CLAUSE NO.	TECHNICAL REQUIREMENTS
2.04.00	PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.
2.05.00	The cable cores shall be laid up with fillers between the cores wherever necessary. It shall not stick to insulation and inner sheath. All the cables, other than single core unarmoured cables, shall have distinct extruded PVC inner sheath of black colour as per IS : 5831.
2.06.00	For multicore armoured cables, the armouring shall be of galvanised steel as follows :-

	Calculated nominal dia of cable under armour	**Size and Type of armour**
1)	Upto 13 mm	1.4mm dia GS wire
2)	Above 13 upto 25 mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
3)	Above 25 upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
4)	Above 40 upto 55mm	1.4 mm thick GS formed wire/ 2.5mm dia GS wire
5)	Above 55 upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
6)	Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The gap between armour wire / formed wire shall not exceed one armour wire / formed wire space and there shall be no cross over / over-riding of armour wire / formed wire. The minimum area of coverage of armouring shall be 90%. The breaking load of armour joint shall not be less than 95% of that of armour wire / formed wire. Zinc rich paint shall be applied on armour joint surface.

2.07.00 Outer sheath shall be of PVC(grade as applicable) and grey in colour . In addition to meeting all the requirements of Indian standards referred to, outer sheath of all the cables shall have the following FRLS properties.

(a) Oxygen index of min. 29 (As per IS:10810 (part-58))

(b) Acid gas emission of max. 20% (As per IEC-754-I).

(c) Smoke density rating shall not be more than 60% during Smoke Density Test as per ASTMD-2843.

2.08.00 Cores of the cables of upto 5 cores shall be identified by colouring of insulation. Following colour scheme shall be adopted.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	1 core - Red, Black, Yellow or Blue 2 core - Red & Black 3 core - Red, Yellow & Blue 4 core - Red, Yellow, Blue and Black 5 core - Red, Yellow, Blue, Black and Grey
2.09.00	For cables having more than 5 cores, core identification shall be done by numbering the insulation of cores sequentially, starting by number 1 in the inner layer (e.g. say for 10 core cable, core numbering shall be from 1 to 10). The number shall be printed in Hindu-Arabic numerals on the outer surfaces of the cores. All the numbers shall be of the same colour, which shall contrast with the colour of insulation. The colour of insulation for all the cores shall be grey only. The numerals shall be legible and indelible. The numbers shall be repeated at regular intervals along the core, consecutive numbers being inverted in relation to each other. When the number is a single numeral, a dash shall be placed under neath it. If the number consists of two numerals, these shall be disposed one below the other and a dash placed below the lower numeral. The spacing between consecuture numbers shall not exceed 50 mm.
2.10.00	In addition to manufacturer's identification on cables as per IS, following marking shall also be provided over outer sheath : (a) Cable size and voltage grade - To be embossed (b) Word 'FRLS' at every 5 metre - To be embossed (c) Sequential marking of length of the cable in metres at every one metre. - To be embossed / printed. The embossing / printing shall be progressive, automatic, in line and marking shall be legible and indelible.
2.11.00	All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part -3.
2.12.00	Allowable tolerances on the overall diameter of the cables shall be +\-2 mm maximum over the declared value in the technical data sheets.
2.13.00	In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.
2.14.00	**Cable selection & sizing**
2.14.01	LT Control cables shall be sized based on the following considerations: (a) Rated current of the equipment

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(b) The voltage drop in the cable, during motor starting condition, shall be limited to 10% and during full load running condition, shall be limited to 3% of the rated voltage (c) Short circuit withstand capability This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let out energy of the fuse.For breaker controlled feeder, cable shall be capable of withstanding the system fault current level for total breaker tripping time inclusive of relay pickup time. (d) The minimum size of conductor shall be 1.5 sqmm
2.14.02	Derating Factors Derating factors for various conditions of installations including the following shall be considered while selecting the cable sizes: a) Variation in ambient temperature for cables laid in air b) Grouping of cables c) Variation in ground temperature and soil resistivity for buried cables.
2.14.03	Cable lengths shall be considered in such a way that straight through cable joints are avoided.
2.14.04	Cables shall be armoured type if laid in switchyard area or directly buried.
3.00.00	**CONSTRUCTIONAL FEATURES**
3.01.00	**1.1 KV Grade Control Cables** Control Cables shall have stranded copper conductor multicore PVC insulated, PVC inner-sheathed , armoured / unarmoured, PVC outer-sheathed conforming to IS:1554. (Part-I).
3.02.00	**Cable Drums** (a) Cables shall be supplied in non returnable wooden or steel drums of heavy construction. The surface of the drum and the outer most cable layer shall be covered with water proof layer. Both the ends of the cables shall be properly sealed with heat shrinkable PVC/ rubber caps secured by 'U' nails so as to eliminate ingress of water during transportation, storage and erection. Wood preservative anti-termite treatment shall be applied to the entire drum. Wooden drums shall comply with IS : 10418. (b) Each drum shall carry manufacturer's name, purchaser's name, address and contract number, item number and type, size and length of cable and net

CLAUSE NO.	TECHNICAL REQUIREMENTS
	gross weight stencilled on both the sides of the drum. A tag containing same information shall be attached to the leading end of the cable. An arrow and suitable accompanying wording shall be marked on one end of the reel indicating the direction in which it should be rolled.
4.00.00	**TESTS**
4.01.00	**GENERAL**
	1.0 All equipments to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
	2.0 In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.
	3.0 All acceptance and routine tests as specified below and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
4.02.00	**TYPE TESTS:**
4.02.01	The Type tests reports for the following shall be submitted for one size each of LT control cable :
	S. No. Type Test — **Remarks**
	a) **For Conductor**
	1. Resistance test
	b) **For Armour Wires / Formed wires**
	2. Measurement of Dimensions
	3. Tensile Test
	4. Elongation test
	5. Torsion test — For round wire only
	6. Winding test — For Formed wires

CLAUSE NO.	TECHNICAL REQUIREMENTS		
	7. Resistance test		
	8. Zinc Coating test	For G.S. conductors only.	
	c) **For PVC insulation & PVC Sheath**		
	9. Test for thickness		
	10. Tensile strength and elongation test before ageing and after ageing		
	11. Ageing in air oven		
	12. Loss of mass test	For PVC insulation and sheath only	
	13. Hot deformation test	For PVC insulation and sheath only	
	14. Heat shock test	For PVC insulation and sheath only	
	15. Shrinkage test		
	16. Thermal stability test	For PVC insulation and sheath only	
	17. Oxygen index test	For outer sheath only	
	18. Smoke density test	For outer sheath only	
	19. Acid gas generation test	For outer sheath only	
	d) **For completed cables**		
	20. Insulation resistance test (Volume resistivity method)		
	21. High voltage test		
	23. Flammability test as per IEC - 332 Part-3 (Category-B)		
4.02.02	**Acceptance Tests** (as per QA table)		
4.03.00	**Routine Tests** (as per QA table)		

