapper check valves, pressure gauges, test valve and orifice assembly and drain valve with pressure gauges, turbine water gong including all accessories necessary and required and as supplied by original equipment manufacturer and required for full and satisfactory performance of the system. A cast iron isolation valve with lock and chain at the inlet of the installation valve shall be provided.

15.6 INSPECTION AND TEST VALVE ASSEMBLY:

Inspection and testing of the automatic starting of the sprinkler system shall be done by providing an assembly consisting of gunmetal valves, gunmetal sight glass, bye-pass valve and orifice assembly as per approved drawing.

15.7 FLOW SWITCH:

Flow switch shall have a paddle made of flexible and strudy material of the width to fit within the pipe bore. The terminal box shall be mounted over the paddle/ pipe through a connecting socket. The Switch shall be potential free in either N O or N C position as required. The switch shall be able to trip and make / break contact on the operation of a single sprinkler head. The terminal box shall have connections for wiring to the Annunciation Panel. The flow switch shall have connections for wiring the seat shall be of S.S to the Annunciation Panel. The flow switch shall have IP: 55 protections.

The flow switches work at a triggering threshold bandwith (flow rate) of 4 to 10 GPM. Further, it shall have a ‘Retard’ to compensate for line leakage or intermittend flows.

15.8 THE MAIN STOP VALVE:

These shall be of cast iron body of requisite size. When closed, these will shut off supply of water to the installation.

A location plate must be fixed on the outside or an external wall, as near to the main stop valve as possible, bearing the following words on raised letters or other approved type letter.

i **Sprinkler Stop Valve Inside:** The word `sprinkler stop valve' shall be in letters of at least 35mm and the word "INSIDE" at least 25mm in height. The words shall be painted white on black back ground.

ii All stop valves shall be right handed i.e. they shall be so constructed that in order to shut the valve the spindle shall turn from left to right. There shall be an indicator which will show whether the valve is open or shut.

15.9 **PIPES FOR DRAINAGE:**

Sprinkler pipes shall be so installed that the system can be thoroughly drained. As far as possible all pipes shall be arranged to drain to the installation drain valve as shown in the drawing for ordinary hazard system.

In the case of basement & other areas where sprinkler pipe-work is below the installation drain valve & in other trapped points in the system, auxiliary valves of the following sizes shall be provided.

-20 mm valves for pipes upto 50mm dia.
-25 mm valves for 80mm dia pipe.
-50 mm valves for pipes larger than 80mm dia.

15.10 **SYSTEM DESIGN:**

The entire sprinkler installation shall be designed to make it a hydraulically balanced system. The pressure requirement at typical floors shall be designed between 2.5 bars and 3.5 bars.

16. HAND HELD FIRE EXTINGUISHERS

16.1 **HAND APPLIANCES:**

16.1.1 **SCOPE:**

Work under this section shall consist of furnishing all labour, materials, appliances and equipment necessary and required to install fire extinguishing hand appliances as per relevant specification of various authorities.

Without restricting to the generality of the foregoing, the work shall consist of the following:

Installation of fully charged and tested fire extinguishing hand appliances of A B C powder type as required and specified in the drawings and schedule of rates.

16.2 **GENERAL REQUIREMENTS**:

Hand appliances shall be installed in easily accessible locations with the brackets fixed to the wall by suitable anchor fasteners.

Each appliance shall be provided with an inspection card indicating the date of inspection, testing, change of charge and other relevant data.

All appliances shall be fixed in a true workmanlike manner truly vertical and at correct locations.

Distribution / installation of fire extinguisher to be in accordance to IS: 2190.

16.3 **MEASUREMENT:**

Fire extinguishers shall be counted in numbers and include installation of all necessary items required as given in the specifications.

16.4. ABC TYPE DRY POWDER EXTINGUISHER:

The Extinguisher shall be filled with ABC grade 40, Mono Ammonium Phosphate 40% from any approved manufacturer.

The capacity of the extinguisher when filled with Dry Chemical Powder (First filling) as per IS: 15683 shall be 6 Kg +/-2% or 9 Kg +/- 3%.

The distribution of fire extinguishers to be as per IS: 15683

It shall be operated upright, with a squeeze grip valve to control discharge. The plunger neck shall have a safety clip, fitted with a pin, to prevent accidental discharge. It shall be pressurised with Dry Nitrogen, as expellant. The Nitrogen to be charged at a pressure of 15 Kg/cm^2

Body shall be of mild steel conforming to relevant IS Standards. The neck ring shall be also mild steel and welded to the body. The discharge valve body shall be forged brass or leaded bronze, while the spindle, spring and siphon tube shall be of brass. The nozzle shall be of brass, while the hose shall be braided nylon. The body shall be cylindrical in shape, with the dish and dome welded to it. Sufficient space for Nitrogen gas shall be provided inside the body, above the powder filling.

The Neck Ring shall be externally threaded - the threading portion being 1.6 cm. The filler opening in the neck ring shall not less than 50 mm. Discharge nozzles shall be screwed to the hose. The design of the nozzle shall meet the performance requirement, so as to discharge at least 85% of contents upto a throw of 4 mtrs, continuously, at least for 15 seconds. The hose, forming part of discharge nozzle, shall be 500 mm long, with 10 mm dia internally for 6 Kg capacity and 12 mm for 9 Kg capacity. It shall have a pressure gauge fitted to the valve assembly or the cylinder to indicate pressure available inside. The extinguisher shall be treated with anti-corrosive paint, and it shall be labelled with words ABC 2.5 cm long, within a triangle of 5 cm on each face. The extinguisher body and valve assembly shall withstand internal pressure of 35 Kg/cm^2 for a minimum period of 2 minutes. The pressure gauge shall be imported and suited for the purpose.

16.5 WATER TYPE EXTINGUISHER (GAS PRESSURE TYPE):

The Extinguishing medium shall be primarily water stored under normal pressure, the discharge being affected by release of Carbon Dioxide Gas from a 120 gms cylinder.

The capacity of Extinguisher, when filled upto the indicated level, shall be 6 & 9 ltr +/- 5%

The skin thickness of the Cylinder shall be minimum 4.0 mm, fabricated from Mild Steel sheet, welded as required, with dish and dome, being of same thickness, and of size not exceeding the diameter of body. The diameter of body to be not less than 150 mm and not exceeding 200 mm. The neck shall be externally threaded upto a minimum depth of 16 mm, and leaded tin bronze.

The cap shall be of leaded tin bronze and screwed on the body upto a minimum of 1.6 cm depth, with parallel screw thread to match the neck ring. The siphon tube to be of brass or G.I. and the strainer of Brass. The cartridge holder, knob, discharge fittings and plunger to be of Brass/Leaded tin bronze, and plunger of stainless steel, spring of stainless steel. The cap to have handled fixed to it. The discharge hose shall be braided nylon, of 10 mm dia and 6 mtr long, with a nozzle of brass fitted at end.

The extinguisher shall be treated for anti-corrosion internally and externally, and externally painted with Fire Red paint. The paint shall be stove enamelled/powder coated. The cartridge shall be as per IS and have 60 gm net carbon dioxide gas for expelling. The extinguisher, body and cap shall be treated to an internal hydraulic pressure of 35 Kg/cm2. It shall have external marking with letter A, of 2.5 cm height, in block letters within a triangle of 5 cm each side. The extinguisher shall be upright in operation, with the body placed on ground and discharge tube with nozzle held in one hand to give a throw of not less than 6 mtr, and continue so for atleast 60 secs. The extinguisher body shall be clearly marked with ISI stamp (IS: 15683).

16.6 CARBON DIOXIDE EXTINGUISHER:

The Carbon Dioxide Extinguisher shall be as per IS: 15683

The body shall be constructed of seamless tube conforming to IS: 7285 and having a convex dome and flat base. Its dia shall be maximum 140 mm, and the overall height shall not exceed 720 mm.

The discharge mechanisim shall be through a control valve conforming to IS: 15683. The internal syphon tube shall be of copper aluminium conforming to relevant specifications.

Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 140 Kg/cm2 and shall be approximately 1.0 meter in length having internal dia of 10 mm. The discharge horn shall be of high-quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form. The hand grip of Discharge horn shall be insulated with Rubber of appropriate thickness.

The gas shall be conforming to IS: 307 and shall be stored at about 85 Kg/cm2. The expansion ratio between stored liquid carbon dioxide to expanded gas shall

be 1:9 times and the total discharge time (effective) shall be minimum 10 secs and maximum 25 secs.

The extinguisher shall fulfill the following test pressures:
Cylinder: 236 Kg/cm2
Control Valve: 125 Kg/cm2

Burst Pressure of Hose: 140 Kg/cm2 minimum

It shall be an Upright type. The cylinder, including the control valve and high-pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking.

16.7 MECHANICAL FOAM TYPE EXTINGUISHER:

The Mechanical Foam Type Extinguisher shall be as per IS: 15683

The body shall be constructed of seamless tube conforming to IS: 7285 and having a convex dome and flat base. Its dia shall be maximum 150 mm, and the overall height shall not exceed 600 mm.

The discharge mechanisim shall be through a control valve conforming to IS: 3224. The internal syphon tube shall be of copper aluminium conforming to relevant specifications.

The capacity of Extinguisher, when filled upto the indicated level, shall be 6 & 9 ltr +/- 5%

Hose Pipe shall be high pressure braided Rubber hose with a minimum burst pressure of 35 bars and shall be approximately 1.0 meter in length having internal dia of 10 mm. The discharge horn shall be of high-quality unbreakable plastic with gradually expanding shape, to convert liquid carbon dioxide into gas form. The hand grip of Discharge horn shall be insulated with Rubber of appropriate thickness.

The total discharge time (effective) shall be minimum 25 secs and maximum 60 secs.

The extinguisher shall fulfill the following test pressures:
Cylinder: 236 Kg/cm2
Control Valve: 125 Kg/cm2

Burst Pressure of Hose: 35 Kg/cm2 minimum

The cylinder, including the control valve and high-pressure Discharge Hose must comply with relevant Statutory Regulations, and be approved by Chief Controller of Explosives, Nagpur and also bear IS marking.

The Extinguisher including components shall be IS marked.

17. FIRE PUMPS AND ALLIED EQUIPMENTS

17.1 SCOPE:

Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install electrically operated and diesel driven pumps and as required by drawings and specified hereinafter or given in the schedule of rates.

a. Electrically operated pumps with motors and diesel engine driven pumps with diesel engine, common base plates, coupling, coupling guard and accessories.

b. Automatic starting system with all accessories, wiring and connections and pressure switches.

c. Motor control centre.

d. Annunciation system with all accessories wiring and connections.

e. Pressure gauges with isolation valves and piping bleed and block valves.

f. Suction strainers and accessories.

g. Vibration eliminator pads and foundation bolts.

h. Leak-off drain shall be led to the nearest floor drain.

17.2. GENERAL REQUIREMENTS:

Pumps shall be installed true to levels on suitable concrete foundations. Base plate shall be firmly fixed by properly grouted foundation bolts.

Pumps and motors shall be truly aligned by suitably instruments. Record of such alignment shall be furnished to the Project Manager.

All pump connections shall be standard flanged type with number of bolts as per relevant standard requirement for the working pressure. Companion flanges shall be provided with the pumps.

Manufacturers' instructions regarding installation, connections and commissioning shall be strictly followed.

Tenderer shall provide necessary test certificates, type test certificates, performance curves and NPSH curves of the pumps from the manufacturer when called for. The tenderer shall provide facilities to the Project Manager and Consultant for inspection of equipment during manufacturing and also to witness various tests at the manufacturer's works without any cost to the Project Manager or Consultant.

Seismic isolation and clamping for each pump and flexible connection on the suction as well as the discharge side shall be provided.

The tenderer shall submit with this tender a list of recommended spare parts for three years of normal operation and quote the prices for the same as a seprate submittal / annexure.

17.3. ELECTRIC FIRE PUMP

GENERAL

The electric fire pump shall be suitable for automatic operation complete with necessary electric motor and automatic starting gear, suitable for operation on 415 volts, 3 phases, 50 Hz. A.C. system. Both the motor and the pump shall be assembled on a common base plate, fabricated M.S. channel type or cast-iron type.

DRIVE

The pump shall be direct driven by means of a flexible coupling. Coupling guard shall also be provided.

17.4. FIRE PUMP

The fire pump shall be horizontally mounted centrifugal type. It shall have a capacity to deliver flow as specified, and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet.

The pump shall be capable of giving a discharge of not less than 150 per cent of the rated discharge, at a head of not less than 65 per cent of the rated head. The shut off head shall be within 120 per cent of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS: 210 and parts like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be of stainless steel. Provision of mechanical seal shall also be made.

Bearings of the pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water. The pump shall be provided with a plate indicating the suction lift, delivery head, discharge, speed and number of stages. The pump casing shall be designed to withstand 1.5 times the working pressure.

Provision of Jockey Pump for low and high zone shall be made. The pump shall be vertical SS type and of detail as in schedule of quantity. Tenderer shall verify

that the capacity of the Jockey pump shall not be less than 3% (Minimum 180 LPM) and not more than 10% of the installed pump capacity.

MOTOR

The motor shall be squirrel cage A.C. induction type suitable for operation on 415 volts 3 phase 50 Hz. system. The motor shall be totally enclosed fan cooled type conforming to protection clause IP 55. The class of insulation shall be F. The synchronous speed shall be 1500 / 2900 RPM (Jockey pump) as specified. The motor shall be rated for continuous duty and shall have a horse power rating necessary to drive the pump at 150 per cent of its rated discharge with at least 65 per cent rated head. The motor shall conform to I.S.325-1978.

MOTOR STARTER

The motor starter shall be as per detail in MCC. The unit shall include suitable current transformer and ammeter of suitable range on one line to indicate the current. The starter shall not incorporate under voltage, no voltage trip overload or SPP.

The starter assembly shall be suitably integrated in the power and control panel for the wet riser system & sprinkler system.

17.5. **DIESEL FIRE PUMP**

GENERAL

The diesel pump set shall be suitable for automatic operation complete with necessary automatic starting gear, for starting on wet battery system and shall be complete with all accessories. Both engine and pump shall be assembled on a common base plate.

DRIVE

The pump shall be only direct driven by means of a flexible coupling. Coupling guard shall also be provided. The speed shall be 1500 RPM as specified.

FIRE PUMP

The fire pump shall be horizontally mounted centrifugal type. It shall have a capacity to deliver as specified and developing adequate head so as to ensure a minimum pressure of 3.5 Kg/Sq.cm at the highest and the farthest outlet. The pump shall be multi stage as specified. The pump shall be capable of giving a

discharge of not less than 150% of the rated discharge at a head of not less than 65% of the rated head. The shut off head shall be within 120% of the rated head.

The pump casing shall be of cast iron to grade FG 200 to IS 210 and parts like impeller, shaft sleeves, wearing-ring etc. shall be of non-corrosive metal like bronze/brass/gun metal. The shaft shall be stainless steel. Provision of mechanical seal shall also be made.

The pump casing shall be designed to withstand 1.5 times the working pressure.

Bearing of pump shall be effectively sealed to prevent loss of lubricant or entry of dust or water.

DIESEL ENGINE

Engine Rating - The engine shall be cold starting type without the necessity of preliminary heating of the engine cylinders or combustion chamber (for example, by wicks, cartridge, heater, plugs etc.). The engine shall be multi cylinder/vertical 4 stroke cycle, aircooled, diesel engine, developing suitable HP at the operating speed specified to drive the fire pump. Continuous capacity available for the load shall be exclusive of the power requirement of auxiliaries of the diesel engine, and the after correction for altitude, ambient temperature and humidity for the specified environmental conditions. This shall be at least 20% greater than the maximum HP required to drive the pump at its duty point.

It shall also be capable of driving the pump at 150% of the rated discharge at 65% of rated head. The engine shall be capable of continuous non-stop operation for 8 hours and major overhaul shall not be required before 3000 hours of operation. The engine shall have 10% overload capacity for one hour in any period of 12 hours continuous run. The engine shall accept full load within 15 seconds from the receipt of signal to start. The diesel engine shall conform to BS 649/IS 1601/IS 10002, all amended up to date.

a. **Engine Accessories** - The engine shall be complete with the following accessories: -

Fly wheel dynamically balanced.
Direct coupling for pump and coupling guard.
Corrosion Resistor.
Air cleaner.
Fuel service tank support, and fuel oil filter with necessary pipe work.
Elect. starting battery (2X12 v).
Exhaust silencer with necessary pipe work.
Governor.
Instrument panel housing all the gauges, including Tachometer, hour meter and starting switch with key (for manual starting).

Necessary safety controls.

b. **Fuel System** - The fuel shall be gravity fed from the engine fuel tank to the engine driven fuel pump. The engine fuel tank shall be mounted either over or adjacent to the engine itself or suitably wall mounted on bracket. The fuel filter shall be suitably located to permit easy servicing.

All fuel tubing to the engine shall be with copper, with flexible hose connections where required. Plastic tubing shall not be permitted.

The fuel tank shall be of welded steel construction (3 mm. thick) and of capacity sufficient to allow the engine to run on full load for at least 8 hours. The tank shall be complete with necessary wall mounted supports, level indicator (protected against mechanical injury) inlet, outlet, overflow connections and drain plug and piping to the engine fuel tank. The outlet shall be so located as to avoid entry of any sediments into the fuel line to the engine.

As semi rotary hand pump for filling the daily service tank together with hose pipe 5 mtr. long with a foot valve etc. shall also form part of the scope of supply.

c. **Lubricating Oil System**- Forced feed Lub. Oil system shall be employed for positive lubrication. Necessary Lub. oil filters shall be provided, located suitably for convenient servicing.

d. **Starting System**- The starting system shall comprise necessary batteries (2x24v), 24 volts starter motor of adequate capacity and axle type gear to match with the toothed ring on the fly wheel. Bi metallic relay protection to protect starting motor from excessively long cranking runs suitably integrated with engine protection system shall be included within the scope of the work.

The capacity of the battery shall be suitable for meeting the needs of the starting system.

The battery capacity shall be adequate for 10 consecutive starts without recharging with cold engine under full compression.

The scope shall cover all cabling, terminals, initial charging etc.

e. **Exhaust System** - The exhaust system shall be complete with silencer suitable for outdoor installation, and silencer piping including bends and accessories needed for a run of 15 metre or as required at site from the engine manifold. The total back pressure shall not exceed the engine manufacture's recommendation. The exhaust piping shall be suitably supported.

f. **Engine shut down mechanism**- This shall be auto/ manually operated and shall return automatically to the starting position after use.

g. **Governing System**- The engine shall be provided with an adjustable governor to control the engine speed within 5% of its rated speed under all conditions of load up to full load. The governor shall be set to maintain rated pump speed at maximum pump load.

h. **Engine Instrumentation**- Engine instrumentation shall include the following: -

i) Lub. oil pressure gauge.
ii) Lub. oil temperature gauge.
iii) Water pressure gauge.
iv) Water temperature gauge.
v) Tachometer.
vi) Hour meter.

The instrumentation panel shall be suitably resident mounted on the engine.

Engine Protection Devices- Following engine protection and automatic shut down facilities shall be provided: -
i) Low lub.oil pressure.
ii) High cooling water temp.
iii) High lub.oil temperature.
iv) Over speed shut down.

i. **Pipe Work** - All pipe lines with fittings and accessories required shall be provided for fuel oil, lub.oil and exhaust systems, copper piping of adequate sizes, shall be used for Lub.oil and fuel oil. M.S. piping will be permitted for exhaust.

j. **Anti Vibration Mounting**- Suitable vibration mounting duly approved by Project Manager shall be employed for mounting the unit so as to minimise transmission of vibration to the structure. The isolation efficiency achievable shall be clearly indicated.

k. **Battery Charger**-Necessary float and boost charger shall be incorporated in the control section of the power and control panel, to keep the battery in trim condition. Voltmeter to indicate the state of charge of the batteries shall be provided.

17.6 PUMP SETS ASSEMBLY

On the main fire sprinkler and hydrant headers near pump sets a 150 mm dia by-pass valve located in an accessible location shall be provided along with a rate of flow rotameter calibrated in 1 pm and able to read 200% of the rated pump capacity. The delivery shall be connected to the fire tank.

Each and every pump set assembly shall be provided with suction valve (only for positive suction head), discharge valve, non-return valve and 150 mm dia Bourdon type pressure gauge with isolation valve.

17.7 FLEXIBLE CONNECTORS

On all suction and delivery lines double flanged reinforced neoprene flexible pipe connectors shall be provided. Connectors should be suitable for maximum working pressure of each pipe line on which it is mounted and tested to a test pressure of 1:5 time the operating pressure. Length of the connector shall be as per manufacturers standard.

17.8 INTERLOCKING

The following inter-locking between the two main fire pumps (i.e. wet riser pump & sprinkler pump), the jockey pump and the diesel engine driven pump.

Only one category of pumps will work at a time i.e. either jockey pump or main fire pumps (wet riser and sprinkler, both the wet riser and sprinkler can come up at a time) or diesel driven pump.

	JOCKEY PUMP	**WET RISER PUMP**	**SPK PUMP**	**DIESEL DRIVEN PUMP**
i.	ON	OFF	OFF	OFF
ii.	OFF	ON	OFF	OFF
iii.	OFF	OFF	ON	OFF
iv.	OFF	ON	ON	OFF
v.	OFF	ON	ON	ON

17.9 ANNUNCIATION PANEL

One solid state electronic annunciation panel, fully wired with visual display and audible alarm unit shall be provided to indicate:

a. Flow condition in any flow switch indicating the area of distress and fire alarm.
b. Starting and stopping of each hydrant pump.
c. Starting and stopping of each jockey pump.
d. Starting and stopping of each sprinkler pump.
e. Failure of Hydrant / Sprinkler pump to start.
f. High level in fire water storage tank compartment.
g. Low level in fire water storage tank compartment.
h. Low level in HSD day tank of the fire pump.

The panel shall be factory fabricated, wired and tested. All details shall be submitted with the tender.

The annunciation panel shall be located in the security office / reception on the ground floor or as instructed by the Project Manager.

17.10 VIBRATION ISOLATION

The pumpset shall be mounted on rolled steel channels and 150 mm thick inertia block spring and ribbed neoprene vibration isolation mounting shall support the inertia block onto a 100-mm thick concrete plinth. The spring mountings shall have a maximum deflection of15 mm. Reference shall be made to the section on "Nose and Vibration" for further technical requirements.

SECTION-02: ELECTRICAL INSTALLATION

1. SCOPE

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Motor Control Centre (MCC), wiring and earthing of all air-conditioning equipment, components and accessories.

2. GENERAL

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

All motor control centres shall be CPRI approved and shall be suitable for operation on 3 phase/single phases 415/230 volts, 50 cycles power supply system.

3. CONSTRUCTIONAL FEATURES

The Motor Control Centre (MCC) electrical panels shall be sheet steel cabinet for indoor installation, dead front, floor mounting/wall mounting type and shall be 3b construction. The control panel shall be totally enclosed, completely dust and vermin proof and shall be with hinged doors with Neoprene gasket. Control panel shall be suitable for the climatic conditions as specified in Specifications. Steel sheets used in the construction of Control panel shall be 2 mm thick and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction shall confirm to relevant BIS Codes.

All panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws shall enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threading screws shall not be used in the construction of Control panels. A

base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum clearance of 275 mm shall be provided between the floor of control panel and the lowest unit.

The control panel shall be of adequate size with a provision of 25% spare space to accommodate possible future breakers. Breakers shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

4. WIRING SYSTEM

All L T power cabling between MCC and motors shall be carried out with 1100 volts grade PVC insulated, overall PVC sheathed aluminium conductor armoured cables, Cables shall be sized by applying proper derating factor. All control wiring shall be carried out by using PVC insulated copper conductor wires in conduits. Minimum size of control wiring shall be 1.5 sq mm. Minimum size of conductor for power wiring shall be 4 sq. mm 1100 volts grade PVC insulated copper conductor wires in conduit.

5. CIRCUIT COMPARTMENT

Each circuit breaker, contactor and relay shall be housed in a separate compartment and shall have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door shall be duly interlocked with the breaker in the “ON” position. Safety interlocks shall be provided to prevent the breaker from being drawn-out when the breaker is in ‘ON’ position. The door shall not form an integral part of the draw-out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

6. INSTRUMENT ACCOMMODATION

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control MCBs. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar `ON’ lamps shall be provided on all outgoing feeders.

7. BUS BAR CONNECTIONS

Bus bar and interconnections shall be of high conductivity electrolytic aluminium complying with requirement of grade E91E of IS:5082-1981 and

shall be of rectangular cross section suitable for carrying the rated full load current and short circuit current without overheating of phase and neutral bus bar and shall be extendable on either side. Bus bar and interconnections shall be insulated with heat shrinkable sleeve and shall be colour coded and shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bar shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross-sectional area shall be added to the bus bar to compensate for the holes. All connections between bus bar and breaker shall be through solid aluminium strips of proper size to carry full rated current as per approved for construction shop drawing and insulated with insulating sleeves. Bus bar shall be rated for current density of 1.0 amps/mm^2 cross section area.

8. TEMPERATURE - RISE LIMIT

Unless otherwise specified, in the case of external surface of enclosures of bus bar trunking system which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature shall be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per relevant IS Codes.

9. CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the control panel for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports shall be provided in cable compartment to support cables as per approved for construction shop drawing.

10. MOULDED CASE CIRCUIT BREAKER (MCCB)

All MCCB's shall be motor duty and Current Limiting type, and comprise of Quick Make - break switching mechanism, preferably Double Break Contact system, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses. All MCCB's shall be capable of defined Variable overload adjustment. All MCCB's rated 200 Amps and above shall have adjustable Magnetic short circuit pick up.

The trip command shall override all other commands. MCCB shall employ maintenance free double break contact system to minimise the let thru' energies and capable of achieving discrimination upto full short circuit capacity of downstream MCCB. The manufacturer shall provide both discrimination tables and let thru energy curves.

The breaking capacity of MCCB's shall be asked for in the schedule of quantities. The breaking capacities specified will be ICU=ICS i.e type-2. Co-ordination as per relevant IS and IEC Codes.

The MCCB's shall be provided with rotary handle operating mechanism. The handle position shall give positive indication of 'ON', 'OFF' or 'Tripped' thus qualifying to Disconnection as per the IS/IEC indicating the true position of all the contacts. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

11. MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker shall comply with relevant IS Codes and shall be quick make and break type for 230/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity shall not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB shall have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer shall publish the values.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP and TPN miniature circuit breakers shall have a common trip bar independent to the external operating handle.

12. PAINTING

All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing) and then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as per relevant BIS code.

13. LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel door and covered with transparent plastic sheet.

14. METERS

i. All voltmeters and indicating lamps shall be through MCB's.

ii. Meters and indicating instruments shall be plug type.

iii. All CT's connection for meters shall be through Test Terminal Block (TTB).

iv. CT ratio and burdens shall be as specified on the Single line diagram.

15. CURRENT TRANSFORMERS

Current transformers shall be provided for Control panels carrying current in excess of 60 amps. All phase shall be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs shall confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitable to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 5P10 and measurement CTs shall be of accuracy class-I.

16. SELECTOR SWITCH

Where called for, selector switches of rated capacity shall be provided in control panels, to give the choice of operating equipment in selective mode.

17. STARTERS

Each motor shall be provided with a starter of suitable rating. Starters shall be in accordance with relevant IS Codes. All Star Delta and ATS Starters shall be fully automatic.

18. CONTACTOR

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system shall consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starter's contactors shall have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta and Reduced Voltage Starters. The insulation for contactor coils shall be of Class "E".

Coil shall be tape wound vacuum impregnated and shall be housed in a thermostatic bobbin, suitable for tropical conditions and shall withstand voltage fluctuations. Coil shall be suitable for 220/415±10% volts AC, 50 cycles AC supply.

19. THERMAL OVERLOAD RELAY

Thermal over load relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay shall operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5° C to +55°C.

All overload relays shall be of three elements, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

20. TIME DELAY RELAYS

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection.

21. INDICATING LAMP AND METERING

All meters and indicating lamps shall be in accordance with IS:1248 and IS-1258. The meters shall be flush mounted type. The indicating lamp shall be of low wattage. Each MCC and control panel shall be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTS of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. Each phase indicating lamp shall be backed up with 5 MCB. Other indicating lamps shall be backed up with fuses as called for in Schedule of Quantities.

22. TOGGLE SWITCH

Toggle switches, where called for in Schedule of Quantities, shall be in conformity with relevant IS Codes and shall be of 5 amps rating.

23. PUSH BUTTON STATIONS

Push button stations shall be provided for manual starting and stopping of motors / equipment Green and Red colour push buttons shall be provided for ‘Starting’ and ‘Stopping’ operations. ‘Start’ or ‘Stop’ indicating flaps shall be provided for push buttons. Push Buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever shall be provided for ‘Stop’ push buttons. The push button contacts shall be suitable for 6 amps current capacity.

24. CONDUITS

Conduits and Accessories shall conform to relevant Indian Standards. Wall thickness shall be 16-gauge upto 32 mm dia and 14 gauges above 32 mm dia conduit. Screwed G.I. conduits shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only. All raw metal shall be painted with bitumastic paint.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Maximum permissible number of 650/1100-volt grade PVC insulated wires that may be drawn into rigid non-metallic or GI Conduits are given below:

Size of wires Nominal Cross section Area (Sq. mm.)	**Maximum number of wires within conduit size(mm)**				
	20	**25**	**32**	**40**	**50**
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	--	6
25	--	--	2	4	6
35	--	--	--	3	5

25. CABLES

M.V. Cables shall be PVC insulated aluminium conductor and armoured cables conforming to IS Codes. Cables shall be armoured and suitable for laying in trenches, ducts, and on cable trays as required. M.V. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

26. CABLE LAYING

Cable shall be laid in accordance with IS code of Practice. Cables shall be laid on 14 gage factory fabricated perforated galvanized sheet steel cable trays, and cable drops / risers shall be fixed to ladder type cable trays factory fabricated out of galvanized steel angle. Access to all cables shall be provided to allow cable withdrawal / replacement in the future. Where more than one cable is running on a cable tray, one dia spacing shall be provided between cables to minimise the loss in current carrying capacity.

Cables shall be suitably supported with Galvanized saddles when run on walls / trays. When buried, they shall be laid in 350 mm wide and 750 mm deep trench and shall be covered with 250 mm thick layer of soft sifted sand & protected with bricks/tiles. Special care shall be taken to ensure that the cables are

not damaged at bends. The radius of bend of the cables when installed shall not be less than 12 times the diameter of cable.

27. WIRE AND WIRE SIZES

1100 volts grade PVC insulted copper conductor wires in conduit shall be used.

For all single phase/ 3 phase wiring, 1100 volts grade PVC insulated copper conductor wires shall be used. The equipment inside plant room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power wiring, cabling shall be of the following sizes:

i. Upto 5 HP motors/ 5 KW heaters 3 x 4 sq. mm copper conductor wires.

ii. From 6 HP to 10 HP motors 3 x 6 sq. mm copper conductor wires
6 KW to 7.5 KW heaters

iii. From 12.5 HP to 15 HP wires 2 Nos. 3 x 6 sq. mm copper conductor wires

iv. From 20 HP to 25 HP motors 2 Nos. 3 x 10 sq. mm copper conductor wires

v. From 30 HP to 35 HP motors 2 nos.3x 16 sq.mm aluminium conductor armoured cable.

vi. From 40 HP to 50 HP motors 2 Nos. 3x25 sq.mm aluminium conductor armoured cable.

vii. From 60 HP to 75 HP motors 1 No. 3 x 70 sq. mm aluminium conductor

armoured cable.

viii. 100 HP motors conductor 1 No. 3 x 150 sq. mm. aluminium armoured cable

ix. 200 HP motor conductor 2 No. 3 x 150 sq. mm. aluminium armoured cable.

All the switches, contactors, push button stations, indicating lamps shall be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer's recommendation.

MOTOR CAPACITY	TYPE OF STARTER CAPACITY	CONTACTOR CURRENT RANGE	OVERLOAD RELAY
5 HP Motors	D O L	16 amps	6-10 amps
7.5 HP motors	D O L	16 amps	9-15 amps
10 HP Motors	D O L	25 amps	9-15 amps
12.5 HP Motors	Star Delta	16 amps	9-15 amps
15 HP Motors	Star Delta	25 amps	9-15 amps
20 HP Motors	Star Delta	32 amps	14-23 amps
25 HP Motors	Star Delta	32 amps	14-23 amps
200 HP Motors	DOL	25 amps	CT Operated relay

Two speed motors when specified, shall be provided with DOL starter irrespective of it rating.

28. EARTHING

Earthing shall be provided in accordance with relevant BIS Codes and shall be copper strips /wires. The main panel shall be connected to main earthing system of the power supply. All single-phase metal clad switches and control panels be earthed with minimum 3 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with 2 numbers distinct and independent copper wires / tapes as follows:

i. Motor upto and including 10 HP rating. 2 Nos. 3 mm dia copper wires.

ii. Motor 12.5 HP to 40 HP capacity 2 Nos. 4 mm dia copper wires

iii. Motor 50 to 75 HP capacity. 2 Nos. 6 mm dia copper

iv.	Motor above 75 HP.	2 Nos. 25 mm x 3 mm Copper tapes.

All switches shall be earthed with two numbers distinct and independent copper wires' tapes as follows:

i.	3 phase switches and control panels upto 60 amps rating.	2 nos. 3 mm dia copper wires.
ii.	3 phase switches, and control panels 63 amps to 100 amps rating.	2 Nos. 4 mm dia copper wires.
iii.	3 phase switches and control panels 125 amps to 200 amps rating.	2 Nos. 6 mm dia copper wires.
iv.	3 phase switches, control panels, bus ducts, above 200 amps rating.	2 Nos. 3 mm x 25 mm copper tapes.

The earthing connections shall be tapped off from the main earthing of electrical installation. The overlapping in earthing strips at joints where required shall be minimum 75 mm. These straight joints shall be rivetted with brass rivets & brazed in approved manner. Sweated lugs of adequate capacity and size shall be used for all termination of wires. Lugs shall be bolted to the equipment body to be earthed after the metal body is cleaned of paint and other oily substance, and properly tinned.

29. DRAWINGS

Shop drawings for control panels and for wiring of equipment showing the route of conduit & cable shall be submitted by the contractor for approval of Architect/Consultant before starting the fabrication of panel and starting the work. On completion, four sets of complete "As-installed" drawings incorporating all details like, conduits routes, number of wires in conduit, location of panels, switches, junction/pull boxes and cables route etc. shall be furnished by the Contractor.

30. TESTING

Before commissioning of the equipment, the entire electrical installation shall be tested in accordance with relevant BIS codes and test report furnished by a qualified and authorised person. The entire electrical installation shall be gotten approved by Electrical Inspector and a certificate from Electrical Inspector shall be submitted. All tests shall be carried out in the presence of Project Manager. Testing of the panels shall be as per relevant BIS Codes:

31. PAINTING

All sheet steel work shall undergo a process of degreasing, thorough cleaning, and painting with a high corrosion resistant primer. All panels shall then be baked in an oven. The finishing treatment shall be by application of powder coating of approved shade.

32. MEASUREMENT OF ELECTRICAL CONTROL PANELS

Panels shall be counted as number of units. Quoted rates shall include as lumpsum (NOT measurable lengths) for all internal wiring, power wiring and earthing connections from the control panel to the starter and to the motor, control wiring for interlocking, power and control wiring for automatic and safety controls, and control wiring for remote start/stop as well as indication as per the specifications. The quoted rate of panel shall also include all accessories, switchgear, contactors, indicating meters and lights as per the Specifications and Schedule of Quantities.

33. RUBBER MAT

Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel.

SECTION-03: COMMISSIONING & GUARANTEE

1. SCOPE OF WORK

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee

connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rota meters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

2. PRECOMMISSIONNIG

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

a. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

b. All strainers shall be inspected and cleaned out or replaced.

c. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:

- Remove oil, grease and foreign residue from the pipe work and fittings;
- Pre-condition the metal surfaces to resist reaction with water or air.
- Establish an initial protective film;
- After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.
- Details and procedures of the pre-treatment shall be submitted to the Architect for approval.

d. Check all clamps, supports and hangers provided for the pipes.

e. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

f. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

FIRE PROTECTION SYSTEM

a. Check all hydrant valves by opening and closing: any valve found to be open shall be closed.

b. Check all the piping under hydro test.

c. Check that all suction and delivery connections are properly made for all pump sets.

d. Check rotation of each motor after decoupling and correct the same if required.

e. Test run each pump set.

f. All pump sets shall be run continuously for 8 hours (if required with temporary piping back to the tank).

COMMISSIONING AND TESTING

a. Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then

b. Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary adjust the pressure switch for the jockey pump. Close by-pass valve.

c. Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However, the jockey pump shall cut-out as soon as the main pump starts,

d. Switch off the main fire pump and test check the diesel engine driven pump in the same manner as the electrically driven pump,

e. When the fire pumps have been checked for satisfactory working on automatic controls, open fire hydrant valves simultaneously and allow the hose pipes to discharge water into the fire tank to avoid wastage.

f. Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to

be incompatible and do not fit into the other properly shall be replace by the Contractor. Each landing valve shall also be checked by opening and closing under pressure.

g. Check all annunciations by simulating the alarm conditions at site.

SPRINKLER SYSTEM

a. Start the sprinkler pump and develop the required pressure in the sprinkler pipes.

b. Open the test valve to test the automatic starting of the pump. If necessary, make necessary adjustments in the setting of pressure switch. The sprinkler water gong alarm shall also operate when the test valve is open. This operation is to be done for each and every section of the sprinkler system and the alarm for each section (via flow switch) shall be checked for operation.

c. After satisfactory operation of the pump the Contractor shall set up mock fire and test the system.

d. Check all annunciations by simulating the alarm conditions at site.

3. STATUTORY AUTHORITIES' TESTS AND INSPECTIONS

As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

4. FINAL ACCEPTANCE TESTS

Following commissioning and inspection of the entire installation, and prior to issue of the Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

5. REJECTION OF INSTALLATION / PLANT

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

6. WARRANTY AND HANDOVER

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

7. HANDING OVER OF DOCUMENTS

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner's site representative and all testing and commissioning documents shall be handed over to the Owner's site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner's site representative.

8. PIPE COLOUR CODE:

S.No.	Pipe Lines	Ground / Base Colour	First Colour Band	Second Colour Band
1	Drinking Water (All cold-water lines after filter)	Sea Green	French Blue	Single Red
2	Treated Water (Soft Water)	Sea Green	Light Orange	
3	Domestic Hot Water	Sea Green	Light Grey	
4	Drainage (Storm Water)	Black		
5	Drainage (Sewage Water)	Brown		
6	Fire System	Post Office Red		

9. CHECK LIST FOR COMMISSIONING

FIRE PROTECTION SYSTEM

a) Check all hydrant & other valves by opening and closing. Any valve found to be open shall be closed.

b) Check all clamps, supports and hangers provided for the pipes.

c) All the pump sets shall be run continuously for 30 minutes (with temporary piping back to tank from the nearest hydrant, using canvas hose pipes).

d) Fire Hydrant System - Pressurise the fire hydrant system by running the jockey pump and after it attains the shutoff pressure of the pump, then

Open bypass valve and allow the pressure to drop in the system. Check that the jockey pump cuts-in and cuts-out at the preset pressure. If necessary, adjust the pressure switch for the jockey pump. Close by-pass valve.

Open hydrant valve and allow the water to flow into the fire water tank in order to avoid wastage of water. The main fire pump shall cut-in at the preset pressure and shall not cutout automatically on reaching the normal line pressure. The main fire pump shall stop only by manual push button. However, the jockey pump shall cut-out as soon as the main pump starts,

Operate booster pump continuously for 30 minutes with piping back to underground tanks from the hydrant nearest to plant room.

Check each landing valve, male and female couplings and branch pipes, for compatibility with each other. Any fitting which is found to be incompatible and do not fit into the other properly shall be replaced by the Contractor. Each landing valve shall also be checked by opening and closing under pressure. Check air cushion tanks on the terrace for proper functioning.

TENDER DOCUMENT FOR HVAC SYSTEM

FOR

PROPOSED RENOVATION WORK FOR KoPT

TECHNICAL SPECIFICATIONS

1. BASIS OF DESIGN

1.1. BASIS OF DESIGN

1.1.1 Site Location : **Kolkata**

1.1.2 Geographic location : **22.65** deg. N; **88.45** deg. E

1.1.3 Altitude : **6** M above mean sea level.

1.1.4 **Outdoor Design Conditions**:

Outdoor Design Conditions for **Kolkata** are based on Weather data files published by ISHRAE (WeDco) exceeding less than 0.4% annual cumulative frequency, are considered as follows:

Summer

Dry Bulb Temperature : 99.7 Deg. F (37.6 Deg.C)

Mean Coincident Wet Bulb Temperature : 83.1 Deg. F (28.3 Deg C)

Monsoon

Wet Bulb Temperature : 94.5 Deg. F (34.7 Deg C)

Mean Coincident Dry Bulb Temperature : 87.3 Deg. F (30.7 Deg.C)

Winter

Dry Bulb Temperature : 54.9 Deg. F (12.7 Deg C)

Mean coincident Wet Bulb Temperature : 52.9 Deg. F (11.6 Deg C)

1.1.5 **Filteration level for different areas**:

Three stages of filtration efficiencies have been considered depending on the requirement. These are specified in Table 2.2.7 and are mainly as follows:

b. One stage of filtration consisting of normal washable filters up to 10 micron particle size (For all other areas).

1.1.6 **Fresh air**:

Fresh air quantities considered for air conditioned areas in accordance with 30% more than ASHRAE Standard.

1.1.7 Indoor Design Conditions

Based on past experience of similar projects, indoor design conditions, minimum fresh air quantities & filtration in different areas are considered as follows:

	INDOOR CONDITIONS		**OUTDOOR AIR VENTILATION RATE BASED ON ASHRAE 62.1-2010**
SPACE	**Temp °C (°F)**	**Relative Humidity %**	
Main Lobby	22±1°C (72±2°F)	Less than 60%	30% more than ASHRAE STANDERED
Offices	22±1°C (72±2°F)	Less than 60%	30% more than ASHRAE STANDERED
Mechanical Plant Rooms / Electrical Rooms			Mechanical ventilation

1.1.8 Mechanical Ventilation

Toilet(Public)	10 ACPH
Stores	6 ACPH
AC Plant	20-25 ACPH
Kitchen	65 ACPH (Exhaust) 60 ACPH (Fresh Air)
Car Parking	12 (Normal Mode) / 30 (Fire Mode) ACPH Exhaust 12 (Normal Mode) / 30 (Fire Mode) - fresh air makeup
Stair case, Lift well and Lift Lobby pressurization	**To be mechanically pressurized for maintaining 50 Pa pressure difference from ambient.**

1.1.9 Building Construction Data

In accordance with Energy Conservation Building (ECBC) Code 2007 <Revised Version May 2008> norms, Kolkata (city) comes under worn &Humid climate zone. Hence, based on the ECBC norms, U Values considered are as follows

Roofs

Roofs shall comply with either the maximum assembly U-factor or the minimum insulation R-value. R-value is for the insulation alone and does not include building materials or air films. The roof insulation shall not be located on a suspended ceiling with removable ceiling panels.

