

 BHEL – ISG BANGALORE	INDENT SPECIFICATION OF LT POWER AND CONTROL CABLES FOR CHP CONVEYOR PACKAGE 2X660MW, STAGE-V, UNIT #7 AND 8, SURATGARH SCTPS	TECH SPEC NO: RRVUNL/ELEC/199
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REF: IS-1-13-2000

CUSTOMER: RRVUNL

**TECHNICAL SPECIFICATIONS OF LT POWER AND CONTROL
CABLES FOR CHP CONVEYOR PACKAGE
2X660MW SUPER CRITICAL THERMAL POWER STATION,
STAGE-V, UNIT #7 AND 8 AT SURATGARH, RAJASTHAN**

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ENCLOSURES:

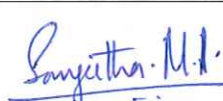
ANNEXURE-1: TYPICAL DATA SHEET OF LT POWER CABLES

ANNEXURE-2: TYPE/ ACCEPTANCE/ROUTINE TEST REQUIREMENTS OF LT POWER CABLES

ANNEXURE -3: TECHNICAL DATA SHEET OF CONTROL CABLES.

ANNEXURE- 4: TYPE, ROUTINE & ACCEPTANCE TEST PROCEDURE OF CONTROL CABLES.

NOTE: Kindly note that supplier shall not be allowed to revise price bid, if there is no change in technical specifications/quantity from BHEL. Please comply with all clauses in the specification. Technical 'No Deviation' format shall be duly stamped and signed along with technical offer. In absence of above, BHEL presumes that there is no technical deviation. In case any technical clarification is required, kindly email to vraov@bhel.in and mas@bhel.in, with a copy to kms@bhel.in and sbanra@bhel.in.

 PREPARED & CHECKED BY V. VENKATESHWAR RAO	 APPROVED BY SANGEETHA MA
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SECTION I: SITE CONDITIONS

1.1	GENERAL SITE CONDITIONS	
1.	Owner / Purchaser	: Rajasthan Rajya Vidyut Utpadan Nigam Ltd. (RRVUNL)
2.	Engineer/consultant	: Tata Consulting Engineers Ltd (TCE) 73/1, St. Marks Road, Bangalore – 560 001
3.	Project Title	: 2 x 660 MW, Super-Critical TPS, Stage-V, Unit # 7 & 8 at Suratgarh, Rajasthan
4.	Project location	: Prabat Nagar, Suratgarh, Sriganganagar district, Rajasthan.
5.	Elevation (above Sea level)	: 186 m (approximate)
6.	Temperatures : Monthly basis	: Mean of daily max. 32.8 deg.C (in the month of May) Mean of daily min. 17.6 deg.C (in the month of Jan)
7.	Temperatures : Annual basis	: Mean of daily max. 32.3 deg.C Mean of daily min. 19.6 deg.C
8.	Highest temperature recorded	: 50 deg.C
9.	Lowest temperature recorded	: (-) 2.8 deg.C
10.	Design temperature	: 50 deg. C
11.	Relative humidity	: Varies between 21% and 81%
12.	Annual average rain fall	: 312 mm
13.	Annual mean wind speed : Calculations for wind effect shall be in accordance with IS:875- 1987(Part-3) taking into account the following	: 4 km/hr a) Basic wind speed = 47 m/sec b) Factor K1 = 1.07 c) Category of terrain = Category 2 d) K3 – as per IS 875
14.	Seismic data (As per IS: 1893 latest issue)	: Zone II; Designs & design coefficients will be based on IS 1893:2002
15.	Nearest railway station	: Suratgarh JN
16.	Nearest airport	: Jaipur
1.2	POWER SUPPLY SYSTEMS	
1.2.1	MV System	
	System Voltage	: 6.6 kV $\pm$ 10%, 3 Phase, 3 wire
	System Frequency	: 50 Hz $\pm$ 5%
	Combined Variation	: 10% (absolute)
	System Fault level	: 40 kA for 3s
	System Earthing	: Non effectively earthed
	Drives	: 161kW-1500kW
1.2.2	LV System	
	System A.C voltage	: 415 V $\pm$ 10%
	System Frequency	: 50 Hz $\pm$ 5%
	Combined Variation	: 10% (absolute)
	Phase	: 3 ph, 3- wire
	System fault level	: 50 kA for 1s
	System Earthing	: Solidly grounded
	Panel space heater, lighting, AC Control & Protection Supply	: 240V, Single phase
	Drives	: up to 160kW
1.2.3	DC System	
	System Voltage	: 220V, +10%, -15%, 2-wire
	Fault level	: 20 kA
	System Earthing	: Unearthed

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SECTION II: APPLICABLE STANDARDS

CODES AND STANDARDS

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 work shall be carried out as per the following standards/codes as applicable.