CLAUSE NO.	TECHNICAL REQUIREMENTS
	CABLING, EARTHING & LIGHTNING PROTECTION
1.00.00	**CODES AND STANDARDS** IS:2309, IEEE:142, IEEE-80, IS:1255, IS:3043, IS:8309
2.00.00	**REQUIREMENTS**
2.01.00	The complete cable support system shall be supplied and installed for the entire work is in the bidder's scope. The system shall enable proper laying of all power, control, instrumentation and telephone cables, and shall provide necessary mechanical protection, ventilation and segregation for them as per latest engineering practices and cable manufacturers' recommendation .The cable installation shall be carried out as per IS:1255. All hardware and anchoring arrangement shall be included. All steel members shall be hot dip galvanised

CLAUSE NO.	TECHNICAL REQUIREMENTS
1.00.00	**ELECTRIC ACTUATORS WITH INTEGRAL STARTERS**
1.01.00	**TYPE:**
1.01.01	The actuators shall have integral starters along with over load relays with built in SPP (Single Phasing Preventer). A 415, 3 phase 3 wire power supply shall be given to the actuator from vendor's/employer's switch board as applicable through a switch fuse unit. Control voltage of the motor starter shall be 110 V AC / 24 V DC, derived suitably from 415V power supply.
1.01.02	In case supplier's standard control voltage for Open/Close contactors is 110V AC, the same is acceptable if suitable Opto Isolation circuit is provided with coupling relays for 24 V DC command inputs.
1.02.00	**INTERFACES:**
1.02.01	Open/Close command termination logic with position & torque Limit Switches, positioner circuit shall be suitably built in the PCB inside the actuator. (a) For Binary Drive (both ON-OFF and INCHING type) :- Open/Close command & status thereof and disturbance monitoring signal (common contact for Overload, Thermostat, control supply failure, L/R selector switch at local & other protections operated) shall be provided. Interface with the control system shall be through hardware signal only. Inter posing relays provided (with coil burden 2.5 VA) in the actuator shall be energized to initiate opening and closing, by 24V DC signal from the external control system. (b) For Modulating Drive:- the command to actuator shall be in form of 4-20mA signal. The necessary positioning circuit and motor protection shall be provided (c) Open/close command termination logic shall be suitably built inside actuator.
1.03.00	**RATING :** (a) Supply Voltage & frequency: 415V +/- 10%, 3 Phase, 3 Wire 50HZ +/-5%. (b) Sizing:- For Open/Close at rated speed against designed differential pressure at 90% of rated voltage. For isolating service:- three successive open-close operations or 15 mins, whichever is higher. For regulating service 150 starts per hour or required cycles, whichever is higher.

CLAUSE NO.	TECHNICAL REQUIREMENTS
1.04.00	**CONSTRUCTION:** (a) Enclosure: Totally enclosed weatherproof minimum IP-55 degree of protection. (b) Gear Train : Metal (Fibre gears are not acceptable) self-locking to prevent drift under torque switch (where ever applicable) spring pressure when motor is de-energised. (c) Manual Wheel: Shall disengage automatically during motor operation.
1.05.00	**MOTOR :** (a) Type : Squirrel cage induction motor suitable for Direct On Line (DOL)starting. (b) Enclosure: Totally enclosed, self ventilated IP-55 degree of protection. (c) Insulation Class B or better. Temperature rise 70 Deg C. over 50 Deg C ambient (d) Bearings: Double shielded, grease lubricated antifriction. (e) Earth Terminals: Two (f) Protection: Single Phasing Protection, Over heating protection through Thermostat and wrong phase sequence protection shall be provided over and above other protection features standard to bidder's design Suitable means shall be provided to diagnose the type of fault locally.
1.06.00	**POSITION/TORQUE SWITCHES:**
1.06.01	Four nos. (2 each in open and close position) position limit switches and two nos. (one in open and other in close direction) torque switches each having two nos. NO and two nos. NC contacts shall be provided. A single shaft shall actuate all contacts of limit switches at each position.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	Limit switch and disturbance signals shall be available to DCS even when the power supply to the actuators is not available. Torque switches shall be bypassed in both the end positions with the other end Limit switches. **Limit switches** Limit switches shall be Silver plated with high conductivity and non –corrosive type. Contact rating shall be sufficient to meet the requirement of Control System subject to a minimum of 60 V, 6 VA rating. Protection class shall be IP-55.
1.07.00	**LOCAL OPERATION:**
1.07.01	It shall be possible to operate the actuator locally also. Lockable local/remote selection shall be provided on the actuator.
1.08.00	**POSITION INDICATOR :**
1.08.01	To be provided for 0 to 100% travel.
1.09.00	**POSITION TRANSMITTER (FOR MODULATING/INCHING TYPE) :**
1.09.01	As required. Suitable for stabilized 4-20 mA signal, 2 wire inductive type, 24 volts DC operated.
1.10.00	**WIRING :**
1.10.01	Suitable voltage grade copper wire.
1.11.00	**TERMINAL BOX :** (i) 9 pin plug and socket (1 no. per actuator to suit 4 pair 0.5 sq.mm. copper overall shielded (16 mm OD), instrumentation cable) suitably mounted in the starter box itself to terminate open/close command and status feedback signals with external control systems. (ii) Additional one number 9 pin plug and socket (to suit 4 pair 0.5 sq.mm copper (16 mm OD) individual and overall shielded instrumentation cable) suitably mounted in the starter box itself for actuators with 4-20 mA position transmitters. (iii) Necessary glands for power cables shall be provided.
1.12.00	**TERMINAL BLOCK :**
1.12.01	650V grade. For power cables.
1.13.00	**SPACE HEATER :**
1.13.01	Space heater of suitable rating. The supply shall be derived from the main power supply available in the actuator.

CLAUSE NO.	TECHNICAL REQUIREMENTS
1.14.00	**TYPICAL WIRING DIAGRAM :**
1.14.01	Refer Tender Drawing No. 0000-999-POI-A-063.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	LIGHTING
1.00.00	**GENERAL**
1.01.00	This specification covers the general description of design, manufacture and construction features, testing, supply, installation and commissioning of the Station Lighting system equipment.
2.00.00	**CODES AND STANDARDS**
2.01.00	All standards and codes of practice referred to herein shall be the latest edition including all applicable official amendments & revisions as on date of bid opening. In case of conflict between this specification and those (IS codes, standards etc.) referred to herein, the former shall prevail. All work shall be carried out as per the following standards & codes.
2.02.00	Lighting Fixtures and Accessories IS:1913 General and safety requirements for luminairies. IS:2148 Flame proof enclosures of electrical apparatus.
2.03.00	Lighting Panels, Switch-boxes, Receptacles and Junction Boxes IS:2147 Degree of protection provided by enclosures for low-voltage switchgear and control gear.
2.04.00	Electrical Installation Practices & Miscellaneous IS:1944 Code of practice for lighting of public thorough fare IS:3646 Code of practice for interior illumination. IS:5572 Classification of Hazardous areas (other than Mines)having flammable gases and Vapours for electrical installation IS:6665 Code of practice for industrial lighting. National Electrical Code Indian Electricity Rules. Indian Electricity Act
3.00.00	**DESIGN PHILOSOPHY**
	1. A comprehensive illumination system shall be provided for the Hydrogen plant

CLAUSE NO.	TECHNICAL REQUIREMENTS

2. All lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.

3. In the Off site area / buildings DC lighting shall be provided by self-contained 4hours duration Emergency lighting fixtures. Each shall be provided with Ni-cd battery, battery Charger & 2x10 W flourescent lamps

4. The system shall include distribution boards, normal/ emergency lighting panels, lighting fixtures, junction boxes, receptacles, switch boards, conduits, cables and wires, etc. The system shall cover all interior and exterior lighting such as area lighting. The constructional features of lighting distribution boards shall be similar to AC/DC distribution boards described in chapter of LT Switchgear. Outgoing circuits in LPs shall be provided with MCBs of adequate ratings.