CLIMATE ZONE	**Maximum U-factor of the overall assembly**
	(W/m^{2-o}C)/(BTU/ft^{2-o}F)
Warm and Humid	U-3.24/U-0.051

a.	Glass façade	:	**<u>North glazing</u>:** SHGC - 0.82 U – 1.02 BTU/Hr.Ft^2.^{0}F **<u>Other glazing</u>:** SHGC - 0.82 U – 1.0 BTU/Hr.Ft^2.^{0}F
b.	Occupancy.	:	As listed.
c.	Lights.	:	Average Maximum 1 W/Ft^2
d.	Exposed wall ‘U’ value.	:	0.36 BTU/Hr.Ft^2.^{0}F
e.	Exposed roof ‘U’ value	:	0.14 BTU/Hr.Ft^2.^{0}F
f.	Outdoor air requirement	:	**30% More than ASHRAE 62.1-2016**

1.3. AIR CONDITIONING LOAD

The building HVAC loads have been calculated as follows for Heritage Building.

Sl. No.	*Description*	*Area (Sq.ft)*	*Occ.*	*Lights (Watt/Sqft)*	*Appliances (Watt/Sqft)*	*Deh.CFM*	*Fresh CFM*	*TR*
1	*FA-HOD (GF)*	*495*	*7*	*1*	*1.0*	*2359*	*84*	*3.73*
2	*FA-CLS2,1 (GF)*	*140*	*3*	*1*	*1.0*	*230*	*30*	*0.58*
3	*FA-CLS1,1 (GF)*	*183*	*3*	*1*	*1.0*	*274*	*34*	*0.66*
4	*WIDE CORRIDOR(GF)*	*1076*	*10*	*1*	*1.0*	*1366*	*84*	*2.28*
5	*FA DY HOD 1 (GF)*	*355*	*8*	*1*	*1.0*	*803*	*80*	*1.79*
6	*FA DY HOD2 (GF)*	*387*	*8*	*1*	*1.0*	*617*	*82*	*1.57*
7	*DISCUSSIONS ROOM (GF)*	*484*	*8*	*1*	*1.0*	*574*	*90*	*1.57*
8	*FA-CLS1,2 (GF)*	*194*	*3*	*1*	*1.0*	*279*	*35*	*0.68*
9	*FA-CLS1,3 (GF)*	*204*	*3*	*1*	*1.0*	*292*	*35*	*0.69*
10	*FA-CLS2,4 (GF)*	*237*	*3*	*1*	*1.0*	*241*	*38*	*0.65*
11	*FA & CAO(16 OFFICERS) (GF)*	*1173*	*17*	*1*	*1.0*	*3448*	*202*	*6.23*
12	*OPEN ROOM (GF)*	*463*	*6*	*1*	*1.0*	*603*	*75*	*1.44*
13	*FA&CAO(14 OFFICERS) (GF)*	*1054*	*14*	*1*	*1.0*	*2120*	*173*	*4.26*
14	*ROOM (GF)*	*258*	*5*	*1*	*1.0*	*1430*	*54*	*2.31*
15	*FA-CAO(6 OFFICERS) (GF)*	*721*	*6*	*1*	*1.0*	*1669*	*95*	*2.91*
16	*FA-CLS2,2 (GF)*	*172*	*3*	*1*	*1.0*	*856*	*33*	*1.39*
17	*FA-CLS2,3 (GF)*	*172*	*3*	*1*	*1.0*	*257*	*33*	*0.64*
18	*VIP RECEPTION DESK (GF)*	*204*	*3*	*1*	*1.0*	*281*	*35*	*0.68*

19	*VIP RECEPTION LOBBY (GF)*	*194*	*4*	*1*	*1.0*	*298*	*40*	*0.76*
20	*SUPPORT TEAM (GF)*	*829*	*17*	*1*	*1.0*	*1848*	*172*	*3.97*
21	*CORRIDOR (GF)*	*732*	*15*	*1*	*1.0*	*1240*	*152*	*3.02*
22	*FA-CLS1,4 (GF)*	*183*	*3*	*1*	*1.0*	*272*	*34*	*0.66*
23	*FA-CLS1,5 (GF)*	*204*	*3*	*1*	*1.0*	*295*	*35*	*0.69*
24	*FA-CLS1,6 (GF)*	*183*	*3*	*1*	*1.0*	*276*	*34*	*0.66*
25	*FA-CLS1,7 (GF)*	*215*	*3*	*1*	*1.0*	*305*	*36*	*0.71*
26	*WIDE CORRIDOR (GF)*	*1915*	*38*	*1*	*1.0*	*2483*	*398*	*6.94*
27	*DISPLAY EXHIBITION (GF)*	*516*	*10*	*1*	*1.0*	*619*	*107*	*1.80*
28	*SPACE FOR MOBIL SHELVING (GF)*	*516*	*10*	*1*	*1.0*	*616*	*107*	*1.80*
29	*CASH SECTION WATTING LOBBY (GF)*	*312*	*6*	*1*	*1.0*	*329*	*65*	*1.04*
30	*CASHER OFFICER (GF)*	*183*	*3*	*1*	*1.0*	*271*	*34*	*0.66*
31	*TREASURER OFFICER (GF)*	*183*	*3*	*1*	*1.0*	*272*	*34*	*0.66*
32	*RECEPTION LOBBY (GF)*	*613*	*10*	*1*	*1.0*	*1180*	*113*	*2.54*
33	*CASH SECTION ENTRY (GF)*	*161*	*4*	*1*	*1.0*	*467*	*39*	*0.97*
34	*CASH VALUE (GF)*	*237*	*5*	*1*	*1.0*	*328*	*51*	*0.91*
	Ground floor Sub-Total	***15150***	***250***			***28801***	***2743***	***62***
35	*CE- CLS 1 ,1 (1F)*	*215*	*3*	*1*	*1.0*	*1199*	*36*	*1.83*
36	*CE-CLS 1,2 (1F)*	*204*	*3*	*1*	*1.0*	*427*	*35*	*0.87*
37	*DMD -CLS1,1 (1F)*	*204*	*3*	*1*	*1.0*	*433*	*35*	*0.87*
38	*DMD -CLS1,2 (1F)*	*215*	*3*	*1*	*1.0*	*638*	*36*	*1.14*
39	*CE DEAWING SPACE (1F)*	*979*	*3*	*1*	*1.0*	*2584*	*96*	*3.98*

40	DMD DRAWING SPACE (1F)	925	4	1	1.0	1448	98	2.60
41	PRINIING ROOM (1F)	323	2	1	1.0	392	38	0.81
42	CE DY HOD 3 (1F)	247	4	1	1.0	353	45	0.86
43	CE DY HOD 4 (1F)	258	4	1	1.0	360	46	0.88
44	CE WORK SPACE (1F)	796	8	1	1.0	2654	114	4.33
45	DISCUSSIONS ROOM (1F)	527	8	1	1.0	610	93	1.63
46	CE HOD (1F)	355	4	1	1.0	1529	54	2.41
47	CE-CLS 2,1 (1F)	140	3	1	1.0	228	30	0.58
48	CE-CLS 1,3 (1F)	194	3	1	1.0	279	35	0.67
49	CE WORK SPACE (1F)	699	8	1	1.0	1271	107	2.57
50	CE DY HOD 2 (1F)	237	4	1	1.0	333	44	0.83
51	CE DY HOD 1 (1F)	226	4	1	1.0	326	44	0.82
52	SPACE FOR MOBILE SHELVING FOR CE (1F)	355	10	1	1.0	480	93	1.53
53	ROOM (1F)	237	0	1	1.0	432	18	0.66
54	CE -DY HOD 5 (1F)	280	4	1	1.0	604	48	1.20
55	CE-CLS1,8 (1F)	215	3	1	1.0	306	36	0.72
56	CE-CLS 1,7 (1F)	215	3	1	1.0	306	36	0.72
57	CONTRACT CELL (1F)	398	4	1	1.0	249	57	1.09
58	CE WORK SPACE (1F)	484	4	1	1.0	889	64	1.68
59	CE-CLS 1,10 (1F)	183	3	1	1.0	273	34	0.66
60	CE-CLS 1,9 (1F)	183	3	1	1.0	273	34	0.66
61	CONTROL ROOM (1F)	280	5	1	1.0	757	54	1.47

62	*CE- CLS 1 ,6 (1F)*	*183*	*3*	*1*	*1.0*	*271*	*34*	*0.66*
63	*CE WORK SPACE (1F)*	*592*	*7*	*1*	*1.0*	*700*	*92*	*1.70*
64	*CE- CLS 1 ,5 (1F)*	*204*	*3*	*1*	*1.0*	*296*	*35*	*0.70*
65	*CE- CLS 1 ,4 (1F)*	*204*	*3*	*1*	*1.0*	*297*	*35*	*0.70*
66	*PASSAGE (1F)*	*2486*	*10*	*1*	*1.0*	*3036*	*259*	*5.90*
67	*ROOM (1F)*	*183*	*2*	*1*	*1.0*	*264*	*27*	*0.58*
68	*CORRIDOR (1F)*	*796*	*6*	*1*	*1.0*	*1137*	*101*	*2.30*
69	*SUPPORT TEAM (1F)*	*839*	*6*	*1*	*1.0*	*1684*	*104*	*2.99*
	First floor Sub-Total	***15064***	***150***			***27317***	***2147***	***54***
70	*GALLERY (2ND F)*	*893*	*22*	*1*	*1.0*	*2700*	*215*	*5.52*
71	*DY.CHAIR MAN ROOM (2ND F)*	*721*	*14*	*1*	*1.0*	*1096*	*147*	*2.79*
72	*ANTE ROOM (2ND F)*	*129*	*2*	*1*	*1.0*	*1383*	*23*	*1.95*
73	*CORRIDOR (2ND F)*	*409*	*5*	*1*	*1.0*	*521*	*64*	*1.23*
74	*EXTERNAL HOD (2ND F)*	*204*	*4*	*1*	*1.0*	*488*	*42*	*1.02*
75	*DY.CHAIR MAN EA (2ND F)*	*86*	*4*	*1*	*1.0*	*175*	*33*	*0.56*
76	*DY.CHAIR MAN FS (2ND F)*	*172*	*4*	*1*	*1.0*	*443*	*39*	*0.94*
77	*BOARD ROOM (2ND F)*	*1087*	*54*	*1*	*1.0*	*1401*	*436*	*6.35*
78	*10' WIDE PASSAGE (2ND F)*	*1076*	*10*	*1*	*1.0*	*1179*	*149*	*2.78*
79	*CONFERENCE (2ND F)*	*312*	*8*	*1*	*1.0*	*432*	*76*	*1.29*
80	*CHAIR MAN ROOM (2ND F)*	*818*	*15*	*1*	*1.0*	*2125*	*161*	*4.20*
81	*ANTE ROOM (2ND F)*	*204*	*2*	*1*	*1.0*	*436*	*29*	*0.81*
82	*E.A. (2ND F)*	*140*	*4*	*1*	*1.0*	*329*	*37*	*0.78*

83	*P.S. (2ND F)*	*151*	*4*	*1*	*1.0*	*351*	*38*	*0.81*
84	*WAITING LOUNGE (2ND F)*	*323*	*6*	*1*	*1.0*	*426*	*64*	*1.15*
85	*HALDIA CELL (2ND F)*	*280*	*6*	*1*	*1.0*	*628*	*61*	*1.37*
86	*HALDIA OFFICER (2ND F)*	*215*	*6*	*1*	*1.0*	*330*	*56*	*0.97*
87	*HALDIA OFFICER (2ND F)*	*226*	*4*	*1*	*1.0*	*322*	*44*	*0.82*
88	*6'7" WIDE PASSAGE (2ND F)*	*958*	*10*	*1*	*1.0*	*1236*	*140*	*2.80*
89	*GAD CLS2,1 (2ND F)*	*183*	*3*	*1*	*1.0*	*271*	*34*	*0.66*
90	*GAD DY HOD (2ND F)*	*312*	*4*	*1*	*1.0*	*536*	*50*	*1.13*
91	*SECRETARY (2ND F)*	*323*	*7*	*1*	*1.0*	*662*	*71*	*1.51*
92	*GAD CLS1,1 (2ND F)*	*323*	*3*	*1*	*1.0*	*395*	*45*	*0.89*
93	*DMD HOD (2ND F)*	*420*	*7*	*1*	*1.0*	*706*	*78*	*1.62*
94	*DMD CLS2,1 (2ND F)*	*129*	*3*	*1*	*1.0*	*232*	*30*	*0.58*
95	*DISCUSSIONS ROOM (2ND F)*	*506*	*8*	*1*	*1.0*	*335*	*91*	*1.61*
96	*CONFERENCE ROOM (2ND F)*	*699*	*14*	*1*	*1.0*	*459*	*146*	*2.40*
97	*GAD CLS1,1 (2ND F)*	*280*	*3*	*1*	*1.0*	*193*	*41*	*0.83*
98	*HALDIA DY CHAIRMAN (2ND F)*	*323*	*4*	*1*	*1.0*	*220*	*51*	*0.98*
99	*CONTROL ROOM (2ND F)*	*312*	*4*	*1*	*1.0*	*216*	*50*	*0.96*
100	*CORRIDOR (2ND F)*	*839*	*5*	*1*	*1.0*	*664*	*98*	*2.46*
101	*SERVER ROOM (2ND F) OLD BUILDING*	*839*	*10*	*1*	*5.0*	*2131*	*130*	*3.88*
102	*SERVER ROOM (2ND F) OLD BUILDING*	*678*	*8*	*1*	*3.0*	*1720*	*105*	*3.13*
	Second floor Sub-Total	***14569***	***267***			***24739***	***2874***	***61***

	Grand-Total	***44783***	***668***			***80857***	***7764***	***176***

The building HVAC loads have been calculated as follows for Annaxe Building.

Sl. No.	***Description***	***Area (Sq.ft)***	***Occ.***	***Lights (Watt/Sqft)***	***Appliances (Watt/Sqft)***	***Deh.CFM***	***Fresh CFM***	***TR***
1	*CONFERENCE (GF-ANN)*	*183*	*6*	*1*	*1.0*	*1728*	*53*	*2.69*
2	*LIBRARY (GF-ANN)*	*721*	*6*	*1*	*1.0*	*2119*	*95*	*3.48*
3	*ROOM (GF-ANN)*	*323*	*5*	*1*	*1.0*	*340*	*58*	*0.97*
	Ground floor Sub-Total	***1227***	***17***			***4187***	***206***	***7***
4	*FA-CLS1,1 (1F-ANN)*	*226*	*3*	*1*	*1.0*	*1205*	*37*	*1.85*
5	*FA-CLS1,3 (1F-ANN)*	*183*	*3*	*1*	*1.0*	*695*	*34*	*1.20*
6	*FA-CLS1,4 (1F-ANN)*	*204*	*3*	*1*	*1.0*	*1076*	*35*	*1.68*
7	*FA-CLS1,5 (1F-ANN)*	*172*	*3*	*1*	*1.0*	*883*	*33*	*1.42*
8	*FA-CLS1,8 (1F-ANN)*	*172*	*3*	*1*	*1.0*	*866*	*33*	*1.40*
9	*FA-CLS1,9 (1F-ANN)*	*183*	*3*	*1*	*1.0*	*1106*	*34*	*1.71*
10	*FA- CLS1,2 (1F-ANN)*	*215*	*3*	*1*	*1.0*	*777*	*36*	*1.30*
11	*WORKSPACE (1F-ANN)*	*742*	*8*	*1*	*1.0*	*813*	*110*	*1.99*
12	*CORRIDOR (1F-ANN)*	*646*	*0*	*1*	*1.0*	*1016*	*50*	*1.61*
13	*FA & CAO (10 OFFICERS) (1F-ANN)*	*689*	*10*	*1*	*1.0*	*868*	*119*	*2.19*
14	*FAIR ESCAP (1F-ANN)*	*140*	*0*	*1*	*1.0*	*193*	*11*	*0.32*
15	*FA-CLS1,10 (1F-ANN)*	*183*	*3*	*1*	*1.0*	*269*	*34*	*0.66*

16	FA-CLS1,11 (1F-ANN)	194	3	1	1.0	325	35	0.73
17	RECORD ROOM (1F-ANN)	75	2	1	1.0	282	19	0.54
	First floor Sub-Total	**4024**	**47**			**10374**	**620**	**19**
18	FA & CAO (2F-ANN)	1689	30	1	1.0	4070	327	8.24
19	CLS 1 ,12 (2F-ANN)	172	3	1	1.0	827	33	1.35
20	FA-CLS1,13 (2F-ANN)	183	3	1	1.0	1138	34	1.74
21	FA & CAO (2F-ANN)	420	6	1	1.0	601	72	1.41
22	FA -CLS1,14 (2F-ANN)	161	3	1	1.0	249	32	0.62
23	FA -CLS1,15 (2F-ANN)	172	3	1	1.0	358	33	0.76
24	SPACE FOR MOBILE SHELVING FOR FA (2F-ANN)	301	3	1	1.0	461	43	0.96
25	RECORD ROOM (2F-ANN)	75	2	1	1.0	189	19	0.42
26	FIRE ESCAPE (2F-ANN)	75	2	1	1.0	156	19	0.38
	Second floor Sub-Total	**3250**	**55**			**8049**	**612**	**16**
27	DMD-CLS1,2 (3RD F)	194	3	1	1.0	1074	35	1.68
28	DMD-CLS1,1 (3RD F)	183	3	1	1.0	876	34	1.42
29	DMD WORKSPACE (3RD F)	678	10	1	1.0	825	118	2.12
30	MOBILE SELVING FOR DMD (3RD F)	355	5	1	1.0	553	60	1.24
31	CORRIDOR (3RD F)	796	10	1	1.0	1038	127	2.45
32	DMD DY HOD 5 (3RD F)	215	4	1	1.0	308	43	0.80
33	DMD DY HOD 3 (3RD F)	215	4	1	1.0	660	43	1.24
34	DMD DY HOD 1 (3RD F)	226	4	1	1.0	1350	44	2.11
35	DMD DY HOD 2 (3RD F)	226	4	1	1.0	752	44	1.36

36	DMD DY HOD 4 (3RD F)	215	4	1	1.0	338	43	0.83
37	DMD DY HOD 6 (3RD F)	215	4	1	1.0	308	43	0.80
38	FIRE ESCAPE (3RD F)	75	0	1	1.0	140	6	0.22
	Third floor Sub-Total	**3594**	**55**			**8221**	**640**	**16**
39	DMD CLS2,3 (4TH F)	172	3	1	1.0	1038	33	1.62
40	DMD CLS2,2 (4TH F)	161	3	1	1.0	854	32	1.38
41	DMD(14 OFFICERS) (4TH F)	753	14	1	1.0	1016	150	2.71
42	SPACE FOR MOBILE SHELVING FOR GAD (4TH F)	334	5	1	1.0	521	59	1.20
43	CORRIDOR (4TH F)	377	5	1	1.0	894	62	1.70
44	GAD WORK SPACE (4TH F)	1689	32	1	1.0	4822	340	9.34
45	FIRE ESCAPE (4TH F)	75	2	1	1.0	156	19	0.38
	Fourth floor Sub-Total	**3562**	**64**			**9302**	**695**	**18**
46	LGL HOD 1 (5TH F)	312	7	1	1.0	1404	70	2.46
47	LGL CLS2,1 (5TH F)	118	3	1	1.0	206	29	0.54
48	DISCUSSIONS ROOM (5TH F)	334	8	1	1.0	552	78	1.46
49	P&R WORKSPACE (5TH F)	807	12	1	1.0	1010	141	2.57
50	FIRE ESCAPE (5TH F)	75	1	1	1.0	147	12	0.30
51	LGL WORKSPACE (5TH F)	1001	12	1	1.0	2463	156	4.53
52	LGL CLS1,1 (5TH F)	194	3	1	1.0	818	35	1.35
53	LGL CLS1,3 (5TH F)	204	3	1	1.0	1280	35	1.93
54	CORRIDOR (5TH F)	183	2	1	1.0	376	27	0.72
55	LGL CLS1,2 (5TH F)	204	3	1	1.0	433	35	1.41

56	LGL CLS1,4 (5TH F)	194	3	1	1.0	282	35	0.68
	Fifth floor Sub-Total	**3626**	**57**			**8970**	**653**	**18**
57	P&R CLS1,1 (6F ANN)	204	3	1	1.0	1282	35	1.93
58	P&R CLS1,3 (6F ANN)	194	3	1	1.0	818	35	1.35
59	P&R CLS2,1 (6F ANN)	118	3	1	1.0	763	29	1.24
60	P&R CLS2,2 (6F ANN)	118	3	1	1.0	635	29	1.09
61	P&R CLS2,3 (6F ANN)	118	3	1	1.0	713	29	1.19
62	P&R CLS2,4 (6F ANN)	118	3	1	1.0	206	29	0.54
63	P&R HOD 1 (6F ANN)	312	4	1	1.0	1395	50	2.21
64	P&R DY HOD (6F ANN)1	226	4	1	1.0	1293	44	2.04
65	P&R DY HOD 2 (6F ANN)	226	4	1	1.0	401	44	0.92
66	P&R DY HOD 3 (6F ANN)	237	4	1	1.0	426	44	0.95
67	P&R WORK SPACE (6F ANN)	1108	6	1	1.0	1284	125	2.65
68	FIRE ESCAPE (6F ANN)	75	2	1	1.0	156	19	0.38
69	P&R CLS 2,5 (6F ANN)	118	3	1	1.0	208	29	0.55
70	P&R CLS 1,4 (6F ANN)	194	3	1	1.0	282	35	0.68
71	P&R CLS 1,2 (6F ANN)	204	3	1	1.0	705	35	1.22
	Sixth floor Sub-Total	**3572**	**51**			**10566**	**611**	**19**
	Grand-Total	**22854**	**346**			**59669**	**4037**	**113**

SUMMARY OF LOAD CALCULATION

MAXIMUM DEMAND = TOTAL AC LOAD = 176+113 = 289TR
MACHINE SELECTED : 2 x 300 TR WATER COOLED CHILLERS (INCLUDING PART STANDBY)

2. WATER CHILLING MACHINE

2.1 CENTRIFUGAL WATER CHILLING MACHINE

2.1.1 SCOPE

This section deals with supply, installation, testing & commissioning of water cooled turbo core variable speed driven centrifugal chiller meeting the requirement of schedule of quantity and the intent of thespecification.

Equipment documentation with manufacturer's catalogue shall be submitted along with the performance data by the tenderer duly certified by AHRI/Eurovent. All performance data shall be in terms of computer print outs for the specified power supply, chiller fouling. Part load performance figures shall be clearly specified.

Vendor in the last 5 years should have engineered, manufactured, tested, supplied andcommissioned at-least 15 nos of identical or similar packages of Magnetic Centrifugal chillers interms of capacity, pressure and purity and at-least 10 of these packages shall have continuousoperation in last 3 financial years.

2.1.2 QUALITY ASSURANCE PROGRAMME

a. Chiller shall be rated in accordance with Parameters indicated in Schedule of Quantities. Pressure vessels shall be designed, constructed, tested, stamped and shall be complete with safety devices in accordance with ANSI/ASHRAE 15-1989 Safety Code and ASME Code.

b. Chiller shall be the product of a manufacturer / licencee normally supplying this type of equipment and who can show evidence, having completed five installations of approximately the same capacity that have been in successful operation for at least five years.

c. The chiller shall be designed/manufactured and tested in accordance with the applicable portions of the latest revisions of the following Standards and Codes.

AHRI 550/590	-	Performance rating of water chilling packages using the vapor compression cycle. **Tenderer shall include performance rating (computer selection print out).**
AHRI 575	-	Air Conditioning and Refrigeration Institute. Standard Method of Measuring Machinery Sound Within Equipment Rooms (Basis of all data presented or field testing of equipment, with relation to sound requirements).
ASME CODE	-	American Society of Mechanical Engineers. (Div. 1 Code for Unfired Pressure Vessels - Section VIII, Design, construction, testing and certification of pressure vessels).
ANSI-B9.1	-	American National Standards Institute. Safety Code for Mechanical Refrigeration (overall general safety requirements, relief device sizing, etc.)
ANSI-B31.5	-	American National Standards Institute. Code for Refrigerant Piping.

TEMA - Tubular Exchanger Manufacturer's Association.

ISO R281 - Rolling Bearings – Dynamic Load Ratings and Rating Life

2.1.3 CAPACITY

Each unit shall have actual cooling capacity of **300 TR with Multiple Compressor**, cooling **min. 720 GPM** of water from **54 – 44ºF** when supplied with **1350 GPM of condenser water at 81 ºF**. **NPLV** shall not be more than **0.34 KW per ton**. **IKW at 100% load shall not exceed 0.49 per TR at DESIGN condition and COP shall be more than 6.4 at AHRI condition**. One unit shall be performance tested at manufacturer's place at two points, i.e. 100% and 50% load. **The test bed shall be certified by AHRI/ Eurovent.**.

2.1.4 CENTRIFUGAL COMPRESSOR

Chiller shall incorporate two stage intelligent oil-free centrifugal compressor with magnetic bearing. **The compressor shall take not more than 2-5 amps. for starter. The compressor shall be provided with in-built VFD which automatically controls the compressor speed as per the required load and operating conditions and thereby making it highly efficient. The speed range of compressor shall be approx. from 18000-48000 RPM.** The high speed design minimizes the vibration considerably. Since magnetic bearing will be used and floating shaft will be in operation, no oil circulation and no oil pump will be required. In the event of power failure compressor motor shall act as generator providing power for the bearing control system. Impeller of the centrifugal compressor shall be dynamically balanced and shall be designed for balanced thrust. Unit shall be over speed tested for smooth and vibration-free operation. The unit shall be compatible to operate with lower temperature cooling tower during part load operation in accordance with AHRI std. 550/590. Pre-rotation vent position shall be controlled automatically by means of an electric actuator mounted externally to maintain constant leaving chilled water temperature.

Cooler & condenser

The cooler shall be of flooded design allowing maximum heat exchange. Moreover due to absence of oil, heat exchanger stays effective for a longer period of time. Common cooler also helps in efficient operation during the part load. The evaporator shall be provided with refrigerant relief device sized to meet the requirement of ASHRAE 15 safety code for mechanical refrigeration. Vent and drain connection with plug shall be provided. A liquid level indicator through sight glasses will be located on the side in determining proper refrigerant charge.

Condenser Shell will be fabricated on rolled carbon steel plate having carbon steel tube sheets suitably drilled & reamed to accommodate the tubes. The refrigerant side shall be designed & tested as per ASME code for boiler and pressure vessel.. The condenser shall be provided with refrigerant relief device sized to meet the requirement of ASHRAE 15 safety code for mechanical refrigeration. Condenser shall be manufactured using doubly enhanced finned copper tube.

Electronic expansion valve

An electronic expansion valve shall be provided for precision control. Normally expansion valve regulates the refrigerant flow through the cooler and maintains the desired liquid level. The expansion valve shall be very sensitive to load variation and adjusts the flow with shorter response time to achieve the power saving.

Micro processor based control panel

Chiller shall be controlled by stand along micro processor based control panel. Chiller control panel shall control chiller operation and shall monitor chiller censer, actuator, relays & switches.

Chiller control panel shall also provide:

1) System operating informationincluding

   a. Return and leaving chilled watertemperature
   b. Return and leaving condenser watertemperature
   c. Evaporator and condenser saturationtemperature
   d. Differential oilpressure
   e. Percent motorcurrent
   f. Evaporator and condenser saturationtemperature
   g. Compressor dischargetemperature
   h. Oil reservoirtemperature
   i. Compressor unloadingstatus
   j. Operatinghours
   k. Number of compressorstarts

2) Digital programming of set points through the universal keypadincluding

   a. Leaving chilled watertemperature
   b. Percent currentlimit
   c. Pull-down demandlimiting
   d. Minimum six-week schedule for starting and stopping the chiller, pumps andtower
   e. Remote reset temperaturerange

3) Status messagesindicating

   a. System ready tostart
   b. Systemrunning
   c. System closedown
   d. System safety shutdown-manualrestart
   e. System cycling shutdown-autorestart
   f. System prelube
   g. Startinhibit

4) Safety shutdowns enunciated through the display and the status bar and consist of system status, system details, day, time, cause of shutdown and type of restart required. Safety shutdowns shallinclude:

   Centrifugal Chiller:

   a. Evaporator – lowpressure
   b. Evaporator – transducer or leaving liquidprobe
   c. Evaporator – transducer or temperaturesensor
   d. Condenser – high pressure contactsopen
   e. Condenser – highpressure
   f. Condenser – pressure transducer out ofrange
   g. Auxiliary safety – contractsclosed

h. Discharge – hightemperature
i. Discharge – lowtemperature
j. Oil – hightemperature
k. Oil – low differentialpressure
l. Oil – high differentialpressure
m. Oil – sump pressure transducer out ofrange
n. Oil-differential pressure calibration
o. Oil – variable speed pump – pressure set point notachieved
p. Control panel – power failure
q. Motor or starter – currentimbalance
r. Thrust bearing – proximity probeclearance
s. Thrust bearing – proximity probeout-of-range
t. Thrust bearing – high oiltemperature
u. Thrust bearing – oil temperaturesensor
v. Watchdog – softwarereboot

5) Safety shutdowns with a VSD shallinclude

a. VSD shutdown – requesting faultdata
b. VSD – stop contactsopen
c. VSD – 105% motor currentoverload
d. VSD – high phase A, B, C inverter heat sinktemp.
e. VSD – high converter heat sinktemperature

Insulation

Anti-sweat insulation will be attached to the cooler shell, flow chamber, tube be a flexible, closed-cell nitrile/polyethylene rubber based material, ¾ inch thick, applied with vapour-proof cement. The insulation will normally prevent sweating in environments with relative humidity upto 99% and dry bulb temperatures ranging from 59 to 105ºF.

Insulation Mounting

The same is included with the unit and having four vibration isolation mounts, consisting of 1” thick neoprene isolation pads for field mounting. The pads are to be mounted under the steel mounting pads on the tube sheets suitable for ground floor/basement installation.

Compressor motor starter

A variable speed drive will be factory assembled on the chiller. It will vary compressor motor speed through frequency and voltage control of the electrical power to the motor. The adaptive capacity control logic shall automatically adjust motor speed and compressor pre-rotation vane position independently for maximum part load efficiency by analyzing information fed to it by sensors located in the chiller.

The variable speed drive will be unit mounted in a NEMA 1 enclosure with all power and control wiring between the drive and chiller factory installed,including power to the chiller oil pump. Field power wiring shall be a single point connection and electrical lugs for incoming power wiring will be provided. The entire chiller package will be ULlisted.

The following features will be provided:

Door interlocked circuit breaker capable of being padlocked. UL listed ground fault protection.
Over voltage and under voltage protection.
3-phase sensing motor over current protection. Single phase protection.
Insensitive to phase rotation. Over temperature protection.

Digital readout at the chiller unit control panel of output frequency, output voltage, 3-phase output current, input Kilowatts and Kilowatt-hours, self- diagnostic service parameters. Separate meters for this information will not be acceptable.

KW Meter – The unit's input power consumption will be measured and displayed digitally via the unit's control panel. The KW meter accuracy is typically ± 3% of reading. KW meter scale is 0-750 KW (min).

KWh Meter – The unit's cumulative input power consumption is measured and displayed digitally via the unit's control panel. The KWh meter is re-settable and it's accuracy is typically ±3% of reading. KWh meter scale is 0-999,999 KWh.

Ammeter – Simultaneous three-phase true RMS digital readout via the unit control panel. Three current transformers provided isolated sensing. The ammeter accuracy is typically ±3% of reading. Ammeter scale is 0-545 ARMS.

Voltmeter – Simultaneous three-phase true RMS digital readout via the unit control panel. The voltmeter accuracy is typically ±3% of reading. Voltmeter same is 0-670VAC.

Elapsed Time Meter – Digital readout of the unit's elapsed running time (0- 876,600 hours, re-settable) is displayed via the unit control panel.

d. Capacity Control

The compressor shall be equipped with an automatic suction damper or inlet guide vanes control for regulating its capacity. The positioning of the damper shall be done by means of thermostatically actuated electronic temperature-controller differential-type with its sensing element or elements in the outgoing chilled water lines. The automatic damper will maintain the constant temperature of chilled water. It should be possible to go down to 30% of full load as per A**H**RI 550/590-, with **nearly**linear reduction in power input to the chilling machine**. If for turndown ratio of 30%, OEM needs to resort hot gas bypass system then OEM shall clearly indicate so in their techno commercial proposal.**

Compressor and motor sole plates, anchor bolts and sleeves and necessary vibration isolation pads shall be included.

e. Microprocessor Control Centre

Each unit shall be furnished with microprocessor control centre in a locked enclosure, factory mounted, wired and tested. The control center shall include a 40-character alphanumeric display showing all system parameters in English language with numeric data in English (FPS) units.

Digital programming of essential set points through a colour coded, tactile-feel keypad shall include: entering and leaving chilled water temperature and condensing water temperature; percent loading: pulldown demand limiting; seven-day time clock for starting

and stopping chiller (complete with local holiday schedule): and remote reset temperature range.

All safety and cycling shutdowns shall be annunciated through the alphanumeric display and consist of day, time, cause of shutdown, and type of restart required. Safety shutdowns shall include: high oil pressure; high compressor discharge temperature: low evaporator pressure: motor controller fault: and sensor malfunction. Cycling shutdowns shall include: low water temperature; low oil temperature: chiller/condenser water flow interruption; power fault; internal time clock; and anti-recycle.

System operating information shall include: return/leaving chilled water temperatures; return/leaving condenser water temperatures; evaporator /condenser refrigerant pressure; differential oil pressure; percent motor current; evaporator/condenser saturation temperatures; guide vaneposition,operating hours(Hours Run) and number of compressor starts, purge unit operation, compressor motor current and fault history.

Security access shall be provided to prevent unauthorized change of setpoints to allow local or remote control of the chiller, and to allow manual operation of the prerotation vanes and oil pump.

The chiller shall be provided with an RS-232/485 port to output all system operating data, shutdown/cycling messages and a record of the last four cycling or safety shutdowns to a remote printer or Building Automation System (BAS). The control center shall be programmable to provide data logs to the BAS/printer at a set time interval.

The chiller control panel shall be able to interface with the Building Automation System (BAS) to provide remote chiller start/stop, reset of chilled water temperature, reset of current limit; and status messages indicating chillier is ready to start, chiller is operating, chiller is shut down on a safety requiring reset, and chiller is shut down on a recycling safety. Control panel should be with open protocol like Modbus RTU/ Bacnet/ Lon work for integrating with BAS.

2.1.5 INTERFACE WITH BUILDING AUTOMATION SYSTEM

All necessary hardwares / softwares to integrate the chiller panel to BAS system shall be provided free of cost by chiller manufacturer / supplier.

For the integration of Microprocessor Panel of the chilling machine with the Building Automation System, an Interface Control Document shall be developed by BAS Contractor. It shall be responsibility of HVAC Contractor to provide following to BAS Contractor for preparing the interface.

a. Hardware Protocol of Chiller Microprocessor panel.

b. Software Protocol of Chiller Microprocessor panel.

c. Communication structure relating to collection of message / event information.

d. Description of the formatted packets / blocks of data which construct controller commands / responses.

e. Written permission to BAS contractor to develop the interface without any financial implication.

2.1.7 DRIVE :

The compressor shall be driven directly or through speed increasing gears as required. The gears and pinions shall be pressure lubricated. The gears shall be provided with oil filter and submerged oil pump. The gears should be of helical type with crown teeth designed such that more than one tooth is in contact at all times to provide even distribution of compressor load and quiet operation. Gears should be integrally assembled in the compressor rotor support and be film lubricated. Each gear should be individually mounted in its own journal and thrust bearings to isolate it from impeller and motor shafts.

2.1.12 PAINTING

Condenser coils, evaporator coils, fins, end plate, compressors, panels, drain pans, fans, grids, enclosures, water collectors and pipes , a corrosion resistive coating (anti-corrosive) applied shall be applicable for heat exchangers components , and based on a special heat conductive coating achieving a long lasting nominal performance. A special polymer shall be added to achieve a smooth surface so that the minimum dust will stick and minimize dirt collection.

This coating shall meet the following durability test requirement :-

a) Salt Spray withstand 3000 salt spray test hours or more as per ASTM P117 - 03.
b) 25 Weeks Cycle aging test -ISO 20340

c) 1000 Cycles Taber abrasion test - ASTM 04060

d) Flexibility - ISO 1520.

e) Anti-Microbial, Anti-Bacterial, Anti-Fungi Standard test.

This coating shall be factory or field applied.

Coating layer thickness for different parts shall be as follows:-

Item	HVAC equipment Part	Thickness
1.	Compressors panels, fans, grids, enclosures, pipes, etc.	0.17 to 0.26mm
2.	Casting	0.17 to 0.26mm
3.	Condenser and evaporator coils	25 to 30 micron

Heat Resistance of the coating shall exceed 150°C.

The protection coating shall be maintainable in site and warrantied against

climate impact and galvanic corrosion for (10) ten years.

The corrosion resistive coating (Anti-corrosive coating) for parts exposed to the direct sun shall be UV resistant.
A multi coating shall be applied for the complete unit including the casing, piping and headers.

2.1.12 PERFORMANCE RATING

The unit shall be selected for the lowest operating noise level. Capacity ratings, and power consumption with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation. Capacity shall be ascertained by measurements of chilled water flow rate and temperature of chilled water in and out of the chilling unit. Power consumption shall be computed from measurements of incoming voltage & input current to the chilling machine.

2.1.13 WITNESS TEST

Prior to shipment, chilling machines shall be subjected to inspection and witness of performance tests by Consultant and Owner's representative to verify various performance parameters as confirmed by vendor earlier at the time of award of contract. Performance test shall be carried out as per procedure laid down by ARI / EUROVENT and as per Spectral specified parameter, at 100%, 75%, 50% and 25% loading.Chilled water leaving temperature shall be kept constant to design value for partial load testing.

Fouling factor simulation for condenser and evaporator shall be done as per ARI-550/590-2003.Incremental temperature difference (to be calculated based on Normative appendix-C of ARI-550/590-2003) on account of designed fouling factors shall be added in condenser water entering temperature and shall be subtracted for leaving chilled water temperature. Chiller shall produce design refrigeration capacity and guaranteed power consumption at these corrected set of entering condenser water and leaving chilled water temperature. Outside tube surface area (for condenser and flooded evaporators) and inside tube surface area (for DX-Evaporator) , being inputs for ARI mathematical model for fouling, shall be submitted along with the offer.

All expenses inclusive of business class airfare, boarding lodging etc. relating to the witness test will be borne by the vendor / contractor.

3. PUMPS

Split Coupled Vertical Inline Condenser water Pumps

Supply and install as shown on plans and specifications Split Coupled Type Vertical In-Line Centrifugal pumping unit. The pumps shall be radially split, single stage centrifugal type with CI/GM casing with equal size suction and discharge flanges and having separate tapped flush line and pressure gauge connections, Gunmetal Bronze (BS1400 LG2C) dynamically balanced impeller, stainless steel shaft, lower carbon throttle bushing, Outside Balanced type mechanical seal with Resin Bonded Carbon rotating face, Sintered Silicon Carbide stationary seat and Viton secondary seal.

The pump is to be fitted with a factory installed flush line. Supply in the flush line to the mechanical seal, a 50 micron cartridge filter (alternatively, a cyclone separator when pump differential pressure exceeds 30 PSIG) and floating ball type sight flow indicator suitable for the working pressure encountered. The mechanical contractor shall change the filters after the system has been flushed and on a regular basis until the pumps are turned over to the owner. The squirrel cage induction type motor, with TEFC enclosure and

shall be connected to the pump through a high tensile aluminum, split type spacer coupling to permit Servicing of the mechanical seal without disturbing pump, motor or electrical wiring. Coupling shall be protected by a guard.

Split Coupled Vertical Inline Primary variable chilled water Pumps

The Vertical In-Line (VIL) pump single stage, single or double suction type, with pump characteristics which provide rising heads to shut off, shall be supplied with a TEFC, 415/3/50 motor efficiency equivalent to IE2 and an IP55/UL Type 12 enclosure variable speed VFD.

The drive shall be integrated with the motor for a self-contained pump, motor and drive combination to ensure optimum component matching and protection from motor overloading at any operating point within the design or operating range.

Pump Construction: Pump Casing - Cast Iron with PN16 flanges for working pressure to 12 bar at 65°C and Ductile Iron with PN25 flanges for working pressures to 25 bar at 65°C . Suction and discharge connections shall be flanged and the same size and shall be drilled and tapped for seal flush and gauge connections.

Impeller - Bronze, fully enclosed type. Dynamically balanced. Two-plane balancing is required where installed impeller diameter is less than 6 times the impeller width.

Shaft - Provide Stainless Steel pump shaft.

Coupling - Rigid spacer type of high tensile aluminium alloy. Coupling to be designed to be easily removed on site to reveal a space between the pump and motor shafts sufficient to remove all mechanical seal components for servicing and replacement without disturbing other components of the pump or motor. The coupling shall be provided with a fully enclosed guard complying with the Machinery Directive.

Mechanical Seals - Shall be Stainless Steel multi-spring outside balanced type with Viton® secondary seal, carbon rotating face and silicon carbide stationary seat. Provide a 316 stainless steel gland plate. Provide factory installed flush line with manual vent to purge air prior to pump start-up. All split coupled pumps shall be provided with a lower seal chamber throttle bushing to ensure seals maintain positively cooling and lubrication. Seal flush line accessories, if required to improve seal chamber cleanliness: Supply in the flush line to the mechanical seal a 50 micron cartridge filter and sight flow indicator, to suit the working pressure encountered. Filters shall be changed, by the installing contractor, after system is flushed and on a regular basis until turned over to the owner.

2.0 Integrated Variable Frequency Drive (VFD)

1. Fundamental Requirements

VFD shall be of the VVC-PWM type providing near unity displacement power factor (cos Ø) without the need for external power factor Correction capacitors at all loads and speeds.

VFD shall incorporate DC link chokes for the reduction of mains borne harmonic currents to reduce the DC link ripple current
thereby increasing the DC link capacitors lifetime

VFD shall be CE Marked showing compliance with both the EMC Directive 2004/108/EC and the Low Voltage Directive
2006/95/EC.

RFI filters shall be incorporated within the drive to ensure it meets the emission and immunity requirements of EN61800-3 to
the 1st Environment Class C1 (EN55011 unrestricted sales class B).

2. VFD and Motor Protection

VFD and motor protection shall include: motor phase to phase fault, motor phase to ground fault, loss of supply phase, over
voltage, under voltage, motor over temperature, inverter overload, over current. Over current is not allowed ensuring Intelligent variable speed.
units will not overload the motor at any point in the operating range of the unit.

3. User Interface
VFD shall incorporate an integrated graphical user interface that shall provide running and diagnostic information and identify
faults and status in clear English language. Faults shall be logged / recorded for interrogation at a later date.
It shall be possible to upload parameters from one VFD into the non-volatile memory of a computer and download the
parameters into other drives requiring the same settings.
The keypad shall incorporate Hand-Off-Auto pushbuttons to enable switching between remote and manual control.

PRIMARY VARIABLE CONTROLLER DESCRIPTION

A. This specification applies to the control of a multiple pump HVAC heated and/or chilled water systems that involves up to 6 variable speed pumps in parallel, allowing for all duty and duty/standby configurations. The system has 4 variable speed primary pumps with integrated controls and capable of providing their flow and head calculated from electrical variables, supplying chilled water to 2 zones, whose demand is measured with 2 critical zones by 2 differential pressure sensors.

B. The controller shall be supplied with all the hardware, software and programming required to control up to 6 variable speed primary pumps.

C. The quantity of pumps to be controlled shall be independently configurable on-site at the graphic user interface by selection from button base menus, without requiring reprogramming or software download. All schematics, tables and menus in the graphic user interface shall show only the data and graphics corresponding to the selected configuration.

