

ANNEXURE-1

Sl. No	SYSTEM	CONTROL SYSTEM	CONTROL & MONITORING		DDCMIS INTERFACE	PERIPHERAL	REMARKS
			LOCAL CONTROL (LCR)	DDCMIS (CCR)			
A. BTG AUXILIARY SYSTEMS							
i.	DM Cooling Water System	DDCMIS based	--	OWS	--	--	
ii.	Turbine Oil Purification System	DDCMIS based	--	OWS	--	--	
iii.	Condensate Polishing Unit	Common DDCMIS based RTU at Regeneration area	OEWS	OWS	--	- One (1) no. OEWS, - One (1) no. printer - Back-up control Desk with colored MIMIC, PB lamps, Hardwired Annunciation	
iv.	Online Condenser Tube Cleaning System	Common DDCMIS based	LCP	OWS	--	LCP with coloured MIMIC ,Annunciation Windows ,PB's and indication lamps.	
v.	Self Cleaning Filter	DDCMIS based	--	OWS	--	--	
vi.	Chemical Dosing System	DDCMIS based	LCP	OWS	Hardwired	Local control panel with PB, lamps, Hardwired Annunciation	
B. OFF-SITE PLANTS							
i.	Coal Handling Plant	- PLC based - RIO	OWS	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	- Two (2) OWS, - One (1) no. OEWS, - One (1) no. printer - Four (4) LVS - Back-up control desk with colored mimic, PB, lamps, Hardwired Annunciation - One (1) no. OWS in CCR	One OWS each shall be placed on Common Control desk in CCR.
ii.	Ash Handling Plant	- PLC based - RIO	OWS	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	- Two (2) OWS, - One (1) no. OEWS, - One (1) no. printer - Two (2) LVS - Back-up control desk with colored mimic, PB, lamps, Hardwired Annunciation - One (1) no. OWS in CCR	One OWS each shall be placed on Common Control desk in CCR.

SL. No.	SYSTEM	CONTROL SYSTEM	CONTROL & MONITORING		DDCMIS INTERFACE	PERIPHERAL	REMARKS
			LOCAL CONTROL (LCR)	DDCMIS (CCR)			
iii.	Mill Reject System	PLC based	OWS	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	- One (1) no. OEWS, - One (1) no.OWS - One (1) no. printer - Backup control desk with colored MIMIC, PB, lamps, Hardwired Annunciation	
iv.	Fuel Oil Handling System	DDCMIS (RTU) based	OWS	OWS	---	- One no. (1) OEWS - Backup Control Desk with colored mimic, PB, lamps, Hardwired Annunciation	
v.	Raw Water Transportation System	PLC based (RTU of PT PLC)	LCP	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	Local control panel with colored mimic, PB, lamps, Hardwired Annunciation	
vi.	Pre-Treatment Plant & Sludge Disposal System	PLC based	OWS	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	- One (1) OWS, - One (1) no. OEWS, - One (1) no. printer - Back-up control desk with colored mimic, PB, lamps, Hardwired Annunciation - One (1) no. OWS in CCR	One OWS each shall be placed on Common Control desk in CCR.
vii.	Filtered Water Transportation System (DM Make-up, CW Make-up, Filter back-wash, service water, potable water system)	DDCMIS (RTU) based	LCP	OWS	---	Local control panel with colored mimic, PB, lamps, Hardwired Annunciation	
viii.	De-Mineralization Plant & Potable Water Treatment Plant	PLC based	OWS	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	- Two (2) OWS, - One (1) no. OEWS, - One (1) no. printer - Two (2) LVS - Back-up control desk with colored Mimic, PB, lamps, Hardwired Annunciation - One (1) no. OWS in CCR	One OWS each shall be placed on Common Control desk in CCR.
ix.	CW Treatment System & CW Chlorination System	Common PLC based	GUI	OWS	Redundant Bidirectional OPC link for monitoring	- GUI - Hardwired Annunciation	

SL. No.	SYSTEM	CONTROL SYSTEM	CONTROL & MONITORING		DDCMIS INTERFACE	PERIPHERAL	REMARKS
			LOCAL CONTROL (LCR)	DDCMIS (CCR)			
					through common DDCMIS network		
x.	DM Transportation System (DM Transfer, Storage, Boiler Fill, Hotwell Make-up)	DDCMIS (RTU) based	LCP	OWS	---	Local control panel with colored mimic, PB, lamps, Hardwired Annunciation	
xi.	CW/ACW System	DDCMIS (RTU) based	OEWS	OWS	---	- One (1) no. OEWS, - One (1) no. printer	
xii.	Waste Water Treatment System	- PLC based - RIO	OWS	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	- Two (2) OWS, - One (1) no. OEWS, - One (1) no. printer - Two (2) LVS - Back-up control desk with Mimic, PB, lamps, Hardwired Annunciation	
xiii.	Sewage Treatment System	PLC Based	LCP	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	Local control panel with colored mimic, PB, lamps, Hardwired Annunciation	
xiv.	Fire Water System	PLC based	OWS	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	- One (1) OWS, - One (1) no. OEWS, - Hardwired Annunciation	
xv.	Compressed Air System	Common DDCMIS (RTU based) Redundant μ P based (for each compressor)	OEWS GUI	OWS	---	- One no. (1) OEWS - GUI for for each Compressor - Back-up control Desk with colored MIMIC, PB lamps, Hardwired Annunciation	

SL. No	SYSTEM	CONTROL SYSTEM	CONTROL & MONITORING		DDCMIS INTERFACE	PERIPHERAL	REMARKS
			LOCAL CONTROL (LCR)	DDCMIS (CCR)			
xvi.	Sump Pumps/ Miscellaneous Pumps	PLC based	LCP	---	Redundant Bidirectional OPC link for monitoring through common DDCMIS network	Local control panel with colored mimic, PB, lamps, Hardwired Annunciation	

- b) Terminal assignment in the termination cabinet will be such that cables originating from a field junction box shall be terminated in one termination cabinet only. This will facilitate use of multi-core cable for field wiring. For each incoming cable an additional terminal block shall be provided adjacent to signal wire termination point for termination and continuation of cable screen.
- c) Relay used for interfacing with other system shall be modular, plug in type and provided with snap on transparent cover. Rating shall be of 24V DC and shall have at least 2 changeover contacts. All contacts of the relay shall be terminated in terminal blocks. Each relay shall be provided with "Coil on" indication LED and coil protection diode. At least 10% of installed capacity shall be kept as spares.
- d) Spare requirement
Bidder shall provide at least 20% or minimum two numbers, whichever are higher, spare channels as hot on rail spares in each configured I / O modules. In addition to this 10% or minimum one number, whichever is higher, extra assigned complete spare I / O modules mounted on rails in sub racks as hot on rail spare for each category of installed I / O modules shall also be provided. Spare modules shall be distributed over each controller group. Spare channel and modules shall be fully wired up to termination cabinets.