5. The illumination system shall be designed on the basis of best engineering practice and shall ensure uniform, reliable, aesthetically pleasing and glare free illumination. The diffusers/ louvres used in fluorescent fixtures shall be made of impact resistant polystyrene sheet and shall have no yellowing property over a prolonged period.

6. Apart from maintenance factor as given below, Temperature correction factor shall be considered in the lighting design for flourescent fixtures located in non air conditioned area. Similarly the correction factor towards ageing of lamps , as recommended by the lamp manufacturer shall also be considered in the lighting design.

   (a) Office area airconditioned : 0.8

   (b) Office area non airconditioned and other indoor area : 0.7

   (c) Dust prone and outdoor area : 0.6

7. All outdoor fixtures shall be weather proof.

8. Wires of different phase shall normally run in separate conduit.

9. Power supply shall be fed from 415 / 240 V normal AC supply, through suitable number of conveniently located lighting distribution boards (LDB) and lighting panels (LP). AC lighting supply shall be isolated from main supply by isolation transformers of max. rating of 100KVA and fault level restricted to 3 KA at Lighting Panels.

10. Atleast one 6/16A, 240V AC universal socket outlet with switch shall be provided in offices, cabins, etc. 20A, 240V AC industrial receptacle with switch shall be provided strategically in all industrial area. Suitable number of 63A,3ph., 415V AC industrial receptacles shall be provided for entire plant for welding purposes, particularly near all major equipment and at an average distance of 50m. Atleast one 63A,3ph.,415V AC receptacle shall be provided in each off site building.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	11. Average lux level of 150 lux shall be maintained in hydrogen plant .The type of fixtures, LP, JB, and receptacle used in Hydrogen generation plant building shall be suitable for group-IIC as per IS:2148 or Class-I division-II as per NEC.
3.01.00	**Ballasts**
	(a) All HPSV and HPMV lamp fixtures shall be provided with wire-wound ballasts. All fluorescent fixtures except for Class-I, Div-IIC fittings/ increased safety fittings (Div-II/Hazardous Area) installed area shall be provided with electronic ballasts.
3.02.00	All luminaires and their accessories and components shall be of type readily replaceable by available Indian makes.
3.03.00	**Fans & Regulator**
	Ceiling Fans, to be provided in non airconditioned office/control room area, shall be suitable for operation on 240 V, 50 Hz, AC supply comprising of class 'F' insulated copper wound single phase motor, 1200mm sweep, aerodynamically designed well balanced MS blades (3 Nos.), down rod, die cast aluminium housing, capacitor, suspension hook, canopies etc. finished in stove enameled white. Power factor of fans shall not be less than 0.9. Each fan shall cover approximately 10sq.m. area.
3.04.00	**Switch Box**
	Switch boxes shall be made of 1.6 mm thick, MS sheet with 3 mm. thick decorative, perspex cover. Switchbox shall be hot dip galvanised
3.05.00	**Junction boxes**
3.05.01	Junction box for lighting fixtures shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanised.
3.06.00	**Conduits, Fittings & Accessories**
3.06.01	Galvanised heavy duty steel conduits for normal area and galvanised heavy duty steel conduits with an additional epoxy coating for corrosive area shall be offered. Alternatively glass reinforced epoxy conduits with comparable compressive and impact strength with that of heavy duty steel conduits may be offered.
3.06.02	**Rigid Steel Conduits**
	(a) Rigid steel conduits shall be heavy duty type,hot dip galvanised conforming to IS : 9537 Part-I & II shall be suitable for heavy mechanical stresses, threaded on both sides and threaded length shall be protected by zinc rich paint. Conduits shall be smooth from inside and outside.
3.06.03	**Flexible Steel Conduits**
	Flexible conduit shall be water proof and rust proof made of heat resistant lead coated steel.

CLAUSE NO.	TECHNICAL REQUIREMENTS
3.06.04	**Pull-out Boxes** Pull out boxes shall be provided at approximately 4 (four) metre interval in a conduit run .Boxes shall be suitable for mounting on Walls, Columns, Structures, etc. Pull-out boxes shall have cover with screw and shall be provided with good quality gasket lining. Pull out boxes used outdoor shall be weather proof type suitable for IP :55 degree of protection and those used indoor shall be suitable for IP :52 degree of protection. Pull out box & its cover shall be hot dip galvanised.
3.07.00	**Lighting Wires** Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R,Y,B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5.sq.mm. for copper and 4 sq.mm. for aluminium.
4.00.00	**TESTS**
4.01.00	All equipments to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
4.02.00	In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.
4.03.00	All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
4.04.00	Selection of samples for type test, acceptance test & routine test and acceptance criteria for all the items shall be as per relevant I.S
4.05.00	Type test reports of the following items as per relevant standards shall be submitted for approval. **SL NO. DESCRIPTION** i. Lighting fixtures of each type ii. Lamps of each type and rating.(life cycle and rating test only) iii. Lighting panel of each type (Degree of Protection)

CLAUSE NO.	TECHNICAL REQUIREMENTS
	iv. Junction Box of each type
	v. Receptacles of each rating
4.06.00	**Acceptance Test and Routine Test**
4.06.01	All lighting fixtures, lamps and other items shall be subjected to acceptance and routine test, as per relevant specified standards.
4.06.02	Junction boxes, switch boxes, receptacle enclosure etc. shall be subjected to physical and dimensional checks.
4.07.00	**Galvanizing Tests**
4.07.01	The quality of galvanizing shall be smooth, continuous, free from flux stains and shall be inspected visually.
4.07.02	In addition following tests shall be conducted as acceptance tests. (a) Uniformity of coating - The coating of any article shall withstand four 1minute dips in standard copper sulphate solution without the formation of an adherent red spot of metallic copper upon the basic metal. (b) The quality of cadmium/zinc plating on items with screw threads shall be free from visible defects such as unplated areas, blisters and modules and shall be inspected visually. (c) In addition, the plating thickness shall be determined microscopically/chemically or electronically.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	LT SWITCHGEAR
1.00.00	**CODES AND STANDARDS IEC : 60947, IS : 13947**
2.00.00	**TYPE**
	Circuit Breakers — Shall be air break, three pole, spring charged, horizontal drawout type, suitable for electrical operation.
	Switchgear — Fully drawout type single front
	MCC — Fully drawout type single front/Double front.
	ACDB/DCDB — Fixed type single front
3.00.00	**SYSTEM PARAMETERS**
	415 V AC +/- 10 %(SOLIDLY GROUNDED)
	50 Hz +3%/-5%
	45 kA RMS (105kA peak) / 1SEC (FAULT LEVEL)
	DC Voltage range shall be 187VDC-250VDC
4.00.00	**TEMPERATURE RISE**
	The temperature rise of the horizontal and vertical busbars and main bus link including all power drawout contacts when carrying 90% of the rated current along the full run shall in no case exceed 55 deg. C with silver plated joints and 40 deg. C with all other types of joints over an ambient of 50 deg C.
5.00.00	**OPERATIONAL REQUIREMENTS**
5.01.00	**Breakers**
5.01.01	Breakers shall have anti-pumping feature.
5.01.02	The incomer and bus coupler breakers for switchgear shall be electrically operated with over current releases or relays.
5.01.03	Breakers shall have inherent fault making and breaking capacities.They shall have shunt trip coils. In case releases are offered, the same shall have contact for energisation of lockout relay. All breakers Shall have built in interlocks for equipment and personnel safety.
5.01.04	Paralleling of two supplies shall be avoided by interlocking except for switchgear where auto-changerover is provided.Breaker contact multiplication ,if required, shall be through latch relay.

