

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

General requirements

- 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.
- The Contractor shall supply, erect, terminate and test all instrumentation cables for control and instrumentation equipment/devices/systems included under Contractor's scope and ensuring completeness of the control system.
- 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.
- 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.
- 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.
- 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 sum price without any further cost implication to the Employer.

SPECIFICATION OF INSTRUMENTATION CABLE

Common Requirements

S. No.	Property	Requirement
1	Operating Voltage	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.
3.	Continuous operation suitability	At 205 Deg C for Type-C cables & heat resistant cables, at 70 Deg C for all other type of cables.
4.	Marking :-	<p>a. <i>Progressive automatic on-line sequential marking of length in meters to be provided at every one meter on outer sheath.</i></p> <p>b. Marking to read 'FRLS' to be provided at every 5 meters on outer sheath except for Type-C cable</p> <p>c. 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 on outer sheath.</p>

S. No.	Property	Requirement
5.	Allowable Tolerance on overall diameter	+/- 2 mm (maximum) over the declared value in data sheet
6.	Variation in diameter	Not more than 1.0 mm throughout the length of cable.
7.	Ovality at any cross-section	Not more than 1.0 mm
8.	CAGE-CLAMP suitability	To be provided
9.	Color	The outer sheath shall be of blue color.
10.	Others	Repaired cables shall not be acceptable.

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 material	ANSI type KX	ANSI type SX	Annealed bare copper	ANSI type KX
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	2/4/8/12/16/24 / 48	2
Max. conductor loop resistance per Km (in ohm) at 20 deg. C	As per ANSI MC 96.1		73.4	As per ANSI MC 96.1
Reference Standard	As per ANSI MC 96.1		VDE : 0815	As per ANSI MC 96.1

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
B. INSULATION				
Material	Extruded PVC type YI 3			Teflon (i.e. extruded FEP)
Thickness in mm (Min/Max)	0.25/0.35			0.4 / 0.50 (nominal)
Volume Resistivity (Min) in ohm-cm	1 x 10 ¹⁴ at 20 deg. C & 1x10 ¹¹ at 70 deg. C.			2.8x 10 ¹⁴ at 20 deg. C & 2x10 ¹¹ at 205 deg. C.
C. PAIRING & TWISTING				
Max. lay of pairs (mm)	50			
Single layer of binder tape on each pair provided	Each core printed with number or Numbered binder tape to be provided on each pair		Yes	Each core printed with number or Numbered binder tape to be provided on each pair
Bunch (Unit Formation) for more than 4P	N.A		To be provided	N.A
Conductor /pair identification as per VDE0815	N.A.		To be provided	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		0.028mm (28 micron)	No
Overall cable assembly shielding	To be provided			
Minimum thickness of Overall cable assembly shielding	0.055 mm (55 micron)			
Coverage /	100% / 20%			

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Overlapping				
Drain wire provided for individual shield	N.A.	Yes (for F-type) Size- 0.5 sqmm No of strands-7 Dia of strands- 0.3mm Annealed Tin coated copper		N.A.
Drain wire provided for overall shield	Yes, Size- 0.5 sqmm, No of strands-7, Dia of strands-0.3mm, Annealed Tin coated copper			
E. FILLERS (if applicable)				
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
Resistant to water, fungus, termite & rodent attack	Required			
Minimum Oxygen index as per ASTM D-2863	29 %			N.A.
Minimum Temperature index as per ASTM D-2863	250 deg.C			N.A.
Maximum Acid gas generation by weight as per IEC-60754-1	20%			N.A.
Maximum Smoke Density Rating as per ASTM D-2843	60%			N.A.
	(defined as the average area under the curve when the results of smoke density test			

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
	plotted on a curve indicating light absorption vs. time as per ASTM D-2843)			
Reference standard	VDE207 Part 5, VDE-816		VDE207 Part 6 ASTM D2116	
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	60dB
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			As per manufacturer's standard subject to employer's approval
I. CABLE DRUM				
Type	Non-returnable wooden drum (wooden drum to be constructed from seasoned wood free from defects with wood preservative applied to entire drum) or steel drum.			

Specification Requirements	Type-A cable	Type-B cable	Type F & G cable	Type-C cable
Length	1000 m \pm 5% for up to & including 12 pairs 500 m \pm 5% for above 12 pairs			

Note: Heat resistant instrumentation cable shall have same specification as of G/F type instrumentation cable as specified above, except that insulation and outer sheath material shall be Teflon and cable shall be suitable for continuous operation at 205 Deg. C.