15.04.00 Controller

15.04.01 Controller shall be Microprocessor based, multi-loop and multi-function type. Controller shall be based on 32-bit processor. These can be configured from hand-held station through front plug and from Engineering Terminal .Diagnostic features shall include invalid command checking, automatic periodic illegal address detection, routine check and memory parity check, , time - out checking, watch dog report to engineering terminal ,processor status display LED, processor fault.

15.05.00 **Operator's & Engineering Station**

- 1. Processor : Latest , minimum Intel Core i5
- 2. Configuration : Tower
- 3. Internal clock : 3.2 GHz (minm.)
- 4. Architecture : 32 bit
- 5. Video Card : PCI
- 6. RAM : 4 GB (Minimum) DDR
- 7. Hard drive : 500 GB SATA
- 8. Cache : 512 KB Level 2

- | | | |
|-----|---------------------|---|
| 9. | CD/DVD Drive | : CD - Both Read & Write for OWS. Both
CD & DVD Read & Write for ES |
| 10. | Audio controller | : 16-bit |
| 11. | Operating system | : Latest , Window |
| 12. | Graphic accelerator | : 8MB (minm.) |
| 13. | Communication ports | : 2nos. (minm.) Ethernet ports(1000 MB) ,
4 nos. USB ports (minm.) |

15.06.00 Server including Historical Storage Unit

15.06.01 Two nos. Intel , Xeon 1.9 GHz(minm.) processor with 2 x 4GB (minm.) DDR RAM ,3 nos. 600 GB SAS Hard disk , DVD +/- RW Drive . RAID 5 configuration , Ethernet ports(1000 MB) , Windows (latest) .

15.07.00 **Monitor**

- | | | |
|----|----------------------|--|
| 1. | Type | : TFT monitor |
| 2 | Screen diagonal | : 24 inch flat |
| 3 | Display | : XGA or better |
| 4 | Resolution | : 1024 X 768 or better |
| 5 | Degree of protection | : IP-30 |
| 6 | External Controls | : Brightness, contrast, Horizontal / Vertical
amplification & shift |
| 7 | Power supply | : 240 V, 50 Hz, 1 phase |
| 8 | Ambient temperature | : 0-50 ° C |
| 9 | Humidity | : 95% non-condensing |
| 10 | Version | : To suit industrial application |

b) Key Board

- | | | |
|----|----------------|--|
| 1. | Type | : Flat spill proof membrane type or Positive
depression type |
| 2. | Different keys | a) Soft and user defined function keys for
software/ programming including text |

- correction, scan rate alteration, zooming/ flashing color selection etc.
- b) Panel select keys for alarm summary, control loop display, overview, trend, graphic, operator guide message etc.
- c) Standard Alphanumeric keys
- d) Alarm acknowledge keys
- e) Cursor keys
- f) Mode/loop status switching keys
- g) Setting change keys
- h) Print-out command keys
- i) Other keys as required to operate the system
- 3. Key lock : Lockable type push button mounted on keyboard
- 4. Life Expectancy 50 million cycles per key
- 5. Version : To suit industrial application
- c) **Laser Printer**
 - 1. Type : Laser jet , tabletop, network ready
 - 2. Printer Memory : 256 MB (min.)
 - 3. Speed : Monochrome 24 ppm - A4, Color 6 ppm - A3/A4
 - 4. Resolution : 1200 x 1200 DPI in color
 - 5. No. of color (Basic) : 4 (four) minimum
 - 6. Power supply : 240 V, 50 Hz, 1 phase
 - 7. Ambient temperature : 0-50 Deg C
 - 8. Humidity : 95% non-condensing

- | | | |
|-----|---------------|---|
| 9. | Size of paper | : Letter, A4, Legal, Ledger, A3 |
| 10. | Print media | : Plain paper, transparencies, thick stock, glossy stock, envelopes |
| 11. | Accessories | : Adapters, Connector Cable, Multiplexer switch (4 point) |
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- 15.08.00 Large Video Screen
- 15.08.01 Bidder shall supply Sixty seven (67) inch or similar Large Video Screen (LVS) display unit in 1 (one) row upright in front of the operator in CCR and local control rooms with seamless integration with DDCMIS for control and monitoring of the plant .Salient plant parameters, plant status, alarms, graphics etc. shall be available in the screen .The System shall be configurable such a way that output of any of the operator station can be directed to any LVS through the controller . The system shall be configured such that any of the operators sitting on the same Ethernet shall be able to work on the LVS sitting at his own position with his local keyboard & mouse in addition to the dedicated Key board of the LVS. This LVS shall be used as an OWS with its own dedicated electronics like Processor, Keyboard and mouse etc. The LVS controller/s shall interface with DDCMIS for monitoring and display of real time information. The quantities shall be as per attached Control System Architectures and Plant Control System Overview Diagram.
- a) The system shall display complete and partial overview of the plant, alarms in the form of normal window appearance, important parameters of the plant and the electrical system in the form of SLD etc.
- b) Large Video Screen system shall be based on Digital Light Processing Technology. The software shall have capability to display multiple windows on the screen. The system shall have facility to zoom on any part of the display.
- Lamp shall be LED type with lamp life more than 60,000 hours.
- c) The LVS . shall have the following minimum features.
- | | | |
|----|-------------------|---|
| 1. | Cube & Controller | : Cube & Controller should be from the same manufacturer. |
| 2. | Manufacturing | : OEM should have a manufacturing setup in India for Video Walls running successfully for the last 3 years or more. |
| 3. | Reputed | : The OEM should be an established multinational in the field of video walls and |

**VOLUME : VI
SECTION-VII
SUB SECTION - C
INSTRUMENTATION AND CONTROL CABLES**

1.00.00 GENERAL TECHNICAL REQUIREMENTS

1.01.00 Cables shall be flame retardant low smoke (FRLS) type. In hazardous areas cables of suitable R/L ratio shall be provided for intrinsic safety. Repaired cables are not acceptable.

1.02.00 FRLS marking shall be provided on the surface of the cable at intervals not exceeding 5 mtrs. Durable marking at intervals not exceeding 625mm shall include Manufacturer's name, Year of manufacture, Voltage grade, Type of cables (Conductor size & no. of pairs / type of compensating /extension cable), Insulation material, FRLS etc.

1.03.00 Progressive sequential length marking shall also be provided at every meter interval on outer sheath of cable.

1.04.00 Non returnable standard seasoned wooden drum containing minimum 500 /1000 M $\pm$ 5% length. Drum shall be anti rodent, anti termite and smooth finish. Both end of cable shall be capped by means of non hygroscopic sealing material.

