

TANGEDCO

2 X 660 MW ENNORE TPP

***TECHNICAL SPECIFICATION FOR
SCREENED CONTROL CABLE***

BHEL DOCUMENT NO. : PE-TS-412-507-E004, REV-00



**BHARAT HEAVY ELECTRICALS LIMITED
POWER SECTOR
PROJECT ENGINEERING MANAGEMENT
NOIDA – 201301**



DOCUMENT TITLE

**TECHNICAL SPECIFICATION FOR
SCREENED CONTROL CABLES**

SPECIFICATION NO. PE-TS-412-507-E004

VOLUME II

SECTION -

REVISION 0

DATE: 15.03.2017

SHEET 1 OF 1

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TOTAL NO. OF SHEETS = **29**
(INCLUDING COVER/SEPARATOR SHEETS)



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COMPLIANCE CERTIFICATE

The bidder shall confirm compliance to the following by signing/ stamping this compliance certificate and furnishing same with the offer.

1. The scope of supply, technical details, construction features, design parameters etc. shall be as per technical specification & there are no exclusion/ deviation with regard to same
2. There are no deviation with respect to specification other than those furnished in the 'schedule of deviations'
3. Only those technical submittals which are specifically asked for in NIT to be submitted at tender stage shall be considered as part of offer. Any other submission, even if made, shall not be considered as part of offer.
4. Any comments/ clarifications on technical/ inspection requirements furnished as part of bidder's covering letter shall not be considered by BHEL, and bidder's offer shall be construed to be in conformance with the specification.
5. Any changes made by the bidder in the price schedule with respect to the description/ quantities from those given in BOQ-Cum-Price schedule of the specification shall not be considered (i.e., technical description & quantities as per specification shall prevail).

BIDDER'S STAMP & SIGNATURE



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SECTION – I

SPECIFIC TECHNICAL REQUIREMENTS



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1.0 SCOPE

- 1.1 Design, Manufacture, Inspection and testing at manufacture's works, proper packing and delivery to site of **Screened Control cables** conforming to this specification.
- 1.2 General technical requirements of the Screened Control cables are indicated in Section-II. Project specific technical/ quality requirements / changes are listed in Section-I.
- 1.3 The stipulations of Section-I, followed by those of Data Sheet-A shall prevail in case of any conflict between the stipulations of Section-I, Data Sheet - A & Section-II.

2.0 BILL OF QUANTITIES:

- 2.1 Quantity requirements shall be as per BOQ-cum-price schedule enclosed in NIT.

3.0 SPECIFIC TECHNICAL REQUIREMENTS

- 3.1 Technical:

<u>S.No.</u>	<u>Reference Clause No. of Section- II (if any)</u>	<u>Specific Requirement/ Change</u>

- 3.2 Quality/ Inspection:

<u>S.No.</u>	<u>Reference Clause No. of Section- II (if any)</u>	<u>Specific Requirement/ Change</u>

4.0 DRAWINGS & DOCUMENTS TO BE SUBMITTED

Following documents/drawings shall be submitted after placement of order for BHEL & Customer's approval:-

Sl. No.	Drawings/Document Description	Drawings / Document Number
1.	Technical Data Sheet - Screened control cables	PE-V0-412-507-E141
2.	Cross-sectional Drawings - Screened control cables	PE-V0-412-507-E143
3.	Manufacturing Quality Plan for Screened control cables	PE-V0-412-507-E916 (*)

NOTE: (*)

Standard Quality Plan as enclosed in the technical specification is to be appended with cover sheet bearing document number & description as stated above. The signed & stamped copy for the same shall be submitted to BHEL without making any changes in the contents of the document.