SPECIFICATION OF OPTICAL FIBER CABLES (OFC)

Optic Fiber cable shall be 4/8/12 core, Electrolytically chrome plated corrugated steel taped (ECCST), 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 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.

The cable core shall have suitable characteristics and strengthening for prevention of damage during pulling viz. Dielectric 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

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

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

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

Spliced / Repaired cables are not acceptable.

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

SPCIFICATION OF LT POWER SUPPLY CABLES

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS: codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS: 1554 - I PVC insulated (heavy duty) electric cables for working voltages upto and including 1100V.

IS: 3961 Recommended current ratings for cables

IS: 3975 Low carbon galvanized steel wires, formed wires and tapes for armouring of cables.

IS: 5831 PVC insulation and sheath of electrical cables.

IS: 7098 (Part -I) Cross linked polyethylene

insulated PVC sheathed cables for working voltages upto and including 1100V.

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

IS: 10418 Specification for drums for electric cables.

IS: 10810 Methods of tests for cables.

ASTM-D -2843 Standard test method for density of smoke from the burning or decomposition of plastics.

IEC-754

(Part-I) Tests on gases evolved during combustion of electric cables.

IEC-332 Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

TECHNICAL REQUIREMENTS

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water.

All cables including EPR cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses developed under steady state and transient operating conditions as specified elsewhere in this specification.

Aluminium conductor used in power cables shall have tensile strength of more than 100 N/ sq.mm. Conductors shall be stranded.

XLPE insulation shall be suitable for a continuous conductor temperature of 90 deg.C and short circuit conductor temperature of 250 deg C. PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

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.

For single core armoured cables, armouring shall be of aluminium wires/ formed wires. For multicore armoured cables, armouring shall be of galvanized steel as follows:

Calculated nominal dia. of cable under armour	Size and Type of armour
Upto 13 mm	1.4mm dia GS wire
Above 13 & upto 25mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
Above 25 & upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
Above 40 & upto 55mm	1.4 mm thick GS formed wire /2.5mm dia GS wire
Above 55 & upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The aluminium used for armouring shall be of H4 grade as per IS: 8130 with maximum resistivity of 0.028264 ohm mm² per meter at 20 deg C. The sizes of aluminium armouring shall be same as indicated above for galvanized steel.

The gap between armour wires / formed wires 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 of G.S.wire/ formed wire.

Outer sheath shall be of PVC as per IS: 5831 & black 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 % (as per ASTM D-2843).

Cores of the cables shall be identified by colouring of insulation. Following colour scheme shall be adopted:

- 1 core - Red, Black, Yellow or Blue**
- 2 core - Red & Black**
- 3 core - Red, Yellow & Blue**
- 4 core - Red, Yellow, Blue and Black**

For reduced neutral conductors, the core shall be black

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 shall be progressive, automatic, in line and marking shall be legible and indelible. For EPR cables identification shall be printed on outer sheath.

All cables shall meet the fire resistance requirement as per Category-B of IEC 332 Part-3.

Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum, over the declared value in the technical data sheets.

In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

Cable selection & sizing:

Cables shall be sized based on the following considerations:

- (a) Rated current of the equipment.
- (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.

Cable lengths shall be considered in such a way that straight through cable joints are avoided.

All Cables shall be of armoured type.

All LT power cables of sizes more than 120 sq.mm shall be XLPE insulated and sizes shall be of 1Cx150, 1Cx300, 1Cx630, 3Cx150 & 3Cx240 sq.mm. However for cable sizes up to 120 sq.mm both XLPE insulated & PVC insulated LT power cables are acceptable.

Same cable sizes to be used for same type & rating of motor i.e. if there are three pumps for one application, all three pumps motor should be provided with same cables sizes.

