Hindustan Prefab Limited
(A Govt. of India Enterprise)
Jangpura, New Delhi – 110014

Provision of Furniture, Acoustic, Heating Ventilating and Air Conditioning System, Audio System and Connected Items for Auditorium at Shokhuvi, Nagaland.

LIST OF SPECIFICATIONS & PREFERRED MAKES

NIT NO: HPL/DGM(C)/TC/2017-18/61 Dated: 16.10.2017

Last date for issue of Tender Form : 31.10.2017

Last date for submission of Tender: 31.10.2017

COST OF TENDER: Rs. 5900/-

EMD: Rs. 9.23 Lakh.

ISSUED TO M/s: .....

Ph- (011) 43149800-899, Fax: (011) 26340365
E-mail:- hindprefab@gmail.com
Website: www.hindprefab.in,

LIST OF PREFERRED MAKES FOR CIVIL WORKS

Sl. No.	Material description	Approved Manufacturer / Brand Name
1.	TMT bars – Fe 500 grade (Ductile or Super Ductile) having Ultimate Strength atleast 15% higher than Yield Strength	Primary / Main producers like SAIL, Rashtriya Ispat Nigam Ltd., TISCO, Jindal Panther,Shyam Steel
2.	Cement (OPC/PPC) as per IS:8112 and IS:12269/IS:1489(Part-I &II) (PPC shall be from reputed manufacturer having annual production of atleast one million tons or more)	Jaypee Cement, J.K. Cement, Shree Ultra Cement, Ultra Tech, A.C.C., Birla, Lafarge, Dalmia.
3.	Ceramic/glazed Tiles	Kajaria, Johnson, Somany, orient of approved design, color and shade.
4.	White Cement	Birla White, J.K. White or equivalent.
5.	Primers, paints (Low VOC) (i/c water proofing cement paint) etc.	Nerolac, Asian, Burger, ICI Exterior paint of Apex Ultima of Asian or Premier Exterior Emulsion of Dulux.
6.	Putty	Birla, J.K. Putty or equivalent.
7.	Wash Basin and WC PAN	Parryware, Hindware, Johnson, Cera. (as per Cat No. mentioned in the BOQ items)
8.	Clear glass	Modi Guard, Saint Gobain, AIS
9.	G.I. pipes and accessories	Tata, Jindal, Prakash Surya, APL Apollo, NVR GI pipe fittings.
10.	Centrifugally Cast Iron Spun Pipes & fittings	Neco, Electrosteel, SKF
11.	DI Pipes & fittings	Kesoram, Electrosteel
12.	Brass / CP Brass fittings	Parrywar, Hindware & Jaquar (as per Cat No. mentioned in the BOQ items)
13.	Aluminium sections (Anodising by approved anodizing firm)	Hindalco, Jindal, Indian Aluminium Co.
14.	Water proofing compound	WEBER, FOSROC, PIDILITE, CICO,dr fixit, BASF
15.	Chemical admixtures and construction chemicals	FOSROC, PIDILITE, dr fixit, BASF
16.	Stainless steel sink	Neelkanth, Nirali, Jayna,
17.	Particle board i/c laminated	BHUTAN, ECO BOARD
18.	Plastic W.C. seat cover	Parryware, Hindware, Johnson (as per Cat No. mentioned in the BOQ items)
19.	Stoneware pipes & gully traps	Perfect, Taya
20.	UPVC Window	Fenesta, Ewin, Rehau
21.	PVC tanks	Sintex or As approved by Engineer-in-Charge.
22.	Mirrors	Saint Gobain & Modi Guard
23.	CP waste & flush pipes	As approved by Engineer-in-Charge.
24.	PVC flushing cistern.	Parryware, Hindware, Johnson. (as per Cat No. mentioned in the BOQ items)
25.	Tile Fixer / Adhesive	FOSROC, PIDILITE, dr fixit, BASF or As approved by Engineer-in-Charge.
26.	Vitreous Floor Tiles	Johnson, Kajaria, SOMANY
27.	Ply board / Block Board	Green Ply, Kitply, Century
28	PPR pipes	SFMC, HPMC, prime

LIST OF PREFERRED MAKES FOR ELECTRICAL WORKS

Sl. No.	DESCRIPTION	MANUFACTURER'S NAME
1.	MCB / RCCB / RCBO / DB	ABB/LEGRAND (Lexic)/ Schneider/ Standard
2.	Industrial outlet	L&T (Hager)/ABB/LEGRAND (Lexic)/ Schneider/ Standard
3.	MCCB (Thermo magnetic/Static)	ABB/L&T/Schnieder/Siemens/GE Power
4.	SWITCH FUSE UNIT WITH HRC FUSES	L & T / ABB/Schnieder/Siemens
5.	CONTRACTORS/ RELAYS	L&T /SIEMENS/ABB/ Schneider
6.	Current Transformers	Kappa/ Pragati/ AE / G&M
7.	Voltage Transformers	Kappa/ AE / G&M
8.	Ammeters/ Voltmeters and metering equipments	L&T/SIEMENS/AE/Neptune
9.	Selector Switches	Kaycee/Salzar/L&T
10.	LED lights	L&T /Bajaj/Syska/Decon/HPL
11.	Change Over Switches	GE/L&T/HH ELCON/ABB/HPL
12.	PVC insulated Copper conductor wires	FINOLEX/Polycab/Rallison/ Henlay/ Skytone/ Havels
13.	Telephone Wires and cables	FINOLEX/Polycab/Skytone/ Havells
14.	Telephone Coaxial cable	FINOLEX/Polycab/Boton/Skytone/ Havells
15.	Switches and Sockets outlets (Conventional piano type)	ANCHOR/SSK/MK/North West/Crabtree/Havells
16.	Switchs and Sockets outlets (Modular type)	ANCHOR/SSK/MK/North West/Crabtree/Havells
17	PVC/XLPE INSULATED 11 KV/1.1 KV CABLES	CCI/ FINOLEX/ POLYCAB/SKYTONE/HAVELLS/
18.	CONTROL CABLES/ WIRES	CCI/ FINOLEX/ POLYCAB/SKYTONE/HAVELLS/
19.	LUGS	DOWELLS/ 3D/C.C.I./ 3M
20.	CABLE GLANDS	SIEMENS/COMET/GRIPPWEL
21.	PVC Conduits and accessories	AKG/BEC/CAP/SEIKO/POLY PACK
22.	Light fitting	PHILIPS/BAJAJ/DECON
23.	HPMV/HPSV/Halogen Lamp Fitting	PHILIPS/ BAJAJ/DECON
24.	Ceiling Fans/Exhaust Fans/ Air Circulators	CROMPTON/USHA/HAVELLS
25.	LT Panel/ Meter Board	Adlec/Tricolite/ Advance/NSG Power Project/KRYPTON
26.	Transformer (Dry Type)	Kirlosker/Voltamp/Crompton Greaves/ Universal/Recon
27.	HT Panel	ABB/Siemens/Crompton Greaves/ Schenider

28.	D.G. Set	Cummins Jakson/Kirloskar electric/ Mahindra
29	UPS	APC/Luminious Power/
30	**HVAC VRV SYSTEM WORKS**	CARRIER AIRCON/ LG/ SAMSUNG/DAIKEN
31	Any Other Items	On approval of Engineer-in- charge

	OTHER MAKES	
I	**Audio Equipment Makes**	
1	Wireless Handheld Microphone	AKG / Sennheiser / Shure
2	Wireless Presenter Microphone	AKG / Sennheiser / Shure
3	Gooseneck Microphone	AKG / Sennheiser / Shure
4	Dynamic Vocal Microphone	AKG / Sennheiser / Shure
5	16Channel Mixer with Effects	Soundcraft/ Mackie / Yamaha
6	Control Room Monitor Speaker	NEXO / JBL / BOSE
7	Mounting Bracket for Control Room Speakers	NEXO / JBL / BOSE
8	Loud Speaker Management System	Dbx / BSS / Tubo Sound
9	Graphic Equalizer	Dbx / BSS / Tubo Sound
10	12 "Two Line Array Speakers	NEXO / JBL / BOSE
11	Amplifier for Line Array speakers	CROWN / LabGruppen / Peavey
12	18 "Subwoofer Speaker	NEXO / JBL / BOSE
13	Amplifier for subwoofer speakers	CROWN / LabGruppen / Peavey
14	Mounting Arrangement & Array Frame for Line Array Speakers	Customized as per the site requirement
15	Balcony Speakers	NEXO / JBL / BOSE
16	Amplifier for Balcony speakers	CROWN / LabGruppen / Peavey
17	Green Room Speakers	NEXO / JBL / BOSE
18	Dual Channel Amplifier	CROWN / LabGruppen / Peavey
19	12 "Two Way Stage Monitor Speakers	NEXO / JBL / BOSE
20	Amplifier for Stage Monitor Speakers	CROWN / LabGruppen / Peavey
21	High quality 2 core /1.5 sq .mm Loudspeaker cable	Chetan / Falcon / Clotz
22	High quality 2 core /1.5 sq .mm Shielded Microphone cable	Chetan / Falcon / Clotz
23	XLR Male/Female, Chassis mount Microphone Connector,	Neutrik / Extron / Kramer

	Speakon Connectors	
24	8 Channels Microphone Junction Box	Behringer / BSS / Pro Sound
25	Equipment Rack	President / Falcon / HCL
26	Bluray DVD/CD Player	Sony / Panasonic / Pioneer
II	**Audio Projection Equipment Makes**	
1	Video Projection System	EPSON / PANASONIC / BENQ / SONY
2	Ultra Long throw Lens	EPSON / PANASONIC / BENQ / SONY
3	Presentation Switcher	EXTRON / KRAMER / BARCO / CRESTRON
4	Twisted Pair Transmitter / Receiver	EXTRON / KRAMER / BARCO / CRESTRON
5	Motorized Screen	DALITE / DRAPER / LIBERTY / HARKNESS
6	CABLES	EXTRON / KRAMER / BELDON / FALCON
III	**CHAIRS /FURNITURE**	Godrej/Wipro/Rana Chairs
IV	**CARPETS**	Miliken/Unitex
V	**FALSE CELING**	Armstrong/ Anutone
VI	**ACOUSTIC FABRIC**	Comrade

Note:- In Case, Any Other Item/ Material Required To Complete The Work For Which Makes Are Not Specified Above, The Contractor Shall Take Prior Approval Of The Engineer-In- Charge.

TECHNICAL SPECIFICATIONS

1.0 GENERAL

1.1 Indian Standards:

Materials: All materials shall conform to the latest edition of the Indian Standard Specification. Standard issued elsewhere may be used only if approved by the Engineer and for those materials only for which appropriate Indian Standards do not exist. All materials shall be tested as per IS and CPWD norms at Site or NABL approved Labs by the contractor and all costs of tests shall be borne by the contractor.

Items of work : All items of work shall be executed as per latest CPWD Specifications Volume I & II amended up to date in general. Specifications used elsewhere may be used only if approved by the Engineer and for those items of work only for which appropriate CPWD Specifications do not exist.

1.2 Sampling and Testing of Materials :

i) All materials used in the works shall be subjected to inspection and test. Samples of all materials proposed to be employed in the permanent works shall be submitted to the Engineer for approval at his own cost and expense before they are brought to the site. These samples shall be submitted 15 days in advance when required for works. If samples are not approved, the Contractor shall forthwith arrange to supply fresh samples for approval. After the sample is approved the materials shall be arranged and brought to site within a fortnight. Samples provided to the Engineer or his representatives for their retention are to be in labeled boxes suitable for storage.

DETAILED SPECIFICATIONS FOR AUDITORIUM CHAIRS :

HIGH-LIGHTS

Push Back System: 8.5 Kg

14G Thick Seam-Less / Weld-Less Seat Supporting Tray

12G Thick Back Clamps to Hold Cushioned Back with 4 Nos. Of 8mm x 6mm Flanged Bolts

100 mm Variable Travel Jerk Free Push Back Movement

25mm x 6mm - 4 Nos MS Support Arms & 50 x 25mm MS Tube 2 nos

Epoxy Powder Coated Paint

Side Stands: 4.5 Kg / 5.5 Kg

2 Nos of CRC Sheets of 16G. Pressed together in Box Construction

12g. CRC Sheetv Deep Drawn Foot rest with Panel Insert in.

Fabric Pasted All over with PPCP Protective TEE on Front & Back

BACK

25 x 5mm / 25 x 3 mm MS Main Inner Frame of Back

Molded Polyuretheane Foam Cushined Back

Fire-Retardent Fabric upholstered with zipper attached

Fabric laminated with 8mm Ufoam with polyster underlay

Back Side of Fabric covered with Injection molded PPCP Cvr

SEAT

Injection molded PPCP Plastic Seat Inner Frame

Molded Polyuretheane Foam Cushined Seat

Fire-Retardent Fabric upholstered with zipper attached

Fabric laminated with 8mm Ufoam with polyster underlay

ARM-REST

PPCP Injectin Molded OR Intritrated SKIN type PU

All Steel Parts-Epoxy Powder Coated Paint

DETAILED SPECIFICATIONS FOR AUDIO SYSTEMS :

Specifications / Features of Wireless Handheld Microphone (Model AKG WMS 45HT Set)

30 Mhz selection bandwidth, 8 hours of operation with a single aa size battery, Gain control on handheld transmitter, Low battery indicator, Noiseless on/off/mute switch on handheld transmitter etc.

Receiver - Carrier frequency range: 500 – 560 MHz, Modulation: FM, Audio bandwidth: 40 – 20,000 Hz, T.H.D. at 1 kHz: typ. 0.8%, Signal/noise ratio: typ. 105 dB(A), Squelch threshold: 100 to -70 dBm adjustable, Audio outputs: Balanced XLR and unbalanced 1/4" (6.3 mm) jack: adjustable from mic to line level. Output level at rated deviation: 500 mV

RMS etc.

Handheld transmitter - Carrier frequency range: 500 – 560 MHz, Modulation: FM, Audio bandwidth: 70 – 20,000 Hz
T.H.D. at 1 kHz: typ. 0.8%, Signal/noise ratio: typ. 105 dB(A), RF output: 10 mW, Power requirement: 1x 1.5 V AA size battery
Battery life: 10 hours etc.

Specifications / Features of Wireless Collar Microphone (Model AKG WMS 45PT Set)

30 Mhz selection bandwidth, 8 hours of operation with a single aa size battery, Gain control on handheld transmitter, Low battery indicator, Noiseless on/off/mute switch on handheld transmitter

Receiver - Carrier frequency range: 500 – 560 MHz, Modulation: FM, Audio bandwidth: 40 – 20,000 Hz, T.H.D. at 1 kHz: typ. 0.8%, Signal/noise ratio: typ. 105 dB(A), Squelch threshold: 100 to -70 dBm adjustable, Audio outputs: Balanced XLR and unbalanced 1/4" (6.3 mm) jack: adjustable from mic to line level. Output level at rated deviation: 500 mV RMS etc.

Lapel transmitter - Carrier frequency range: 500 – 560 MHz, Modulation: FM, Audio bandwidth: 70 – 20,000 Hz
T.H.D. at 1 kHz: typ. 0.8%, Signal/noise ratio: typ. 105 dB(A), RF output: 10 mW, Power requirement: 1x 1.5 V AA size battery

Specifications / Features of Gooseneck Microphone (Model AKG CGN521STS)

50 cm slim line gooseneck microphone, Polar pattern: Cardioid, Frequency range: 70 - 18.000 Hz, SPL max: 125 dB, Impedance: 600 Ohm, 120° recording angle, Programmable Thomann button, LED square, Heavy duty metal housing, Matte black surface, Supply voltage: 9 - 52V etc.

Specifications / Features of Dynamic Vocal Microphone (Model AKG D 5S)

- Polar pattern – supercardioid, Frequency range - 70Hz to 20kHz, Sensitivity - 2.6 mV/Pa (-52 dBV), Max. SPL - 147/156dB SPL (for 1% / 3% THD), Equivalent noise level - 18dBa, Impedance - <= 600 ohms, Recommended load impedance - >= 2000 ohms

Connector - 3-pin XLR, Finish - matte grayish blue etc.

Specifications / Features of 16Channel Mixer with Effects (Model Sound craft FX16ii)

16 inputs, 4 stereo returns, 4-bus architecture, Built-in 24 bit Lexicon digital effects processor, 32 effects settings, Tap tempo,
3 effects parameter rotaries, Direct outputs for recording, inserts on all mono channels, inserts on stereo mix output, 3-band EQ with swept mix-band, Stereo 18dB/octave 100Hz highpass filter, 48v global phantom power option on channels 1-8 or 9-16, Two sub-group outputs, Universal power supply, EQ Bands, 3-band, Sweepable Mid, Aux Sends - 2 x Pre, 1 x Pre/Post, 1 x FX, Busses/Groups, 2 Bus Sub, Faders - 20 x 100mm etc.

Specifications / Features of Control Room Monitor Speaker (Model JBL C2PS)

Transducers: LF: 135 mm (5.25 in) low frequency loudspeaker, HF: 19 mm (.75 in) Polycarbonate dome tweeter, Frequency Range: 80 Hz - 20 kHz, Amplifier Power: 35 Watts per channel,Maximum SPL Per Pair: 115 dB, Crossover Frequency: 4.2 kHz Input Sensitivity: +4 dBu XLR 1/4"; 0 dBu RCA, Signal Input Connectors (x2): Balanced Neutrik®* Combo XLR 1/4" TRS; Unbalanced RCA, Power Requirements: 19 VDC / 3.42 A - use only supplied power supply, Headphone Jack: 3.5 mm (1/8") **etc.**

Specifications / Features of Mounting Bracket for Control Room Speakers (Model JBL MTC-2P)

OEM Mounting bracket for Control Room Speakers

Specifications / Features of Loud Speaker Management System (Model Dbx Drive Rack 260)

- Feedback elimination, 2.7 seconds of Alignment and Zone Delay, RS-232 PC GUI control, Classic dbx Compression and Limiting

Graphic and Parametric EQ, Auto-EQ function, Full Bandpass, Crossover, and Routing configurations, Auto Gain control, Pink Noise Generator and fulltime RTA, Set-up Wizard with JBL speaker and Crown Power Amp tunings, Security lockout, Wall Panel Control inputs, 6 XLR Analog output etc.

Specifications / Features of 31 Band Graphic Equalizer (Model Dbx 231S)

- 1/3-octave Constant Q frequency bands, Switchable boost/cut ranges of +/-6 or +/-12Db, 12dB/octave 50Hz low-cut filter
- Front panel bypass switch, +/-12dB input gain range, 4-segment LED ladders for monitoring output level, XLR and TRS inputs and outputs, Frequency response of <10Hz to >50kHz, Dynamic range of greater than 108Db etc.

Specifications / Features of 12" Two Line Array Speakers (Model JBL VRX 932LA-1)

Frequency Range (-10 dB)1: 57 Hz - 20 kHz, Frequency Response (3 dB)1: 75 Hz - 20 kHz, Coverage Pattern: 100 x 15 nominal
Crossover Modes: Bi-amp / passive, externally switchable, Crossover Frequency: 1.2 kHz, Power Rating Passive: 800 W / 1600 W / 3200 W (Continuous/Program Peak)2: Bi-amp LF: 800 W / 1600 W / 3200 W, Bi-amp HF: 75 W / 150 W / 300 W, LF Driver: 1 x JBL 2262H 12 in Differential Drive woofer with neodymium-magnet, dual voice-coils and magnetic gap, HF Driver: 3 x JBL 2407J, 1.0 in voice-coil, neodymium compression driver, Nominal Impedance: Passive: 8 ohm, Bi-amp LF: 8 ohms, Bi-amp HF: 8 ohms, Active Tunings, Finish: Black Dura Flex finish, Grille: Powder coated, black, 16-gauge perforated steel with acoustically transparent foam, Input Connectors: Neutrik Speakon NL-4 (x2) etc

Specifications / Features of Amplifier for above speakers (Model Crown XTi 6002)

- Stereo Wattage: 3000W @ 2 ohms, 2100W @ 4 ohms, 1200W @ 8 ohms, Bridged Mono Wattage: 4200W @ 8 ohms, 6000W @ 4 ohms, Peak Plus Limiters provide the ultimate in system performance and protection by allowing full control over threshold, attack, and release, Enhanced Subharmonic Synth section provides user control over frequency, gain and filter type for system-specific tuning, 3 User-defined fan mode controls - normal, early and fullspeed- for matching fan performance to a specific application, system

monitoring provides software visibility of AC line voltage and power supply temperature, Integrated cast-aluminum handles for easy handling and enhanced durability, Locking power cord clip provides a secure connection between the amplifier and power cord, Updated HiQnet Band Manager and System Architect control software, Increased number of presets to a total of 30; 29 of which are user definable 20 Amp power etc.

- **Specifications / Features of 18" Subwoofer Speaker (Model JBL SRX 828S)**
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- Dual 18 in. Super Vented Gap woofers for extended low frequency output, Dual 18 in. Super Vented Gap woofers for extended low frequency output, Rugged DuraFlex coated enclosures sized to be truck pack friendly, 14-Gauge steel grille lined with acoustically transparent cloth, Frequency Range (–10 dB): 32 Hz-250 Hz, Frequency Response (± 3 dB): 37 Hz-120 Hz, Sensitivity (1W/1m): 99 Db, Power Rating: (Cont. Pink Noise/Program/Peak): 2000 W / 4000 W / 8000 W, Rated Maximum SPL: 138 dB SPL Peak, Nominal Impedance: 4Ω, Input Connectors: Two NL4, Operational Modes: Subwoofer etc.

Specifications / Features of Amplifier for above speakers (Model Crown XTi 6002)

Stereo Wattage: 3000W @ 2 ohms, 2100W @ 4 ohms, 1200W @ 8 ohms, Bridged Mono Wattage: 4200W @ 8 ohms, 6000W @ 4 ohms, Peak Plus Limiters provide the ultimate in system performance and protection by allowing full control over threshold, attack, and release, Enhanced Subharmonic Synth section provides user control over frequency, gain and filter type for system-specific tuning, 3 User-defined fan mode controls - normal, early and fullspeed- for matching fan performance to a specific application, system monitoring provides software visibility of AC line voltage and power supply temperature, Integrated cast-aluminum handles for easy handling and enhanced durability, Locking power cord clip provides a secure connection between the amplifier and power cord, Updated HiQnet Band Manager and System Architect control software, Increased number of presets to a total of 30; 29 of which are user definable 20 Amp power etc.

Specifications / Features of Mounting Arrangement & Array Frame for Line Array Speakers

Customized Mounting arrangement for JBL 932LA-1 matching with site requirement

Specifications / Features of Balcony Speakers (Model JBL Control 29AV)

Extremely smooth, flat frequency response with extended bandwidth, 110° x 85° HF coverage, rotatable horn, 110-Watt transformer for 70V or 100V lines, with 8 ohms through, SonicGuard overload protection, 8" (200mm) Kevlar cone woofer, 1" (25mm) titanium diaphragm compression driver, InvisiBall mounting hardware, Ten 6mm attachment points for suspension and optional U-bracket, Sealed input panel cover and screw-down input terminals, Frequency Range (-10 dB): 37 Hz — 18 kHz, Frequency Response (±3 dB): 43 Hz — 15 kHz, 100-Hour Power Capacity: 300 Watts Continuous Program Power, 150 Watts Continuous Pink Noise, Maximum SPL @ 1m3: Short-Term: 118 dB; Long-Term: 112 dB, Nominal Sensitivity: (half-space average 100 Hz to 10 kHz): 90 dB, 1W @ 1 m (3.3 ft), Nominal Coverage Angle: 110°H x 85°V, rotatable etc.

Specifications / Features of Amplifier for above speakers (Model Crown XLS 1502)

Watts/Side @ 8 ohms - 300W, Watts/Side @ 4 ohms - 525W, Watts/Side @ 2 ohms - 775W, Watts Bridged - 1550W @ 4 ohms, 1550W @ 8 ohms, Inputs - 2 x XLR, 1 x stereo RCA, 2 x 1/4",, Massive DSP capabilities maximize your sound, Bandpass filters for crossover tuning,

loudspeaker matching, and system EQ, Large LCD display lets you keep an eye on your parameters, Selectable input sensitivity with 1.4Vrms and .775Vrms options, Sleep mode shuts the unit down after a specified time, Security setting disables menu buttons, System reset allows factory settings to be restored, Remote power trigger, Peak-x Limiters provide maximum output while protecting your speakers, XLR, 1/4", and RCA inputs provide flexibility etc.