1.05.00 Thermocouple Extension & Compensating Cable

- | | | |
|-----------------------------|---|--|
| 01. Conductor | : | Solid conductor |
| 02. Conductor size | : | 16 AWG (1.31 Sq. mm) |
| 03. Type | : | KX (Compensating) (Chromel Alumel)
RX (Compensating) (Copper-Copper alloy) JX (Compensating) (Iron Constantan) |
| 04. Conductor Insulation | : | HR PVC Type-C (IS-5831,1984) 0.6 mm thick |
| 05. Operating Voltage | : | 650V |
| 06. Twisting | : | Pair twisted with lay of 60 mm (max) |
| 07. Twisting Direction | : | All pairs in the same direction. Lapped to form bunch with mylar tape. |
| 08. Screen (Pair & Overall) | : | Aluminium mylar tape with a thickness of 28 μ m (min.) for individual pair screen and 60 μ m (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire. |
| 09. Drain wire | : | Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm) (For both individual and overall screen) |
| 10. Inner Sheath | : | Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) |

- | | | |
|-----|--|--|
| | | HR PVC Type ST2 of IS-5831,1984 |
| | | Thickness as per IS-1554Part-I 1976 |
| 11. | Rip Cord | : Non metallic under sheath |
| 12. | Armouring | : GI wire / strip as per IS 3975 |
| 13. | Outer Sheath | : Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties) |
| | | HR PVC Type ST2 of IS-5831,1984 |
| | | Thickness 1.8 mm (Min) |
| 14. | Filler | : Non hygroscopic with FRLS property |
| 15. | Temperature Range | : Up to 85 °C |
| 16. | Insulation at 20 ⁰ C | : 100 MOhms/Km [Min] |
| 17. | Capacitance at 800 Hz | : 200 nf/km |
| 18. | Cross talk | : 60 dB |
| 19. | Attenuation | : 1.2 dB/Km |
| 20. | Codes & Standards | : a) IEC 332-1
b) ANSI MC 96.1
c) IS-8784-1987 |
| 21. | Tests | : a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
a) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
b) Temp Index : Min 250 DEG C at 21Oxy. Ind. (ASTM-D-2863)
c) Smoke Density Rating : Max.60% (ASTM-D-2843).
d) Flammability Test : as per IEC 332 Part-I /IEEE-383
Swedish Chimney Test - SS-424-1475 F3
e) High voltage test
Core to core- 2.0 KV for 1 min.
Core to screen- 2.0 KV for 1 min.
f) Insulation Resistance 100 M Ohm / Km Min
g) Rodent & Termite repulsion test (Presence of lead shall be confirmed) |
| 22. | Conductor material & sheath color for thermocouple cable as per ANSI MC 96.1 | |

CABLE TYPE	OVERALL SHEATH COLOR	WIRE	SHEATH COLOR	CONDUCTOR MATERIAL
KX	Yellow	Positive	Yellow	Nickel / Chromium
		Negative	Red	Nickel / Aluminum
JX	Black	Positive	White	Iron
		Negative	Red	Constantan
RX	Green	Positive	Black	Copper
		Negative	Red	Copper Nickel Alloy

23. Durable printed or embossed numbering at regular interval of 50mm shall be provided for identification of pairs. Each core printed with number or numbered binder tape shall be provided on each pair.

1.06.00 **Instrumentation multi Paired Signal Cable**

01. Conductor type : Stranded (7) annealed tinned copper
02. Conductor size : 0.5
03. Conductor resistance : 39 Ω
04. Conductor Insulation : HR PVC Type-C (IS-5831,1984) 0.6 mm thick
05. Operating Voltage : 650V
06. Twisting : Twin twisted with lay of 60 mm
07. Twisting Direction : All pairs in the same direction. Lapped to form bunch with mylar tape.
08. Screen (Pair & Overall) : Aluminium mylar tape with a thickness of 28 μm (min.) for individual pair screen and 60 μm (min.) for overall screen with 100% coverage and 25% overlapped edges. Over the individual pair screening tape two laps of 0.05 mm thick (min.) polyester tape shall be applied with minimum overlap of 25%. Metallic side of the screen shall be in contact with drain wire.
 - * Analog signals- Individual pair & overall shield to be considered.
 - * Binary signals- overall shield to be considered.
09. Drain wire : Annealed tinned copper wire, stranded. Size 0.5 Sq. mm. (No. of strands / size:- 7 / 0.3mm)

- | | | |
|----------------------------|---|---|
| 10. Inner Sheath | : | Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)
HR PVC Type ST2 of IS-5831,1984
Thickness as per IS-1554, Part-I 1976 |
| 11. Rip Cord | : | Non metallic under sheath |
| 12. Armouring | : | GI wire / strip as per IS 3975 |
| 13. Outer Sheath | : | Extruded FRLS PVC (anti rodent, anti termite & moisture resistant properties)
HR PVC Type ST2 of IS-5831,1984
Thickness 1.8mm (Min) |
| 14. Filler | : | Non hygroscopic with FRLS property. |
| 15. Temperature Range | : | 85 °C |
| 16. Insulation at 20 Deg.C | : | 100 MOhms/Km [Min] |
| 17. Capacitance at 800 Hz | : | 120 nf/km |
| 18. Cross talk | : | 60 dB |
| 19. Attenuation | : | 1.2 dB/Km |
| 20. Codes & Standards | : | a) IPCEA-S-61-402
b) BS 5308
c) IEC 332-1
d) ASTM-B-33
e) IS-8130-1984
f) IS 1554 Part-1
g) IS 10810 |
| 21. Sheath colour | : | Inner- Black and Outer- Gray |
| 22. Tests | : | a) Oxygen Index: Min.29 at room temp. (ASTM-D-2863)
b) Acid Gas Gen.: Max.20% by weight as per IEC 754 Part-I
c) Temp Index : Min 250 ° C at 21Oxy. Ind. (ASTM-D-2863)
d) Smoke Density Rating : Max.60% (ASTM-D-2843).
e) Flammability Test : as per IEC 332 Part-I
f) Swedish Chimney Test-SS-424-1475 F3
g) Insulation Resistance 100 M Ohm / Km Min
h) High voltage test |

Core to core- 2.0 KV for 1 min.

Core to screen- 2.0 KV for 1 min.

- i) Rodent & Termite repulsion test
(Presence of lead shall be confirmed)

23. Colour of core for Instrumentation Cable (As per IS-9938)

PAIR	CORE	COLOR
1st	1st	Blue
1st	2nd	Red
2nd	1st	Gray
2nd	2nd	Yellow
3rd	1st	Green
3rd	2nd	Brown
4th	1st	White
4th	2nd	Black

Above 4 Pairs, 4 Pairs making a unit shall have indelible printed colour coded bands like Pink for 1st unit, Orange for 2nd unit and Violet for 3rd unit and so on. In addition band marking, for example single band for 1st. unit, double band for 2nd. unit and so on, shall be provided on each conductor for identification of unit. Band marking on individual core shall be provided at regular intervals not exceeding 50 mm.