Type Tests

The reports for the following type tests shall be submitted for one size each of LT XLPE and LT PVC Power cables. Size shall be decided by the employer during detailed engineering:

S.No.	Type test	Remarks
	For Conductor	
1.	Resistance test	
2.	Tensile test	For circular non-compacted conductors only
3.	Wrapping test	For circular non-compacted only
	For Armour Wires/ Formed Wires	
4.	Measurement of Dimensions	
5.	Tensile Test	
6.	Elongation test	
7.	Torsion test	For round wires only
8.	Wrapping test	For aluminium wires / formed wires only.
9.	Resistance test	
10(a)	Mass of zinc coating test	For GS Formed wires/wires only
10(b)	Uniformity of zinc coating	For GS Formed wires /wires only
11.	Adhesion test	For GS Formed wires/wires only
	For PVC/XLPE insulation & PVC Sheath	
12.	Test for thickness	

- | | | |
|-----|--|------------------------------------|
| 13. | Tensile strength & elongation before ageing and after ageing tests | |
| 14. | Ageing in air oven | |
| 15. | Loss of mass test | For PVC insulation and sheath only |
| 16. | Hot deformation test | For PVC insulation and sheath only |
| 17. | Heat shock test | For PVC insulation and sheath only |
| 18. | Shrinkage test | |
| 19. | Thermal stability test | For PVC insulation and sheath only |
| 20. | Hot set test | For XLPE insulation only |
| 21. | Water absorption test | For XLPE insulation only |
| 22. | Oxygen index test | For outer sheath only |
| 23. | Smoke density test | For outer sheath only |
| 24. | Acid gas generation test | For outer sheath only |
| | For completed cables | |
| 25. | Insulation resistance test
(Volume resistivity method) | |
| 26. | High voltage test | |
| 27. | Flammability test as per IEC-332 Part-3 (Category-B) | |

Indicative list of tests/checks, Routine and Acceptance tests shall be as per Quality Assurance & Inspection table of LT power cables enclosed.

LT CONTROL CABLES

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as on date of opening of bid. In case of conflict between this specification and those (IS : codes, standards, etc.) referred to herein, the former shall prevail. All the cables shall conform to the requirements of the following standards and codes:

IS :1554 - IPVC insulated (heavy duty) electric cables for working voltages up to and including 1100V.

IS : 3961 Recommended current ratings for cables

IS : 3975 Low carbon galvanized steel wires, formed wires and tapes for armouring of cables.

IS : 5831 PVC insulation and sheath of electrical cables.

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

IS : 10418 Specification for drums for electric cables.

IS : 10810 Methods of tests for cables.

ASTM-D –2843 Standard test method for density of smoke from the burning or decomposition of plastics.

IEC-754 (Part-I) Tests on gases evolved during combustion of electric cables.

IEC-332 Tests on electric cables under fire conditions. Part-3: Tests on bunched wires or cables (Category-B).

TECHNICAL REQUIREMENTS

The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water.

All cables including EPR cables shall be flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

Conductor of control cables shall be made of stranded, plain annealed copper.

PVC insulation shall be suitable for continuous conductor temperature of 70 deg C and short circuit conductor temperature of 160 deg. C.

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.

For multicore armoured cables, the armouring shall be of galvanized steel as follows:

Calculated nominal dia

of cable under armour	Size and Type of armour
Up to 13 mm	1.4mm dia GS wire
Above 13 upto 25 mm	0.8 mm thick GS formed wire / 1.6 mm dia GS wire
Above 25 upto 40 mm	0.8mm thick GS formed wire / 2.0mm dia GS wire
Above 40 upto 55mm	1.4 mm thick GS formed wire/2.5mm dia GS wire
Above 55 upto 70 mm	1.4mm thick GS formed wire / 3.15mm dia GS wire
Above 70mm	1.4 mm thick GS formed wire / 4.0 mm dia GS wire

The gap between armour wires / formed wires 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.

Outer sheath shall be of PVC as per IS: 5831 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 ASTM D-2843.

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

- 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

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 underneath 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 consecutive numbers shall not exceed 50 mm.

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. For EPR cables identification shall be printed on outer sheath.

All cables shall meet the fire resistance requirement as per Category-B of IEC- 332 Part-3.

Allowable tolerances on the overall diameter of the cables shall be ± 2 mm maximum over the declared value in the technical data sheets.

In plant repairs to the cables shall not be accepted. Pimples, fish eye, blow holes etc. are not acceptable.

Cable selection & sizing

Control cables shall be sized based on the following considerations:

- (a) The minimum conductor cross-section shall be 1.5 sq.mm.
- (b) The minimum number of spare cores in control cables shall be as follows:

No. of cores in cable	Min. No. of spare cores
2C, 3C	NIL
5C	1
7C-12C	2
14C & above	3

Cable lengths shall be considered in such a way that straight through cable joints are avoided.

All Cables shall be of armoured type.