Specifications / Features of Green Room Speakers (Model JBL Control 25-1)

- Power rating - 200W (built-in optional 30W multi-tap 70V/100V transformer), 5.25" woven fiberglass cone woofer yields excellent low-end response, 0.75" PEI-diaphragm tweeter with fluid cooling delivers great-sounding high frequencies, 60Hz-20kHz frequency response for rich, high-fidelity sound, Wide 100-degree x 100-degree coverage fills the entire area with sound, Built-in InvisiBall hardware mounts almost anywhere, Weather-resistant enclosure and transducers, Contemporary design etc.

Specifications / Features of Dual Channel Amplifier (Model Crown XLi 800)

- 600-watts in bridged-mono mode, up to 300-watts stereo/parallel operation, Includes both unbalanced RCA and balanced XLR input connectivity, Binding post and speakON output connectors let you use virtually any passive PA speakers, Selectable input voltage (.755V or 1.4V) lets you set up your rig to match your gear, LED power, fault, signal-presence, and clip indicators let you keep an eye on the safety of your amplifier, Forced-air cooling and protection against shorts, no-load, and on/off thumps ensure smooth operation and long life, Excellent shielding against radio-frequency interference keeps your sound clean, even in heavy wireless conditions etc.

Specifications / Features of 12" Two Way Stage Monitor Speakers (Model LBL PRX 412M)

Frequency Range (-10 dB): 50 Hz – 20 kHz, Frequency Response (+3 dB): 62 Hz – 19 kHz, Coverage Pattern: 90° x 50° nominal, System Sensitivity: 95 dB SPL (1w@1m), Power Rating, Pink Noise: 300W / 600W / 1200W Continuous/Program/Peak), Rated Maximum SPL: 126 dB SPL peak, Dual-angle pole socket for applications requiring tripod mounting, Heavy Duty 16 gauge protective screen backed steel grille, Tough DuraFlex™ enclosure finish, Utilizes twelve M10 suspension points for safe deployment in light duty installations, SonicGuard™ protects the highfrequency driver from excess power without interrupting the performance etc.

Specifications / Features of Amplifier for Stage Monitor Speakers (Model Crown XLS 2502)

- Watts/Side @ 8 ohms - 440W, Watts/Side @ 4 ohms - 775W, Watts/Side @ 2 ohms - 1200W, Watts Bridged - 2400W @ 4 ohms, 1550W @ 8 ohms, Inputs - 2 x XLR, 1 x stereo RCA, 2 x 1/4",, Massive DSP capabilities maximize your sound, Bandpass filters for crossover tuning, loudspeaker matching, and system EQ, Large LCD display lets you keep an eye on your parameters, Selectable input sensitivity with 1.4Vrms and .775Vrms options, Sleep mode shuts the unit down after a specified time, Security setting disables menu buttons, System reset allows factory settings to be restored, Remote power trigger, Peak-x

Limiters provide maximum output while protecting your speakers, XLR, 1/4", and RCA inputs provide flexibility etc.

TECHNICAL SPECIFICATIONS FOR ELECTRICAL WORKS

1.0 GENERAL

To provide electrical equipment and materials for the distribution of electrical power from the ESS including ESS as shown in the drawings and described in these specifications. The quantities mentioned in BOQ are tentative. It will be the bidder's responsibility to work out the exact quantities from drawings, which trade provides said equipment, materials.

It is not the intent to specify completely herein all aspects of design and constructional features of equipment and details of work to be carried out, nevertheless, the equipment and work shall conform in all respects to high standards of Engineering, design and workmanship and shall be capable of performing in continuous commercial operation in a manner acceptable to the owner who will interpret the meaning of the specifications and drawings and shall have right to reject or accept any work or material which in his assessment is not complete to meet the requirement of this specifications and or applicable code and standards mentioned elsewhere in these specifications.

2.0 SCOPE

The scope of work under these specifications shall include design, manufacture, supply, loading and unloading, storage, erection and testing & commissioning of following items for complete electrification work including labour, tools, tackles and plants including supply of hardware consumables and steel fabrication etc. as required in the proposed **Greater Kailash-I Police Station of Delhi Police at New Delhi**. The scope also covers the detailed engineering and calculations of the various equipment/system mentioned hereunder and the same shall be approved by the Owner prior to execution of the job.

- Internal Electrical Works including Light Fixtures, Switch Boards, Switches, Receptacles, DBs, Wiring, Conduit & Conduit Accessories, Exhaust/Bracket/Ceiling Fans, Data Networking System, Telephone System, and Fire Detection & Alarm System
- LV Panels
- LT Cables
- Cable Trays
- Earthing & Lightning Protection
- External Lighting

Compliance with these specifications and/or approval of any of the Contractor's documents shall in no case relieve the Contractor of his contractual obligations.

All supplies to be effected that are a part of contract require specific approval/review of Owner or his authorized representative. Major activities requiring approval/review shall include but not be limited to the following:

The engineering activities shall comprise the submission for approval of the following:

· Basic engineering documents e.g. schematic & wiring diagrams, testing, type test report, guaranteed particulars of all equipment and maintenance manuals.

· Quality assurance procedure.

· Field testing and commissioning procedures.

· Control and protection schemes.

Bidder shall be responsible for

· Inter-connection Drawing.

· Protection co-ordination drawings/tables.

· Shop inspection and testing procedures.

· Field testing and commissioning procedures.

Bidder shall also be responsible for

· Any other work/activity that is not listed above however is necessary for completeness and correctness of electrical system.

. All minor civil works associated with earthing, system, lighting and power panels/ distribution boards, in walls for light points switch boxes, receptacles and their drops etc. such as fixing of anchor bolts, clamps, cleats, cutting of chases in wall, ceiling including refilling and plastering etc. of the same

Bidder shall clearly understand and quote accordingly

· The bidder shall bring to the notice of the Owner the differences, if any, and get the same clarified failing which the Owner may impose the more stringent of the specification/clauses at the sole risk and costs of the bidder.

3.0 CODES & STANDARDS

The design engineering and manufacturing shall be in accordance with established standards/codes (with amendments upto date), sound engineering practices, specifications and shall conform to the statutory regulations applicable in the country. Some of the relevant Standards/Codes are listed below:

Indian Electricity Act, 2003
Indian Electricity Rules, 1956

IS:8130	:	Conductors for insulated electrical cables and flexible cords.

IS:5831	:	PVC insulation and sheath of electric cables.
IS:694	:	PVC insulated electric cables for working Voltage upto and including 1100 volts.
IS:424, 1475 (F-3)	:	Power cable flexibility test.
IEC:754(1)	:	FRLS PVC insulated cable.
IS:13947 / IEC: 947 Part 1-5	:	Air Circuit Breaker / Moulded Case Circuit Breaker.
IS:8623	:	Specification for factory built assemblies of switch gear and control gear for voltage upto and including 1000V AC/1200V DC.
IS:10118	:	Switchgear and Controlgear selection, installation and maintenance.
IS:1248 Part 1-9	:	Direct acting indicating analogue electrical measuring instruments and testing accessories.
IS:13779	:	Digital measuring instruments and testing accessories.
IS:3156	:	Voltage Transformer.
IS:2705	:	Current Transformer for metering and protection with classification, burden and insulation.
IS :2147	:	Degree of protection provided by enclosures for low voltage switchgear and controlgear.
IS:3427	:	Metal enclosed switchgear and control gear.
BS:162	:	Safety clearance.
IS:3202	:	Code of practice for climate proofing of electrical equipment.

IS:375	:	Marking and arrangement for switchgear, bus bars, main connections and auxiliary wiring.
IS:722	:	AC electric meters.
IS:3231	:	Electrical relays for power system protection.
IS:5082	:	Electrolytic copper / aluminium Bus bars.
IS:2834	:	Capacitors.
IS:7752	:	Guide for improvement of power factor at consumer's installation.
IS:4201	:	Application guide for Current Transformer.
IS:4146	:	Application guide for Voltage Transformer.
IS:4029	:	Air Break switches.
IS:2959	:	Contactors.
IS:5578	:	Guide for marking of insulated conductors.
IS:11050	:	Guide for forming system of marking and identification of conductors & apparatus terminal.
IS:6005		Code of practice for phosphating of iron & steel.

Any other standard may be followed provided it is equivalent or more stringent than the standards specified above.

In case of any deviation / conflict of this specification with the codes & standards, the following order of precedence shall govern

a) Specification, particular specification if any, and drawings.

b) Indian regulations /codes and standards.

4.0 DESIGN

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The requirement offered

by the contractor shall be complete in all respects. Any materials or accessories which may not have been specifically mentioned, but which are usual and necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost to the purchaser. This shall also include spares for commissioning of the equipment.

5.0 DRAWINGS

i) Any information / data shown in the drawings furnished with the specifications shall not relieve the contractor of his responsibility to carry out the entire work as per the specifications and to the satisfaction of Engineer-in-Charge. Additional information required by the bidder for successfully completing the work shall be obtained by him.

ii) Shop Drawings

The contractor shall prepare detailed shop drawings indicating General Arrangement, Schematic, Inter-connection of the various equipment and submit to the Engineer-in-Charge for approval before commencing the work. The shop drawings shall indicate all setting out details and physical dimensions of all components with wiring and cable details including system operating write up in the system. All work shall be carried out on the approval of these drawings. However, approval of these drawings do not relieve the contractor of his responsibility for providing maintenance free and fool proof system including any missing component/accessories to meet with the intent of the specifications. Contractor will submit 2 prints for preliminary approval and finally six prints for distribution.

5.01 MATERIALS AND EQUIPMENTS

All the materials and equipment shall be of the approved make and design. Unless otherwise called for any approval by Owner's Engineer-in-Charge, only the best quality materials and equipment shall be used.

A. SPACE HEATERS

One or more adequately rated heaters thermostatically controlled with On-Off switch and fuse shall be provided to prevent condensation in any panel compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

B. FUNGISTATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts that may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

C. VENTILATION OPENING

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds.

D. DEGREE OF PROTECTION

The enclosures of the Control Cabinets, Junction Boxes and Marshalling Boxes, Panels etc. to be installed shall provide degree of protection as detailed here under.

- Installed out door : IP56.
- Installed indoor in air conditioned area: IP31.
- Installed in covered area: IP52.
- Installed indoor in non air conditioned area where possibility of entry of water is limited: IP44.

The degree of protection shall be in accordance with IS: 2147. Type test report for degree of protection test, on each type of the box shall be submitted for approval.

E. RATING PLATES, NAME PLATES AND LABELS

Main LT Panel to have rating/name plate and label permanently attached to it in a conspicuous position. A rating plate of non-corrosive material with engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions of equipment in question has been designed to operate and such diagram plates as may be required by the purchaser. The rating plate of equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

F. QUALITY ASSURANCE PROGRAM

To ensure that the equipment and services under the scope of this Contract manufactured within the Contractor's works or at his sub-contractor's premises are in accordance with the specifications, the Contractor shall adopt suitable quality assurance program to control such activities at all points necessary. Such program shall be outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A quality assurance program of the contractor shall generally cover the following:

- His organization structure for the management and implementation of the proposed quality assurance program.

- Documentation control system.

- Qualification data for bidder's key personnel.

- The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

· System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.

· Control of non-conforming items and system for corrective actions.

· Inspection and test procedure both for manufacture and field activities.

· Control of calibration and testing of measuring instruments and field activities.

· System for indication and appraisal of inspection status.

· System for quality audits.

· System for authorizing release of manufactured product to the Purchaser.

· System for maintenance of records.

· System for handling storage and delivery and

· A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his Vendor's quality management and control activities.

G. INSPECTION, TESTING AND INSPECTION CERTIFICATE

· The Purchaser and the Engineer-in-Charge shall have at all reasonable times free access to the Contractor's premises or works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection, if part of the works is being manufactured or assembled at other premises or works, the Contractor shall obtain permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

· All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Bidder shall submit the type tests reports for approval. The Contractor shall intimate the Engineer-in-Charge the detailed program about the tests at least three (3) weeks in advance in case of domestic supplies. If for any item type test is pending payment would be made on successful completion of type/routine test(s) actually carried out as per Engineer-in-Charge's instructions.

· The Contractor shall give the Engineer-in-Charge thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account. The Consultant/Owner unless witnessing of the tests is virtually waived will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the

test which shall be deemed to have been made in the presence of Engineer-in-Charge and he shall forthwith forward to the Consultant duly certified copies of tests in triplicate.

· The Engineer-in-Charge shall within fifteen (15) days from the date of inspection as defined shall inform in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and make the necessary modifications accordingly.

· When the factory tests have been completed at the Contractor's or Sub-contractor's works, the Engineer-in-Charge shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Engineer-in-Charge, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer-in-Charge. Failure of the issue such a certificate shall not prevent the Contractor from proceeding with the works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Specification. The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Engineer-in-Charge.

· For tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be required by Engineer-in-Charge or this authorized representative to carry out effectively such tests of the equipment in accordance with the Specification.

· The inspection by Engineer-in-Charge and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

· The Engineer-in-Charge will have the right of having at his own expenses any other tests(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests to satisfy that the material comply with the specifications.

· The Engineer-in-Charge reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Contractor.

6.0 PACKAGING

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. While packing all the materials, the limitation from the point of view of availability of Railway wagon/truck/trailer sizes in India should be taken account of the Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Owner takes no responsibility of the availability of any special packaging/transporting arrangement.

7.0 PROTECTION

All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

8.0 GENERAL

8.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanised after fabrication. High tensile steel nuts and bolts and spring washers shall be electro galvanised. All steel conductors used for earthing/grounding (above ground level) shall be galvanised according to IS: 2629.

8.2 HOT DIP GALVANISING

· The minimum weight of the zinc coating shall be 610 gm/sq.mm and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface that shall be embedded in concrete, the zinc coating shall be 610 gm/sq.mm minimum.

· The galvanised surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, splatter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

· After galvanizing drilling or welding shall be performed on the galvanised parts of the earthing materials. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

· The galvanized steel shall be subjected to six, one minute dips in copper sulphate solution as per IS-2633.

· Sharp edges with radii less than 2.5mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness,
- Uniformity of zinc,
- Adhesion test,
- Mass of zinc coating.

· Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

8.3 PAINTING

· All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces which will not be easily accessible after shop assembly shall beforehand be treated and protected for the life of the equipment. The surfaces that are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

· After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

· Powder coating/electrostatic painting of approved shade shall be applied.

· The exterior color of the paint shall be as per shade no.697 of IS: 5 and inside shall be white. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipment, if required.

· In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures like electrostatic painting etc. the procedure shall be submitted along with the Bids for Owner's review and approval.

9.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment.

TECHNICAL SPECIFICATIONS

CONDUIT

All conduits shall be of heavy gauge solid drawn ERW welded manufactured out of 16 (1.6mm) gauge MS Sheet upto 32mm dia and of 14 (2 mm) gauge for sizes higher than this. Both inner and outer surfaces shall be smooth without burrs, dents and kinks. Conduits shall be black stove enameled inside and outside. The cross section of conduit shall be uniform throughout. The welding shall be uniform such that welded joints do not yield when subjected to flattening test. Welded joint shall not break when threaded or bent at an angle. Conduit shall conform to specifications of IS:1653-1972 and the capacity of conduits shall be in accordance with the standards and shall never be exceeded. The minimum size of the conduit shall be 25mm dia. Care shall be taken to ensure that all conduits are adequately protected while stored at site prior to erection and no damaged conduit shall be used.

FIXING/LAYING OF CONDUITS

Conduit accessories such as normal bends, unions, circular junction boxes and pull boxes, locknuts etc. shall be heavy gauge type and of approved make. Wherever several conduits are running together, adequately sized adaptable boxes common to all runs shall be used to avoid inserting inspection boxes in the individual run. Where it is necessary to segregate wiring metal filler shall be fixed with in the box.

Conduits shall be laid before casting in the upper portion of a slab or otherwise, as may be instructed or in accordance with approved drawings, so as to conceal the entire run of conduits and ceiling outlet boxes. Vertical drops shall be buried in columns or walls. Wherever necessary, chases will be cut by the contractor with the help of chase cutting m/c or by hand. Nothing extra shall be paid to the contractor on this account. In case of exposed brick/rubble masonry/tile work special care shall be taken to fix the conduit and accessories in position along with the building work.

Sufficient depth of the chases will be made to accommodate the required number of conduits. The chase will be filled with cement, coarse sand mortar (1:3) and properly cured by watering for one week. If a chase is cut in an already finished surface the contractor shall fill the chase and finish it to match the existing finish. Contractor must not cut any iron bars to fix conduits. Conduits shall be kept at a minimum distance of 100mm from the pipes of other non-electrical services. Where the conduit is to be embedded in a concrete member it shall be adequately tied to the reinforcement to prevent displacement during casting, conduits in chases shall be held by steel hooks of approved design at maximum of 60cm centre. The embedding of conduits in walls shall be so arranged as to allow at least 12mm plaster covers the same. All threaded joints of conduit

- Pipes shall be treated with some approved ‘preservative compound’ to secure protection against rust.

- Suitable expansion joints fittings of approved make and design shall be provided at all the points where the conduit crosses the expansion joint in the building. Conduits shall cross at right angles of the joints only.

Separate conduit shall be used for:

1) Normal Lighting, Fans, Light Plug, Emergency Lighting, Exit Light
2) 6/16 Amps Power Outlets
3) CCTV / Access Control System
4) Telephone System
5) Fire Alarm System
6) Data Outlets
7) P.A System
8) Or any other services not mentioned here.

In case of surface conduit the colour codes enamel paints shall be used for each and every services for easy identification as directed by Engineer-in-Charge.

Wiring for short extensions to outlets in hung ceiling or to vibrating equipments, motors etc. shall be installed in flexible conduits. Flexible conduits (Pilca pipe) shall be formed from a continuous length of spirally wound interlocked wire steel with a fused zinc coating on both sides. The conduit shall be water tight type and approved make/sample. A separate and accessible earth connection shall bond across the flexible conduit.

Conduit runs on surfaces shall be supported with metal 1.2 mm thick saddles which in turn are properly secured on to GI spacer to the wall or ceiling. Fixing screws shall be with round or cheese head and of rust proof materials. Exposed conduits shall be nearly run parallel or at right angles to the walls of the building and shall be painted in colour matching the adjoining area. Unseemly conduit bends and offsets shall be avoided by using better appearance. Cross cover of conduits shall be minimum and entire conduit installation shall be clean and with good appearance. For surface work, the boxes shall be raised back pattern type, designed for use with distance saddles to give clearance of 6mm between the back of conduit and the fixing surface.

Where conduits are run on steel work, they will be fixed by means of purpose made GI Caddy clips in manner meeting with the approval of the Engineer prior to the installation being carried out. Other methods of fixing may be agreed in special circumstances, but approval must first be obtained from the site Engineer.

The spacing of saddles shall be at 750mm centre for upto 25mm diameter conduits and at 1000mm for conduit sizes of 32mm diameter and above. In addition, saddles shall be fixed at each side of any bend, or set at a distance of 225mm from the bend. The holes in the brick work or concrete for fixing plugs shall be neatly drilled by means of a masonry drill of the appropriate size.

All the GI sheet steel/zinc passivated boxes used for housing switches, plugs, fan regulator etc. shall be five sided conforming to IS: 5133 Part I-1969. The boxes shall be provided with four to six fixing lugs located at the corners and vertical sides. Suitable earth terminal inside each box shall be provided. All fixing lugs shall be threaded to receive standard machined chromium plated brass screws. Sufficient number of knockouts shall be provided for conduit entry. Conduits carrying wires of different circuit can terminate in common J.B. having metal compartments. Necessary GI pull wires shall be inserted into the conduit for drawings wires. In case conduit pipe is required to cross any RCC beam special adopter boxes shall be provided for crossing & nothing shall be paid extra.

Where conduits are used for non air-conditioned space to air-conditioned space or into a fan chamber or duct, a junction box shall be installed to break the continuity of such conduit at the point of entry or just outside and conduit shall be sealed around the conductors.

Particular care shall be taken during the progress of the work to prevent the ingress of dirt and rubbish such as plaster droppings into erected conduits. Conduit which has become so clogged shall be entirely freed from these accumulations or will be replaced. Screwed plastic or metal caps or turned wooden plugs shall be employed to protect all open ends. Plugs of waste wood, paper, cotton or other fibrous matter shall not be used. All unused conduit entries shall be blanked off in an approved manner and where conduits terminate in adoptable boxes, all removable box covers shall be firmly secured to provide complete enclosure. If considered necessary by the Engineer-in-charge, the conduits shall be swabbed out by drawing swabs of rag through the conduit to remove moisture prior to any cables being drawn in.

All conduit installations must be completed and erected in their totality before they are wired and must be fully re-wirable from outlets to distribution boards or trunking systems etc. to which they connect. No wiring of any part of the installation shall be commenced until instructions are received to do so by the Engineer-in-charge at such time as he is satisfied that the wiring will not be damaged due to building operations.

Conduits shall be installed so that they are self draining in the event of ingress of moisture due to condensation or any other reason. A suitable drainage hole shall be drilled at the bottom of the lowest conduit box in every 9 metre of horizontal run.

MS bush of good quality shall be used in each conduit termination in a switch box, draw box, lighting fixtures and circular junction boxes.

Exposed conduits running above false ceilings shall be suitably clamped independently along with the dropped ceiling. Perforated strap hangers or twisted attachment shall not be acceptable. In no case shall raceways be supported or fastened to other pipe for repair and maintenance. They shall be arranged symmetrically and in the cost compact design, in no way unduly criss-crossing each other. Proper spacing shall be maintained when two or more conduits run side by side. The layout of the pipes shall be coordinated with other services if any. The junction boxes and conduits used in hazardous areas shall be flame proof type with cast iron construction complete with threaded covers.

The conduit of each circuit or section shall be completed before conductors are drawn in. The entire system of conduit after erection shall be tested for mechanical and electrical continuity throughout and permanently connected to earth conforming to the requirements by means of special approved type of earthing clamp efficiently fastened to conduit pipe in a workman like manner for a perfect continuity between the earth and conduit.

The conduit system shall be so laid out that it will obviate the use of tees, elbows and sharp bends. No length of conduit shall have more than the equivalent of two quarter bends from inlet to outlet. The conduit itself being given required smooth bend with radius of bends suiting to the site conditions but not less than 6 times overall diameter.

Outlet boxes shall be of heavy duty type installed as to maintain continuity throughout. These shall be so protected at the time of laying that no mortar finds its way inside during concrete filling or plastering. For fluorescent fittings, the outlet boxes shall be provided 300mm off centre for a 1200mm fitting and 150mm off centre for a 600mm fitting.

Draw boxes of ample dimensions shall be provided at convenient points to facilitate pulling of long runs of cables. They shall be completely concealed with MS covers flush with plaster work painted to match the wall. These boxes will be as few as possible and located where found suitable by the consultant.

SWITCH BOXES

The switch boxes shall be 18 SWG. Passivated box will be so designed that accessories could be mounted on integral pedestals or on adjustable flat iron mounting straps with tapped holes by brass machine screw leaving ample space at the back and on the sides for accommodating wires and check nuts at conduit entries. These shall be attached to conduits by means of check nuts on either side of their walls. These shall be completely concealed leaving edges flush with wall surfaces.

Moulded plate switches as specified in item of work shall be fixed to these by means of chromium plated brass machine screws. No timber shall be used for any supports. Boxes which come within concrete shall be installed at the time of casting. Care shall be taken to fix the box rigidly so that its position is not shifted while concreting.

WIRING

All the wiring installation shall be as per IS:732 with latest amendments. FRLS PVC insulated copper conductor cables as specified in bill of quantities shall be used for sub-circuit runs from the distribution boards to the points and shall be pulled into conduits. They shall be twisted copper conductors with thermoplastic insulations of 1100 volts grade. Colour Code for wiring shall be followed.

Looping system of wiring shall be used, wires shall not be jointed. Where joints are unavoidable, they shall be made through approved mechanical connectors with prior permission of the consultant. No reduction of strands is permitted at terminations. No wire smaller than 2.5 sq.mm shall be used or as per B.O.Q. Wherever wiring is run through trunking or raceways, the wires emerging from individual distributions shall be bunched together with cable straps at required regular intervals. Identification ferrules indicating the circuit and DB number shall be used for sub-main, sub-circuit wiring. The ferrules shall be provided at both ends of each sub-main and sub-circuit.

Where single phase circuits are supplied from a three phase and a neutral distribution board, no conduit shall contain the wiring fed from more than one phase. In any one room in the premises where all or part of the electrical load consists of lights, fans and/or other single phase current consuming devices, all shall be connected to the same phase of the supply. Circuits fed from distinct sources of supply or from different distribution boards or through switches or MCBs shall not be bunched in one conduit. In large areas and other situations where the load is divided between two or three phase, no two single phase switches connected to different phase shall be mounted within two meters of each other.