1.07.00 Cables near high temperature zone shall be capable of withstanding high temperature and terminated in junction box / panel in normal temperature zone. Teflon insulated and sheathed thermocouple extension cables and copper conductor cables shall be used in high temperature zone. Conductor and sheath shall be extruded FEP (Teflon) as per VDE 0207 Part 6 and ASTM D 2116. These cables shall be pair, multipair, and twisted & shielded.

1.08.00 Control & power Cable

Bidder shall refer to Volume IIF of the electrical specification for detail.

1.09.00 **Optical Fiber Cable**

Bidder shall supply and install optical fiber cable and all cable accessories and fittings like Light Interface Unit, Surge suppressors, Opto isolators, Interface converters, Fiber Optic Card Cage, Fiber Optic Line Driver, Repeater/ Modem, cable glands, grommets, lugs, termination kits etc on as required basis.

Optical Fiber Cable shall be 4/8/12 core. Each core shall be of ultra pure fused silica glass with UV cure acrylate suitable to withstand temperature between 20 and 80°C. The cable shall have multiple mono mode fiber. On as required basis so as to avoid usage of any repeaters. . Fiber optic cable shall be of loose buffer tube design with 4 fibers per buffer tube (minimum). Interstices and buffer tubes shall be filled with water blocking compound such as thixotropic gelly to protect against moisture and vibration. Buffer tube shall

be made of materials like Poly-Butelene Terathylate (PBT). They shall be colored for easy identification.. Buffer tubes shall be stranded around Central Strength Member utilizing Reverse Oscillating Lay (ROL). Blank fillers shall be used as necessary to maintain circular cable structure.

The central strength member shall be Fiber Reinforced Plastic (FRP) or other material with equivalent mechanical strength to provide both tensile and anti-buckling strength to cable.

The interstices between buffer tube and jacket layers shall be protected from water intrusion by a combination of dry water blocking yarns and tapes. These dry materials shall be easily removable from core during cable preparation without use of cleaning solvent.

In addition to central strength member, additional strengthening substance like aramid yarns shall be applied helically over the cable core to provide additional tensile strength to cable.

The cable shall be of dual jacket and armoured. Inner sheath consists of medium density poly ethylene extruded over cable core. Two highly visible ripcords are placed under the jacket to aid in sheath removal. Electrolytically chrome plated corrugated steel taped (ECCST) armouring is provided around inner jacket to provide additional cable compression strength and rodent protection. The armour is covered with outer black MDPE sheath with FRLS and UV resistance properties. A ripcord is also placed under neath the armour for easy outer sheathing removal. The cable shall be suitable for a maximum tensile force of 2000N during installation and once installed, a tensile force of 1000N minimum. The compressive strength of cable shall be 3000N minimum and crush resistance 4000N minimum. Minimum bending radius shall be equal to or more than 15D.

Specification for G.652 Monomode Fiber:

Sl. No.	Attribute	Value
1	Core Diameter	9±1 micrometer
2	Cladding Diameter	125±1 micrometer
3	Cladding non circularity	≤1.0%
4	Attenuation coefficient at (i) 1290 nm to 1340 nm (ii) 1525 nm to 1575 nm	<0.36 Db/km <0.25 Db/km
5	Chromatic dispersion coefficient at (i) 1310 nm (ii) 1550 nm	<3.5 ps/ nm.km <18 ps/ nm.km
6	Polarization Mode Dispersion (PMD)	≤0.5 ps/√km

	coefficient	
7	Mode field diameter at (i) 1310 nm (ii) 1550 nm	9.2±0.4 micrometer 10.50±1.0 micrometer
8	Mode field concentricity error	≤0.5 micrometer
9	Proof test	≥1%
10	Fiber Curl	≥ 4.0 m
11	Macro bend test on fiber at 1550 nm	≤0.1 dB

The entire length of the cable shall be marked with the manufacturer name, month and year of manufacture, coded description of the cable based on Telcordia's(Bellcore) SR-2014 Suggested Optical Cable Code (SOCC), progressive sequential length marking at every meter interval on outer sheath.

Following tests as per any approved standards such as FOTP, IEC etc shall be carried out on the cables:

- a. Attenuation and dispersion characteristics test
- b. Proof test
- c. Macro-Bend Resistance Test
- d. Mechanical Tests
- e. Low and High Temperature Cable Bend Test
- f. Impact Resistance Test
- g. Compressive Strength Test
- h. Tensile Strength Test
- i. Cable Twist Test
- j. Cable Cyclic Flexing Test
- k. Environmental Characteristics Test
- l. Temperature Cycling Test
- m. Color Performance Test
- n. Cable Aging Test
- o. Water Penetration Test
- p. Lightning Test
- q. Routine Test/ Sample Test
- r. Site Test (Continuity and Attenuation)

s. FRLS Test

1.10.00 Coaxial Cable

1	Standard	: MIL-17G, IS-5026
2	Inner conductor	: Tinned copper (Cu Sn)
3	Size	: 0.94 mm dia (19 stranded)
4	Dielectric insulation	: Cellular foam polyethelyne
5	Overall diameter	: 2.95 mm
6	Shielding	: Aluminium mylar tape
7	Outer conductor	: Cu Sn- Braid, 96% lapping (Overall dia 3.60 mm)
8	Armoring	: Galvanized mild steel
9	Outer sheath	: FRLS PVC
10	Temperature range	: 85°C
11	Attenuation	: Up to max 39.5 Db/100 m

tightness between kick plate and finished floor

f) Lifting hook / Eye bolt

g) Drawing pocket

h) Door switch, lamps, thermostat, heaters and industrial grade cooling fans,, illumination fixtures

- | | | |
|---------------------------------|---|--|
| 12. Name Plate | : | Both at front and back surface of the panel |
| 13. Fixing of name plate | : | Stainless steel pan head screws |
| 14. Name plate material | : | Laminated phenolic (3 layers) |
| 15. Lettering | : | Black with white engraved |
| 16. Mounting of terminal blocks | : | Vertical angle support bracket tack welded on sheet steel plate, screwed on internal wall of enclosure |

2.05.00 FURNITURE

All the furnitures in the Central / Local control Room (s), Engineers' rooms, Instrument laboratory , SWAS Room & any other rooms with C&I equipments located in different plant buildings under Bidder's scope shall be included in Bidder's scope of supply. Bidder shall provide following industrial grade furniture items as a minimum from reputed manufacturers/suppliers meeting International Standards. The furniture shall be modular and latest with ease of operational features. The furniture shall be modern, aesthetically designed, modular, flexible, space saving and future safe.