D. The controller shall be supplied with all the hardware, software and programming required to be seamlessly integrated with the reporting and remote read-write capabilities of the building automation system (BAS). The pump set controller shall allow field adjustments of control parameters as described below.

1.2 RELATED SECTIONS

A. Section 25 50 00 - Integrated Automation Facility Controls
B. Section 23 64 00 - Package Water Chillers
C. Section 23 52 00 – Heating Boilers
D. Section 23 20 00 - HVAC Piping and Pumps Plumbing Systems
E. Section 23 09 00 - Instrumentation and Control for HVAC

1.3 STANDARDS REFERENCES AND QUALITY ASSURANCE

A. The controller shall be assembled with components that conform to the latest edition of the following as applicable:
1.ANSI – American National Standards Institute
2.NEMA – National Electrical Manufacturers Association
3.UL – Underwriters Laboratories
4.CSA – Canadian Standards Association
5.IEC - Degrees Of Protection Provided By Enclosures (IP Code)
6.ASHRAE 90.1-[2013] - American Society of Heating, Refrigeration and Air-Conditioning Engineers – Energy Efficient Design of New Buildings
7.ASHRAE 100 - American Society of Heating, Refrigeration and Air-Conditioning Engineers – Energy Efficient Design of Existent Buildings
8.The pump set controller manufacturer must hold an ISO 9000 QA certification or approved equal.

1.4 INSTALLATION AND CONTROL CONTRACTOR RESPONSIBILITIES

A.The controls contractor is responsible for the following:
1.Inspect interior and exterior and report any obvious damage or equipment shifting that may have taken place between the time the unit arrived on site and when in its final resting position
2.Mechanical installation of the control package and mount in place. Re-align and level the control panel(s).
3.Install all life safety equipment as needed.
4.All field electrical connections to the unit. Hook up electrical supply needed by the plant pump set controller (including field sensors). Connect with the BAS and confirm that BAS is ready to send/receive commands to the pump set controller. Provide internet connection to the automation system.
5.Field connect equipment including pressure/temperature sensors, flow meters and their associated wiring to the unit (a list of field installed equipment will be supplied, along with installation instructions). As required by device instructions, where necessary, calibrate all sensors and auto valves.
6.Touch up and paint scratches and minor dents occurred during hoisting and rigging
7.Permits and inspections needed to start up the system
8.Start-up of system with the supervision of manufacturer personnel

2 HARDWARE
A.PUMP CONTROLLER AND ASSOCIATED EQUIPMENT
1.The controller shall be a stand-alone system capable of operating independently of the building automation system (BAS), and at the same time capable of receiving remote instructions from the BAS.
2.The pump set controller shall be performed solely by the PLC and the Graphic User Interface shall not be required for plant operation, other than initial setup or configuration.
3.The controller shall include :
a. An internal circuit breaker and run on 100-240 Vac /1Ph/50-60Hz power supply
b.4.3” back-lit touch-screen for all necessary user interface functions. Keypad based interfaces, LCD readouts, and LED displays will not be accepted.
c. Operation temperature range: 0°C - 45°C (32°F-113°F) (must not be exposed to direct sunlight)
d. Operation humidity range: (10% - 85%) non-condensing
e. Operating altitude up to 2000 m (6561 feet)
f. Ambient air temperature for storage : 0°C - 60°C (32°F-140°F)
g. Power supply: AC 100-240V, 120 W
h. {select one of the following} {UL mark, FCC compliant} or {CE mark, EN 61000-4-3 compliant}

4. The pump set controller shall have a key lockable IP 54 rated cabinet. All operator interface control switches, indicators and displays shall be physically separated from any field terminations. Switches and indicators must be protected from unauthorized operation by a key lockable door.

5. The controller shall have Hand-Off-Automatic (H-O-A) control and provide the option for a remote on/off signal from a Single dry type relay or via BMS serial communication signal. These virtual H-O-A switches shall be accessible through the touch screen display, and in Hand mode, the controller shall allow the pump speed to be manually set and changed.

B.SCREEN

1.The pump set controller shall include a back-lit touch screen color display operator interface of at least 4.3” and show active-element schematic displays with links to sub-menus for status reports, data and setup menu options. Keypad based interfaces, LCD readouts, and LED displays will not be accepted. The pump set controller shall perform online self-diagnostic testing of the CPU(s), RAM, and flash memory. No data shall be lost during power supply interruptions.

2.The pump set controller shall be self-prompting. All messages shall be displayed in plain English and support for display of multiple languages and characters simultaneously. The operator interface shall have storage memory for at least 50 faults and be able to recall them on the screen, on-screen help functions, and separate user screens for:
a.{select one of the following} {Chiller} or {Boiler} minimum and maximum flow (including factory default setup data)

b. Pump configuration (including factory default setup data)
c. Alarm history and event review
d. Display of {select one of the following} {Chiller} or {Boiler} status, pump status and system status
e. Design set-point and end of curve data
f. Best Efficiency Point speed setup (including factory default setup data)
g. PID control parameters setup (including factory default setup data)
h. BAS communication setup (including factory default setup data)
i. System schematic(s) showing pumps and valves operating parameters and sensors readings

D.SOFTWARE

1.Capabilities: The pump set controller software shall be pre programmed to perform, but will not be limited to, the following:
a. Manual or automatic pump set controller
b. Duty cycling
c. Automatic lock-out of malfunctioning equipment
d. Backup sequences of control for any sensor failure
e. Primary pumps control to satisfy the system demand as indicated by Sensorless readings.
f. Control sequences for headered pumps
g. Optimized sequencing of the Chilled or Heated Water pumps
h. Control sequences for Sensorless™ and zone sensors distribution pump speed control optionsi. Maintain minimum flow through the {select one of the following} {Chiller} or {Boiler}
j. Monitoring the status of the isolation valve to determine the system minimum and maximum flow.
k. Setpoints reset based on most open load valve
l. Scanning and alarm processing
m. Graphic screen reporting

2. User Friendliness: The pump set controller software shall be easy and intuitive to operate. Operators shall be able to perform the following operations after 4 hours of training:

a. View systems parameters
b. Select relevant screens, systems and points
c. Turn on and off controlled points manually
d. Acknowledge alarms

3. Input/Output: A complete point schedule shall be provided detailing analogue and digital input and output point description, functions, types and any special requirements. The pump set controller shall be capable of accepting and processing appropriate signals (Differential Pressure, Temperature, or Flow) for the following dedicated terminal blocks:

a. Up to 6 digital inputs (DI), one per {select one of the following} {Chiller} or {Boiler} status
b. 1 DI for remote connection for start/stop
c. 6 DIs, one per pump for fault signal,
d. 1 DI for alarm silencer,
e. Up to 3 DO for alarms: (a) pump/motor/VFD alarm, (b) DP transmitter alarm, (c) general system alarm
f. 1 serial port for communication with the graphical HMI.
g. 1 serial port for communication with the BMS,
h. 1 serial port for communication with the pumps,
i. 1 terminal block for power supply 100V-240V AC / 50-60 Hz.

4.Trending and Reporting Capabilities: The controller provides a log of alarms, and events. The controller shall be capable of displaying the alarm history on its graphical touchscreen.

5.The pump set controller shall display live data on demand. The pump set controller shall provide graphic screens
of system schematics.

6.Communication Protocol: The pump set controller shall be able to communicate with the Building Automation System over one or more of the following protocols: Modbus RTU, BACnet MS/TP, BACnet IP or Lonworks.

7.The pump set controller shall allow changes in the field of the network address and baud rate it uses to communicate with the BAS. Network addresses cannot be hard coded.

8.Remote Access: The pump set controller shall include webserver functionality and be accessible through an internet TCP/IP internet address with read/write functionality. This access shall allow the relevant staff to:

a. Remotely view all screens available at the local graphic user interface (GUI), with the same functionality. i.e.:view plant status, view and modify parameters and set points, override equipment and navigate screens.
b. View all available live and historic data
c. Receive alarm messages, automatically processed and conveyed via the network.
d. BAS and Internet connection shall be provided by others, but the controls contractor installing the pump set controller is responsible of requesting it and coordinating with the IT contractor.

e. Remote manual override by the BAS shall be possible for the following equipment settings:
i. Pump set controller ON/OFF

9. Alarms: Alarms shall be generated and the alarm messages shall be displayed in clear textual form on the screen until it is acknowledged by the operator. Alarms shall include but not limited to the following list:

a. System fault alarms
b. General alarm
c. Pumps run feedback alarms
d. Pump alarm
e. Pump communication alarm
f. 4 potential free contacts shall be provided for general alarm, buzzer and communication alarm

10.Safety Features shall include but not limited to the following list:
a. Auto omission of pump in case of pump failure
b. Deadhead protection when no flow
c. Indication of any Failure (or) malfunctioning in the touchscreen screen user interface, the remote access
screens, in the BAS communication.
d. Remote stop for emergency shutdown.

11. Access Security: The pump set controller shall have at least two levels of password security: Level zero (view only) and Level one modify all parameters visible on the HMI + and set equipment in Hand (Site Operator).

12. Sequence of Operation:

a. All pump set controller settings, including the number of pumps, as well as how they are connected (headered can be modified at the graphic user interface (GUI) after entering the appropriate password.

b. The pump set controller determines the most efficient combination of operating pumps, and pump operating speed based on the zone differential pressure, zone Temperature sensor signals and/or Parallel Sensorless™ as per the field adjustable configuration

c. The pump set controller shall respond to an increase in demand by increasing either, the number of operating pumps, or the pump speed.

d. In the case the demand decreases, the pump set controller shall respond by decreasing either, the number of operating pumps (or) the pump speed so as to optimize the energy efficiency of the pumping operation while meeting system demand.

e. The pump logic pump set controller shall rotate the pumps based on a field adjustable interval of operating hours with a “bump-less” transfer algorithm. The logic controller incorporates embedded logic to prevent hunting, pump flow surge, and motor overloading.

f. On any vfd /pump/by-pass unit fail, the appropriate alarm signal will be activated. In the place of the failed assembly, a standby vfd/pump unit will be operated in variable speed mode.

g. The pump set controller modulates the bypass valve to maintain the minimum flow required by the operating {select one of the following} {Chillers} or {Boilers}.

h. The pump set controller shall determine the minimum and maximum flow either by monitoring the opening position of up to 6 isolation valves or directly from the BAS. It shall adjust the pump number, speed and the bypass valve position in order to maintain the flow between those limits.

i. The pump set controller shall not allow the flow to vary more than 10%/min.

j. Manual operation mode (for commissioning): When the pump set controller is switched to the manual operation mode by the operator, there is no automatic operation or sequencing of any pump and operation of the water distribution pumps can be manually set. When operation mode is switched back to auto, the automatic operation mode is restarted.

13. The pump set controller shall be capable of providing parallel primary pump station control for speed and sequencing of pumps using Sensor less pump speed and Parallel Sensor less pump staging.

FAN COIL UNITS/CASSETTE UNIT

10.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of fan coil units conforming to these Specifications and in accordance with the requirements of the Drawings and Schedule of Quantities.

10.2 TYPE

The fan coil units shall be vertical type for floor mounting, horizontal type for ceiling-suspension. Floor-mounted vertical units shall have vertical top discharge; and horizontal units mounted within ceiling space shall have horizontal discharge and shall be ductable. All units shall be complete with chilled water coil, one or more centrifugal fans and motor, cleanable fabric filters, insulated condensate drain pan.

10.3 CAPACITY

The air moving and coil capacities shall be as shown on Drawings and indicated in Schedule of Quantities.

10.4 CABINETS

Cabinets for floor mounted exposed FCU shall be constructed of 18 gauge die-formed cold-rolled galvanized sheet steel, bonderized and painted with approved shade of powder coating finish. The cabinets shall be of sufficient size to enclose all piping and control valves, and shall have access doors to piping and controls. Access panels shall have positive locking fasteners for easy removal.

Horizontal furred-in type units mounted within ceiling space shall be provided with a GI casing of 18 gauge, the coil and fan section with provision to mount filters within the fan section.

10.5 INTERIOR CHASSIS

The interior chassis shall be constructed of not less than 16 gauge cold rolled galvanized sheet steel bonderized and painted with approved shade of powder coating finish. All ceiling suspended vertical fan coil units shall be securely mounted from the building structure with top panel set dead level in both directions. In case of ceiling suspended horizontal units fan deck and cooling coil shall be easily removable from FCU without lowering down of the FCU or disturbing the other installation.

10.6 DRAIN PAN

Primary drain pan shall be pre-pressed 22 gauge SS-304 and an additional inner bottom panel of 22 gauge SS-304 shall be provided to prevent damage to, and floatation of the bottom panel insulation. The pan shall be insulated with not less than 6 mm thick nitrile rubber (class O as per BS 476) insulation shall be effective to prevent condensation. The pan shall be of sufficient size to catch all drippage of condensation from any part of the unit. In all cases pan shall be large enough to cover cooling coil supply and return water headers and bends, control valves and ball valves with copper pipes. A secondary (auxiliary) condensate pan similar to primary drain pan may be provided by the manufacturer of these units which are so identified in Schedule of Quantities. All drain pans shall be with powder coating finish as per interior chassis defined above.

10.7 COOLING COIL

All cooling coils shall be standard three-row staggered seamless copper tube with aluminum sine wave fins. The coil shall be fitted with dielectric coupling for connection with MS pipes by HVAC contractor. Tubes shall be minimum 10 mm OD and wall thickness shall be minimum 0.41 mm. Fin spacing shall be 12 fins per inch. All bends and joints shall be enclosed within insulated end sections of the base unit for protection against sweating. Tubes shall be mechanically expanded for minimum thermal contact resistance with fins. Air vent shall be provided in headers at a level higher than coils. The cooling coil shall be easily removable from back side of FCU along with fan section without disturbing the Installations. All coils shall be factory tested at 21 KG per sq. cm (300 psig) air pressure while submerged in water.

10.8 FANS

Fans shall be centrifugal forward curve DIDW, direct driven by a fractional horse power shaded-pole motor.

10.9 MOTOR

Motor shall be 220 ± 6% volts, 50 cycles single phase, energy efficient, six pole, shaded pole type, speed not exceeding 1000 rpm at maximum airflow. Motors shall have three speed windings and shall be factory wired to a terminal block mounted within the fan section. Motors shall have extended shaft on both sides.

10.11 INSTALLATION

Ceiling suspended horizontal units and units mounted within the ceiling space shall be hung through rubber-in-shear vibration isolator suspenders.

10.12 ACCESSORIES

All fan coil units shall be equipped with copper piping connections, dielectric union and manual air vent at the cooling coil outlet header. In addition, the following accessories may be required at fan coil units; their detailed Specifications are given in individual sections and quantities separately identified in Schedule of Quantities.

a. Imported fan coil units as specified in Schedule of Quantities shall be factory fitted with Ball valves at inlet and outlet. Ball valve with `Y' strainer shall be installed in the tapping of the chilled water pipe installed in riser/shaft or as shown on Drawings and in Schedule of Quantities.

b. ALTERNATELY Ball valve with 'Y' strainer, and ball valve as shown on Drawings and in Schedule of Quantities.

c. Adjustable discharge air grille as shown on Drawings and in Schedule of Quantities.

10.13 PAINTING

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

10.14 PERFORMANCE DATA

Fan coil units shall be selected for the lowest operating noise level having standard sound level rating of NC 30 at low speed and NC 35 at medium/high speed. Fan performance rating and power

consumption data, with operating points clearly indicated, shall be submitted by the Contractor and verified at the time of testing and commissioning of the installation.

10.15 TESTING

Cooling capacity of various fan coil unit models shall be computed from the measurements of air flow and dry and wet bulb temperatures of air entering and leaving the coil. Flow measurements shall be by anemometer and temperature measurements by accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

12. COOLING TOWERS

12.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of cooling towers in accordance with requirements of Drawings and of the Schedule of Quantities.

12.2 TYPE

Cooling Towers shall be induced draft /forced draft in accordance with requirement of Drawings and of the Schedule of Quantities.Cooling towers shall be as per CTIor shall be tested at site as per CTI norms (for green buildings only). In case of multiple fans in cooling tower, HVAC contractor to provide a electrical panel for one incoming and multiple outgoings/ (including starters DOL/ Star delta / VFD as required) equal to number cooling tower fans. This panel shall be included in cooling tower rate.

12.3 INDUCED DRAFT COOLING TOWER

Cooling Towers shall be suitable for outdoor use. Tower shall be vertical, induced draft, counter/cross flow type. FRP / zinc Coated Steel (As described below) construction, in rectangular/ square /octagonal profile, complete with fan, motor, diffusion deck spray section, eliminators, steel supports, and sound attenuation equipment where called for in Schedule of Quantities.

For Zinc-Coated Steel Construction:

Components fabricated of zinc-coated steel shall be not lighter than 16 gauge steel, protected against corrosion by a zinc coating. The zinc coating shall conform to ASTM A153 and ASTM A123, as applicable and have an extra heavy coating of not less than 2-1/2 ounces per square foot (762 g per square meter) of surface. Galvanized surfaces damaged due to welding shall be coated with zinc rich coating conforming to ASTM D 520, Type 1. Bolts shall be cadmium-plated, zinc-coated steel, or Type 304 stainless steel. Each bolt shall be provided with neoprene and cadmium-plated steel washers under the heads. Nails shall be silicon bronze, commercial bronze, or stainless steel. Hardware shall meet the salt-spray fog test as defined by ASTM B117.

a. Capacity

The cooling tower capacities shall be as per the Drawings and Schedule of Quantities.

b. Side Casing

This shall be made out of FRP construction of minimum 5 mm thick and UV stabilized with smooth surface on both sides for minimum resistance to air flow. It shall have sufficient structural strength to adequately withstand high wind velocities and vibration. The casing may be installed in the reinforced cement concrete basin if so identified in drawings, or in Schedule of Quantities. The tower supporting structure shall be made out of hot dipped galvanized tubular frame. Air intake shall be all along the sides so that tower can be installed quite independent of prevailing wind direction. Anodized aluminium or PVC louvers integrated with fill UV stabilized PVC fill and backed up by galvanized bird screen / FRP Louvers shall be provided at air intake. Sufficient clearance between casing and adjoining structures shall be provided to enable servicing and periodic cleaning.

c. Cold Water Basin

Cold water basin shall be a min. 600 mm deep sumpand made out of 5 mm thick FRP construction and UV stabilized on which cooling tower super structure shall be supported. RCC suction tank with easily removable double brass strainers may be provided with this basin, if separately identified in drawings or in Schedule of Quantities. Basin shall be constructed and installed to ensure that air will not be entrained in outlets when operating and no water will overflow on shutdown. Each individual sump shall be provided with an individual outlet. Each outlet shall be provided with a 1/2-inch (13 mm) mesh, zinc-coated steel wire securely mounted to prevent trash from entering the outlet. Each basin shall be provided with overflow and valved drain connections. Each basin shall be provided with a float-controlled, makeup water valve as indicated. The makeup water shall discharge not less than 2 inches (51 mm) or two pipe diameters, whichever is greater, above the top of the basin.

Basin fittings shall include the following :

i. Bottom outlet.

ii. Screened suction assembly.

iii. Drain connected to the side / underside of basin.

iv. Overflow connected to the side of basin.

v. Built-in bleed off attached to inlet header discharging through polyethylene tube into overflow pipe.

vi. Ball type automatic make up water valve.

vii. Quickfill connected to the side of basin.

viii. Equalizing connection and balancing valve for multiple CTs.

d. Distribution System

Hot water distribution system shall comprise of header and branch arms system or open pan gravity flow system.

e. Filling

Fillings shall be made of corrosion proof and rigid PVC film in honey comb design and arranged in square / rectangular form. Fill sheets shall be suspended from H.D.G steel structural tubing supported from the lower structure & shall be elevated above the floor of the cold water basin to facilitate cleaning and easy replacement. They shall be arranged in such a manner to ensure negligible resistance to air flow and to eliminate back water spots and prevent fouling through scales that may form. In order to reduce carry-over losses through entrainment of moisture drops in air stream, PVC drift eliminator shall be installed.

f. Mechanical Equipment

The tower shall be provided with low speed fan running at less that 360 RPM through gear reducer. Direct driven fan speed shall not exceed 700 RPM. Fan shall be of the propeller type light-weight rotor fitted with multiple aerofoil blades. The entire fan assembly shall be statically and dynamically balanced. Fan shall be driven by 415±10% volts, 3

phase, 50 cycles, AC supply, energy efficient motor totally-enclosed, fan-cooled, weather-proof construction, designed and selected to operate in humid air stream. Fan shall be protected by a fan guard and bird screen of galvanized steel construction to prevent birds from nesting during idling period & shall be easily accessible for inspection and maintenance. A service ladder (Aluminium construction) shall also be provided for greater convenience. The mechanical equipment assembly shall be adequately supported on a rugged steel base welded to tubular support assuring vibration-free support. Fan guard and bird screen (of galvanized steel construction) shall be provided to prevent birds from nesting during idling periods. Gear-reducer shall be of spiral bevel type. G.S.S canopy shall be provided over the fan motor for protection against rain water. Care shall be taken that fan air is not restricted. Motor terminal box shall be made water tight.

12.5 PERFORMANCE DATA

Complete performance ratings and power consumption at varying loads and outdoor wet bulb temperatures, shall be submitted and verified at the time of testing and commissioning of the installation.

12.6 TESTING

Capacity of the cooling tower shall be computed from the measurements of water flow, incoming/outgoing water temperatures and ambient air wet bulb temperature using accurately calibrated mercury-in-glass thermometers. Computed ratings shall conform to the specified capacities and quoted ratings. Power consumption for cooling towers shall be computed from measurements of incoming voltage and input current.

13. FANS

13.1 SCOPE

The scope of this section comprises the supply, erection, testing and commissioning of centrifugal, in-line and propeller type fans and roof mounted units conforming to these Specifications and in accordance with the requirement of Drawings and Schedule of Quantities.

13.2 TYPE

Centrifugal, in-line propeller fans and roof mounted units shall be of the type as indicated on Drawings and identified in Schedule of Quantities.

13.3 CAPACITY

The air-moving capacity of fans shall be as shown on Drawings and in Schedule of Quantities.

CENTRIFUGAL FAN

Centrifugal fans will be of the type specified on the Drawings. No more than two centrifugal fans will be driven on a common shaft. Backward curved centrifugal fans with aero foil section blades will be used all systems incorporating variable speed control or requiring a total fan static pressure in excess of 1.0Kn/m2. Fan impellers will be both statically and dynamically balanced. Centrifugal fan scrolls will be constructed of zinc coated or galvanized mild steel with angle stiffeners and base angles to ensure freedom from drumming and the construction will be suitable for continuous operation at the maximum ratings published by the manufacturer. Double inlet double width fans will have a bearing on each side of the fan which will be pedestal mounted on fans above 200mm diameter impellers. Forward curved centrifugal fan impellers will be constructed of galvanized mild steel blades welded or riveted to spiders of robust cast aluminum alloy or welded steel. Shaft bearings for all single inlet centrifugal fans will be twin bearings mounted on a common pedestal. Lubrication of bearings will be in accordance with the manufacturer's recommendations and bearings requiring regular lubrication service will have lubrication nipples extended to a convenient location outside the fan casing and will incorporate an oil reservoir where applicable. After installation and before running all fans will be checked for misalignment and the presence of foreign bodies or matter in the fan casings and any such faults will be rectified.

Wall Mounted Extract fan (EF/WM)

Through the wall extract fans will be provided and located as indicated on the Contract Drawings and of the duties specified on these drawings. Extract fans will be from a reputed manufacturer with plastic based blades and shaded pole induction type motor having self align sealed life lubricated bearings and oil impregnated porous bronze bushes with oil reservoir. The fans will incorporate a method of fixing to encourage ease of maintenance or removal of the fan unit only, enabling the frame to remain in position in the wall. The motor will be complete with in-built thermal cut-out. The fans will be complete with intake grille and discharge grille. The on/off switch will be complete with switch and run indicator.

Ducted Axial Extract Fan (EF/DAX)

Duct mounted centrifugal/axial flow extract fans will be provided as detailed on the Contract drawings as specified herein. The fans will be single speed constructed of galvanized steel or fire retardant polyamide glass fibre impregnated material. The motor will be complete with in-build thermal cut-out.

Ceiling Mounted Toilet Extract Fans (EF/CM)

Where indicated as Ceiling Mounted Type, the fan will be complete with extract fan and extract grille in-built to the unit. The exhaust air will be ducted and discharged to outside as shown on the Drawings. The motor will be thermally protected and supported to the assembly through resilient mounting to reduce the transmission of vibration. The fan will be switched on/off by a wall mounted switch with “on” indicator.

Twin Type Toilet Extract Fan Units-(EFU-TWT)

The fan unit will be Twin Fan type suitable for duty standby operation. Twin fan casing is manufactured from heavy gauge galvanised steel suitable for internal mounting. The casing can also be supplied in mill finish aluminium. All casings have full size removable bottom access panel with quick release clamps for ease of servicing. The twin fan assembly comprises of two centrifugal forward curved blowers each running in an individual scroll with separate motor. The fans discharge into a common plenum and each fan is fitted with aluminium gravity non-return dampers as standard to prevent recirculation of air through the standby fan or during system shut down periods. Rectangular inlet and outlet spigots are standard. Single phase 220-240 Volts-50 Hz capacitor start and run. Three phase 380-415 Volts-50 Hz. All motors are fitted with Standard Thermal Overload Protection (STOP) to prevent motor damage by overloading / overheating. The fans are supplied completely factory prewired from motors and air flow switches, mounted inside the fan casing, to an IP55 terminal supplied with all models, ensuring suitability for external use. The standard auto changeover controllers provide fans with automatic duty sharing every 10 hours by means of integral electronic timer. During the run mode if any fan develops fault, the system automatically switches ‘ON’ the standby fan and indicates a fault signal on the panel. The fire retardant polypropylene panel casing is protected to IP55 and includes ‘RUN’ & ‘FAIL’ indications for both fans along with power ‘ON/OFF’ switch. The fans are AMCA tested as per AMCA Standard 210-85 for Air Performance Test and AMCA Standard 300 for Sound Test and the factory to hold BS EN ISO 9002 : 1994 certification. The fanunits located outside or specified as Weatherproof, will be manufactured to suit outside conditions in Oman. BMS – Provision will be provided in the control system for the BMS connection to switch on/off and Run/Fault indication as detailed in the Data Point Schedule.

13.5 AXIAL FLOW FAN

Fan shall be complete with motor, motor mount, belt driven (or direct driven) and vibration isolation type, suspension arrangement as per approved for construction shop drawings.

a. Casing : shall be constructed of heavy gage sheet steel. Fan casing, motor mount and straightening vane shall be of welded steel construction. Motor mounting plate shall be minimum 15 mm thick and machined to receive motor flange.

An inspection door with handle and neoprene gasket shall be provided. Casing shall have flanged connection on both ends for ducted applications. Support brackets for ceiling suspension shall be welded to the casing for connection to hanger bolts. Straightening vanes shall be aerodynamically designed for maximum efficiency by converting velocity pressure to static pressure potential and minimizing turbulence. Casing shall be bonderized, primed and finish coated with enamel paint.

b. Rotor : hub and blades shall be cast aluminium or cast steel construction. Blades shall be die-formed aerofoil shaped for maximum efficiency and shall vary in twist and width from hub to tip to effect equal air distribution along the blade length. Fan blades mounting on the hub shall be statically and dynamically balanced. Extended grease leads for external lubrication shall be provided. The fan pitch control may be manually readjusted at site upon installation, for obtaining actual air flow values, as specified and quoted.

c. Motor: shall be energy efficient squirrel-cage, totally-enclosed, fan cooled, standard frame, constant speed, continuous duty, single winding, suitable for 415±10% volts, 50 cycles, 3 phase AC power supply, provided with class `F' insulation. Motor shall be specially designed for quiet operation. The speed of the fans shall not exceed 1000 RPM for fans with impeller diameter above 450 mm, and 1440 RPM for fans with impeller diameter 450 mm and less. For lowest sound level, fan shall be selected for maximum efficiency or minimum horsepower. Motor conduit box shall be mounted on exterior of fan casing, and lead wires from the motor to the conduit box shall be protected from the air stream by enclosing in a flexible metal conduit.

HP	**POWER FACTOR**			**EFFICIENCY**		
	FL	**3/4L**	**1/2L**	**FL**	**3/4L**	**1/2L**
0.50	0.71	0.62	0.50	73.00	73.00	68.00
0.75	0.74	0.64	0.50	78.00	78.00	70.00
1.00	0.76	0.67	0.55	82.50	82.50	77.00
1.50	0.77	0.70	0.57	83.80	83.80	80.00
2.00	0.77	0.70	0.57	85.00	85.00	81.00
3.00	0.82	0.74	0.60	86.40	86.40	84.00
5.00	0.82	0.78	0.63	88.30	88.30	86.00
7.50	0.85	0.80	0.71	89.50	88.50	88.00
10.00	0.86	0.83	0.76	90.30	90.30	89.00
12.50	0.84	0.82	0.73	90.50	90.50	88.00
15.00	0.85	0.83	0.76	91.50	91.50	89.50
20.00	0.85	0.83	0.76	92.20	92.20	91.00
25.00	0.85	0.82	0.76	92.40	92.40	91.00
30.00	0.85	0.80	0.72	92.80	92.80	92.00
40.00	0.86	0.85	0.80	93.20	93.20	91.00
50.00	0.87	0.85	0.77	93.60	93.60	91.60
60.00	0.88	0.86	0.78	93.90	93.90	91.90
75.00	0.87	0.85	0.78	94.20	94.20	92.80

d. Drive : to fan shall be provided through belt drive with adjustable motor sheave and standard sheet steel belt guard with vented front for heat dissipation. Belts shall be of oil-resistant type.

e. Vibration Isolation : The assembly of fan and motor shall be suspended from the slab by vibration isolation suspension of heavy duty spring isolators type.

f. Accessories : The following accessories shall be provided with all fans :

i. Outlet cone for static pressure regain.

ii. Inlet cone.

Fan silencers may be provided where specifically called for in Schedule of Quantities. Fans shall be factory assembled and shipped with all accessories factory-mounted.

Axial Flow Fan shall be AMCA certified for Air and Sound performance in accordance to AMCA 210 and AMCA 300

Axial Flow Fan (for Fire,Smoke and Heat exhaust)

The fans shall be of the direct drive axial type with cast aluminum aerofoil propellers and shall be suitable for mounting in duct or floor/slab as required/indicated on the tender drawings. The casing shall be constructed of continuously welded steel and include integral punched inlet and outlet flanges to prevent air leakage and shall withstand 250 degree 2 hours. The casing and motor base shall be constructed and formed members of heavy gauge steel to prevent vibration and rigidly support the motor. Motor support brackets shall be welded to fan casing for increased strength. Motors for emergency fire, smoke and heat ventilation shall certified according to stand BS EN 12101-3:2002 for 250°C for 2 hours.

Blades shall be aerofoil design. Hub and blades shall be a high strength cast aluminum alloy and shall withstand 250°C for 2 hours. Blade pitch shall be manually adjustable without removing from the fan casing. Rotors shall be statically and dynamically balanced.

All Fan casing are with integral punched flanges for sizes up through size 1600mm dia and shall be constructed of rolled steel with a continuous seam weld. Casing to be coated with a minimum of 2 coats of high temperature paint or Powder coated after phospating process. Motor support framework to be constructed of structural steel that is suitable to handle the weights of the motor and propeller. Motor supports within the fan housing to be welded to the fan casing. Bolted construction is not acceptable. The impeller and fan casing shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

Complete Fan assembly (Fan Impeller, Fan Casing, Motor base frame along with Motor) shall be tested and in accordance with BS EN 12101-3:2002 standard for "Powered Smoke and Heat Exhaust Ventilators for Smoke Control Systems" for (250° C) temperature for 2 hours of operation.

13.6 PROPELLER FAN

Propeller fan shall be direct-driven, three or four blade type, mounted on a steel mounting plate with orifice ring.

a. Mounting Plate shall be of steel construction, square with streamlined venturi inlet (reversed for supply applications) coated with baked enamel paint. Mounting plate shall be of standard size, constructed of 12 to 16 gauge sheet steel depending upon the fan size. Orifice ring shall be correctly formed by spinning or stamping to provide easy passage of air without turbulence and to direct the air stream.

b. Fan Blades shall be constructed of aluminium or steel. Fan hub shall be of heavy welded steel construction with blades bolted to the hub. Fan blades and hub assembly shall be statically and dynamically balanced at the manufacturer's works.

c. Shaft shall be of steel, accurately ground and shall be of ample size for the load transmitted and shall not pass through first critical speed thru the full range of specified fan speeds.

d. Motor shall be standard (easily replaceable) permanent split capacitor or shaded pole for small sizes, totally enclosed with prelubricated sleeve or ball bearings, designed for quiet operation with a maximum speed of 1000 rpm for fans 60 cm dia or larger and 1440 rpm for fans 45 cm dia and smaller. Motors for larger fans shall be suitable for 415±6% volts, 50 cycles 3 phase power supply, and for smaller fans shall be suitable for 220 ± 6% volts, 50 cycles single phase power supply. Motors shall be suitable for either horizontal or vertical service as indicated on Drawings and in Schedule of Quantities.

e. Accessories : The following accessories shall be provided with propeller fans :

i. Wire guard on inlet side and birdscreen at the outlet.

ii. Fixed or gravity louvers built into a steel frame at the outlet.

iii. Regulator for controlling fan speed for single phase fan motor.

iv. Single phase preventors for 3 phase fans.

13.7 ROOF MOUNTED FAN

Roof mounted fan shall be propeller type or centrifugal fans, direct driven or belt driven as shown on drawing and in Schedule of Quantities, complete with motor drive, and housing with weather-proof cowl.

a. Housing: shall be constructed of 16 gage steel sheet. The housing shall have an adjustable flange to facilitate installation and shall be especially adapted to receive fan, motor, and drive. The housing shall have a low silhouette. For belt driven units, motor shall be installed in ventilated water proof housing outside the air stream. The discharge cowl shall be hinged along one edge for easy access to motor and drive, for inspection and maintenance. The entire assembly shall be weatherproof and raised from the roof terrace sufficiently to prevent downflow of rain water accumulated on the terrace. 18 gage galvanized steel mesh birdscreen shall be provided on all discharge cowls around the outlet area.

b. Fans : shall be backwardly inclined centrifugal wheel or propeller type as required, designed for maximum efficiency, minimum turbulence and quiet operation. Fan shall be statically and dynamically balanced.

c. Motor : shall be shaded pole, of split capacitor type with lubricated sleeve or ball bearings, designed for quiet operation. Bearings shall be designed for vertical mounting. Motor name-plate horse-power shall be such that the motor shall not be overloaded in the entire range of rated speed. Motor and fan assembly shall be easily removable. Motor power supply characteristic and maximum speed shall be as specified for propeller fans and as indicated in the Schedule of Quantities.

d. Fan Bearings : shall be heavy duty, self aligning sleeve/ball bearings designed for thrust load and sealed for grease retention.

e. Backdraft Damper : Where called for in the Schedule of Quantities, roof-mounted fan shall be equipped with a rattle-free backdraft damper to prevent air from re-entering the

fan when fan is not in operation, thus sealing completely in closed position. Damper shall be chatterproof under all conditions.

f. Vibration Isolation : The motor and fan assembly shall be isolated from the base with vibration isolators.

13.8 CAR PARK VENTILATION& SMOKE EXTRACTION FANS

13.8.1 System description and functional responsibilities

The contractor shall provide a turnkey car park ventilation system that is consistent with the scheme as indicated on the drawings. The proposed scheme utilizes Jet / Induction / Impulse fans with main intake and exhaust fans located along the perimeter of the car park. The system shall serve both CO evacuation and smoke extract function.

The contractor shall provide a full engineering proposal that includes the following information for review by the Engineer.

CFD models for the car park allowing 3 number runs each for CO and Smoke Extract mode.

Full bill of materials to be utilized in the system implementation.

Specification, manufacturer's data and performance data for all devices and equipment to be utilized in the system.

Control schematic for operation of the system.

All ancillary devices such as motorized dampers, silencers, smoke detectors, CO detectors, etc. that are required to ensure proper system operation in both the CO and smoke modes.

All necessary devices that are required to interface with the base building systems such as fire alarm and detection BMS etc.

The system principles are as follows:

Smoke control designed to provide such a much safer engineered system.
Fully automatic smoke control.
Lower the air temperatures during fires.
No ductwork distribution.
Improved fire fighting access.
High air movement preventing fire spread.
Efficient cross ventilation.

13.8.2 System description

The main extract fan shall be axial fans mounted in parallel. All fans shall be located close to risers as shown in the drawings. Jet / Induction / Impulse fans shall be located throughout car park level to assist in the air movement.

Under "normal" ventilation conditions, normal case running exhaust fans (equivalent to 12 ACPH) shall be ON. Also Jet fans shall be at lower speed. Jet fans can stop working if CO level drops below 20 PPM. If CO level increases above 35PPM, Jet fans shall run at higher speed, while normal working fans (12 ACPH) continue functioning. In case of fire, normal working fans (12 ACPH) + Fire fans (additional 18 ACPH) shall be ON, with Jet fans running at higher speed.

Fire / Smoke detection shall be based upon multi-criteria smoke detector which shall indicate the area in which the fire is located. Upon detection the main extract fans shall operate at full speed, increasing the airflow on the fire floor. The control system shall determine set of extract fans to be activated to contain the smoke.

The distribution and selection operation of these Jet / Induction / Impulse fans on the fire floor shall contain and channel smoke through an air corridor. The air corridor shall be created by the jet streams of the induction / impulse fans, and guided towards the extract point. The air velocity within the corridor shall be sufficient to overcome the buoyancy effect for a designed fire load as per BS / European codes.

All fans in car park and for smoke extraction shall be rated to withstand a temperature rating of 300^0C for a period of 1 Hour. The cable supplying the power to these fans shall also be fire rated. The entire fan including motor, terminals and incoming cables shall also be suitable for 300 deg C for a period of one hour.

The car park ventilation system shall be a stand alone life safety system. The control system shall be of the intelligent PLC type assuming control of both carbon monoxide and smoke evacuation

13.8.3 CO Detection

The car park ventilation systems shall be controlled by an individual CO-Monitoring system for entire car park located on each level to optimize efficiency. The contactors within the motor control panel shall be controlled by a Carbon Monoxide monitoring panel which shall contain DDCs (Direct Digital Controllers) where the pre-determined switching strategy and logic shall be loaded. The CO monitoring panel shall receive signals from CO sensors located throughout the levels at a spacing of no. more than 1 per 350 m^2. The 24Vac power supply for the CO sensors shall be mounted in the same panel. The power supply shall be looped across the CO sensors. The proposed CO sensor shall provide a 0-10 VDC signal for measuring the CO level in the car park area.

CO monitoring devices shall be mounted remotely throughout the car parks. The devices shall be mounted in accordance with the manufacturers guidelines but no greater than 1.5 m above FFL.

The contractor should refer to the specific requirements of the sensor supplier for quantities of CO-detectors.

13.8.4 CO Sensor

The sensor shall be suitable for wall mount & capable of following features:

Digital display of the CO level : 0 to 200 ppm
Analog output : 4 to 20 mA / 0-10VDC
Low Voltage operation : 24 VAC / VDC
Wall Mount Configurations
Test Switch : Provides mode for system self test.
Automatic Calibration (Field Calibration Kit)
Over-range indication.
Start-up mode : steps display and output through test ranges.
Solid – Stat sensor : Life expectancy of 7 to 10 years.
Multiple sensors with one power supply.

Carbon monoxide sensor shall comprise of a carbon monoxide meter and a 4-20mA/ 0-10 VDC transmitter an all electronic system that utilizes a microprocessor to measure carbon monoxide (CO) levels, calculate various calibration factors and analog output. The sensor shall averages samples over a time period and updates the output every 2 ½ minutes. The sensor shall be intended to be used in enclosed parking garages, where it provides CO data to building automation computers or

controllers. A UL knockout box shall house the sensor and provide an easy-to-mount, study housing for the system.

Sensors shall be mounted on walls or columns about 1600 mm above the floor.
Sensors shall be evenly spaced and not put in corners, or directly in front of air inlets.
Each sensor must have a cable directly to the control panel.
In addition to above CO-sensor shall comply with following :

Power	24 VAC / VDC @ 150 mA
Colour	Gray
Measurement range	0 to 200 ppm of CO (4-20 mA)
Electrical class	General Purpose, non-hazardous.
Operating temperature range	0 deg. To 125 deg.F (-18 deg. To 52 deg.C)

13.8.5 Fire / smoke detection

The car park ventilation system shall be designed based on 30 ACPH in fire mode.

The car park ventilation system shall interface with the fire alarm control panel to receive signals from the detectors.

The Contractor shall be responsible for the full integration of the fire alarm and car park ventilation control systems.

13.8.6 Control Panels

The manufacturers engineered solution shall allow for a stand alone intelligent PLC control system for both CO monitoring and smoke control. Each car park shall have individual PLC Control Panel. The PLC control system shall be seperate for each level of entire car parking and shall control all exhaust & jet fans located on each level. The broad logic shall be as follows:

PLC based Logic panel shall be provided to receive signals from the Carbon Monoxide Detector panel and the Fire Control Panel which will contain DDC (Direct Digital Controller) to give command to Jet and Exhaust fans for their operation on the basis of the logic provided to the PLC panel as shown below:-

Condition 1 :Under normal ventilation condition, air shall be drawn through all parts of the car park by the Axil fans (operating at low speed) at a rate equivalent to 12 air changer per hours.

Condition 2: When the CO level rise beyond 25 ppm the Jet fan shall start at low speed.

Condition 3: If the CO level continue to rise to the high limit set value to 35 ppm, the Jet fans and extract fans shall operatre at high speed to provide a rate equivalent to min. 12 air changes per hour.

Condition 4: In the event that Smoke is detected in the car park a priority Signal shall be provided by the fire detection panel which shall switch the car park ventilation system to smoke extract mode. The Jet fan will be started at high speed in order to dilute the dense smoke and smoke extract fans shall operate at full speed.

13.9 PERFORMANCE DATA

All fans shall be selected for the lowest operating noise level. Capacity ratings, power consumption, with operating points clearly indicated, shall be submitted and verified at the time of testing and commissioning of the installation.

13.10 TESTING

Capacity of all fans shall be measured by an anemometer. Measured air flow capacities shall conform to the specified capacities and quoted ratings. Power consumption shall be computed from measurements of incoming voltage and input current.

16. PIPING

16.1 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. All welders used for piping erection shall be well qualified (certificate should be submitted to Project Manager for approval) and shall have minimum 8 to 10 years experience.

16.2 PIPE SIZES

Pipe sizes shall be as required for the individual fluid flows. Various pipe sizes have been indicated on the Drawings, these are for Contractor's guidance only and shall not relieve contractor of responsibility for providing smooth noiseless balanced circulation of fluids.

16.3 CHILLED, HOT AND CONDENSING WATER PIPING

Following material shall be used for pipes and fittings.