TYPE TESTS

The reports for the following type tests shall be submitted for one size of control cables. Size shall be decided by the employer during detailed engineering

S. No.	Type Test	Remarks
	For Conductor	
1.	Resistance test	
	For Armour Wires / Formed Wires (If applicable)	
2.	Measurement of Dimensions	
3.	Tensile Test	
4.	Elongation test	
5.	Torsion test	For round wire only
6.	Wrapping test	For aluminium wires / formed wires only.
7.	Resistance test	
8(a).	Mass of zinc Coating test	For GS wires/formed wires only
8(b).	Uniformity of zinc coating	For GS wires/formed wires only
9.	Adhesion test	For GS wires/formed wires only
	For PVC insulation & PVC Sheath	

S. No.	Type Test	Remarks
10.	Test for thickness	
11.	Tensile strength and elongation test	before ageing and after ageing
12.	Ageing in air oven	
13.	Loss of mass test	For PVC insulation and sheath only
14.	Hot deformation test	For PVC insulation and sheath only
15.	Heat shock test	For PVC insulation and sheath only
16.	Shrinkage test	
17.	Thermal stability test	For PVC insulation and sheath only
18.	Oxygen index test	For outer sheath only
19.	Smoke density test	For outer sheath only
20.	Acid gas generation test	For outer sheath only
	For completed cables	
21.	Insulation resistance test(Volume resistivity method)	
22.	High voltage test	
23.	Flammability test as per IEC-332 Part-3 (Category-B)	

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 / Marshalling – cum Termination Cubicle / local group JB	Plug in connector	Post 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	Local junction box / 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	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/ 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 / Marshalling – cum Termination Cubicle	Cage clamp (Rail mount) type.	Cage clamp (Post mounted) type.	F,G
Marshalling cubicle/ Termination Cabinet	Electronic system cabinet	Cage clamp (Post mounted) type.	Plug-in connector / other system as per Mfr.'s Standard	Internal wiring

Application		Type Of Termination		Type Of Cable
FROM (A)	TO (B)	END A	END B	
Marshalling/ Termination System Cabinets	UCD mounted equipments	Cage clamp (Post mounted) type.	Plug in connector / Cage clamp type (rail mounted).	F,G (with plug-in connect or at one end)
DDCMIS/PLC cabinets	PC, Printers etc.	Plug in connector	Plug in connector	Mfr.'s Standar d

Notes:

1. Normally 10% spare cores shall be provided when the numbers of pairs of cables are more than four pairs, except for pre-fabricated cables which shall be as per manufacturer's standard.
2. For analog signals, individual pair shielding & overall shielding & for Binary signals, only overall shielding of instrumentation cables shall be provided.
3. * For high temperature applications only.
4. For connection between field/JB and DDCMIS marshalling cabinet Minimum 4 pair instrumentation cable shall be used.
5. All the spare cores of instrumentation cable have to be terminated in Marshalling cabinets/ DCS panel end.
6. Not used.

TERMINAL BLOCKS:

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.

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 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.

All the terminal blocks shall be provided complete with all required accessories including assembly rail, locking pin and section, end brackets, partitions, small partitions, transparent covers, support brackets, distance sleeves, warning label, marking, etc.

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.

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.

INTERNAL PANELS/ SYSTEM CABINETS WIRING

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.

All internal wires shall be provided with tag and identification nos. etched on tightly fitted ferrules at both ends. All wires directly connected to trip devices shall be distinguished by one additional red colour ferrule.

All external connection shall be made with one wire per termination point. Wires shall not be tapped or spliced between terminal points.

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.

All the special tools as may be required for solder less connections shall be provided by Bidder.

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).

INSTRUMENTATION CABLE INSTALLATION AND ROUTING

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.

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:

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

Cables shall terminate in the enclosure through cable glands. All cable glands shall be properly gasketed. 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.

The cables emanating from redundant equipment/devices shall be routed through different paths. The above segregation of cables & wiring for redundant equipment's/devices shall be in accordance with IEEE-Std-422.

CABLE LAYING AND ACCESSORIES

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 No jointing is permissible for Instrumentation cables. For other cables jointing for more than 250 Meters run of cable shall be permitted.

5 Buried cable protection

With concrete slabs; Route markers at every 20 Meters along the route & at every bend.

6 Segregation (physical isolation to prevent fire jumping)

All cable associated with the unit shall be segregated from cables of other Units.

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.

7 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.