Sl. No.	Standard	Description
1.	IS :1554 - I	Specification for PVC insulated (Heavy duty) electric cables for working voltages up to 3.3 KV and including 11 KV
2.	IS : 3961	Recommended current ratings for cables
3.	IS : 3975	Specification for mild steel wires, formed wired and tapes for armouring of cables
4.	IS : 4905	Methods for random sampling
5.	IS: 7098- Part -1	Cross-linked Polyethylene Insulated, PVC Sheathed cable for working voltage from 3.3KV up to and including 33KV
6.	IS : 8130	Specification for conductors for Insulated electric cables and flexible cords
7.	IS : 10418	Specification for drums for electric cables
8.	IS : 10810	Methods of tests for cables
9.	IS : 10810	Water Absorption Test
10.	Class F3 of Swedish standard SENSS-424-1475,IEC-60332 Part 1, IEEE 383, IS-10810 Part-53, IS 10810 Part-61 & 62 (Category-A),	Flammability Tests
11.	ASTMD-2843, ASTMD-2863, IEC-60754 Part-1	FRLS Tests
12.	BS EN ISO -4892 -2	Ultraviolet test

This above list is not exhaustive. Standards not listed above but are applicable also to be followed to meet the requirement.

Equipment complying with other internationally accepted standards such as IEC, BS, DIN, USA, VDE etc. will also be considered if they ensure performance and constructional features equivalent or superior to standards listed above. In such a case, the Bidder shall clearly indicate the standard(s) adopted, furnish a copy in English of the latest revision of the standards along with copies of all official amendments and revisions in force as on date of opening of bid and shall clearly bring out the salient features for comparison.

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SECTION III: SCOPE OF WORK

Design, manufacture, testing and supply of the following:

LT Power cables of 1100 V earthed grade with stranded aluminium conductor, XLPE insulation, core identification by colour coding, extruded inner sheath of PVC (type ST2), wire/strip armour and extruded PVC type ST2 outer sheath with FRLS properties, generally conforming to IS: 7098 (Part 1).

Sl. No.	Description	Qty	UOM
1.	3C X 2.5 Cu	730	Mtr
2.	3C X 25 Al	200	Mtr
3.	3C X 50 Al	250	Mtr
4.	3C X 240 Al	480	Mtr

Design, manufacture, testing and supply of the following:

Control cables shall be 1.1KV grade, with stranded plain annealed copper conductor having minimum 7 strands, PVC Type-A insulated, core identification by colour coding (upto five cores)/number marking (more than five cores), distinct extruded inner sheath of PVC type ST1 material, GS round/formed steel wire armour as per IS 3975, and extruded PVC type ST1 outer sheath with FRLS properties, generally conforming to IS 1554 Part-I and BHEL specification.

Sl. No.	Description	Qty	Unit
1	3CX1.5 Sqmm Armoured Copper Cable	2350	Mtr

Note: Above quantity may vary during detail engineering. Unit rate shall be furnished for all items.

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SECTION IV: TECHNICAL SPECIFICATION

1. LT Power and Control Cable Specifications shall be as per **Annexure-1** and **Annexure-3** respectively.
2. The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water.
3. Cables shall be designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions as specified elsewhere in this specification.

CABLE DRUMS

- 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.
- Each drum shall Manufacturer's name, year of manufacture, country of manufacture, Cable size (cross section area and number of cores), Voltage grade, Length of cable, Direction of rotation of drum and gross weight shall be marked on 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.

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SECTION V: INSPECTION AND TESTING

Cable shall be tested at manufacturers work in presence of BHEL/RRVUNL representative as per approved QAP. QAP shall be submitted by Bidder for approval by BHEL/RRVUNL.

Inspection notice shall be issued fifteen (15 days) in advance along with internal (manufacturer) TCs.

All materials, components covered under this specification shall be procured, manufactured, inspected and tested as per approved Quality plan only.

Cost towards the inspection of LT Power and Control cable by RRVUNL/TCE Engineer/Inspector will be to bidder's account, which includes to & fro Airfare/Railway/Road fare charges, Boarding and Lodging, local transportation and other related expenses. The cost shall be included in the quoted supply prices.

TESTS:

- Cost of cables consumed for testing shall be to bidder's account.
- The charges of Hydrolytic Stability test, if asked to perform shall be reimbursed extra at actual against original money receipt of Govt. Lab (CPRI/ERDA).
- Testing procedure for LT Power Cable shall be as per **Annexure-2**.
- All tests on Control Cable shall be conducted as per attached **Annexure-4**.

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SECTION VI: DOCUMENTATION

The following documentation shall be submitted to BHEL at different stages of the Project. In preparing and submitting the documentation, the requirements given in subsequent clauses shall be strictly adhered to

Sl. No.	Description	Category	No. of copies	TIME SCHEDULE
1.	Data sheet for cables	For approval	12	Within 7 days of LOI/Order
2.	De-rating factors for various conditions	For review	2	Within 7 days of LOI/Order
3.	Test Certificates/Inspection reports	For review	2	Along with Inspection Call
4.	Packing/drum details	For information	2	Along with Inspection Call
5.	Storage instructions for long period storage	For information	2	Along with Dispatch.
6.	Erection instructions	For information	2	Along with Dispatch.
7.	Final documents for Sl. Nos. 1 & 3	For distribution	12	-
8.	Catalogues, Operation and Maintenance manuals	For distribution	12	Along with Dispatch.

DATA TO BE FURNISHED BY THE VENDOR AFTER THE AWARD OF CONTRACT:

- Construction details including type of material used and thickness of each material for each type of cable in a tabular form.