Pipes Nominal size (mm)	**Material Specification**
≤150	IS 1239 Part-1
200 and above	IS 3589 Gr. FE 410 (8mm thick)
Fittings Nominal size (mm)	**Material Specification**
≤40	Socket welded, ASTM A105 as per ANSI B16.11
50-150	Butt welded, ASTM A234 Gr. WPB as per ANSI B16.11
≥200	Site fabricated from IS 3589 Gr. FE 410 (8mm)
Flanges Nominal size (mm)	**Material Specification**
≤ 150	IS 2062 Gr.Aas per ANSI B16.5 (#150 class)
≥200	IS 2062 Gr.A, as per ANSI B16.5 (#150 class)

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 BIS Code of practice for manual metal arc, welding of Mild Steel.

b. All welded joints (except pipe welded end-to-end) shall be made by use of one-piece welding flanges, caps, nozzles, elbows, branch outlets and tees of approved make. Cut samples shall be submitted for approval, if directed. All such fittings etc., shall be of a type which maintain full wall-thickness at all points, simple radius and fillets, and proper bevels or shoulders at ends. All job welding shall be done by the electric arc welding process in accordance with the following :

- All joints shall have 45 degree bevel type, pipe mill-bevelled or machine-bevelled by the contractor.
- All scale and oxide shall be removed with hammer, chisel or file and bevel left smooth and clean.
- Pipe lengths shall line up straight with abutting pipe ends concentric.
- Both conductors from the welding machine shall be extended to locations at which welding work is being done. The leads from welding machine to location of welding

work shall be held together with tape or other approved means so as to prevent induced current in structural steel, in piping or in other metals within the building. The ground lead shall be connected to length of pipe through joints in pipe, structural steel of building or steel pipe supports.

c. All pipes and their steel supports shall be thoroughly cleaned and given one primary coat of red oxide paint before being installed. For vibration isolators premoulded polyurethane pipe sections of 160 Kg/m^3density with adhesive shall be fixed between pipe and MS support. 10 mm thick MS 'U' clamp with resistoflex shall be fixed on the pipe so that the pipe is kept in position. All welded piping shall be subject to the approval at site.

d. Fittings shall be malleable casting of pressure rating suitable for the piping system. Fittings used on welded piping shall be of the weldable type. These shall form part of piping and are not separately identified in Schedule of Quantities.

e. 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.

f. Ball and butterfly valves conforming to the following specifications shall be provided as shown on Drawings :

Size	Construction	Ends	Type
15 to 25mm	Bronze ASTM B62	Screwed	Ball
32mm and over	Body Cast iron,	Wafer	Butterfly

Type and requirements shall be as indicated in Schedule of Quantities. Valves shall have non-rising spindles unless specified otherwise and shall be suitable for PN 16 rating. Butterfly valve should be of wafer type long neck construction single stem design with centre lugs to ensure proper alignment of pipe flanges. Mount valve onto flanges only after flanges have been welded to pipes using a tool piece and cooled down to room temperature to prevent damage to resilient seat. The rubber liner should be fully supported by the valve flanges. Appropriate dimensions and thickness of Flanges and Bolts, as per the Flange Tables *ANSI B16.5 (#150 class)*, should be used. The flanges should be properly aligned with each other so that bolts are exactly perpendicular to the flanges.Evenly tighten the flange bolts to secure the valves. Counter flanges with nut-bolts and gaskets shall be provided by valve manufacturer.

g. Butterfly valves shall perform the function of isolating valves and shall be suitable for PN16 rating.Butterfly valves shall have Epoxy Coated cast iron body with Integrally moulded EPDM liner of replaceable type. The liner shall be integrally moulded on hard backup ring and shall be suitable for PN16 rating unless specified otherwise. All butterfly valves shall be provided with locking devices. Valves 250 mm and above dia shall be gear driven.

h. Automatic balancing valves shall automatically control flow rates with + 5% accuracy. Valve control mechanism shall consist of a stainless steel cartridge with a ported cup and coil / helical spring to avoid corrosion. Four operating ranges shall be available with the minimum range requiring less than 14 kPa to actuate the mechanism. Manufacturer shall provide independent laboratory tests verifying assurance of performance.

i. Balancing cum control valves shall be sized based on flow rates and pressure drops across cooling coil.

j. Manual double regulating balancing valves shall be provided at chiller, condenser, various tapp-offs and each AHU outlet line as indicated in Schedule of Quantities. These valves shall have built-in pressure-drop measuring facility to compute flow rate across the valve. The test cocks shall be long enough to protrude out of pipe insulation. To enable accurate and practical operation, measurement of flow and differential pressure shall be made with a computerised balancing instrument which shall enable the operator to read the flow directly without the use of diagrams or tables. In addition to measuring flowrate, differential pressure and temperature, computerised balancing instrument shall have a computer programme to provide the following functions:

i. To balance the HVAC installation and calculate the necessary valve settings, based on system measurements.

ii. To store the results of balancing.

iii. To log measured values from a valve (differential pressure, flowrate or temperature).

iv. To printout saved data in computerised measurement protocol (CMP) consisting of :
- Name and size of Balancing Valve (BV)
- Presetting position of BV
- ΔP at BV
- Flow at BV
- Design Flow

k. The supply of flanges shall form part of piping (not separately identified in Schedule of Quantities) and shall also include supply of bolts, washers, nuts and suitable asbestos fibre / rubber insertion gaskets (minimum 3 mm thick). Flanges shall be as per ANSI B16.1 class 150#.

l. All ball valves and ball valves with Y strainer shall be bronze forged body construction with chrome plated bronze ball and handle of stainless steel constructions. These are separately identified in Schedule of Quantities.

m. Non return valves shall be dual plate check valve provided as shown on the Drawings, and identified in Schedule of Quantities conforming to relevant Codes and in accordance with the following Specifications :

Size	Construction	Ends
40 to 300 mm	**Body:** Grey Cast iron (Epoxy Coated), *CI IS 210 Gr. FG 260* **Plates:** CF-8 (SS-304), **Hinge/Stop Pin:** SS-410 **Spring(s):** SS-316. **Seal:** EPDM	Flanged
350 mm to 500 mm	**Body:** Grey Cast iron (Epoxy Coated), *CI IS 210 Gr. FG 260* **Plates:** SS-409.	Flanged

Hinge/Stop Pin: SS-410
Spring(s): SS-316.
Seal: EPDM

The spring and hinge/stop pin shall be SS304 and bearing PTFE material. Valves shall be PN 16 rating.

n. Strainers shall be 'Y' type or Pot Strainer suitable for PN 16 rating as shown on drawings and included in BOQ. 'Y' Strainer shall be fabricated out of MS 'C' class pipe two sizes higher than that of Strainer pipe size. Flanges as per *ANSI B16.5 (#150 class*)shall be provided at inlet and outlet connectors. The body shall be hot dip galvanized. Permanent magnet shall be provided in the body of the Strainer to arrest MS particles. Filter element shall be of non magnetic 20 gage SS sheet with 3 mm perforation. Cartridge having five different type of filters made out of SS 304 with different mesh sizes shall be provided. These will be replaced so as to get good quality of water in system during commissioning. Strainers shall be provided at inlet of each Air Handling Unit and Pump as shown in drawings and included in SOQ.

Pot Strainers body shall be fabricated out of MS plate IS 226. Thickness of sheet shall be as per size of the strainer chamfered pipes with flanges shall be provided at inlet /outlet connections of the strainer. The tangential entry of water shall create a centrifugal action and due to velocity shall separate sediments and deposit on the inner surface of Filter Element and at bottom of the Strainer. Butterfly valves shall be provided at inlet / outlet connections as shown in drawing and included in BOQ. The strainer body shall have two separate chambers properly sealed to avoid mixing of filtered and unfiltered water. A powerful magnet shall be provided in the body to arrest MS particles. Filter element of Pot Strainer shall be of non magnetic 18 gage SS sheet properly reinforced to avoid damage of the element. A cone with sufficiently large drain pipe with butterfly valve shall be provided at the bottom chamber to flush-out foreign particles. This arrangement shall avoid frequent opening of Pot Strainer for cleaning of filter element. Gage connection shall be provided at inlet and outlet connection.

Pot strainers shall be provided with automatic backwash system if called for in SOQ. This shall be with heavy duty reduction gear motor provided at top of upper lid. During backwash, motoriseddrain valve shall be opened along with vent cock. Power supply cabling with tray shall be included in cost of pot strainer. Entire operation shall be through BAS.

A set of MS flanges with tongue and groove arrangement and neoprene rubber gasket shall be provided on the top cover and Pot Strainer flange with sufficient bolts and nuts to make the joint water light. Bearing loaded tope cover lifting and swinging arrangement shall be provided. The Pot strainer body shall be properly de-rusted and epoxy coated from inside and outside. Manufacturers Test Certificate shall be provided with each Pot Strainer..

Size of various Pot Strainer, Filter Element and Thickness of MS sheet shall be as under:

Pipe size (mm)	Pot Dia (mm)	Pot HT (mm)	Element Dia (mm)	Element HT (mm)	MS Plate Thickness (mm)
50	300	400	200	240	6
80	350	450	250	250	6
100	450	500	300	280	6
125	500	600	330	340	8
150	540	700	360	390	8
200	610	815	400	470	8
250	800	955	550	510	8

300	1000	1105	750	580	8	
350	1190	1300	895	678		12
400	1350	1500	1020	785	12	
450	1518	1700	1060	890		12
500	1690	1800	1100	900	12	
600	2000	2200	1500	1160	12	

Each Port strainer shall be provided with a Test Certificate.

o. All chilled water piping &fittings, chilled water pumps, expansion tank and Air separator shall be pressure tested, painted and then insulated as described under the section "Insulation".

p. Groovedcoupling :Grooved coupling shall have 3 main parts viz. Housing, Gasket and bolting arrangement. Housing shall be made out of ASTM-A 536 Grade 65-45-12. The housing key shall engage into the grooves around the full pipe circumference, securing the pipe ends together with positive grip. Housing shall be designed to provide optimum combination of pressure, stress relief and end load conditions while maintaining reasonable weight. Gasket shall be of high sealing efficiency and shall be able to withstand upto (-) 0.35 Bar pressure. Bolt shall confirm to ASTM A183, while nut shall confirm to ASTM A194. Nut-bolt shall be electro-galvanized.

16.4 Pressure independent balancing cum control valves

Each Air Handling Unit / Fan Coil Unit shall be provided with 2/3Way Pressure Independent Balancing Cum Control Valve with Integrated in a single Body with Globe Type in Construction as indicated in BOQ.

Control - Valve should be equipped with electronic modulating actuator which can accept either 4(0)-20 mA / 2(0)-10 V DC signals. Operating voltage for actuator shall be 24V AC. Delta p controller should ensure 100% valve authority at all loads (part load Actuator shall be able to work against maximum closing pressure of 6 Bar at full load). With feedback signal to Control system. 230/24V transformer shall be included.

Balancing – Each Valve should have steeples adjustable maximum flow limitation as per the designed flow rate of coils. Balancing should be done only in Valve not in actuator so that at any given condition of failure balancing is not lost and easily accessible.

All Valve actuator shall be microprocessor based with self calibrating feature.
Valve should be of linear control characteristics with stepless characteristics.

VALVE SPECIFICATIONS

Discription	**For 15 to 32 mm**	**For 40 to 150 mm**
Diff Pressure (P1-P3)	16 To 400 kPa	35 To 600 kPa
Media Temperature	+1 ° to 110 °C,	-10 ° to 120 °C,
Body Material	Brass	Grey iron/Ductile iron
Test Ports	Needle measuring nipple	Needle measuring nipple
Shut off Leakage	Max. 0.05% of Kvs	Max. 0.05% of Kvs
Stem Seals	EPDM	EPDM
Maximum Close Off Pr	Minimum Should be 400 kPaD,	600 kPaD
Pressure rating	PN16 or above	PN16 or above

ACTUATOR SPECIFICATIONS FOR ALL SIZES

Supply Voltage **:** 24V AC (230/24 Transformer shall be included)
Power Consumption **:** 10V AC Max.
Frequency **:** 50 HZ
Control Input **:** 2-10V DC, 4-20mA, 3-point Selection.
Position Output **:** 2-10V DC 4-20mA
Body Housing Insulation **:** Non Corrosive - IP 40 or above

Valve Body and Characteristics:-

1. Pressure Controller Device should maintain the Pressure, irrespective of fluctuations in the system with the help of a self adjusting diaphragm.
2. Control valve shall accurately control the flow, with help of Modulating Actuator
3. All Valve Sizes should have Testing Ports for verifying the flow with respect to the Differential Pressure.

Valve Actuator and Housing:-

1. Control/Dip Switch Setting should be easy to access for doing the balancing at site.
2. The valve should be mounted with the actuator above the valve to prevent condensation water leaking into the actuator.

Valve Flow Balancing :

1. Balancing & Control: Balancing should be accomplished by the Diaphragm and Control should be taken care by Actuator receiving signals from Room Thermostats or BMS.
2. Manual Override facility shall be provided to either open or close the valve.
3. Flow Setting Balancing (Commissioning) for the Valves should be simple and not require measuring devices.
4. Proper operation of the valve should not be dependent on additional operations like de-airing of the valve or flushing procedures

16.5 Grooved Pipe Jointing System

A. References:

1. American Society for Testing Materials (ASTM)
   a. ASTM A-53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
   b. ASTM A-183 – Carbon Steel Track Bolts and Nuts
   c. ASTM A-234 – Standard Specification For Piping Fittings or Wrought Carbon Steel and Alloy Steel.
   d. ASTM A-449 – Quenched and Tempered Steel Bolts and Studs
   e. ASTM A-536 – Ductile Iron Castings
   f. ASTM F-1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

2. American Society of Mechanical Engineers
   a. ASME B16.9 – Factory Made Wrought Butt Welded Fittings
   b. ASME B31.1 – Chemical Plant and Petroleum Refining Piping
   c. ASME B31.9 – Building Services Piping

3. American Water Works Association
   a. AWWA C-606 – Grooved and Shouldered Joints

B. Quality Assurance

1. All grooved components (including couplings, fittings, valves and accessories) to be supplied by one manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

C. Grooved Mechanical Couplings for Joining Carbon Steel Pipe

1. Grooved Mechanical Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard Victaulic.

   a. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.
   b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three Couplings shall be placed in close proximity to the vibration source.

2. Flange Adapters: For use with grooved end pipe and fittings, for mating to ANSI Class 150 flanges.

3. Grooved couplings shall meet the requirements of ASTM F-1476.

4. Gasket: Synthetic rubber, wide width, conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

D. Grooved End Fittings: Fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.

1. Grooved Hole-Cut Branch Outlets:

   a. Bolted Branch Outlet: Branch reductions on 2"(DN50) through 8"(DN200) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.

   b. Strapless Outlet: 1/2"(DN15) or 3/4"(DN20) NPT outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

   c. Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

16.6 COLD WATER AND DRAIN PIPING

a. All pipes to be used for cold water (makeup), drain, condensate drain and fittings shall be GI / C-PVC as indicated in BOQ.

b. All jointing in the pipe system shall be by screwed joints and/or by screwed flanges using 3 mm 3 ply rubber insertion gaskets. Pipe threads and flanges shall be as per relevant BIS Codes.

c. All pipes supports shall be mild steel, thoroughly cleaned and given one primary coat of red oxide paint before being installed.

d. Fittings shall be galvanized steel `medium class' malleable casting of pressure rating suitable for the piping system. Flanges shall be of approved make. Supply of flanges shall include bolts, nuts, gaskets as required. Sufficient number of flanges and unions shall be provided for future cleaning and servicing of piping. Tee-off connection shall be through equal or reducing tees. All equipment and valve connections, or connections to any other mating pipes shall be through flanges required for the mating connections. Fittings & flanges shall form part of piping and are not separately identified in Schedule of Quantities.

e. Gate valves, globe valves, check valves and strainers shall be similar to those specified for chilled, condensing and hot water piping.

f. For proper drainage of AHU Condensate, 'U' trap shall be provided in the drain piping.

g. All condensate drain piping shall be insulated and painted as per the section "Insulation" as indicated in Schedule of Quantities.

16.7 REFRIGERANT PIPING

a. All refrigerant pipes and fittings shall be hard drawn copper tubes and wrought copper / brass fittings suitable for connection with silver solder / phos-copper.

b. All joints in copper piping shall be sweat joints using low temperature brazing and / or silver solder. Before jointing any copper pipe or fittings, its interiors shall be thoroughly cleaned by passing a clean cloth via wire or cable through its entire length. The piping shall be continuously kept clean of dirt etc. while constructing the joints. Subsequently, it shall be thoroughly blown out using carbon dioxide / nitrogen.

c. Refrigerant lines shall be sized to limit pressure drop between the evaporator and condensing unit to less than 0.2 kg per sq.cm.

d. Sight glass with moisture indicator and removable type combination dryer cum filter with MS housing and brass wire mesh / punched brass sheet shall be installed in liquid line of the refrigeration system incorporating a three valve by pass. After ninety days of operation, liquid line drier cartridges shall be replaced.

e. Heat exchanger shall be MS heavy duty pipe in pipe type and without any joint in the inner pipe.

f. Horizontal suction line shall be pitched towards the compressor and no reducers shall be provided for proper oil return.

g. After the refrigerant piping installation has been completed, the refrigerant piping system shall be pressure tested using Freon mixed with nitrogen / carbondioxide at a pressure of 20 kg per sq. cm (high side) and 10 kg per sq. cm (low side). Pressure shall be maintained in the system for a minimum of 12 hours. The system shall then be evacuated to a minimum vacuum of 70 cm of mercury and held for 24 hours. Vacuum shall be checked with a vacuum gage.

h. All refrigeration piping shall be installed strictly as per the instructions and recommendations of air conditioning equipment manufacturer.

16.8 PIPING INSTALLATION

a. Design Drawings indicate schematically the size and location of pipes. The Contractor, on award of the work, shall prepare detailed shop drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in the building through which pipes are designed to pass.

Pipe shall be cut only with hack saw blades and welding rods shall not be used for this purpose. All the pipes shall be cleaned and applied with one coat of Zinc chromate primer.

b. 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.

All pipes in HVAC plant room shall be supported with pipes and channels from floor only with necessary PUF pipe supports and resistoflex sheet.

c. Pipe supports shall be of steel, adjustable for height and Zinc chromate primer coated 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	Rod Size
Upto 12 mm	1.5 Meter	10 mm
15 to 25 mm	2.0 meter	10 mm
30 to 150 mm	2.0 meter	10 mm
Over 150 mm	2.5 meter	12.5 mm

d. Vertical pipes passing through floors shall be plumb and parallel to wall. Pipes shall be supported on alternate floor. MS cleats shall be wleded on pipes and rest on MS channel placed on the floor with 15 mm thick resistoflex pads between the cleat and channel. U clamps with resistoflex sheet shall be provided to keep the pipe in position.

e. Bull heading in water/refrigerant piping shall be avoided.

f. Pipe sleeves atleast 3 mm thick, 50 mm / 100 mm larger in diameter than condenser / chilled water pipes respectively shall be provided wherever pipes pass through **retaining** wall and slab. Annular space shall be filled with fibreglass and finished with retainer rings welded on the ends of the sleeve.

g. Wherever pipes pass through the brick or masonry / slab openings, the gaps shall be sealed with **fire sealant** such as fire barrier caulks.

h. Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 20 gage metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending atleast 15 cm on both sides of the clamp, saddles or roller.

j. All piping work shall be carried out in a workmen like manner, causing minimum disturbance to the existing services, buildings and structure. The entire piping work shall be organized, in consultation with other agencies work, so that laying of pipes, supports, and pressure testing for each area shall be carried out in one stretch.

k. Cut-outs in the floor slabs for installing the various pipes are indicated in the Drawings. Contractor shall carefully examine the cut-outs provided and clearly point out where the cut-outs shown in the Drawings do not meet with the requirements.

l. The Contractor shall make sure that the clamps, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

m. All pipes shall be accurately cut to the required size in accordance with relevant BIS Codes, edges bevelled 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.

n. Flanged inspection pieces 1.5 meters long, with bolted flanges on both ends, shall be provided no more than 30 meters centres, or where-ever shown in Approved-for-Construction shop drawings, to facilitate future cleaning of all welded pipes.

o. All buried pipes shall be cleaned and coated with zinc chromate primer and bitumen paint, and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters and wrapped with three layers of fibre glass tissue, each layer laid in bitumen.

p. Insulated buried pipes shall be cleaned, derusted, then coated with Zinc chromate primer and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. Insulation shall be applied as per the section "Insulation", wrapped with GI wire and covered with polyethylene sheet. Two coats (each 6 mm thick) of cement plaster shall be applied over chicken wire mesh lath. Where indicated in Schedule of Quantities, buried insulated pipes shall be water-proofed using coat of Shalibond, or approved adhesive, over the plastered surface; wrapping one layer of fibre glass RP tissue and one layer of roofing tarfelt with sufficient overlaps, set and sealed with the adhesive, held in position by 16 gage G.I wire tied at 15 cm intervals.

q. Auto purge valves shall be provided at all highest points in the piping system for venting air. Air valves shall be 15 mm pipe size with screwed joints.

Discharge from the air valves shall be piped through an equal sized mild steel or galvanized steel pipe to the nearest drain or sump. These pipes shall be pitched towards drain points.

16.9 PRE-INSULATED PIPES

Pre insulated pipes, as called for in schedule of quantities shall be sourced from the factory in length of minimum 6m. Metered dose of Polyurethane foam shall be injected in annular space between pipe OD and outer jacket to achieve average density of 36 Kg/m^3. After expanding, homogenous foam shall be formed between the cavity with no air gaps. Suitability of temperature range shall be from (-) 20^{0}C to 120^{0}C.
Outer jacket shall be of ALas indicated in schedule of quantities.

16.10 PRESSURE GAGES AND THERMOMETERS

a. Pressure gages as specified under section "Automatic Controls and Instruments" shall be provided at suction and at discharge of each pump, at chilled water supply and return at each air handling unit, at each chillers and condenser, and as shown on the Drawings and included in Schedule of Quantities. Care shall be taken to protect pressure gages during testing. Pressure gage sockets on insulated pipes and accessories shall be extended upto insulation to avoid damage of insulation for replacement of gages.

b. Thermometers as specified under section "Automatic Controls and Instruments" shall be provided at chilled water supply and return at each air handling unit, at each chiller and condenser, and as shown on Drawings and included in Schedule of Quantities.

c. Thermometers on CHW lines shall be with long stem. Thermometer socket shall be extended upto insulation thickness so that the thermometer shall be removable without damaging the insulation.

16.11 TESTING

a. During construction , the contractor shall properly cap all lines, so as to prevent the entrance of sand, dirt, etc. Each system of piping shall be flushed thoroughly after completion (for the purpose of removing dirt, grit, sand etc. from the piping and fittings) for as long a time as is required to thoroughly clean the system.

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

d. Piping may be tested in sections and such sections shall be securely capped, then re-tested for the entire system.

e. 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.

f. The contractors shall provide temporary pipe connections to initially by-pass condenser/chiller and circulate water through condenser/chilled water pipe lines for minimum 8 hours. Water should be drained out from the lowest point. The temporary lines shall be removed and blanked with dead flanges. Pot strainers and Y strainers shall be cleaned and fresh water filled in the circuits.

g. 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. If proper circulation is not achieved due to air bound connection, 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 of floors and walls if required.

h. After the piping has been installed, tested and run for atleast three days of eight hours each, all insulated exposed piping in plant room shall be given two finish coats, 3 mils each of approved colour, conforming to relevant BIS Codes. The direction of flow of fluid in the pipes shall be visibly marked with identifying arrows. For painting of insulated and clad pipes refer to Insulation section.

j. After testing, all systems shall be chemically cleaned. Chemical cleaning shall be carried out in 3 stages. In first stage biological cleaning shall be done to remove algae, bacteria, SRB etc which produces slimes. Second stage is pre-cleaning in which loose rust, oil, and debris

are removed. Chemical addition and hold up time shall be as per chemical supply agencies recommendations.Third stage is passivation, in which chemicals will be added and passivation film will be formed over inside surfaces of piping system. Type of chemical used and quantity of the same along with detailed method statement shall be submitted by contractor before starting this activity.

Before handover Owner's site representative shall be provided with certificate of cleaning of pipe systems, signed by the contractor.

k. 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.

16.12 BALANCING

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

b. All balancing valves, Automatic control valves and two-way diverting valves shall be set for full flow condition during balancing procedure. Each water circuit shall be adjusted thru balancing valves provided for this purpose; these shall be permanently marked after balancing is completed, so that they can be restored to their correct positions, if disturbed.

c. Complete certified balancing report shall be submitted for evaluation and approval by Owner's site representative. Upon approval, four copies of the balancing report shall be submitted with the as-installed drawings and completion documents.

16.13 VALVE IDENTIFICATION

Provide 30 mm dia brass valve tag, with embossed letters and number for each valve and attach the tag to valve handle by "S" hook or by suitable means. Contractor shall provide valve tag schedule and valve chart for each piping system, consisting of schematic drawing of piping layout, along with a valve list, showing and identifying each valve by number, service and location and describing its function.

The contractor shall frame under glass in the airconditioning plant room or as directed by Owner's site representative two copies of valve chart. Two additional unmounted copies shall be supplied to the Owner's site representative.

Tags shall correspond with the valve schedule and record drawings. In back of house areas, where ceilings are installed and the valve or valve tag is not visible, a self adhering tag with the valve number shall be installed on the wall or directly under the ceiling. For public area ceiling valves, these tags are to be installed in the service corridor, leading to the public areas.

16.14 MEASUREMENT FOR PIPING

Unless specified otherwise, measurement for piping for the project shall be on the basis of centre line measurements described herewith.

Piping shall be measured in units of length along the centre line of installed pipes including all pipe fittings, flanges (with gaskets, nuts, and bolts for jointing), unions, bends, elbows, tees, concentric and / or eccentric reducers, inspection pieces, expansion loops etc. The above accessories shall be measured as part of piping length along the centre line of installed pipes, and no special multiples of pipe lengths for accessories shall be permitted.

The quoted rates for centre line linear measurements of piping shall include all wastage allowances, pipe supports including hangers, MS channel, PUF supports, nuts, check nuts,

vibration isolator suspension where specified or required, and any other item required to complete the piping installation as per the Specifications. None of these items will be separately measured nor paid for.

However, all valves (gate / globe / check / balancing / purge / butterfly / drain etc), strainers, thermometers, pressure gages shall be separately counted and paid as per their individual unit rates, which shall also include their insulation as per Specifications. Piping measurements shall be taken before application of the insulation.

Contractor shall get pressure testing of pipes/measurements etc verified by the Owners representative at site.

BUTTERFLY VALVE SERIES (forhandlever operated Valves)

Preinsulated Extended Neck Butterfly Valves With Manual Actuator, Extended Seat Lining Upto Contact Faces, With TSS Technology And Universal Fitment To Is, Bs, Din, Etc., And Using Integrally Reinforced Insulation Of Rigid Polyurathene Of 70 Density Min. Which Avoids Any Cladding Requirements, Insulation Which Aligns Exactly In Shape Of Valve To Aesthetically Appear In Shape Of Valves Only, With Pressure Rating Of PN.10,16,20 & 25 Along With Preinsulated Flanged Tail Piece Set Of Matching Diameters Consisting Of Two Nos For Convenient Connectivity And Having Arrangement Of Bare Portion Of Min. Length For Welding Purpose At The Ends.

Size starts from 40 mm.

BUTTERFLY VALVE SERIES (for Gear operated Valves)

Preinsulated Extended Neck Butterfly Valves With Gear Actuator, Extended Seat Lining Upto Contact Faces, With TSS Technology And Universal Fitment To Is, Bs, Din, Etc., And Using Integrally Reinforced Insulation Of Rigid Polyurethane Of 100 Density Min. Which Avoids Any Cladding Requirements, Insulation Which Aligns Exactly In Shape Of Valve To Aesthetically Appear In Shape Of Valves Only, With Pressure Rating Of PN. 10,16,20 & 25 Along With Preinsulated Flanged Tail Piece Set Of Matching Diameters Consisting Of Two Nos For Convenient Connectivity And Having Arrangement Of Bare Portion Of Min. Length For Welding Purpose At The Ends.

VALTREE BALANCING VALVE SERIES (forHandwheel Operated Valves)

Preinsulated Balancing Valves With Manual Handwheel Actuator, With Nozzle Ports Of Cf8/Cf8m/Ltb With Universal Fitment To Is, Bs, Din, Etc., And Using Integrally Reinforced Insulation Of Rigid Polyurathene Of 100 Density Min. Which Avoids Any Cladding Requirements, Insulation Which Aligns Exactly In Shape Of Valve To Aesthetically Appear In Shape Of Valves Only, With Pressure Rating Of PN.10,16,20 & 25 Along With Preinsulated Flanged Tail Piece Set Of Matching Diameters Consisting Of Two Nos For Convenient Connectivity And Having Arrangement Of Bare Portion Of Min. Length For Welding Purpose At The Ends.

DUAL PLATE CHECK VALVE SERIES

Preinsulated Dual Plate Check Valves, With TSLP Technology And Universal Fitment To is, Bs, Din, Etc., And Using Integrally Reinforced Insulation Of Rigid Polyurethane Of 100 Density Min., Which Avoids Any Cladding Requirements, Insulation Which Aligns Exactly In Shape Of Valve To Aesthetically Appear In Shape Of Valves Only, With Pressure Rating Of PN. 10,16,20 & 25 Along With Preinsulated Flanged Tail Piece Set Of Matching Diameters Consisting Of Two Nos For Convenient Connectivity And Having Arrangement Of Bare Portion Of Min. Length For Welding Purpose At The Ends.

Y STRAINER SERIES

PreinsulatedY Strainers, With Stainless Steel Mesh/Screen And Universal Fitment To Is, Bs, Din, Etc., And Using Integrally Reinforced Insulation Of Rigid Polyurethane Of 100 Density Min., Which Avoids Any Cladding Requirements, Insulation Which Aligns Exactly In Shape Of Valve To Aesthetically Appear In Shape Of Valves Only, With Pressure Rating Of PN. 10,16,20 & 25 Along With Preinsulated Flanged Tail Piece Set Of Matching Diameters Consisting Of Two Nos For Convenient Connectivity And Having Arrangement Of Bare Portion Of Min. Length For Welding Purpose At The Ends.

PRE-INSULATED POT STRAINER SERIES

Preinsulated Pot Strainers, With Stainless Steel Mesh/Basket And Universal Fitment To IS, BS, DIN, Etc., And Using Integrally Reinforced Insulation Of Rigid Polyurethane Of 100 Density Min., Which Avoids Any Cladding Requirements, Insulation Which Aligns Exactly In Shape Of Valve To Aesthetically Appear In Shape Of Valves Only, With Pressure Rating Of PN. 10,16,20 & 25 Along With Preinsulated Flanged Tail Piece Set Of Matching Diameters Consisting Of Two Nos For Convenient Connectivity And Having Arrangement Of Bare Portion Of Min. Length For Welding Purpose At The Ends.

17. AIR DISTRIBUTION:

17.1 SCOPE

The scope of this section comprises supply fabrication, installation and testing of all sheet metal / aluminum ducts, supply, installation, testing and balancing of all grilles, registers and diffusers. All to be in accordance with these specifications and the general arrangement shown on the Drawings.

17.2 DUCT MATERIALS

17.2.1 RAW MATERIALS

Galvanizing shall be Class VII – light coating of zinc, nominal 180gm/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.

17.2.2. GAUGES, BRACING BY SIZE OF DUCTS

All ducts shall be factory fabricated from galvanized steel / aluminum of the following thickness, as indicated as below :

17.2.2.1For Ducts with external SP upto 250 Pa (ESPupto 25mmWg)

Rectangular Ducts G. S.	**Pressure 250 Pa**		
	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	Nil
1501 – 1800 mm	22	TDF Flange	JTR or ZEE BAR
1801 – 2100 mm	20	TDF Flange	JTR or ZEE BAR
2101 – above	18	TDF Flange	JTR or ZEE BAR

17.2.2.2 For Ducts with External SP upto 500 Pa (50mmWg)

Rectangular Ducts G. S.	**External Pressure 500 Pa**		
	Duct Section Length 1.2 m (4 ft)		
Maximum Duct Size	**Gauge**	**Joint Type**	**Bracing Spacing**
1–400 mm	26	C&S Connector	Nil
401-700 mm	24	C&S Connector	Nil
701-900 mm	24	TDF Flange	Nil
901-1000 mm	22	TDF Flange	Nil
1001-1200 mm	22	TDF Flange	JTR or ZEE BAR

1201-2100 mm	20	TDF Flange	JTR or ZEE BAR
2101-above	18	TDF Flange	JTR or ZEE BAR

*Distance of reinforcement/bracing from each joint. Bracing material to be same as of material used for joining of duct sections.

FOR ALUMINUM DUCTS MATERIAL SHALL BE ONE COMMERCIAL GAUGE HIGHER WITH 22 G AS MINIMUM

17.2.3 For Round Ducts

Duct diameter mm	Upto 50 mm Wg static pressure (+ve)		51 – 250 mm Wg static pressure (+ve)		Upto 50 mm Wg static pressure (-ve)	
	Spiral seam gauge	Longitudinal seam gauge	Spiral seam gauge	Longitudinal seam gauge	Spiral seam gauge	Longitudinal seam gauge
Upto 650	26	24	24	22	24	22
651-900	24	22	22	20	22	20
901 – 1250	22	20	20	20	20	18
1251 – 1500	20	18	18	18	18	16
1501 – 2100	18	16	18	16	16	14

17.3 FABRICATION STANDARDS & EQUIPMENT

All duct construction and installation shall be in accordance with SMACNA standards. In addition ducts shall be factory fabricated utilizing the following machines to provide the requisite quality of ducts.

1. Coil (Sheet metal in Roll Form) lines to facilitate location of longitudinal seams at corners/folded edges only, for required duct rigidity and leakage free characteristics. No longitudinal seams permitted along any face side of the duct.

2. All ducts, transformation pieces and fittings to be made on CNC profile cutter for requisite accuracy of dimensions, location and dimensions of notches at the folding lines.

3. All edges to be machine treated using lockformers, flangers and rollers for turning up edges.

5. 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 fire fighting 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 .**

Laundry and dish washer extract duct shall be air and water tight construction manufactured from Aluminium sheets in accordance to BS 1470

17.4 DUCT CONSTRUCTION

17.4.1 All ducts shall be fabricated and installed in workmanlike manner, conforming to relevant SMACNA codes.

a) Ducts so identified on the Drawings shall be acoustically lined and insulated from outside 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. The fabricated duct dimensions should be as per approved drawings and care should be taken to ensure that all connecting sections are dimensionally matched to avoid any gaps.

b) Ducts shall be straight and smooth on the inside with longitudinal seams shall be airtight and at corners only which shall be either Pittsburgh or snap button as per SMACNA practice, to ensure air tightness.

c) All ducts up to 75cms width within conditioned spaces shall have C&S connector. The internal ends of slip joints shall be in the direction of airflow. Care should be taken to ensure that Cleats are mounted on the longer side of the duct and Cleats on the shorter side. 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 (between 1:4 and 1:7). Air-turns (vanes) shall be installed in all bends and duct collars designed to permit the air to make the turn without appreciable turbulence.

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 ample size to keep the ducts true to shape and to prevent buckling, vibration or breathing.

f) All sheet metal connection, partitions and plenums, required to confine the flow of air to and through the filters and fans, shall be constructed of 18 gauge GSS / 16gauge aluminum, thoroughly stiffened with 25mm x 25mm x 3mm galvanized steel angle braces and fitted with all necessary inspection doors as required, to give access to all parts of the apparatus. Access doors shall be not less than 45cm x 45cm in size.

g) Plenums shall be shop/factory fabricated panel type and assembled at site. Fixing of galvanized angle flanges on duct pieces shall be with rivets heads inside i.e. towards GS sheet and riveting shall be done from outside.

h) Self adhesive Neoprene rubber / UV resistant PVC foam lining 5mm nominal thickness instead of felt, shall be used between duct flanges and between duct supports in all ducting installation.

i) All fire rated duct, smoke exhaust ducts shall be quoted with flamebar BWII or equivalent to achieve the required fire rating also all the related accessories gaskets shall be suitable for the required fire rating.

17.4.2 **Pre-insulated ducts**

Pre-Insulated Ducting shall be fabricated from 20 mm thickness air duct panel sheet having dimensions of 3000 (Length) mm by 1200 (Width) mm and produced and Sandwiched with

Polyisocyanurate (PIR) first quality insulating Foam having 35 Kg / m^3 density. The Ducting Sheet shall have Lacquered & Embossed Aluminium facing on both sides.

Insulating foam material shall be Expanded Rigid Polyisocyanurate foam having Closed cell content not less than 95%, CFC/ HCFC free, Non Toxic, Non combustible, zero ozone depletion, Zero Global Warming Potential and Non ignitable.

Ducting panels shall comply with following or equivalent standards and manufacturer should produce M1 & F1 certification for Fire & Toxicity test results.

- BS 476: PART 6--Fire Propagation for Products
- BS 476: PART 7--- Surface Flame Spread (Class 1)
- Class O Fire Rating as per Building Regulation requirements.
- Thermal Conductivity Coefficient at 10^0C--0.022 W/m. K
- Smoke Opacity Index—less than 10
- Rigidity class: 200000 Nm m^2/mm
- Water vapor permeability of laminations = 0

All required accessories; Connecting Flanges, Invisible Bayonet, Adhesive, Sealant, Duct Supports shall be part of ducting work for fabrication of the HVAC ducting in Square, rectangle, radius, offset construction etc., appropriate sizes of Aluminium flanges with self-adhesive good quality gasket shall be provided as a joinery or connection of duct pieces.

Excellent quality Silicon Neutral Sealant of Approved make along with fire rated PVC corners shall be used for sealing of all joints & corners.

Complete ducting shall be installed incorporating duct supports such as galvanized angles, threaded rods, self adhesive brackets, Etc.

Panel Specifications: --

Description	**Internal Areas**	**External Areas of Building**
Dimensions of panel	3000 x 1200 mm	3000 x 1200 mm
Thickness of panel	20 mm	20/30 mm
Thickness of aluminium laminations	60/60 microns	60/200 microns
Density of the foam	35 kg/m^3	35 kg/m3
Surface finish	Embossed/Embossed	Embossed/Embossed
Anti-rust lacquer	2 gm/m^2 both sides	2 gm/m^2both sides

17.5. INSTALLATION PRACTICE

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

a) 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

b) 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 conduits, the ducts shall be transformed, divided or curved to one side (the required area being maintained) all as per the site requirements.

b) 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 owner's site representative.

c) All ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with hangers formed of galvanized steel wire ropes (as per clause 16.12) and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel wire hangers under ducts, rigid supports may be provided at certain interval if need be**.** The spacing between supports should be not greater than 2.4 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates or Toggle end wire fixing left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the wire rope hanger shall be welded to the plates. Trapeze hanger formed of galvanized steel wire rope using Gripple shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Wire rope supports shall hang through the cleats or wire rope threaded studs can be screwed into the anchor fasteners.

d) Alternatively, if mentioned in the BoQ, all ductwork shall be independently supported from building construction. All horizontal ducts shall be rigidly and securely supported, in an approved manner, with trapeze hangers formed of galvanized steel rods and galvanized steel angle/channel or a pair of brackets, connected by galvanized steel rod under ducts**.** The spacing between supports should be not greater than 2.0 meter. All vertical ductwork shall be supported by structural members on each floor slab. Duct supports may be through galvanized steel insert plates left in slab at the time of slab casting. Galvanized steel cleat with a hole for passing the hanger rods shall be welded to the plates. Trapeze hanger formed of galvanized steel rods shall be hung through these cleats. Wherever use of metal insert plates is not feasible, duct support shall be through dash/anchor fastener driven into the concrete slab by electrically operated gun. Hanger rods shall then hang through the cleats or fully threaded galvanized rods can be screwed into the anchor fasteners.

e) 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 contractor's work in the building.

f) Where ducts pass through brick or masonry openings, it shall be provided with 25mm thick **TF quality expanded polystyrene around the duct and totally covered with fire barrier mortar for complete sealing.**

g) All ducts shall be totally free from vibration under all conditions of operation. Whenever ductwork is connected to fans, air handling units or blower coil units that may cause vibration in the ducts, ducts shall be provided with a flexible connection, located at the unit discharge. Flexible connections shall be constructed of fire retarding flexible heavy canvas sleeve at least 10cm long securely bonded and bolted on both sides. Sleeve shall be made smooth and the connecting ductwork rigidly held by independent supports on both sides of the flexible connection. The flexible connection shall be suitable for pressure at the point of installation.

h) Duct shall not rest on false ceiling and shall be in level from bottom. Taper pieces shall taper from top.

17.6 <u>DAMPERS</u>

a. Dampers : All duct dampers shall be opposed blade louver dampers of robust 16 G GSS construction and tight fitting. The design, method of handling and control shall be suitable for the location and service required.

b. Dampers shall be provided with suitable links levers and quadrants as required for their proper operation. Control or setting device shall be made robust, easily operable and accessible through suitable access door in the duct. Every damper shall have an indicating device clearly showing the damper position at all times.

c. Dampers shall be placed in ducts 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 air distribution system.

e. Pressure relief dampers: Pressure relief dampers shall be constructed with 18G Aluminum construction with parallel blade construction. Leafs shall be 100% air tight upon closure. Leafs shall be loaded with spring pressure of stiffness (k value) corresponding to set point pressure.

f. Non return damper (Back draft damper) : Non return damper shall be constructed out of 16G GSS. Blades shall ensure 100% air leak proof performance on closure. Design shall ensure that no rattling noise is produced at design duty.

h. Constant Volume Regulator(For Hotel/ Hospital TFA / Exhaust ducts)

Constant volume regulators (KVR) shall be used to obtain constant air volume at a given pressure range.

The constant volume regulators (KVR) shall be of the circular type for high pressures and to be inserted into ductwork and suitable for vertical as well as horizontal mounting and it should be placed at a minimum distance of 3x the duct diameter from air supply grilles and minimum distance of 1x the duct diameter from air exhaust grilles

Constant volume regulator body, valve and piston shall be made out of flame retardant PVC, fire classification M1. They shall contain a self regulating PVC valve, piston, rubber strip for air tightness inside the duct and stainless steel calibrated spring and shall have preset air volume.

Constant volume regulator shall be made of PVC. The range covers an air flow range from 15 up to 1200 m^3/h within a pressure range from 50 up to 600 Pa.