CLAUSE NO.	TECHNICAL REQUIREMENTS
5.01.05	Mechanical tripping shall be through red 'Trip' push button outside the panels for breakers, and through control swtiches for other circuits.
5.01.06	Provision of mechanical closing of breaker only in 'Test' and 'Withdrawn' position shall be made. Alternatively, mechanical closing facility should be normally inaccessible, accessibility rendered only after deliberate removal of shrouds. It shall be possible to close the door with breaker in test position.
5.01.07	Clear status indication for each circuit shall be provided through lamps, switch positions or other mechanical means.
5.01.08	Supervision relay shall be provided for trip coil monitoring.
5.02.0	Switches, Contactors and Fuses
5.02.01	Incomers for MCCs and DBs rated upto 630A could be load break isolators.
5.02.02	Motor starter contactors shall be of air break, electromagnetic type suitable for DOL starting of motor, and shall be of utilisation category AC-3 for ordinary and AC-4 for reversing starters. DC contactor shall be of DC-3 utilisation category.
5.02.03	Fuses shall be HRC type with operation indicator. Isolating switches shall be of AC 23A category when used in motor circuit, and AC 22A category for other applications. Fuse switch combination shall be provided wherever possible.
5.02.04	Isolating switches and MCCBs shall have door interlocks and padlocking facility.
5.03.00	Panels
5.03.01	All switchgears, MCCs, DBs, panels, modules, local starters and push buttons shall have prominent engraved indentification plates.
5.03.02	Local push button stations shall have metal enclosure of die cast aluminium or rolled sheet steel of 1.6mm thickness & shall have DOP of IP-55. Push buttons shall be of latch type with mushroom knobs.
5.03.03	Where breaker/starter module front serves as compartment cover, suitable blanking covers, one for each size of modules per switchboard shall be supplied for use when carriage is withdrawn.
5.03.04	All non-current carrying metal work of boards/panels shall be effectively bonded to earth bus of galavanised steel, extending throughout the switchboard/MCC/DB. Positive earthing shall be maintained for all positions of chassis and breaker frame.
5.03.05	Suitable trolley arrangement shall be provided for breaker/starter modules. Two trolleys per switchgear room shall be provided so that top most breaker module of all types, sizes and rating can be withdrawn on trolley and lowered for maintenance purpose.
5.03.06	The incoming connection to transformer of more than 1000KVA and inter-connecting sections between switchboards shall preferably be of busducts.The busduct enclosure shall be made of minimum 3mm thick aluminium alloy. The section of the busduct

CLAUSE NO.	TECHNICAL REQUIREMENTS
	should have adequate strength to withstand internal and external forces resulting from the various operating conditions. Aluminium sheet hood shall be provided for outdoor busduct enclosure joints to provide additional protection against water ingress. The busduct top shall be sloped to prevent retention of water.The busduct shall have DOP of IP55.
5.03.07	It should be possible to carryout maintenance on a feeder with adjacent feeders alive.
5.04.01	Control, Protection & Metering Requirements
5.04.01	Control circuits shall operate at suitable voltage of 110V AC or 220V DC. Necessary control supply transformers having primary and secondary fuses shall be provided for each MCC, 2 x 100% per section. However the breakers shall operate on 220V DC The auxiliary bus bars for control supply shall be segregated from main bus bars. The control supplies shall be monitored.
5.04.02	Contractor shall fully co-ordinate overload and short circuit tripping of breaker with upstream and down stream breakers/fuses/MCCBs motor starters. Various equipments shall meet requirement of Type-II class of coordination as per IEC.
5.04.03	All relays and timers shall operate on available DC supply and not have any inbuilt batteries. They shall be provided with hand-reset operation indicator (flags) or LEDs with pushbuttons for resetting.
5.04.04	All equipments shall have necessary protections. However, following minimum protections shall be provided: 1) Contactor controlled motor feeders (Motors up to 160 kW) a) Instantaneous short circuit protection on all phases through HRC cartridge type fuses rated for 80 kA rms (prospective breaking capacity at 415V). b) Thermal overload protection c) Single phasing protection for motors protected by fuses 2) Breaker controlled motors feeders (motors rated above 160kW) a) Instantaneous short circuit protection on all phases b) Overload protection on two phases c) Over load alarm on third phase d) Earth fault protection e) Under voltage protection f) hand reset lockout relay with a blue lamp for monitoring

CLAUSE NO.	TECHNICAL REQUIREMENTS
	3) Incomers/bus coupler/outgoing breaker feeders other than motor feeders. a) Definite time delay short circuit protection b) Hand reset lockout relay with a blue lamp 4) Incomer From DG Set. a) Differential Protection (87) - Three Pole b) Reverse Power Protection. c) Overload Alarm on one phase d) Earth Fault Detection Relay (64) e) Voltage controlled overcurrent relay e) Generator under/over voltage Protection f) Hand Reset/Lockout Relay with a blue lamp. g) 3 Phase Energy Meter having accuracy of 1.0 class.
5.04.05	**Meters / instruments** All meters/ instrument shall be flush mounted on front panel, at least 96 sq.mm. size with 90 degree linear scales and accuracy class of 2.0.
5.04.06	All motors of 30kW and above shall have an Ammeter. Bus-section shall have bus VT, voltmeter with selector switch, and other relay and timers required for protection. Adequate control and selector switches, push buttons and indicating lamps shall be provided. Thermostatically controlled space heaters with switches shall be provided to prevent condensation.
5.04.07	In case of remote controlled breaker panels,following shall be ensured. Each feeder shall have local/remote selector switch. Closing from local shall be possible only in test possition whereas closing from remote shall be possible in either service or test position.Tripping from local shall be possible only when local/remote selector switch is in local position.Tripping from remote shall be either breaker in service position or selector switch being in remote position.
5.05.00	**Control from Remote** Necessary hardware shall be provided in the switchgear panel like coupling relays(24V DC,with max burden 2.5VA), auxiliary relays, current & voltage transducers(4-20 mA,dual output) etc. to effect interlocks, exchange information / status and exercise control from remote.