Instruction Manuals

- Two (2) numbers of copies of instruction manuals, descriptive bulletins etc. shall be furnished prior to dispatch of cables. The manual shall include amongst others, the following particulars.
- General information.
- Principal technical data.
- Description of insulation, sheathing and screening. This should include data on resistance to attack by chemicals, fungus, termites, rodents, water and ultra-violent radiation.
- Installation and termination instructions.

Test Certificates

Type test certificates for all types of cables included in the order and special tests on FRLS/FS cables.

- Any other information specifically called for by PURCHASER or ENGINEER subsequent to order.

Notes:

- All drawings, documents and catalogues shall be available in soft copy.
- Manually prepared drawings are not acceptable
- Soft copy in CD-ROM and reproducible tracings of all drawings / documents shall be submitted along with final / as-built submission
- For all technical tables, diagrams, calculations, results, drawings, test data and scales adopted in the design the standard international unit system (SI) as per International Organization for Standardization (ISO) shall be uniformly employed.
- All engineering documents and drawings shall be of international A series size, i.e., of A0, A1, A2, A3 and A4.

Information required from bidder:

The following information/documents shall be specifically submitted by the bidder along with the bid in addition to the other information as called for in various sections of this specification:

- Technical literatures /catalogues of offered equipment
- Filled in data sheet strictly in the format enclosed
- Price schedule (in Price Bid) shall be submitted strictly in the format given
- Separate list of deviations, if any. Otherwise, bidder to categorically confirm that there are no deviations

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BHEL - ISG
BANGALORE

TYPICAL DATA SHEET OF LT POWER CABLES

ANNEXURE-1

1.0	Type of Cable	Flame Retardant Low Smoke (FRLS)
2.0	Standard applicable in general	IS: 7098 PART (I)
3.0	Voltage Grade	1.1kV
4.0	Number of cores, cross sectional area of conductors	As per Section-III
5.0	Formula for calculating short circuit current for different durations	$I_{sh} = k A / \sqrt{t}$ where, I_{sh} = Short circuit current in kA t = Fault clearing time in sec. $K = a$ constant $= 0.094$ for Aluminum conductor XLPE insulation $= 0.141$ for copper conductor XLPE insulation
6.0	Installation Conditions for specified current rating	
(a)	Ambient air temperature	50 deg. C
(b)	Ground temperature	50 deg. C
(c)	Thermal resistivity of soil	150 deg. C cm/W
7.0	CONDUCTOR	
(a)	Material	Aluminum
	Grade and Class	Stranded compacted, H2, Class 2
(b)	Standard Applicable	IS: 8130
	Shape	Circular / shaped as per IS
(d)	Min. number of strands	As per Table-2 of IS: 8130
8.0	INSULATION	
(a)	Material	XLPE
(b)	Standard Applicable	IS: 7098 Part-I
(c)	Continuous withstand temperature	90°C
(d)	Short-circuit withstand temperature	250°C
(e)	Method of application	By extrusion; sleeve extrusion not permitted.
(f)	Method of Curing	Gas curing/ Steam curing/ Sioplas.
9.0	CORE IDENTIFICATION	Colour coding as per IS.
10.0	INNER SHEATH	
(a)	Material	PVC
(b)	Colour	Black
(c)	Whether FRLS	No
(d)	Fillers	Acceptable
(e)	Material of fillers (if permitted)	Same as inner sheath (Material of filler to be compatible with that of inner sheath)
(f)	Method of application	

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SHEET 1 OF 3

 BHEL – ISG BANGALORE	TYPICAL DATA SHEET OF LT POWER CABLES	ANNEXURE-1
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(1)	Multi-core cables:	
(i)	With fillers	<i>Pressure/Vacuum extruded</i>
(ii)	Without fillers	<i>Pressure extruded</i>
11.0	ARMOUR (where applicable)	
(a)	Material:	
(i)	Single core cables	Aluminum Round Wire H4 grade to IS: 8130
(ii)	Multi-core cables	Galvanized Steel Wire/ Strip armor
(b)	Minimum Coverage	90%
(c)	Gap between armor wires	Shall not exceed one armor wire space (No cross-over/ over-riding)
(d)	Breaking load of joint	95 % of normal armor
12.0	OUTERSHEATH	
(a)	Material	PVC Type ST2 as per IS: 5831
(b)	Colour	<i>Black</i>
(c)	Whether FRLS	Yes
(d)	Method of application	Extruded
(e)	Marking	Cable size (cross section area and no. of cores) and voltage grade @ 1m (by embossing) Type of insulation, Type of inner & outer sheath e.g. "FRLS" etc, @ 1m (by embossing) Manufacturer's name and/ or trade name, and year of manufacture @ 1m (by embossing) 'BHEL-ISG' and 'RRVUNL' @ 1m (by embossing) Progressive sequential marking @ 1m (by embossing)
(f)	Other properties	The sheath shall be resistant to water, UV radiation, fungus, termite and rodent attack
14.0	TEST CONDUCTED	
(a)	Oxygen index test	YES, (Minimum 29 when tested at 27+ 2C as per ASTM-D-2863-77)
(b)	Temperature index test	YES, (Minimum 250°C at oxygen index value of 21 when tested as per ASTM-D-2863)
(c)	Acid gas generation test	YES, (Max. 20% as per IEC-60754-1 (1994)).
(d)	Smoke density rating test	YES, Max. 60% As per ASTM-D-2843-7 (1988).
(e)	Flammability Test	Cable shall pass test under fire condition as per 10810-Part-53 Cable shall also pass test under fire condition as IS-10810-Part-61, 62. Category group shall considered as Category 'A'. The finished cable pass flammability test as per IEEE-383.
(h)	Anti-fungal, Anti-rodent and Termite repulsion Test	YES
(i)	UV Radiation Test (As per BS EN ISO 4892-2/ ASTM G 154)- Duration-14 days	YES
15.0	TOLERANCE ON OUTER DIAMETER	Up to 30mm; ± 1.5mm Above 30mm; ±5% or ± 2mm, whichever is less.
15.0	MINIMUM BENDING	