17.7 FIRE & SMOKE DAMPERS

a. All supply and return air ducts at AHU room crossings and at all floor crossings or as indicated in the drawings shall be provided with Motor operated Fire & smoke damper of at least 90 minutes rating. These shall be of multi-leaf type and provided with Spring Return electrical actuator having its own thermal trip for ambient air temperature outside the duct and air temperature inside the duct. Actuator shall have Form fit type of mounting, metal enclosure and guaranteed long life span. The dampers shall meet the requirements of NFPA90A, 92A and 92B. Dampers shall have a fire rating of 1.5 Hrs. in accordance with latest edition of UL555 and shall be classified as Leakage Class 2 smoke damper in accordance with latest version of UL555S. Each fire/smoke damper shall be AMCA licensed and bear the AMCA seal for air Performance. Pressure drop shall not exceed 7.5Pa when tested at 300m/min face velocity on 600x600mm size damper. Actuator shall be UL listed.

b. Each damper shall be supplied with factory mounted sleeve of galvanized steel of thickness as per SMACNA and of minimum 500mm long or as specified in schedule of quantities depending up on the wall thickness. The damper shall be fitted in to sleeve either using welding or self tapping screws. All welded joints shall be finished using heat resistance steel paint . UL listed and approved Silicon sealant shall be applied at all corners as well as at joints between damper frame and sleeve. Damper Frame shall be a roll formed structural hat channel , reinforced at corners, formed from a single piece of 1.6mm galvanized steel . Damper blades shall be airfoil shaped (equivalent to 2.3mm thickness strength) roll formed using 0.8mm thick single piece of galvanized sheet. Bearings shall be of stainless steel fitted in an extruded hole in the damper frame. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked in to the blade edge (adhesive type seals are not acceptable). Side Jam seals of stainless steel and Top and bottom seals of galvanized steel shall be provided. All galvanized steel used shall be with minimum 180GSM Zinc coating Bigger size Dampers shall be supplied in Multiple modules of sizes not exceeding in dimensions of certified module, jack shafted together. Multiple actuators shall be provided for large dampers with higher torque requirements as prescribed in UL.

c. The electric actuator shall be energized either upon receiving a signal from smoke detector installed in AHU room supply air duct / return air duct. Electric Actuator of suitable Torque and as approved by UL shall be factory mounted and tested. The actuator shall be suitable for 24V AC supply.In addition actuator shall have elevated temperature rating of 250 deg.F. Electric Actuator shall have been energized hold open tested for a period of at least one year with no spring return failure. Each fire/smoke damper shall be equipped with a heat actuated release device which shall allow controlled closure of damper rather than instantaneous to prevent accident.(Electrical fusible link).The EFL shall allow the damper to reopen automatically after a test, smoke detection or power failure condition. The damper shall be equipped with a device to indicate OPEN and CLOSE position of Damper blades through a link mounted on the damper blade.

d. Each damper shall be provided with its own control panel, mounted on the wall and suitable for 240 VAC supply. This control panel shall be suitable for spring return actuator and shall have atleast the following features:

- Potential free contacts for AHU fan ON/ Off and remote alarm indication.
- Accept signal from external smoke / fire detection system for tripping the electrical actuator.
- Test and reset facility.
- Indicating lights / contacts to indicate the following status:
- Power Supply On
- Alarm
- Damper open and close position.

e. Actuators shall be mounted on the sleeve by the damper supplier in his shop and shall furnish test certificate for satisfactory operation of each Motor Operated Damper in conjunction with it’s control panel. Control panel shall be wall mounted type.

f. It shall be HVAC Contractor’s responsibility to co-ordinate with the Fire Alarm System Contractor for correctly hooking up the Motor Operated Damper to Fire Detection / Fire Management System. All necessary materials for hooking up shall be supplied and installed by HVAC Contractor under close co-ordination with the fire protection system contractor.

g. HVAC Contractor shall demonstrate the testing of all Dampers and its control panel after necessary hook up with the fire protection / fire management system is carried out by energising all the smoke detectors with the help of smoke.

h. HVAC Contractor shall provide Fire retardant cables wherever required for satisfactory operation and control of the Damper.

j. HVAC Contractor shall strictly follow the instructions of the Damper Supplier or avail his services at site before carrying out testing and installation at site.

k. Fire/smoke damper shall be provided with factory fitted sleeves; however, access doors shall be provided in the ducts within AHU room in accordance with the manufacturer's recommendations.

l. The Contractor shall also furnish to the Owner, the necessary additional spare actuators and temperature sensor (a minimum of 5% of the total number installed) at the time of commissioning of the installation.

17.8 FIRE DAMPERS

a. Whenever a supply/return duct crosses from one fire zone to another, it shall be provided with approved fire damper of at least 1½ hour fire rating as per UL555/1995 tested by CBRI. This shall be curtain type fire damper.

b. Fire damper blades shall be one piece folded high strength 16 gage galvanised steel construction. In normal position, these blades shall be gathered and stacked at the frame head providing maximum air passage and preventing passing air currents from creating noise or chatter. The blades shall be held in position through fusible link of temp 70° C. The HVAC contractor shall supply UL classified Fire Dampers meeting or exceeding the specifications. Fire Dampers shall be furnished and installed at locations shown in Drawings and as described in Schedule of quantities. Fire Dampers shall have a fire rating of 1.5/3 Hrs.as specified in BOQ, in accordance with latest edition of UL555. Each Fire damper shall be AMCA licenced and shall bear the AMCA seal for air performance.

Damper shall be equipped with UL labelled Fusible Link with Temprature setting 165 or 212deg. F or as specified in Bill of quantities.Fire dampers shall have been tested to close under dynamic air flow conditions with pressure up to 1000 pa and velocities up to 10.2 m /sec. Fire damper shall be approved for Horizontal or vertical installation as may be required by the location shown in the drawings.

Damper Frame shall be a roll formed structural hat channel , reinforced at corners, formed from a single piece of 1.6mm galvanized steel . Damper blades shall be roll formed 3-v groove (1.6mmthick) or airfoil shaped in case of 3 Hrs. fire rating (equivalent to 2.3mm thickness strength) roll formed using 0.8mm thick single piece of galvanized sheet. Bearings shall be of stainless steel fitted in an extruded hole in the damper frame. All galvanized steel used shall be with minimum 180GSM Zinc coating Bigger size Dampers shall be supplied in Multiple modules of sizes not exceeding in dimensions of certified module jack shafted together.

Fire damper shall be equipped with a electric limit switch to indicate open and close position of the damper blades.

Fire Damper shall be installed in wall or floor opening using galvanized steel sleeve of minimum 435mm length of sheet thickness as per SMACNA and as per Installation instruction of Manufacturer.

c. In case of fire, the intrinsic energy of the folded blades shall be utilized to close the opening. The thrust of the suddenly released tension shall instantly drive the blades down and keep it down without the use of springs, weights or other devices subject to failure.

d. Fire damper sleeves and access doors shall be provided within the duct in accordance with the manufacturer's recommendation.

e. The contractor shall also furnish to the Owner, the necessary additional fusible links (spares), as recommended by the manufacturer, at the time of commissioning of the installation.

17.9 SUPPLY AND RETURN AIR REGISTERS

Supply & return air registers shall be of either steel or aluminium sections as specified in schedule of quantities. Steel construction registers shall have primer Coat finish whereas extruded aluminium registers shall be either Anodised or Powder Coated as specified in Schedule of Quantities. These registers shall have individually adjustable louvers both horizontal and vertical. Supply air registers shall be provided with key operated opposed blade extruded aluminium volume control damper anodised in matt black shade.

The registers shall be suitable for fixing arrangement having concealed screws as approved by Architect. Linear continuous supply cum return air register shall be extruded aluminium construction with fixed horizontal bars at 15 Deg. inclination & flange on both sides only (none on top & bottom). The thickness of the fixed bar louvers shall be minimum 5.5 mm in front and 3.8 mm in rear with rounded edges. Flanges on the two sides shall be 20 mm/30 mm wide as approved by Architect. The grilles shall be suitable for concealed fixing. Volume control dampers of extruded aluminiumanodised in black color shall be provided in supply air duct collars. For fan coil units horizontal fixed bar grilles as described above shall be provided with flanges on four sides, and the core shall be & suitable for clip fixing, permitting its removal without disturbing the flanges.

a. All registers shall be selected in consultation with the Architect. Different spaces shall require horizontal or vertical face bars, and different width of margin frames. These shall be procured only after obtaining written approval from Architect for each type of register.

b. All registers shall have a soft continuous rubber/foam gasket between the periphery of the register and the surface on which it has to be mounted. The effective area of the registers for air flow shall not be less than 66 percent of gross face area.

c. Registers specified with individually adjustable bars shall have adjustable pattern as each grille bar shall be pivotable to provide pattern with 0 to +45 degree horizontal arc and upto 30 degree deflection downwards. Bars shall hold deflection settings under all conditions of velocity and pressure.

d. Bar longer than 45 cm shall be reinforced by set-back vertical members of approved thickness.

e. All volume control dampers shall be anodisedaluminium in mat black shade.

17.10 SUPPLY AND RETURN AIR DIFFUSERS

Supply and return air diffusers shall be as shown on the Drawings and indicated in Schedule of Quantities. Mild steel diffusers/dampers shall be factory coated with rust-resistant primer. Aluminium diffusers shall be powder coated & made from extruded aluminium section as specified in schedule of quantities.

a. Rectangular Diffusers shall be steel / extruded aluminium construction, square & rectangular diffusers with flush fixed pattern for different spaces as per schedule of quantities These shall be selected in consultation with the Architect. These shall be procured only after obtaining written approval from Architect for each type of diffuser.

b. Supply air diffusers shall be equipped with fixed air distribution grids, removable key-operated volume control dampers, and anti-smudge rings as required in specific applications, and as per requirements of schedule of quantities. All extruded aluminiumdiffusers shall be provided with removable central core and concealed key operation for volume control damper.

c. Linear Diffuser shall be extruded aluminium construction with removable core, one or two way blow type. Supply air diffusers shall be provided with volume control/ balancing dampers within the supply air collar. Diffusers for different spaces shall be selected in consultation with the Architect, and provided as per requirements of schedule of quantities. All diffusers shall have volume control dampers of extruded aluminium construction anodised in mat black shade.

d. Slot Diffuser shall be extruded aluminium constructionmultislot type with air pattern controller provided in each slot. Supply air diffusers shall be provided with Hit & Miss volume control dampers in each slot of the supply air diffusers. Diffusers for different spaces shall be selected in consultation with the Architect and provided as per requirement of Schedule of Quantities.

e. Data centers shall be provided with floor grilles. Grilles shall be of nominal size of 600mm x 600mm and shall be fitted in floor tile of false floor. Grille shall be with dampers for flow control. Grill shall be heavy duty 16G Aluminium and shall take care of human traffic load. Damper shall be operable in situ without requirement of removal of grille.

17.11 FIRE RATED DUCTWORK

Ducting for kitchen exhaust & fire evacuation, staircase pressurization if not in a separate shaft shall be fire rated as per following specifications.

a. All fire rated ductwork constructed for mechanical or dual ventilation/pressurization/basement car park/smoke extract systems and kitchen exhaust shall be fabricated from Lock Forming Quality grade prime Galvanized Steel Sheet, constructed to enhanced SMACNA American/DW144 European standard to either low, medium or high velocity/ pressure.

b. Test requirement of fire rated ductwork should be tested to BS476: Part 24 [1987] and ISO 6944 providing required fire rating for Stability and Integrity.

c. Stability: the ability of a duct, ductwork & the support system to remain intact & fulfill their intended function for a specified period of time, when tested to the requirements of BS476: Part 24 and ISO 6944.

d. Integrity: the ability of a duct or ductwork to remain free of cracks, holes or openings out side the compartment in which the fire is present for a specified period of time, when tested to the requirements of BS476 Part 24 ISO 6944.

e. Insulation: the ability of a duct or ductwork to maintain its separating function without developing temperatures on its external surface outside the compartment in which the fire is present, which exceeds, (i) $140^{O}C$ as an average value above ambient & or, (ii) $180^{O}C$ as maximum value above ambient at any point, when tested for a specified period of time to the requirements of BS476: Part 24 ISO 6944.

f. Its important that the fire rated ductwork has a smooth internal surface in order to minimize the pressure loss within the fire rated ductwork system thereby reduce the power requirements.

g. All fire rated ducts for Smoke Extract Duct shall have Stability / Integrity and Insulation for smoke temperatures up to $300^{O}C$ upto 1.5 hrs, restriction of the duct due to twisting or buckling after the fire test shall not cause 25% or more reduction in cross sectional area proven by certification from an independent test house.

h. Each duct shall have fire rated coating. Fire rated coating compound used for construction of fire rated ductwork shall be protected with minimum 0.7mm to 1mm nominal thickness tested to properties as per the requirements of BS 476: 6 & 7, including non-combustibility Class O and fire propagation - Class 1 surface spread of flame & materials in accordance with Building Regulations.

i. Fire duct to be tested / assessed to BS476: Part 24 for all sizes up to 25 meters x 3 meters cross-sectional area and fully certified to vertical and horizontal plane.

j. Fire rated duct fabricated to Method 3 of BS 5588: Part 9, factory produced. The coating compound shall be applied either offsite or onsite on the ground, dried and cured.

k. Fire duct expansion under fire conditions shall not exceed following,
   - at $430^{O}C$ an expansion of 0.006106mm per mm
   - at $600^{O}C$ an expansion of 0.00852mm per mm
   - at $1100^{O}C$ an expansion of 0.01562mm per mm.

17.12 BRAIDED (WIRE) ROPE SUPPORT

Braided (Wire) Hangers shall be used to suspend all static mechanical, electrical and HVAC services.

Braided (Wire) Rope Hangers shall consist of a pre-formed wire rope sling with either a ferruled loop, permanently fixed threaded M8 stud, or permanently fixed nipple end with toggle, at one end or hook or eyelet or any other end fixture type or size as per manufacturers recommendation. The end fixings and the wire must be of the same manufacturer. The system is secured and tensioned with a wire rope Hanger self-locking grip at the other end.

Only wire and/or supports supplied and/or approved, shall be used with the system.

a. Braided (Wire) Rope Hangers have been independently tested by Lloyds Register. APAVE, TUV, UL, CSA and SMACNA, approved by ULC and CSA and comply with the requirements of DW/144 and BSRIA – wire Rope Suspension systems. Wire rope is manufactured to BSEN 12385: 2002.

b. The contractor shall select the correct specification of wire Hanger to use for supporting each particular service from table 1 below. Each size is designated with a maximum safe working load limit.

The correct specification of Braided (Wire) Rope Hanger required is determined using the following formula.

Weight per meter of object suspended (kg) X distance between suspension points (m) = weight loading per Braided (Wire) Rope**Hanger suspension point (kg).**

The contractor shall select the correct length of Braided (Wire) Rope required to support the service. Lengths from 1-10m lengths. No in–line joints should be made in the rope.

Table. 1

size	minimum breaking load of Braided (Wire) Rope	Braided (Wire) Rope construction	tensile strength(Nmm2)	working load limit (kg/lbs)
No. 1	80kg/176 lbs	7 x 7 (6/1)	1770	0-10 kg / 0-22 lbs
No. 2	260kg/572 lbs	7 x 7 (6/1)	1770	10-45 kg / 23-100 lbs
No. 3	580kg/1276 lbs	7 x 7 (6/1)	1770	45-90 kg / 101-200 lbs
No. 4	1500kg/3300 lbs	7 x 19 (12/6/1)	1770	90-225 kg / 210-495 lbs
No. 5	2160kg/4752 lbs	7 x 19 (12/6/1)	1770	225-325 kg / 496-715 lbs

The standard range of Braided (Wire) Rope Hanger Kits shall be used which contains galvanized high tensile steel wire rope, the minimum specification is as above and shall be manufactured to BS 302 (1987), BSEN12385.

Ducting Supports: All duct work shall be independently supported from building construction. All horizontal ducts shall be adequately secured and supported. In an approved manner, with trapeze Hangers formed of galvanized steel wire rope in a cradle support method under ducts at no greater than 2 meter centre. All vertical duct work shall be supported by structural members on each floor slab. Duct support shall be through dash / anchor fastener driven into the concrete slab by electrically operated gun. Hanger wire shall then hang around the ducting. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services. Rigid support must also be used in conjunction with wire rope hangers with duct work at each change of direction or connection. Support ducting in accordance with Schedule I.

Ducting over furred ceiling shall be supported from the slab above or from beams after obtaining approval of Construction manager/consultant. In no case shall any duct be supported from false ceiling Hangers or be permitted to rest on false ceiling. All metal work in dead or furred down spaces shall be erected in time to occasion no delay to other Contractor's work in the building.

Piping Supports: Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services. Rigid support must also be used in conjunction with wire rope hangers with pipe work at each change of direction or connection. For insulated pipe, provide protective sleeve to protect the entire circumference of the pipe insulation. All supports of pipe shall be taken from structural slab/wall by means of fastener. Support piping in accordance with Schedule II at the end of this Section.

Electrical Cable Tray/Raceway Supports: Y-Fit solution shall be used to a maximum width of 500mm tray. For Tray over 500mm cradle support method or independent Gripple supports must be taken as appropriate based on load. Rigid supports shall be used in conjunction with wire rope hangers to assist with alignment of services. Any other Gripple solution can be used based on manufacturer's recommendation on site conditions after prior approval.

Refer to manufacturers catalogue and installation guide for further technical information. **Comply with manufacturer's load ratings and recommended installation procedures.**

Schedule I: Duct Hanger Schedule

For ducts with external SP upto 250 Pa			For ducts with external SP upto 500 Pa		
Maximum Duct Size (mm)	**Gauge**	**Gripple Hanger No.**	**Maximum Duct Size (mm)**	**Gauge**	**Gripple Hanger No.**
1 - 751	26	2	1–600 mm	26	2
751-1000	26	2	601-750 mm	26	2
1001-1200	24	3	751-1000 mm	24	3
1201 - 1500	24	3	1001-1200 mm	22	4
1501 - 1800	22	4	1201-1300 mm	20	4
1801-2100	20	4	1301-1500 mm	18	4
2101-2700	18	4	1501-1800 mm	18	4
			1801-2100 mm	18	4
			2101-2250 mm	18	4

All supports shall be at 2400 mm interval.

Schedule II: Pipe Hanger Schedule

Pipe Size	Weight of pipe + fluid	Weight of pipe + fluid per Rmt	Spacings (pipe + fluid+insulation)	Spacings (pipe + fluid+plaster)	Total Weight of pipe + fluid	Total Weight of pipe + fluid	Gripple Hanger No.	Gripple Hanger No.
(mm)	with insulation (kgs/rmts)	with sand cement plaster (kgs/rmts)	between supports (mts)	between supports (mts)	with insulation (kgs/rmts)	with sand cement plaster (kgs/rmts)	with insulation (kgs/rmts)	with sand cement plaster (kgs/rmts)
12-35	11.73	14	1.5	1.5	18	21	2	2
40-65	11.73	14	2	2	23	28	2	2
80-125	34.73	41.67	2	2	69	83.34	3	3
150-250	112	134	2	1.5	224	201	4	4
300 - 350	180	215	1.5	1.5	270	322.5	5	5
400-500	320	383	1.5	-	480	-	6	-

17.16 FLEXIBLE DUCT:

Insulated flexible duct should be UL 181 CLASS I AIR DUCT LISTED AND LABELLED WITH NFPA 90A & 90B ANDSEAL OF AIR DIFFUSION COUNCIL with double lamination of tough polyester which encapsulates steel helix wire forms the air tight inner core , double layer core wrapped in a multiple thickness of fiberglass wool with R Value 4.2 , Green guard certification of fiberglass wool must. , Reinforced and sheathed in a rugged and durable tridirectionally reinforced matlized polyester jacket.

Flexible duct connections should be made as per UL181 listing procedure with proper flexible right forming brace connection allowing right connections for flexible duct into energy efficient . and Strapping the flexible duct connections with flexible duct strap ties.

17.17 TESTING AND BALANCING

After the installation of the entire air distribution system is completed in all respects, all ducts shall be tested for air leaks by visual inspection.

The entire air distribution system shall be balanced using an anemometer. Measured air quantities at fan discharge and at various outlets shall be identical to or less/excess than 5 percent in excess of those specified and quoted. Branch duct adjustments shall be permanently marked after air balancing is completed so that these can be restored to their correct position if disturbed at any time. Complete air balance report shall be submitted for scrutiny and approval, and four copies of the approved balance report shall be provided with completion documents.

19. INSULATION:

19.1 SCOPE

The scope of this section comprises the supply and application of insulation conforming to these specifications.

19.2 MATERIAL

Thermal insulation material for Duct & Pipe insulation shall be closed cellElastomeric non Polar-Anti Microbial-UV resistant – UL94 – Class O Nitrile Rubber / EPDM of Thermal conductivity as per **BS 874 part 2 – 86 (DIN 52613 52612)**of the insulation material shall not exceed 0.038 W/m^{o}K or 0.212 BTU / (Hr-ft^2-^{o}F/inch) at an average temperature of 30°C. Density of the nitrile rubber shall be 40-60 Kg/m^3. The product shall have temperature range of –40°C to 105°C. The insulation material shall be fire rated for Class 0 as per BS 476 Part 6 : 1989 for fire propagation test and for Class 1 as per BS 476 Part 7, 1987 for surface spread of flame test. Water vapour permeability shall be not less than 0.024 perinch (2.48 x 10^{-14} Kg/m.s.Pa i.e. $\mu \geq 7000$: Water vapour diffusion resistance)

Product shall be FM Global approved.

In addition to above properties, for Hospital, insulation shall be anti-microbial with EPA approval. Microbiological growth on insulation surface shall be in accordance with UL 181 and bacterial resistance to ASTM G22.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer's test certificate for thermal conductivity values, density, water vapour permeability and fire properties. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost.Adhesive used for sealing the insulation shall be non-flammable, vapour proof adhensive strictly as per manufacturer's recommendations.

Ducting insulation thickness shall be as per table below.

Ducting position	**Thk. for non-coastal places**	**Thk. for coastal places**
SA duct in RA path	13mm	19mm
Ducted return air system	SA duct: 19mm RA duct: 13mm	SA duct: 25mm RA duct: 19mm
Both SA& RA exposed	Both 25mm	Both 25mm

19.3 DUCT ACOUSTIC LINING

Insulation material for Duct Acoustic Lining shall be resin bonded fibre glass. The thermal conductivity of the fibre glass for air-conditioning application shall not exceed 0.034 K Cal/(hr-sq.m-deg C/meter) or 0.23 BTU/(hr.sq.ft.-deg F)/inch) at 32 deg C (90 deg F) mean temperature and density shall be not less than 48 kg/ m^3. Thickness of the material shall be as specified for individual application as per schedule of quantity.

Ducts so identified and marked on drawings and included in Schedule of Quantities shall be provided with acoustic lining of thermal insulation material for a distance of minimum 5 meters as follows:

The inside surface for the ducts shall be covered with adhesive, and provided with 22 gauge GI Channels 25 x 25 mm screwed back to back and fixed on the inside of duct, spaced not more than 60 cm center to form a frame work of 60 x 60 cms square. Cut panels 60 x 60 cms of resin bonded fiber glass 25 mm thick shall be fitted in the squares.

These insulation panels shall be fixed to the sheet metal with cold setting adhesive compound. The inner most surface shall be covered with fiberglass tissue and 28 gage peforatedaluminium sheet having atleast 15 percent perforations. The aluminium sheet shall be screwed to GI channels using cup washer and neatly finished to give true inside surface.

Acoustic lining in Plenums especially for Air diffusion connected to slot diffusers shall have 12mm thick rigid board of fiberglass/mineral wool having density of 48 Kg/m3**.**

19.4 DUCT INSULATION

External thermal insulation shall be provided as follows :

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 rubber sheets to size with sufficient allowance in dimension. Cutting of nitrile rubber sheets shall be done with adjustable blade to make 90^0 cut in thickness of nitrile rubber sheet. Hackshaw or blades are not acceptable tools for cutting the insulation.

Material shall be fitted under compression and no stretching of material shall be permitted. A film of adhesive shall be applied on the back of the insulating material sheet and then on to the metal surface. When adhesive is tack dry, insulating material sheet shall be placed in position and pressed firmly to achieve a good bond. All longitudinal and transverse joints shall be sealed by providing 6 mm thick 50 mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer.

Where ducts penetrates walls / floor it shall be suitable flashed and provided with water proofing(external Agnecy for exposed crossings) before application of the Insulation

19.5 PIPING INSULATION

All chilled water, refrigerant, and condensate drain piping shall be insulated in the manner specified herein. Before applying insulation, all pipe shall be brushed and cleaned. All MS pipes shall be provided with a coat of zinc chromate primer. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Pipe nominal bore	**Thk. for non-coastal places**	**Thk. for coastal places**
15mm – 25mm	19mm	25mm
32mm – 80mm	25mm	32mm
100mm – 400mm	32mm	38mm
Above 400mm	45mm	45mm

Insulating material in tube form shall be sleeved on the pipes. On piping, slit opened tube from insulating material 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 end and working towards centre. Wherever flat sheets shall be used it shall be cut out in correct dimension using correct tools. Scissors or Hacksaw-blade shall not be allowed.All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. All longitudinal and transverse joints shall be sealed by providing 6 mm thick, 50 mm wide nitrile rubber tape. The adhesive shall be strictly as recommended by the manufacturer. The insulation shall be continuous over the entire run of piping, fittings and valves. 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.

Manufacturer's installation manual shall be submitted and followed for full compliance. All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labeled (S.R. or R.R.) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. Un-insulated MS pipes shall be painted throughout and direction of fluid marked. All painting shall be as per relevant BIS codes.

19.6 DATA CENTRE FLOOR INSULATION

Floor of data centre shall be insulated with 9mm thick nitrile rubber insulation as per specifications. 750mm x 750mm grid shall be made on the floor. This grid shall be made from 25mm wide 22G GI C-section. These C-sections shall be screwed to floor. Depth of screwing in to the floor shall not be more than 5mm. Sections of insulation shall be sticked to floor with self adhesive / adhesive solution as recommended by insulation manufacturer.

19.7 PROTECTIVE COATING/**VAPOUR BARRIER** OVER INSULATION

To provide mechanical strength and protection from damage all pipe / duct insulated with nitrile rubber shall be covered with thermal insulation protecting coating with alkali resistance glass fibre fabric (**UL Listed**)of weight 200 GSM and 7 mil minimum thickness reinforcement. The coating non-volatile content shall be as per guideline of ASTM 1644-01 and Water permanence (perms) as per guideline ASTM E-96. The coating flammability, surface burning characteristics shall be as per ASTM E-84 and UL 723.

The coating shall be applied as explained below.
Apply 7 mil glass cloth(Dark Shaded) over the insulated surface adhered within two coat of fire resistant fungicidal protective vapour barrier. And Finished with one additional coat of Fire resistant Fungicidal Protective Vapour Barrier.

Insulated pipes & ducts exposed to UV rays shall be covered with fibreglass fabric. Over fabric one coat of fire proof epoxy or acrylic compound shall be applied. The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface**.**

19.8 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.

19.9 SHELL INSULATION

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

19.10 COLD WATER AND EXPANSION TANK INSULATION

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

19.11 ACOUSTIC LINING OF MECHANICAL ROOMS

Two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining of resin bonded fibreglass as per Schedule of Quantities and as shown on the Drawings. The surface shall be cleaned and frame work of 22 gage GI fabricated Channels 25 mm x 50 mm screwed back to back at 60 cm centres shall be provided vertically and horizontally so that 60 x 60 cm squares are formed. The gaps between frames shall be filled with 50 mm thick about 60 cm x 60 cm cut panels of resin bonded fibreglass slabs. The entire surface shall then be covered with fibreglass tissue and 26 gage perforated aluminium sheet, 60 cm or 120 cm wide having atleast 15 percent perforations, fixed with sheet metal screws. Over-lapping of sheets shall be covered with Aluminium beading. Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

Alternatively

Two walls and ceiling of air conditioning plant room and air handling unit rooms may be provided with acoustic lining. Material shall be processed from Nitrile rubber foam.

The material should be fibre free. The density of the same shall be 140-180 Kg/m^3. The material should have thermal conductivity not exceeding 0.05 W/Mk. The maximum surface temperature of material shall withstand is 105^{0}C. and minimum temp shall be -20^{0}C. Thickness shall be as specified. The material should confirm to class 1 rating for surface spread of flame as per BS 476 Part 7. Thickness, if not specified, shall be considered as 20mm.

Surface shall be cleaned and adhesive recommended by the manufacturer should be applied on the walls. The foam sheets should be cut to required size and a layer of adhesive should also be applied to it. When it is tack dry it is stuck to the walls / ceiling.

Acoustic lining of walls shall be terminated approximately 15 cm above the finished floor to prevent damage to insulation due to accidental water-logging in plant/AHU rooms.

19.12 OVERDECK INSULATION

Overdeck insulation shall be done with 75mm thick extruded polystyrene of density 45-48 kg/cm^3& thermal conductivity of 0.21 Btu in / ft^{2}hr^{o}F (at 24°C as per ASTMC – 518). Minimum compressive strength as per ASTM D-2842 shall be 570 kPa water absorption as per ASTM D-2842 shall not be more than 1%.

Method of Application

(a) Clean RCC slab and make it free from dust and other laitance matter.

(b) Lay cement based water proofing on roof with a minimum slope of 1:100 and average thickness of 110 mm using brickbats of appropriate size and shape suitable to achieve the required slope laid over 15 mm thick waterproof c3ement mortar 1:4 and finished with 20 mm thick waterproof plaster wing cement mortar 1:4 and making false squares of 300 mm size including rounding off the junction of roof and parapet walls for a height of 300 mm with brickbats and 20 mm thick waterproof plaster and conducting necessary leakage / dampers tests, etc.

(c) Lay 75 mm thick extruded polystyrene boards over prepared surface fixing with adhesive. Adhesive shall be strictly as per recommendations from manufacturer.

(d) Lay 80 gsm geotextile fabric over insulation board

(e) Lay 40 x 40 x 4 cm precast paver blocks.

(Note : If contractor is awarded work of waterproofing + overdeck insulation, follow all steps from (a) to (e). if contractor is awarded work of only overdeck insulation follow step (c) and (d). Rest will be done by Civil Contractor).

19.13 UNDERDECK INSULATION

Underdeck insulation shall be 50mm thick TF Quality expanded polystyrene (32 Kg/m^3) or 30mm thick phenotherm. Underdeck surface of ceiling shall be cleaned and made dirt free. Insulation panels shall be pasted on this surface with black CPRX compound. 28g wire net shall be tightened around insulation so as to avoid any kind of sagging. Ends of net shall be overlapping by at least 25mm. Overlaps shall be screwed with galvanised screws to avoid rusting.

19.14 SOUND ATTENUATORS

Attenuators shall be installed in ducts in accordance with requirements of drawings and as included in Schedule of Quantities.

Noise levels within conditioned spaces shall be not greater than those set out in schedule below :

a. Noise Level Design Criteria

S.No.	Area	Acceptable Noise Levels (NC)
i.	Guest room or Suite	25-30
ii.	Service Apartment	25-30
iii.	Ball Room/Meeting Rooms	25-30
iv.	Guest floor corridors	30-35
v.	Restaurant / Staff Dining	40-45
vi.	Health Club-Gym. Squash, Snooker	40-45
vii.	Public Circulation.	40-45
viii.	Back-of-the-house areas	40-45
ix.	Offices	30-35
x.	Office Corridor	35-40

b. Attenuators shall be of steel construction with casings out of minimum 22 G galvanized steel. Acoustic fill shall be inert, non-hygroscopic, vermin proof, fibre glass of required density adequately protected against corrosion and covered with 26 gage perforated aluminium sheet. Attenuators shall be supplied complete with flanges.

c. Acoustic performance of the attenuators (net insertion loss) shall meet or exceed the values listed below :

OCTAVE BAND CENTRE FREQUENCY HZ

	63	125	250	500	1K	2K	4K	8K
Insertion loss dB 900 mm long attenuators	2	7	12	19	23	23	18	11

Insertion loss dB

1500 mm long attenuators	6	10	18	30	42	34	23	14

23. THERMAL HEAT RECOVERY WHEEL

23.1 SCOPE

The scope of this section, comprises the supply, erection, testing and commissioning of Thermal Heat Recovery Wheel, conforming to these Specifications and in accordance with requirements of drawings and of the Schedule of Quantities.

23.2 TYPE

The Thermal Heat Recovery Wheel shall be cabinet type construction, comprising of various sections such as supply air, exhaust air and fresh air connections as shown on drawings and included in schedule of quantities.

23.3 CAPACITY

The Heat Recovery capacities, maximum motor horse power shall be as shown on Drawings and in Schedule of Quantities.

23.4 ACCESSORIES

a. **Wheel :** The wheel shall be made of alternate layer of corrugated and intervening flat composite material of aluminium foil of uniform width to ensure smooth surface. The wheel medium should be bonded together to form rigid transfer medium forming a multitude of narrow channels ensuring laminar flow. The wheels shall be of proven design.

The wheel can be fully wound or on larger units, sectorised, i.e. assembled in segments. In latter case the segments are assembled between rigid spokes thus ensuring structural longevity and allowing replacement of one or specific segments only.

The wheel shall be cleanable by spraying its face surface with compressed air, low temperature steam or hot water or by vacuum cleaning without affecting its latent properties.

The face velocity across the wheel should not exceed 700 fpm (3.5 m/s).

The wheels shall be tested in accordance with ASHRAE S4-78 method of testing air to air heat exchangers. Development an manufacturers shall meet all quality assurance criteria specified in BSEN ISO 9001.

The minimum sensible and latent efficiencies should be 75%. A computerized selection should be enclosed along with offer.

b. **Casing :** The casing shall be constructed as a single skin, self-supporting, galvanized sheet steel structure and include rotary wheel support beams and purging sector. The casing shall be supplied with access panels to facilitate inspection and service. Size 2150 mm and larger shall be in two sections to facilitate shipping and handling.

c. **Seals :** The casing shall be equipped with adjustable brush seals, which minimize the carryover to max 0.05 – 0.2%.

d. **Hub and Spokes :** Hub and Spokes on one piece rotor shall be Aluminium and on sectorrized rotor Hub shall be made of steel, painted with anicorosion paint and galvanized sheet steel spokes.

e. **Drive :** The wheel shall be belt driven along its perimeter. A constant speed fractional horsepower motor shall be used. The motor shall be mounted on a self-adjusting base to provide correct belt tension.

23.5 TESTING

The Thermal Wheel shall be tested in accordance with the parameters fixed as below.

i. Supply Air Capacity - FDB/FWB.
ii. Exhaust Air Capacity - FDB / FWB.
iii. Fresh Air Capacity - FDB / FWB.

25. ELECTRICAL INSTALLATION

25.1 SCOPE

The scope of this section comprises of fabrication, supply, erection, testing and commissioning of Motor Control Centre (MCC), wiring and earthing of all air-conditioning equipment, components and accessories.

Note – Configuration of MCC panels shall be design to suit the requirement of system \ process. Necessary single line diagrams \ GA drawings shall be furnished by contractor for approval by consultant \ owner.

25.2 GENERAL

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

All motor control centres shall be suitable for operation on 3 Phase/single phase, 11,000/415/240 volts, 50 cycles, 4 wire system with neutral grounded at transformer. All MCCs be CPRI tested design and manufactured by a approved manufacturer. **CPRI certificate be made available.**

MCCs comply with the latest Relevant Indian Standards and Electricity Rules and Regulations and shall be as per IS-8623. MCCs / starter panels for outdoor equipment shall be suitable for outdoor duty application.

25.3 CONSTRUCTIONAL FEATURES

The Motor Control Centre (MCC) shall be of 2 mm thick sheet steel cabinet and suitable for indoor installation, dead front, floor mounting/wall mounting type and shall be form 3b construction. The Distribution panels be totally enclosed, completely dust and vermin proof and be with hinged doors and folded covers, Neoprene gasket, padlocking arrangement and bolted back. All removable/ hinged doors and covers shall be grounded by flexible standard connectors. MCC shall be suitable for the climatic conditions as specified in Special Conditions. Steel sheets used in the construction of panels be 2 mm thick and be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet metal shall be seam welded, all welding, slag shall be rounded off and welding pits wiped smooth with plumber metal. The general construction confirm to IS-8623-1977 (Part-1) for factory built assembled switchgear & control gear for voltage upto and including 1100 V AC.

All MCCs/panels and covers shall be properly fitted and square with the frame, and holes in the panel correctly positioned. Fixing screws enter into holes tapped into an adequate thickness of metal or provided with wing nuts. Self threadingscrews not be used in the construction of Distribution panels. A base channel of 75 mm x 40 mm x 5 mm thick shall be provided at the bottom for floor mounted panels. Minimum **operating** clearance of 275 mm be provided between the floor of panels and the lowest operating height.

The MCCshall be of adequate size with a provision of spare feeders. Feeders be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and minimum clearance between phase and earth be 20 mm and phase to phase be 25 mm.

Panels with ACB shall necessarily have front and rear access as per requirement whereas panels with all MCCB breaker shall be provided with front access with sufficient clearance.

25.4 WIRING SYSTEM

All control wiring shall be carried out by using PVC insulated copper conductor wires in conduits. Minimum size of control wiring be 1.5 sq mm. Minimum size of conductor for power wiring shall be 4 sq. mm 1100 volts grade PVC insulated copper conductor wires in conduit. All conductors shall be stranded.

25.5 CIRCUIT COMPARTMENT

All components for each feeder shall be housed in a separate compartment and have steel sheets on top and bottom of compartment. Sheet steel hinged lockable door be duly interlocked with the breaker in the "ON" position. Safety interlocks be provided to prevent the breaker from being drawn-out when the breaker is in 'ON' position. The door not form an integral part of the draw-out portion of the panel. Sheet steel barriers shall be provided between the tiers in a vertical section.

All MCCs shall be provided with feeders of appropriate capacity as per Single Line Diagram. All MCCs shall be completely factory wired, ready for connection. All the terminals shall be of proper current rating and sized to suit individual feeder requirements. Each circuit be clearly numbered from left to right to correspond with wiring diagram. All the switches and circuits be distinctly marked with a small description of the service installed.

Continuous earth bus sized for prospective fault current shall be provided with arrangement for connecting to station earth at two points. Hinged doors/ frames shall be connected to earth through adequately sized flexible braids.

25.6 INSTRUMENT ACCOMMODATION

Adequate space shall be provided for accommodating instruments, indicating lamps, control contactors and control MCBs. These shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker and bus bar `ON' lamps shall be provided on all outgoing feeders.

25.7 BUS BAR CONNECTIONS

Bus bar and interconnections shall be of high conductivity electrolytic grade aluminium/copper complying with requirement of IS : 5082 – 1981 and of rectangular cross section suitable for carrying the rated full load current and short circuit current and shall be extendable on either side. Copper conductor shall be used for busbar of rating 1000A and above. Bus bars and interconnections shall be insulated with heat shrinkable sleeve of 1.1 KV grade and shall be colour coded. Bus bars shall be supported on glass fiber reinforced thermosetting plastic insulated supports at regular intervals to withstand the force arising from in case of short circuit in the system. All bus bars shall be provided in a separate chamber and all connections shall be done by bolting. Additional cross sectional area to be added to the bus bar to compensate for the holes. All connections between bus bars and breakers shall be through solid copper / aluminium strips of proper size to carry full rated current and insulated with insulating sleeves. Maximum current density for the busbars be 0.8 A/sq.mm for aluminium and 1.4 A/sq.mm for copper busbars.
Maximum allowable temperature for the Bus bar to be restricted to 85 deg C

25.8 TEMPERATURE - RISE LIMIT

Unless otherwise specified, in the case of external surface of enclosures of bus bar compartment which shall be accessible but do not need to be touched during normal operation, an increase in the temperature rise limits of 25° C above ambient temperature be permissible for metal surface and of 15° C above ambient temperature for insulating surfaces as per IS 8623(Part-2) 1993.

25.9 CABLE COMPARTMENTS

Cable compartment of adequate size shall be provided in the panel for easy clamping of all incoming and outgoing cables entering from the top/bottom. Adequate supports be provided in cable compartment to support cables as per approved for construction shop drawing.

25.10 AIR CIRCUIT BREAKERS (ACB)

The ACB conform to the requirements of IEC 60947-2 / IS 13947-2 and shall be type tested & certified for compliance to standards from–CPRI, ERDA/ any accredited international lab. The circuit breaker shall be suitable for 415 V ± 10%, 50 Hz supply system. Air Circuit Breakers be with moulded housing flush front, draw out type and shall be provided with a trip free manual operating mechanism or as indicated in drawings with mechanical "ON" "OFF" “TRIP” indications.

The ACB be 3/ 4 pole with modular construction, draw out, manually or electrically operated version as specified. The circuit breakers shall be for continuous rating and service short Circuit Breaking capacity (Ics) shall be as specified on the single line diagram and should be equal to the Ultimate breaking capacity(Icu) and short circuit withstand values(Icw) for 1 sec.

Circuit breakers shall be designed to ‘close' and `trip' without opening the circuit breaker compartment door. The operating handle and the mechanical trip push button shall be at the front of the breakers panel. Inspection of main contacts should be possible without using any tools. The ACB shall be provided with a door interlock. i.e. door should not be open when circuit breaker is closed and breaker should not be closed when door is open.

All current carrying parts shall be silver plated and suitable arcing contacts with proper arc chutes shall be provided to protect the main contacts. The ACB have double insulation (Class-II) with moving and fixed contacts totally enclosed for enhanced safety and in accessibility to live parts. All electrical closing breaker be with electrical motor wound stored energy spring closing mechanism with mechanical indicator to provide ON/OFF status of the ACB.

The auxiliary contacts blocks shall be so located as to be accessible from the front. The auxiliary contacts in the trip circuits close before the main contacts have closed. All other contacts close simultaneously with the main contacts. The auxiliary contacts in the trip circuits open after the main contacts open. Minimum 4 NO and 4 NC auxiliary contacts be provided on each breaker.

Rated insulation voltage be 1000 volts AC.

25.10.1 CRADLE

The cradle shall be so designed and constructed as to permit smooth withdrawal and insertion of the breaker into it. The movements be free from jerks, easy to operate and be on steel balls/rollers and not on flat surfaces.

There shall be 4 distinct and separate position of the circuit breaker on the cradle.
Racking Interlock in Connected/Test/Disconnected Position.

Service Position : Main Isolating contacts and control contacts of the breaker are engaged.

Test Position : Main Isolating contacts are isolated but control contacts are still engaged.

Isolated Position : Both main isolating and control contacts are isolated.

There shall be provision for locking the breaker in any or all of the first three positions.

The following safety features be incorporated :

f. Withdrawal or engagement of Circuit breaker not be possible unless it is in open condition.

g. Operation of Circuit breaker not be possible unless it is fully in service, test or drawn out position.

h. All modules shall be provided with safety shutters operated automatically by movement of the carriage to cover exposed live parts when the module is withdrawn.

i. All Switchgear module front covers have provision for locking.

j. Switchgear operating handles shall be provided with arrangement for locking in 'OFF' position.

25.10.2 PROTECTIONS

The breaker should be equipped with micro-controller based , communicable type release with RS 485 port for communication to offer accurate and versatile protection with complete flexibility and offer complete over current protection to the electrical system in the following four zones :

- Long time protection.
- Short time protection with intentional delay.
- Instantaneous protection.
- Ground fault protection.

The protection release generally have following features and settings **however for exact selection of protection releases shall be made based on project requirement,**

a. True RMS Sensing

The release sample the current at the rate of 16 times per cycle to monitor the actual load current waveform flowing in the system and monitor the true RMS value of the load current. It take into account the effect of harmonics also.

b. Thermal Memory
When the breaker reclose after tripping on overload, then the thermal stresses caused by the overload if not dissipated completely, get stored in the memory of the release and this thermal memory ensure reduced tripping time in case of subsequent overloads. Realistic Hot/Cold curves take into account the integrated heating effects to offer closer protection to the system.

c. Defined time-current characteristics :

A variety of pick-up and time delay settings shall be available to define the current thresholds and the delays to be set independently for different protection zones thereby achieving a close-to-ideal protection curve.

d. Trip Indication

Individual fault indication for each type of fault should be provided by LEDs for faster fault diagnosis.

e. Self powered

The release draw its power from the main breaker CTs and require no external power supply for its operation.

f. Zone Selective Interlocking

The release shall be suitable for communication between breakers to enable zone selective interlocking. This feature shall be provided for both short circuit and ground fault protection zones to offer intelligent discrimination between breakers. This feature enables faster clearance of fault conditions, thereby reducing the thermal and dynamic stresses produced during fault conditions and thus minimises the damage to the system.To implement ZSI manufacturer should supply all related equipment like power supply, wiring etc.