All splicing shall be done by means of terminal blocks or connectors and no twisting connection between conductors shall be allowed.

Metal clad sockets shall be of die-cast non-corroding zinc alloy or polycarbonate sheet enclosure and deeply recessed contact tubes. Visible scraping type earth terminal shall be provided. Socket shall have push on protective cap. Socket shall have MCB/ELCB/RCCB as specified in the schedule of work.

Maximum number of PVC insulated 1100V grade copper conductor cable conforming to IS:694-1990.

Nominal	Clause 4.2.1 (ii)									
	25mm		32mm		38mm		51mm		64mm	
Cross-Sectional area of conductor in Sq.mm	S	B	S	B	S	B	S	B	S	B
1	2	3	4	5	6	7	8	9	10	11
1.50	10	8	18	12	-	-	-	-	-	-
2.50	8	6	12	10	-	-	-	-	-	-
4	6	5	10	8	-	-	-	-	-	-
6	5	4	8	7	-	-	-	-	-	-
10	4	3	6	5	8	6	-	-	-	-
16	2	2	3	3	6	5	10	7	12	8
25	-	-	3	2	5	3	8	6	9	7
35	-	-	-	-	3	2	6	5	8	6
50	-	-	-	-	-	-	5	3	6	5
70	-	-	-	-	-	-	4	3	5	4

Note:

1) The above table shows the maximum capacity of conduits for a simultaneous drawing of cables.

2) The columns heads ‘S’ apply to runs of conduits which have distance not exceeding 4.25 m between draw in boxes and which do not deflect from the straight by an angle

of more than 15 degrees. The columns heads 'B' apply to runs of conduit which deflect from the straight by an angle of more than 15 degrees.

3) Conduit sizes are the nominal external diameter.

LUMINAIRES/FANS

General

All the materials used in the construction of luminaires shall be of such quality, design and construction that will provide adequate protection in normal use, against mechanical, electrical failures/faults and exposure to the risk of injury or electric shock and shall withstand the effect of exposure to atmosphere.

Fluorescent/CFL Lamp Luminaires

Luminaire shall be supplied as per the design specified in the schedule of quantities. Luminaires shall be complete in all respects with basic mounting channel, shock proof insert contact rotor lamp holders, starter with holder for fl. lamp luminaries/standard holder for CFL, low watt loss high frequency electronic ballast, dimmable electronic ballast connector block, internal wiring and decorative attachments, if any as per B.O.Q. The mounting channel shall be made of CRCA steel sheets suitably rust inhabited and stove enameled. A dust proof cover stove enameled of white shade shall be of provided to form the channel to protect the accessories and wiring from dust and vermin and to act as reflector. Ballast shall be silent in operation, and shall have a long life and shall be highly reliable.

Diffusers, louvers, acrylic cover etc. shall be of opal acrylic or polystyrene material and for similar decorative attachments. The attachments shall be guaranteed against discolourisation, warping and deformation under continuous operation. Fluorescent lamps shall conform to BS:1853 in all respects. Luminaires shall be provided with an earthing terminal for bonding the body of the luminaire to earth. Luminaires shall be installed as specified on the drawings. Wherever luminaires are fixed on the false ceiling, suitable supporting and fixing arrangements independent of the frame work of false ceiling shall be provided. Suspended luminaires shall be provided with swivel type hangers, comprising of suspension pipes, swivel sockets, screws, bolts etc. for installing the luminaires.

Luminaires shall be suspended true to alignment in plumb and level and capable of resisting all lateral and vertical forces Lead-in-wires shall be protected from abrasion. Erection of the fixtures shall include assembling of all components of the fixtures such as chokes (ballast) condensers, starters, decorative attachments etc. Where suspended ceiling are installed the contractor shall cooperate with the ceiling installer to ensure that the luminaires layout is compatible with the ceiling panel layout.

Fans:

Ceiling Fans

Ceiling fans shall conform to IS:374 (latest edition) all respects and shall be smooth and silent in operation. The fan motor shall be a capacitor type motor with internal stator and external rotor pattern. The blades shall be made of aluminium sheets painted in white shade. The design and construction of blades shall be such that

maximum quantity of air is displaced in smooth manner. The motor and blades shall be statically and dynamically balanced. The fans shall be provided with ball bearing only that is accessible for lubrication. The ceiling fan shall be provided with rubber shackle and a down rod of suitable length as required. The suspension arrangement shall be jointed to the fan motor by means of a thread joint and a safety locking arrangement. Fans shall be provided with bottom cover and top canopy. Electronic step regulators shall be provided, with every fan. Ceiling fans shall be suspended from the special hooks or special fan hook boxes. Where hooks are used the wiring to the fan shall be from a ceiling rose. Wherever special fan hook boxes are used, the fan wiring shall be terminated in porcelain / PVC three way connector. Lead-in-wires shall have cross-section area of not less than 23/.0076 (copper).

Exhaust Fan

Propeller type exhaust fan shall conform to IS:2312 (latest edition)in all respects. The motor shall be of die-cast aluminium case. The fan motor shall be of squirrel cage induction type single phase motors shall be capacitor start and run type.

Exhaust fans be provided with a special anticorrosive treatment to withstand normal concentrations of chemical fumes in the environment.

The fan shall be designed to withstand the effects of moisture under normal conditions of use. The design of motor and its windings shall be such that moisture in surrounding is not absorbed by the windings. Exhaust fans shall be complete with mounting rings, ring arms and a resilient suspension. The motor and blades shall be of mild steel and so designed that they operate smoothly with minimum noise. The fans shall be finished to be a glossy grey shade with an approved enamel paint. The fans shall also be provided with gravity louvers for exhaust arrangement or bird screen for inlet arrangement.

Exhaust fans shall be fixed at the locations shown on the drawings. The fans shall be fixed by means of rag bolts grouted in wall. Exhaust fan be connected to the exhaust fan point by means of a 3 core flexible cord.

DISTRIBUTION BOARDS

Distribution boards including MCBs shall be of approved make. Distribution boards shall be constructed out of steel sheet all weld enclosure with double door IP42 protection and shall be powder coated. Ample clearance between the conductors of opposite pole, between conductors and sheet steel body shall be maintained in order to obviate any chance of short circuit. Removable conduits entry plates shall be provided at top and bottom to facilitate drilling holes at site to suit individual requirements. The MCBs shall be mounted on high grade rigid insulating support and connected by electrolytic copper bus bars. Each incoming MCB/Isolator/MCCB shall be provided with solder less cable sockets for crimping. Phase separation barriers made out of arc resistant materials shall be provided between the phases. Bus bars shall be colour coded for phase identification.

Distribution boards shall be recessed in wall niche or if required mounted on the surface of the wall with necessary clamp bolts etc. The mounting height shall not exceed 1500mm bottom from finished floor level. Distribution board shall be provided with proper circuit identification name plate and danger sticker/plate as per requirements.

All the distribution boards shall be marked with ‘lighting’, ‘power’ or ‘essential’ with DB Nos., as the case may be. Each DB shall be provided with a circuit list giving details of each circuit. All the outgoing circuit wiring shall be provided with identification ferrules giving the circuit number & phase.

Each distribution board shall have a separate neutral connection bar equal to the phase bus and a separate earth connection bar mounted within the DB each having the same number of terminals as the total number of outgoing individual circuits from the distribution board. Conduit & cable armoring shall be bonded together & connected to the distribution board earth bar.

Where oversized cables are specified due to voltage drop problems, it shall be contractors responsibility to ensure that satisfactory terminal arrangements are provided without any extra cost. Separate adopter box of suitable size shall be provided to facilitate the wiring of the DB and no payment shall be made on this account.

MINIATURE CIRCUIT BREAKER

1. The MCB shall be suitable for manual closing and opening and automatic tripping under overload and short circuit conditions. The MCB shall also be trip free type.

2. Single / double / three / four pole versions shall be furnished as required.

3. The MCB shall be rated for 10 KA fault level.

4. The MCB shall be suitable for its housing in the lighting boards and shall be suitable for connection at the outgoing side by tinned cable lugs and for bus-bars connection on the incoming side.

5. The terminal of the MCBs and the open and close conditions shall be clearly and indelibly marked.

6. The MCB shall generally conform to IS:8828.

LOW VOLTAGE (L.V.) CABLES

A. Wires

The design manufacture, testing and supply of single core FRLS PVC insulated 1.1 KV grade stranded twisted wires under this specifications shall comply with latest edition of following standards.

IS: 3961 Current rating for cables
IS: 5831 PVC insulation and sheath of electric cables
IS: 694 PVC insulated cables for working voltage upto and including 1100 volts
IEC: 754(i) FRLS PVC insulated cables

Copper stranded twisted conductor FRLS PVC insulated shall be used in conduit as per item of work. Copper conductor FRLS PVC insulated cables for control & power cables shall be used.

The wires shall be colour coded R Y B, for phases, Black for neutral and Green for earth.

Progressive automatic in line indelible, legible and sequential marking of the length of cable in metres at every one metre shall be provided on the outer sheath of cable.

B. Cables

The design, manufacture, testing and supply of the cable under this specifications shall comply with latest edition of following standards:

IS : 8130	Conductors for insulated electric cables and flexible cords.
IS : 5831	PVC insulation and sheath of electric cables.
IS : 3975	Mild steel wires, strips and tapes for armouring cables.
IS : 3961	Current rating of cables.
IS : 694	PVC insulated (heavy duty) electric cables for working voltage upto and including 1100 volts.
IS : 424-1475 (F-3)	Power cable-flammability test.
IS : 7098 (Part - I) - 1988	Specification for cross linked polyethylene insulated PVC sheathed armoured/unarmoured cable for working voltage upto 1.1 KV.
IS : 1554	Specification for PVC insulated (heavy duty) electric cables for working voltages upto and including 1100 volts.
IS : 10810	Testing method of cable.
IS : 6121	Cable glands.
ASTM-D : 2863	Standard method for measuring the minimum oxygen concentration to support candle-like combustion of plastics (Oxygen Index).
ASTM-D : 2843	Standard test method for measuring the density of smoke from the burning or decomposition.
IEEE : 383	Standard for type of test Class-IE, Electric cables, field splicers and connections for power generation station.

ASTME : 662	Standard test method for specific optical density of smoke generated by solid materials.
IEC : 754	
IS : 10418	Cable drums.

(A)

C. Technical Requirements

a) The cables shall be suitable for laying in racks, ducts, trenches conduits and under-ground buried installation with uncontrolled back fill and chances of flooding by water.

b) They shall be designed to withstand all mechanical, electrical and thermal stresses under steady state and transient operating condition.

c) The aluminium/copper wires used for manufacturing the cables shall be true circular/sector in shape before stranding and shall be of uniformly good quality, free from defects. The conductor used in manufacture of the cable shall be of H2 grade as per BOQ.

d) The fillers and inner sheath shall be of non-hygroscopic fire retardant materials and shall be suitable for the operating temperature of the cable. Filler and inner sheath shall not stick to insulation and outer sheath.

e) Progressive automatic in line indelible, legible and sequential marking of the length of the cable in metres at every one metre shall be provided on the outer sheath of all cables and at every 5 metre ‘FRLS’ marking in case of ‘FRLS’ cables.

f) Strip/Wire armouring following method (b) mentioned in IS: 3975 shall only be acceptable. For single core cable aluminium wire armouring shall be used as per BOQ (Upto 10 sq.mm wire & above shall be strip armouring).

g) Allowable tolerance on the overall diameter of the cables shall be + 2mm.

h) The normal current rating of all PVC insulated cables shall be as per I.E.C.

i) A distinct inner sheath shall be provided by pressure extrusion process for all multi-core armoured and unarmoured cables as per I.E.C.

j) Outer sheath shall be provided by extrusion process as per I.E.C.

k) The breaking load of armour joint shall not be less than 95% of that armour wire. Zinc rich paint shall be applied on armoured joint surface as required.

l) In plant repairs to the cables shall not be accepted.

m) All the cables shall be supplied in non-returnable drums as per I.E.C.

D. Inspection

All cables shall be inspected at manufacture place and on receipt of the same at site checked for any damage during transit.

E. Joint in Cables

The contractor shall take care that the cables received at site are distributed to various locations in such a manner as to ensure maximum utilisation and avoidance of cable jointing. Cable shall be rechecked before cutting in lengths, where the joints are unavoidable, the location of such joints shall be got approved from the Consultant. The joints shall be done by qualified jointer strictly in accordance with manufacturer's instruction/drawings.

F. Joint Boxes For Cables

The cable joint boxes shall be of appropriate size suitable for type of cable of particular voltage rating.

G. Jointing of Cables

All cable joints shall be made in suitable, approved cable joints boxes, on the jointing of cables in the joint box and the filling in of compound shall be done in accordance with manufacturer's instructions and in an approved manner. All straight through joints shall be done in epoxy mould boxes with epoxy resins. Straight through joints shall not be permitted unless the length of run is in excess of cable drum.

End terminations of cables more than 1.1 KV grade shall be done with epoxy mould boxed and epoxy resin. Cable glands shall be 1.1KV grade double compression type and made to tin plated heavy duty brass casting and machine finished. Glands shall be of robust construction capable of clamping cable and cable armour, firmly without injury of cable.

All washers and hardwares shall be made of brass tinned. Rubber components used in the glands shall be made of neoprene of tested quality.

Cable lugs shall be tinned copper/aluminium solderless crimping type conforming to IS:8309 suitable for aluminium or copper conductor.

Crimping of terminals shall be done by using Corrosion inhabitory compound, with crimping tool.

Fire resistant paint has to be applied 1 Metre on either side of cable joint.

The contractor shall liaise fully with all other contractors to achieve an efficient and properly coordinated installation where equipment has to be re-positioned due to lack of site liaison, no extra cost shall be incurred by the client.

H. Testing of Cables

Cables shall be tested at factory as per requirement of I.E.C. The tests shall incorporate routine tests, type tests and acceptance tests. Prior to despatch of cables. All the testes will be witnessed by Employer / Consultant in accordance with testing procedure approved by Consultant at no extra cost to Employer. Besides that the following tests shall be carried out:

a) Insulation test between phases and phase to earth for each length of cable before and after jointing.

On completion of cable laying work, the following test shall be conducted in the presence of Architect/Owner.

a) Insulation resistance test (Sectional and overall) 1000/5000V depending upon the voltage grade of cable.
b) Continuity test.

I. Laying of Cable

The cable drum shall be placed on jacks before unwinding the cable. Great care shall be exercised in laying cables to avoid forming kinks. At all changes in directions in horizontal & vertical places, the cable shall be bent with a radius of bend not less than 12 – 15 times diameter and 8 times only at places of space constraints.

The cable of 1.1KV grade shall be laid not less than 750mm below ground level in a 375mm wide trench (throughout), where more than one cable is to be laid in the same trench, the width of the trench shall be increased such that the inter axial spacing between the cables except where otherwise specified shall at least be 150mm minimum or as per site requirements or as approved by the Engineer-in-charge. Where single core cables are used in multiphase systems, the cables shall be installed in trefoil where possible.

In case the cables are laid in vertical formation due to unavoidable circumstance the depth per tier shall be increased by 200mm (minimum). Cable shall be laid in reasonably straight line, where a change in direction takes place a suitable curvature shall be i.e. either 20 times the dia meter of the cable or the radius of the bend shall not be less than twice the diameter of the cable drum or whichever is less. Minimum 3 meter long loop shall be provided at both sides of every straight through joint & 3 meters at each end of cable or as directed at site.

The cable drum shall in-verbally conveyed on wheels and the cable unrolled in right direction as indicated on the drum by the manufacturer. The cable shall be pulled over rollers in the trench steadily and uniformly without jerks and strains.

Cables laid in trenches in single tier formation, 10 cm. in total sand cushioning be provided below and above the cable before a protective cover is laid. For every additional vertical tier, 30 cm of sand cushion be provided over the initial tier. The cable shall be protected by 2nd class bricks of size not less than 230x115x75mm, stone tiles/RCC curved channel be placed on top of the sand breadth wise for the full length of the cable and where more than one cable is to be laid in the same trench the

brick shall cover all cables and project at least 8 cms. over the outer sides of the end cables.

Filling of trenches shall be done after the sand cushioning and laying of tiles or bricks are carried out to the satisfaction of the Engineer-in-charge (Refer drawing). Back fill for trenches shall be filled in layer not exceeding 150 mm. Each layer shall be properly rammed & consolidate before laying the next layer.

RCC Hume pipe shall be provided for all road crossing. The size of the pipe shall be according to the cable and a minimum 100mm dia. pipe shall be provided. The pipe shall be laid in ground with special arrangement and shall be cement jointed and concreting with 1:5:10 shall be made as per relevant IS with latest amendment. Nothing extra shall be paid on this account. Location of cables laid directly underground shall be indicated by cable marker at an interval of 30 meters & with change of direction. Aluminium strip cable tag of 20mm wide with engraved tag no. shall be provided at both ends of cable.

Where the cables are to be laid in ducts (pucca trenches) inside the building, they will have to be laid on MS rack/ on MS cable trays grouted in walls trenches. Cables passing through floors shall be protected from mechanical damage by a steel channel to a height of one meter above the floor where cable pass through wall they shall be sleeved with PVC/steel conduit.

Where the cables are laid in open (in building) along walls, ceiling or above false-ceiling, cable rack (ladder type) or cable tray shall be provided. The size of the cable tray or rack shall depend on the number of cables to pass over that rack. Cable tray/rack shall be properly supported through wall/ceiling according to the site conditions. Cable laid on tray & riser shall be neatly dressed &clamped at an interval of 1000 mm & 750mm for horizontal & vertical cable run respectively either side at each bend of cable. All power cables shall be clamped individually & control cables shall be clamped in groups of three or four cables. Clamps for multi-core cables shall be fabricated of 25x3 GI flats. Single core power cable shall be laid in trefoil formation & clamped with trefoil clamps made of PVC/fibre glass.

Cable openings in wall/floor shall be sealed by the contractor suitably by hessian tape & bitumen compound or by any other proven to prevent ingress of water.

After the cables are laid, shall be tested as per IS and the results submitted to Consultant/Engineer and in case the results found unsatisfactory, all the repairing/ replacing of cables will be done by the contractor free of charge.

J. Fire Seal System

a) All the floor/wall opening provided for cable crossing shall be sealed by fire seal system.

b) The fire proof sealing system shall fully comply with the requirements of relevant codes. The fire proof seal system shall have minimum one hour fire resistance rating.

c) The fire proof seal system shall be physically, chemically, thermally stable and shall be mechanically secured to the masonry concrete members. The system shall be completely gas and smoke tight, anti-rodent and anti-termite.

d) The material used in fire proof seal system shall be non-toxic and harmless to the working personnel.

e) Type of fire proof seal system shall be foaming type or flam mastic type compound or approved equivalent.

After laying and jointing work is completed, high voltage test should be applied to all cables to ensure that they have not been damaged during or after the laying operation and that there is not fault in the jointing.

Cable for use on low and medium voltage system (1.1 KV grade cables) should withstand for 15 minutes a pressure of 1000 V DC applied between conductors and also between each conductor and sheaths. In the absence of pressure testing facilities it is sufficient to test for one minute with a 3000V insulation tester In case the test results are unsatisfactory the cost of repairs and replacements and extra work of removal & laying will be made good by the contractor.

Cable shall be installed so that separation shown in the table below is observed.

HV Cable (11 KV)	-	HV Cable (11 KV)	50 mm
ELV & LV 230 V/433 V	-	ELV & LV cable 230 V/433 V	50 mm
HV cables (11 KV)	-	ELV & LV cables 230 V/433 V	300 mm
LV cables 433 V	-	Telephone/Instrument cable	350 mm
All cables	-	All hot pipe work	600 mm

CABLE TRAYS

Cable trays shall be ladder type fabricated out of mild steel/slotted angles and flats of required width as per design. Bends shall be prefabricated. The cable tray shall be primed and painted with powder coating as approved by Engineer-in-Charge. Suitable provision shall be made where a tray crosses expansion joints. The width of the tray shall allow for a suitable separation between cables the design shall allow for adequate bending radiuses for the sizes of cables. No sharp bend to be allowed in cable tray. Joints between sections shall be bolted.

The perforated cable trays are fabricated out of 2mm thick CRCA sheet steel having minimum 75mm depth with epoxy coated of approved shade. Perforations are maximum 10mm spaced at maximum 20mm distance. The cables shall be tied with the cable tray with Nylon Strip/Aluminium Clamps/MS Clamps as per requirement.

The tray shall be suspended from the surface of the concrete slab by means of approved steel hangers spaced at a distance of not more than 100cms. Suitable bushes shall be provided where cables pass through apertures in the tray. Cables must be securely fixed to the tray with clamps. In routing necessary barrier and spacing shall be maintained for cables of different voltages in case they lie side by side. Telephone cables shall cross the power cables only at about right angle and these two shall not run in close proximity. Full details of the tray shall be approved by the Consultant/Site Engineer before fabrication. Earth continuity shall be maintained between each section of cable tray and each total run of tray shall be effectively

bonded to the nearest earth continuity conductor. All nuts and bolts used shall be of galvanised steel.

Cable tray is to be manufactured to comply with the specifications of National Electrical Code (NEC) and National Electrical Manufacturer's Association (NEMA).

Shop drawing of cable trays shall be submitted to the Consultant/ Site Engineer before fabrication for approval a sample of the same be got approved. All nuts and bolts used shall be of galvanised steel. Cable shall be neatly arranged on trays in such manner that criss crossing is avoided and final take off to switchgear is easily facilitated.

Note: The cable tray shall be worked out/selected with 25-30% spare space for future cable.

EARTHING

All non current carrying metal parts of electrical installation shall be earthed as per IEC with latest amendments. All metal conduits, cable armour, DBs, light fixture, switchgear, feeder pillars etc. and all other parts made of metal shall be bonded together and connected by means of specified earthing conductor to earth electrodes. Earthing shall be in conformity with provision of Indian Electricity Rules, 1956 / IS 3041. Steelwork supporting electrical equipment shall be effectively bonded. Conduit or trunking shall not be used as the role circuit protective conductor. Where flexible conduit is installed the metal screen shall be connected to earth. In addition, a separate circuit protective conductor shall be installed from the junction box to the item of plant. The armouring of multi-core cables shall be bonded to the metal parts of the equipment to which it is connected.

All earthing conductors shall be high conductivity GI & copper shall be protected against mechanical damage. The cross sectional area of earth conductors shall not be smaller than half that of the largest current carrying conductor. However, the Contractor shall use the size specified in the bill of quantities.

a) All fixtures, sockets outlets, fans, switch boxes and junction boxes etc. shall be earthed with PVC insulated copper wire as specified in item of work. The earth wires ends shall be connected with solder less bottle type copper lugs.

b) All single phase DBs upto shall be earthed with one no. GI / copper wire / strip as per item of work.

c) All switch boards of rating shall be earthed with 2 Nos. separate and GI/Copper tape or as per item of work/drawing.

d) All the earthed wires in switch boxes, DBs and light fixture shall be provided with green colour PVC sleeve.

The electrical resistance of earthing conductors shall be low enough to permit passage of fault current necessary to operate fuse or circuit breaker and shall not exceed 2 ohm.

The earthing electrode shall consist of (60cm x 60cm x 3.15mm) thick tinned copper plate or GI plate electrode (60cm x 60cm x 6.3mm) or GI pipe 40mm dia 2.5 metre

length ‘B’ class as described under schedule of quantities. Galvanising of the pipe/plate shall conform to relevant Indian Standards. The plate electrode shall be buried in ground with its faces vertical and top not less than 30 cm below GL. The earth plate shall be buried in the ground below the permanent moisture level but not less than 2.5 meter below ground level.

The plate shall be filled with charcoal and common salt filling extending 15cm around it on all sides. There shall be a 20mm dia ‘B’ class GI pipe running from top of plate upto the ground level for watering pipe. The top of the pipe shall be provided with a funnel and a GI mesh screen for watering the earth. This will be housed in a masonry sump with cement plastering or a cement concrete sump not less than 30cm square and 30cm deep. Heavy duty M.S. frame heavy duty with hinged cover and locking arrangement shall be suitably provided over the sump. The earthing lead from electrode onwards shall be suitably protected from mechanical injury by a 15mm dia, GI pipe in case of wire and by suitable dia ‘B’ class GI pipe in case of strip. This protection pipe within ground shall be buried at least 30cm deep (to be increased to 60cm in case of road crossing and pavements). The portion within the building shall be recessed in walls and floors to adequate depth. In the case of plate earth electrode the earthing lead shall be securely bolted to the plate with two bolts, nuts, check nuts and washers. In case of pipe earth electrode, it shall be connected by means of strap welded around pipe including bolt, nuts and washers and cable socket. All materials used for connecting the earth lead with electrode shall be GI in case of GI pipe and GI plate electrodes and of tinned brass in case of copper plate electrode.