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	RADIUS	
(a)	Single core cables	15 x O.D.
(b)	Multi core cables	12 x O.D.
16.0	SAFE PULLING FORCE	
(a)	Aluminum conductor cable	30 N/ sq. mm.
(b)	Copper conductor cable	50 N/ sq. mm.
17.0	CABLE DRUMS	
(a)	Type & construction	As per IS 10418
(b)	Standard drum length	500m (±) 5% /1000m (±) 5%.



1. Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine tests.

S. No.	TEST	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS \$	REMARKS
1.0	Tests for Conductor			
I.	Annealing test	For copper conductor only	T, A	
II.	Tensile test	For aluminium conductor only	T, A	
III.	Wrapping test	For aluminium conductor only	T, A	
IV.	Resistance test	For Al/Cu	T, A, R	
2.0	Tests for Armour Wires/Strips			
I.	Measurement of dimensions	Applicable for Aluminium wire & GS wire/Strip	T, A	
II.	Tensile test	Applicable for Aluminium wire & GS wire/Strip	T, A	
III.	Elongation test	Applicable for GS wire/Strip only	T	
IV.	Torsion test	For GS round wire only	T	
V.	Winding test	For GS strip only	T	
VI.	Resistance test	Applicable for Aluminium wire & GS wire	T	
VII.	Uniformity of Zinc coating test	For G. S. wires/Strip only	T	
VIII.	Mass of Zinc coating test	For G. S. wires/Strip only	T	
IX.	Wrapping Test	For Aluminium wires only	T, A	
3.0	Physical Tests for XLPE Insulation & PVC sheath			
I.	Test for thickness	Applicable for XLPE insulation, PVC inner sheath & PVC outer sheath	T, A	
II.	Tensile strength and elongation test at break	Applicable for XLPE insulation & PVC outer sheath		
(a)	Before ageing		T, A	

[illegible]

[illegible]

\$.:- (.) coma shown in 'Test conduction required As' column shall be treated as "AND"

(A) Hydraulic stability test, if asked to perform, shall be conducted as per ASTM-D-3137:81

[illegible]

ANNEXURE-3

Sr.No.	Description	Offered
1.0	GENERAL	
1.1	Name of manufacture	:
1.2	Place of manufacture	:
2.0	STANDARDS APPLICABLE	
2.1	IS-1554 (Part-I)	Yes
	For general specification of PVC cables	
2.2	IS: 8130	Yes
	For conductor material	
2.3	IS-5831	Yes
	For material of insulation, innersheath & outersheath.	
2.4	IS:3975 / IS:8130	Yes
	For armour multi core/single core cables)	
2.5	IS: 10810	Yes
	For method of tests.	
2.6	IS: 10418	Yes
	For cable drums	
2.7	ASTMD-2863	Yes
	For Oxygen index test	
2.8	SS: 424-14-75, IEC: 332-Part-III and Part-I (Category-A), IEEE: 383/74	Yes
	For flammability test	
2.9	IEC-754-1	Yes
	For acid gas generation test.	
2.10	ASTM D-2843	Yes
	For smoke generation test	
2.11	IS: 5831	Yes
	For heat shock test, loss of mass test & thermal heat stability test	
2.12	Current rating of cables conforms to	IS: 3961 (Pt-2)
2.13	Short circuit rating conforms to	IEC: 60949
3.0	CABLE CONSTRUCTION	
3.1	Conductor	
	Conductor material to IS: 8130 (Class/Grade)	Untinned Plain annealed high conductivity E.C Grade stranded bare copper conductor as per class 2 of IS: 8130, latest
	a) Control cables	Circular
3.2	Insulation	
	a) Method of Application	Extruded
	b) Material	PVC, Type A
	c) Dielectric constant at normal frequency	6-8 kV/mm
	c) Insulation resistance constant (min.)	
	i) at 27 deg. C	36.7 (Mohm-Km)
	ii) at 70/85 deg.C	0.037 (Mohm-Km)
	d) Minimum volume resistivity	
	i) at 27 deg. C	1×10^{13} (Ohm-cm)
	ii) at 70/85 deg.C	1×10^{10} (Ohm-cm)