2.05.01 WORK STATION FURNITURE

Modular work station furniture, suitable for mounting servers & historians, programmer stations, PC based systems, printers (A4/A3 color laserjet) etc. shall be provided.

2.05.02 PC RACK

PC Racks shall be provided to mount CPUs of workstations/PCs of OWS/LVS etc. in control room. For each PC / workstation / monitor at least one chair shall be included.

2.05.03 CHAIRS

Industry standard revolving chairs with wheels and with provision for adjustment of height (hydraulically/gas lift) shall be provided for the operators, unit-in-charge & other personnel in control room area. These shall be designed for sitting for long duration such that these are comfortable for the back.

2.05.04 TABLES

Industry standard computer tables shall be provided & shall be as approved by Owner during detailed Engineering. Glass top teak wood horse shoe shaped table with vertical file mounting arrangement (two layers to house approx. 40 Nos of files and lockable drawers at both ends) for Engineering Room shall be provided.

2.05.05 ALMIRAHs

Steel Almirahs shall be provided for keeping documents in the documentation room. Glass doors for each rack shall be provided such that the documents are visible from outside. Size of the rack shall be sufficient to easily fit technical manuals. The exact details shall be approved by Owner during detailed Engineering.

2.05.06 KEYPAD

One keypad per unit shall be provided for the storing of keys of relevant areas of the unit in the control room.

2.05.07 LOCKERS

Suitable lockers shall be provided in the room adjacent to the control room for storing of personal articles of control room personnel. Also, lockers of bigger size shall be provided in documentation Room for storing of personal documents. Details shall be finalized and approved by Employer during detailed engineering.

3.00.00 **LVS PANEL**

3.01.00 An arc shaped Large Video Screen (LVS) panel shall be supplied for mounting large video screens in number of tiers in various Control rooms as specified elsewhere in this specification.

Bidder shall provide and fix ACP cladding around the LVS screen including covering the LVS back side and LVS stand. The cladding will be from floor finish to 600 mm above LVS screen like a self-standing partition with necessary openings for system requirement. ACP paneling shall be with 304 grade & approx. 0.5 mm mirror finish SS strip.

3.02.00 The profile, dimensions and the general arrangement shall be finalized & approved by Owner during detailed engineering. Recommendations, if any, for the control room lighting in order to ensure continuous proper viewing of the LVS screen by the operator & shift incharge (without any fatigue) shall be

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SECTION-IV

**TECHNICAL SPECIFICATION
FOR
CABLES**

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ATTACHMENTS

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SECTION-IV

TECHNICAL SPECIFICATION FOR CABLES

1.00.00 SCOPE OF SUPPLY

1.01.00 Power and Control Cables shall cover the requirement of entire Plant including the switchyard.

Other cables including special cables, if any, which may be necessary as per proven engineering practice for satisfactory and trouble free operation of the entire cable system of the plant shall also be within the scope of supply. These shall include all such cables for electrical integral with mechanical equipment systems and subsystems.

1.02.00 Cable shall be furnished in accordance with this specification and the following annexures :

- | | | | |
|----|----------------------------|---|--------------|
| a) | 11kV & 3.3 kV Power cables | : | Annexure - A |
| b) | 1100V Power Cables | : | Annexure – B |
| c) | Control Cables | : | Annexure – C |
| d) | Fire Survival Cables | : | Annexure – D |
| e) | Flexible Trailing cable | : | Annexure – E |

1.03.00 All relevant drawings, data and instruction manuals

2.00.00 CODES & STANDARDS

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

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

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

3.00.00 DESIGN CRITERIA

3.01.00 Cables will be generally laid on ladder type trays or drawn through rigid PVC/GI /HDPE pipe/conduits. Cable tunnels shall be avoided as far as possible, except at locations where overhead trays are not possible, with prior approval of the Owner.

- 3.02.00 For continuous operation at specified rating, maximum conductor temperature shall be limited to the permissible value as per relevant standard and/or this specification which one is more stringent.
- 3.03.00 The insulation and sheath materials shall be resistant to oil, acid and alkali and shall be tough enough to withstand mechanical stresses during handling.
- 3.04.00 Armouring shall be single round wire of galvanized steel for multicore cables and aluminum for single core cable for power and control cables. For fire survival control cable, the armouring over inner sheath shall consist of single layer of wire / round galvanised steel wire as per IS 3975 amended upto date. For Fire survival power cable, Single core cables to be used in A.C. system, the armouring over inner sheath shall consist of single layer of round copper wire, for multi-core cables to be used in A.C. system and single core cables in D.C. System, the armouring over inner sheath shall consist of single layer of round galvanised steel wire.
- 3.05.00 The outer sheath shall have flame retardant low smoke halogen evolution (FRLSH) characteristics or fire survival characteristics as applicable and shall meet the requirements of additional tests specified for the purpose.
- 3.06.00 Core identification for multicore cable shall be provided by colour coding.
- 3.07.00 HT cables shall be manufactured by triple extrusion dry cured (CCV) process using pressurized nitrogen.

4.00.00 **SPECIFIC REQUIREMENTS**

4.01.00 **General Description**

All Cables shall be furnished in strict compliance with ratings and requirements and sizes as given in Annexures to this Specification.

4.02.00 **Drum Length and Tolerance**

The cables shall be supplied in non-returnable packing steel drum for 11 kV & 3.3 kV power cables, wooden drums for 1100V power and control cables, each containing minimum 500 meters length of larger sizes of cable unless specifically asked for. For smaller sizes of cables, each drum shall contain 1000 meters length of cable. Allowable tolerance on individual drum length is $\pm 5\%$.

4.03.00 **Non-Standard Length**

Non-standard lengths upto 5% of the total ordered quantity may be accepted. However the Contractor will be required to obtain approval before packing the Cables on drums. Non-standard lengths shall not be less than 100 metres in any case.

4.04.00 **Cable identification**

Cable identification shall be provided by embossing on every meter on the outer sheath the following :

- a) TSGENCO
- b) Manufacturer's name or trade mark
- c) Voltage grade
- d) Year of manufacture
- e) Type of insulation, e.g. XLPE/PVC/HR85/IE2 etc.
- f) No. of core and size of cables.
- g) Type of improved fire performance, e.g. FR/FRLSH/FS
- h) IS number

4.05.00 Packing

4.05.01 Cables shall be supplied in non returnable drums. The drums shall be of heavy construction. All wooden parts shall be manufactured from seasoned wood. All ferrous parts used shall be treated with suitable rust preventive finish or coating to avoid rusting during transit or storage. Wooden cable drum shall be treated by immersing in copper-nitrate solution.