CLAUSE NO.	TECHNICAL REQUIREMENTS
6.00.00	**DESIGN AND CONSTRUCTIONAL FEATURES**
6.01.00	All 415V switch gear motor control centers (MCCs), AC & DC distribution boards (DB s), etc shall have following features : 1) Shall be of metal enclosed, indoor, floor mounted and free standing type. 2) All frames and load bearing members shall be fabricated using mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2mm. 3) Frame shall be enclosed in cold rolled sheet steel of thickness not less than 1.6mm.Doors and covers shall also be of cold rolled sheet steel of thickness not less than 1.6 mm.Stiffeners shall be provided whereever necessary. Removable gland plates of thickness 3mm (hot/cold rolled sheet steel) or 4 mm (non-magnetic material) shall be provided for all panels. 4) All switchboards/panels shall be of dust and vermin proof. All cutouts shall have synthetic rubber gaskets. 5) For motors above 160kW, remote controlled electrical circuit breakers, and for smaller motors, switch-fuse contactor feeders shall be provided. The other outgoing feeders would be switch-fuse units or moulded case circuit breakers. 6) All switchboards, MCCs and DB s shall have following distinct vertical sections. a) Completely enclosed bus bar compartment for horizontal and vertical bus bars. b) Completely enclosed switchgear compartments (one for each circuit housing circuit breakers, motor starter or switch-fuse feeder). c) Compartment for cable alley or cable box for power and control cables. In case of cable box, they shall be segregated with complete shrouding for individual feeders at the rear for direct termination of cables. d) For cable connection to circuit breaker, a separatelly enclosed cable compartment shall also be acceptable. e) Compartment for relays and other control devices associated with a circuit breaker, wherever necessary. f) The switchboards/MCC/DBs shall be of DOP IP52 as per IS: 13947.However, the busbar chamber having DOP of IP:42 are also acceptable where continuous busbar rating is 1600A and above. g) All 415V switchgears,MCC's, AC & DC distribution boards etc. shall be painted by powder coating process.Paint shade for complete panels

excluding end covers shall be RAL9002 & RAL5012 for extreme end covers of all boards.

h) All 415V switchgears,MCC's, AC & DC distribution boards etc. shall have two incomers and one buscoupler arrangement ,unless asked for specifically.

i) All drawout modules shall have distinct service, test and isolated positions.Power contacts shall get disconnected in both test and isolated positions where as the control contacts shall get disconnected in isolated position only.

7) Busbars shall be of high conductivity aluminium alloy or copper.

8) The cross-section of the horizontal busbars shall be uniform throughout the length of switchboard and both horizontal as well as vertical busbars shall be adequately supported and braced to withstand the stresses due to the specified short circuit currents. Neutral busbar short circuit strength shall be same as main busbars.

9) Minimum air clearance in air between phases and phase-earth shall be 25 mm for busbars and cable terminations. For all other components, the Clearances shall be at least 10mm. Wherever above is not possible except for horizontal and vertical busbars, insulation shall be provided by anti tracking sleeving or barriers. However for horizontal and vertical busbars, clearances specified above shall be maintained even when busbars are insulated/sleeved. In case of DC DBs/ fuse boards, the busbar system shall be insulated or physically segregated with barriers to prevent interpole short circuit.

10) Busbar insulators shall be of track-resistant high strength non-hygro- scopic, non-combustible type and suitable to withstand stresses due to over-voltages and short circuit current. Insulators and barrier of inflammable material such as Hylam shall not be accepted.

11) All types of relays and timer shall be subject to Employer's approval. They shall be flush mounted with connections from inside, and shall have transparent & dust tight cover, removable from front, drawout construction for easy replacemernt and testing facility. The auxiliary relays and timer may be provided in fixed cases.

12) Maxi terminal /cage clamp type terminal blocks shall be provided for signals to be interfaced with DDCMIS/PLC.

13) The switchgears/MCC shall be designed to offer adequate level of safety to operating/ maintenance personnel. Means shall be provided to prevent access to the live part to avoid accidents during service as well as maintenance period. Bidder shall bring out the safety means provided to achieve above. A detailed instruction plate suitable for wall mounting shall be provided for each switchgear/MCC room discribing various safe operating procedure/safety precautions for safe operation and maintenance of switchgear/MCC.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	14) All current and voltage transformers as required for metering & protection specified shall be completely encapsulated, cast resin insulated type. Incomers from transformers shall have CTs for transformer REF protection. All current and voltage transformers as required for metering and protection specified shall be completely encapsulated, cast resin insulated type. Incomers from transformers shall have CTs for transformer restricted earth fault protection. The accuracy shall be as follows:
	CTs / **PTs** Protection: 5P20 / 3P Metering: 1.0 / 1.0 REF: PS
6.02.00	Indicating lamps shall be cluster LED type.
6.03.00	20% spare feeders of each type & rating used in the MCC with a minimum one (1) number on each bus section shall be provided.
7.00.00	**TYPE TESTS**
7.01.00	GENERAL
	(a) All equipments to be supplied shall be of type tested quality. The Contractor shall submit for Owner's approval the reports of all the type tests as listed in this specification and carried out within last five years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.
	(b) In case the Contractor is not able to submit report of the type test(s) conducted within last five years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Contractor shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.
	(c) All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.
7.02.00	**BUSDUCTS (if applicable)**
	The follo**wing t**ype test certificates on each rating of busduct shall be submitted.
	(a.) Heat run test on an assembly of representative sections and fittings
	(b.) Short circuit test for a duration and current as covered in the specification on an assembly of representative section .

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(c.) One minute high potential power frequency voltage withstand test. (d.) Degree of protection tests.
7.03.00	**L. T. SWITCHGEAR** The following type test certificates on each type & rating of L.T. Switchgear, MCC panel and distribution boards shall be submitted. (a) Short time withstand test with circuit breaker mounted inside the switchgear panel. (b) Temperature rise test. (c) Type II - Short circuit co-ordination test for any three ratings of MCC moduleas selected by the Employer. (d) Test sequence -1 & combined test sequence shall be carried out on each rating of circuit breaker mounted inside the panel. (e) Degree of protection tests

CLAUSE NO.	TECHNICAL REQUIREMENTS

INSTRUMENTATION AND POWER SUPPLY CABLE

1.00.00 **INSTRUMENTATION CABLE, POWER SUPPLY CABLE, INTERNAL WIRING AND ELECTRICAL FIELD CONSTRUCTION MATERIAL**

1.01.00 **General Requirements**

1.01.01 All cables including special cables, internal wiring and electrical field construction material shall conform to this specification, Employer approved detail engineering drawings & documents and the latest edition of the relevant standards & guidelines. The Bidder shall furnish all material and services required for the completeness of the work identified in his scope as per this specification.

1.01.01 The Contractor shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under Contractor's scope as illustrated in the enclosed Drg. No. 0270-110-POI-A-021 and ensuring completeness of the control system.

1.01.02 Any other application where it is felt that instrumentation cables are required due to system/operating condition requirements, are also to be provided by Contractor.

1.01.03 Other type of cables like fiber optic/co-axial cables for system bus, cables for connection of peripherals etc. (under Contractor's scope) are also to be furnished by the Contractor.

1.01.04 Contractor shall supply all cable erection and laying hardware from the main trunk routes like branch cable trays/sub-trays, supports, flexible conduits, cable glands, lugs, pull boxes etc. on as required basis for all the systems covered under this specification.