Sr.No.	Description	Offered
	e) Minimum tensile strength	12.5 N/mm ²
	f) Minimum % Elongation at rupture.	150%
	g) Tolerance on thickness (-ve)	0.1 + 0.1*t (t = Nominal thickness of Insulation)
3.3	Inner Sheath	
	a) PVC Type ST-1 to IS: 5831	Yes
	b) Weather FRLS	No
	c) Method of application	
	i) With fillers	Pressure/Vacuum extrusion
	ii) Without fillers	Pressure Extrusion
	d) Type & shape of fillers (if used)	PVC - Circular filler (Type ST-1)
	e) Colour	Black
3.4	Armour	
	a) Galvanised steel wire/Formed wire conforming to IS: 3975. for multi core cable	Yes
	b) Hard drawn Aluminium wire H4 grade conforming to IS: 8130	Yes
	c) Method of joining	Brazing or Welding
	d) Breaking Load of joint	95% of normal armour
	e) Gap between armour	Gap between armour wires shall not exceed one armour wire space
3.5	Outer Sheath	
	a) PVC Type ST-1 to IS: 5831	Yes
	b) Whether FRLS	Yes
	c) Method of application	Extruded
	d) Minimum Tensile strength	12.5 N/mm ²
	e) Minimum % elongation at rupture	150%
	f) Colour	Black
	g) Tolerance on thickness	Not Applicable
	h) Whether progressive sequential length marking provided by embossing	Yes
	i) The outer sheath of cable shall be Resistant to water, UV Radiation, fungi, termite & rodent	Confirm
	j) Type of End Sealing for cable Drum	PVC End Caps
	k) Anti-fungal, Anti-rodent & Termite repulsion Test	Confirm On Outer Sheath
4.0	PERMISSIBLE VOLTAGE AND FREQUENCY VARIATION	
	a) Voltage	± 10%
	b) Frequency	± 5%
	c) Voltage frequency combined.	ABS 10%
5.0	Permissible Conductor Temp. for	
	a) Maximum Continuous Rating	70 °C
	b) Short Circuit	160°C
6.0	Installation Conditions for specified current rating	
	a) Ambient air temperature in deg. C	50°C
	b) Ground temperature.	30°C
	c) Depth of laying of cables buried in ground	75cm
	d) Thermal resistivity of soil	150 ° C Cm/W
	e) Thermal resistivity of insulation	650 ° C Cm/W
7.0	Formula for calculating short circuit current for different duration	$k \cdot A / \sqrt{t}$, k = Constant, A - Cross sectional area. t → time in sec

Sr.No.	Description	Offered
8.0	CHARACTERISTICS OF FRLS SHEATH	
	a) Oxygen Index	: Minimum 29 when tested at $27 \pm 2^{\circ}\text{C}$ as per ASTM-D-2863
	b) Temperature index	: Minimum 250°C at oxygen index value of 21 when tested as per ASTM D-2863
	c) Acid gas generation	: Max. 20% (by weight) as per IEC 60754-1
	d) Smoke density rating	: Max. 60% as per ASTM-D-2843-7
	e) Flammability test	: Cable shall pass test under fire condition as per IS: 10810 (Part-53) Cable shall also pass test under fire condition as per IS: 10810 (Part-61) & Part-62 (Cat-A) IEEE-383 and Class F3 of Swedish Standard SS-424 -1475 (F3)
9.0	CABLE DRUMS	
	a) Type & construction	: As per IS: 10418
	b) Standard Drum Length (Mtrs)	: 1000 mtrs
	c) Standard Drum Length (Mtrs) (for mandatory spares)	: 500 mtrs
	d) Individual Drum Tolerance (for main item)	: $\pm 5\%$
	e) Individual Drum Tolerance (for mandatory spares)	: + 5% (No Negative Tolerance)
	f) Overall Quantity tolerance (for main item)	: -2% (No Positive tolerance)
10.0	DOCUMENTATION	
	Whether following enclosed.	:
	a) X-sectional drawing with construction details	: Yes
	b) BHEL's Quality Plan with seal of acceptance	: Yes
	c) Derating factors as stipulated in section -D	: Yes
	d) Packing drawing	: No