4.05.02 Cable shall be wound and packed on drums in such a manner that it will be properly sealed and firmly secured to the drum. The ends of each length shall be sealed before shipment.

4.05.03 The cable drums should carry the following details in printed form:

- a) TSGENCO
- b) Manufacturer's name or trade make
- c) Type of cable & voltage grade
- d) Year of manufacture
- e) Type of insulation e.g. XLPE/HRPVC/IE2
- f) No. of core and size of cables
- g) Cable code e.g. FRLSH/FS
- h) Length of cable on drum
- i) No. of length on drum, if more than one
- j) Direction of rotation, by arrow
- k) Approx. gross mass.

- l) IS/IEC number and ISI mark

4.06.00 **Joints and Terminations**

Materials of construction for a joint/termination shall perfectly match with the dielectric chemical and physical characteristics of the associated cables. The material and design concepts shall incorporate a high degree of operating compatibility between the cable and joints. The protective outer covering (jacket) used on the joints/terminations shall have the same qualities as that of the cable outer sheath in terms of ambient/operating temperature withstand capability and resistance to hazardous environments and corrosive elements. Straight through joints and terminations for HT cables shall be heat shrinkable type.

4.07.00 **Selection Criteria**

- 4.07.01 a) HT and LT power cables shall be selected on the basis of current carrying capacity, short circuit rating and permissible voltage drop.
- b) While sizing power cables, following aspects shall be reckoned:
- i) Ground/Ambient Air temperature
 - ii) Depth of Laying.
 - iii) Power Cables touching each other.
- c) Cables, for circuit breaker controlled feeders, shall withstand the short circuit current for the fault clearing time 0.16 Sec. for outgoing feeder, 0.5 Sec. for Tie feeder and 1.0 Sec. for Incomer.
- d) HT cables shall be sized based on the following considerations:
- Rated current of the equipment and ground/ambient temperature.
 - Touching/spacing of cable.
 - Laying on multi-tier racks, trench
 - Depth of laying.
 - The voltage drop of the cable , during motor starting condition , shall be limited to 15% and during full load running condition shall be limited to 3 % rated voltage. For BFP motor, the voltage drop during motor starting condition shall be limited to 20% and for Mill motor shall be limited to 10%. Other outgoing feeder / transformer feeder shall be limited to 3% rated voltage.
 - Short circuits withstand capability
- e) For fuse/MCCB/Breaker protected circuits the conductor size shall depend upon full load current subject to voltage drop limited to 3% during running of all feeders and 15% during starting for motor feeders. In addition, transformer regulation shall also be considered for loads fed from 415V PMCC. Incase of other out going line feeder voltage drop shall be limited to 3%.

- f) For loads fed from local panels, the total running voltage drop in cable from 415V PMCC to local panel and from local panel to individual motor shall be limited to 3% at full load motor current while the same during starting shall be limited to 15%.
- g) As per national electric code (NEC) current rating capacity of motor feeder/cables should be 125% of full load current.
- h) For welding receptacle, 3% running drop shall only be considered.

The minimum sizes of L.T cable to be chosen are as below:

AL - 16 mm² (3 core) & 16mm² (2 core) Cu - 2.5 mm²

- 4.07.02 Apart from above, consideration shall also be given to limit the cable to some standard sizes instead of using too many types.
- 4.07.03 The standard cable sizes, amp capacities, derating factors. as given in IS/IEC will be generally followed.
- 4.07.04
 - a) For breaker protected circuits minimum size of the cable shall be as follows:

1100V Power Cable	:	240 Sq mm XLPE AL
3300V Power Cable	:	185 Sq mm XLPE AL
11000V Power Cable	:	240 Sq mm XLPE AL
 - b) For motor circuits the selection of size will be made ensuring that the cable shall withstand a short circuit fault directly following a second hot start.
- 4.07.05 For fuse/MCCB protected circuit, the conductor size will depend on full load current subject to voltage drop not exceeding 3%. For practical purposes, the minimum size chosen is as below :
 - a) Aluminium : 6 Sq mm.
 - b) Copper : 2.5 Sq mm.
- 4.07.06 All control cables shall be 2.5 Sq mm copper cable.
- 4.07.07 Multicore control cables will generally have spare conductor (s) in accordance with the following chart :

Conductors required	Cables
1 or 2	1-3/C
3 or 4	1-5/C
5 or 6	1-7/C
7 or 8	1-9/C

	9 or 10	1-12/C
	Above 10	Two or more of above cables
4.07.08	Separate cables for each type of following services/functions as applicable shall be used for each feeder. Same multicore cable using different services shall not be acceptable.	
	a) Power.	
	b) Control, interlock and indication.	
	c) Metering and measuring.	
	d) Alarm and annunciation.	
	e) C.T. Cables.	
	f) V.T. Cables.	
4.08.00	Cable Identification	
	Cable identification shall be provided by embossing on the outer sheath the following :	
	a) Manufacturer's name or trade mark	
	b) Manufacturer's name or trade mark	
	c) Voltage grade	
	d) Year of manufacture	
	e) Type of insulation, e.g. XLPE, HRPVC & IE2 etc.	
	f) No. of core & size of cables	
	g) Type of outer sheath e.g. FRLSH, FS etc.	
4.09.00	Selected sizes of power and control cables are given in Annexure-G.	
4.10.00	Fire Survival Cables shall be used for important auxiliaries / area as recommended in Standard Technical Specification by CEA for the following services. The fire survival time of these cables shall not be less than 3 hours at 750 deg. C.	
	i. DC emergency lube oil pump	
	ii. DC hydrogen seal pump	
	iii. Turbine lube oil pump/barring gear	
	iv. DC emergency lighting for main building and service building	
	v. DC cables for battery to charger & DC distribution boards	

- vi. Jacking oil pump
- vii. Emergency turbine trip in control room
- viii. Boiler Turbine : Generator inter trip which include the interconnection between
 - Boiler master fuel trip and turbine trip relays
 - Generator trip relays & turbine trip relays
 - Generator trip relays & generator breaker
 - Generator trip relays & field breaker
 - Generator trip relays & unit auxiliary transformer breaker
 - Incomer cables for DG board, emergency board, DC lighting board etc.

5.00.00 **TESTS**

5.01.00 **Shop Tests**

The Cables shall be subject to shop tests in accordance relevant IS/IEC standards to prove the design and general qualities of the Cables as below:

- 5.01.01 Routine tests on each drum of cables.
- 5.01.02 Acceptance Tests on 1 drum out of every 10 drums chosen at random for acceptance of the lot for every size.
- 5.01.03 Type test on each type and size of cable, inclusive of measurement of armour DC resistance of power cables on one drum out of every 10 drums of cable.