On-Line change of settings should be possible. It should be possible to carry out testing of release without tripping the breaker.

g. The release meet the EMI / EMC requirements.

h. The setting range of release shall be generally as follows :

	SETTING RANGE OF RELEASE	
Type of Protection	PICK-UP CURRENT	TIME DELAY
Long Time	0.4 to 1.0 times I_n (I_r) Steps : 0.4, 0.5, 0.55, 0.60, 0.65, 0.70, 0.75, 0.80, 0.85, 0.90, 0.95, 1.00. Operating Limit : 1.05 to 1.2 times I_r	0.5 to 30 sec at 6 I_r Steps 0.5,1, 2,4, 6, 8,12,18,24 and 30 secs Tolerance : Corresponding to ±10% of current.
Short Time	2 to 10 times I_r Steps : 2,3,4,5,6,7,8,9 & 10 Tolerance : ±10%	20 ms to 600 ms Steps 20,60,100,160,200,260,300 400,500 and 600 ms Tolerance : ±10% or 20ms whichever is higher
Instantaneous	2 to 12 times I_n Steps : 2,3,4,6,8,10,12 Tolerance : ±10%	
Ground Fault	0.2 to 0.6 time I_n Steps : 0.2,0.3,0.4,0.5,0.6 Tolerance : ±10%	100 ms to 400 ms Steps : 100,200,300,400ms Tolerance :±10% or 20 ms whichever is higher.

All **incomer** ACBs have following additional protections other than mentioned above.

- Under and over voltage
- Under and over frequency
- Restricted Earth Fault protection
- Trip Circuit supervision with PS class CT's.
- Undercurrent, (for DG set only)
- Reverse power (for DG set only)
- Phase sequence reversal (for DG set only)
- Load shedding and reconnection thru programmable contacts.
- Release should display the Contact wear indication.

The release should provide local indication of actual %age loading at any instant. The release should be able to communicate on MODBUS RTU protocol using inbuilt RS485/232/Ethernet port and shall be integral part of supply with trip unit. Parameters of the Protection Release should be changeable from Release as well as thru communication network. Release should have graphical LCD for display of power parameters. The release of incoming breakers should provide comprehensive metering with the following parameters

- Phase currents (running, avg& max) – All parameters in single window.
- Release should be able to capture short circuit current on which ACB has tripped. The last ten trips and alarms shall be stored in memory with the date & time stamping along with type of fault and alarm. The sensing CT Should be Rogowsky type with measurement precision of 1%.
- Release should be self powered .
- Release should have facility to select different type of IDMTL protection(DT,SIT,VIT,EIT,HVF) for better co-ordination with HT Breaker/Fuse.
- Phase voltages (running, avg& max)
- Energy & power parameters (active, reactive and apparent)
- PF
- Frequency
- Maximum Demand (KVA & KW)
- Total Harmonics distortion

<u>All **O/G** ACBs have following functions.</u>

Protection

- The ACB control unit offer the following protection functions as standard:
  Long-time (LT) protection with an adjustable current setting and time delay;
- Short-time (ST) protection with an adjustable pick-up and time delay;
- instantaneous (INST) protection with an adjustable pick-up and an OFF Position.
- Current and time delay setting be indicated in amperes and seconds respectively On a digital display.
- Earth-fault protection with an adjustable pick-up and time delay be provided if indicated on the appended single-line diagram.

Measurements

- An ammeter with a digital display indicate the true rms values of the currents for each phase.Release acknowledge the current & time delay settings done by user on the LCD display.
- A LED bargraph simultaneously display the load level on the three phases.
- A maximeter store in memory and display the maximum current value observed since the last reset. The data continue to be stored and displayed even after opening of the circuit breaker.

25.10.3 SAFETY FEATURES

I. The safety shutter prevent inadvertent contact with isolating contacts when breaker is withdrawn from the Cradle.

II. It not be possible to interchange two circuit breakers of two different thermal ratings. For Draw-out breakers, an arrangement be provided to prevent rating mismatch between breaker and cradle.

III. There shall be provision of positive earth connection between fixed and moving portion of the ACB either thru connector plug or sliding solid earth mechanism. Earthing bolts shall be provided on the cradle or body of fixed ACB.

IV. The incoming panel accommodating ACB shall be provided with indicating lamps for ON-OFF positions, digital voltmeter and ammeter of size not less than 96 mm x 96 mm, selector switches, MCB for protection circuit and measuring instrument circuits.

V. It shall be possible to bolt the draw out frame not only in connected position but also in TEST and DISCONNECTED position to prevent dislocation due to vibration and shocks.

VI. Draw out breakers should not close unless in distinct Service/Test/Isolated positions.

VII. The insulation material used conform to Glow wire test as per IEC60695.

VIII. The ACB provide in built electrical and mechanical anti-pumping.

IX. All EDO ACB`s have Ready to Close Contact to ensure that the ACB gets a command only when it is ready to close for applications of Remote Control, AMF, Synchronization and Auto Source Change Over Systems.

25.11 MOULDED CASE CIRCUIT BREAKER (MCCB)

The MCCB should be current limiting type with trip time of less than 10 msec under short circuit conditions. The MCCB should be either 3 or 4 poles. MCCB comply with the requirements of the relevant standards IS13947 – Part 2/IEC 60947-2 and should have test certificates for Breaking capacities from independent test authorities CPRI / ERDA or any accredited international lab.

MCCB comprise of Quick Make -break switching mechanism, arc extinguishing device and the tripping unit shall be contained in a compact, high strength, heat resistant, flame retardant, insulating moulded case with high withstand capability against thermal and mechanical stresses

The breaking capacity of MCCB be as specified in the Drawings. The rated service breaking capacity (Ics) should be equal to rated ultimate breaking capacities (Icu).MCCBs for motor application should be selected in line with Type-2 Co-ordination as per IEC-60947-2, 1989/IS 13947-2. The breaker as supplied to meet IP54 degree of protection.

25.11.1 Current Limiting & Coordination

- The MCCB employ maintenance free minimum let-through energies and capable of achieving discrimination up to the full short circuit capacity of the downstream MCCB. **The**

manufacturer provide both the discrimination tables and let-through energy curves for all.

Protection Functions

- MCCBs with ratings less than 100 A shall be equipped with Thermal-magnetic (**adjustable** thermal for overload and **fixed** magnetic for short-circuit protection) trip units
- Microprocessor MCCBs with ratings 100A and above shall be equipped with microprocessor based trip units.
- Microprocessor and thermal-magnetic trip units shall be adjustable and it shall be possible to fit lead seals to prevent unauthorized access to the settings
- Microprocessor trip units comply with appendix F of IEC 60947-2 standard (measurement of RMS current values, electromagnetic compatibility, etc.)
- Protection settings apply to all poles of circuit breaker.
- All Microprocessor components withstand temperatures up to 125 °C

25.11.2 Testing

a) Original test certificate of the MCCB as per IEC 60947-1 &2 or IS13947 be furnished.
b) Pre-commissioning tests on the switch board panel incorporating the MCCB shall be done as per standard specifications.

25.11.3 Interlocking

Moulded, case circuit breakers be provided with the following interlocking devices for interlocking the door of a switch board.

a) Handle interlock to prevent unnecessary manipulations of the breaker.

b)Door interlock to prevent the door being opened when the breaker is in ON position.

c) Defeat-interlocking device to open the door even if the breaker is in ON position.

- The MCCB shall be current limiting type and comprise of quick make – Break switching mechanism. MCCBs shall be capable of defined variable overload adjustment. All MCCBs rated 100 Amps and above have adjustable over load & short circuit pick-up .

  - All MCCB with microprocessor based release unit, the protection be adjustable Overload, Short circuit and earth fault protection with time delay.

  The trip command override all other commands.

25.12 MOTOR PROTECTION CIRCUIT BREAKER (MPCB)

Motor circuit breakers conform to the general recommendations of standard IEC 947 -1,2 and 4 (VDE 660, 0113 NF EN 60 947-1-2-4, BS 4752) and to standards UL 508 and CSA C22-2 N°14.

The devices shall be in utilization category A, conforming to IEC 947-2 and AC3 conforming to IEC 947-4.MPCB have a rated operational and insulation voltage of 690V AC (50 Hz) and MPCB shall be suitable for isolation conforming to standard IEC 60947-2 and have a rated impulse withstand voltage (Uimp) of 6 kV. The motor circuit breakers shall be designed to be mounted vertically or horizontally without de-rating. Power supply be from the top or from the bottom. In order to ensure maximum safety, the contacts shall be isolated from other functions such as the operating mechanism, casing, releases, auxiliaries, etc, by high performance thermoplastic chambers. The operating mechanism of the motor circuit breakers must have snap action opening

and closing with free tripping of the control devices. All the poles close, open, and trip simultaneously. The motor circuit breakers accept a padlocking device in the “isolated” position.

The motor circuit breakers shall be equipped with a “PUSH TO TRIP” device on the front enabling the correct operation of the mechanism and poles opening to be checked. The auxiliary contacts shall be front or side mounting, and both arrangements be possible. The front-mounting attachments not change the breaker surface area. Depending on its mounting direction the single pole contact block could be NO or NC. All the electrical auxiliaries and accessories shall be equipped with terminal blocks and shall be plug-in type. The motor circuit breakers have a combination with the downstream contactor enabling the provision of a perfectly co-ordinated motor-starter. This combination enable type 1 or type 2 co-ordination of the protective devices conforming to IEC 60947-4-1.Type 2 co-ordination be guaranteed by tables tested and certified by an official laboratory: LOVAG (or other official laboratory).The motor circuit breakers, depending on the type, could be equipped with a door-mounted operator which allow the device setting. The motor circuit breakers shall be equipped with releases comprising a thermal element assuring overload protection and a magnetic element for short-circuit protection. In order to ensure safety and avoid unwanted tripping, the magnetic trip threshold (fixed) be factory set to an average value of 12 Ir.

All the elements of the motor circuit breakers shall be designated to enable operation at an ambient temperature of 60°C without derating. The thermal trips shall be adjustable on the front by a rotary selector. The adjustment of the protection shall be simultaneous for all poles. Phase unbalance and phase loss detection shall be available. Temperature compensation (-20°C to +60°C)

25.13 MINIATURE CIRCUIT BREAKER (MCB)

Miniature Circuit Breaker comply with IS-8828-1996/IEC898-1995. Miniature circuit breakers shall be quick make and break type for 240/415 VAC 50 Hz application with magnetic thermal release for over current and short circuit protection. The breaking capacity not be less than 10 KA at 415 VAC. MCBs shall be DIN mounted. The MCB shall be Current Limiting type (Class-3). MCBs shall be classified (B,C,D ref IS standard) as per their Tripping Characteristic curves defined by the manufacturer. The MCB have the minimum power loss (Watts) per pole defined as per the IS/IEC and the manufacturer publish the values.MCB ensure complete electrical isolation & downstream circuit or equipment when the MCB is switched OFF.

The housing shall be heat resistant and having a high impact strength. The terminals shall be protected against finger contact to IP20 Degree of protection. All DP, TP, TPN and 4 Pole miniature circuit breakers have a common trip bar independent to the external operating handle.

25.14 PAINTING

All sheet steel work undergo a process of degreasing, pickling in acid, cold rinsing, phosphating, passivaiting (seven tank processing)

This coating shall meet the following durability test requirement :-

a) Salt Spray withstand 3000 salt spray test hours or more as per ASTM P117 - 03.
b) 25 Weeks Cycle aging test -ISO 20340

c) 1000 Cycles Taber abrasion test - ASTM 04060

d) Flexibility - ISO 1520.

e) Anti-Microbial, Anti-Bacterial, Anti-Fungi Standard test.

This coating shall be factory or field applied.

Then painted with electrostatic paint (Powder coating). The shade of colour of panel inside/outside shall be as indicated in datasheets & relevant BIS code.

Heat Resistance of the coating shall exceed 150°C.

The protection coating shall be maintainable in site and warrantied against climate impact and galvanic corrosion for (10) ten years.

The corrosion resistive coating (Anti-corrosive coating) for parts exposed to the direct sun shall be UV resistant.
A multi coating shall be applied for the complete unit including the casing, piping and headers.

25.15 LABELS

Engraved PVC labels shall be provided on all incoming and outgoing feeder. Circuit diagram showing the arrangements of the circuit inside the control panel shall be pasted on inside of the panel door and covered with transparent plastic sheet.

25.16 METERS

i. All voltmeters and indicating lamps shall be through MCB's.

ii. Meters and indicating instruments be plug type.

iii. All CT's connection for meters shall be through Test Terminal Block (TTB).

iv. CT ratio and burdens shall be as specified on the Single line diagram.

25.17 CURRENT TRANSFORMERS

Current transformers be provided for Control panels carrying current in excess of 60 amps. All phase be provided with current transformers of suitable VA burden with 5 amps secondaries for operation of associated metering.

The CTs confirm to relevant Indian Standards. The design and construction shall be dry type, epoxy resin cast, robust to withstand thermal and dynamic stresses during short circuits. Metering CTs, have inbuilt busbar mounting arrangement. Secondary terminals of CTs be brought out suitable to a terminal block which be easily accessible for testing and terminal connections. The secondary terminal should be covered with insulation cap/cover so that there should not be any possibility of touching the live terminal. The protection CTs be of accuracy class 5P20 and measurement CTs be of accuracy class I.

25.18 SELECTOR SWITCH Where called for, selector switches of rated capacity be provided in control panels, to give the choice of operating equipment in selective mode.

25.19 CONTACTOR

Contactor shall be built into a high strength thermoplastic body and shall be provided with an arc shield for quick arc extinguishing. Silver alloy tips shall be provided to ensure a high degree of reliability and endurance under continuous operation. The magnet system consist of laminated yoke and armature to ensure clean operation without hum or chatter.

Starters contactors have 3 main and 2 Nos. NO / NC auxiliary contacts and shall be air break type suitable for making and breaking contact at minimum power factor of 0.35. For design consideration of contactors the starting current of connected motor shall be assumed to be 6 times

the full load current of the motor in case of direct-on-line starters and 3 times the full load current of the motor in case of Star Delta and Reduced Voltage Starters. The insulation for contactor coils be of Class “E”.

Coil shall be tape wound vacuum impregnated and be housed in a thermostatic bobbin, suitable for tropical conditions and withstand voltage fluctuations. Coil be suitable for 220/415±10% volts AC, 50 cycles AC supply.

25.20 THERMAL OVERLOAD RELAY

Thermal over load relay have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5° C to +55°C.

All overload relays shall be of three element, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable setting. Relays shall be directly connected for motors upto 35 HP capacity. C.T. operated relays be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

25.21 TIME DELAY RELAYS

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and have one set of auxiliary contacts for indicating lamp connection.

25.22 INDICATING LAMP AND METERING

All meters and indicating lamps be in accordance with relevant IS standard specification. The meters shall be flush mounted type. The indicating lamp shall be of LED type . Each MCC and control panel be provided with voltmeter 0-500 volts with three way and off selector switch, CT operated ammeter of suitable range with three nos. CTS of suitable ratio with three way and off selector switch, phase indicating lamps, and other indicating lamps as called for. All indicating lamp be backed up with 5 amps MCB.

25.23 TOGGLE SWITCH

Toggle switches, where required, shall be in conformity with relevant IS Codes and be of 5 amps rating.

25.24 PUSH BUTTON STATIONS

Push button stations shall be provided for manual starting and stopping of motors / equipment Green and Red colour push buttons shall be provided for 'Starting' and 'Stopping' operations. 'Start' or 'Stop' indicating flaps shall be provided for push buttons. Push Buttons shall be suitable for panel mounting and accessible from front without opening door, Lock lever be provided for 'Stop' push buttons. The push button contacts be suitable for 6 amps current capacity.

25.25 CONDUITS

Conduits and Accessories conform to latest edition of Indian Standards IS-9537 part 1 & 2. 16/14 (16 gauge upto 32mm diameter & 14 gauge above 32 mm diameter) gauge screwed GI or MS conduits to be used. Joints between conduits and accessories shall be securely made by standard accessories, as per IS-2667, IS-3837 and IS-5133 to ensure earth continuity. All conduit accessories shall be threaded type only.

Only approved make of conduits and accessories be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit bear the label of the manufacturer.

Note. : Whatever materials required to be billed by the Contractor should come on site with proper Challan Numbers and quantity mentioned in each such Challan..

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into metallic Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	**Maximum number of wires within conduit size(mm)**				
	20	**25**	**32**	**40**	**50**
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

Maximum permissible number of 1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or PVC Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	**Maximum number of wires within conduit size(mm)**				
	20	**25**	**32**	**40**	**50**
1.5	7	12	16	--	--
2.5	5	10	14	--	--
4	4	8	12	--	--
6	3	6	8	--	--
10	--	4	5	6	--
16	--	3	3	6	6
25	--	--	2	4	6
35	--	--	--	3	5

25.26 CABLES

1100V grade Cables of sizes 25 sq. mm. and above shall be XLPE FRLS insulated aluminium conductor armoured type and PVC insulated Copper conductor armoured cables for sizes 16 sq. mm. and below. All cables shall be conforming to IS Codes. Cables shall be suitable for laying in trenches, ducts, and on cable trays as required. Cables shall be termite resistant. Cable glands shall be heavy duty double compression brass glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

The equipment inside plant room shall be connected to the control panel by means of suitable cables of adequate size. An isolator shall be provided near each motor/equipment (mounted within 10 ~ 15 mtr distance on nearest wall or self supported on floor) wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

Cables shall be cross linked polyethylene (XLPE) insulated PVC inner sheathed and ~~FR PVC~~ FRLS PVC outer sheath of 1100 volts grade. Cables shall be suitable for laying in trenches, ducts, and on cable trays as required. Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables. All conductors shall be stranded.

Cabling shall be of the following sizes as mimimum :

i.	From 30 HP to 35 HP motors	2 nos. 3 x 16 sq. mm aluminium conductor armoured cable.
ii.	From 40 HP to 50 HP motors	2 Nos. 3 x 25 sq. mm. aluminium conductor armoured cable.
iii.	From 60 HP to 75 HP motors	1 No. 3 x 70 sq. mm aluminium conductor armoured cable.
iv.	100 HP motors	1 No. 3 x 150 sq. mm. aluminium conductor armoured cable
v.	150 HP motor	1 No. 3 x 240 sq. mm. aluminium conductor armoured cable.
vi.	250 HP motor	2 Nos. 3 x 240 sq. mm. aluminium conductor armoured cable.
vii.	400 HP motor	3 Nos. 3 x 240 sq. mm. aluminium conductor armoured cable.
viii.	600 HP motor	3 Nos. 3 x 400 sq. mm. aluminium conductor armoured cable.

25.27 CABLE LAYING

Cables shall be laid by skilled and experienced workmen using adequate rollers to minimize stretching of the cable. The cable drums be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks.

25.27.1 Laying of Cables on Cable Trays

The relative position of the cables, laid on the cable tray be preserved and the cables not cross each other. At all changes in direction in horizontal and vertical planes, the cable shall be bent smooth with a radius as recommended by the manufacturer's. All cables be laid with minimum one diameter gap and shall be clamped at every metre to the cable tray. Cables be tagged for identification with aluminum tag and clamped properly at every 20M. Tags be provided at both ends and all changes in directions both sides of wall and floor crossings. All cable be identified by embossing on the tag the size of the cable, place of origin and termination.

All cables passing through holes in floor or walls shall be sealed with fire retardant Sealant and shall be painted with fire retardant paint upto one meter on all joints, terminations and both sides of the wall crossings by "VIPER CABLE RETARD".

25.27.2 **Laying of Cables in Ground**

The width of trench for laying single cable be minimum 350 mm. Where more than one cable is to be laid in horizontal formation, the width of the trench be workout by providing 200 mm gap between the cables, except where otherwise specified. There shall be clearance of 150 mm between the end cable and the side wall of the trench. The minimum depth of the cable trench no to be less than 750 mm for single layer of cables. When the cables are laid in more than one tier the depth of the trench shall be increased by 300 mm for each additional tier.

Excavation of trenches : The trenches shall be excavated in reasonably straight lines. Wherever there is a change in direction, suitable curvature shall be provided. Where gradients and changes in depth are unavoidable, these shall be gradual. The excavated soil shall be stacked firmly by the side of the trench such that it may not fall back into the trench. The bottom of the trench shall be levelled and shall be made free from stone, brick bats etc. The trench then shall be provided with a layer of clean, dry sand cushion of not less than 100 mm in depth. Prior to laying of cables, the cores shall be tested for continuity and insulation resistance. The cable drum be properly mounted on jacks, at a suitable location, making sure that the spindle, jack etc. are strong enough to carry the weight of the drum and the spindle is horizontal. Cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains. The entire drum length shall be laid in one stretch. However, where this is not possible the remainder of the cable be removed by `Flaking' i.e. by making one long loop in the reverse direction. After the cable has been uncoiled and laid into the trench over the rollers, the cable shall be lifted off the rollers beginning from one end by helpers standing about 10 meters apart and laid in a reasonably straight line. Cable laid in trenches in a single tier formation have a cover of clean, dry sand of not less than 150 mm. above the base cushion of sand before the protective cover is laid. In the case of vertical multi-tier formation after the first cable has been laid, a sand cushion of 300 mm shall be provided over the initial bed before the second tier is laid. Finally the cables be protected by second class bricks before back filling the trench. The buried depth of uppermost layer of cable not be less than 750mm.

Back Filling : The trenches shall be back filled with excavated earth free from stones or other sharp edged debris and shall be rammed and watered, if necessary, in successive layers not exceeding 300 mm. Unless otherwise specified, a crown of earth not less than 50 mm in the centre and tapering towards the sides of the trench shall be left to allow for subsidence.

25.28 WIRE AND WIRE SIZES

1100 volts grade PVC insulted copper conductor wires in conduit shall be used.

For all single phase/ 3 phase wiring, 1100 volts grade PVC insulated copper conductor LSZH wires shall be used. The equipment inside plant room and AHU room shall be connected to the control panel by means of insulated copper conductor wires of adequate size in exposed conduits. Final connections to the equipment shall be through wiring enclosed in galvanized flexible conduits rigidly clamped at both ends and at regular intervals. An isolator shall be provided near each motor/equipment wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads be provided at both the ends for easy identification of control wiring.

The minimum size of control wiring shall be 1.5 sq. mm PVC insulated stranded soft drawn copper conductor wires drawn through conduit to be provided for connecting equipment and control panels.

Power cabling shall be of the minimum following sizes:

i.	Upto 5 HP motors/ 5 KW heaters	3C x 4 sq. mm copper conductor PVC insulated cables.

ii. From 6 HP to 10 HP motors 6 KW to 7.5 KW heaters — 3 x 6 sq. mm copper conductor PVC insulated cables.

iii. From 12.5 HP to 15 HP motors — 2 Nos. 3 x 6 sq. mm copper conductor PVC insulated cables.

iv. From 20 HP to 25 HP motors — 2 Nos. 3 x 10 sq. mm copper conductor PVC insulated cables

STARTERS

Each motor shall be provided with a starter of suitable rating. Starters be in accordance with relevant IS Codes. All Star Delta Starters be fully automatic. **Motors up to 7.5 HP be provided by Direct On Line (DOL) starter, motors above 7.5 HP and up to 45 HP shall be provided by star/delta starter and motors above 45 HP shall be provided by soft starter**. All starters be with Type II coordination for breaker, contactor and over load relay.

All the switches, contactors, push button stations, indicating lamps be distinctly marked with a small description of the service installed. The following capacity contactors and overload relays shall be provided for different capacity motors or as per manufacturer's recommendation.

TYPE OF STARTER CAPACITY	CONTACTOR CURRENT RANGE		OVERLOAD RELAY
5 HP Motors	D O L	16 amps	6-10 amps
7.5 HP motors	D O L	16 amps	9-15 amps
10 HP Motors	Automatic Star Delta	25 amps	9-15 amps
12.5 HP Motors	Automatic Star Delta	16 amps	9-15 amps
15 HP Motors	Automatic Star Delta	25 amps	9-15 amps
20 HP Motors	Automatic Star Delta	32 amps	14-23 amps
25 HP Motors	Automatic Star Delta	32 amps	14-23 amps
30 HP Motors	Automatic Star Delta	40 amps	20-33 amps
35 HP Motors	Automatic Star Delta	40 amps	20-33 amps
40 HP Motors	Automatic Star Delta	40 amps	30-50 amps
50 HP Motors	VFD	70 amps	30-50 amps
60 HP Motors	VFD	110 amps	30-50 amps
75 HP Motors	VFD	110 amps	90-150 amps
100 HP Motors	VFD	200 amps	CT operated relay
125 HP Motors	VFD	200 amps	CT operated relay
150 HP Motors	VFD	200 amps	CT operated relay
150 HP Motors	VFD	300 amps	CT operated Relay.
200 HP Motors	VFD	300 amps	CT operated Relay.
250 HP Motors	VFD	400 amps	CT operated Relay.
300 HP Motors	VFD	400 amps	CT operated Relay.
400 HP Motors	VFD	600 amps	CT operated Relay.
600 HP Motors	VFD	900 amps	CT operated Relay.

Two speed motors when specified, be provided with DOL starter irrespective of it rating.

25.29 CABLE TRAYS

Ladder and perforated type Cable Trays be of Hot dip Galvanized type and factory fabricated out of CRCA sheet with standard accessories like tee, bends, couplers etc. for different loads and number and size of cables as given below :

Cable trays be galvanized as per Specifications..

a. 1500 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

b. 1200 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

c. 1000 mm wide
Runners 25 x 100 x 25 x 3 mm
Rungs 2# 20 x 40 x 20 x 3 mm 250 mm C/C
Suspenders 2 Nos. 40 x 40 x 5 mm GI angle 1500 mm C/C with base support of 40x 40 x 5mm GI angle.

d. 750 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

e 600 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 32 x 32 x 5 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

f. 450 mm wide
Runners 20 x 75 x 20 x 2.5 mm
Rungs 20 x 30 x 20 x 2.5 mm 250 mm C/C
Suspenders 2 Nos. 25 x 25 x 4 mm GI angle 1800 mm C/C with base support of 40x 40 x 5mm GI angle.

g. Supply and fixing of perforated type cable trays of the following sizes of pre-galvanized iron.

i. 600 x 40 x 40 x 2 mm thick
i. 450 x 40 x 40 x 2 mm thick
i. 300 x 40 x 40 x 2 mm thick
ii. 150 x 40 x 40 x 2 mm thick

Note : Suitable length of 10 mm dia GI rod suspenders at 1800 mm interval shall be included in the item for perforated type cable tray.

26. VARIABLE FREQUENCY DRIVES FOR HVAC SYSTEMS

26.1 GENERAL REQUIREMENTS

1.1 This specification covers complete variable frequency drives (VFDs) designated on the drawing schedules to be variable speed. All standard and optional features shall be included within the VFD.

1.2 The frequency converter shall not be a general purpose product, but a dedicated HVAC engineered product.

1.3 The VFD and its options shall be factory mounted and tested as a single unit under full load before dispatch.

1.4 The VFD shall be tested to UL 508C. The appropriate UL label shall be applied.

1.5 The VFD shall be CE marked and conform to the European Union Electro Magnetic Compatibility directive.

1.6 The VFD shall be UL listed for a short circuit current rating of 100 kA and labeled with this rating.

26.2 TECHNICAL REQUIREMENTS

2.1 The VFD shall convert incoming fixed frequency three-phase AC power into an adjustable frequency and voltage for controlling the speed of three-phase AC motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating.

When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.

2.2 VFD shall be installed within panel, suitable for operating conditions.

2.3 The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.

2.4 The VFD shall have a dual 5% impedance DC link reactor (harmonic filters) on the positive and negative rails of the DC bus to minimize power line harmonics &protect the VFD from power line transients, alongwith advance harmonics filters at integral component of VFD to maintain TH id < 5% at drive terminals to meet IEEE 519, 1992 guidelines.

2.5 VFDs with saturating (non-linear) DC link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.

IEEE519, 1992 recommendations shall be used for the basis of calculation of total harmonic distortion (THD) at the point of common coupling (PCC). On request VFD manufacturer shall provide THD figures for the total connected load. The contractor shall provide details of supply transformer rating, impedance, short circuit current, short circuit impedance etc to allow this calculation to be made.

2.6 All VFDs shall contain integral EMC Filters to attenuate Radio Frequency Interference conducted to the AC power line. The VFDs shall comply with the emission and immunity requirements of IEC 61800-3 : 2004, Category C1 with 50m motor cable (unrestricted distribution). The suppliers of VFDs shall include additional EMC filters if required to meet compliance to this requirement.

2.7 The VFD's full load output current rating shall meet or exceed the normal rated currents of standard IEC induction motors. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

2.8 The VFD shall provide full motor torque at any selected frequency from 20 Hz to base speed while providing a variable torque V/Hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque V/Hz curve was used at reduced speeds. Breakaway current of 160% shall be available.

2.9 A programmable automatic energy optimization selection feature shall be provided as standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.

2.10 The VFD must be able to produce full torque at low speed to operate direct driven fans.

2.11 Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.

2.12 An Automatic Motor Adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.

2.13 Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog I/O and discrete digital I/O shall include additional isolation modules.

2.14 VFD shall minimize the audible motor noise through the used of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.

2.15 The VFD shall allow up to at least 100 meters of SWA (Single Wire Armour) cable to be used between the FC and the motor and allow the use of MICS (Mineral Insulated Copper Sheath) cable in the motor circuit for fire locations.

26.3 PROTECTIVE FEATURES

3.1 A minimum of Class 20 I^2t electronic motor overload protection for single motor applications shall be provided. Overload protection shall automatically compensate for changes in motor speed.

3.2 Protection against input transients, loss of AC line phase, output short circuit, output ground fault, over voltage, under voltage, VFD over temperature and motor over temperature. The VFD shall display all faults in plain language. Codes are not acceptable.

3.3 Protect VFD from input phase loss. The VFD should be able to protect itself from damage and indicate the phase loss condition. During an input phase loss condition, the VFD shall be able to be programmed to either trip off while displaying an alarm, issue a warning while running at reduced output

capacity, or issue a warning while running at full commanded speed. This function is independent of which input power phase is lost.

3.4 Protect from under voltage. The VFD shall provide full rated output with an input voltage as low as 90% of the nominal. The VFD will continue to operate with reduced output, without faulting, with an input voltage as low as 70% of the nominal voltage.

3.5 VFD shall include current sensors on all three output phases to accurately measure motor current, protect the VFD from output short circuits, output ground faults, and act as a motor overload. If an output phase loss is detected, the VFD will trip off and identify which of the output phases is low or lost.

3.6 If the temperature of the VFD's heat sink rises to 80°C, the VFD shall automatically reduce its carrier frequency to reduce the heat sink temperature. It shall also be possible to program the VFD so that it reduces its output current limit value if the VFD's temperature becomes too high.

3.7 In order to ensure operation during periods of overload, it must be possible to program the VFD to automatically reduce its output current to a programmed value during periods of excessive load. This allows the VFD to continue to run the load without tripping.

3.8 The VFD shall have temperature controlled cooling fan(s) for quiet operation, minimized losses, and increased fan life. At low loads or low ambient temperatures, the fan(s) may be off even when the VFD is running.

3.9 Protect from output switching : The VFD shall be fully protected from switching a contactor / isolator at the output with out causing tripping e.g.: for switching on/off the isolators of the AHU / ventilation fans / pumps near the motor with VFD in ON mode.

3.10 The VFD shall store in memory the last 10 alarms. A description of the alarm, and the date and time of the alarm shall be recorded.

3.11 When used with a pumping system, the VFD shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

26.4 INTERFACE FEATURES

4.1 Hand, Off and Auto keys shall be provided on the control panel to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

4.2 There shall be an "Info" key on the keypad. The Info key shall include "on-line" context sensitive assistance for programming and troubleshooting.

4.3 The VFD shall be programmable to provide a digital output signal to indicate whether the VFD is in Hand or Auto mode. This is to alert the Building Automation System whether the VFD is being controlled locally or by the Building Automation System.

4.4 Password protected keypad with alphanumeric, graphical, backlit display can be remotely mounted. Two levels of password protection shall be provided to guard against unauthorized parameter changes.

4.5 All VFDs shall have the same customer interface. The keypad and display shall be identical and interchangeable for all sizes of VFDs.

4.6 To set up multiple VFDs, it shall be possible to upload all setup parameters to the VFD's keypad, place that keypad on all other VFDs in turn and download the setup parameters to each VFD. To facilitate setting up VFDs of various sizes, it shall be possible to download from the keypad only size independent parameters. Keypad shall provide visual indication of copy status.

4.7 Display shall be programmable to communicate in multiple languages including English, Chinese, Korean, Japanese, Thai and Indonesian.

4.8 A red FAULT light, a yellow WARNING light and a green POWER-ON light shall be provided. These indications shall be visible both on the keypad and on the VFD when the keypad is removed.

4.9 A quick setup menu with factory preset typical HVAC parameters shall be provided on the VFD. The VFD shall also have individual Fan, Pump, and Compressor menus specifically designed to facilitate start-up of these applications.

4.10 A three-feedback PID controller to control the speed of the VFD shall be standard.

4.11 This controller shall accept up to three feedback signals. It shall be programmable to compare the feedback signals to a common setpoint or to individual setpoints and to automatically select either the maximum or minimum deviating signal as the controlling signal. It shall also be possible to calculate the controlling feedback signal as the average of all feedback signals or the difference between a pair of feedback signals.

4.12 The VFD shall be able to apply individual scaling to each feedback signal.

4.13 For fan flow tracking applications, the VFD shall be able to calculate the square root of any or all individual feedback signals so that a pressure sensor can be used to measure air flow.

4.14 The VFD's PID controller shall be able to actively adjust its setpoint based on flow. This allows the VFD to compensate for a pressure feedback sensor which is located near the output of the pump rather than out in the controlled system.

4.15 The VFD shall have three additional PID controllers which can be used to control damper and valve positioners in the system and to provide setpoint reset.

4.16 Floating point control interface shall be provided to increase/decrease speed in response to contact closures.

4.17 Five simultaneous meter displays shall be available. They shall be selectable from (at a minimum), frequency, motor current, motor voltage, VFD output power, VFD output energy, VFD temperature in degrees, feedback signals in their own units, among others.

4.18 Programmable Sleep Mode shall be able to stop the VFD. When its output frequency drops below set "sleep" level for a specified time, when an external contact commands that the VFD go into Sleep Mode, or when the VFD detects a no-flow situation, the VFD may be programmed to stop. When the VFD's speed is being controlled by its PID controller, it shall be possible to program a "wake-up" feedback value that will cause the VFD to start. To avoid excessive starting and stopping of the driven equipment, it shall be possible to program a minimum run time before sleep mode can be initiated and a minimum sleep time for the VFD.

4.19 A run permissive circuit shall be provided to accept a "system ready" signal to ensure that the VFD does not start until dampers or other auxiliary equipment are in the proper state for VFD operation. The run permissive circuit shall also be capable of initiating an output "run

request" signal to indicate to the external equipment that the VFD has received a request to run.

4.20 VFD shall be programmable to display feedback signals in appropriate units, such as inches of water column (in-wg), pressure per square inch (psi) or temperature (°F). Examples can be room temperature in ^{0}C , return air temperature in ^{0}C , supply air temperature in ^{0}C, CO_2 concentration in ppm, pressure in bar, differential pressure in PSI etc.

4.21 VFD shall be programmable to sense the loss of load. The VFD shall be programmable to signal this condition via a keypad warning, relay output and/or over the serial communications bus. To ensure against nuisance indications, this feature must be based on motor torque, not current, and must include a proof timer to keep brief periods of no load from falsely triggering this indication.

4.22 Standard Control and Monitoring Inputs and Outputs

4.22.1 Four dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.

4.22.2 Two terminals shall be programmable to act as either as digital outputs or additional digital inputs.

4.22.3 Two programmable relay outputs, Form C 240 V AC, 2 A, shall be provided for remote indication of VFD status.

4.22.4 Each relay shall have an adjustable on delay / off delay time.

4.22.5 Two programmable analog inputs shall be provided that can be either direct-or-reverse acting.

4.22.6 Each shall be independently selectable to be used with either an analog voltage or current signal.

4.22.7 The maximum and minimum range of each shall be able to be independently scalable from 0 to 10 V dc and 0 to 20 mA.

4.22.8 A programmable low-pass filter for either or both of the analog inputs must be included to compensate for noise.

4.22.9 The VFD shall provide front panel meter displays programmable to show the value of each analog input signal for system set-up and troubleshooting,

4.22.10 One programmable analog current output (0/4 to 20 mA) shall be provided for indication of VFD status. This output shall be programmable to show the reference or feedback signal supplied to the VFD and for VFD output frequency, current and power. It shall be possible to scale the minimum and maximum values of this output.

4.22.11 It shall be possible to read the status of all analog and digital inputs of the VFD through serial bus communications.

4.22.12 It shall be possible to command all digital and analog output through the serial communication bus.

4.23 Optional Control and Monitoring Inputs and Outputs

4.23.1 It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs.

4.23.2 These modules shall use rigid connectors to plug into the VFD's control card.

4.23.3 The VFD shall automatically recognize the option module after it is powered up. There shall be no need to manually configure the module.

4.23.4 Modules may include such items as:

4.23.5 Additional digital outputs, including relay outputs

4.23.6 Additional digital inputs

4.23.7 Additional analog outputs

4.23.8 Additional analog inputs, including Ni or Pt temperature sensor inputs

4.23.9 It shall be possible through serial bus communications to control the status of all optional analog and digital outputs of the VFD.

4.24 Standard programmable firefighter's override mode allows a digital input to control the VFD and override all other local or remote commands. It shall be possible to program the VFD so that it will ignore most normal VFD safety circuits including motor overload. The VFD shall display FIREMODE whenever in firefighter's override mode. Firemode shall allow selection of forward or reverse operation and the selection of a speed source or preset speed, as required to accommodate local fire codes, standards and conditions.

4.25 A real-time clock shall be an integral part of the VFD.

4.25.1 It shall be possible to use this to display the current date and time on the VFD's display.

4.25.2 Ten programmable time periods, with individually selectable ON and OFF functions shall be available. The clock shall also be programmable to control start/stop functions, constant speeds, PID parameter setpoints and output relays. Is shall be possible to program unique events that occur only during normal work days, others that occur only on non-work days, and others that occur on specific days or dates. The manufacturer shall provide free PC-based software to set up the calendar for this schedule.

4.25.3 All VFD faults shall be time stamped to aid troubleshooting.

4.25.4 It shall be possible to program maintenance reminders based on date and time, VFD running hours, or VFD operating hours.

4.25.5 The real-time clock shall be able to time and date stamp all faults recorded in the VFD fault log.

4.25.6 The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.

4.25.6.1 The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:

4.25.6.2 Comparators for comparing VFD analog values to programmed trigger values

4.25.6.3 Logic operators to combine up to three logic expressions using Boolean algebra

4.25.6.4 Delay timers

4.25.6.5 A 20-step programmable structure

4.26 The VFD shall include a Cascade Controller which allows the VFD to operate in closed loop set point (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.

26.5 SERIAL COMMUNICATIONS

26.5.1 The VFD shall include a standard EIA-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:

Metasys N2
Modbus RTU

26.5.2 VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge PC software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.

26.5.3 The VFD shall have provisions for an optional 24 V DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

26.6 ADJUSTMENTS

26.6.1 The VFD shall have a manually adjustable carrier frequency that can be adjusted in 0.5 kHz increments to allow the user to select the desired operating characteristics. The VFD shall also be programmable to automatically reduce its carrier frequency to avoid tripping due to thermal loading.

26.6.2 Four independent setups shall be provided.

26.6.3 Four preset speeds per setup shall be provided for a total of 16.

26.6.4 Each setup shall have two programmable ramp up and ramp down times. Acceleration and deceleration ramp times shall be adjustable over the range from 1 to 3,600 seconds.

Each setup shall be programmable for a unique current limit value. If the output current from the VFD reaches this value, any further attempt to increase the current produced by the VFD will cause the VFD to reduce its output frequency to reduce the load on the VFD. If desired, it shall be possible to program a timer which will cause the VFD to trip off after a programmed time period.

If the VFD trips on one of the following conditions, the VFD shall be programmable for automatic or manual reset: external interlock, under-voltage, over-voltage, current limit, over temperature, and VFD overload.

The number of restart attempts shall be selectable from 0 through 20 or infinitely and the time between attempts shall be adjustable from 0 through 600 seconds.

An automatic “start delay” may be selected from 0 to 120 seconds. During this delay time, the VFD shall be programmable to either apply no voltage to the motor or apply a DC braking current if desired.

Four programmable critical frequency lockout ranges to prevent the VFD from operating the load at a speed that causes vibration in the driven equipment shall be provided. Semi-automatic setting of lockout ranges shall simplify the set-up.

26.7 OPTIONAL FEATURES

26.7.1 All optional features shall be built and mounted by VFD manufacturer as an inbuilt factory solution. All optional features shall be UL listed by the VFD manufacturer as a complete assembly and carry a UL label.

26.8 SERVICE CONDITIONS

26.8.1 Ambient temperature at full speed, full load operation with continuous drive rated output current:

26.8.2 -10 to 45°C for ratings upto 90 kW without derating

26.8.2 -10 to 40°C for ratings 110 kW and higher without derating

26.8.3 Relative Humidity : 0 to 95%, non-condensing.

26.8.4 Elevation : Up to 3,300 feet without derating.

26.8.5 AC line voltage variation :± 10% of nominal with full output.

26.8.6 VFD Enclosure protection :Minimum IP 55, integral, with no additional cabinets.

26.8.7 Side Clearances : No side clearance shall be required for cooling.

26.8.8 All power and control wiring shall be done from the bottom.

26.8.9 All VFDs shall be plenum rated.

26.9 QUALITY ASSURANCE

26.9.1 To ensure quality, the complete VFD shall be tested by the manufacturer. The VFD shall drive a motor connected to a dynamometer at full load and speed and shall be cycled during the automated test procedure.