Sl. No.	DESCRIPTION	Units	3C x 1.5	1.1 kV															
11.0	No. of cores x size	kV		17	14	13	11	10	24	17	15	13	12						
12.0	Voltage Grade			21	16	14	13	11	27	20	18	16	14						
13.0	Base current ratings (*) based on Cl. 5.0, Cl. 6.0			17	14	13	11	10	24	17	15	13	12						
	a) In Air @ 40 °C	Amps																	
	b) In Ground @ 30 °C	Amps																	
	c) In Duct @ 30 °C	Amps																	
14.0	Short Circuit rating	kA/sec.		0.173	0.173	0.173	0.173	0.173	0.288	0.288	0.288	0.288	0.288						
15.0	a) D.C. resistance of conductor at 20° C	Ohm/km		12.1	12.1	12.1	12.1	12.1	7.41	7.41	7.41	7.41	7.41						
	b) A.C. resistance of conductor at 70°C/85°C (approx)	Ohm/km		14.5	14.5	14.5	14.5	14.5	8.89	8.89	8.89	8.89	8.89						
	c) Reactance of cable at normal frequency (approx)	Ohm/km		0.126	0.126	0.126	0.126	0.126	0.119	0.119	0.119	0.119	0.119						
16.0	CONDUCTOR																		
	a) Material, type and grade																		
	b) No. and Nominal dia of wires in each core (before stranding)	no x mm		7/0.53	7/0.53	7/0.53	7/0.53	7/0.53	7/0.67	7/0.67	7/0.67	7/0.67	7/0.67						
	c) Shape																		
17.0	Nominal thickness of insulation	mm		0.80	0.80	0.80	0.80	0.80	0.90	0.90	0.90	0.90	0.90						
	Core Identification																		
	Inner sheath thickness (minimum)	mm		0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3						
18.0	ARMOUR																		
	a) Size (Nominal dia. of round wire/ Dimension of strip incl. nominal Thickness)	mm (W x T)		G.S Wire	G.S Wire	G.S Wire	G.S Wire	G.S Wire	G.S Wire	G.S Wire	G.S Wire	G.S Wire	G.S Wire						
	b) Approx No. of wires/ formed wires	Nos.		1.4	1.4	1.4	1.4	4 x 0.8	1.4	1.4	4 x 0.8	4 x 0.8	4 x 0.8						
20.0	Minimum thickness of outersheath	mm		1.24	1.24	1.24	1.4	1.4	1.24	1.24	1.4	1.4	1.4						
21.0	DIAMETERS																		
	a) i) Fictitious diameter of insulated conductor	mm		3.0	3.0	3.0	3.0	3.0	3.6	3.6	3.6	3.6	3.6						
	ii) Approx. cable diameter of insulated conductor	mm		3.3	3.3	3.3	3.3	3.3	3.9	3.9	3.9	3.9	3.9						
	b) i) Fictitious cable diameter of under armour/over inner sheath	mm		7.08	8.7	9.6	12.6	13.8	8.4	11.4	15.0	16.5	18.6						
	i) Approx. cable diameter of under armour/over inner sheath	mm		8.7	10.5	11.5	14.8	16.2	10.0	13.3	17.2	18.8	21.1						
	c) i) Fictitious cable diameter of over armour/under outer sheath	mm		9.9	11.5	12.4	15.4	15.4	11.2	14.2	16.6	18.1	20.2						
	ii) Approx. cable diameter of over armour/under outer sheath	mm		11.5	13.3	14.3	17.6	17.8	12.8	16.1	18.8	20.4	22.7						
	d) i) Fictitious overall diameter of cable	mm		12.4	14.0	14.9	18.2	18.2	13.7	16.7	19.4	20.9	23.0						
	ii) Approximate overall diameter of cable	mm		14.5	16.3	17.3	19.4	21.2	15.8	19.1	20.3	25.4	27.7						

Sl. No.	DESCRIPTION	Units	3C x 1.5
11.0	No. of cores x size	(±) mm	
21.0	Tolerance on overall diameter	x O.D.	± 1.5 mm
22.0	Minimum bending radius	N/mm ²	12 times the overall diameter
23.0	Safe pulling force		50
24.0	Weight of cable (approx)	Kg/km	400 500 575 750 775 500 850 1000 1250
25.0	Dimension of Drum (approx.)		
	Flange	mm	
	Traverse	mm	
	Barrel	mm	
	Drum Material		Shall be as per IS: 10418
	Drum Length	Mtrs	Wooden drum
	Drum Length (for mandatory spares)	Mtrs	39 x 1000 8 x 1000 38 x 1000 78 x 1000 19 x 1000 17 x 1000 20 x 1000 12 x 1000 42 x 1000
			1 x 500 1 x 500 1 x 500 1 x 500 1 x 500 1 x 500 1 x 500 1 x 500 1 x 500
26.0	Shipping weight. (approx.)	kg.	460 575 661.25 862.5 891.25 575 833.75 977.5 1150 1437.5
27.0	Identification mark on outer sheath (Marking)		A) By embossing @ 1m interval
			1) Cable size (nominal cross sectional area and no. of cores) and voltage grade
			2) " FRLS"
			3) Manufacturer's Name/Trade Name
			4) Year of manufacturer
			5) 'BHEL-ISG' & RVUNIL
			B) Progressive sequential marking by embossing

[illegible]