5.0 DRAWING/ DOCUMENT DISTRIBUTION SCHEDULE.



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DRAWING/DOCUMENT DISTRIBUTION LIST

All documents & drawings shall be in English and in metric units

Sl		LII	NLC (HQ)	NLC-SITE	BHEL SITE	PMG BHEL	PEM/ UNITS/ PSSR	REMARKS
1	Master list of drawings / document (duly indicating schedule of submission)	Soft copy	Soft copy	Soft copy		Soft copy	Soft copy (S)	
2	Drawings / document for Approval/Information (First Submission)	Soft copy + 2 prints	Soft copy + 3 prints	Soft copy + 1 print		Soft copy	Soft copy (S)	
3	Return with comments/approval	Soft copy (S)	Soft copy	Soft copy		Soft copy	Soft copy	
4	Drawings / Documents for approval (second & subsequent submissions till approval)	Soft copy	Soft copy	Soft copy		Soft copy	Soft copy (S)	
5	Drawings / documents for distribution (Approved by NLC, in cat. 1 or Received for Information)	Soft copy + 2 print (HQ+ Site)	Soft copy + 3 prints	Soft copy + 3 prints	Soft copy + 5 prints	Soft copy	Soft copy (S)	
6	Erection Drawings / documents	-	Soft copy + 1 print	Soft copy + 3 prints	Soft copy + 5 prints	Soft copy	Soft copy (S)	
7	As built Drawings / documents	Soft copy + 1 print	Soft copy + 1 print	Soft copy + 3 prints	Soft copy + 5 prints	Soft copy	Soft copy (S)	
8	Operation & Maintenance Manual	-	Soft copy + 1 print	Soft copy + 10 prints	Soft copy + 5 prints	Soft copy	Soft copy (S)	
9	Type Test Certificate	Soft copy	Soft copy + 1 print	Soft copy + 3 prints	Soft copy + 5 prints	Soft copy	Soft copy (S)	

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DATA SHEET-A
SPECIFIC TECHNICAL REQUIREMENTS

1.0 Type of cable : FRLS SCREENED CONTROL CABLES

2.0 Standards Applicable :

S. No.	STANDARD	APPLICATION
1	IS-1554-I	General Construction & tests for cables.
2	IS-694	For insulation thickness.
3	SEN-SS-424-1475, IEC-60332 Part 1, IEEE 383	Flammability Tests
4	ASTMD-2843, ASTMD-2863, IEC-754 Part-1, VDE 0815	FRLS Tests

3.0 Voltage grade : 1.1 kV

4.0 CONDUCTOR

a) Material : High conductivity multi stranded
annealed tinned electrolytic Copper

b) Minimum number of strands:
(dia.), cross sectional area 7 (0.3 mm.), 0.5 sq. mm.

5.0 INSULATION

a) Material : HR PVC Type C (as per IS-5831)

b) Application : Extruded

c) Insulation thickness : 0.6 mm (nominal) as per IS-694

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- c) Volume resistivity (Min.) : i. 3.5×10^{14} Ohm-cm at 27°C/ room temp. (Min.)
ii. 3.5×10^{11} Ohm-cm at 85°C (Min.)

6.0 LAYING OF CORES

- a) Min. number of twist per : 25
Metre for paired cables.
- b) Maximum lay of individual : 40 mm
twisted pair

- 7.0 IDENTIFICATION OF : As per attached Annexure-B-I
CORES

8.0 INDIVIDUALLY SCREENED

- a) Material : Aluminium-Mylar tape
- b) Coverage : 100%
- c) Overlap : Minimum 25%
- d) Min. thickness (Micron): **60 micron**

9.0 OVERALL SCREENED

- a) Material : Aluminium-Mylar tape
- b) Coverage : 100%
- c) Over lap : Minimum 25%
- d) Min. thickness (Micron) : **75 micron**

10.0 DRAIN WIRE

To be provided separately for individual pair shield (wherever applicable) and overall shield.

- a) Material : Annealed tinned copper conductor

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b) Size & no. of strands : 0.5 sq. mm. (0.8 mm dia.) & 7 Strands

11.0 BEDDING

a) Material : Mylar tape.

12.0 INNER SHEATH

a) Material : Extruded HR PVC Type ST2 as per IS-5831 & IS-1554 Part-I

b) Whether FRLS : YES

c) Fillers : Acceptable

d) Material of fillers : Same as inner sheath

e) Method of application

i) With fillers : Pressure / Vacuum Extrusion

ii) Without fillers : Pressure Extrusion

f) Inner sheath Thickness: As per IS-1554 Part-1

g) Colour : Black

13.0 RIP CORD : Non-metallic cord under inner sheath

14.0 FILLERS

a) Fillers : Acceptable, only if Flame Retardant & Moisture Resistant.