5.02.00 **Additional Tests**

Following additional acceptance tests shall also be performed on each type of cables having outer sheath with improved fire performance (category C1, Type FR/ Category C2, Type FRLSH)

- 5.02.01 Oxygen index test (both C1 & C2)

The Oxygen index shall not be less than 29.
- 5.02.02 Temperature Index Test (both C1 & C2)

The measured value of temperature index shall be 21 at a temperature of 250°C for FRLS cables and 350°C for FS cables
- 5.02.03 Flame Retardance test on single cable and on bunched cables (both C1 & C2)

After the test, there should be no visible damages on the test specimen within 300mm from its upper end.

After burning has ceased, the cables should be wiped clean and the charred or affected portion should not have reached a height exceeding 2.5 meter above the bottom edge of the burner, measured at the front and rear of the cable assembly. 3 Hours fire rating test shall be carried out for FS cable as per IEC-331

5.02.04 Halogen acid gas evolution test (for Category C2)

The level of HCL evolved shall not exceed 20 per cent by weight. HCL evolved shall not be exceed 2% for FS cable.

5.02.05 Smoke density test (for Category C2)

The cables shall meet the requirements of light transmission of minimum 40% after the test. Minimum transmission shall be 80% for FS cable.

5.02.06 Test for specific optical density of smoke

The cables shall meet the requirements of IS/IEC.

5.02.07 Test for rodent & termite repulsion property

The test shall be carried out to note the presence of rodent and termite repelling chemical in PVC compound. Normal procedure is that a few chippings of the PVC compound are slowly ignited in a porcelain dish or crucible in a muffle furnace at about 600°C. The resulting ignited ash is boiled with a little ammonium acetate solution (10%). A drop of aqueous sodium sulphide solution is placed on a thick filter paper and it is allowed to soak. The spot is touched with a drop of above extract. A black spot indicates the presence of anti-termite & rodent compound.

Flammability test shall be carried on finished cables as per following standards-

- a) Swedish Chimney test – SS: 424-14-75
- b) IEEE std.383 – 1974 latest
- c) IEC std. 332-1, 332-3 and IEC 331

6.00.00 **DRAWINGS, DATA & MANUALS**

6.01.00 Drawings, Data and Manuals shall be submitted with the bid and for approval/reference and subsequent distribution after the issue of Letter of Intent in quantities and procedures as specified in General condition of contract and/or

6.02.00 **To be submitted with the Bid**

- a) Manufacturer's catalogues giving cable construction details and characteristics.

- b) Cable current ratings for different types of installation, inclusive of derating factors for ambient temperature, grouping etc.
- c) Write-up on Manufacturer's recommended method of splicing, jointing, termination etc. of the cables.
- d) Type test reports on 11 KV & 3.3 KV Power, LT FRLSH Power & control, FS power and control cables.
- e) Filled-up proposal particulars.

6.03.00 To be submitted for Owner/Purchaser's Approval and Distribution

All relevant drawings and data pertaining to the equipment like GTP, QAP, etc. shall be submitted by the Bidder for the approval of Owner/Owner's consultant. Also refer clause no. 1.19.02(u) of Section-I of Volume – V-A: Technical Specifications for Electrical Equipment & Accessories.

ANNEXURE-A

RATINGS AND REQUIREMENTS HV POWER CABLES (11 KV & 3.3 KV)

- | | | | |
|-----|--|---|--|
| 1.0 | 11000/11000V & 3300/3300V grade 90°C continuous rating under normal condition and 250°C rating under short circuit condition heavy duty XLPE power cable suitable for use in 11000V/3300V non-effectively earthed system conforming to following requirement and in line with IS-7098, IS-8130, IS-5831 & IS-3975, manufactured by Triple Extrusion Dry Cure (CCV) process using pressurized Nitrogen. | | |
| 1.1 | Conductor | : | Stranded and compacted aluminium conductor of grade H2 & class 2 for all sizes, generally conforming to IS: 8130. |
| 1.2 | Conductor Screen | : | Extruded semi-conducting compound. |
| 1.3 | Insulation | : | Extruded cross linked polyethylene (XLPE) conforming to IS: 7098 (Part-2) |
| 1.4 | Insulation Screen | : | Extruded semi-conducting compound with a layer of non-magnetic metallic tape. For single core armoured cables, the armouring shall constitute the metallic part of screening. The semi-conducting tape shall be easily strippable. |
| 1.5 | Core Identification | : | By coloured strips applied on (For three core cables) cores. |
| 1.6 | Inner Sheath | : | Extruded HRPVC/FRLS compound conforming to type ST2 of IS: 5831 for three core cables. Single core cables shall have inner sheath. Filler material shall also be of type ST2 PVC. |
| 1.7 | Armour | : | Galvanised single round steel wire armour for twin and multicore cables.

Non-magnetic hard drawn aluminum single round wire conforming to H4 of IS-8130 latest for single core cables |
| 1.8 | Overall Sheath | : | Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831. |
| 1.9 | Drum | : | Steel Drum |

ANNEXURE-B

**RATINGS AND REQUIREMENTS
LV POWER CABLES [1.1KV (XLPE TYPE)]**

- 1.0 1100 V grade, 90°C continuous rating under normal condition and 250°C under short circuit condition rating, XLPE heavy duty, power cable conforming to following requirement and in line with IS 7098 Part-I. IS 8130 & IS 5831 and IS 3975.
- 1.1 Conductor : Stranded and compacted plain aluminium of grade H2 and class 2 stranded, high conductivity annealed plain copper for cable sizes upto 2.5 mm² conforming to IS:8130.
- 1.2 Insulation : Extruded cross-linked polyethylene (XLPE) conforming to IS: 7098 (Part-1)
- 1.3 Core Identification : By color coding
- 1.4 Inner Sheath : Extruded HRPVC FRLS compound conforming to type ST2 of IS: 5831 for multicore cable. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST2
- 1.5 Armour : Galvanized single round steel wire armour for twin and multicore cables.