		STANDARD QUALITY PLAN			CUSTOMER : RRVUNL		PROJECT :2X660MW SURATGARH SUPER CRITICAL THERMAL POWER STATION STAGE-V, Units 7 & 8				Drawing No:IS-4-QP-843-100-E622		
					BIDDER/ : VENDOR		TITLE: Quality Plan for LT PVC Control Cables				Drawing Title:Data Sheet for Control Cables		
					SYSTEM		QUALITY PLAN:				Revision No:		
							NUMBER:				BHEL's Remarks:		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTIC CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	SECTION			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
2.0	IN PROCESS												
2.1	Wire Drawing , Tinning and Annealing	1. Physical, Electrical, Finish & dimension	CR	Phy. & Elect. Tests Visual / Meas.	Sample	IS:8130 & BHEL Specn.	IS:8130 & BHEL Specn.	Log Book	2	-	1		
		2. Chemical test for Tinning (if applicable)	CR	Chemical Test	Sample	-do-	-do-	-do-	2	-	-		
2.2	Stranding of wires	1. No. of wires	MA	Counting	Sample	Vendors/BHEL Specn & Apprd. Data Sheet & Relevant IS	Vendors/BHEL Specn & Apprd. Data Sheet & Relevant IS	-do-	2	-	-		
		2. Sequence, lay length & Direction	MA	Visual, Meas.	Sample	-do-	-do-	-do-	2	-	-		
		3 Surface Finish	MA	Visual	Sample	-do-	-do-	-do-	2	-	-		
		4. Dimension	MA	Measurement	Sample	-do-	-do-	-do-	2	-	-		
2.3	Core Insulation: (No repair permitted)	1. Surface finish	MA	Visual	100%	-	Free from bulding burnt particles lumps, cuts & scratches	Log Book	2	-	1		
		2. Insulation thickness	CR	Measurement	Sample	Appd. Data Sheet/ IS:1554	Appd. Dats Sheet/ IS:1554	-do-	2	-	-		
		3. Concentricity #	CR	Measurement	Sample	Mfr's Std./Appd. data sheet	Mfr's Std./Appd. data sheet	Log Book	2	-	1	# To be checked at starting & finish end of Extruded Length	
		4 Dia over insulation	MA	Measurement	Sample	-do-	-do-	-do-	2	-	-		
		5. Spark Test or Water Immersion test	CR	Electrical	100%	Mfrs.Std.	Mfrs.Std.	-do-	2	-	1		
		6. Core Identification	MA	Visual	100%	IS: 1554	IS: 1554	-do-	2	-	-		

		STANDARD QUALITY PLAN		CUSTOMER : RRVUNIL		PROJECT :2X660MW SURATGARH SUPER CRITICAL THERMAL POWER STATION STAGE-V, Units 7 & 8		Drawing No:IS-4-QP-843-100-E622					
SL. NO.		COMPONENT/OPERATION		SHEET 1 OF 5		CHARACTERISTIC CHECK		BIDDER/ VENDOR		TITLE: Quality Plan for LT PVC Control Cables		Drawing Title:Data Sheet for Control Cables	
								SYSTEM CAT.		NUMBER:			
								QUALITY PLAN:		Revision No:		BHEL's Remarks:	
								EXTENT OF CHECK		ITEM : PVC CONTROL CABLES		SECTION AGENCY	
								TYPE/ METHOD OF CHECK		REFERENCE DOCUMENT		ACCEPTANCE NORM	
										FORMAT OF RECORD		P	
										7		8	
										9		10	
										11		11	
2.4	Core Laying	1. Dia over laidup core		MA	Measurement	Sample	-do-	-do-	Log Book	2	-	-	
		2.Sequence of lay, Lay length & direction for laid up core		MA	Visual & Meas.	Sample	Mfrs.Std./relevant IS	Mfrs.Std./relevant IS	-do-	2	-	-	
		1. Surface finish		MA	Visual	100%	--	Free from bulging, burnt particles, lumps cuts & scratches.	-do-	2	-	-	
2.5	Inner/Sheath Extrusion (if applicable)	2. Sheath thickness		MA	Measurement	Sample	IS: 5831, Appd. Data Sheet, IS:1554	IS: 5831, Appd. Data Sheet, IS:1554	-do-	2	-	-	
		3. Dia over inner sheath		MA	-do-	-do-	-do-	-do-	-do-	2	-	-	
		1. No.of wires/Strips		MA	Counting	At the start of the process	BHEL Specn./ Apprd.Data sheet IS-3975 & IS-1554	BHEL Specn./ Apprd.Data sheet IS-3975 & IS-1554	-do-	2	-	-	
2.6	Armouring (if applicable)	2. Lay Direction		MA	Visual	-do-	-do-	-do-	-do-	2	-	-	
		3. Lay Length		MA	Visual, Meas.	At the start of the process	BHEL Specn./ Apprd.Data sheet IS-3975 & IS-1554	BHEL Specn./ Apprd.Data sheet IS-3975 & IS-1554	Log Book	2	-	-	
		4. Coverage		MA	Measurement	-do-	-do-	-do-	-do-	2	-	-	
2.7	Outer Sheath Extrusion	5. Dia over armouring		MA	Measurement	-do-	-do-	-do-	-do-	2	-	-	
		1. Surface Finish		MA	Visual	100%	-	Free from Porosity, Bulging,Burnt particles, lumps, cuts & scratches	Log Book	2	-	-	
		2.Sheath thickness		MA	Measurement	Sample	Appd. Data Sheet IS-5831 & IS:1554	Appd. Data Sheet IS-5831 & IS: 1554	Log Book	2	-	-	
		3. Dia over outer sheath		MA	Measurement	Sample	-do-	-do-	-do-	2	-	-	
		4. Marking		MA	Visual	100%	IS:1554 & BHEL	IS:1554 & BHEL	Test Report	2	-	-	