15.0 ARMOURING

a) Material : Galvanized steel round wire/ strip as per IS-3975 & IS-1554 Part-I

b) Minimum coverage : 90%

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c) Breaking load of joints : 95% of normal armour

d) Method of jointing : Welding

16.0 OUTER SHEATH

a) Material : Extruded HR PVC Type ST2 as per IS-5831 & IS-1554 Part-I

b) Thickness : As per IS-1554 Part-1

c) Application : Extruded

d) Colour : **Black.**

e) Whether FRLS : YES

17.0 FRLS/ FLAMMABILITY TESTS

a) Oxygen Index : 29% Minimum as per ASTM D 2863

b) Temperature Index : 250 °C Minimum as per ASTM D 2863

c) Acid gas generation : less than 20% by weight (As per IEC-754-1)

d) Average area under curve (Smoke density rating) : Not more than 60% (As per ASTM D 2843)

e) Water immersion Test: As per VDE 0815

f) Flammability Test : As per **IEC-60332-1**, IEEE-383 & Swedish Chimney SS-424-1475, class F3

18.0 Rodent & Termite Test : Few chippings of PVC compound are slowly ignited in a porcelain dish in a muffle furnace at about 600 deg. 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 (lead).

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19.0 TOLERANCE ON OVERALL : $\pm 2\text{mm}$ max. over the declared value in
DIAMETER Technical Data Sheet

20.0 VARIATION IN DIA & : Not more than 1 mm.
OVALITY AT ANY
CROSS-SECTION

21.0 (i) DRUM MATERIAL : Non-returnable wooden drums

(ii) DRUM LENGTH

a) Standard drum length : 1000 metres upto & including 12 Pairs;
500 metres above 12 Pairs

b) Tolerance on drum length : $\pm 5\%$

22.0 MARKING

a) Progressive sequential : Yes @ 1 m by printing/ embossing
Length marking to be provided
on outer sheath

b) Progressive marking @ 1 m : Manufacturer's name or trade mark,
Type of cable, voltage grade, Year of
manufacture, Type of insulation, Type of
outer sheath e.g. "FRLS" etc., Nominal
cross sectional area of conductor and
number of pairs @ 1 metre by printing/
embossing.

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23.0 TECHNICAL PARAMETERS (C & I) As per Table below

STANDARD CABLE PARAMETERS FOR INSTRUMENTATION CABLE

Parameter	0.5 mm ² (IS & OS) type-F	0.5 mm ² (OS) type-G
Mutual Capacitance (max.) at 0.8 kHz, nF/Km	100	100
Conductor Loop Resistance (max.), Ohm/Km	78.4	78.4
Insulation Resistance (min), M Ohm/ Km	100	100
Cross Talk attenuation (min) at 0.8kHz, dB/Km	70	70
Characteristic impedance (max.) at 1 kHz	320	320
Attenuation (max.) at 0.8 KHz, db/100m	0.11	0.11
Attenuation (max.) at 10 KHz, db/100m	0.29	0.29
Coupling capacitance (min) at 0.8kHz, pF/m	200	200
Capacitance unbalance (max), pF/500m	400	400

Note:

1. Cable parameters indicated above are at 20 degC (+/- 3 degC)

24.0 Test voltage & duration

(a) High Voltage Tests

- (i) Core to core : 2KV for 1 minute
(ii) Core to shield : 2KV for 1 minute

25.0 All cables shall be provided with anti termite, anti Rodent, anti-fungal & moisture resistant properties.



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ANNEXURE: B-I

CORE IDENTIFICATION / PAIR IDENTIFICATION



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ANNEXURE: B-I

The wires of pairs shall be coded by base colours on insulation which are repeated in every unit. Base colours of the pairs in a unit shall be as follows:

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

Each four pair is laid to form one unit and wound with Mylar tape. The cores of each unit shall then be identified by colour bands for cables of more than 4-pair. e.g. All eight cores of the first unit shall have a single band of pink colour.