No earth pit shall be fixed within 2 metre of a wall of foundation. Effort shall be made to locate them in grass lawns or near flower beds or water taps. The distance between two earthing stations shall be not less than 2.5 meters.

Where instrumentation and computer systems are installed a separate clean insulated earth system shall be provided within control equipment a separate insulated earth bar shall be provided to allow for cable screens to be bonded. A separate earth electrode for each system with a minimum resistance to earth of 1 ohm shall be used. The contractor shall ensure that throughout the installation the cable screen do not come into contact with protective earth.

LIGHTNING PROTECTION SYSTEM

Protection of buildings against lightning shall generally be done in accordance with IS: 2309 with amendments upto date. The installation shall be done as per routes and location of equipment indicated on the drawing and bill of quantities. The conductors and the earth electrode conductor shall be fixed so that they are free to expand and contract. Special care shall be taken in the fixing of support to allow free movement.

The materials of lightning conductors, down conductors, earth termination etc. shall be reliably resistant to corrosion or be adequately protected against corrosion. All air terminations shall be copper/GI as per the BOQ and the conductors shall be GI.

The entire lightning protection system should be mechanically strong to withstand the mechanical forces produced in aces of a lightning strike. The system shall be installed such that it does not spoil the architectural or aesthetic beauty of the buildings but on other hand at should meet IS code/ safety code.

Horizontal air terminations should be so interconnected that no part of the roof is more than 9 metre away from the nearest horizontal conductor. For a flat roof horizontal, air termination along the outer perimeter of the roof is used. For a roof of larger area a network of parallel horizontal conductors shall be installed. Horizontal air terminations shall be coursed along contours such as ridges, parapets and edges of flat roofs and where necessary area flat surfaces in such a way as to connect each air termination to the rest and shall themselves form a closed network.

All metallic finials, chimneys, ducts, vent pipes, railings, gutters, metallic flag staff, on or above the main surface of the roof of the structure shall be bonded to and form part of the air termination network. All air terminations shall be effectively recessed against overturning either by attachment to the object to be protected or by means to substantial braces and fixing which shall be permanently and rigidly attached to the buildings.

Down conductors shall be distributed around the outside walls of the structure. They shall preferably be run along the corners and other projection, due considerations being given to the locations of air terminations and earth terminations. Lift shafts shall not be used for fixing down conductors. Metal pipes leading rain water from the roof to the ground may be connected to the down conductors but cannot replace them. Such conductors shall have disconnecting joints. All vertical conductors shall be plumbed before fixing.

The lighting protective system shall have as few joints in it as possible. Wherever joints in the down conductor above ground level are necessary they shall be mechanically and electrically effective. The joint overlap shall not be less than the width of the tape. In the down conductor below ground level there shall be no joint. The joints may be clamped, screwed, bolted, riveted, sweated, braced or welded. The bonding of the external metal forming part of a structural or drain water pipe shall have a cross sectional area not less than that employed for the main conductors. Gas pipe, however, in no case shall be bonded to the earth termination system.

Conductors shall be securely attached to the building to be protected by fasteners which shall be substantial in construction, not subject to breakage and shall be of steel. The conductors shall be secured at not more than 1200mm apart for horizontal run and 1000mm for vertical run.

Where tape are required to pass through roof asphalting or waterproofing membranes, a special seal shall be used comprising a 38mm diameter plastic, copper or aluminium tube with 100mm diameter flange 50mm from the top of the tube. The tube length shall suit the thickness of the roof through which the conductor passes, allowing for the tube to protrude 50mm above the membrane. The seal is to be asphalted in position and the conductor shall be sealed in the tube by a setting waterproof compartment.

Each down conductor shall have an independent earth termination. The interconnection of all the earth termination shall be preferable. It should be capable of isolation for testing purpose by “testing joints” at position approachable easily for the megger testing. The whole of the system could have a combined resistance to earth not exceeding 2 ohm before any bonding has been affected to metal in or on structure or to surface below ground.

LV PANELS

The LV Panels shall conform to the equipment of the latest revision including amendments of the relevant codes and standards.

The drawings and specifications & BOQ complement each other and which is shown or called for one shall be interpreted as being called for on both. Material, if any, which may not have been specified but fairly required to make a complete assembly of switch gear as shown on the drawing, specifications shall be construed as being required and no extra charges shall be payable on this account.

CODES & STANDARDS

The design, manufacture and performance of equipment shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (BS), International Electro Technical Commission (IEC) Publication, Electro NEMA, IDE & DEMA standard as amended upto date.

The board shall be metal enclosed single front, indoor, floor mounted free standing type or wall mounting type as mentioned in BOQ. The panel shall be designed for a degree of protection of IP44. However bus bar chamber shall have IP42 degree of protection incase bus bar rating exceeds 1600 Amps. Keeping in view the operating ease, maximum height of the top switch shall be 1750mm from finish floor. 200mm clear space shall be left throughout the panel at bottom. The cold rolled sheet steel will be of 2mm thick. The structure shall be mounted on a rigid base frame of folded sheet steel of minimum 3mm thickness and 50mm height.

All cutouts and covers shall be provided with synthetic rubber gaskets (neoprene)

The panel shall be divided into distinct vertical sections each comprising of:

i) Complete enclosed bus bar compartment for running horizontal and vertical bus bars.

ii) Complete enclosed switchgear compartment one for each circuit for housing air circuit breaker, MCCB etc.

iii) Compartment for power and control cables of at least 300mm width covering entire height provided.

iv) The panel shall have sufficient extra space for at least 20% of outgoing feeders with wiring provision for future use.

The front of each compartment shall be provided with hinged single leaf door with locking facilities. Panel shall be provided with suitable lifting facilities. MCCBs/ACBs, Isolators and accessories shall be of fixed/draw out type as per BOQ.

Each feeder shall have compartmentalized or non-compartmentalized for MPCB feeders only. Ri-tall type with separate construction cable entry shall be from top/bottom (3mm thick gland plate shall be provided) as required.

The panel shall be provided with three phase buses and neutral bus bars of high conductivity electrolytic aluminium as per IS: 5082 sections throughout the length of the panel and shall be adequately supported and braced to withstand the stressed due to the short circuit current of 20 to 80 KA rms. for 1 sec. as called for in BOQ.

Maximum temperature rise of bus bars and bus bar connection while carrying rated current shall not exceed 35 deg.C over an ambient temperature of 50 deg.C

The minimum clearance in air between phases and between phases and earth for the entire run of the bus bar connections shall be as per IS. Bus bars support insulators shall be made of non-hygroscopic, non-combustible track resistant and high strength SMC or polyester fibre glass moulded material.

All bus bars shall be colour coded as per IS: 375.

GI earth bus of suitable size shall be provided at the bottom of the panel throughout the length. Similarly suitable size of GI strip in each vertical section for earthing the individual equipment/accessories shall be provided and connected to main horizontal bus.

Sheet steel hinged lockable doors shall be interlocked with MCCB to prevent opening of the panel where MCCB is on position. Safety interlock with operating handle shall be provided. All MCCB shall be with vertical operation.

Contactors shall be electromagnetic type with interrupting duty as per IS:2959. The main contacts shall be of silver or silver alloy, provided with minimum 2 NO and 2 NC auxiliary contacts. The push button should be of shrouded type and each should be provided with 1 NO and 1 NC contact. Colour coding shall be as per IS: 6875 (Part-II).

ACB (AIR CIRCUIT BREAKER)

General

The circuit breaker shall be of air break type in order to eliminate fire and explosion risk and shall comply with the IEC 60947/IS: 13947-1993 Part-2 with a rupturing capacity of not less than 35 MVA at 415 volts or as specified elsewhere. The rated insulation voltage shall be equal to or greater than 1000 V.

Type & Construction

The breaker shall be provided with variable microprocessor based releases for over load, short circuit and earth fault protection (and shall be compatible with PC) and shall be in conformance with this specification. ACBs shall be EMI/EMC compatible.

The breaker shall consist of a horizontal draw out enclosed pattern triple pole, fully interlocked, independent manual/motorized spring operated mechanism. The mechanism should be such that the circuit breaker is at all times free to open immediately when the trip coil is energized. The ACBs shall be strong and robust in construction with suitable arrangement for anchoring when in fully engaged or fully drawn out positions. The carriage or cradle on which the breaker is mounted shall be of robust design made of fabricated steel, supported on rollers. The withdrawal arrangement shall be such as to allow smooth and easy movement. Current carrying parts should be silver plated and suitable arcing contacts shall be provided to protect the main contact with efficient Arc-chutes for each pole that shall be able to be lifted out for the inspection of main and arcing contact. The arc chutes shall be suitable for ready replacement. The contacts shall be of spring-loaded design. The sequence of

operation of the contacts shall be such that arcing contacts `make' before and `break' after the main contacts.

There should be total segregation between the power circuit and control circuit, thus making double insulation and ensuring fitting of accessories while the circuit breaker is in the ON position. It shall be possible to inspect the arcing chamber and main contacts. The ACB shall have metal load bearing structures. The main contacts shall be separate from the arc-breaking contacts. It shall be possible to check the wear of the main contacts with the ACB in its racked-out position, removing the arcing chambers. No mechanical junctions in the main contact shall be there so that losses are minimal.

The design of the breaker shall be such that all the components are easily accessible to inspection, maintenance and replacement. The ACB at its rated current shall be suitable for operation in extremely tropical humid climate at 50°C ambient temp. The manufacturer shall declare ideal de-rating charts.

Self aligning cluster type isolating contacts with automatic shutters shall be provided on breaker to screen the live parts. Suitable number of NO & NC auxiliary contacts as stated in BOQ rated for 10 Amps at 415 V AC and 6 Amp at 48V DC, in addition to ones already in use for the operation of the breaker shall be provided for interlocking, protection, metering and for any other purposes. The breaker should have 3 distinct positions - SERVICE/TEST/ISOLATED within the cubicle.

Breaker shall be provided with automatic safety shutters to screen the main live contact when the breaker is withdrawn. The frame of the circuit breaker could be positively earthed when the breaker is racked into the cubicle.

The following safety arrangements shall be provided for the safety of the personnel to prevent mal-operation.

i) Interlock to prevent the truck from being withdrawn or replaced except in the fully isolated position.

ii) Interlock to prevent earth connection from being made by the earthing device except breaker is open.

iii) Interlock to prevent the breaker being closed unless it is fully raised.

iv) Interlock to prevent the breaker from being made alive without its rack in position.

v) If under voltage release is provided then circuit breaker will close only if it is energized.

Testing of each circuit breaker shall be carried out at the works as per IEC: 60947 and the original
test certificate shall be furnished in triplicate. The tests shall incorporate at least the following:

a) Impulse withstand test

b) Insulation test
c) Di-electric rigidity /Insulation test
d) Mechanical operation checking
e) Thermal protection with a current of 3ith starting from cold conditions.

MOULDED CASE CIRCUIT BREAKER (MCCB)

The MCCB should be current limiting type with trip time of less than 10 millisecond 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-60947-4, 1989/IS 13947-4. The breaker as supplied with ROM should meet IP44 degree of protection.

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

- Incomer MCCBs shall be equipped with microprocessor based trip units for Closer protection and better accuracy.

- Microprocessor trip units shall be adjustable and it shall be possible to fit lead seals to prevent un-authorized access to the settings

- In all MCCBs, the protection shall be adjustable Overload and Short circuit protection

- Microprocessor trip unit should have thermal memory. In the event of repeated overloads, the trip unit shall optimize protection of cables and downstream devices by memorizing temperature variations.

- 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

- Four-pole devices shall be equipped for neutral protection as standard with a 3-position setting : - neutral not protected - neutral tripping threshold equal to half the phase value - neutral threshold equal to the phase value

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.

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 wherever required.

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.

<u>CAPACITORS & CAPACITOR CONTROL PANEL</u>

CAPACITORS

Power factor correction capacitors shall conform in all respects to IS 2834-1964, IS-13340 and latest IEC specification. The capacitors shall be suitable for 3 phase 440 V at 50Hz. Frequency and shall be available in units of 25/50 KVAR size (heavy duty) with self healing property as per BOQ to form a bank of capacitors of desired capacity. All these units shall be connected in parallel by means of high conductivity electrolytic copper bus bars of adequate current carrying capacity having SC rating of 50 KA for 1 sec. Each capacitor bank shall be for PVC insulated aluminium conductor armoured cables. Two separate earthing terminals shall be provided for each bank for earth connection.

The capacitor bank shall be subject to routine tests as specified in relevant Indian Standard and the test certificate shall be furnished. The capacitor shall be suitable for indoor use up to 45 Deg.C over and above ambient temperature of 50 Deg.C. The permissible overloads shall be as given below:

a) Voltage overload shall be 10% for continuous operation and 15% for 6 hours in a 24 hours cycle.

b) Current overload of 15% for continuous operation and 50% for 6 hours in a 24 hours cycle.

The capacitor banks shall be floor mounting type indoor housing using minimum floor space with protective guard or fencing.

Capacitors shall be of metallized polypropylene film (capacitor grade), hermetically sealed in sturdy corrosion-proof sheet steel 2mm thick containers and impregnated with non-inflammable synthetic liquid and of low power loss version. Every element of each capacitor unit shall be provided with its own built in silvered fuse. The capacitor shall have suitable discharge device to reduce the residual voltage from crest value of the rated voltage to 50 V or less within one minute after capacitor is disconnected from the source of supply. The loss factor of capacitor shall not exceed 0.005 for capacitors with synthetic impregnates. The capacitors shall withstand voltage of 2500V AC supply for 1 minute.

The insulation resistance between capacitor terminals and containers when test voltage of 500V AC is applied shall not be less than 50 mega ohms.

Capacitor bank and switching equipment shall be housed in a cubicle having degree of protection IP-54 and constructed with sheet steel of minimum 2mm thickness.

Capacitors shall be unit type having non-PCB, non-flammable non-toxic dielectric.

Necessary discharge resisters shall be provided externally to reduce the terminal voltage to less than 50V in 60 seconds after disconnection from supply.

Testing shall be done as per applicable standards for shunt capacitors.

CAPACITOR CONTROL PANEL

The capacitor control panel shall generally comprise of the following:

a) Automatic power factor correction relay.(APFCR)

b) Step controller with reversing motor.

c) Time delay and no-volt relays.

d) Protection ACB with static O/C and S/C releases.

e) Contactor for individual capacitors of suitable rating.

f) Change over switch for either automatic or manual operation with push button control.

g) CTs with ammeter and selector switch.

h) Voltmeter with selector switch.

j) Indicating lights RYB.

All the capacitors and contactors shall be interconnected with PVC insulated copper conductor wires of adequate size in a neat and acceptable manner. Three phases and neutral bus bar shall be provided in panel as required.

NAME PLATES & LABELS

i) Panel and all modules shall be provided with prominent engraved identification plates. The module identification designation. For single front switchboards, similar panel and board identification labels shall be provided at the rear also.

ii) All name plates shall be of non-rusting metal or 3 ply lamicold, with white engraved lettering on black background. Inscription and lettering sizes shall be subject to Owner's approval.

iii) Suitable stencilled paint marks shall be provided inside the panel/module identification of all equipment in addition to the plastic sticker labels. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

PAINTING

All steel work shall be pretreated in tanks and finally powder coated of approved shade as per painting clause.

WIRING

Control and protective wiring shall be done with copper conductor PVC insulated 1100 volts grade multi-stranded flexible wire of 2.5sq.mm cross section. The colour coding shall be as per latest edition of IS: 375.

Each wire shall be identified by plastic ferrule. All wire termination shall be made with type connection. Wire shall not be taped or spliced between terminal points.

Terminal blocks shall preferably by grouped according to circuit function and each terminal block group shall have at least 20% spare capacity.

Not more than one wire shall be connected to any terminal. All door frame of L.T. switchboard shall be earthed with bare braided copper wire.

TESTING & INSPECTION

After completion of all work at the manufacturer's works the switchboards shall be inspected and tested in presence of Purchaser's representative. However, stage inspection may be carried out from time to time to check progress of work and workmanship. The following tests shall be carried out:

i) All routine tests specified in relevant Indian/IEC Standards shall be carried out on all circuit breakers.

ii) Test for protective relay operation by primary and secondary injection method.

iii) Operation of all meters.

iv) Secondary wiring continuity test

v) Insulation test with 1000 Volts Megger, before and after voltage test.

vi) HV test on secondary wiring and components on which such test is permissible (2.5 KV for one minute)

vii) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.

viii) Measurement of power required for closing/trip coil of the breaker.

ix) Pick up and drop out voltages for shunt trip and closing coils.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out along with copies of type test certificates and certificates from Sub-Vendor for the components procured from them are to be submitted before dispatch of switch boards.

DRAWINGS AND INFORMATION

The Vendor shall furnish following drawings/documents in accordance with enclosed requirements:

i) General Arrangement drawing of the Switchboard, showing front view, plan, foundation plan, floor cut outs / trenches for external cables and elevations, transport sections and weights.

ii) Sectional drawings of the circuit breaker panels, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

iii) Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.

iv) Terminal plans showing terminal numbers, ferrules markings, device terminal numbers, function etc.

v) Relay wiring diagrams.

vi) Equipment List.

Vendor shall furnish required number of copies of above drawings for Purchaser's review, fabrication of switch boards shall start only after Purchaser's clearance for the

same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following:

i) Technical literature giving complete information of the equipment.

ii) Erection, Operation and Maintenance Manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.

iii) A comprehensive spare parts catalogue.

TOOLS

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switch board shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

SPARES

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

QUALITY ASSURANCE

Quality Assurance shall follow the requirements of Owner/ Consultant as applicable.

Quality Assurance involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

DEVIATIONS

Deviation from specification must be stated in writing at the quotation stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

H.T. SWITCHGEAR PANEL (VACUUM CIRCUIT BREAKER)

1. *HT Panel:*

   1.1. HT panel shall be indoor metal clad cubicle pattern, floor mounting, free standing type, totally enclosed dust and vermin proof design with suitable screens being provided for all ventilating openings to prevent insects, rodents etc. from entering the panel.

   1.2. The panel shall be suitable for use on an 11 KV, 3 phase, 50 Hz system. The panel shall house Vacuum circuit breaker with short circuit capacity not less than 350 MVA and should be suitable to withstand impulse voltage of 75 KV peak.

   1.3. The panel shall be factory built assembly of modular construction fabricated out of 14 SWG thick CRCA sheet steel, of single tier design and shall be provided with extension facility. Panel shall generally conform to the requirements of relevant IS standards and latest IEC. The HT panel board shall be designed such that the switchgear, instrument relays, bus bars, small wiring etc. are arranged and mounted with due consideration for the following:

a) Facility for inspection, maintenance and repairs, testing terminals and terminal boards for case of external connection.

b) Minimum noise and vibrations.

c) Risk of accidental short circuits and open circuits.

d) Secured and vibration proof connections for power and control circuits.

e) Risk of accidental contact and danger personnel due to live connections.

2. *Construction:*

   2.1. The HT panel conforming to IS 13118:1991 shall be of robust design with adequate bracings for structural rigidity. Separate compartments shall preferably be provided for circuit breakers, bus bars and cable boxes which will be fully and effectively segregated from one another so that fault in any one compartment should not cause damage to equipment in any other compartment.

   2.2. The equipment shall be installed indoor in a hot, humid climate. All equipment, accessories and wiring shall be provided with tropical finish to prevent fungus growth. Space heaters shall be provided so that humidity does not affect the components.

   2.3. The maximum temperature rise in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in relevant standards.

   2.4. The housing shall consist of two sections. Bottom section shall be to house safety shutters, earth bars, circuit breaker etc and the top section shall contain instrument chamber, bus bar chamber and current transformer chamber. Top portion of housing shall contain fixed instruments/relay panel and voltage transformers. The panel shall be vertical isolation horizontal draw out type with single bus bar extensible on either side. Bus bars shall be air insulated.

   2.5. The housing shall be of welded construction to ensure compact and rigid structure presenting a neat and pleasing appearance and to ensure a very rigid structure without unnecessary weight. The stationary housing shall be so designed as to ensure accurate location of withdrawal truck on which CB is mounted.

   2.6. The panel shall be machined pressed with punched opening for meters and instruments etc. The sheet steel and the steel sections shall before fabrications, be

given a rigorous rust proofing treatment using seven/ nine tank process comprising of alkaline decreasing, de-scaling in dilute sulphuric acid solution and a recognized phosphate process. The steel work shall then be given two coats of red oxide prier before final finishing with epoxy based powder coating is given.

2.7. All the live parts of the panel shall be insulated and enclosed in an earthed metal enclosure or shrouded to prevent accidental contact when the withdraw able truck is removed. Suitable screens shall be provide for all ventilating openings to prevent insects, rodents etc. from entering the panel.

2.8. All meters, instruments, relays, control push buttons/ switches/ handles etc. shall be mounted on the front side on top of circuit breaker compartment of the panel and shall be visible with doors in closed position easily accessible from the ground, the doors shall be hinged with bent edges and square rubber gaskets. The instrument / relay terminals on the front panel shall be shrouded using clear acrylic sheets. All cable entries shall be from the bottom of the panel on the rear side. Adequate space and clamping arrangement shall be provided for cable terminations.

2.9. The panel shall be of horizontal draw out design with built in positive safety interlocks as per latest IEC. Circuit breaker compartment shall be withdrawable cassette type trolley. The CBS of some rating can be interchangeable. The bus bar compartment shall be at the rear top.

2.10. The standard phase arrangement when facing the switchgear shall be R-Y-B from left to right, from top to bottom, and front to back. All relays, instruments, other devices, buses and equipment involving three phase circuit shall be arranged and connected in accordance with the standard phase arrangement.

2.11. The switchgear buses shall be rated for continuous current of magnitude as specified. Maximum temperature rise of bus and connection shall be limited to as per IS specification.

2.12. The bus bars of the switchgear section shall be of hard drawn electrolytic copper liberally sized with high safety factor for required current rating and shall be of the same cross-section. The busbar connection and their insulated supports shall be mechanically strong, and shall withstand all the stresses which shall be imposed upon them in ordinary working due to fixing, vibration, fluctuation in temperature, short-circuit or other causes.

2.13. The bus bars shall have the marking, colour coding and arrangement according to the relevant IS and shall run in a separate bus bar chamber. The bus bars and joints shall be fully insulated and so enclosed as not to leave any exposed live parts. Provision shall be made for expansion and contraction of the bus bars and connections with variation of temperature.

2.14. Rating plate, name plate and danger board shall be provided. All unused entitles between the circuit breaker compartment shall be sealed before dispatch of panel.

2.15. The similar design of panel should have tested for internal is fault in the various compartments.

3. Circuit Breaker:

3.1. The circuit breakers shall be vertically and horizontally draw-out type VCB mounted on the moving carriage. The circuit breaker shall be of modular design. The rating of the circuit breaker shall be as specified.

i) Normal Service Conditions: Ambient temperature : 45° C- 2° C

ii) Humidity: Not exceeding 60% at maximum temperature

iii) System:

a) System Voltage: 11KV, effectively earthed system

b) Highest system voltage: 5 KV

c) Frequency: 50 HZ + 3%

d) Continuous current rating: 630 Amps

e) Impulse withstand voltage (KVP): 75

f) Fault interrupting capacity (KA): 26.3

g) Fault withstand time: 1 Sec

h) Operating duty cycle: 0.03 sec – CO-3 min –CO

iv) Main circuit terminal

Circuit breaker should be provided with 3 main terminals and 3 load side terminals.