Non-magnetic hard drawn aluminum single round wire conforming to H4 of IS-8130 latest for single core cables
- 1.6 Overall Sheath : Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831.
- 1.7 Drum : Conforming to IS-10418 (Wooden drum)

ANNEXURE-C

**RATINGS AND REQUIREMENTS
CONTROL CABLES**

- 1.0 1100 V grade 85°C continuous rating under normal condition and 160°C under short circuit condition rating HRPVC Control cable (YWY) conforming to following requirement and in line with IS:1554, IS:8130, IS:5831 and IS:3975.
- 1.1 Conductor : Stranded, non-compacted & circular, high conductivity annealed plain copper, generally conforming to IS: 8130.
- 1.2 Insulation : Extruded HRPVC type-C compound conforming to IS: 5831. The minimum volume resistivity of insulation shall be 3.5×10^{14} ohm-cm at 27°C and 3.5×10^{11} OHM-CM at 85°C.
- 1.3 Core Identification : By color coding and numbering at interval of 100mm or less
- 1.4 Inner sheath : Extruded HRPVC compound conforming to type ST2 FRLS of IS: 5831 for multicore cables. Single core cables shall have no inner sheath. Filler shall be of same material as of inner sheath i.e. ST2.
- 1.5 Armour : Galvanised single round steel wire for twin and multicore cables.
- 1.6 Overall sheath : Extruded FRLSH HRPVC compound conforming to type ST2 of IS: 5831.
- 1.7 Drum : Conforming to IS: 10418 (Wooden drum)

ANNEXURE-D

**RATINGS AND REQUIREMENTS
(1.1KV GRADE COPPER CONDUCTOR FS POWER CABLES)**

1100 V, copper conductor, heat resisting insulation, extruded inner sheath of low smoke and very low halogen content fire resisting material, single layer of copper wire armour for single core/ single layer of round galvanised steel wire for multicore, outer sheath of low smoke and very low halogen content fire resistant material, suitable for minimum temperature of 750 deg.C for 3 hours. The cables shall be in compliance with IEC-60331, Part 11.

**RATINGS AND REQUIREMENTS
(1.1KV GRADE COPPER CONDUCTOR FS CONTROL CABLES)**

1100 V, copper conductor, heat resisting insulation, extruded inner sheath of low smoke and very low halogen content fire resisting material, single layer of copper wire armour for single core/ single layer of round galvanised steel wire for multicore, outer sheath of low smoke and very low halogen content fire resistant material, suitable for minimum temperature of 750 deg.C for 3 hours. The cables shall be in compliance with IEC-60331, Part 11.

ANNEXURE-E

**RATINGS AND REQUIREMENTS
FLEXIBLE TRAILING CABLES**

i) 3300 V Unearthed Grade

Flexible trailing cable, annealed plain copper conductor, Class-5 of IS-8130, insulated with EPR, conductor and insulation shielded with EPR, cores screened with ATC wire braiding, cores laid up, HD CSP inner sheathed, proof cotton taped and FRLS HD CSP sheathed overall, conforming to IS:9968. Alternatively PCP sheathing may be acceptable.

ii) 1100 V Grade

1100 V Grade trailing cable shall be plain copper of Class-5 of IS-8130, heat resistant elastomeric compound based on EPR insulation, inner sheath of heat resistant elastomeric compound PCP sheath, nylon cord reinforcement and heat resistant, oil resistant and flame retardant heavy duty elastomeric compound FRLS CSP outer sheath.

ANNEXURE-F

CABLE SIZES

Following sizes are given as a general guideline. Standard sizes as per IEC/IS shall be adopted.

Sl. No.	Cable Size	Conductor	Insulation
1.0	H. T. CABLES (11kV)		
1.1	1 core 1000 sq.mm	AL	XLPE (FRLS)
1.1	1 core 630 Sq.mm	AL	XLPE (FRLS)
1.2	3 core 400 Sq.mm	AL	XLPE (FRLS)
1.3	3 core 240 Sq.mm	AL	XLPE (FRLS)
1.4	1 core 70 Sq.mm	AL	XLPE (FRLS)
1.0	H. T. CABLES (3.3kV)		
1.1	1 core 630 Sq.mm	AL	XLPE (FRLS)
1.2	3 core 300 Sq.mm	AL	XLPE (FRLS)
1.3	3 core 240 Sq.mm	AL	XLPE (FRLS)
1.4	3 core 185 Sq.mm	AL	XLPE (FRLS)
1.5	1 core 70 Sq.mm	AL	XLPE (FRLS)
2.0	L. T. POWER CABLES		
2.1	3 core 2.5 Sq.mm	CU	XLPE (FRLS)
2.2	2 core 16 Sq.mm	AL	XLPE (FRLS)
2.3	3 core 16 Sq.mm	AL	XLPE (FRLS)
2.4	4 core 16 Sq.mm	AL	XLPE (FRLS)
2.5	2 core 35 Sq.mm	AL	XLPE (FRLS)
2.6	3 core 35 Sq.mm	AL	XLPE (FRLS)
2.7	4 core 35 Sq.mm	AL	XLPE (FRLS)
2.8	3 core 70 Sq.mm	AL	XLPE (FRLS)

Sl. No.	Cable Size	Conductor	Insulation
2.9	3.1/2 core 70 Sq.mm	AL	XLPE (FRLS)
2.10	3 core 95 Sq.mm	AL	XLPE (FRLS)
2.11	3.1/2 core 95 Sq.mm	AL	XLPE (FRLS)
2.12	3 core 185 Sq.mm	AL	XLPE (FRLS)
2.13	3.1/2 core 185 Sq.mm	AL	XLPE (FRLS)
2.14	3 core 240 Sq.mm	AL	XLPE (FRLS)
2.15	3.1/2 core 240 Sq.mm	AL	XLPE (FRLS)
2.16	3 core 300 Sq.mm	AL	XLPE (FRLS)
2.17	3.1/2 core 300 Sq.mm	AL	XLPE (FRLS)
2.18	1 core 630 Sq.mm	AL	XLPE (FRLS)
3.0	CONTROL CABLE		
3.1	2 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.2	3 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.3	5 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.4	7 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.5	9 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.6	12 core 2.5 Sq.mm	CU	HRPVC (FRLS)
3.7	20 core 2.5 Sq.mm	CU	HRPVC (FRLS)
4.0	FS POWER CABLES		
4.1	3 core 2.5 Sq.mm	CU	EPR
4.2	2 core 16 Sq.mm	CU	EPR
4.3	3 core 16 Sq.mm	CU	EPR
4.4	4 core 16 Sq.mm	CU	EPR
4.5	2 core 35 Sq.mm	CU	EPR

Sl. No.	Cable Size	Conductor	Insulation
4.6	3 core 35 Sq.mm	CU	EPR
4.7	4 core 35 Sq.mm	CU	EPR
4.8	3 core 95 Sq.mm	CU	EPR
4.9	3.1/2 core 95 Sq.mm	CU	EPR
5.0	FS CONTROL CABLE		
5.1	2 core 2.5 Sq.mm	CU	EPR
5.2	3 core 2.5 Sq.mm	CU	EPR
5.3	5 core 2.5 Sq.mm	CU	EPR
5.4	7 core 2.5 Sq.mm	CU	EPR
5.5	9 core 2.5 Sq.mm	CU	EPR
5.6	12 core 2.5 Sq.mm	CU	EPR

HT Motor

CW Motor

BFP Motor

ID Fan Motor

LT Control Cables

LT Power Cables

HT Cables