Unit	Ring Colour	Ring Group
1	PINK	I
2	PINK	II
3	PINK	III
4	PINK	IIII
5	PINK	IIIII
6	ORANGE	IIIIII
7	ORANGE	IIIIIII
8	ORANGE	IIIIIIII

The vertical lines under column (Ring Group) in the above table indicate number of rings at intervals of approx. 60 mm length of the wires of the units. For cables above 4 pair, each 4 pair units shall be open helically lapped with numbered binder taped for the purpose of binding & unit identification.



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DATA SHEET-C

S.No.	Particulars	Unit	Description
1	Manufacturer's name	-	
2	Reference design standards	-	
3	Conductor size	sq. mm	
4	Rated Voltage	V	
5	Number of pairs	No.	
6	Cable suitable for both earthed & unearthed system	-	
7	Conductor		
	a) Material	-	
	b) Reference Standard	-	
	c) Grade	-	
	d) No. of strands	No.	
	e) Diameter of strands (nom.)	mm	
	f) Approx. dia of conductor	mm	
	g) Cross Section area	sq. mm	
8	Insulation		
	a) Reference Standard	-	
	b) Material composition	-	
	c) Application	-	
	d) Minimum thickness	mm	
	e) Nom.Thickness	mm	
	f) Max. thickness	mm	
	g) Minimum volume resistivity as per IS 5831	Ohm cm	
	h) Dielectric constant	-	
	i) Maximum conductor temperature withstand capacity	°C	
	j) Core diameter including insulation	mm	
9	Core laying		
	a) Whether cores are twisted.	-	
	b) Maximum lay of twist	mm	
	c) Identification of cores	-	
10	Individual Shield		



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	a) Material	-	
	b) Thickness of tape	micron	
	c) Coverage/ Overlap	%	
	d) Noise interference better than	dB	
11	Drain wire for individual shield		
	a) Reference standard	-	
	b) Size (No. of strands/ dia. of each strand)	sq. mm (no./mm)	
	c) Material	-	
	d) Resistance of drain wire per km at 20 deg.C	ohm	
12	Overall shield		
	a) Material	-	
	b) Thickness of tape	mm	
	c) Coverage/Overlap	%	
	d) Noise interference better than	dB	
13	Drain wire for overall shield		
	a) Reference standard	-	
	b) Size/ No.of strands	sq. mm/ no.	
	c) Material	-	
	d) Resistance per Km (with shield) at 20°C	Ohm/ km	
14	a) Fillers: Material (if applicable)		
	b) Bedding Material		
15	Inner sheath		
	a) Material, type and standard	-	
	b) Whether FRLS	-	
	c) Colour	-	
	d) Method of application	-	
	e) Thickness (min)	mm	
16	Armour		
	a) Material,	-	
	b) Formed wire / round wire		
	c) Minimum Coverage	%	
	d) Method of jointing	-	
	e) Breaking load of joint	-	
	f) Size (approx.)	mm	
	g) Dia of armour	mm	
	h) No. of wires	mm	
17	Outer sheath		
	a) Reference standard	-	
	b) Material	-	
	c) Minimum thickness of sheath	mm	



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	d) Calculated dia under outersheath	mm	
	e) Oxygen index (as per ASTM D 2863)	-	
	f) Temperature index (in deg. C as per ASTM D 2863)	-	
	g) Maximum acid gas generation as per IEC754-1	%	
	h) Maximum smoke density rating as per ASTM D 2843	%	
	i) Colour of outer sheath	-	
18	Dia over laid-up core	mm	
19	Dia under armour	mm	
20	Dia above armour	mm	
21	Overall diameter of cable	mm	
22	Tolerance on overall diameter	mm	
23	Weight of		
	Copper (conductor & drain wire)	MT. / km	
	PVC (insulation, sheath & fillers)	MT. / km	
	Armour	MT. / km	
	Cable (approx.)	MT. / km	
24	Cable parameters at 20°C(+/-3 deg. C)		
	a) Conductor resistance (max)	Ohm/ km	
	b) Insulation resistance (min)	M-Ohm	
	c) Mutual capacitance at 0.8KHz (max)	nF/ km	
	d) Cross talk at 0.8KHz (min)	dB	
	e) Attenuation at 1 KHz (max)	dB/ km	
	f) Characteristic impedance at 1 KHz (max)	Ohm	
25	Continuous operating temp. (deg.C)	deg. C	
26	(a) Relevant IS standard including Part & category for Flame retardance of complete cable	-	
	(b) Relevant IEC standard including Part & category for Flammability of complete cable		
27	Whether complete cable passes Swedish Chimney test as per SEN 4241475 (F3)	-	
28	Identification		
	a) Length of cable marked at every mtr.	-	
	b) FRLS marked at every 5 mtrs	-	
	c) Each core of the pair numbered	-	
	d) Conductor identification details for pairs	-	
	e) Details of cable markings	-	
29	Test voltage		
	a) High voltage test/ Dielectric Strength		
	i) Voltage (KV), Core - Core	kV	
	ii) Duration	min	
	b) High Voltage test		