26.9.2 All optional features shall be functionally tested at the factory for proper operation.

LIST OF APPROVED MAKES

S.No.	Details of Materials / Equipment	Manufacturer's Name	
		Imported	Indigenous
1	Magnetic Bearing oli free centrifugal turbo core Chiller	Carrier	
		Trane	
		Climaveneta (Mitsubisi Eletric)	
		York (Johnson Control)	
2	Heat pumps	Bluebox	
		Climaveneta	
		Trane	
		York (JCI)	

3	Variable Refrigerant Flow System	Daikin	
		Hitachi	
		Mitsubishi	
		Toshiba	
4	Primary Pump (Split casing/Monobloc) & Condenser Water Pump.	Armstrong	
		TACO	
		Bell & Gosset	
5	Secondary CHW/HW pump with Variable Speed Pumping System including following :		
	Adjustable Frequency Drive	Armstrong	
	Automatic AFD Bypass	TACO	
	Pump Controller / Tertiary loop controller	Bell & Gosset	
	Differential Pressure Sensor /Transmitter		
6	Pressurized Expansion Tank and Air Separator		
			Armstrong
			Grundfoss
			ITT
7	Air Handling Unit	Carryaire	
		Edgetech	
		ETA	
		VTS-TF Class I	
	Air Handling Unit accessories such as Corners, Profiles, Hinges, Handles etc		HiraArosio
			VTS-TF Class I
	Cooling Coil for AHU	To be manufactured	Carryaire
		by individual supplier	Hi-Tech
		as indicated above	International Coil company
			Nutech
8	Precision AC unit	Blue Box	
		Climaveneta (Mitsubisi Eletric)	
		GEA	
		Stulz	
9	Active under Floor System for Data Centre	Titus	
		Uniflair(Schneider Electric)	
		Trox	
10	Split Unit		Blue Star
	(5 Star as per BEE) / Package Unit		Carrier
			ETA

11	Split Unit (with Refrigerant R-410A/R-407c)	Toshiba	
		Trane	
		York	
12	Fan Coil Unit	Midea	Carryaire
		Sinko	Edgetech
		York	VTS
13	Chilled Water Cassette Unit	Carryaire	Carryaire
		Climaveneta	DAIKIN
		Midea	VTS
		Mitsubishi	
14	Variable Air Volume Box (Unit)	Honeywell	Systemaire
		Titus	Honeywell
		Trox	
15	Cooling Tower	Baltimore	
		GEA Polacel	Bell
		Marley	Marley
			GEA Polacel
16	Centrifugal Fan	KRUGER	Nadi
		NICOTRA	Nicotra
		Flaktwoods	Humidin
		ELTA	Carryaire
17	Mixed flow fan	Flakt	
		Kruger	
18	Plug fans	NICOTRA/KRUGER	Carryaire
19	Axial Flow Fan	KRUGER	Kruger
		NICOTRA	Nadi
		Flaktwoods	Carryaire
		ELTA	Nicotra
20	Inline / Propeller Fan / Roof extractor Fan	Chaysol	Air flow
		Nuaire	Alstom
		Ostberg	Nadi
		ELTA	Nicotra
		Systemair	Carryaire
21	JET Ventilation fan for basement carparking	Aerovent	
		Flaktwoods	
		Systemair	Nicotra
		ELTA	Carryaire
22	Thermal Heat Recovery Wheel	Flakt Woods	
		Ostberg(Enventus)	
		DRI	

23	Inline UV sterilizer	Arklite	
		Ruks Engineering Ltd.	
		Sterile	
		UV-Lux	
24	Dessicant wheels	Ostberg (Enventus)	
		DRI	
25	PIPES & FITTINGS		
26	M.S. Pipe upto 200 MM Dia.		AST
			Jindal
			Tata Steel
27	MS PIPES above 200 mm dia factory rolled		Jindal
			SAIL
			Welspun
28	Butterfly valve (32 mm and upwards)	KITZ	
		Audco	
		CRI	
		C & R	
29	Butterfly Valve with Actuator		
		Honeywell	
		Kitz	
		Sauter	
		Siemens	
30	Balancing valve (Manual)		Advance Valve
			Navtech
31	Balancing Valve cum flow control (Pressure independent dynamic) valve with modulating actuator for AHUs and FCUs	Siemens	
		Flowcon	
		Honeywell	
		Overtrop (AZV)	
		TA Auto Flow	
32	PICV & Ball valve (upto 32 mm)	Siemens	
		Honeywell	
		KITZ	
		RB	
		Zoloto	
		Rapid Control	
33	Check valve	Kitz	
		Honeywell	
		Advance Valve	
34	Pot / Y Strainer		Emerald
			Sant

35	Pressure Gauge		Fiebig
			H Guru
36	Thermometer		H Guru
			Emerald
			Grundfoss
	Combined pressure/temperature gauge with digital display with BAS compatibility		Grundfoss
37	Ball valve (Fan Coil Unit)	Overtrop	Emerald
			Rapid Control
			Zoloto
38	Ball valve with Y-Strainer	Tiemme	Emerald
	(Fan Coil Unit)	Overtrop	Rapid Control
39	Auto Air Vent Valve	RB	Rapid Control
			Anergy
40	GI Sheet		ESSAR
			Jindal
			Lloyd
			SAIL
			TATA
41	Terminal HEPA filter plenums		Airtech
			AAF synder general
			Fabtech
			Sankalp Enterprise
42	Factory Made Duct		Nuaire Engineers
			Rolastar
			Seven star
			Zeco
43	Factory Made Spiral Duct		Atco
			Karthila Industries
			Seven Star
			Spiral Tubes Pvt. Ltd.
			Western Air Duct
44	Flexible duct		Atco
			Caryaire
			Seven star
			UP Twiga
45	Pre-insulated duct		ALP
			Nutech
			Pai Pal
46	Pipe / duct supports		Diamond

			Hitech
			Seven star
47	Passivation system for hydraulic systems (CHW/CDW/Hot water)		Biocide
			Chemtex
			Airflow
48	Grille/diffuser/dampers		Air Master
			Caryaire
			Dynacraft
			Ravistar
49	Smoke / Fire Damper	Greenheck	
	(Actuator shall be UL listed)	Ruskin	
		Airmaster	
		Carryaire	
		George Rao	
		Ravistar(Systemair)	
50	Sound Attenuator	ELTA	
		Carryaire	
		George Rao	
		Ravistar (Systemair)	
51	Anchor Fastener	Fischer	
		Hilti	
52	Insulation		
	Closed Cell Elastomeric nitrile rubber/EPDM along with adhesive		
		TWIGA	
		Eurobatex – Union Foam	
		Armacell	
		K flex	
	Microban Closed Cell Elastomeric nitrile rubber along with adhesive	K flex	Armacell
		A flex	
	Cross link polyethylene foam with adhesive	Trocellen	
	Fibreglass (Al. Foil Faced)		Lloyd insulation
			UP Twiga
53	Acoustic insulation		
	a. Fibre glass		Lloyd insulation
			UP Twiga
	b. Nitrile rubber with	K flex	Armacell
	Antimicrobial property	A flex	
54	Expanded Polystyrene (TF Quality)		Beardsell
			Coolite
			DEBS Products
55	Extruded Polystrene for Overdeck Insulation	Isoboard	
		Owens Corning	

		Polybond	
		Thermosheild	
56	Premoulded PUF section for pipe support		Lloyd
			Malanpur
57	Protective Coating over Closed Cell Elastomeric – Fibreglass Woven Cloth		K flex
			Fosters
			Armacell
58	UV Protective coating		K flex
			Armacell
			Polybond
59	Fire Sealant	Birla 3 M	
		OBO Bitterman	
60	Fire Wrap/Board/Paint	Birla 3 M	
		Flamebar	
		Hilti	
		Promat	
	Controls		
61	Three way Modulating / Two way valve / PIBCV for AHU		
		Honeywell	
		Sauter	
		Siemens	
62	Three way / Two way modulating control Valve for FCU	Danfoss (Model: VRG)	
		Honeywell (Model: VC7936)	
		Johnson Control (VG 5400 MC)	
		Schneider (VB-7215-0-4-07/8)	
		Siemens (Model: VVP/VXP 469)	
63	Proportionate Room Thermostat with Digital Temperature Indication for FCU		
		Honeywell (Model: T 6865)	
		Johnson Control	
		Schneider (TA-168-2)	
		Siemens (Model: RDF 340)	
64	Humidistat	Honeywell	
		Invensys	
		Johnson Control	
		Siemens	
65	Safety thermostat for heater		Anergy Controls
66	Dial Thermometer Capillary Type.	Penn	
		Tadington	

67	Flow Switch		Rapid Control
68	Airstat		Rapid Control
	Miscellaneous		
69	Vibration Isolator, Flexible Pipe Connection, Flexible duct connector, Heavy duty pipe support clamp		Cori
			Dunlop
			Easyflex
			Flexionics
			Kanwal Industrial Corporation
			Resistoflex
70	Grooved Pipe Connector	Grinnel Tyco	
		Sharjoint	
		Victaulic	
71	**ELECTRICAL ACCESSORIES**		
A.	**MEDIUM VOLTAGE EQUIPMENT**		
		North side Projects	**Westside Projects**
1	Power Distribution Panel and Motor Control Centre & Air Insulated Bus ducts	Adlec Control System	Accusonic (Pune)
		Advance Panels & Switchgear	Antia Electricals
		KMG Atoz	Arrow Engineers
		SPC Electrotech	Manshu (Pune)
		Sudhir Engineering	Popular Switchgear
		Tricolite	Scoot Engineering
			Smash Electricals
			Sterling & Wilson
		Southside Projects	Zenith Engineering
		Bangalore	
		Dynam	
		Load Controls	**Chennai**
		Lotus Powergear	Electro Alagen
		Elins	Formaplastic Controls
		Power Control Equipments	Ohm Energy
		Pragati Controls	Shanti Electricals
		Kolkata	
		Electro Allied Products , Adroid, L&T	
2	Sandwiched Construction Busduct	Control & Switchgear	
		EAE (IIGM)	
		GE Power Control	
		Henikwon	
		Intraco BKS (Marketed by Larsen & Toubro)	
		Power Plug Malaysia (Marketed By Tricolite)	
		Schneider Electric	

3	Motor	ABB	
		Bharat Bijlee	
		HAVELL	
		Kirloskar	
		Marathon	
		Siemens	
4	Starter	ABB	
		Allen Bradley	
		Kirloskar	
		L & T	
		Schneider	
		Siemens	
5	Variable Frequency Drive (VFD)	ABB	
		Alan Bradley	
		Fuji Electric	
		L&T	
		Siemens	
		Schneider Electric	
		VACON	
6	Air Circuit Breaker (3/4 Pole)	ABB(E-Max)	
		GE Power Controls (M-Pro)	
		Larsen & Toubro (U-Power)	
		Schneider Electric (Master Pact NW)	
		Siemens (3WL)	
7	Moulded Case Circuit Breaker (MCCB)	ABB (T – Max)	
		GE Power Controls (Recod plus)	
		Larsen & Toubro (Dsine)	
		Schneider Electric (Compact NSX/ NS)	
		Siemens (3VL)	
8	Motor Protection Circuit Breaker(MPCB)	ABB	
		GE Power Control	
		Hager (Marketed by Larsen & Toubro)	
		Schneider Electric	
		Siemens	
9	Automatic Transfer Switch (ATS)	ASCO	
		Cummins	
		GE Power Control	
10	Miniature Circuit Breakers (MCB)	ABB	
		Hager (L&T)	
		MDS Legrand	

		Mitsubishi Electrical (DIN rail mounted)	
		Schneider Electric–(Multi 9)	
		Siemens	
11	Residual Current Circuit Breaker (RCCB)	ABB	
		Hager (L&T)	
		MDS Legrand	
		Mitsubishi Electrical (DIN rail mounted)	
		Schneider Electric–(Multi 9)	
		Siemens	
12	Power/Aux. Contactor	ABB	
		Larsen & Toubro	
		Mitsubishi Electrical	
		Schneider Electric	
		Siemens	
13	Change Over Switch	C & S	
		Havells	
		Elcon	
		HPL – Socomec	
		Larsen & Toubro	
14	Control Transformer/Potential Transformers	Automatic Electric	
		Gilbert & Maxwell	
		Matrix	
		Reco	
15	Current Transformer	Automatic Electric	
	(Epoxy Cast Resin)	Gilbert & Maxwell	
		Matrix	
		Reco	
16	Protection Relay		
	a. Numeric Type	ABB	
		Areva	
		Larsen & Toubro	
		Siemens	
	b. Electromagnetic Type	ABB	
		Areva	
		Larsen & Toubro	
17	Indicating Lamps LED type and Push Button	Altos	
		GE Power Controls	
		Larsen&Toubro (ESBEE)	
		Schneider Electric (MG)	
18	Overload relays with built in Single Phase preventer	ABB	
		Larsen & Toubro	

		Mitsubishi Electrical	
		Schneider Electric(Telemechanique)	
		Siemens	
19	a. Electronic Digital Meters (A/V/PF/Hz/KW/KWH) with LED Display	ABB	
		Conzerv	
		L & T	
	b. Dual Energy Meter with centralized metering & billing system	ActarisConserve	
		El Measure	
		Secure	
	c. Prepaid Meters & accessories	Actaris	
		Conzerve	
		Secure	
	d. Electromagnetic Meters	Automatic Electric	
		Rishabh (L&T)	
20	Static Power Meter & Logger (SPML) with RS 485 port	Conzerv	
		El measure	
		Larsen & Toubro	
21	Power Capacitor	ABB	
		Matrix	
		Meher (Larsen & Toubro)	
		Siemens (Epcos)	
22	Autoamtic Power Factor Correction Relay (Numeric Type)	Areva	
		BELUK (Germany)	
		Conzerv	
		Siemens	
23	Thyristerised APFC Control Panel	ABB	
		Meher(Larsen & Toubro)	
		Siemens	
24	PVC insulated XLPE aluminium/copper conductor armoured MV Cables upto 1100 V grade	Finolex	
		Polycab	
		RPG	
25	LT Jointing Kit / Termination	Raychem	
		REPL	
		Safe Kit	
26	Cable Glands Double Compression with earthing links	Baliga Lighting	
		Comet	
		Cosmos	
27	Bimettalic Cable Lug	Comet	
		Cosmos	

		Dowell's (Biller India)	
		Hax Brass (Copper Alloy India)	
28	PVC insulated copper conductor stranded flexible wires (FRLS) -	Anchor	
		Finolex	
		Havells	
		KEI	
		R Rkabel	
29	Mettalic Conduit (ISI approved)	AKG	
		BEC	
		NIC	
		Vimco	
30	PVC Conduit (ISI approved)	AKG	
		BEC	
		Polypack	
		Precision	
31	Industrial Socket		
	Splash Proof	Clipsal	
		MDS Legrand	
		Neptune Balls	
32	Industrial Socket Metal Clad	BCH	
		MDS	
33	Selector Switch, Toggle switch	Kaycee	
		Salzer (Larsen & Toubro)	
34	Timer	ABB	
		Larsen & Toubro	
		MDS Legrand	
		Schneider Electric	
		Siemens	
35	LT Servo Automatic Voltage Stabilizer & Isolation Transformers	Abhishek Electrical	
		Aplab	
		Automatic Electric	
		Recon	
36	Inverter	Luminous	
		Megatech	
		Neel Industrial Corporation	
37	Cable Trays (Factory Fabricated) / Raceways	Asian Ancillary Corporation	
		Elcon	
		Profab Engineer	
		Rico Steel	
		Slottco	
38	Fire Sealant & Fire Retardant Paint	BTHM Engineering	
		Birla 3 M	

		HILTI	
		Promat	
39	230/12 V Step Down Transformer with Built in Isolation Transformer	Talema	
		Volstat	

Technical Specifications for Plumbing & Sanitary Items for KOLKATA PORT TRUST in KOLKATA

SECTION – I

SANITARY FIXTURES

1.0 SCOPE OF WORK

1.1 Work under this section shall consist of furnishing all labour materials necessary and required to completely install all sanitary fixtures, chromium plated fittings and accessories required by the drawings and specified hereinafter or given in the schedule of quantities.

1.2 Without restricting to the generality of the foregoing the sanitary fixtures and chromium plated fittings shall include the following: -

a) Sanitary fixtures
b) Bath tubs, shower trays if any
c) Chromium plated fittings
d) Porcelain or stainless-steel sinks
e) Accessories e.g. towel rods, toilet paper holders, soap dish, coat hook, towel rack etc.

1.3 Whether specifically mentioned or not all fixtures and appliances shall be provided with all fixing devices, nuts, bolts, screws, hangers as required.

1.4 All exposed pipes within toilets and near fixtures shall be chromium plated brass or copper unless otherwise specified.

2.0GENERAL REQUIREMENTS

2.1 Sanitary fixtures shall be of the best quality approved by the Engineer-in-charge. Wherever particular makes are mentioned, the choice of selection shall remain with the engineer-in-charge.

2.2 All fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned in the schedule of quantities, specifications or shown on the drawings. The rate quoted will include all devices for proper fixing arrangement, nuts, bolts, screws and required connection pieces.

2.3 All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per architectural/interior designer's requirements. Wherever necessary, the fittings shall be centered to dimensions and pattern desired.

2.4 Fixing screws shall be half round head chromium plated brass screws with C.P. washers wherever required as per directions of engineer-in-charge.

2.5 All fittings and fixtures shall be fixed in a neat work manlike manner true to level at show non-drawings and in accordance with the manufacturer’s recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling or terrace shall be made good at contractor's cost.

2.6 When directed contractor shall install fixtures and accessories in a mock up room for the approval of the engineer-in-charge. Sample room fixtures may be re-used on the works if undamaged, but no additional payment for fixing or dismantling shall be admissible.

2.7 Supply of fixtures& fittings by owners**:**

a. All Porcelain fittings, C.P fittings & accessories shall be supplied by the owners free of cost at site.
b. Contractor shall take the delivery of the materials directly from the suppliers and will be responsible for its safe storage (appropriate temperature-controlled storage if required) and custody.
c. Only materials, accessories and fixing devices supplied as standard supplies by the manufacturer shall be given to the contractor.

d. All balance materials e.g. nuts, bolts, CP nuts & bolts, sealant other fixing devices shall be supplied by the contractor within the quoted rates.

e. Description and method of fixing is given below for the contractor to understand the scope and extent of the work for which main materials will be supplied by the Owners.

3.0EUROPEAN W.C.

3.1 European W.C shall be wash down or symphonic wash down type floor/wall mounted set of best quality as shown in the drawings. Cast iron floor mounted chair or any other supporting arrangement to be provided for wall mounted WC.

3.2 The flushing cistern shall be low level type (porcelain / thin wall HDPE or other plastics type connected to the W.C. by means of a 25 /32 mm dia. flush pipe and connected to the WC pan with a compatible rubber adapter. (UNLESS THE WC SET IS COUPLED WHEN FLUSH PIPE IS NOT REQUIRED)

3.3 The cistern shall be provided with all internal fittings & ball cock to be a complete working cistern.

3.4 The flushing cistern shall be only those which are fully compatible for use for its flow and flushing characteristics with the particular type of WC of specific manufacture and approved and accepted for fixing by the WC fixture manufacturer.

3.5 The flush pipe shall be chromium plated when exposed inside the bathroom and GI (IS 1239 Medium class) when concealed in wall chase or shaft.

3.6 Each W.C. set shall be provided with an approved type of plastic /wooden/ Bakelite seat of approved finish compatible and fitting appropriately with the WC set with rubber buffers and hinges. The WC seat shall be those approved and accepted for fixing on a particular type of WC.

a. The seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the W.C.

b. The edge between the fixture and the wall shall be sealed with approved type of white cement of appropriate grade.

4.0 ORISSA W.C:

4.1 Orissa W.C shall be in glazed vitreous chinaware white or colour of size specified by the Architect or Client. The W.C shall be provided with a 100-mm white vitreous chinaware P or S trap.

4.2 Each W.C shall be provided with an exposed or concealed type brass flush valve or flushing cistern of approved make.

4.3 Each WC shall be provided with 110 mm dia (OD) PVC Pan connector connecting the ceramic outlet of WC to CI pipe.

5.0 ANGLO INDIAN W.C:

5.1 Anglo Indian W.C shall be in glazed vitreous chinaware white or colour of size specified by the Architect or Client. The W.C shall be provided with a 100 mm white vitreous chinaware P or S trap.

5.2 Each W.C shall be provided with an exposed or concealed type brass flush valve or flushing cistern of approved make.

5.3 Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges. Seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

5.4 Each WC shall be provided with 110 mm dia (OD) PVC Pan Connector connecting the ceramic outlet of WC to CI pipe.

6.0 CISTERNS / FLUSH VALVE:

Low level flushing cistern (exposed or concealed) shall be provided for WC in specified toilets. Contractor shall install cistern in accordance to the manufacturer's specification to the satisfaction of the Owner Site Representative. Provision of flush valve shall be made for Public / Staff toilets.

Standards and Specifications for Residential and Commercial Water-Using Fixtures and Appliances

- Dual flush closets – 4 /2 liters per flush
- Urinals <1 liter per flush
- Sinks < 3.5 liters per minute
- Showers < 4 liters per minute.
- Laboratory faucet < 1.4 liters per minute.

7.0 BIDETS IF ANY:

7.1 Every pedestal bidet shall be secured to the floor using stainless steel or non-ferrous fixing screws. Provision shall be made in the floor to receive the fixing screws.

7.2 Wall hung bidet pan shall be fixed with stainless steel bolts and nuts or other approved means to an underground support frame such that no strain is transmitted to the bidet pan connection or any other part of the plumbing system. The support frame, depending on the design, shall be either fully or partially fixed within the structure of the building.

7.3 Every bidet shall be provided with a spray nozzle fixed above the spill over level of the bidet pan.

7.4 Every bidet shall be provided with a fitting trap of at least 40 mm in diameter. The connection by means of a bidet trap of at least 75 mm in diameter shall be made directly to an individual branch drain line or to a discharge pipe on the upper story level.

8.0 WASH BASIN:

8.1 Wash basins shall be white/coloured or white glazed vitreous china of best quality, size, shape and type specified in the schedule of quantities.

8.2 Each basin shall be supported on MS Galvanized or painted C.I. brackets and the basin securely fixed to wall or under /above counter installation. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.

8.3 Each basin shall be provided with 32 mm dia C.P. waste with overflow/ pop-up or standard waste with rubber plug and chain, 32 mm dia C.P. brass bottle trap with CP pipe to wall and flange as specified in the BOQ.

8.4 Each basin shall be provided with a single tap or a hot & cold CP mixer as specified in the BOQ.

8.5 The edge between the fixture and the wall or the counter shall be sealed with approved type of white cement of appropriate grade.

8.6 Washbasins shall be fixed at proper heights as shown on drawings. If height is not specified, the rim level shall be 79 cms or as directed by Project Manager.

8.7 Each washbasin connection (separately for hot and cold) shall be provided with angle valves with CP wall flange and CP connecting pipe and of required length.

9.0SINKS:

9.1 Sinks shall be stainless steel as specified in the schedule of quantities.

9.2 Each sink shall be supported by GI or painted C.I. brackets and clips and the basin securely fixed to wall or on the counter. The design of the brackets shall suit the basin selected and as recommended by the manufacturer.

9.3 Stainless steel sinks shall be provided with 40 mm dia C.P. basket waste with plug (as supplied by manufacturer), Waste shall be rigid PVC pipes concealed or exposed. Fixing shall be done as directed by engineer-in-charge.

9.4 Each sink shall be provided with hot & cold CP mixer with approved type of a neck spout or individual taps or as directed by the Project Manager or as given in BOQ.

10.0SHOWER SET:

10.1 Shower set shall comprise of hot & cold-water mixer, C.P. shower arm with wall flange and shower head.

10.2 Mixer shall be exposed or concealed type, single lever, concealed stop cocks with diverter and spout as selected by the Project Manager / Architects) or as given in B.O.Q.

10.3 Contractor shall fix any of the shower mixer /combination supplied by the owners at the quoted rates.

10.4 Concealed wall mixer shall be so fixed as to keep the wall flange cleared off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

11.0ACCESSORIES:

Accessories shall be of any of the following types:

- Towel rail
- Towel Rack
- Towel ring
- Coat hook
- Soap dispenser
- Soap dish
- Toilet paper holder
- Health faucet
- Hand drier
- Tissue paper holder

11.1 Contractor shall install all chromium plated and porcelain accessories as shown on the drawings directed by engineer-in-charge and given in the schedule of quantities.

11.2 All C.P. accessories shall be fixed with C.P. brass half round head screws and cut washer in wall with rawl plugs and shall include cutting and making good as directed by engineer-in-charge.

11.3 Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 (1 cement, 2 fine sand) and fixed in relation to the tiling work.

12.0 HEALTH FAUCET/SPRAY NOZZLE:

12.1 A chromium plated spray shower with integral hand control valve and connected to a flexible pipe and angle valve with wall flange shall be provided as shown on the drawings or as directed by the Engineering In charge.

12.2 A chromium plated spray Nozzle connected to a flexible pipe and angle valve with wall flange shall be provided as shown on the drawings or as directed by the project manager.

13.0 BATH TUB IF ANY:

13.1 Bath tub and panel shall be white enameled cast iron or pressed steel or as specified in the Bill of Quantities of guaranteed quality and specifications.

13.2 Bath tub shall be provided with 40mm dia C.P. cast brass waste with 32mm C.P. brass overflow, 40mm dia cast brass overflow - cum – waste trap with pop-up waste assembly or as given in Bill of Quantities.

13.3 Bath tub shall be provided with 4-way diverter including 2 nos. concealed stop cocks, bath spout, overhead shower head with arm and rosette and flexible telephonic shower or as given in Bill of Quantities.

13.4 Bath tub shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer. Edges touching the wall shall be slightly recessed in the wall finishing so as ensuring water tightness. The fixing shall be perfectly done so that the wall behind does not tend to get dump or patchy.

13.5 During the entire period of installation and afterwards protect the bath tub by providing suitable cover or any other protection to prevent any damage to the bath tub until handing over.

14.0 URINALS:

14.1 Urinals shall be White glazed vitreous china half stall urinals with 15 mm dia C.P. spreader, 32 mm dia C.P. domical waste and C.P. cast brass bottle trap with pipe and wall flange, and shall be fixed to wall by C.I. brackets and C.I. wall clips as recommended by manufacturers. (CI brackets and clips shall be painted as approved by Engineering In charge)

14.2 Exposed flush pipes shall be chromium plated and provided with required type of spreaders.

14.3 Waste pipes for urinals shall be G.I. medium class (I.S. 1239) with all fittings and connected to the urinal trap independently as directed by the Engineering In charge

14.4 Flushing system comprising of Infra-red photocell electrical mains or battery-operated solenoid valve concealed in recessed box with stainless steel plate and shall include accessories, wiring and connecting piping complete as required to provide satisfactory functioning of system to be able to flush the urinal after use by a person.

14.5 The edge between the fixture and the wall shall be sealed with approved type of white cement of appropriate grade.

15.0 URINAL PARTITIONS:

15.1 Urinal partitions shall be white glazed vitreous china or 25 mm thick marble of size specified in the Bill of Quantities or directed by the Engineering In charge / the Architects.

15.2 Porcelain partitions shall be fixed at proper heights with stainless steel screws/ bolts, and anchor fasteners and painted M.S. clips as recommended by the manufacturer and directed by Project Manager.

15.3 The edge between the fixture and the wall or the counter shall be sealed with approved type of white cement of appropriate grade.

16.0 HAND DRIER:

16.1 The hand drier shall be no touch operating type with solid state time delay to allow user to keep hand in any position. It shall be fully hygienic, rated for continuous repeat use (CRU).

16.2 The rating of hand drier shall be such that time required to dry a pair of hands upto wrists is approximately 30 seconds. It shall be wall mounting type suitable for 230 volts, single phase, 50 Hz, A.C. power supply.

17.0 TOILET PAPER HOLDER:

17.1 Toilet paper holder shall be white glazed vitreous china or chrome plated of size, shape and type specified in the Schedule of Quantities.

17.2 Porcelain toilet paper holder shall be fixed in walls and set in cement mortar 1:2 (1 cement: 2 coarse sand) and fixed in relation to the tiling work.

17.3 The latter (chrome) shall be fixed by means of screws/capping having finish similar to the toilet paper holder in wall/temper partitions with raw l plugs or nylon sleeves. When fixed on timber partition, it shall be fixed on a solid wooden base member provided by the Owner's Site Representative.

18.0 TOWEL RAIL:

18.1 Towel rail shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the Schedule of Quantities.

18.2 Towel rail shall be fixed with screws/capping having finish similar to the towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by the Owner's Site Representative.

19.0 JANITOR'S SINK:

19.1 Janitor's sink shall be stainless steel, single bowl type of size as called for in the Schedule of Quantities, provided with painted R.S. or CI brackets and clips and securely fixed. Each sink shall be provided with 40mm dia CP waste. Fixing shall be as directed by the Owner's Site Representative.

19.2 The supply fittings for Janitor's sink shall be wall mounted type of size as mentioned in Schedule of Quantities.

20.0 DRINKING WATER FOUNTAIN:

20.1 Drinking water fountain shall be well mounting type made of vitreous china, stainless steel or any other material as given in the Schedule of Quantities.

20.2 The drinking water fountain shall be with anti-squirt bubble less, self closing valve type with automatic volume regulator.

20.3 The drinking water fountain shall be provided with an anti-splash back and integral strainer with 32mm or 40mm cast brass trap.

21.0 LIQUID SOAP DISPENSERS:

21.1 Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only be key provided.

21.2 Liquid soap dispenser body and shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container.

21.3 The valve shall operate with less than 2.27 Kg (5 lbs) of force.

22.0 WATER HEATER:

These shall be of best-approved make and type and capacity as per schedule of quantities. They shall be mounted on the wall / left with necessary bolts of approved make. They shall have 8 mm / 12 mm nylon braded hose inlet pipe, 12 mm copper pipe nylon braded outlet, 15 mm non – return valve, pressure relief, anti – vacuum and drainage. Water heater shall be designed to operate under high pressure (3-4.5 kg / cm^2). These shall be measured per number and the quoted rate shall include.

a) Cost of water heater with all the built-in electrical accessories like pilot lamp, thermostat, standard length of cable and 3 pin 16A plug.
b) PVC / Nylon braded hose inlet lead outlet pipe and non – return valve.

23.0 SUPPORTING AND FIXING DEVICES:

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly SS:304 Nut Bolts & screw. Where the location demands, the Architect may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances, the contractor shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

24.0 PROTECTION AGAINST DAMAGE:

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained shall be removed and new fixtures and fittings shall be installed at his own cost to complete the work.

25.0 FINAL INSTALLATION:

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built-in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid. Plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints it shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, washbasins, sinks and other appliances.

26.0 TESTING AND ACCEPTANCE

26.1 All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The contractor shall block the ends of waste and ventilation pipes and shall conduct an air test.

26.2 The sanitary fixtures shall be inspected for scratches or chippings and alignment before acceptance.

26.3 All tests shall be conducted at each and every fixture except for flush valves which shall be at the lowest and highest test connections to be made on each riser/down take. The contractor shall make the temporary valve connections which shall be plugged with a brass plug after validation.

27.0 MEASUREMENTS

Sanitary fixtures shall be measured by numbers:

27.1 Rate for providing and fixing of sanitary fixtures and accessories shall include all items, and operations stated in the respective specifications and schedule of quantities, and nothing extra is payable.

27.2 Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, C.P. screws, nuts, bolts and any fixing arrangement required and recommended by manufacturers, testing and commissioning.

End of Section – I

SECTION – II

SOIL, WASTE, VENT AND RAIN WATER PIPES & FITTINGS

1.0SCOPE OF WORK:

1.1 Work under this section shall consist of furnishing all labour, materials, equipment and appliances necessary and required to completely install all soil, waste, vent and rain water pipes as required by the drawings, specified hereinafter and given in the schedule of quantities.

1.2 Without restricting to the generality of the foregoing, the soil waste and vent pipes system shall include the following:

a. Vertical and horizontal soil, waste and vent pipes rain water pipes and fittings, joints, clamps and supports (MS) connections to fixtures.

b. Connection of soil - waste pipes to sewer lines and rain water pipes to storm line as shown on the drawings at ground floor levels.

c. Floor and urinal traps, cleanout plugs, inlet fittings and rainwater heads/Khurrahs.

d. Testing of all pipe lines.

2.0GENERAL REQUIREMENTS

2.1 All materials shall be now of the best quality conforming ISI or equivalent local standard code and specifications and subject to the approval of engineer-in-charge.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in neat workmanship.

2.3 Pipes shall be fixed in a manner as to provide best accessibility for repair and maintenance and shall not cause obstruction in shafts, passages etc.

2.4 Pipes shall be securely fixed to walls by suitable clamps at intervals specified.

2.5 Access door for fittings and cleanouts shall be so located that they are easily accessible for repair and maintenance.

2.6 All work shall be executed as directed by the Engineer-in-charge.

3.0 SOIL, WASTE & VENT PIPE SYSTEM:

3.1 The Soil & Waste pipe system above ground has been planned as a “two pipe system" as defined in NBC: having separate pipes for waste and for kitchen sinks, bath tubs, showers, washbasins, HVAC equipment’s condensate drains and floor drains and is approved by concerned Authorities.

3.2 Waste stacks have been laid along the basement ceiling or buried at Ground floor level if basement is not available and discharged in to local authority manhole cum Gully trap outside of the premises or directly in to STP as per site conditions.

3.3 All waste water from AHU's plant air conditioners and pump rooms will be provided with a deep seal trap before connecting to the main drain or vertical stack wherever applicable.

3.4 Vertical soil & waste stacks shall be connected to a common horizontal drain pipe at basement ceiling or to an external manhole directly where feasible and shown on the drawings.

3.5 Floors of toilets, kitchens and other service areas located on structural slab are SUNK below the finished floor level (FFL) or where the structural slab is not sunk the pipes are hang below slab and there is provision of false ceiling in area as directed by Engineering in charge.

3.6 All soil and waste from areas below general ground level (Basements) will be collected in sumps and pumped into sewer lines.

3.7 75 mm dia. anti-siphon age pipe (ASP) shall be provided for soil fittings on vertical stacks. and shall be connected to main anti-syphonage stack It may be provided for waste lines where shown on the drawings.

3.8 Vent pipes shall be provided at all sewer lines.

3.9 All vertical horizontal soil, waste and vent pipes within the shaft or inside the toilets shall be of uPVC (SWR) pipes conforming to IS: 13592 as given in B.O.Q.

4.0 RAIN WATER PIPES AND FITTING:

All rain water and vent pipes and fittings used within the plumbing shafts vertical run, basement ceiling suspended run, shall be PVC pipes of SWR quality type "B" as per IS: 13592. They shall be made of polyvinyl chloride (PVC) and shall be sound with good surface finish, mechanical strength and capacity. During manufacture only, those additives may be added to produce the above characteristics. No additives shall be added separately or together in quantities sufficient to constitute a toxic hazard or impair the fabrication or welding properties of the pipe or impair its physical or chemical properties. All pipes shall be spigot and socket type.

5.0 TOLERANCES :

Tolerances on diameters and wall thickness shall be as per IS 4985.

6.0 FITTINGS :

All fitting shall be injection molded socket fittings with or without inspection doors as specified and shall be in accordance with the requirements of the relevant IS 7834.
Pressure ratings and Tolerances shall be as per IS 4985.

7.0 LAYING AND JOINTING :

Pipes shall be cut to length required including the portion to be inserted in the socket with a hacksaw. The pipe shall be cut square. Pipes and sockets shall be clean and dry and burrs removed both inside and outside with a file. The surface to surfaces to be in contacted shall be roughened with emery paper, and dry fir checked.

A thick coat of solvent cement shall be applied to the outer surface of the pipe and a thin coat on the inside surface of the socket by means of a brush. Solvent cement shall be of approved make and quality. The pipe shall then be inserted in the socket and turned for 90^0 to ensure even distribution of cement. Excess cement shall be wiped off. GI clamps of required size shall be used for clamping the pipes to the walls etc., pipe shall be clamped at least two inch away from the wall surface using GI clamps screwed to the wooden plugs, not more than 1 meter apart.

8.0 CLEAN OUTS :

At every bend, branches and where necessary suitable cleanouts shall be provided in to the piping system.

9.0 RAIN WATER COLLECTION GRATINGS :

9.1 The rain water collection grating at the terrace level shall be of CI grating with CI frame embedded on to the water proof surface. Waterproofing shall be done around the pipe, frame and grating to ensure the water tightness around the collection point. Adequate slope on the terrace level shall be provided for collecting all rainwater at the collection gratings.

9.2 The rain water collection detail at the balconies shall be done using PVC pipe bend installed concealed in the concrete slab and connected to the vertical main PVC rain water stack. The CI frame shall be laid in the slab above the pipe with water seal joint all-round the frame.

10.0 RAIN WATER / STORM WATER, GULLIES / CHAMBERS :

Storm water gullies shall be constructed for admitting storm water from the courtyard area. It is constructed of specified size and is provided with precast RCC or CI grating on top for admitting storm water run-off into it. A typical drawing shall be provided giving all details of construction. For other details of construction refer specification for manholes and inspection chambers.

11.0 RAIN WATER PIPES:

11.1 All terraces shall be drained by providing down-takes rainwater pipes.

11.2 Rainwater pipes are separate and independent and connected to the storm water drainage system as shown on the drawings.

11.3 Rainwater in enclosed courtyards shall be collected in catch-basins and connected to storm water drains.

11.4 All Rain Water pipe shall be of uPVC SWR type “A” as per IS: 13592 or as given in B.O.Q.

12.0 BALCONY / PLANTER DRAINAGE:

All balconies, terraces, planters and other formal landscape areas will be drained by vertical down takes as per the landscape /architectural drawings and details

13.0uPVC SWR PIPES & FITTINGS:

13.1 The pipes shall be supplied in straight lengths with socketed ends. The internal & external surfaces of pipes shall be smooth, clean and free from grooving & other defects. The ends shall be cleanly cut & square with the axis of the pipe.

13.2 Soil & Waste pipe shall be uPVC (SWR) type ‘A’ confirming to IS: 13592-1992 [From 75mm OD to 160mm OD].

13.3 The pipe shall be designated by external diameter and confirm to IS: 4985-1988 for Rain water drainage and vent pipe shall be uPVC (SWR) type ‘A’ and conforming to IS: 13592-1992.

FITTINGS:

Fittings shall be of the same make as that of pipes, injection molded & fittings dimension shall be as per DIN 19531 and DIN 19534 and conforms to IS: 14735-99.

14.0 TECHNICAL DETAILS FOR uPVC SWR PIPE:

Sl No.	Nominal out side diameter mm	Tolerance On out side diameter mm	Wall Thickness Type-A (t) mm		Wall Thickness Type-B (t) mm		Wall Thickness – Sufla (Non –standard) (t) mm	
			Min	Max	Min	Max	Min	Max
1.	40	+0.3	1.8	2.2	3.2	3.8	-	-
2.	50	+0.3	1.8	2.2	3.2	3.8	-	-
3.	63	+0.3	1.8	2.2	3.2	3.8	-	-
4.	75	+0.3	1.8	2.2	3.2	3.8	1.4	1.6
5.	90	+0.4	1.9	2.3	3.2	3.8	-	-
6.	110	+0.4	2.2	2.7	3.2	3.8	1.5	1.65
7.	160	+0.5	3.2	3.8	4.0	4.6	2.7	3.2

NOTES:

(i) As per IS: 13592-1992 Type 'A' pipes are recommended for use in ventilation pipe work & Rain water piping system and Type 'B' pipes are recommended for use in soil & waste discharge system.

(ii) Fitting dimension shall be as per DIN 19531 and DIN 19534 and conforms to IS: 14735-99.

(iii) Rubber ring shall conform to IS: 5382.

15.0 LAYING & JOINTING:

The pipes shall be laid & clamped to wooden plugs fixed above the surface of the wall; alternatively, plastic clamps of suitable designs shall be preferred. Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion. Keep a gap of minimum 10 mm between all pipes and fittings to accommodate thermal expansion and contraction of pipe for longer life of the system. Jointing of uPVC SWR pipe and fitting shall be made by solvent cement in horizontal line and 'o' type rubber ring joint type using rubber lubricant for vertical line.

16.0. SUPPORTS:

UPVC pipes require supports at close intervals. Recommended vertical support spacing for unplasticised PVC pipes is 2000 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The contractor shall adequately design all the brackets, saddles, anchors, clamps, hangers & be responsible for their structural sufficiency. Pipe supports shall primer coated with rust preventive paint & finish coated black.

17.0 MAXIMUM SUPPORT DISTANCE IN METERS:

Sl. No.	**Size in mm**	**Horizontal Supports**	**Vertical Supports**
1.	40 mm OD	0.4	1.2

2.	50 mm OD	0.5	1.5
3.	75 mm OD	0.75	2.00
4.	110 mm OD	1.10	2.00
5.	160 mm OD	1.60	2.00

18.0 REPAIRS:

Temporary or emergency repairs may be made to the damaged pipes, permanent Repairs should be made by replacement of the damaged section. If any split or chip out occurs in the wall of the pipe, the repair shall be carried out by cutting the pipe and the inserting new piece of pipe of same length and bath joints (ends) should be sealed with couplers.

19.0 PIPE SLEEVES:

Pipe sleeves, 50 mm larger diameter than pipes shall be provided wherever pipes pass through walls & slabs and annular space filled with fiberglass & finished with retainer rings. All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes & burrs removed before lying. Open ends of the pipe shall be closed as the pipe is installed to avoid entrance of foreign matter.

20.0 TRAPS:

20.1 floor trap inlets:

Bath room traps and connections shall ensure free and silent flow of discharging water, where specified contractor shall provide a special type inlet hopper without or with one, two or three inlet sockets to receive the waste pipe. Joint between waste and hopper inlet sockets shall be solvent joints. Hopper shall be connected to a P trap with at least 50mm seal. Floor trap inlet hoppers and the traps shall be set in cement concrete blocks or hung at ceiling level without extra charge.

20.2 C.P./Stainless steel gratings:

Floor traps shall be provided with 100-150mm square or round C.P./Stainless steel grating, with rim of approved design and shape. Thickness shall be as specified in the schedule of quantities.

21.0 TESTING:

All lengths of PVC rain water pipes shall be fully tested for water tightness by means of water test maintained for not less than 30 minutes. All pipes shall be subjected to a test pressure of at least 1.5-meter head of water head. The test pressure shall, however, not exceed 6-meter head at any point. The pipes shall be plugged preferably with standard design plugs with rubber plugs on both ends. The upper end shall, however, be connected to a pipe for filling with water and getting the required head.

22.0 CLEANOUT PLUGS:

Contractor shall provide pvc cleanout plugs as required. Cleanout plugs shall be threaded and provided with key holes for openings.

23.0 WASTE PIPE FROM APPLIANCES:

23.1 Waste pipe from appliances e.g. Wash basins, sinks, and urinals shall be of uPVC Schedule – 40 or as given in the Bill of Quantities or drawings.

23.2 All pipes shall be fixed in gradient towards the outfalls of drains. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required pipes may be run at ceiling level in suitable gradient and supported on galvanized structural clamps.

24.0 CUTTING AND MAKING GOOD:

24.1 Pipes shall be fixed and tested as building proceeds. Contractor shall provide all necessary holes cut outs and chases in structural members as building work proceeds.

24.2 Wherever holes are cut or left originally, they shall be made good with cement concrete 1:2:4 (1 cement 2 coarse sand 4 stone aggregate 20 mm thick nominal size) or cement mortar 1:2 (1 cement 2 coarse sand) and the surface restored to original condition.

FITTINGS:

Unit of measurement shall be the number of pieces. Floor traps, gratings, hoppers, cleanouts, plugs shall be measured by numbers and shall include all items described in the relevant specifications.

End of Section - II

SECTION – III

WATER SUPPLY SYSTEM

1.0 SCOPE OF WORK:

1.1 Work under this section consists of furnishing all labour, materials, equipment and appliances necessary and required to completely install the water supply system as required by the drawings, specified hereinafter and given in the schedule of quantities.

1.2 Without restricting to the generality of the foregoing, the water supply system shall include the following:

a. Distribution main from overhead tanks to toilets/kitchens.
b. Insulation of hot water pipe lines.
c. Control valve, masonry chambers and other appurtenances.
d. Excavation and refilling of pipe trenches, if necessary.
e. Pipe protection and painting.
f. Painting for exposed piping.

2.0 GENERAL REQUIREMENTS:

2.1 All materials shall be new of the best quality conforming to specifications. All works executed shall be to the satisfaction of the engineer-in-charge.

2.2 Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.

2.3 Short or long bends shall be used on all main pipe lines as for as possible. Use of elbows shall be restricted for short connections. As for as possible all bends shall be formed by means of hydraulic pipe bending machine for pipes up to 65 mm dia.

2.4 Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts, passages, etc.

2.5 Pipes shall be securely fixed to walls and ceilings by suitable clamps at intervals specified.

2.6 Valves and other appurtenances shall be located to provide easy accessibility for operation, maintenance and repairs.

2.7 Pipe threaded joints will be made by applying suitable grade of TEFLON tape used for domestic /Drinking water supply **(use of red or White Lead and Solti will not be permitted for Screw Joins).**

3.0 WATER SUPPLY SYSTEM:

3.1 Contractor should study the site plan and water supply system diagram for overviews of the system.

3.2 SOURCE:

a) Water supply will be acquired from municipal water mains through a service connection

b) Additional water supply will be obtained from captive tube-wells within the site. The rising mains will be connected to the main underground fire static tank and then overflow into the main raw water or domestic water tank located on the drawing.