3.2. *Closing mechanism & Anti-pumping device:*

a) Motor operated closing mechanism and mechanical and electrical anti-pumping device shall be provided. Motor operating mechanism shall be complete with universal motor, opening

b) Spring, closing spring, and all necessary accessories. The motor shall be suitable for 240V AC supply

c) Spring charged/discharged indicator shall be provided. Closing will and shunt trip (coils) suitable for 24V DC, 2 wire DC supply. These shall operate satisfactorily between 85% to 110% of rated voltage.

d) The symmetrical breaking capacity in MVA shall remain constant for 11 KV breakers.

e) Breakers shall be capable of making, carrying and breaking starting and full load currents.

f) Breakers shall be suitable for local electrical operation. Mechanical interlocks shall be provided to prevent a closed circuit breaker from being moved from service position to test position/isolated position.

g) Closing and opening of the circuit breaker in an intermediate position between "Service Test".

h) Circuit breaker can be racked in to service position only with the front door closed.

i) Breakers shall be complete with the following accessories.

j) Mechanical operating device for manual closing and tripping of the breaker.At least three (3) NO and three (3) NC mechanically operated auxiliary contacts of sufficient rating (in addition to those required for breaker operation) shall be wired out to terminal block for external connection.

k) In the case of 11 KV breakers in addition to the circuit breaker auxiliary contacts provided on breaker trolley for circuit breaker operation, a mechanically operated switch shall be provided on a stationary part of switchgear. This switch shall be positively operated by the breaker mechanism when the breaker is in "service" position but not when the breaker is isolated. The switch shall be provided with at least six (6) normally open and at least six (6) normally closed adequately rated auxiliary contacts for each circuit breaker for inter locking.

l) In case a switch with six (6) NC contacts cannot be offered as required then a switch with six (6) normally closed and two (2) normally open contacts offered along with an auxiliary relay having four (4) normally open and two (2) normally closed contacts (out of which any four contacts shall be wired out), shall be provided on each feeder cubicle.

m) Each circuit breaker, disconnector and bus VT cubicle shall have necessary limit switches for service and test positions, which shall provide the required contacts for breaker operation and interlocking, position indication and disconnection of remote control circuits.

n) Each breaker shall have the following protections :-

i. Short circuit and overload protection:-

Short circuit and overload protection shall be provided through inverse definite minimum time (IDMT) type of relay. Relay rated time shall be less than 1.3 seconds. The relay shall be of three (3) element type. Two elements for overload protection and one element for earth fault protection. Current setting range of the relay shall be 50-200%.

ii. Earth Fault Protection:

Earth fault protection shall be provided through a static earth fault relay. This relay shall be provided only on transformer feeders. The relay shall have a setting range of 20- 80%.

iii. Master Trip Relay:-

The relay shall be fast acting multi contact, attracted armature with high mechanical stability. It shall be suitable for tripping duties requiring simultaneous switching operation. The relay shall be suitable on 24 V DC. The operating time shall not exceed more than ten (10) millisecond. The number of hand reset contact NO/NC shall be as per final approved scheme plus 25% spare. The contact used for tripping circuit breakers shall be blow out type.

o) Each breaker shall be power operated by stored energy, charged spring mechanism for both closing and opening operations. Accidental failure of any spring shall not trip or close a breaker. Spring shall be charged full at all times. Breaker shall close, upon closing a contact in its closing circuit momentarily. A second closing impulse shall have no effect on the closing mechanism.

p) Red lights, indicating 'Breaker-closed' shall be wired to supervise shunt trip circuit. Green lamps mounted on remote panels indicating 'Breaker-open' shall be wired to light up only when remote/local switch is on 'Remote' position.

q) All protective relays shall be provided with flag indication and all relays directly tripping the breakers shall be provided with hand reset contacts in addition to the flag indication.

3.3. *Interlocking and safety arrangements:*

a) HT panel shall be provided with the following interlocking and safety arrangement.

i. The breaker cannot be plugged in unless it is ‘off’.
ii. The breaker cannot be drawn out when it is ‘on’.
iii. The access to bus bar is prevented by automatic shutters when breaker is removed.
iv. The circuit breaker cannot be put into service without completing the protective electrical and earth circuits.
v. A safety catch to ensure that the movement of the breaker as it is withdrawn, is checked before it is completely out of the panel shall be provided.
vi. Safety shutter of the self aligning type.
vii. Emergency trip button on the panel front door.
viii. Positive sliding contact arrangement for earthing on the drawout carriage.
ix. Safety interlocks to prevent inadvertent contact with live parts and faculty operation.

3.4. *Shutter Gear:*

Suitable shutter gear shall be provided for shrouding of bus bar and feeder orifices. These shutters shall be automatic in operation. Suitable hinged shutters with padlocking arrangement shall also be provided in addition to the automatic shutters.

a) Instrumentation, Metering & Indication:

i. Current Transformer:

- **General Requirements**

The CTs shall be of the bar primary, epoxy resin cast types. Accommodation shall be provided in the circuit breaker panel to mount 2 sets of CT's one reserved for protection and the other for metering/instrumentation purposes. Access to the CT's for cleaning, testing or changing shall be from the front back or top of the panel.

- **Rating**

Dual ratio CTs suitable burden (but not less than 15 VA burden) shall be preferred with 5 amps secondaries. The ratio shall normally be one of the following specified: 300/150/5 or as specified.

- **The CTs shall conform to relevant Indian Standards.**

The design and construction shall be robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitably to a terminal block which shall be easily accessible for testing and terminal connections. The protection CTs shall be of accuracy class 1 & 5P10 of IS: 2705 - Part III-1992. The metering CTs shall conform to the metering ratio and accuracy class 1 of IS 2705.

- The CTs shall be housed in the cable terminal compartment.
- The CTs shall have class E insulation.
- The CTs shall be tested on per IS. Test certificate shall have to be furnished.
- Disconnecting link type terminal which shall only be used for CT wiring. Both terminals of each of the CTs shall be brought to the LT chamber and no shrouding required shall be carried out in this chamber only.

a) Voltage Transformer:

i) The PTs shall be of the epoxy resin cast type.

ii) The P.Ts shall have class E insulation and voltage factor.

iii) The PTs shall provide on the incoming side and the P.T. shall be mounted independently on draw out type trolley with HT fuses and shall not be mounted on the circuit breaker carriage.

iv) The PTs shall be tested as per IS. Test certificate shall have to be submitted.

v) The PTs shall be provided with HRC fuse protection on H.T side and MCBs on secondary side.

vi) All the PT secondary terminals shall be individually wired up to the LT chamber.

vii) A voltage transformer of burden not less than 100 VA and of proper ratio as specified shall be plug type and shall be suitable for easy withdrawal. HRC fuses shall be provided on both HV and LV sides. Inter-lock shall be provided to prevent access to live HV parts when the transformer is withdrawn. The transformer shall be plug in type and shall be suitable for easy manual movement on guide rails.

b) Metering & Instruments Panel Accessories:

The combined over current and earth fault relays shall be micro processor based, Communicable type. The high speed hand reset trip relay, Voltage operated auxiliary relays for transformer protection; DC supervision relay and other auxiliary relays shall be electromechanical type.

3.4.6 Instrument Panel:

a) The Instrument panel shall from part of the housing. Relays, meters and instruments shall be

mounted as per general arrangement drawings to be submitted by the tenderer. They shall

be preferably of flush mounting type.

b) Instruments:

a) A 96 Sq. mm voltmeter of class 1 accuracy as per IS:1248 shall be provided at each incomer panel, with selector switch. The instrument shall be calibrated for the ranges specified.

b) Energy meters of class 1.0 conforming to IS: 722 (Part IX) and power factor meter (96 Sq. mm) of class 1 accuracy conforming to IS : 1248 - 1968 shall be provided, if specified.

c) Ammeter 96 Sq. mm of specified range to class 1 accuracy as per IS: 1248 shall be provided at both incomer and outgoing panels along with necessary selector switches.

d) Trivector meter suitable for 3 phases 3 wire unbalanced KVA, integrated over a period of 30 minutes.

e) The board assembly shall also take care of the following requirements :

i) Lamp indication shall be provided to indicate ON/OFF (By red/green respectively) of switchgear.

ii) Healthy trip supply shall be indicated by clear lamp.

iii) Separate fuses shall be provided for lamps heaters and voltmeters, other instrumentation etc. on each panel.

iv) Anti-condensation space heaters suitable for each panel if specified. Supply and control equipment for the above shall be provided by the tenderer.

c) Auxiliary and Control Power Supply:

AC power supply for space heater and cubicle illumination lamps:

a) Each carriage control panel including the breaker operating mechanism shall be provided with thermostatically controlled space heater. The thermostat shall have adjustable range. The space heaters shall be rated for 230 volts, 1 phase, 50 Hz. For cubicle illumination, receptacle arrangement at suitable location of each control panel shall be provided so that hand lamp connection may be taken from this receptacle during inspection and maintenance.

b) Wiring for space heaters shall be suitably grouped so as to form a more or less balanced conditions on 230 V, 1 phase, 50 Hz supply. Suitable number of space heaters along with thermostat may be provided.
c) Each space heater and hand lamp circuit shall be provided with ON/OFF switch and suitable protection.

d) DC Power Supply :(If Required)

The power for breaker control and indication shall be taken from 24 V DC power supply from DC distribution board. In addition, each cubicle shall be provided with one double pole, single throw switch for its control circuit power supply.

e) Circuit Protection:

All control and power circuits shall be protected with suitable MCBs.

f) Control Wiring:

All control, auxiliary and small wiring shall be carried out with 1.5/2.5/4 sq.mm PVC insulated multi stranded 1100V grade copper conductor.

For PT and controls : 1.5 Sq.mm

For CTs : 2.5 Sq.mm

Inter panel : 4.0 Sq.mm

Inter compartment wiring shall be carried out using PVC troughs.

Wiring shall be colour coded and neatly laid out in bunches and firmly fastened to the steel members of the panel. All potential circuits shall be protected by MCBs fuses near the tap-off points from the main connections. The terminations shall be crimped with proper sockets. All the conductors shall be provided with black printed yellow PVC ferrules at both ends for easy identification.

a) Each wire shall be terminated at separate terminal. Wires shall not be joined between terminal points. Shorting links shall be provided for all CT terminals. Wiring shall be neatly bunched.
b) PVC glands shall be provided wherever the wires are crossing the panels. Gromets if used shall be glued to the panel so that they are not displaced during transportation and handling at site.
c) Minimum size of terminals for control wiring shall be 2.5 Sq.mm or higher to suit the wiring sizes stipulated. 10% Spare terminals shall be provided on each terminal block. The terminal blocks for CT connections shall have CT disconnection and shorting facility. All the CT wires to be brought to terminals and shorted at the terminals as required.

g) Alarm Annunciation System:

The annunciator shall be provided on each panel to indicate the various circuit conditions

and shall be placed at suitable height. The various functions shall be as follows:

a) Circuit breaker closed

b) Circuit breaker open

c) Trip circuit healthy

d) Alarm & Auto trip

e) Transformer non trip (Buchholtz, etc.)

f) C/B in test

g) Hooter/Buzzer shall be provided with a manually operated switch so that it can be silenced.

h) Cable Termination:

Power Cable:

a) Cable pot heads for termination of 11 KV XLPE type insulated cables shall be furnished. All power cable entry shall be from the top / bottom and the cable pot heads shall be selfsupported, detachable type as per the site conditions.

b) Where more than one cable pot heads are used per phase, the Contractor shall be required to arrange pot heads in such a way that detachment of any pot head is possible without disturbing the other units

i) Control Cable:

a) All control cables shall enter the switchgear from top/bottom as per the site conditions. Removable plates at the top/bottom of the panel shall be furnished with compression type Cable glands to make entry dust-tight and no weight are transferred on the terminal. The glands shall be suitable for terminating cable armour.

b) All connections and accessories required to complete the whole installation shall be supplied by the Sub Contractor.

j) Terminal Blocks:

Terminal blocks shall be provided as specified and shall be clip on type. They shall be shrouded Preferably by a transparent acrylic sheet. The terminal block of different voltage classes shall be Segregated.

k) Accessories:

Following accessories shall be provided for each switchgear:

a) Channel base and foundation bolts.

b) Lifting lugs

c) Maintenance closing handle for circuit breaker

d) Draw handle for circuit breaker

e) Hook stick, indoor use, 1.5 m long

f) Test plug for draw out type relay

l) Earthing:

a) The earthing of the breaker tank and moving portion shall be so arranged that the earthing of the non-current carrying structure to the frame earth bar is completed well before the main circuit breaker plugs enter the fixed housing sockets.

b) HT panels shall be provided with 50x6 mm copper earth bus running through out the length of the panel. Suitable stationary earthing contacts shall be provided for the earthing the body of the circuit breaker when the same is plugged in. Sufficient number of star washers at the joints to achieve earth continuity between the sheet metal parts of the panel and the earth bus shall be provided. The circuit Breaker carriage shall have a scraping earth connection, which shall earth the trolley before the circuit breaker safety shutters are opened.

m) Tests:

a) The switchgear unit shall be completely assembled, wired, adjusted and tested for operation under similar conditions to ensure accuracy of wiring, correctness of control schemes and proper functioning of all equipment.

n) Routine test:

a) Each of the following equipment shall be subjected to standard routine tests as per applicable clauses of relevant IS specifications:

i) Circuit breakers

ii) Bus bar assembly

iii) Instrument transformers

iv) Auxiliary relays

v) Control switches and indication lamps

o) Design test:

a) Typical type test report of the tests mentioned below conducted on similar equipments in the

past shall be furnished along with the tender.

b) Operation and continuity tests.

c) Impulse test

d) One minute power frequency high voltage withstand test

e) Temperature rise test

f) Short circuit test

g) Megger test with 5KV megger.

h) Multivot drop test of CB contacts.

In addition to the above, secondary injection tests should be conducted on all overcurrent/ earth fault relays in the presence of the purchaser's inspector.

p) Test Certificates:

Test certificate shall be furnished in required number of copies. The routine and type test Certificates shall be furnished to the Engineer-in-charge for approval before despatch of the equipment from the works. The approval in writing shall be required to effect the despatch of the equipment.

- The routine and type test certificates of the miscellaneous components shall also be furnished to the Engineer-in-charge for approval.
- The report shall furnish complete identification of data including serial number of each equipment.
-

q) Drawings, Data and Manuals:

After award of contract, the successful Bidder shall submit the required number of copies of the following drawings for approval of the Engineer-in-charge:

a) Confirmed outline dimensional drawing of the various switchgears showing the general arrangement and indicating the following:

i) Space required in the front for breaker withdrawal.

ii) Control cable entry points and termination arrangement.

iii) Power cable entry points and termination arrangement.

iv) Bus bar clearance phase to phase and phase to ground.

v) Configuration of bus bar.

vi) Technical detail of supporting insulator and their spacing.

vii) Location of instrument transformers.

viii) Control panel details with equipment layout.

ix) Terminal blocks details.

b) Single and three line diagram of all switchgears showing instrument transformers control switches, instruments and indication, etc.

c) Control schematic diagram of each breaker showing all safety and operation interlocks, annunciation, etc

d) Transport/shipping dimensions with weights.

e) Foundation and anchor bolt details including dead load and impact load.

f) Cross-section with parts list.

g) Cubicle wiring diagram with terminal board disposition.

r) Any other relevant data, drawing and information necessary for review of items whether specifically mentioned or not shall be furnished by the Contractor along with those information.

s) The responsibility of correctness of wiring diagram shall be with Contractor. The Engineer-incharge will check the final schematic after submission. If any modification, addition or alteration is considered necessary to comply with the approved schematic drawing as stated herein above, the said modification, addition or alteration shall be carried out by the Contractor either in their works if it is before delivery, or at Site after delivery at no cost to the Owner.

t) Before starting manufacture of the equipment, the Contractor shall have to take approval of these design drawings from the Engineer-in-charge in writing. Any manufacturing done prior to approval of drawings shall be rectified in accordance with the approved drawing by the Contractor at his own cost and the equipment shall be supplied within the stipulated period.

DIESEL GENERATOR SET

1.0 GENERAL

This specification is intended to cover supply, installation, testing and commissioning of **380 KVA DG Set** for **Police Station of Delhi Police at GK-I in New Delhi**.

2.0 SCOPE OF WORK

The scope of work shall include under this specification design, manufacture, test at works, supply, loading, unloading, storage, installation, testing and commissioning of the Diesel engine Generator set of Silent type including labour, tools, tackles and plants, hardware and consumables, steel fabrication and items as prescribed below:

2.1 Diesel engine Generator set complete with base frame, accessories and enclosure.

2.2 Engine mounted, Engine & Alternator monitoring, control & protection integrated panel duly wired up to terminal box for engine safeties, EFC Governor with solid state potentiometers and AVR.

2.3 Fuel oil system including service day fuel tank, piping, valves, filters etc. from engine to service day fuel tank. Return fuel line with fuel cooler and piping with accessories up to day service tank or collecting point as called for.

2.4 Lube oil system with piping including engine mounted priming pump, lube oil cooler, filter, solenoid valves etc.

2.5 Cooling system including engine mounted radiator.

2.6 Exhaust emission shall meet CPCB & SPCB norms with or without catalytic converter or online scrubber and residential silencer, exhaust piping with mineral wool insulation and aluminium cladding as called for.

2.7 Steel fabricated structure/support/hanger including fixing, grouting and bolting etc.

2.8 Painting of steel work.

2.9 LT, Control cabling.

2.10 Auxiliary Control panel.

2.11 The bidder shall also indicate in his offer the time schedule for routine maintenance / overhauling operations necessary for continuous satisfactory operation of DG Set.

2.12 The item rate shall remain valid for variation to any extent of the estimated quantities given in the Schedule of Quantities.

2.13 All equipment shall be of the class most suitable for working under the conditions specified and shall withstand the atmospheric conditions without deterioration.

2.14 Minor civil work is included in the contractor's scope of work. However, the responsibility of coordination with the civil and other contracting agencies ensuring completion of turnkey contract rests with the contractor.

2.15 Contractor shall co-ordinate with all other agencies working at site for interconnection and safety aspects.

2.16 Also the DG supplier shall furnish back up combined guarantee for 1 year from the date of successful commissioning from Engine and alternator supplier for smooth running. In case there is any defect the free replacement of any part or in whole shall be made immediately at no loss to Owner.

2.17 Provide engineering data, drawings, O & M manuals, etc.

2.18 Packing and transportation from the manufacturer's works to the site.

2.19 Receipt, storage, preservation and conservation of equipment at the site including handling.

2.20 Fabrication, pre-assembly, if any, erection, testing and putting into satisfactory operation of all the equipment including successful completion of trial operation.

2.21 Reliability test and performance guarantee tests including performance demonstration after successful completion of trial operation.

2.22 Furnishing of mandatory spares

2.23 Recommended spares, capital spares and O&M spares.

2.24 Satisfactory conclusion of the contract

3.0 FEES & PERMITS

The contractor shall obtain all sanctions and permits required for the running of DG sets from all the relevant authorities. All actual fee payable in this regard will be reimbursed against receipt/documentary proof (evidence). On completion of the work, the supplier shall obtain NOC/Statutory Approval from concerned authorities in original and shall be delivered to the Owner.

4.0 CODES & STANDARDS

The design, construction, manufacture, inspection, testing and performance shall comply with all the currently applicable statutes, safety codes, relevant Bureau of Indian Standards (BIS), British Standards (BS), International Electro Technical Commission (IEC) publication, NEMA & VDE Standards amended upto date.

Some of the applicable standards are listed below:

IS – 1601	:	Performance and testing of IC engines for general purpose.
BS – 649	:	Performance and testing of IC engines for general purpose.
BS – 4613	:	Electrical performance of rotating electrical machine.
BS – 4999/5000	:	Applicable parts of BS 4999/5000.
IEC – 34-1/ IS – 4722/VDE – 0530	:	Specification for rotating electrical machines.
IS – 4889	:	Method of determination of efficiency of rotating electrical machinery.
IS – 6491	:	Degrees of protection provided by enclosures for rotating Electricity machinery.
IS – 4729	:	Measurement and evaluation of vibration of rotating Electrical machines.
AIEE – 606	:	Recommended specification for speed governing (1959) of internal combustion engine generator units.

IS – 2705	:	Current transformers.
IS – 1248	:	Electrical indicating instruments.
BS – 5514 / IS – 03046 or IS – 08528 Part 2	:	Reciprocating Internal Combustion (IC) engine driven AC Generators.
IEEE – 115	:	Test procedure for synchronous machine.
IS-7098 Part I & II	:	XLPE insulated PVC sheathed for working voltage 1.1 to 33 KV.
IS-13947/ IEC 947	:	Air Circuit Breaker / Moulded Case Circuit Breaker.
IS 1018	:	Switchgear and control gear selection/installation and maintenance.
IS-13779	:	Digital measuring instruments and testing accessories.
IS -2147 (Part I, II & III)	:	Degree of protection provided by enclosures for low voltage. Switchgear & control gears.
IS-3427	:	Metal enclosed switchgear and control gear.
BS-162	:	Safety clearance.
IS-3202	:	Code of practice for climate proofing of electrical equipment.
IS-4201	:	Application guide for Current Transformer.
IS-4146	:	Application guide for Voltage Transformer.
IS-3034	:	Code of practice for fire safety of industrial building-electrical generating and distribution station.
IP-30	:	National electrical code (NEC) BIS publication.
IS-2959	:	Contactors.
IS-1030-1982	:	Specification for carbon steel castings for general engineering purpose.

5.0 DESIGN

The design and workmanship shall be in accordance with the best engineering practices, to ensure satisfactory performance and service life. The equipment offered by the contractor shall be complete in all respects. Any materials or accessories, which may not have been specifically mentioned, but which are usual and necessary for the satisfactory and trouble free operation and maintenance of the equipment shall be provided without any extra cost to the purchaser.

6.0 PERFORMANCE REQUIREMENT

6.1 The equipment shall be capable of delivering power continuously at the generator terminals, a net output not less than the specified value at 0.8 pf excluding auxiliary power (shall be included over and above), when operating under the site ambient conditions described in this specification. Genset should have minimum 50% single step loading capacity and it should be able to take full load in less than 25 sec from start. (The set shall be suitable for prime duty).

6.2 The design parameters of the generator and excitation system shall be so chosen that the set is stable while running at any load between no-load and full load and also during starting of motors as specified in Annexure-I. It should also have iso-synchronous speed control with load sensing governing system suitable for parallel running of DG sets.

6.3 Engine should be heavy duty four stroke, turbo charged after cooler, 'V' construction, electric start. Engine should have lube oil change period of minimum 300 hrs.

6.4 The set shall have vibration limit less then 130 microns (as per BS: 4999 Part-142) and noise level shall be 75 dB(A) at 1 metre in open free field environment as per ISO 8528 part 10 under all conditions of load. The set shall be dynamically balanced. The set shall be mounted directly on the inertia foundation or with foundation bolts etc. The efficient residential silencer shall be provided with or without catalytic converter on-line scrubber & the set shall meet CPCB & SPCB norms for DG set's exhaust emission. Air inlet shall also be provided.

6.5 The total harmonics contents should be less than 3% as per IS 4722/1969. The graph & calculation for harmonic distortion shall be submitted.

6.6 Contractor to specify and guarantee maintenance contract cost and to give an undertaking to take a comprehensive maintenance contract after expiry of warranty period for which price may be quoted.

6.7 The successful bidder shall submit shop drawing of the equipment / accessories selected for this work for the approval of Consultant / Owner.

7.0 DIESEL ENGINE - CONSTRUCTION

7.1 Material of construction of major parts shall be as under or as per manufacturer design.

a) MS Base frame with anti-vibration mountings.

b) Crankcase - Aluminium alloys.

c) Crank shaft, connecting rods - Forged Alloy Steel.

d) Piston - Al. alloy casting

e) Piston rings - Alloy steel.

f) Engine block - Cast iron.

g) Cylinder liner - Cast Iron.

h) All other materials of construction shall be as per relevant standard/code and the copies of same shall be supplied free of cost to Consultant.

7.2 The Diesel Engine shall be multi-cylinder, totally enclosed, continuous duty, direct fuel injection, turbo charged, compression ignition, inter cooled oil engine or with individual cylinder head with provision to measure exhaust temperature and smoke quality with alarm and tripping facility. Fuel cooler to be provided in the fuel return line.

7.3 One common base frame shall be provided for mounting the engine & radiator and alternator complete with electric suspension between DG Set and foundation bolts, levelling lines etc. as required.

7.4 All externally mounted hardware shall be high tensile steel only.

7.5 The normal speed of the engine shall be 1500 RPM and the direction of rotation shall be clearly marked on the set.

7.6 The engine shall be fitted with an exhaust gas driven turbo charger of air/water cooled type complete with its own self-contained lubricating system. The turbo-charger shall be positioned at the free end of the engine preferably. The turbo-charger shall be provided with a provision to check its lube oil level.

7.7 The engine shall be fitted with a charge air inter cooler of the air/water type. Air from the turbo-charger compressor passes through the inter-cooler and then to the engine manifold. The inter cooler shall be of tubular construction or as per manufacturer design with aluminium bronze tubes, mild sheet steel and cast iron water headers.