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	i) Voltage (KV), Core - Screen	V	
	ii) Duration	min	
	c) Resistance to direct current test (applicable for 225 V cable as per VDE)	-	
	Voltage	V	
	Duration	hrs/days	
30	Min bending radius	mm	
31	Ovality at any cross section	mm	
32	Variation of dia through out cable length		
33	Cable cross-sectional drawings for each type of cable furnished		
34	i) Length of single coil in a drum	M	
	ii) Marking on drum	-	
	iii) Seasoned wood drum provided	-	
	iv) Both ends of cable to be sealed with PVC/ Rubber caps to prevent water/ moisture ingress		
	v) Gross weight (approx.)	kg.	
	vi) Net weight (approx.)	kg	
35	Type test procedures as per BHEL Technical Spec. and other relevant standards enclosed.		
36	Anti termite & rodent test		



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SECTION-'II'

GENERAL TECHNICAL SPECIFICATION



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1.0 TECHNICAL REQUIREMENTS

- 1.1 Technical requirements for SCREENED CONTROL CABLES shall be as indicated in this section, in addition to those specified in Datasheet-A.
- 1.2 It is not the intent to specify herein all the details of design & manufacture. However, the equipment shall conform in all respects to high standards of design engineering and workmanship and shall be capable of performing in continuous commercial operation at site conditions.

2.0 CODES & STANDARDS

- 2.1 The design, material, construction, manufacture, inspection and testing of Screened control cables shall conform to the latest revision of relevant standards and codes of practices mentioned in Data Sheet - A.
- 2.2 In case of conflict between the applicable reference standard and this specification, this specification shall govern.

3.0 QUALITY ASSURANCE REQUIREMENTS

- 3.1 Bidder shall confirm compliance with the BHEL Standard Quality Plan (PE-QP-999-507-E004) as attached with the specification without any deviations. At contract stage, the successful bidder shall submit the same QP for BHEL/ ultimate customer's approval. In case bidder has reference QP agreed with ultimate customer, same can be submitted for specific project after award of contract for BHEL/ultimate customer's approval. There shall be no commercial implication to BHEL on account of minor changes in QP during contract stage.
- 3.2 All materials shall be procured, manufactured, inspected and tested by vendor/ sub-vendor as per approved Quality Plan.
- 3.3 Type testing requirements, routine/ acceptance testing and special testing requirements shall be as per Annexure to QP. Charges for all these tests for all the equipments & components shall be deemed to be included in the bid price (except UV Radiation & Hydraulic Stability test).
- 3.4 The charges of UV Radiation test & Hydrolytic Stability test (if applicable) shall be reimbursed extra at actual against original money receipt of Govt. Lab. (CPRI/ ERDA etc).
- 3.5 Cost of cables consumed for testing shall be to bidder's account.
- 3.6 Type Test Reports for Tests conducted shall be submitted for BHEL's/ Customer's review/approval.