3.3 SUPPLY AREAS:

The project has following systems for water distribution: -
Water distribution in the block for toilets and kitchen shall be by gravity system only. There is a provision of pressure reducing valve for toilets / kitchen inlet pipe to maintain the pressure not more than 2 Kg / cm2 wherever required.

4.0G.I. PIPE FITTINGS AND VALVES:

4.1 All pipes outside the building shall be galvanized steel tubes conforming to IS 1239-1979 of class “C”.

4.2 The pipes shall be clearly finished, well galvanized in and out and free from cracks, surface flow, laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with axis of the tube.

4.3 Fittings shall be malleable iron galvanized fittings of approved make. All fittings shall have manufacturer's trade mark stamped on it. Fittings of G.I. pipes shall include couplings, bends, tees, nipples, reducers, unions, bushes. Fittings shall be I.S. 1879 (part I to X) 1987 / equivalent local standard.

4.4 Pipes and fittings shall be joined with screwed fittings. Care shall be taken to remove but from the end of the pipe after cutting by a round file. Genuine red lead with grummet and a few strands of fine hemp shall be applied. All pipes shall be fixed in accordance with layout and alignment shown on the drawings. Care shall be taken to avoid air pocket. G.I. pipes inside toilets shall be fixed in wall chases well above the floor. No pipes shall be run inside as sunken floor as for as possible. Pipes may be run under the ceilings or floors and other areas as shown on drawings.

5.0 CUTTING AND JOINTING:

5.1 The pipes and fittings shall be inspected at site before use to ascertain that they confirm to specification given above. The defective pipes shall be rejected. Where the pipes have to be cut or re-threaded, the ends shall be carefully filled out so that no obstruction to bore is offered. The end of the pipes shall then be threaded conforming to the requirements of IS: 544-1955 or its latest version with pipe dies and taps carefully in such a manner as will not result in slackness of joints when the two pieces are screwed together. The taps and dies shall be used only for straightening screw threads which have become bend or damaged and shall not be used for turning of the threads so as to make them slack, as the later procedure may not result in water tight joint.

5.2 The screw threads of pipes and fittings shall be protected from damage until they are fitted.

5.3 The pipes shall be cleaned and cleared of all foreign matter before being laid. In jointing the pipes, the inside of the socket and the screwed end of the pipes shall be oiled and rubbed over with white lead and a few turns of spun yarn wrapped round the screwed end of the pipe or alternately Teflon tape or an equivalent jointing compound of approved make shall be used. Compound containing red Lead shall not be used because of the danger of contamination of water. The end shall then be screwed in the socket. Care should be taken that all pipes and fitting are properly jointed so as to make the joints completely water tight and pipes are kept at all times free dust and dirt during the fixing. Burr from the joint shall be removed after lying. The open ends of the pipes shall be temporarily plugged to prevent access of water, solid or any other foreign matter.

6.0 INSTALLATION of G.I. PIPE:

6.1 Tender drawings indicate schematically the size and location of pipes. The Contractor on the award of the work, shall prepare detailed coordinated with other trades working drawings, showing the cross-section, longitudinal sections, details of fittings, locations of isolating and control valves, drain valves and all pipe support, structural supports. He must keep in view the specific openings in buildings and other structures through which pipes are designed to pass.

Piping shall be properly supported on or suspended from connection clamps, hangers as specified and as required. Install pipes in a manner to avoid strain on equipment's connections. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers, and be responsible for their structural sufficiency.

6.2 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 dielectric fitting shall be provided in between. Spacing of pipe supports shall not exceed the following:

Pipe Size Dia (mm)	Spacing between supports (mtr)	Hanger Rod Dia (mm)
Up to 25	1.5	6
32 to 50	2.7	10
65 to 100	2.7	12
125 to 150	3.0	16
200 to 300	3.5	19

6.3 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 steel structural supports attached to pipe and with a 15-mm thick rubber pad or any resilient material. Where pipes pass through the terrace floor, suitable flashing shall be provided to prevent water leakage. Risers shall have a suitable clean out at the lowest point and air vent at the highest point.

6.4 Pipe sleeves, 50 mm larger diameter than pipes, and 50mm above F.FL. Shall be provided wherever pipes pass through walls and slabs, and annular space filled with fire proof materials like putty, fire seal etc.

6.5 All pipe work shall be carried out in a workman like manner, causing minimum disturbance to the existing services, buildings, roads and structure. The entire piping work shall be organized in consultation also coordinated with other Contractors work so that particular area work shall be carried out in one stretch.

6.6 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 wherever the cut outs shown in the drawings, do not meet with the requirements.

6.7 The Contractor shall make sure that the clamps, steel structural supports, brackets, clamp saddles and hangers provided for pipe supports are adequate. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required.

6.8 All pipes shall be accurately cut to the required sizes in accordance with relevant BIS codes and burrs removed before lying. Open ends of the 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.

6.9 All buried pipes under floor shall be cleaned and coated with zinc chromate primer and bitumen paint, then wrapped with bitumen faced hessian or tar felt over a coat of bitumen paint with final coat of bitumen over bitumen faced hesitator tar felt **or as mentioned in BOQ.**

a. In case the pipe is embedded in walls or floors, it should be painted with two coats of anti-corrosive bit mastic paint of approved quality, covered with one layer of fiberglass tissue and finally painted with one coat of bitumen paint. The pipe should not come in contact with cement mortar or cement concrete as the pipe will be affected by cement. Under the floors, the pipes shall be laid in layer of filling under concrete floors for CWS pipes only.

6.10 For pipes 15mm to 25mm dia, the holes in the walls and floors shall be made by drilling with chisel or jumper and not by dismantling the brick work or concrete. However, for bigger dimension pipes the holes shall be carefully made of the smallest size as directed by the Client's Representative. After fixing the pipes the holes shall be made good with cement mortar 1:3 (1 cement: 3 coarse sand) properly finished to match the adjacent surface.

6.11 All pipes above ground shall be painted with **approved** one coat of red lead and two coats of synthetic enamel paint of approved shade and quality. Pipes shall be painted to standard colour code/or as specified by the Client's Representative.

6.12 Springing or forcing pipe into place will not be permitted. Protect piping at all times from dirt and moisture. During storage at construction site, keep end plugged to prevent dirt and moisture entering.

6.13 Carefully grade all pipes to eliminate traps and pockets. Where air pockets or water traps cannot be avoided provide means of drainage with valve hose connection for water traps and valve automatic air vents for air pockets.

6.14 Below **ground** piping shall be installed in such a manner that it does not appear directly on ground.

6.15 Any location where pipes/valves through or closed to basement walls shall be protected from direct contact of concrete block.

6.16 Pipes passing through building walls shall be protect by cast iron sleeves large enough to permit changes size eccentric fittings shall be used except where branch pipes connect into mains and in domestic system.

7.0 TESTING:

7.1 After laying and jointing, the pipes and fittings shall be inspected under working condition of pressure and flow. Any joint found leaking shall be redone and all leaking pipes removed and replaced without extra cost. Use of any compound or stop leak compound will not be permitted.

7.2 The pipes and fittings after they are laid shall be tested to hydraulic pressure of 1.5 times the working pressure or 7.5 Kg/Sq.cm whichever is more. The pipes shall be slowly and carefully charged with water allowing all air to escape and avoiding all shock or water hammer. The draw

of taps and stop cocks shall then be closed and specified hydraulic pressure shall be applied gradually. Pressure gauge must be accurate and preferably should have been recalibrated before the test. The test pump having been stopped, the test pressure should be maintained without loss for at least two hours. The pipes and fittings shall be tested in sections as the work of laying proceeds, having the joints exposed for inspection during the testing.

8.0 PAINTING:

The pipes shall be finally provided with synthetic enamel paint of approved quality for exposed pipes after the Hydrostatic test pressure. The cost of such painting should be included to the Contractor's quote.

9.0 CLAMPS

G.I. pipes in shafts and other locations shall be supported by M.S. clamps of design approved by the engineer-in-charge. Pipes at ceiling level shall be supported on structural clamps fabricated on M.S. structural. Pipes in typical shaft shall be supported on slotted angles/channels as specified elsewhere.

10.0UNIONS:

Contractor shall provide adequate number of flanges on all larger diameter pipes to enable dismantling later. Unions shall be provided for smaller diameter pipes at appropriate locations and required and/or directed by engineer-in-charge.

11.0 FLANGES:

Flanged connections shall also be provided on all equipment connections as necessary and required or as directed by the engineer-in-charge. Flanges shall be of forged type and not casted. Connections shall be made by the correct number and size of the bolts and made with 3 mm thick insertion rubber washer.

12.0TRENCHES:

12.1 All G.I. pipes below ground level shall be laid in trenches shall have a minimum cover of 0. 6 mtrs. Excavation for trenches shall be done as specified in subsequent pages of this tender but the width and depth of the trenches shall be as follows:

Dia.of pipes	Width of trenches	Minimum depth of trench
15 mm to 50 mm	0.30 mtrs	0.75 mtrs
65 mm to 100 mm	0.45 mtrs	1.00 mtrs

12.2 Where specified all G.I. pipes in trenches shall be protected with fine sand 150 mm all-round before filling in the trenches.

13.0 PIPE PROTECTION:

Where specified in the schedule of quantities all pipes in chase or below ground shall be protected against corrosion by applying one coats of bitumen paint, wrapping with multilayered non-woven polyester mat as per manufacturer's specifications.

A. VALVES AND APPURTENANCES:

14.0 BALL VALVE:

14.1 The ball valve shall be of high-pressure class and shall be sizes as specified and directed.

14.2 The nominal size of ball valve shall be that corresponding to the size of the pipe to which it is fixed. The valve shall be of gunmetal as specified with standard polyurethane float. The float should be special in shape. The jointing of float shall be efficiently finished, lapped and soldered seam or brazing. Polyurethane floats shall be used as specified.

14.3 The ball valve shall generally confirm to IS. Specifications No.1703, The weight of ball cock and size of ball shall as per table given below:

14.4 Both high pressure and low-pressure ball valves are designed for use on mains having pressure of 17 kg/sq.cm and above.

Dia. In mm	Total weight high pressure	Total weight Low pressure
15	524 gms	481 gms
20	986 gms	867 gms
25	1549 gms	1411 gms
32	2120 gms	1873 gms
40	2646 gms	2303 gms
50	4454 gms	3959 gms

15.0 BRASS FULL WAY VALVE:

Full way valve is a valve with suitable means of connection for insertion in a pipeline for controlling or stopping the flow. The valve shall be of brass fitted with a cast iron wheel and shall be of gunmetal gate valve type opening full way of the size as specified. The valve shall be of best quality approved by the Consultants \ Architects.

16.0 GUN METAL FULL WAY VALVE WITH WHEEL:

These shall be of the gunmetal fitting with wheel and shall be of gate valve type opening full way and of the size as per specification. These shall generally conform to I.S. 780-1984 (Sixth Revision).

17.0 BUTTERFLY / BALL VALVE:

17.1 Valves up to 40 mm dia and below shall be Nickel plated brass body heavy stainless-steel ball, lever operated, tested to 20Kg/sq.cm with female screwed ends. All ball valves shall be of full-bore type.

17.2 Valves from 50mm up to 150mm dia shall be of cast of iron body butterfly valves lever operated with flange ends. Valves shall carry IS certification mark.

17.3 All valves shall be approved by consultants before they are used on work.

17.4 All globe and check valves shall have working parts suitable for hot and cold water, as required. Valves shall be tagged with permanent label under hand wheel indicating type or duty.

18.0 FOOT VALVE:

Provide cast iron body with brass disc and strainer of approved quality, wherever shown.

19.0. "Y" STRAINERS:

''Y'' strainers up to 50mm shall be of gunmetal and above 50mm shall be of cast iron body. Strainers shall incorporate a removable bronze screen with mm (1/8'') perforations and a permanent magnet. Strainers shall be provided with flanges at both inlet and outlet. They shall be designed to enable blowing out of accumulated dirt and facilitate dirt and facilitate removal and replacement of the screen without disconnection of the main pipe.

20.0 PRESSURE REDUCING VALVE:

Pressure reducing valves shall be of "Hawk "make bronze pivot operated spring-loaded valves for reducing pressure as required suitable for specified dia of pipe.

21.0 SLUICE VALVE:

21.1 The sluice valves are used in a pipeline for controlling or stopping flow of water. They shall be of specified size and class and shall be of inside non – raising screw type spindle with either double flange or double sockets ends and cap or hand – wheel.

21.2 These shall in all respects comply with the Indian Standard specification IS. 780 – 1984 for Valves up to and including 300mm, size and No. BDC (429) p2 for valves above 300mm, size. Calls – I sluice valves are used for maximum working pressure of 10kg / cm2, (100-meter head) and class – II sluice valves for 15kg / cm2 (150-meter head).

21.3 The body, domes, covers, wedge gate and stuffing box shall be of good quality cast iron, the spindle of bronze the nut and valves seats of leaded tin bronze. The bodies, spindles and other parts shall be truly machined with surfaces smoothly finished. The area of the waterway of the fitting shall be not less than the area equal to the nominal bore of the pipe. The valve wheel shall be marked with an arrow to show the direction of turn for closing the valves.

21.4 The valve shall be fully examined and cleared of all foreign matter before being fixed. The fixing of the valve shall be done by means of bolts, nuts, and 3mm rubber insertions or chemically treated compressed fiber board of 1.5mm thick minimum thickness and of weight not less than 0.183gm per sq.cm with the flanges of spigot and the socketed tail pieces drilled, to the same specification in the case of S & S

pipe and with flanges in case of flanged pipes. The tailpieces shall conform to IS. 1938 – 1960. These shall be jointed to the pipes line by means of lead caulked joints.

22.0 VALVE SCHEDULE:

Service	Type	Size	Rating	Ends	Materials
Water	Ball Valve	40 & under	300 psi	Screwed	Bronze/GM
Water	Horizontal vertical check	40 & under	20kg / cm2	Screwed	Bronze
Water	Horizontal vertical check	50 & over	20kg / cm2	Flanged	Iron body bronze trim
Water	Butter Fly Valve	50 & over	20kg / cm2	Flanged	CI. body bronze trim

23.0 AIR RELEASE VALVES:

23.1 Air release valves shall be provided in all high points in the system to prevent air locks, as shown on the drawings or directed by engineer-in-charge.

23.2 Air release valves shall be of single acting heavy-duty brass spring type as specified in the schedule of quantities.

24.0 REFLUX / NON RETURN VALVE :

These are fixed so as to open in the direction of flow but automatically close if the water flows back. They are used to diminish the damage done by the escape of water due to a burst or prevent damage to impellers of pumps.

25.0 MEASUREMENTS:

The length above ground shall be measured in running meter correct to a cm for the finished work, which shall include G.I. pipe and G.I. fittings such as bends, tees, elbows, reducers, crosses, plugs, sockets, nipples and nuts, unions etc. Deductions for length of valves shall be made. Rate quoted shall be inclusive of all fittings, clamps, cutting holes chased and making good the same and all items mentioned in the specifications and Bill of Quantities.

B. CPVC PIPES AND FITTINGS:

26.0 DESCRIPTION:

26.1 CPVC Pipe shall be tough, rigid, corrosion resistant, chemical resistant, low thermal expansion, lower bacterial growth, superior installation, hot & cold-water compatible, no scale, pit or leach formation, low pressure loss, higher flow rates & unaffected by chlorine in the water.

26.2 All Domestic pipes within the toilets, kitchens etc. (in chases or under the floor) shall be CPVC (Chlorinated Polyvinyl Chloride) pipes made as per ASTM - D-2846, SDR-11conforming to IS: 15778.

27.0 PIPE FITTINGS:

27.1 The fittings shall be of CPVC and brass with female screwed ends as called for in the specification complying with all the appropriate requirements given in Para A.1.1 or as specified. The fitting shall be designated by the respective nominal bores of the pipes for which they are intended.

27.2 The fittings where the taps, stop cock, mixer fitting, are intended to be fixed, shall be of brass body and shall have screw threads at the ends / female threads or fittings shall be parallel and male threads (except on running nipples and collars of unions) shall be tapered. Unions shall be provided at regular intervals in the pipelines for easy Maintenance / Repair / Replacement of pipes

28.0 HANDLING AND STORAGE:

Flow Guard CPVC is a tough, corrosion resistant material, but it does not have the mechanical strength of metal. Reasonable care should be exercised in handling CPVC pipes and fittings. They should not be dropped, stepped on, or have objects thrown on them. If improper handling or heavy impact results in cracks, splits, or gouges, the damaged section shall be discarded. Flow Guard tubing should be covered with a non-transparent material when stored outdoors for long periods of time.

29.0 PIPE CUTTING:

29.1 Pipes shall be cut with either a wheel type plastic pipe cutter or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within the joint. Dry cloth shall be used to wipe dirt and moisture from the fitting sockets and tubing ends. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket. Only CPVC solvent should be used for joining the pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways.

29.2 After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds approximately in order to allow the joint to set up.

30.0 DEBURRING & BEVELLING:

Burrs and fillings can prevent proper contact between tube and fittings during assembly and should be removed from outside and inside of the pipe. Debarking tool, pocked knife or files are suitable for this. A slight bevel on the end of the tubing will ease entry of the tubing into the fitting socket and minimize the chances of pushing solvent cement to the bottom of the joint.

31.0 FITTING PREPARATION:

Using a clean, dry rag, wipe dirt and moisture from the fittings socket and tubing end. The tubing should make contact with socket wall 1/3 to 2/3 of the way into the fitting socket. At this stage, tubing should not bottom out in the socket.

32.0 LAYING AND JOINTING:

The pipes and fittings shall be inspected at site before use, to ascertain that they confirm to the specification given in parA1.1. The defective pipe shall be rejected. Where the pipes have to be cut or jointed the ends shall be carefully filed, so that no obstruction to bore is offered. The jointing to be dry fit checked. A thick coat of solvent cement shall be applied to the outer surface of the socket by mean of a brush. Solvent cement shall be of approved and of good quality ASTM – F493. The pipe shall be then inserted is to the fitting and turned 90 degrees to ensure even distribution of solvent cement within the joint. Excess solvent cement shall be wiped off. Properly align the fitting. Hold the assembly for approximately 10 seconds, allowing the joint to set – up. An even bead of cement should evident around the joint. If this bead is not continuous around the socket edge, it may indicate that insufficient cement was applied. In this case, remake the joint to avoid potential leaks. Wipe excess cement from the tubing and surfaces for an attractive professional appearance. Clamps / pipe hooks a required size shall be used for clamping the pipe to the walls.

33.0 SET AND CURE TIMES:

33.1 Solvent cement set and cure times are a function of pipe size, temperature, and relative humidity. Curing time is shorter for drier environments, smaller size, and higher temperatures. Refer to the following table for minimum cure time after the last joint has been made of before pressure testing can begin.

33.2 Minimum cure prior to pressure testing at 150 psi (10 bar):

Ambient Temperature During Cure Period	Pipe Sizes ½” – 1”	Pipe Sizes 1 ¼” – 2”
Above 15^0 C	1 Hour	2 Hours
4-15^0 C	2 Hours	4 Hours
Below 4^0 C	4 Hours	8 Hours

Special care should be exercised when assembling Flow Guard systems in extremely low temperature (below 4^0 C) or extremely high temperature (above 38^0 C). In extremely hot temperatures, care should be taken to ensure both surfaces to be jointed are still wet with cement when putting them together.

34.0 SOLVENT CEMENT APPLICATION:

34.1 When making a joint apply a heavy, even coat of cement to the pipe end. Use the same applicator without additional cement to apply a thin coat inside the fitting socket. Too much cement can cause clogged water ways.

34.2 Number of joints per liter of cement by pipe size

Diameter of Pipe		**Approximate No. of Joints**
(Inch)	**(mm)**	**(Nos)**
½”	15	1200
¾”	20	750
1”	25	500
1 1/4”	32	450
1 ½ “	40	325
2”	50	225

35.0 ASSEMBLY:

Immediately insert the tubing into fitting socket, rotating the tubing ¼ to ½ turn while inserting. This motion ensures an even distribution of cement within the joint. Properly align the fitting to set-up. Hold the assembly for approximately 10 seconds, allowing the joint to set-up. An even bead of cement should be evident around the socket joint. If this bead is not continuous around the socket edge, it may indicate that insufficient cement was applied. In this case, remake the joint to avoid potential leaks. Wipe excess cement from the tubing and fitting surface for an attractive, professional appearance.

36.0 HORIZONTAL & VERTICAL SUPPORTS:

Horizontal and Vertical runs of CPVC pipe should be supported by pipe clamps or by hangers located on the horizontal connection close to the riser hangers should not have rough or sharp edges, which come in contact with the pipe.

HORIZONTAL AND VERTICAL SUPPORT SPACING				
Nominal Pipe Size	**21ºC (70ºF)**	**49ºC (120ºF)**	**71ºC (160ºF)**	**82ºC (180ºF)**
Inch (mm)	**FT (cm)**	**FT (cm)**	**FT (cm)**	**FT (cm)**
½ (15)	5.5 (167.7)	4.5 (137.16)	3.0 (91.44)	2.5 (76.2)
¾ (20)	5.5 (167.7)	5.0 (152.4)	3.0 (91.44)	2.5 (76.2)
1 (25)	6.0 (182.9)	5.5 (167.7)	3.5 (106.7)	3.5 (91.44)
11/4 (32)	6.5 (198.1)	6.0 (182.9)	3.5 (106.7)	3.5 (106.7)
1½ (40)	7.0 (213.4)	6.0 (182.9)	3.5 (106.7)	3.5 (106.7)
2 (50)	7.0 (213.4)	6.5 (198.1)	4.0 (121.9)	3.5 (106.7)

37.0 DIMENSIONAL DETAILS OF CPVC PIPES (SDR-11):

The Pipe & Fittings are as per ASTM D2846, Standard rating of 7 kg/cm2 @ 82 deg C & 28kg/cm2@ 23deg C and CPVC fusion compound (Solvent Cement) as per ASTM F493 STANDARD.

38.0 DIMENTIONAL TABLE OF CPVC PIPES:

Sl. NO.	Nominal Size		Avg. Outside Diameter (SDR-11)	Min. Wall Thickness (SDR-11)
	Inch	MM	MM	MM
1	½”	15	15.90	1.73
2.	¾”	20	22.20	2.03
3.	1”	25	28.60	2.59
4.	1-1/4”	32	34.90	3.18
5.	1-1/2”	40	41.30	3.76
6.	2”	50	54.00	4.90

C. HOT WATER PIPING INSULATION:

39.0 HOT WATER PIPES CEILING AND WALL CHASE:

Hot water pipes including CPVC with in a toilet / Kitchen from hot water Geyser shall be insulated with 6 to 9 mm thick closed cell elastomeric nitrile rubber or crossed linked polythene foam.

40.0 INSULATION FOR PIPES IN SHAFT AND AT ROOF LEVEL FOR SOLAR SYSTEM:

40.1 Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

40.2 Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer’s recommendations. The insulation shall be continuous over the entire run of piping, fitting and valves. All valves, fitting, joints, strainers, etc. in hot 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.

40.3 All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labeled (HWS / HWR) and provided with 300mm wide band of paint along circumference at every 1200mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

41.0 PROTECTIVE COATING OVER INSULATION:

To provide mechanical strength and protection from damage & UV rays all exposed pipe insulated with nitrile rubber as indicated in BOQ shall be covered with fiberglass fabric. The fiberglass fabric shall be applied with one coat of fire proof epoxy or acrylic compound. The coat shall be allowed to cure to non-stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

42.0INSULATION

All exposed hot water supply pipes at terrace and in shaft shall be wrapped thermal insulation a flexible elastomeric foam of closed cells structure having thermal conductivity of 0.038 W/M. K at 40oC, water vapour permeability fire propagation including all accessories e.g. adhesive and ape on joint complete as per specification. All joints shall be sealed with adhesive & cotton tape. (9/13mm thick)

43.0 TESTING

43.1 Once an installation is completed and cured per these recommendations, the systems should be hydrostatically pressure tested. 10bar (150 PSI) for one hour is recommended. When pressure testing, the system should be filled with water and all air bled from the highest and farthest points in the run. If a leak is found, the joint must be cut out and discarded. A new section should be installed using couplings. During sub – freezing temperatures, water should be blown out of the lines after testing to eliminate potential damage from freezing.

43.2 In addition to the sectional testing carried out during the construction, contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings to the building, furniture and fixtures shall be made good during the defects liability period without any extra cost.

43.3 After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

44.0 PRIMER & CLEANER APPLICATION:

Primer or cleaner prepares the bonding area for the addition of cement and subsequent assembly. It is important to use a proper applicator. A dauber or natural bristle paint brush approximately ½ the size of tubing diameter is appropriate. Apply primer to both the outside of tubing end and in the fitting socket.

D. MEASUREMENT:

45.0 CPVC PIPES:

Pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings eg. Couplings, tees, bends, elbows, unions, flanges. Deduction for values shall be made. Rate quoted shall be inclusive of all fittings, excavation, back filling and disposal of surplus earth, cutting holes and chases and making good and all items mentioned in the specifications and schedule of quantities.

46.0 INSULATION:

46.1 Unless otherwise specified measurement for pipe insulation for the project shall be on the basis of centre line measures described herewith.

46.2 Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers shall not be separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including valves, orifice plates and strainers etc. shall be considered strictly by linear measurement along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

47.0FITTINGS AND VALVES:

47.1 Brass valves, cast iron valves, air release valves and all other similar items mentioned in the schedule of quantities shall be measured by number and shall include all items mentioned in the specifications.

47.2 Brick masonry pillars of sizes mentioned in the schedule of quantities or shown on drawings shall be measured by volume of the finished pillar and shall be paid per cu.m.

47.3 Cement plaster for brick pillars etc. shall be measured by area of the finished surface.

48.0 Painting:

48.1 For painting pipes with enamel or black bitumastic paint no separate payment shall be admissible.

48.2 Protection to pipes with polyethylene tape shall be measured per linear meter and shall be inclusive of all fittings and valves.

END OF SECTION – III

1. LIST OF APPROVED MAKES

LIST OF APPROVED MAKES:		
SL. NO.	**MATERIAL DESCRIPTIONS**	**MAKE/MODEL**
1	Floor / wall mounted EWC/ Wash Basin/ IWC/ Urinal/ Cistern/	Roca/ Parry ware/ Hind Ware
2	Shower arm/ Shower Rose/ Health Faucet/ Two-way bib cock/ Pilar Cock/ Basin Mixture/ Sink Mixture/ Sink Cock/ Angular stop cock/ Divertor/ 3 in 1 wall mixture/ Long body bib cock/ Short body bib cock/ Concealed Stop cock	Jaquar/ Parriware/Hindware
3	SS Sink	Nirali Regular Medium/ Parryware/ Hindware
4	uPVC pipes SWR Type A & B/ PVC pipe Schedule – 40/80, CPVC pipe SDR-11 or 13.5/	Finolex/ Astral/ Ashirbad
5	GI Pipe Class “C”/ “B” as per IS: 1239	Jindal/ TATA
6	NP3 R.C.C Hume Pipe for External Drainage Work.	W.B Concrete Pvt. Ltd / Indian Hume pipe / Quality Precast.
7	Gun Metal/ Brass Ball Valve/ GM Pressure reducing valve/ Buffer type CI Butter Fly Valve/ GM Float Valve/ Buffer type dual Check valve/ CI Y Strainer/ CI Sluice Valve	Zoloto/ Leader/ Itap/ Audco/Kitz
8	S.S Cockroach Trap with Grating	Chilli/Equivalent
9	CI Pipes, Fittings/ Cl manhole covers	BIC/ Neco
10	RCPC Manhole Cover/Grating	Oam Concrete/GK Industries
11	Submersible Dewatering Pumps/ Submersible Tube well pumps/ Cold water transfer pump/ Filter feed pump/ Hydro Pnuematic Pump/Booster Pumps etc.	Wilo/ Grundfoss / Xylem

2. COMPLETION TIME

PROJECT COMPLETION: Erection, Commissioning and handing over of the plumbing system shall be considered to have been completed as described below:

ERECTION: The plumbing system shall be considered erected once the interconnecting piping, instruments and accessories and testing the relevant systems are in place. Minor job completion, not affecting commissioning, shall not be reason to consider it not completed.

HANDOVER: Once the commissioning is conducted and system is run without any hindrances, it considered to be handed over.

TRAINING: Training will be imparted to maximum 4- 5 personnel.

EQUIPMENT GUARANTEE: All the pipes, fittings and equipment's will be guaranteed against defective material and /or bad workmanship for a period of 12 months from the date of commissioning.

DELIVERY: The material will be ready for dispatch within a period of 4/6 weeks from the date of receipt of Purchase Order with all technical and commercial confirmations along with advance payment. A period of 1 week will be required for erection and commissioning from the date on which we get clear working site at our disposal.

VALIDITY: The offer will remain valid for a period of 30 days from the date of this offer after which this will remain subject to our written confirmation.

3. Project Schedule:

Sl.No	Description of Project	1ST Days	2ND Month	4TH Month	11TH Month	12TH Month
1.	Acceptance of Work order					
2.	Preparing Shop Drawing					
3.	Supply of all type of materials at site					
4.	Erection of pipe line and relevant accessories					
5.	Commissioning of Systems					

4. CODES AND STANDARDS

All codes and standards referred to in the specification shall be understood to be latest version on the date of offer made by the Bidder unless otherwise indicated.

5. Bought out Material's

All materials shall be sourced from Owner's approved vendors. The approved make list for Plumbing Systems is attached with this specification.

6. Bid Submission

Bidder shall furnish an offer in line with all the requirements of the specification.

7. Technical Queries

In case bidder requires any clarification to the specification, the bidder shall clarify the same with the Purchaser within a week of receipt of enquiry.

8. Technical Offer

Bidder's offer shall be in line with the Bid documents. In case the bidder is not able to meet any the bid stipulation, the bidder shall clearly indicate the deviation and the reason thereof in the Schedule for Deviations. All deviations shall be mutually discussed and agreed before award.

9. Bidder shall submit a complete offer within the time period prescribed in the Enquiry document, including all the details of equipment/systems for Plumbing package in his scope.

i. Bar chart covering milestones such as preparation of shop drawings, obtaining approval and execution of works at site, testing and commissioning.

ii. Bidder shall provide L2 schedule for Engineering, Procurement, Erection and commissioning in line with completion time given in completion schedule. Further Bidder shall provide schedule for submission of major input drawings if any.

CLARIFICATIONS OF CIVIL QUERY

Sr.No	BOQ No.	BOQ Item	Queries	Remarks / Suggestion
CIVIL-INTERIOR PACKAGE				
	Main Building & Annexe Building			
1	1,2	**Anti-Termite Treatment**	UOM for Anti Termite Treatment is given in RMT, Please clarify it should be in SQM or RMT, as standard practice for measurement is in SQM.	Given as per PWD schedule
2	General	**RCC Works**	Need Detailed RCC drawings of Concrete Work for Plinth , Foundation etc. Works.	To be provide during execution. Quote as per quantity given
3	44,45	**Granite Flooring**	Need Basic Rate of Granite Flooring.	Rs. 1800 per sqm
4	46	**Mosaic Tiles**	1) Need Basic Rate of London Mosaic Tiles.	Rs.45000 per sqm
			2) This being a imported Item, Need Design Pattern, Style , scaled architects plans, selected Tile sample images etc. for pricing purpose.	Reference image uploaded

5	50	**Washing & Cleaning Item**	Need Clarification on UOM and QTY of items as Qty mentioned is in % .	Quantity in % sqm amount calculated as per % sqm check as per % sqm Check PWD schedule for further clarification
6	63	**Wooden Beam**	Need Detailed Drawing or Size of Wooden Beams , Also need Area of Application of the item.	To be provide during execution.
7	75 - 76	**Rolling Shutter / Gate**	Need Detailed drawings of Rolling Shutter and Collapsible Gate.	To be provide during execution.
8	91 - 92	**Rolling Shutter**	Need Accurate details regarding Renewing of Rolling Shutter w.r.t Size , Dimension , Hardware etc.	To be provide during execution.
9	95	**Wooden Door**	Please clarify Door shutter to be considered of Flush / Block Board or Wood Door.	Shutter of wood door (pannelled door of solid wood)
			If wood is to be consider, Please share Basic Rate / Grade of Wood to be used.	All wood to be used shall be of Burma Teak
10	96	**Louver Shutters**	Need Detailed drawings of Fixed Louvers Shutter for Door & Windows with Size and dimension of shutters.	To be provided during execution
11	104	**Timber Planks**	Need Basic Rate of Timber Planks.	Basic rate shall be Rs. 1260/Sq.m.
12	110	**Styles & Rails of Wooden Shutter**	Need Size / Dimension (WxH) of styles & Rails of Wooden Shutters.	To be provide during execution.
13	105	**Eaves Board**	Need Make or Basic Rate of Eaves Board.	Basic rate shall be Rs. 2100/Sq.m.
14	131 - 136	**General**	Need Clarification on UOM and QTY of items as Qty mentioned is in % , as there is a error in Amount Calculation of Item no. 136.	Quantity in % sqm,amount calculated as % sqm, check PWD schedule
15	154	**Glass Planes Removal**	Need Sizes of Glass Planes for Removal Purpose.	To be provide during execution.
16	155	**Anti Skid Vitrified Tiles**	Need Basic Rate of Anti Skid Vitrified Tiles.	300 x 300 x 10 - 600/sqm, 600 x 600 x 10 - 1100/sqm

17	157	**Fire Rated Acoustical Door**	UOM of F.R.A Door is mentioned as RMT, Please clarify rate quoted is to be SQM or RMT, as standard practice for measurement is in SQM.	confimed to be in SQM Given as per PWD schedule
18	161	**FRP Panels**	Need Detailed Drawings of FRP Panels to be installed with Reference Images.	To be provide during execution.
19	162	**Wallpaper**	Need Basic Rate of Wallpaper	Rs. 900/sqm
20	166	**Veneer Wood**	Need Basic Rate of Veneer Wood.	Natural veneer including wenge, wallnut, anegre, cycamore, whiteash, sapele, mahagony, red cedar
21	168	**Officer's Table**	Need Detailed Drawing of Officer's Table.	To be provide during execution.
22	184	**General**	Need Clarification on UOM and QTY of items as Qty mentioned is in % , as there is a error in Amount Calculation of Item no. 136.	Calculation have been vetted & verified correctly.Unit in % Mtr given as per PWD schedule.
23		**Furniture**	1. As per the discussion during the pre bid meeting it was informed to us that the chairs mentioned in sl. no. 173, 174, 188 & 189 will have mixed type of chairs i.e. carpentered & manufactured. The requirement is not clear from present BOQ and specification, request you to differentiate the two variety of chairs and also share the detail specification and drawing of the same. For manufactured item request you to specify the make and nearest model.	REFERENCE IMAGES UPLOADED. KINDLY REFER TO THE SAME.
			2. In item no. 152 & 168 the specification is exactly same, however, the estimated price is different, please clarify if the item required is same for both. For manufactured item request you to specify the make and nearest model.	
			3. For item no. 176, 177, 191 & 192 the specification is not clear, the dimensions are not given in the specification. For manufactured item request you to specify the make and nearest model.	

			4. Kindly confirm the if the dimension mentioned for sl. no. 179 & 194 i.e. Center Table is correct or there will be change in dimension. For manufactured item request you to specify the make and nearest model.	
24	190	**Conf. Room Table**	Need Detailed Drawing of Conference Room Table.	
25	196	**POP Cornice**	Need Detailed Specification / Ref. Images / Dimension of POP Cornice.	
26	General	**Partition**	Need detailed drawings of Full Height / low Partition , Semi Glazed Partition, Wall Panelling, Storage Units.	
27	General	**Wood Works**	As per BOQ specification for Woodworks, 1st Class Burma Teak Wood is specified , same is not avialable in the Market. Request you to please change the specs to 1st Class Teak Wood.	No change in specification allowed, contractor need to burma teak wood as specified
28	General	**Drawing & Detail**	Please provide schematic drawings & 3D views of proposed design.	Reference images attached.
29	19, 20, 21	**BRICK WORK WITH LIME AND SURKI MORTAR**	To be substituted by cement morter because nowadays surki is not available easily	As heritage building so specs cannot be changed
30	30e	**SHUTTERING, CENTERING AND STAGING**	unit will be cum in place of sqm	UOM will be in Sqm & the rate will remain unchanged
31	46	**LONDON MOSAIC**	London mosaic vendor details & basic rate of this item is required	basic rate 45000 per sqm
32	125, 126	**FINISHING WITH LIME PLASTER**	Item to be changed by Cement Plaster instead of Lime Plaster, If permitted	No Change in specification
33	157	**FIRE RESISTANT ACOUSTIC DOOR SHUTTER**	Unit will be sqm, in place of Metre	UOM will be in Sq.m. & the rate will remain unchanged

34	176	**BAFFLE FALSE CEILING**	Unit will be rm, in place of sqm	The UOM will be in Sq.m. as mentioned in the BOQ.

CLARIFICATIONS OF MEP QUERY

Tender no. : KOPT/KDS/CIV /T/2402/64			
Tender : HVAC WORKS FOR REFURBISHMENT OF KOPT HEAD OFFICE BUILDING AT 15, STRAND ROAD KOLKATA-700001W			
Spec. No	**As per Specification**	**Query**	**Consultants Reply**

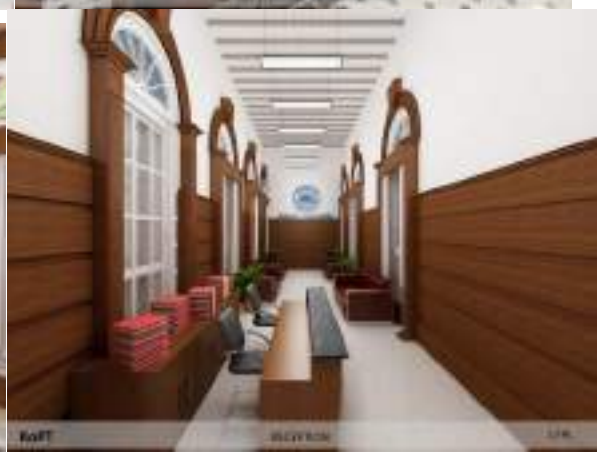
BOQ-A.1	**Magnetic Bearing oil free centrifugal turbo core chiller with multi compressor machine,**	**1) BOQ asked for magnetic bearing chiller with multi compressor . Please note, Turbocor compressor is manufactured by Danfoss & used by other chiller manufacturers. Since Turbocor compressor is of limited capacity , so to meet the building's cooling capacity they are using multiple compressors.** **But at York we manufacturer compressor as per load/ tonnage requirement. We are not like packager, we manufacturer our own compressor .** **Just because there are two compressors, there is still only:** **One refrigerant circuit** **One control circuit** **One expansion valve** **One power panel** **One flow switch** **This means if any one of these items goes bad then the chiller will go in shut down .** **Please note that York manufactures magnetic bearing chiller with single compressor & can not participate with this clause which in turn restrict the fair competion & enable only one manufacturer to bid.** **Request you to consider magnetic bearing chiller with single compressor also.** **Please Confirm.**	**As the chiller configurartion was done based on proper heat load analysis and project requirement. Others technical advantage of Multiple Compressors are flexibility for operation in case of any mechanical or electrical failure with any one compressor which is not the case for Single Compressors machines. Another advantage of Multiple compressors are Efficiency in part load operations. However, Danfoss make or equivalent make of Oil free turbocore compressors is accepted, but it should be with multi compressors only as mentioned in the tender.**
BOQ-A.1	**IkW/TR : 0.58 kw/Tr (At Operating Condition)**	**1) Please note that none of the approved chiller vendors are able to comply to IkW/TR : 0.58 kw/Tr (At Operating Condition) . To ensure compliance from all vendors request you to amend the same suitably as IkW/TR : 0.68 kw/Tr (At Operating Condition).** **Please confirm.**	**IKW/TR : 0.58 Kw/TR (at Operting conditions) to be achieved at below conditions:** **Chw In :54° F , Chw Out: 44° F , Fouling Factor : 0.0005 FPS. Cond Water In : 89.6^{o} F , Cond Water Out**

			:96.8^{o} F , Fouling Factor :0.001 FPS
BOQ-A.1	**NPLV : 0.34 kW/TR (Max)**	**1) Please note that none of the approved chiller vendors are able to comply to NPLV = 0.37kW/TR. To ensure compliance from all vendors request you to amend the same suitably as NPLV: 0.37kW/TR. Please confirm.**	**The NPLV has to be maximum of 0.34 KW/TR with AHRI relief.**
BOQ-A.1	**VFD Protection rating shall be minimum IP54**	**1) Our chiller are designed with factory fitted and unit mounted VFD and seating at a height of minimum 6 ft from the ground level. As VFD is integral part of chiller, and the complete chiller including the VFD shall comply to NEMA I protection standards. Additional protection rating are required for free standing VFD's as they are mounted on floor and have risk of water exposure during any pipe leakage or water flooding in the plant room.**	**As per Specification the minimum requiremnet of VFD protection is IP 54. However any advantage on protection standard is acceptable.**
BOQ-A.1	**Condenser with 2 pass configuration and max pressure drop up to 3.0 meters.**	**Please note that for the 300TR chiller 3 meters pressure drop in condenser is too low which will restrict heat exchanger performnace at part load.** **For example in HVAC specification of CPWD, Condenser maximum pressure drop allowed is 10 meters.** **Restricting pressure drop to 3 meter will restrict the fair competion & enable only one manufacturer to bid.** **Request you to allow condenser pressure drop up to 7m .**	**The pressure drop upto 7m is acceptable. However there will be a technical weightage given for a lesser pressure drop design since there can be an energy savings in the Primary pumps**
We request you to incorporate below points in the BOQ for smooth operation of chiller.			

1)	**UPS and capacitor bank for a trouble free operation**	**The chiller starter panel shall include a UPS and capacitor bank for a trouble free operation of the chiller during power break downs or switch overs. Capacitors shall not require scheduled replacement and shall work through out the life of chiller. Capacitors provided for bearing must be having life equivalent to life of the chiller.**	**The proposed chiller should have UPS/Capacitor bank/other power back up devices to ensure the smoothe operation of chiller during power failure. The life of the Capacitor bank is at least 8 years and to be checked periodically . If any replacement is required that has to be taken care by the OEM's**
2)	**Active Harmonic Filter IEEE519 Compliant THD level below 5 %**	**Boq does not asked for active harmonic filter , please note that to keep magnetic bearing centrifugal compressor safe & for longevity of chiller , active harmonic filter with IEEE519 Compliant THD level below 5 % at drive terminal is must. Request you to incorporate active harmonic filter with IEEE519 Compliant THD level below 5 % in BOQ. Please confirm.**	**AHF is not required for this project.**
3)	**Factory fitted Unit mounted VSD & Active Harmonic Filter**	**Request you to consider only factory fitted Unit mounted VSD and Active Harmonic filter for the below reasons :1) To have all performance parameters like KW/TR, COP, IPLV & NPLV etc inclusive of all losses of VFD & Active Harmonic Filter etc.1) Power losses due to AHF will be clearly stated in AHRI/Eurovent certified performance sheets of the manufacturer which in other case is not .2) For smooth synchronization between Chiller VSD & AHF to guarantee the desired performance of chiller.3) No extra space needed for mounting free standing VFD and Active Harmonic filter in plant**	**AHF is not required for this project. However the VSD's should be factory fitted.**

		room.4) No extra cabling, Cable tray, or Cable support is needed. This give huge saving in overall project.	

VIEWS



All other terms & conditions and Clauses will remain same as per original

Superintending Engineer(Contract Cell)
For मुख्य अभियंता **/ Chief Engineer**