8.0 GOVERNING SYSTEM

8.1 The Governor shall be electronic fuel control type for coupled Genset along with speed control switch (solid state potentiometer) at the end of start on overspeed.

9.0 ENGINE STARTING SYSTEM

Starting of the Diesel Engine shall be done by electric starting system.

The electric starting system shall comprise starter motor, starter batteries and battery charger including with all required instruments and accessories. The engine mounted alternator shall charge the batteries while engine is running and floor panel mounted solid state battery charger while engine is stationery. The battery charger shall be of 2 rate (boost cum trickle) with all metering and control instruments and protections for AC and DC circuit. The total system shall be suitable for auto and manual

operation including their wiring etc. Calculation for the battery and battery charger capacity as well as complete descriptive circuit diagram shall be submitted for review of Consultant based on 6 consecutive start commands.

10.0 FUEL OIL SYSTEM

10.1 The fuel system shall be provided with full flow duplex oil cartridge filter preferably changeable during running of the set.

10.2 The fuel oil system shall be equipped with a crankshaft driven PT fuel oil transfer pump which will draw the fuel oil from the day tank via filters and shall be as per the engine manufacturer design.

10.3 Multi-point (electronically controlled) fuel injection system or direct injection with PTC injectors through iso synchronous fuel Governing system shall be designed taking into account the type of fuel used, engine speed etc. so as to achieve safe knock free performance with low emission smoke exhaust meeting CPCB norms for DGs with or without catalytic converter/on line scrubber.

10.4 Engine shall be supplied with fuel leakage module to detect the fuel leakage from the engine and transfer it back to day tank for reuse.

11.0 LUBRICATING OIL SYSTEM

11.1 All lubricating parts of the engine shall be connected to a pressurised lubricating oil distribution piping system being continuously charged by gear type lube oil pump mounted at the free end of the engine and driven from the engine crankshaft. The pumps shall take suction from a sump tank integral with the engine through a foot valve, suction filter through oil cooler and deliver oil to a main supply header. High-pressure oil shall be supplied to the main and big end bearings, crankshaft bearings, governor, auxiliary drive gear etc. Suitable lubricating arrangement for engine cylinder valve gear, cams and pistons at the required level shall be arranged. A pressure relief valve shall be mounted on the main supply header for safety against too high-pressure while starting with cold oil. A timer based, auto running (auto priming pump) shall be provided to keep engine primed all the time complete with control system (if required).

11.2 The lube oil system shall be provided with full flow duplex lube oil cartridge filters. The minimum lube oil change shall be 300 hrs.

11.3 Arrangement shall be provided to bypass the lube oil pressure switches and safety at the starting till the pressure is built up.

11.4 The lube oil sump shall have provision to sense the low level of lube oil in the sump and fill it up manually or automatically from the main lube oil tank/sump and stop the transfer pump, once the lube oil is filled in the sump without stopping the engine. Pressure switches to give alarm under extreme low pressure of lube oil and subsequently to trip the unit when the minimum safe pressure has been reached, shall be provided.

11.5 All necessary accessories such as pressure gauges, temperature indicators, pressure relief valves, bypass valves, pressure switches shall be provided and the safeties shall be wired up to junction box with interfaced converter for compatibility with PLC.

12. COOLING SYSTEM

12.1 The engine shall be cooled by means of a water jacket, heavy-duty air blast radiator with integral radiator header tank, circulating pump and engine driven pusher type fan. The fan shall draw air in from the vicinity of the engine block and discharge it through the radiator core. The radiator shall be mounted on the same bedplate as the engine and alternator on suitable spring type vibration isolators and be arranged so that it is located directly behind the hot air discharge duct which is used to discharge the hot air out side.

12.2 A thermostatically operated by-pass valve shall be fitted in the cooling system to maintain an optimum operating temperature during starting and running conditions. Drain cocks shall be provided so that all the water can be drained from the system.

12.3 Separate oil cooler shall be used for cooling the engine oil. A thermostatic by-pass valve shall be incorporated.

12.4 Anti-vibration mountings shall be common type with the engine AVM, since both the engine and radiators are mounted on the same base plate.

12.5 The engine shall have a separate after cooling circuit to maintain the inlet air temperature within the desired limits.

13.0 EXHAUST SYSTEM

Engine emission exhaust system shall be fitted with/without catalytic converter on line scrubber to control pollution to meet the CPCB/SPCB norms of exhaust emissions for DG set, silencer. Ducting, bends, hood/canopy, thermally insulated aluminium clad exhaust piping etc. shall be provided along with structural support with stays for engine. Heat resistant paint shall be provided on exhaust pipe for the portion that is outside the enclosure. Exhaust system pollution level shall be indicated and shall be got approved by authorities. (Exhaust smoke quality & quantity should be within the norms of central & state pollution control board).

14.0 ENGINE & ALTERNATOR CONTROL PANEL

Engine & alternator control

DG set shall be supplied with engine & alternator control panel that shall be a microprocessor based generator set monitoring, protection and electronic governing system. It shall be equipped with (digital) electronic Governor along with solid-state AVR to facilitate discreet control of speed and voltage. The system shall be equipped with starting control including integrated fuel ramping to limit the black smoke, frequency overshoot with optimized cold weather starting. The control panel shall be equipped with digital status and alarm to monitor and display the following parameters. The necessary CTs/PTs shall be included and wired accordingly to meet the requirements.

14.1. ENGINE PROTECTION & INDICATORS

a) Lube oil pressure
b) Coolant Temperature
c) Engine Speed
d) Hours Run
e) Battery Voltage
f) Common warning
g) Common shutdown
h) High Coolant temp warning and shutdown
i) Low Lube Oil Pressure warning and shutdown
j) Low Coolant Level shutdown
k) Over Speed shutdown
l) Charging failure indication

14.2 ALTERNATOR PROTECTION & INDICATORS

a) 3-phase AC Amps
b) 3-phase AC Volts
c) kW
d) kVA
e) Power Factor
f) Frequency
g) Over Voltage
h) Under Voltage
i) Over Frequency
j) Under Frequency
k) Over current

15.0 EXCITATION SYSTEM

15.1 The Alternator shall be provided with a complete rotating diode type brushless excitation system, capable of supplying the excitation current to the generator under all conditions of output from no load to full load and capable of maintaining voltage of the generator constantly at one particular value.

15.2 The exciter shall have Class 'H' insulation and should be vacuum impregnated.

15.3 The excitation system shall comprise a shaft driven AC exciter with rotating rectifiers. The rectifiers shall have in-built protection for over-voltage.

15.4 The Alternator shall be complete with PMG/auxiliary winding excitation. The exciter shall be fast response type and shall be designed to have a low time constant to minimise voltage transients under severe load changes. The excitation voltage response ratio shall be at least 0.8.

15.5 No external supply shall be required during starting and normal running of the alternator.

16.0 ALTERNATOR (415V – 3 Phase, 4 Wire System)

16.1 The Alternator shall be industrial type, screen protected, drip proof, IP-23, Class 'H' insulation, self ventilated, air cooled, rotating field, salient pole, brushless machine with self excited, self regulated exciter and shall be rated for continuous duty.

16.2 The Alternator shall have a continuous rating of not less than the value specified under specific requirement at 0.8 (lag) pf. The alternator shall be suitable to run for 0.95 (lag) pf with capacitor controlled by APFC relay.

16.3 The short circuit ratio (SCR) of the generator at rated KVA and rated voltage shall not be less than 0.48.

16.4 The Alternator shall withstand without mechanical damage, an over speed of 20% for a period of 2 minutes.

The generator/alternator shall with stand over load of 10% for one hour in any 12 hours of operation without exceeding temperature rise limits specified in BS:2613 or BS:5000 when corrected to ambient temperature at site. The terminal voltage shall be adjustable and the range of adjustment shall be $\pm$ 5% of nominal voltage.

16.5 The Alternator shall be capable of withstanding without damage/injury for 3 sec., 3-phase short circuit at its terminals, when operated at rated KVA and power factor at 5% over voltage with fixed excitation (3 times the line current for 3 Sec.).

16.6.1 The Alternator shall be capable of withstanding for 30 seconds, a current of 50 percent in excess of its rated current, the voltage being maintained, as near the rated value as possible, consistent with maximum capacity of the prime mover.

16.6.2 6 nos. embedded Resistance Temperature Detectors (RTDs) of Platinum (100 ohms resistance at 0 degree) to measure the winding temperature and 2 nos. Bearing temperature Detectors (BTDs) for bearing temperature shall be provided.

16.6.3 The leads of embedded RTDs shall be wired up to the terminal block in a separate auxiliary terminal box. Manufacturer shall indicate the setting values for each RTD/BTD for alarm and trip with scanner and RS 232/485 port totally compatible with PLC.

16.9 On line greasing facility with grease nipples and grease relief device shall be provided.

16.10 All external nuts and bolts shall be of high tensile steel only.

16.11 Alternator shall be provided with anti-condensation space heater of adequate rating suitable for 240V, 50 Hz, 1ph AC supply and shall be wired up to a separate terminal box. Thermostatically controlled shall work when the machine is in idle condition only (wiring and equipment shall be provided by D.G. supplier).

16.12 Two independent earth terminals on the frame complete with nuts, spring washer and plain washer shall be provided.

16.13 Alternator shall be provided with suitable terminal box for terminating TP&N bus-duct/cables.

16.14 The alternator shall be capable to sustain the unbalanced current between the phases of minimum 40% of rated current provided that the KVA rating and maximum current does not exceed 11% of rated current in any phase as per BS-4999 Part-101.

16.15 The alternator shall be dynamically balanced complete with rotor and shaft.

16.16 Alternator should have bearings at both shaft ends.

16.17 Damper winding shall be provided in the pole to damp the oscillations and ensure satisfactory performance during parallel operation.

16.18 Winding of 3 phase alternator shall be of star connected and neutral point shall be brought out to the terminal box through protection and earthed with independent earth or through contactor as per scheme.

16.19 Protection CTs, PTs, Neutral CT shall be mounted above the terminal box with enclosure. Bus duct / cable shall be terminated on terminals through this.

16.20 Diesel generating set shall be able to start motor of 30% capacity of DG set with a 20% base load.

17.0 AUTOMATIC VOLTAGE REGULATOR

17.1 An automatic high speed, dead band type dual channel voltage regulator shall be provided complete with all accessories. The regulation system shall be with equipment accessories for automatic as well as for manual switchover control.

17.2 The voltage regulator shall be dual control type i.e. the voltage regulation shall be through compound transformer or magnetic amplifier and the electronic regulation through solid state devices automatically both shall be secured from all three phases.

The combined voltage regulation shall be ± 1% from full load to no-load from hot to cold at unity power factor and 0.8 to 0.95 power factor with 4% speed regulation of the engine.

17.3 Voltage regulation and steady state modulation shall be within ±1% of the line voltage and with auto-manual voltage adjustment capability within ±5%. The maximum permissible wave form distortion should not exceed 5% at any load.

17.4 Necessary equipment for field suppression and surge protection shall be provided.

17.5 The response time of the exciter and the generator shall be properly matched to avoid hunting.

17.6 In the event of AVR failure, the generator excitation control is transferred automatically without any change in the excitation current.

17.7 Necessary equipment shall be furnished for the following:

a. To prevent automatic rise of field voltage in case of failure of potential supply.

b. To initiate transfer from automatic to manual control of excitation on fuse failure in the generator potential signal.

c. To facilitate reactive load sharing of parallel operating generator if any in proportion to their ratings. The quadrate droop current transfer compensation feature should be provided on exciter regulation and the droop voltage shall be within 1% variation.

18.0 TESTS

18.1 The Diesel Generator set shall be tested as per the relevant IEC Standards. All the tests will be witnessed by the representative of employer with no extra claim to employer. The supplier shall submit test reports with complete description / testing procedure:

A. Quality Test of materials

- Crack detection and ultrasonic tests of forging and castings.
- Hydrostatic tests on pressure parts.
- Static balancing of rotating parts; shafts shall be statically and dynamically balanced.
- Bench tests on safety control devices.
- Performance tests on fuel pump and injectors.

B. Acceptance Tests on DG Set (factory and at site).

a) Rating Test (IS: 10000 Part-VIII-1980)
b) Governing Test (IS: 10000 Part-VIII-1980)
c) Phase Sequence Test.
d) One (1) hour at full load with fuel consumption (factory and site).
e) One (1) hour at 3/4th load with fuel consumption (factory and site).
f) One (1) hour at 50% load with fuel consumption (factory and site).
g) Seven (7) hours at full load with fuel consumption (factory and site).
h) Two (2) hours at 110% load at 6th and 12th hour shall be done with fuel consumption (total – 12 hrs.).
i) Engine starting time (factory).
j) Noise/vibration test.
k) Fuel consumption at intervals of 1 hr. (total 3 hrs.) (ISI: 10000 Part VIII-1980).
l) Cooling water temperature at inlet and outlet.
m) Lube oil temperature at inlet and outlet.
n) Dynamometer test (engine).
o) Emission test.

Before each test, the engine shall be brought to a steady state under the conditions of the test.

C. Type Tests on Alternator (Factory & At Site)

The alternator shall be type tested as per the relevant specifications. Type tests shall include following tests:

a. Measurement of dc resistance of stator and rotor winding.
b. Insulation resistance of stator and rotor winding
c. High Voltage test on stator and rotor winding
d. Open circuit and short circuit characteristics
e. Temperature rise test/heat run test.
f. Regulation test
g. Efficiency test
h. Momentary overload test
i. Vibration and noise level measurement.
j. Over-speed test as well as electronic over speed trip
k. Determination of deviation of voltage wave form
l. Load characteristics test.

D. Notice Period

At least 3 weeks notice time shall be maintained for the tests mentioned above by the manufacturer.

18.2 Voltage Regulator

a. Sensitivity test
b. Response time test

18.3 Commissioning Checks

In addition to the checks and tests recommended by the manufacturer, the Contractor shall supervise the following commissioning checks to be carried out at site.

a) **Load Test**

The engine shall be given test run for a period of at least 6 hours. The set shall be subjected to the maximum achievable load as directed by Purchaser without exceeding the specified DG Set rating:

During the load test, half-hourly records of the following shall be taken:

i) Ambient temperature

ii) Exhaust temperature.

iii) Cooling water temperature at a convenient point adjacent to the water output from the engine jacket.

iv) Lubricating oil temperature where oil cooler is fitted.

v) Lubricating oil pressure.

vi) Colour of exhaust gas.

vii) Speed.

viii) Voltage, wattage and current output.

ix) Oil tank level.

The necessary load to carry out the test shall be provided by the Manufacturer.

b) **Insulation Resistance Test for Alternator**

Insulation resistance in mega-ohms between the coils and the frame of the alternator when tested with a 1000V megger shall not be less than

IR = 2 x (rated voltage in KV) + 1

c) **Check of Fuel Consumption**

A check of the fuel consumption shall be made during the load run test. This test shall be conducted for the purpose of proper tuning of the engine.

d) **Insulation Resistance of Wiring**

Insulation resistance of control panel wiring shall be checked by 500V megger. The IR shall not be less than one mega-ohm.

e) **Functional Tests**

i) Functional tests on control panel.

ii) Functional test on starting provision on the engine.

iii) Functional tests on all Field devices.

iv) Functional tests on AVR and speed governor.

f) **Measurement of Vibration**

The vibration shall be measured at Load as close to maximum achievable load and shall not exceed 110 microns.

g) **Noise Level (Sound Pressure Level) Check**

Noise level measurement shall be done generally following the guidelines given in IS: 121065. The measurement shall be carried out with a calibrated integrating sound level meter as per IS: 9779.

Sound level shall be measured all round the Diesel Generator set at a distance of 1 M from the nearest surface of the machine and at a height of 1.5M from the floor level as illustrated in IS: 12065 for electrical machines (105-110 dbA at 1 metre).

A minimum of 8 points (5 around diesel engine and 3 around alternator) shall be covered for measurement. Additional measurement points shall be considered in case of criteria indicated in Clause 3.3.3 of IS: 12065 is not met.

The measurement shall be done with slow response meter on the A-weighting scale. The average of the A-weighted sound level measurement expressed in decibels to a reference of 0.0002 micro bar shall not generally exceed 93 db A.

The tests shall be carried out with the DG set operating at rated speed and at maximum achievable load. DG set shall be located in a room having an approximate dimension as per manufacturer recommendation. Necessary correction for Test environment condition and background noise will be applied as per IS:12065.

18.4 Test Certificate

a. Test Certificate shall be submitted in eight (8) copies.

b. The test certificates shall be furnished to the purchaser for prior approval before dispatch of any equipment from works and the approval in writing from purchaser shall be essential to effect dispatch of the equipment.

c. The test reports shall furnish complete identification of the data including serial number of each equipment.

19.0 SPECIAL TOOLS AND TACKLES

a. The contractor shall furnish to the purchaser a complete and unused set of all special tools & tackles, which are necessary for erection, testing and commissioning, maintenance and overhauling of any of the equipment provided under this specification.

b. The tools shall be shipped in separate containers clearly marked with the name of equipment for which they are intended.

c. The contractor shall submit a list of tools proposed to be furnished under the scope of supply with his proposal.

d. Other tools needed (but not a part of this supply).

e. Hydraulic cam for dismantling the DG Set heads should form part of the supply.

20.0 SPARES

The manufacturer / tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

21.0 DRAWINGS, DATA & MANUALS

Drawings and details of foundation, lube oil circulation, cooling system, fuel oil shall be furnished along with each of the bid. Wiring diagram of all auxiliary devices shall be furnished. Installation, operation and maintenance manuals shall be furnished.

22.0 DEVIATIONS

Should the contractor desire to deviate from this specification in any way, he shall draw specific attention to such deviation giving complete reasoning/comparison with other products.

Unless such deviations are recorded in the separately attached Deviation Sheets, as submitted with offer, it will be taken for granted that the offer is made in conformity with this specification.

23.0 QUALITY ASSURANCE PROGRAMME

Quality Assurance shall follow the requirements of Owner/ Consultant as applicable. Quality Assurance involvement will commence at inquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

24.0 GUARANTEED PERFORMANCE

The contractor shall furnish, along with the offer, the technical particulars as called in the Annexure 'II' & 'III'. The performance figures quoted in the technical particulars sheets shall be guaranteed within the tolerance permitted by relevant standards. In case of failure of equipment to meet the guarantee, the purchaser reserves the right to use these rejected equipment until the new equipment meeting the guaranteed requirements is supplied by the contractor.

25.0 PACKING FOR SHIPMENT

25.1 The equipment shall be suitably protected by respective packing for the shipment distance and weather conditions involved.

25.2 For transportation, if totally enclosed boxes are not used, the equipment shall be mounted on skids and enclosed in the open frame wooden crates. However, items like instruments and other components not assembled with equipment shall be separately marked with equipment number and part number for case of identification.

26.0 APPROVALS

Contractor shall obtain all the necessary statutory approvals/clearances required from the Director of Safety, Pollution Control Board.

AMF PANEL FOR DG SET

The Generator control shall be indoor type, floor mounted, dust and vermin proof in sheet steel construction. The panel shall have doors at the front and back for proper maintenance. The panel shall have steel channel fabricated kick-plate and bolted type cable gland plate fitted at the bottom. The panel shall be constructed from 2 mm thick steel sheet. All the joints shall have proper gaskets.

Monitoring and control devices shall be housed on the front door. Generally the construction of the panel will be such that various equipments for applications will be housed in compartments. All incoming and outgoing power and control cables shall be from the bottom.

Panel will be equipped as follows:

a) 2 nos. 4 pole, **630Amp** EDO Type ACB
b) 1 set of CTs for Metering

METERING

a) Ammeter with selector switch
b) Voltmeter with selector switch

AMF LOGIC

a) One Main supply voltage monitor
b) One Alternator supply voltage monitor
c) One set of DC control relays and timers
d) One Set of control relays for the automatic control system

BATTERY CHARGER

a) One Battery charging transformer/ rectifier unit
b) One DC Ammeter
c) One DC Voltmeter

INDICATIONS

a) Set running
b) Set on Load
c) Phase Indication

SOUND PROOF ENCLOSURE

a) The enclosure shall be sound proof and weather proof.
b) It shall conform to statutory Govt. noise level norms.
c) It shall be of modular construction with the provision to assemble and dismantle easily.
d) It shall be fabricated in 16 SWG-CRCA-sheet.
e) The sheet metal components shall be eight tank pretreated and polyester based powder coated (inside as well as outside) for long life.
f) All Nuts-bolts, hardware shall be of Stainless Steel
g) Battery shall be provided in a tray inside the Enclosure.
h) Doors shall be gasketed with high quality EPDN gaskets to avoid leakage of sound.

i) Sound proofing of enclosure shall be done with high quality rock wool confirming to IS 8183 to suitable thickness and density. Rock wool is further covered with fibre glass sheet and perforated powder coated sheet.

j) Suitable openings with acoustic hoods shall be provided for increasing the inflow of air required for combustion & forced ventilation. Radiator shall not allow the temperature to rise more than 7^0C above ambient temperature within the enclosure.

k) Sound attenuators shall be provided to control sound at air entry & exit points inside the Enclosure.

l) The enclosure shall be designed and layout of the equipment shall be such that there is easy access to serviceable parts.

m) Adequate ventilation shall be provided to meet air requirement for combustion & heat removal.

n) There shall be an arrangement for illumination inside the Enclosure.

ANNEXURE-I

TECHNICAL PARTICULARS OF DIESEL GENERATOR SETS

1.	Quantity and Rating at prime duty	:	380 KVA at 0.8 – 0.95 pf (Unit shall be rated for feeding continuous prime load).
2.	Mode of Operation	:	Standalone
3.	Engine/Alternator		
3.1	Output rating at ambient temp of 50Deg.C (for each) at prime duty	:	380 KVA at 0.8 lag pf continuous for prime load. Alternator suitable for 0.8 – 0.95 pf.
3.2	Class of insulation for Stator & Rotor (For calculation & testing)	:	Class 'H' limited to Class 'H'
3.3	Rated Voltage & Frequency	:	415 Volts, 50 Hz. three phase 4 wire AC
3.4	Maximum permissible time for building up rated voltage from stand still	:	Less than 5 seconds
3.5	Variation of voltage from no load to full load	:	±1% of rated voltage
3.6	Voltage adjustment	:	±5%
3.7	Capacity of largest motor load	:	30% of DG Set capacity
3.8	Dynamic voltage response & permissible voltage drop at generator terminals during largest rating motor starting	:	Less than 15% of rated voltage under operating condition at 3.6 & 3.7 above
3.9	Temperature detectors with scanner/converter	:	8 Nos. resistance temperature detectors of type PT-100 for winding temperature and bearing temperature measurements
3.10	Type of excitation system	:	PMG type / Auxiliary plus relating field diode.
3.11	Type of control for voltage regulator	:	Local/Remote (Manual/Automatic)

4.	Miscellaneous		
4.1	Type of fuel for engine	:	High Speed Diesel in accordance with F-DMA or F-DMS as per ISO 8217. (IS : 1460 1974 amended upto date)
4.2	Day Fuel tank capacity	:	520 litres
4.3	Maximum permissible starting time for attaining full speed	:	Less than 25 seconds
4.4	Engine Starting	:	Electric starting system
4.5	Type of Governor Electronic Fuel Control	:	Electronic fuel controlling with mechanical over-speed protection complete with solid-state potentiometer for remote operation.
4.6	Lubrication system	:	Pressure fed type.
4.7	Cooling System	:	Radiator cooled
4. 8	Engine cranking system	:	To be included
4.9	Noise Level	:	75 db (A) at 1 metres

Technical literature, testing procedure with acceptable value shall be submitted along with the bid.

Any deviation shall be explained with supporting documents that shall also be submitted.

ANNEXURE -II

The following will be the part of the DG Set supply but not limited to these:

(a) Engine Specification:

- Engine governor and control box for coupled Genset
- Speed control switch, end of start and over speed
- Fuel and lube oil duplex cartridge filters
- Switches & Transmitters on lube oil pressure and temperature, water temperature, oil sump level, after cooler air temperature.
- Control panel
- Automatic/manual lube oil filling
- Wiring box
- Electric pre-lubricating lube oil pump

(b) Alternator 415 V:

- According to the standards IEC, VDE, BS, ANSI
- Flanged on engine, connection with elastic coupling
- Double long life re-greasable bearings
- Single and ventilated discharge at the drive end
- Insulation class 'H', temperature rise limited to Class 'H' (for calculation purpose).
- Enclosure: IP23
- Excitation: PMG / Auxiliary winding.
- Dual AVR with auto/manual changeover.
- 6 Stator and 2 bearing PT100 sensors with analog converter
- Preheating resistance
- Overload capacity: 110% for 1 hour at every 6 hours.
- Unbalanced load: The unbalanced current between phases shall not exceed 30 % of the rated current
- Radio Interference: Within limits of CISPR standard (less than 5 %).
- Regulation performances: The voltage is kept constant within +/- 1 %
- Manual voltage adjustment +/- 5 %
- Dynamic balancing of the complete rotor and shaft
- Short circuit withstand: 3 times the line current for 10 sec.
- Vibration sensor with converter.