4.0 Packing

- 4.1 Cables shall be supplied in non-returnable drums. Material of cable drum shall be as specified in Datasheet-A.
- 4.2 In case of wooden drums, all wooden parts shall be manufactured from seasoned wood treated with copper naphthenates/ zinc naphthenates (refer IS: 401). Dimensions of wooden drums shall be as per IS 10418. All ferrous parts shall be treated with suitable rust protective finish or coating to avoid rusting during transit and storage. BIS certification mark shall be stamped on each cable drum. Over the cables polyethylene sheet shall be wrapped and then sealed properly.
- 4.3 In case of Steel drums, new or practically new cable drums made of steel and painted with epoxy resin paint are to be used. Cable ends are carefully protected before packing. Over the cables polyethylene sheet shall be wrapped and then sealed properly.

		QUALITY PLAN SHEET 1 OF 5		CUSTOMER : TANGEDCO		PROJECT : 2X660MW ENNORE STPP		SPECIFICATION : PE-TS-412-507-E004			
				BIDDER/ VENDOR :		TITLE		NUMBER :			
				SYSTEM		QUALITY PLAN NUMBER: PE-QP-999-507-E004, REV 01.		SPECIFICATION TITLE			
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SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY	REMARKS	
									P W V		
1	2	3	4	5	6	7	8	9	10	11	
Instructions: 1. Cable manufacturer to maintain records to show co-relation of raw materials to finished cables i.e. raw material batch/ lot no. should be traceable to the final cable drum number or batch no. 2. Cable manufacturer to maintain all quality records identified as per all QP stages enumerated below whether it is identified for BHEL verification or witness or not.											
1.0	RAW MATERIAL										
1.1	Copper Rods/ Wires (For Conductor & drain wire)	GENERAL : 1. Physical properties 2. Elec.Properties SPECIFIC CHECKS : a) Make b) Grade c) Resistivity	MA	Physical Tests	Sample	Relevant Standard/ Approved datasheet	Relevant Standard/ Approved datasheet	Inspection Report/ Test Cert.	2/3	-	1/2
			MA	Electrical Tests	Sample	-do-	-do-	-do-	2/3	-	1/2
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	Log book/ Test Cert.	3/2	-	1
			MA	-do-	-do-	IS 613/ Approved datasheet	IS 613/ Approved datasheet	-do-	3/2	-	1
			MA	Electrical Tests	Manufacturer	IS 613	IS 613	-do-	3/2	-	1
1.2	PVC Compound (for insulation)	GENERAL : 1. Physical properties 2. Elec.Properties SPECIFIC CHECKS : a) Make b) Type/ Grade c) Shelf life/ Storage condition	MA	Physical Tests	Sample	Relevant Standard/ Approved datasheet	Relevant Standard/ Approved datasheet	Inspection Report/ Test Cert.	2/3	-	1/2
			MA	Electrical Tests	Sample	-do-	-do-	-do-	2/3	-	1/2
			MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	COC/ Test Cert.	3/2	-	1
			MA	-do-	-do-	Approved datasheet	Approved datasheet	-do-	3/2	-	1
			MA	-do-	-do-	Compound Manufacturer std.	Compound Manufacturer std.	-do-	3/2	-	1
1.3	Screen / Tapes/ Binders	1. Make 2. Dimension 3. T.S. & Elongation 4. Chem. & Phys. Properties	MA	Verify	100%	Manufacturer approved source	Manufacturer approved source	TC & IR	3/2	-	1/2
			MA	Measurement	Manufacturer std.	Manufacturer datasheet/ Approved datasheet	Manufacturer datasheet/ Approved datasheet	TC & IR	3/2	-	1/2
			MA	Physical Tests	-do-	Manufacturer datasheet	Manufacturer datasheet	-do-	3/2	-	1/2
			MA	Chemical & Physical Tests	-do-	Manufacturer std.	Manufacturer std.	-do-	3/2	-	1/2
BHEL			PARTICULARS		BIDDER/VENDOR						
			NAME								
			SIGNATURE								
			DATE								
							BIDDER'S/VENDORS COMPANY SEAL				
			CUSTOMER :		PROJECT		SPECIFICATION :				