ANNEXURE 'A' TO QAP					
TYPE TEST PROCEDURE FOR LT CONTROL CABLES					
TYPE/ACCEPTANCE/ROUTINE TEST REQUIREMENTS					
A. Type Test Conduction					
1. Tests for which "T" is indicated in the 'Test Conduction Required As' column below shall be conducted as Type Test on one size of cable for every lot offered for inspection to be selected by purchaser at the time of testing as type tests. The same may be witnessed by BHEL/Owner, for which due notice shall be given by the vendor					
B Acceptance Test Conduction:					
1. Tests for which "A" is indicated in the 'Test Conduction Required As' column below shall be conducted as Acceptance Tests					
2. Sampling: Sampling for acceptance tests shall be as per Appendix-B of IS: 1554 (P-1)					
C. Routine Test Conduction					
1. Tests for which "R" is indicated in the 'Test Conduction Required As' column below shall be conducted as Routine Tests.					
S.NO.	TESTS	APPLICABLE FOR	TEST CONDUCTION REQUIRED AS	REMARKS	REFERENCE STANDARDS TO BE FOLLOWED FOR EACH TEST
1.0	Tests for Conductor				
I.	Annealing Test	For Copper Conductor	T,A	In process records shall be furnished to inspector at the time of inspection	IS: 8130
II.	Resistance Test	For Copper Conductor	T,A,R		IS: 8130
2.0	Tests for Round Steel Wires/Strips				
I.	Measurement of dimensions	For GS Round Wire/strip	T,A		IS: 3975 and IS: 1554 (P-1)
II.	Tensile Test	For GS Round Wire/strip	T,A		IS: 3975 and IS: 1554 (P-1)
III.	Elongation Test	For GS Round Wire/strip	T,A		IS: 3975 and IS: 1554 (P-1)
IV.	Torsion Test	For GS Round Wire	T,A		IS: 3975 and IS: 1554 (P-1)
V.	Winding Test	For GS Formed Wire	T,A		IS: 3975 and IS: 1554 (P-1)
VI.	Resistivity Test	For GS Round Wire/strip	T,A		IS: 3975 and IS: 1554 (P-1)
VII.	Uniformity of Zinc coating test	For GS Round Wire/strip	T,A		IS: 3975 and IS: 1554 (P-1)
VIII.	Mass of Zinc coating Test	For GS Round Wire/strip	T,A		IS: 3975 and IS: 1554 (P-1)
3.0	Physical Tests for PVC Insulation & PVC Sheath				
I.	Test for thickness	Applicable for PVC insulation, PVC inner sheath & PVC outer sheath	T,A		IS: 1554 (P-1) & approved data sheet
II.	Tensile strength & elongation test at break	Applicable for PVC insulation & PVC outer sheath			
	a) Before ageing		A		IS: 5831
	b) Before & after ageing		T		IS: 5831
III.	Ageing in air oven	Applicable for PVC insulation & PVC outer sheath	T		IS: 5831
IV.	Loss of mass in air oven test	Applicable for PVC insulation & PVC outer sheath	T		IS: 5831
V.	Hot deformation test	Applicable for PVC insulation & PVC outer sheath	T		IS: 5831
VI.	Heat shock test	Applicable for PVC insulation & PVC outer sheath	T		IS: 5831
VII.	Shrinkage Test	Applicable for PVC insulation & PVC outer sheath	T		IS: 5831
VIII.	Thermal Stability Test	Applicable for PVC insulation & PVC outer sheath	T		IS: 5831

ANNEXURE 'A' TO QAP					
TYPE TEST PROCEDURE FOR LT CONTROL CABLES					
4.0	<u>FRLS/Flammability Tests</u>				
I.	Oxygen Index test	For PVC Outer sheath only	T,A		ASTM D 2863
II.	Smoke Density test	For PVC Outer sheath only	T,A		ASTM D 2843
III.	Acid Gas Generation test	For PVC Outer sheath only	T,A		IEC-754-1
IV.	Temperature Index Test	For PVC Outer sheath only	T,A		ASTM D 2863
V.	Flammability test as per IS 10810 Part 53 for single cable	For complete cable	A	Project Specific (As indicated in Data Sheet- A)	IS 10810 Part 53
VI.	Flammability test as per IS 10810 Part 62 Cat 'A' for bunched cables	For complete cable	A		IS 10810 Part 62 Cat 'A'
VII.	Swedish chimney test to SEN SS-424-1475	For complete cable	A		SS: 424-1475
VIII.	Flammability Test as per IEEE: 383	For complete cable	A		IEEE-383
5.0	<u>Electrical Tests</u>				
I.	High voltage Test (Water immersion Test)	On cores	T		IS: 1554 (P-1)
II.	High voltage Test at room temperature	For complete cable	T,A,R		IS: 1554 (P-1)
III.	Insulation Resistance Test (Volume resistivity method)	For complete cable	T,A		IS: 5831
6.0	<u>Anti- rodent & termite repulsion test</u>	For PVC Outer sheath only	A	Shall be conducted on one sample only/lot	
7.0	<u>Special tests (*)</u>				
I.	Ultraviolet Test* as per BS EN ISO 4892	For complete cable	T(*)		BS EN ISO 4892

* These Test shall be conducted on one sample for the entire contract & duration of these tests shall be 14 days