<u>Auxiliaries supply:</u>

The panel should incorporate the power outgoing for the following genset auxiliaries:

- Battery charger (SMPC)
- Alternator anti-condensing heater.
- Pre-lube oil pump.
- Return fuel cooler.

ANNEXURE - III

TECHNICAL PARTICULARS OF DG SET
(TO BE FURNISHED BY THE CONTRACTOR)

Contractor shall furnish following technical particulars for Engine, Alternator, Governor and Remote Radiator together with tender documents.

1.0	**ENGINE**	**:**
1.1	Engine Rating (standard)	:
1.2	Engine rating at NTP (as per BS:649)	:
1.3	Maximum Engine rating at site	:
1.4	Time interval between successive starts	:
1.5	Maximum time required to start the diesel engine from cold and to bring up to rated speed and in condition to take load	:
1.6	Cylinder bore and stroke (mm)	:
1.7	No. of strokes/cycle	:
1.8	No. of cylinders and arrangement	:
1.9	Direction and rotation when viewed from free end	:
1.10	Lube oil pressure at pump inlet	:
1.11	Lube oil change intervals in hours with oil quantity	:
1.12	Minimum acceptable lube oil temperature at start up	:
1.13	Method of cooling	:
1.14	Method of starting	:
1.15	Compression ratio	

a) Compression pressure (PSI) :
b) Max. cylinder pressure (PSI) :
c) Fuel injection pressure (PSI) :

1.16 Heat balance

a) Fuel input mechanical :
b) Thermal exhaust :
c) Engine radiation :
:
:

1.17 Specific fuel consumption

a) Full load (on incidental power) :
b) ¾ load (on incidental power) :
c) ½ load (on incidental power) :
d) ¼ load (on incidental power) :

1.18 Emissions

a) Meeting Euro-II norms with or without catalytic converter/online scrubber : Gets approved lab test certificate of this engine required.

1.19 Cooling circuit

a) H.T. engine water inlet temp :
b) H.T. engine water outlet temp :
c) H.T. water flow :
d) L.T. engine water inlet temp :
e) L.T. engine water outlet temp :
f) L.T. water flow :

1.20 Air intake

a) Combustion Air intake flow, kg/hr :
b) Exhaust gas flow, kg/hr :
c) Exhaust gas temperature, deg.C :
d) Maximum gas back pressure, mbar :

1.21 Method of Lubrication :

1.22 Lube oil consumption at NTP full rated output (ltr./bhp/min) :

1.23 No. of inlet valves per cylinder head :

1.24 No. of exhaust valves per cylinder head :

1.25 Fuel oil heat exchanger

A.	Shell side a) Fluid circulated b) Quantity of fluid circulated in kg/hr. c) Temperature inlet/outlet Tube side a) Fluid circulated b) Quantity of fluid circulated in kg/hr. c) Temperature inlet/outlet	: : : : : :	
1.26	Crank case hater type/number rate Make up water tank capacity	:	
1.27	Vibration limit	:	
1.28	Noise level	:	
1.29	Efficiency a) Mechanical b) Thermal	 : :	
1.30	Safety Protection	:	
1.31	Method of Aspiration	:	
2.0	**ALTERNATOR DESIGN DATA**	**:**	
2.1	General	:	
2.1.1	Manufacture/Type	:	
2.1.2	Rating site value	:	
2.1.3	Maximum rating design/site	:	
2.1.4	Rated voltage, current (continuous) & P.F.	:	
2.1.5	Rated speed and frequency	:	
2.1.6	Insulation class – stator/rotor	:	Class ‘H’ limited to class ‘H’
2.1.7	Temperature rise above 50 deg. C. + 5 deg. C. Stator/rotor/core	:	
2.1.8	Enclosure details	:	
2.1.9	Maximum rated KW of motor that can be started with direct on line starter with voltage dip not more than 15 % without base load		

2.1.1	a) Unloaded	:
	b) 50% loaded	:
	c) 80% loaded	:
2.1.10	Excitation at MCR	:
2.1.11	Permanent/temporary voltage variation at terminal	
2.1.1	a) Full load thrown on	:
	b) Full load thrown off	:
2.1.12	Over load (As per BSS : 649)	:
2.2	Alternator Parameters	
	a) Synchronous reactance – Xs	:
	b) Transient reactance – Xd’	:
	c) Sub-transient reactance – Xd”	:
	d) Zero sequence reactance – Xo	:
	e) Negative sequence reactance – X2	:
	f) Short circuit ratio	:
	g) Resistance of stator winding at operating temperature	:
	h) Resistance of rotor winding at operating temperature	:
	i) Impedance – Stator, rotor, stator + rotor combined	:
2.3	Alternator Performance	:
2.3.1	Generator Losses	
	a) Full load losses	:
	b) Armature copper loss	:
	c) Rotor copper loss	:
	d) Core loss	:
2.3.2	Efficiency	
	a) Efficiency at full load	:
	b) Efficiency at ¾ load	:
	c) Efficiency at ½ load	:
	d) Efficiency at ¼ load machine	:
2.3.3	Variation of terminal voltage and frequency %	:
2.3.4	Load power factor	:
2.3.5	Form factor of the % deviation of the above shape from standard	:
2.3.6	Maximum continuous and momentary unbalanced load capacity	:

2.3.7 Symmetrical short circuit current withstand :

2.3.8 Asymmetrical short circuit current withstand :

2.3.9 Vibration limit :

2.3.10 Noise level :

2.4 Engine/Alternator Auxiliaries and Accessories :

2.4.1 Exciter
Type
a) Rated voltage/current :
b) Voltage at rated speed with no load :
c) Voltage at rated speed with full load :
d) Response ratio :
e) Class of insulation – stator/rotor

2.4.2 Automatic voltage regulator
a) Type :
b) Dead band :
c) Response time :
d) Voltage regulation :
e) Line drop compensator for maintaining bus voltage constant :
f) Range of voltage adjustment
g) Catalogues and characteristics curves attached :

2.4.3 Governor
a) Make/type :
b) Steady state speed regulation :
c) Steady state governing speed plus of minimum % of rated speed :
d) Momentary over speed after full load rejection % of rated speed :
e) Momentary under speed of rated speed after sudden increase of 25% rated load :
f) Prescribed speed band + rated speed :

2.4.4 Fly Wheel

	a) Weight	:
	b) Width of rim	:
	c) Diameter	:
	d) Thickness of rim	:
	e) Cyclic variation (Cyl. Se.c)	:
2.4.5	Damper windings on poles	:
3.0	Fuel Requirements	
	a) Capacity of day fuel tank	:
	b) Grade of fuel oil to be used	:
	c) Grade of lube oil to be used	:
4.0	Weight Schedule	:
4.1	Weight of engine	
	a) Total shipping weight	:
	b) Weight of alternator	:
	c) Heaviest piece to be handled in normal maintenance	:
5.0	Piping, Fitting and Valves	:
5.1	Furnish piping schedule giving size, of pipe, wall thickness type of bends, manufacturer, material of construction, rating etc.	:
5.2	Furnish all fittings, drains, vents, valves & any other accessories etc. as required	:

The DG supplier shall furnish the technical calculation and literature etc. for the following for the verification of consultant.

1. Pressure drop in exhaust pipe and pipe diameter.

2. Short circuit calculations (rotor, stator and rotor + stator combined impedance).

3. FDV (ventilation required for DG).

4. Starting battery and battery charger capacity.

5. Descriptive testing procedure of individual equipment and combined set with accepted value etc.

6. DG set dimensions (L x B x H).

7. Terminal box flange details in case of bus duct.

8. Deviation statement if any.

9. Maximum in rush current capacity for 10 minutes.

OIL TRANSFORMER

1. SCOPE

The scope of work includes design, manufacturing, testing at manufacturer's works, inspection, and supply of 11 KV/433 V; 630 KVA; ONAN; Delta-Star with thirty degree phase displacement oil filled copper wound distribution transformer with on load tap changer for **Police Station of Delhi Police at Greater Kailash-I, New Delhi**. The percent voltage impedance of the transformer shall be 5.0 percent subject to IS tolerance

2. APPLICABLE STANDARDS

2.1 CODES & STANDARDS

i) The design, material, fabrication, manufacture, inspection, testing before dispatch, erection, testing, commissioning and performance of transformers at site shall comply with all currently applicable statutory regulations and safety codes in the locality where the equipment shall be installed. The equipment shall also conform to the latest applicable standards and codes of practice. Nothing in this specification shall be construed to relieve the Supplier of this responsibility.

ii) Transformer shall conform to the current applicable standards and codes of practice as specified in Clause No. 2.2.

2.1.1 The equipment, materials and service covered by this specification shall conform to the latest applicable provision of the following standards:-

1.	IS : 5	Colour for ready mixed paints.
2.	IS : 325	Three phase Induction Motors.
3.	IS : 335	New insulating oil for transformers, Switch gears.
4.	IS : 1271	Classification of insulating materials for electrical machinery and apparatus in relation to their stability in services.
5.	IS : 2026(Part I to IV)	Power Transformer
6.	IS : 2071	Method of high voltage testing
7.	IS : 2099	High voltage porcelain bushings.
8.	IS : 2147	Degree of protection.
9.	IS : 2705	Current Transformer
10.	IS : 3202	Code of practice for climate proofing of electrical equipment.
11.	IS : 3347	Dimensions for porcelain transformer Bushes.
12.	IS : 3637	Gas operated relays.
13.	IS : 3639	Fittings and accessories for power transformers.
14.	IS : 5561	Electric power connectors.
15.	IS : 6600 / BS :CP" 1010	Guide for loading of oil immersed transformers.
16.	IS : 10028	Code of practice for selection, installation and maintenance of transformers. Part I, II & III.
17.	C.B.I.P. Publication	Manual on Transformer.

If the standard is not quoted for any item, it shall be presumed that the latest version of Indian Standard shall be applicable to that item.

The equipment complying with other internationally accepted standards, may also be considered if they ensure performance superior to the Indian Standards.

3. GENERAL CONSTRUCTION

3.1 Tanks and Radiators

3.1.1 Tanks shall be of MS plates and structural, electrically welded. The construction shall be robust and substantial, suitable for road/ rail transport and to withstand vibration. Radiator tubes shall be electrical resistance welded type, round or elliptical or rectangular. They shall be welded to separate detachable radiator banks connected through intermediate leak proof valves. Detachable radiator banks shall have top and bottom headers with flanged connections, with drain and vent fittings. Tanks shall be provided with lifting lugs and jacking lugs. Inspection hole with cover shall also be provided. Oil conservators shall be mounted on brackets attached to the top cover on tank. Dimensions of the conservator shall be such as to allow change in volume of oil due to change in temperature from 10° C to 95° C.

3.1.2 Tanks shall be thoroughly cleaned, degreased and sand blasted inside and outside. A coat of rust resisting primer shall immediately be given on outside surface. Inside surface shall be painted with oil resistance enamel paint. Tank and radiators shall be

hydraulically pressure tested. Tanks shall also be tested for full vacuum. The procedure for testing shall be as follows:

i. **Vacuum Test**

The tanks designed for all vacuum shall be tested at an internal pressure of 3.33 KN/sq.mtr. (25 mm of Hg) for one hour. The permanent deflection of flat plates after the vacuum has been released shall not exceed the value specified in Table 'A' without affecting the performance of the transformer.

ii **Pressure Test**

When specified, one transformer tank of each size together with its radiators, conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/sq.m (0.35 kg/sq.cm) whichever is lower measured at the base of the tank and will be maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released shall not exceed the figure specified in Table 'A'.

TABLE 'A'

Horizontal length of flat plate (in mm)	**Permanent deflection (in mm)**
Upto and including 750	5.0
750 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

3.1.3 **Core**

3.1.3.1 The Core shall be built with thin laminations of high grade, non ageing low loss high permeability cold rolled super grain oriented silicon steel. The core laminations shall be insulated from each other by suitable high temperature resistant, oil proof, adhering coating materials. Core clamps and clamping bolts shall be heavily insulated from the core laminations

3.1.3.2 The insulation of core bolt shall be of minimum class 'A'. The bottom and top frames shall be connected with the tie rods to make a complete structure rigid for carrying the weight of core-coil assembly without unduly stressing the laminations or windings. Lifting eyes shall be provided on the frame for removal of core assembly from the tank. Completed core shall be flash tested for insulation with 2500 Volts between the core and each of the clamps or core bolts (core being connected to earth).

3.1.3.3 All the core frames shall be bonded together with two metallic strips and connected to the tank for earthing to ensure earth return and operation of protective gear in the event of a fault. Lifting eyes (or any other provision) for lifting the core from the tank shall be provided.

3.1.4 Winding and Insulation

Winding shall be three phase with minimum class 'A' insulation. High conductivity electrolytic quality copper shall be used for winding. Windings shall be suitably braced to withstand the dynamic forces due to short circuit. Winding insulation shall be uniform and windings shall have full insulation.

Windings shall be subjected to shrinking and seasoning process, so that no further shrinkage occurs during service. Adjustable devices shall be provided for taking up possible shrinkage in service.

Coils shall be supported at frequent intervals by means of wedge type insulation spacers permanently secured in place and arranged to ensure proper oil circulation. To ensure permanent tightening of winding assembly, the insulation spacers shall be dried and compressed at high pressure before use.

Windings shall not contain sharp bends that might damage the insulation or produce high dielectric stresses. No strip conductor wound on edge shall have width exceeding six times the thickness.

Materials used in the insulation and assembly of the windings shall be insoluble, non-catalytic and chemically inactive in the hot transformer oil, and shall not soften or be otherwise affected under the operating conditions.

Varnish application on coil windings may be given only for mechanical protection and not for improvement in dielectric properties. In no case varnish or other adhesive be used which will seal the coil and prevent evacuation of air and moisture and impregnation by oil.

All threaded connections shall be locked. Leads from the winding to the terminal board and bushings shall be rigidly supported to prevent injury from vibration. Guide tubes shall be used where practicable.

Coil clamping rings shall be of steel or of a suitable insulating material.

Permanent current carrying joints in the windings and leads shall be welded or brazed. Clamping bolts for current carrying parts inside oil shall be made of oil resistance material which shall not be affected by acidity in the oil. Steel bolts, if used, shall be suitably treated.

Termination of all windings, also of stabilizing windings, shall be brought out of the tank for external connections.

Windings conductor shall be transposed at sufficient intervals in order to minimize eddy currents and equalize the distribution of currents and temperatures along with the windings.

The completed core and coil assembly shall be dried in vacuum at not more than 0.5mm of mercury absolute pressure and shall be immediately impregnated with oil after the drying process to ensure the elimination of air and moisture within the insulation. Vacuum may be applied in either vacuum over tank or in the transformer tank. Vapour phase dry out shall be preferred.

3.1.5 Insulating Oil

3.1.5.1 The insulating oil for transformer shall be EHV grade, generally confirming to IS: 335. No inhibitors shall be used in the oil.

3.1.5.2 The quantity of oil required for the first filling of the transformer and its full specification shall be stated in the bid. The bidder shall quote the price of transformer complete with first filling of oil plus 10% extra. However the rate of transformer oil in Rs. per litre shall also be quoted separately. The transformer oil shall be supplied in non-returnable drums.

3.1.5.3 The design materials used in the construction of the transformer shall be such as to reduce the risk of the development of acidity in the oil.

3.1.5.4 The supplier shall warrant that oil furnished is in accordance with the following specifications:-

S.No.	Characteristic	Requirement	Method of Test.
1.	***Appearance***	The oil shall be clear & transparent & free from suspended matter of Sediment.	A representative sample of oil shall be examined in a 100 mm thick layer at ambient temp.
2.	***Density at 20'c***	0.89g / cm3 Max.	IS : 1448
3.	***Kinematic Viscosity at 27 deg. C. Max.***	27 CST	IS : 1448
4.	***Interfacial tension at 27 deg. C.Min.***	.03 N / M	IS : 6104
5.	***Flash Point***	136 deg. C	IS : 1448
6.	***Pour Point Max***	- 6 deg. C	IS : 1448
7.	***Neutralization value (Total Acidity) Max.***	0.03 mg KOH / gm	IS : 335
8.	***Electric strength Breakdown Voltage Min.***	Not less than 72.5 KV	IS : 6792
9.	***Dielectric dissipation factor for delta at***	0.03 Max.	IS : 6262

	90Deg. C.		
10.	***Min. specific resistance (resistivity) at 90deg. C.***	35 x 10^{12} ohm cm (min)	IS : 6103
11.	***Oxidation stability***		
12.	***Neutralization value after oxidation***	0.40 mg KOH / g	
13.	***Total sludge after oxidation***	.10% by weight max	
14.	***Presence of oxidation inhibitor***	The oil shall not contain antioxidant additives.	IS : 335
15.	***Water content Max***	Less than 25 ppm.	IS : 2362

3.1.6 The transformer shall be equipped with surge arrestors at HV and LV side. The surge arrestors shall also be mounted on the bracket fitted on the transformer. Supplier shall be responsible of properly choosing the rating of the surge arrestors on HT & LT side both.

4. IMPEDANCE & GUARANTEED TECHNICAL PARTICULARS OF TRANSFORMER

a) Core/iron loss:- 'X'
b) Load/copper loss:- 'Y'
c) Maximum percentage impedance shall be 5.0 %.

The transformer impedance shall be 5.0 %. The transformer shall be low loss type and provide maximum efficiency. The ratio X : Y shall be 1 : 6 (maximum). This ratio has to be mentioned in the offer by the Supplier.

5. **GENERAL REQUIREMENTS**

The transformer shall be outdoor type as specified. Unless otherwise specified the transformer in addition shall have thermal and dynamic ability to withstand external short circuit as per Clause 9 of IS: 2026 (Part I) 1977.

6. **TEMPERATURE RISE**

6.1 The reference ambient temperatures assumed for the purpose of this specification are as follows:-

a. Maximum ambient air temperature 50 Deg. C.
b. Maximum daily average ambient temperature 40 Deg. C.
c. Maximum yearly weighted average ambient temperature 32 Deg. C.
d. Minimum ambient air temperature + 3 Deg. C.

6.2 The temperature rise at the above conditions and at an altitude not exceeding 1000 meters shall be as follows:

By resistance method - 55 Deg. C.
By thermometer - 50 Deg. C.

If the site conditions indicated for a particular job are more severe than the reference ambient temperature mentioned above, the temperature rise shall be suitably scaled such that hot spot temperature shall not exceed the values for the reference conditions.

7. TAP CHANGING DEVICE

On load Tap changing device with local manual & electrical operation shall be provided on HV side. It shall be designed for bi-directional operation and shall have the following steps from –15 % to +5 % in steps of 1.25 % each to give constant secondary voltage of 433 volts.

8. VOLTAGE RATIO

Unless otherwise specified, the transformer shall be suitable for a voltage ratio of 11 KV / 433 V.

9. VECTOR GROUP

The winding connection shall conform to vector group Dyn11 unless otherwise specified.

10. COOLING

Unless otherwise specified, the transformer shall be oil immersed natural air-cooled type (ONAN).

11. ACCESSORIES

a. Oil Conservator Tank:-

1) The conservator tank shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment.

2) The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.

3) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.

4) The conservator tank shall be fitted with flexible diaphragm type.

5) Transformer shall be provided with thermo siphon filters to prolong the life of transformer oil.

b. Oil temperature Indicator (OTI)

The transformers shall be provided with a 150 mm dial thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent potential free alarm and trip contacts. Maximum reading pointer and resetting device shall be mounted in the local control panel. A temperature sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be ± 1% or better.

c. Winding Temperature Indicator:-

A device for measuring the hot spot temperature of the winding shall be provided. It shall comprise the following:-

1) Temperature sensing element.

2) Image Coil.

3) Auxiliary CTs, if required to match the image coil shall be furnished and mounted in the local control panel.

4) 150 mm dial local indicating instrument with maximum reading pointer mounted in local panel and with adjustable electrically independent ungrounded contacts, besides that required for control of cooling equipment, on for high winding temperature alarm and one for trip.

5) Calibration device.

d. Valves

i) Valves shall be of forged carbon steel upto 50mm size and gun metal of cast iron bodies with gun metal fittings for sizes above 50mm. They shall be of full way type with screwed ends and shall be opened by turning counter clockwise when facing the hand wheel. There shall be no oil leakage when the valves are in closed position.

ii) Each valve shall be provided with an indicator to show the open and closed positions and shall be provided with facility for padlocking in either open or closed position. All screwed valves shall be furnished with pipe plugs for protection. Padlocks with duplicate keys shall be supplied along with the valves.

iii) All valves except screwed valves shall be provided with flanges having machined faced drilled to suit the applicable requirements. Oil tight blanking plates shall be provided for each connection for use when any radiator is detached and for all valves opening to atmosphere. If any special radiator valve tools are required, the Supplier shall supply the same.

iv) Each transformer shall be provided with following valves on the tank:-

1) Drain valve so located as to completely drain the tank.

2) Two filter valves on diagonally opposite corners, of 50 mm size.

3) Oil sampling valves not less than 8mm at top and bottom of main tank.

4) One 15 mm air release plug.

5) Valves between radiators and tank.

Drain and filter valves shall be suitable for applying vacuum as specified in the specifications.

e. **Pressure relief Device:-**

The pressure relief device provided shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage of the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. A pair of electrically insulated contacts shall be provided for alarm and tripping.

f. **Oil Sealing:-**

The oil preservation shall be diaphragm type oil sealing in conservator

to prevent oxidation and contamination of oil due to contact with atmospheric moisture.

The conservator shall be fitted with a dehydrating filter breather. It shall be so designed that.

1) Passage of air is through a dust filter & Silica gel.

2) Silica gel is isolated from atmosphere by an oil seal.

3) Moisture absorption indicated by a change in colour of the crystals of the silica gel can be easily observed from a distance.

4) Breather is mounted not more than 1400 mm above rail top level.

g. **Thermo-syphon Filter:-**

To extract the harmful constituents like water, acids etc. from oil, thermo-siphon filter of cylindrical shape with perforated steel trays filled with absorbents such as active alumina should be provided.

The filter assembly shall be mounted on the transformer as well as ground supported and connected with pipes and shut off valves. Suitable instructions required to be followed for commissioning, dismantling and maintenance of filter arrangement, re-generation and storage of the absorbent etc. must be included in the instrumentation manual. A detailed drawing showing internal arrangement shall be submitted.

The oil & absorbent capacity required in the thermo-siphon filter is as under:-

i) Quantity of oil - 1.0% of total oil by weight.

ii) Quantity of absorbent - 0.2% to 0.25% of total oil by weigh.

12. FITTINGS

12.1 The following fittings shall be provided on the transformers:-

1) Conservator with isolating valves, oil filling hole with cap and drain valve. The conservator vessel shall be fitted with constant oil pressure diaphragm oil sealing system.

2) Magnetic type oil level gauge (150 mm dia) with low oil level alarm contacts.

3) Prismatic / toughened glass oil level gauge.

4) Silica gel breather with oil seal and connecting pipe complete with first fill of activated silica gel or alumina mounted at a level of 1300 mm above ground level.

5) Bleeding pipe & testing cock. The test cock shall be suitable for a flexible pipe connection for checking its operation. A 5 mm dia Copper pipe shall be connected from the relay test cock to a valve located at a suitable height above ground level to facilitate sampling of gas with the transformer in service. Interconnection between gas collection box and relay shall also be provided. The device shall be provided with two electrically independent ungrounded contacts, are for alarm on gas accumulation and the other for tripping on sudden oil surge. These contacts shall be wired upto transformer marshalling box. The relay shall be provided with shut off valve on the conservator side as well as on the tank side.

6) Pressure relief devices (including pressure relief valve) and necessary air equalizer connection between this and the conservator with necessary alarm and trip contacts.

7) Air release plugs in the top cover.

8) Inspection cove, access holes with bolted covers of access to inner ends of bushing etc.

9) Winding temperature (hot spot) indicating device for local mounting complete in all respects. Winding temperature indicator shall have three sets of contacts to operate at different settings.

   a) To provide winding temperature ‘high alarm’.

   b) To provide temperature too high ‘trip’.