1.01.05 Wherever the quantity has been defined as on as required basis, the same are to be furnished by contractor on as required basis within his quoted lump sump price without any further cost implication to the Owner.

2.00.00 Specification of Instrumentation cable

2.01.00 Common Requirements

S. No.	Property	Requirement
1	Voltage grade	225 V (peak value)
2.	Codes and standard	All instrumentation cables shall comply with VDE 0815, VDE 0207, Part 4, Part 5, Part 6, VDE 0816, VDE 0472, SEN 4241475, ANSI MC 96.1, IS-8784, IS-10810 (latest editions) and their amendments read along with this specification.

CLAUSE NO.	TECHNICAL REQUIREMENTS

S. No.	Property	Requirement
3.	Continuous operation suitability	At 70 deg. C for all types of cables, while 205 Deg C for Type-C cables.
4.	Progressive automatic on-line sequential marking of length in meters	To be provided at every one meter on outer sheath.
5.	Marking to read 'FRLS'	To be provided at every 5 meters on outer sheath except for Type-C cable.
6.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
7.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
8	Ovality at any cross-section	Not more than 1.0 mm
9	Others	a) Durable marking at intervals not exceeding 625 mm shall include manufacturer's name, insulation material, conductor's size, number of pairs, voltage rating, type of cable, year of manufacturer to be provided. b) Cables shall be suitable for laying in conduits, ducts, trenches, racks and underground-buried installation c) Repaired cables shall not be acceptable.

2.02.00 Specific Requirements

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
A. Conductors				
Cross section area	0.5 sq. mm			
Conductor	ANSI type	ANSI type	High conductivity	ANSI type KX

CLAUSE NO.	TECHNICAL REQUIREMENTS

material	KX	SX	Annealed bare copper	
Colour code	Yellow-Red	Black-Red	As per VDE-815	Yellow-Red
Conductor Grade	As per ANSI MC 96.1		Electrolytic	As per ANSI MC 96.1
No & dia of strands	7x0.3 mm (nom)			
No. of Pairs	2	2	4,8,12,16,24,48	2
Max. conductor resistance per Km (in ohm) at 20 deg. C	As per ANSI MC 96.1		73.4 (loop)	As per ANSI MC 96.1
Reference Standard	As per ANSI MC 96.1		VDE 0815	As per ANSI MC 96.1
B. Insulation				
Material	PVC type YI 3			Teflon (i.e. extruded FEP)
Thickness in mm (Min/Nom/Max)	0.25/0.3/0.35			0.4/0.50
Volume Resistivity (Min) in ohm-cm	1×10^{14} at 20 deg. C & 1×10^{11} at 70 deg. C.			---
Voltage Rating	225 V peak operating voltage			
Reference Standard	VDE 0207 Part 4			VDE 0207 Part 6 & ASTMD 2116.
Core diameter above insulation	Suitable for cage clamp connector			
C. Pairing & Twisting				
Max. lay of pairs (mm)	50			
Single layer of Numbered binder	Yes			

tape on each pair provided			
Unit formation of four pairs with printing of no. of Unit provided	N.A.	Yes	N.A.
Conductor /pair identification as per VDE0815	N.A.	To be provided (color coding attached).	N.A.
D. Shielding			
Type of shielding	Al-Mylar tape		
Individual pair shielding	No	To be provided for F-type cable	No
Minimum thickness of Individual pair shielding	No	28 micron	No
Overall cable assembly shielding	To be provided		
Minimum thickness of Overall cable assembly shielding	55 micron		
Shielding coverage	100% with at least 20% overlap		
Drain wire provided for individual shield	N.A.	Yes (for F-type) 7-strand 20 AWG (0.51 mm^2) annealed Tin coated copper	N.A.
Drain wire provided for overall shield	Yes. 7-strand 20 AWG (0.51 mm^2) annealed Tin coated copper		

CLAUSE NO.	TECHNICAL REQUIREMENTS

E. FILLERS				
Non-hygroscopic, flame retardant	To be provided			
F. Outer Sheath				
Material	Extruded PVC compound YM1 with FRLS properties			Teflon (i.e. extruded FRP)
Minimum Thickness at any point	1.8 mm			0.4 mm
Nominal Thickness at any point	>1.8 mm			0.5 mm
Color	Blue			
Resistant to water, fungus, termite & rodent attack	Required			
Oxygen index as per ASTMD-2863	not less than 29%			N.A.
Temperature index as per ASTMD-2863	not less than 250 deg.C			N.A.
acid gas generation by weight as per IEC-60754-1	Maximum 20%			N.A.
Smoke Density Rating as per ASTMD-2843	Maximum 60% (defined as the average area under the curve when the results of smoke density test plotted on a curve indicating light absorption vs. time as per ASTMD-2843)			N.A.
Reference standard	VDE207 Part 5			VDE207 Part 6 & ASTM D2116

CLAUSE NO.	TECHNICAL REQUIREMENTS

G. Electrical Parameters				
MUTUAL CAPACITANCE BETWEEN CONDUCTORS AT 0.8 KHZ (MAX.)	200 nF/km		120 nF/km for F type 100 nF/km for G-type	200 nF/km
INSULATION RESISTANCE(MIN.)	100 M Ohm/Km			
CROSS TALK FIGURE (MIN.) AT 0.8 KHZ	60 dB		60 dB	N.A.
CHARACTERISTIC IMPEDANCE (MAX) AT 1 KHZ	N.A.		320 ohm for F-type 340 ohm for G-type	N.A.
ATTENUATION FIGURE AT 1 KHZ (MAX)	N.A.		1.2 db/km	N.A.
H. Complete Cable				
Complete Cable assembly	Shall pass Swedish Chimney test as per SEN-SS 4241475 class F3.			N.A.
Flammability	Shall pass flammability as per IEEE-383 read in conjunction to this specification			N.A.
I. Accessories				
Cable accessories of flame retardant quality.	Yes. (Accessories such as harnessing components, markers, bedding, cable jointer, binding tape etc.)			
J. Tests				
Routine & Acceptance tests	Refer sub-section IIIE			

CLAUSE NO.	TECHNICAL REQUIREMENTS

Type tests	Refer sub-section-CNI TYPE TEST			
K Cable Drum				
Type	Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to the entire drum) or steel drum.			
Outermost layer covered with waterproof paper	Yes			
Painting	Entire surface to be painted			
Length	1000 m ± 5% for up to & including 12 pairs 500 m ± 5% for above12 pairs			

3.00.00 **SPECIFICATION OF OPTICAL FIBER CABLES (OFC)**

3.01.00 Optic Fiber cable shall be 4/8/12 core, galvanised corrugated steel taped armoured, fully water blocked with dielectric central member for outdoor/indoor application so as to prevent any physical damage. The cable shall have multiple single-mode or multi mode fibers on as required basis so as to avoid the usage of any repeaters. The core and cladding diameter shall be 9 +/- 1 micrometer and 125 +/- 1 micrometer respectively. The outer sheath shall have Flame Retardant, UV resistant properties and are to be identified with the manufacturer's name, year of manufacturer, progressive automatic sequential on-line marking of length in meters at every meter on outer sheath.