10) Dial thermometer with pocket for oil temperature indicator with one set of alarm and one set of trip contacts and maximum reading pointer.

11) Lifting eyes or lungs for the top core, core and coil and for the complete transformer.

12) Jacking pads.

13) Haulage lugs

14) Protected type mercury / alcohol in glass thermometer and a pocket to house the same.

15) Top and bottom filter valves on diagonally opposite ends with pad locking arrangement on both valves.

16) Top & bottom sampling valves.

17) Drain valve with pad locking arrangement.

18) Rating and connection diagram plate.

19) Two numbers tank earthing terminals with associated nuts and bolts for connections to purchaser's grounding strip.

20) Bi – directional flagged rollers with locking and bolting device.

21) Marshalling box (MB)

22) Emergency push button for tripping the HT Incomer

23) Shut off valve on both sides of flexible pipe connections between radiator bank & transformer tank.

24) Cooling accessories:

    a) Requisite number of radiator provided with:

        - One shut off valve on top
        - One shut valve at bottom
        - Air release device on top
        - Drain & sampling device at bottom
        - Lifting lungs.

    b) Air release device and oil drain plug on oil pipe connectors.

25) Terminal marking plates for current transformer and main transformer.

26) Oil preservation equipment.

27) LA along with the fittings.

28) Oil temperature indicator

Note:- i) The fittings listed above are indicative and any other fittings which are generally required for satisfactory operation of the transformer are deemed to be included in the quoted price of the transformer.

ii) The contacts of various devices required for alarm & trip shall be potential free and shall be adequately rated for continuous making and breaking current duties as specified.

13. EXPLOSION VENT

Explosion vent or pressure relief device shall be provided of sufficient size for rapid release of any pressure that may be generated within the tank and which might result in damage to the equipment. The device shall operate at a static pressure less than the hydraulic test pressure for transformer tank. Means shall be provided to prevent the ingress of moisture and gas accumulation.

14. RATING AND DIAGRAM PLATES

The following plates shall be fixed to transformer tank in a visible position.

a. A rating plate of weatherproof material bearing the data specified in the appropriate clauses IS: 2026.

b. A diagram plate showing the internal connections and also the voltage vector relationship of the several windings in accordance with IS: 2026 and a plan view of the transformer giving the correct physical relationship of the terminals.

15. JOINTS AND GASKETS

All gaskets used for making airtight joints shall be of proven material such as granulated cork bonded with synthetic rubber gaskets or synthetic rubber.

16. GAS AND OIL ACTUATED (BUCHHOLTZ) RELAYS

16.1 Buchholz relay shall be provided for the transformers.

16.2 Oil actuated relay equipment shall conform to IS: 3637 and shall be double float type having contacts which close following oil surge or under incipient fault conditions.

16.3 Each gas and oil actuated relay shall be provided with a test cock to take a flexible pipe connection or checking the operation of the relay.

16.4 To allow the gas to be collected at ground level, a pipe approximately 5mm inside diameter shall be connected to the release cock of the gas and oil actuated relay and brought down to a point approximately 1.25 m above ground level, where it shall be terminated by a cock. A machined surface shall be provided on the top of each relay to facilitate the setting of the relays and to check the mounting angle in the pipe and the cross level of the relay.

16.5 The design of the relay mounting arrangements, the associated pipe work shall be such that mal-operation of the relays shall not take place under normal service. The pipe work shall be so arranged that all gas arising from the transformer shall pass

through the gas and oil-actuated relay. The oil circuit through the relay shall not form a delivery path in parallel with any circulating oil pipe, nor shall it be tied into, or connected through, the pressure relief vent. Sharp bends in the pipe work shall be avoided.

16.6 All wiring connections, readily wired upto Marshalling box terminal boards, fuses and links etc. connected with gas actuated relays shall be suitable for tropical atmosphere. Any wiring liable to be in contact with shall have oil resisting insulation and the bared ends of stranded wire shall be sealed together to prevent creepage of oil along the wire. There shall be no possibility of oil entering connection boxes used for cables or wiring.

17. CABLE BOX

Cable box shall not be mounted on the tank covers. It shall be feasible to remove the tank covers for inspection during maintenance etc. without recourse to breaking the joints or disturbing the cables already terminated.

18. SPECIFIC TECHNICAL REQUIREMENTS (STANDARD CONDITIONS)

1.	Rated MVA (ONAN rating)	:	630 KVA
2.	No. of Phase	:	3
3.	Type of Installation	:	Outdoor
4.	Frequency	:	50 Hz
5.	Cooling medium	:	Insulation oil
6. a) b)	Rated voltage:- High Voltage winding Low voltage winding	 : :	 11 KV 433 V
7. a) b)	Highest continuous system voltage: HV Side LV Side	 : :	 12 KV 433 V
8.	Type of tap changer	:	On Load
9.	Range of tapping	:	+5 % to –15 % in steps of 1.25 %
10.	Neutral terminal to be brought out	:	On LV side only
11.	Impedance on rated MVA base at 75 Dec. C.	:	As per CBIP manual or as specified by the utility.
12.	Type of insulation and insulation level	:	‘A’ Class; Uniform
13.	Impulse withstand test voltage (KV peak) & Power frequency withstand test voltage (KV rms)	:	75 & 28

14. a) b)	Winding connection HV Side LV Side	 : :	 Delta Star
15.	Winding material	:	Electrolytic Copper
16.	Vector Group	:	Dyn11
17.	Type of cooling	:	ONAN
18.	Neutral earthing	:	LV neutral shall be solidly earthed.
19.	Neutral current transformer	:	One No. 1 Core CT shall be provided in the neutral circuit of LV side of the transformer. The CT secondary shall be wired out to the Transformer panel. This shall be for REF protection.
20.	Winding temperature indicator	:	One No.
21.	Oil temperature indicator	:	One No.

19. **Marshalling Box**

A metal enclosed, weather, vermin and dust proof marshalling box fitted with required glands, locks, glass door, terminal board, heater with switch, illumination lamp with switch etc. shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have a degree of protection of IP 55 as per IS: 2147. Schematic drawing of the wiring including external cables shall be put under the propane sheet on inside door of the transformer marshalling box.

20. **Capitalization of Losses**

The capitalization of guaranteed losses of the transformer shall be calculated and considered with evaluation of the bids. The guaranteed values of no load losses and load losses shall be stated in the bid.

21. **PERFORMANCE**

i) Transformer shall be capable of withstanding for two seconds without damage to any external short circuit, with the short circuit MVA available at the terminals.

ii) The maximum flux density in any part of the core and yoke, voltage and frequency shall be such that the flux density under 12.5% over voltage conditions shall not exceed 1.9 Tesla.

iii) Transformer shall under exceptional circumstances due to sudden disconnection of the load, be capable of operating at the voltage approximately 25% above normal rated voltage for a period of not exceeding one minute and 40% above normal for a period of 5 seconds.

iv) The transformer may be operated continuously without danger on any particular tapping at the rated KVA plus minus 12.5% of the voltage corresponding to the tapping.

v) The thermal ability withstand short circuit shall be demonstrated by calculation.

vi) With combined voltage variation of +12.5% and frequency variation of –5% the flux density shall not exceed 1.9 Tesla.

vii) Transformer shall be capable of withstanding thermal and mechanical stress caused by any symmetrical and asymmetrical faults on any winding.

22. **MISCELLANEOUS:-**

i) Padlocks along with duplicate keys as asked for various valves, marshalling box etc., shall be supplied by the Supplier wherever locking arrangement is provided.

ii) Foundation bolts for wheel locking devices of transformer shall be supplied by the Supplier.

23. **TESTS**

The transformer shall be subjected to the following routine tests at the manufacturer's works before dispatch.

a) Measurement of winding resistance.

b) Voltage ratio, polarity and phase relationship.

c) Measurement of impedance voltage at extreme & principal taps.

d) Load losses at extreme & principal taps. (Copper loss)

e) No load losses and no load current at 90, 100 & 110 % . (Iron loss)

f) Induced over voltage withstand.

g) Separate source voltage withstand.

h) Dielectric test

i) Insulation resistance

j) Oil leakage test

The quoted rate for the transformer shall include all routine tests to be carried out at the manufacturer's works and all routine tests to be carried out at site as per specifications. The supplier shall quote separately for type/special tests as detailed below which shall be carried out only on the written instructions of Engineer in charge otherwise test certificates for them shall be furnished.

a) Temperature Rise test

b) Tan delta & Capacitance test

c) Magnetic balance test

d) Measurement of Harmonic

e) Dynamic short circuit test (Prototype Test certificate only)

24. PRECOMMISSIONING TESTS

1.	General inspection	a)	Control and relay panels, etc.
		b)	Junction boxes and marshalling kiosks.
		c)	Transformer oil HV test to withstand 12 KV
2.	Secondary injection		On all transformer protection relays
3.	Primary injection (also to be repeated at the end of all other commissioning tests)	a)	Tests on operation and stability of earth fault relays on high voltage side.
		b)	Test on over current relays on low voltage side.
		c)	Tests on operation and stability of earth fault relays on low voltage side.
		d)	Tests on operation of standby earth fault relays on low voltage side.
		e)	Tests on over current relay on high voltage side (when current transformers are not in transformer bushings)
		f)	Voltage compensation.
4.	Ratio tests	a)	With 415 V applied on high voltage side, measure the voltage between all phases on the low-voltage side.
		b)	To check phasing, measures volts: A to a, b and c B to a, b and c

			C to a, b and c Where A, B and C are the terminals of three phases on high voltage side and a, b and c are the corresponding terminals on low voltage side.
		c)	Magnetic balance test.
5.	Tripping tests	a)	High voltage.
		b)	Low voltage
		c)	Inter-tripping tests.
		d)	Winding temperature trips.
6.	Calibrate earthing resistance		
7.	Tap changing tests to check mechanism, indication, buzzer, lamp etc.		
8.	Insulation tests	a)	On high voltage and low voltage windings.
		b)	On current and voltage transformers, circuits etc.
9.	See that neutral earthing switches are closed before making alive.		
10.	Check transformers on equal	a)	For transformers in a taps before switching in bank.
11.	Set down relays before closing I advise control.		
12.	Load tests	a)	Voltmeter, ammeters etc. on both high and low voltage side.
		b)	Over current.
		c)	No spill in high voltage star point.
		d)	No creeping of contacts on both high and low voltage earth fault relays.
		e)	Voltage on relays.
13.	Advise control of any new equipment.		
14.	Low voltage excitation current.		
15.	Single phase, magnetic balance test.		

The power frequency test voltage for the secondary winding shall be 2.5 KV rms. The transformer shall be charged only after the tests are conducted and approval of all concerned local authorities obtained.

25. CONTROL CONNECTIONS & INSTRUMENT AND WIRING TERMINAL BOARD AND FUSES.

1. Normally no fuses shall be used anywhere. Instead of fuses, MCBs (both in AC & DC circuits) shall be used. Only in case where a MCB cannot replace a fuse due to system requirements, a HRC fuse can be accepted.

2. All wiring connection, terminal boards, fuses/MCBs and links shall be suitable for tropical atmosphere. Any wiring liable to be in contact with oil shall have oil resisting insulation and the bare ends of stranded wire shall be sweated together to prevent seepage of oil along the wire.

3. Panel connections shall be neatly and squarely fixed to the panel. All instruments and panel wiring shall be run in PVC or non – rusting metal cleats of the compression type. All wiring to a panel shall be taken from suitable terminal boards.

4. Where the conduits are used, the runs shall be laid with suitable falls and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

5. When 400 volt connections are taken through junction boxes or marshalling boxes, they shall be adequately screened and 400 volts Danger Notice must be affixed to the outside of the junction boxes or marshalling box. Proper colour code for Red, Yellow, Blue wires shall be followed.

6. All box wiring shall be in accordance with relevant IS. All wiring shall be of standard copper (48 strands) of 1100 Volt grade and size not less than 2.5 sq.mm.

7. All wires on panels and all multi – core cables shall have ferrules, for easy identifications, which bear the same number at both ends, as indicated in the relevant drawing.

8. At those points of interconnection between the wiring carried out by separate Suppliers, where a change of number can not be avoided double ferrules shall be provided on each wire. The change of numbering shall be shown on the appropriate diagram of the equipment.

9. The same ferrule number shall not be used on wire in different circuits on the same panels.

10. Ferrules shall be of white insulation material and shall be provided with glossy finish to prevent the adhesion of dirt. They shall be clearly and durably marked in Black and shall not be affected by dampness or oil.

11. Stranded wire shall be terminated with tinned Ross Courtney terminals, claw washers or crimped tubular lugs. Separate washers shall be suited to the size of the wire terminated. Wiring shall, in general be accommodated on the sides of the box and the wires for each circuit shall be separately grouped. Back of panel wiring shall be arranged so that access to the connecting items of relay and other apparatus is not impeded.

12. All circuits in which the voltage exceeds 125 volts, shall be kept physically separated from the remaining wiring. The function of each circuit shall be marked on the associated terminal boards.

13. Where apparatus is mounted on panels all metal cases shall be separately earthed by means of stranded (48 nos.) copper wire of strip having a cross section of not less than 2 sq.mm where strip is used, the joints shall be sweated. The copper wire shall have green coloured insulation for earth connections.

14. All wiring diagram for control & relay panel shall preferably be drawn as viewed from the back and shall show the terminal boards arranged as in services.

15. Terminal block rows should be spaced adequately not less than 100 mm apart to permit convenient access to external cables and terminations.

16. Terminal blocks shall be place with respect to the cable gland (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multi-core cable tails.

17. Terminal block shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shall be such as to give adequate protection while allowing easy access to terminals. The terminals shall be adequately protected with insulating dust proof covers. No live metal shall be exposed at the back of the terminal boards. CT terminal shall have shorting facilities. The terminals for CTs should have provision to insert banana plugs and with isolating links.

18. All interconnecting wiring as per the final approved scheme between accessories of transformer and marshalling box is included in the scope of this specification and shall be done by the transformer supplier.

19. The schematic diagram shall be drawn and fixed under a transparent prospane sheet on the inner side of the marshalling box cover.

20. To avoid condensation in the marshalling box, a space heater shall be provided with an MCB and thermostat.

21. Suitable 11W, CFL light shall be provided in the marshalling box for lighting purpose.

26 RADIO INTERFERENCE AND NOISE LEVEL

Transformer shall be designed with particular care to suppress at least the third & fifth harmonic voltage so as to minimize interference with communication circuits. Transformer noise level, when energized at normal voltage and frequency shall be as per NEMA stipulations.

27 PERFORMANCE

The performance of the transformer shall be measured on the following aspects:-

i) The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variation of ± 10% corresponding to the voltage of tapping.

ii) The maximum flux density in any part of the cores and yokes at normal voltage and frequency shall be such that the flux density on any tap position with + 12.5% voltage variations and –5% frequency variations shall not exceed 1.9 weber /sq.m.

iii) Radio interference and Noise level.

iv) The transformer shall be designed with particular attention to the suppression of third and fifth harmonics so as to minimize interference with communication circuits.

28 FAULT CONDITIONS

i) The transformer shall be capable of withstanding for two (2) seconds without damages any external short circuit to earth.

ii) Transformer shall be capable of withstand thermal and mechanical stresses conveyed by symmetrical or asymmetrical fault on any winding.

iii) The method of test loading shall be described in the test report for determination of both average and hottest spot temperature. Where the winding temperature equipment is specified, data shall also be included for calibration of hottest spot temperature indicator.

iv). Resistance of each winding of each phase shall be measured at principal and at all the taps and corrected to 75 Dec. C.

v) Impedance voltage shall be measured at principal and at all taps.

vi) No load loss measurement at 415 volt.

vii) Certified test report and oscillogram shall be furnished to the purchase / Consultant for evaluation as per the schedule of distribution of documents. The Supplier shall also evaluate the test result and rectify the defects in the equipment based on his and the purchaser's evaluations of the test without any extra charges to the purchaser. Manufacturer's test certificates in respects of all associates auxiliary and ancillary equipment shall be furnished.

viii) The bidder shall state in his proposal the testing facilities available at his works. Incase full testing facilities are not available, the bidder shall state the method proposed to be adopted so as to ascertain the transformer characteristics corresponding to full capacity testing.

30 WITNESSING OF TESTS AND EXCESSIVE LOSSES

i) The purchaser and / or his representative reserve the right to witness any or all tests or to accord waiver at its sole discretion.

ii) The purchaser reserves the right to reject the transformer if losses exceed the declared losses beyond tolerance limits as per IS or if temperature rise of oil and winding exceed the values specified elsewhere.

31 CAPITALISATION OF LOSSES

31.1 LOSSES

Transformer with lower losses shall be preferred. The bidder shall indicate the value of load and no load losses of the transformer in his bid. He shall indicate whether losses are firm or subject to tolerance. If nothing is indicated regarding tolerance on losses, it will be considered that losses are firm. In case no ceiling is specified these will be taken as per IS and there after shall be loaded as per table 7 of latest issue of IS: 2026 Part – I.

The no load loss in KW at the rated voltage and frequency and the load loss in KW at rated voltage, rated frequency, rated output and at 75 degree centigrade shall be quoted and these figures shall be guaranteed.

31.3 REJECTION

The purchaser may reject any transformer if during tests or service any of the following conditions arise:

i) No load loss exceeds the guaranteed value by 20% or more.
ii) Load loss exceeds the guaranteed value by 205 or more.
iii) Impedance value exceeds the guaranteed value by $\pm$ 10% or more.
iv) The difference in impedance values of any two phases during single phase short circuit impedance test exceeds 2% of the average value guaranteed by the vendor.
v) Oil or winding temperature rise exceeds the specified value.
vi) Transformer fails on impulse test.
vii) Transformer fails on power frequency voltage withstand test.
viii) Transformer is proved to have been manufactured not in accordance with the agreed specification.

32 SPARE PARTS

In case the manufacturer goes out of production of spare parts, then he shall make available the drawings of spare and specification of materials at no extra cost to the client to fabricate or procure spare parts from other sources.

32.1 COMPLETENESS OF EQUIPMENT

i) All fittings and accessories, which may not be specifically mentioned in the specification but which are necessary.

iii) All deviations from this specification shall be separately listed under the requisite schedules in the absence of which it will be presumed that all the provisions of the specification are complied with by the bidder.

33 ON LOAD VOLTAGE CONTROL

33.1 The transformer shall be provided with OLTC equipment for varying its effective transformation ratio without phase displacement. The tap range shall be +5% to -15 % with steps of 1.25% on HV winding for adjustment of output voltage of LV side with variation HV input.

33.2 Each OLTC shall have local manual and local electrical control.

33.3 The cranking device for manual operation of OLTC gear shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with mechanical tap position indicator which shall be clearly visible from near the transformer; mechanical operation counter and mechanical stoppers to prevent over cranking of the mechanism beyond the extreme position

33.4 The manual control considered as backup to the motor operated tap control shall be interlocked with the motor to block motor start up during manual operation. The manual operating mechanism shall be labeled to show the direction of operations for raising the secondary voltage and vice-versa.

33.5 The equipment shall be suitable for supervisory control and indication. A multi-way switch (make before break after) having one fixed contact for each taps position shall be provided. Supervisory indication for "TAP CHANGE INCOMPLETE" shall also be provided.

33.6 Only one tap change shall be completed at a time and control switch must return to off position for the next operation.

33.7 The equipment shall be such as to ensure that once a tap change has been initiated it shall be completed independently of the operation of control relays & switches.

33.8 Adequate safeguard shall be provided for the transformer and auxiliary equipment in case of auxiliary supply failure leaving the tap change incomplete.

33.9 The mechanical and electrical indication of the number of tap in use shall be provided at the transformer.

33.10 All control and indicating gear shall be designed for 415 V, 3 phase, 4 wires and 50Hz supply subject to a variation of + 10% to – 20%.

33.11 Limit switches shall be provided in the circuit of motor to prevent over running of mechanism beyond minimum and maximum tap position in addition to a mechanical stop.

33.12 The motor and control circuit shall be provided with thermal protection. All relays fuses and switches shall be mounted in marshalling box or driver gear housing and clearly labeled.

33.13 A five digit counter shall be fitted to indicate the number of operations completed by the tap changer.

33.14 The main tap changing equipment shall be transition resistance type oil immersed. These oil compartments which contain current making or breaking contacts shall be kept under the conservator head by means of a pipe connection from the highest point of compartment to conservator tank and controlled by suitable value. Any gas generated in it shall pass through single float gas and oil surge actuated relay to trip the transformer controlling current breaker in the event of a fault in the OLTC tank mechanism. The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.

33.15 The oil in the current interrupting or making chamber shall not come in contact with oil in the main transformer tank or other than non-current interruption chamber.

33.16 Each compartment that is not maintained under the conservator head shall be provided with prismatic oil gauge.

33.17 A permanently legible lubricating chart shall be put in the driving mechanism chamber.

33.18 The following type and routine test shall be carried out on the On load tap changer and motor driven mechanism in accordance with IS: 8468 – 1977 or its latest version.

34 TESTS: ON LOAD TAP CHANGER

TYPE TESTS

Type test shall be performed on the samples of the relevant tap changer or components after their final development. The following shall constitute the type test.

i) Mechanical test
ii) Auxiliary Circuit insulation test.
iii) Tests for temperature rise of contacts.
iv) Switching tests.
v) Short circuit test.
vi) Transition impedance test.
vii) Mechanical life test.
viii) Di-electric test.

ROUTINE TESTS

The following shall constitute the routine test.

i) Mechanical test
ii) Auxiliary Circuit insulation test.
III) Di-electric test.

MOTOR DRIVEN MECHANISM

TYPE TESTS

The following shall constitute the type test.

a) Mechanical tests
b) Auxiliary circuit insulation test.
c) Mechanical load test.
d) Over run tests.
e) Protection of Motor Driver Cubicle.

ROUTINE TESTS

The following shall constitute the routine tests.

a) Mechanical tests
b) Auxiliary circuit insulation tests.

35 DRAWINGS AND INFORMATION

The vendor shall furnish following drawings/documents in accordance with enclosed requirement.

a) General arrangement of Transformer.
b) General arrangement of HV cable box with connection diagram.
c) General arrangement of LV cable box and connection arrangement.
d) General arrangement of marshalling box and wiring diagram.
e) Rating and diagram plate indicating % impedance etc.
f) Type tests certificates and guaranteed technical parameters.

36 QUALITY ASSURANCE PROGRAM

Quality Assurance Program shall follow the requirements of Owner/ Consultant as applicable.

Quality Assurance Program involvement will commence at enquiry and follow through to completion and acceptance thus ensuring total conformity to Purchaser's requirements.

37 DEVIATIONS

Deviation from specification must be stated in writing at the quotation stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.

TECHNICAL PARTICULARS

- 1.1 Name of the Manufacturer :
- 1.2 Service :
- 1.3 Rated MVA :
- 1.4 No. of Phase :
- 1.5 Type of Installation :
- 1.6 Frequency :
- 1.7 Type of Cooling :
- 1.8 Rated voltage:

High Voltage winding :

Low Voltage winding :

- 1.9 Highest continuous system voltage:

HV Side :

LV Side :

- 1.10 Rated nominal current at
Ambient temp., Amps/ ^{0} C :

- 1.11 Derating factor for specified 50 ^{0} C
Ambient temp. and
site condition (if any) :

- 1.12 Temperature rise above
50 ^{0}C ambient :

- 1.13 Type of tap changer :
- 1.14 Range of tapping and No. of steps :
- 1.15 Impedance voltage on rated MVA
ONAN/ONAF base at 75 deg.C, % :

– 1.16 Type of insulation and insulation level :

– 1.17 Impulse withstand voltage, KV (peak) :

– 1.18 Power frequency withstand voltage, KV (rms) :

– 1.19 Total loss at rated voltage at principal tapping and rated frequency :

– 1.20 No load loss at rated voltage at principal tapping and rated frequency :

– 1.21 Load loss at rated current at 75 deg.C :

– 1.22 No load current at rated voltage and rated frquency :

– 1.23 Efficiencies at 75 deg.C at unity pf:
a) At full load, % :
b) At ¾ full load, % :
c) At ½ full load, % :

– 1.24 Regulation at full load at 75 deg.C:
a) At unity pf, % :
b) At 0.8 pf lagging, % :

– 1.25 Approximate masses:

a) Core and windings, kg :

b) Tank, fittings and accessories :

c) Oil :

d) Total mass :

– 1.26 Approx. quantity of oil required for first filling :

– 1.27 Approx. overall dimensions:
a) Length :

b) Breadth :

c) Height :