3.02.00 The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Steel central member, Loose buffer tube design, 4 fibers per buffer tube (minimum), Interstices and buffer tubes duly filled with Thixotropic jelly etc. The cable shall be suitable for a maximum tensile force of 2000 N during installation, and once installed, a tensile force of 1000 N minimum. The compressive strength of cable shall be 3000 N minimum& crush resistance 4000 N minimum. The operating temperature shall be –20 deg. C to 70 deg.C

3.03.00 All testing of the fiber optic cable being supplied shall be as per the relevant IEC, EIA and other international standards.

3.04.00 Bidder to ensure that minimum 100% cores are kept as spares in all types of optical fibre cables.

3.05.00 Cables shall be suitable for laying in conduits, ducts, trenches, racks and under ground buried installation.

3.06.00 Spliced / Repaired cables are not acceptable.

CLAUSE NO.	TECHNICAL REQUIREMENTS

3.07.00 Penetration of water resistance and impact resistance shall be as per IEC standard.

4.00.00 **SPCIFICATION OF POWER SUPPLY CABLES**

Refer relevant subsections of this specification.

5.00.00 **INSTRUMENTATION CABLE INTERCONNECTION AND TERMINATION PHILOSOPHY**

The cable interconnection philosophy to be adopted shall be such that extensive grouping of signals by large scale use of field mounted Group Junction Boxes (JBs) at strategic locations (where large concentration of signals are available, e.g. valves limit & torque switches, switchgear) is done and consequently cable with higher number of pairs are extensively used. The details of termination to be followed are mentioned in the given Table A.

TABLE A: CABLE TERMINATION TO BE FOLLOWED

Application		Type Of Termination		Type Of Cable
FROM (A)	TO (B)	END A	END B	
Valves/dampers drives (Integral Junction box)	Marshalling cubicle/ Marshalling cum termination Cubicle/local group JB	Plug in connector	Posts mount cage clamp type.	G
Transmitters, Process Actuated switches mounted in LIE/LIR	Integral Junction box of LIE/LIR	Plug in connector	Cage clamp (Rail mount) type.	F,G
RTD heads	Local junction box	Plug in connector	Cage clamp (Rail mount) type.	F
Thermocouple	CJC Box (if applicable)	Plug in connector	Cage clamp (Rail mount) type.	A,B,C*
Other Field Mounted Instrument	Local JB/Group JB	Plug in connector	Screwed, Cage clamp (Rail mount) type	F,G

RTD	Temperature transmitter	Plug in connector	Screwed, Cage clamp type	F
Thermocouple	Temperature transmitter	Plug in connector	Screwed, Cage clamp type	A,B,C*
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/Group JB/ MCC/SWGR	Group JB	Cage clamp (Rail mount) type.	Cage clamp (Rail mount) type.	F,G
Local Junction box, Temperature Transmitter, Int. Junction box of LIE/ LIR/Group JB/ MCC/SWGR	Marshalling Cubicle/ Marshalling cum Termination Cabinet	Cage clamp (Rail mount) type.	Posts mount cage clamp type.	F,G
Marshalling cubicle/ Termination Cabinet	Electronic system cabinet	Cage clamp Post mounted type.	Plug in connector/Other System as per manufacturer's Standard	Internal wiring
Marshalling/ Termination System Cabinets	UCD mounted equipments	Post mount cage clamp type.	Plug in connector/Cage clamp type (rail mounted).	F,G (with plug-in connector at one end)
DDCMIS/PLC cabinets	PC, Printers etc.	Plug in connector	Plug in connector	Mfr.'s Standard

Notes

1. Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs.

2. For analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	3. Also refer Drg. 4610-110-POI-A-021. 4. *For high temperature applications only. 5. Instrument Cabling for instruments/equipments covered under subsection MAIN EQP INST SYS shall be as per manufacturer's standard .
6.00.00	**TERMINAL BLOCKS**
6.01.00	All terminal blocks shall be rail mounted/post mounted, cage clamp type with high quality non-flammable insulating material of melamine suitable for working temperature of 105 deg. C. The terminal blocks in field mounted junction boxes, temperature transmitters, instrument enclosures/racks, etc., shall be suitable for cage clamp connections. The terminal blocks in Control Equipment Room logic/termination/marshalling cubicles shall be suitable for post mounted cage clamp connection at the field input end. The terminal blocks for DDCMIS input/output connections from/to SWGR/MCC, Actuators with Integral Starter (for coupling relays and check back signals of 11 kV and 3.3 kV auxiliaries, LT drives/valves & dampers/solenoids, CT & VT, etc.) shall be provided with built in test and disconnect facilities complete with plug, slide clamp, test socket etc. The exact type of terminal blocks to be provided by the Bidder and the technical details of the same including width etc. shall be subject to Employer's approval.
6.02.00	All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, test plug bolts and test plug (as specified above for SWGR connections) transparent covers, support brackets, distance sleeves, warning label, marking, etc.
6.03.00	The marking on terminal strips shall correspond to the terminal numbering on wiring diagrams. At least 20% spare unused terminals shall be provided everywhere including local junction boxes, instrument racks/enclosures, termination/marshalling cabinets, etc. All terminal blocks shall be numbered for identification and grouped according to the function. Engraved labels shall be provided on the terminal blocks.
6.04.00	For terminating each process actuated switches, drive actuators, control valves, Thermocouple, RTD, etc. in Local Junction Boxes, etc, refer Drg no. 0000-999-POI-A-065.
6.05.00	The terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal blocks and between terminal blocks and junction box walls.
6.06.00	For ensuring proper connections, Bidder shall provide suitable accessories, along with insulation sleeves. The exact connecting accessory shall be finalised as per application during detail engineering stage subject to Employer's approval without any cost repercussions.
6.07.00	Internal wiring in factory pre-wired electronic equipment cabinets may be installed according to the Bidder's standard as to wire size and method of termination or internal equipment. Terminal blocks for connection of external circuits into factory

CLAUSE NO.	TECHNICAL REQUIREMENTS
	prewired electronic equipment cabinets shall meet all the requirements as specified above.
7.00.00	**INTERNAL PANELS/ SYSTEM CABINETS WIRING**
7.01.00	Internal panel/cabinet wiring shall be of multi-stranded copper conductor with FRLS PVC insulation without shield and outer sheath meeting the requirements of VDE 0815.
7.02.00	Wiring to door mounted devices shall be done by 19 strand copper wire provided with adequate loop lengths of hinge wire so that multiple door opening shall not cause fatigue breaking of the conductor.
7.03.00	All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferules at both ends in Employer's approved format. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.
7.04.00	All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.
7.05.00	All floor slots of desk/panels/cabinets used for cable entrance shall be provided with removable gasketed gland plates and sealing material. Split type grommets shall be used for prefabricated cables.
7.06.00	All the special tools as may be required for solder less connections shall be provided by Bidder.
7.07.00	Wire sizes to be utilised for internal wiring. (i) Current (4-20 mA), low voltage signals (48V); Ammeter/Voltmeter circuit, control switches etc. for electrical system. — 0.5 Sq.mm. (ii) Power supply and internal illumination. — 2.5Sq.mm. minimum (shall be as per load requirement.)
8.00.00	**INSTRUMENTATION CABLE INSTALLATION AND ROUTING**
8.01.00	All cables assigned to a particular duct/conduit shall be grouped and pulled in simultaneously using cable grips and suitable lubricants. Cables removed from one duct/conduit shall not be reused without approval of Employer.
8.02.00	Cables shall be segregated as per IEEE Std.-422. In vertically stacked trays, the higher voltage cable shall be in higher position and instrumentation cable shall be in bottom tier of the tray stack. The distance between instrumentation cables and those of other system shall be as follows:

CLAUSE NO.	TECHNICAL REQUIREMENTS
	From 11 kV/6.6 kV/3.3 kV tray system - 914 mm From 415V tray system - 610 mm From control cable tray system - 305 mm
8.03.00	Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. Fire proof sealing (to prevent ingress of dust entry and propagation of fire) shall be provided for all floor slots used for cable entrance. Compression cable glands (double for armoured and single for other cables) shall be provided.
8.04.00	All cables shall be identified by tag. Nos. provided in Employer's approved format at both the ends as well as at an interval of 5 meters.
8.05.00	Line voltage drop due to high resistance splices, terminal contacts, insulation resistance at terminal block, very long transmission line etc. shall be reduced as far as practicable.
8.06.00	The cables emanating from redundant equipment/devices shall be routed through different paths. The above segregation of cables & wiring for redundant equipments/devices shall be in accordance with IEEE-Std-422.
9.00.00	**CABLE LAYING AND ACCESSORIES**
9.01.00	**CABLE LAYING** 1 CABLES SHALL BE LAID STRICTLY IN LINE WITH CABLE SCHEDULE. 2 IDENTIFICATION TAGS FOR CABLES. INDELIBLE TAGS TO BE PROVIDED AT ALL TERMINATIONS, ON BOTH SIDES OF WALL OR FLOOR CROSSING, ON EACH CONDUIT/DUCT/PIPE ENTRY/EXIT, AND AT EVERY 20 M IN CABLE TRENCH/TRAY. 3 CABLE TRAY NUMBERING AND MARKING. TO BE PROVIDED AT EVERY 10M AND AT EACH END OF CABLE WAY & BRANCH CONNECTION. 4 JOINTS FOR LESS THAN 250 METERS RUN OF CABLE SHALL NOT BE PERMITTED. 5 BURIED CABLE PROTECTION WITH CONCRETE SLABS; ROUTE MARKERS AT EVERY 20 METERS ALONG THE ROUTE & AT EVERY BEND.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	6 ROAD CROSSINGS CABLES TO PASS THROUGH BURIED HIGH DENSITY PE PIPES ENCASED IN PCC. AT LEAST 300 MM CLEARANCE SHALL BE PROVIDED BETWEEN - HT POWER & LT POWER CABLES, - LT POWER & LT CONTROL CABLES - LT CONTROL & INSTRUMENTATION CABLES, SPACING BETWEEN CABLES OF SAME VOLTAGE GRADE SHALL BE IN ACCORDANCE WITH THE DERATING CRITERIA ADOPTED FOR CABLE SIZING. 7 SEGREGATION (PHYSICAL ISOLATION TO PREVENT FIRE JUMPING) A ALL CABLE ASSOCIATED WITH THE UNIT SHALL BE SEGREGATED FROM CABLES OF OTHER UNITS. B INTERPLANT CABLES OF STATION AUXILIARIES AND UNIT CRITICAL DRIVES SHALL BE SEGREGATED IN SUCH A WAY THAT NOT MORE THAN HALF OF THE DRIVES ARE LOST IN CASE OF SINGLE INCIDENT OF FIRE. 8 CABLE CLAMPING ALL CABLES LAID ON TRAYS SHALL BE NEATLY DRESSED UP & SUITABLY CLAMPED/TIED TO THE TRAY. FOR CABLES IN TREFOIL FORMATION, TREFOIL CLAMPS SHALL BE PROVIDED. 9 Optical fiber cables inside conduit shall be laid on cable trays wherever available and feasible. In areas where the same are required to be buried, the same shall be buried in separate trench approx.1.6 meter depth, to be laid in 2” GI/rodent proof HDPE conduits covered with sand, brick and soil along the pipe line route; While crossing roads - to be laid in GI/rodent proof HDPE conduits with sand filling at bottom and sand, soil filling at top with cement concrete; While crossing canals/river- to be laid in GI/rodent proof HDPE conduits within hume pipe.
9.02.00	Bidder shall supply and install all cable accessories and fittings like Light Interface Units, Surge suppressors, Opto isolators, Interface Converters, Fibre Optic Card Cage, Fibre Optic Line Driver, Repeater / Modem (for Optical Fibre Cables), cable glands, grommets, lugs, termination kits etc. on as required basis.

CLAUSE NO.	TECHNICAL REQUIREMENTS
9.03.00	Bidder shall furnish two completely new sets of cable termination kits like Crimping tools, etc., which are required for maintenance of the system as per the type of termination used.
9.04.00	Cables, which terminate in cabinets of draw out sections shall have sufficient cable coiled in the bottom of the cabinet to permit full withdrawal of draw out sections without disconnecting the cables. When prefabricated cables with factory connectors on both ends are longer than required, the excess cable shall be coiled in the bottom of one or both termination cabinets.
9.05.00	No splices shall be made in conductors for instrument and control circuits except where required at connections to devices equipped with factory installed pigtails. Such splices shall be made only in approved splicing boxes of fitting with removable cover. The splices shall be made with sufficient slack left in the wires to permit withdrawal of the splice from the splicing box for ease of future disconnection of the splices. All exposed conductor or connector surfaces shall be covered with a minimum of three half-lapped layers of all weather vinyl plastic electrical tape. Taping shall extend a minimum of two cable diameters over the cable jacket and a similar distance over the other insulation or connections requiring insulation.
9.06.00	The Bidder shall be responsible for proper grounding of all equipment under C&I package. Further, proper termination of cable shields shall be verified and the grounding of the same shall be coordinated so as to achieve grounding of all instrumentation cable shields at same potential. This shall be completed prior to system tests. All the cables etc. required for grounding of all equipments supplied under this package are to be supplied by the Bidder.
9.07.00	The Contractor shall take full care while laying / installing cables as recommended by cable manufacturers regarding pulling tensions and cable bends. Cables damaged in any way during installation shall be replaced at the expense of the Contractor.
10.00.00	**FIELD MOUNTED LOCAL JUNCTION BOXES**
	(i) No. of ways: 12/24/36/48/64/72/96/128 with 20% spares terminals.
	(ii) Material and Thickness: 4mm thick Fiberglass Reinforced Polyester (FRP).
	(iii) Type: Door gasket shall be of synthetic rubber.
	(iv) Mounting clamps and accessories: Suitable for mounting on walls, columns, structures etc. The brackets, bolts, nuts, screws, glands and lugs required for erection shall be of brass, included in Bidders scope of supply. Raceways shall be provided inside JBs for proper termination of cables.
	(v) Type of terminal blocks: Rail mounted cage-clamp type suitable for conductor size upto 2.5 mm^2. A M6 earthing stud shall be provided.