		QUALITY PLAN		BIDDER/ : VENDOR		TITLE QUALITY PLAN NUMBER: PE-QP-999-507-E004, REV 0.			NUMBER :				
SHEET 2 OF 5		SYSTEM		ITEM :INSTRUMENTATION CABLES			SPECIFICATION : TITLE			VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	P	W	V		
1.4	Fillers (as applicable)	1. Type 2. Flame retardant & moisture resistant (as applicable)	MA CR	Verify Chemical/ Environ.	-do- -do-	Approved datasheet -do-	Approved datasheet -do-	-do- -do-	3/2 3/2	- -	1 2	* Sample from each size/ Batch/Lot.	
1.5	Galvanised steel wire/strip for Armour (if applicable)	<u>GENERAL :</u> 1. Make 2. Dimension 3. Phy.and Elec. Properties 3.Galvanization Quality	MA MA MA MA	Verify Measurement Physical & Electrical Tests Galv.Tests	Manufacturer std. -do- Sample* -do-	Manufacturer approved source -do- Relevant Standard/ Appd. Data Sheet/ -do-	Manufacturer approved source -do- Relevant Standard/ Appd. Data Sheet/ -do-	Inspection Report/ Test Cert. -do- -do- -do-	2/3 2/3 2/3 2/3	- - - -	1 2 2 2		
1.6	PVC compound for Sheath	<u>GENERAL :</u> 1. Physical properties 2. Elec.Properties 3. FRLS Properties (as applicable) <u>SPECIFIC CHECKS :</u> a) Make b) Type/ Grade c) Shelf life/ Storage condition	MA MA CR MA MA MA	Physical Tests Electrical Tests Chemical/ Environ. Verify -do- -do-	Sample Sample Sample 100% -do- -do-	Relevant Standard/ Approved datasheet -do- -do- Manufacturer approved source Approved datasheet Compound Manufacturer std.	Relevant Standard/ Approved datasheet -do- -do- Manufacturer approved source Approved datasheet Compound Manufacturer std.	Log book/ Test Cert. -do- -do- Log book/ Test Cert. -do- -do-	3/2 3/2 3/2 3/2 3/2 3/2	- - - - - -	1/2 1/2 1/2 1 1 1		
1.7	Wooden drums	1. Phy. & Constructional checks 2. Anti termite treatment	MA MA	Visual Chem.	Mfr's Plant Std. -do-	IS 10418 Mfr's Plant Std.	IS 10418 Mfr's Plant Std.	Log book/ Test Cert. COC	3/2 3/2	- -	1 1		
1.8	Steel drums	1. Dimension 2. Surface finish	MA MA	Meas. Meas.	Mfr's Plant Std. -do-	Mfr's Plant Std. -do-	Mfr's Plant Std. -do-	Log book/ Test Cert. -do-	3/2 3/2	- -	1 1		
2.0	IN PROCESS												
2.1	Wire Drawing & Annealing.	1. Size 2. Surface finish 3. % of Elongation	MA MA MA	Dimensional Visual Mechanical	Mfr's Plant Std. -do- -do-	Approved datasheet Surface shall be smooth IS 8130	Approved datasheet Surface shall be smooth IS 8130	Inspection Report	2	-	1		(Applicable only for tin-coated copper conductor and drain wire)
2.2	Tinning (Conductor or drain wire)	1. Size 2. % of Elongation	MA MA	Dimensional Mechanical	Plant Mfg. Std. -do-	Approved datasheet IS 8130	Approved datasheet IS 8130	Log Book	2	-	1		
2.3	Stranding of wires	1. No.of wires	MA	Counting	Mfr's Plant Std.	IS 8130/ Appd. Data Sheet	IS 8130/ Appd. Data Sheet	-do-	2	-	-		
			PARTICULARS		BIDDER/VENDOR								
BHEL			NAME										
			SIGNATURE										
			DATE					BIDDER'S/VENDORS COMPANY SEAL					

	QUALITY PLAN SHEET 3 OF 5			CUSTOMER :		PROJECT TITLE		SPECIFICATION : NUMBER :						
				BIDDER/ VENDOR		QUALITY PLAN NUMBER: PE-QP-999-507-E004, REV 0.		SPECIFICATION : TITLE						
				SYSTEM		ITEM :INSTRUMENTATION CABLES		SECTION VOLUME III						
SL. NO.	COMPONENT/OPERATION			CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS
1	2	3	4	5	6	7	8	9	10	11	P	W	V	11
2.4	Core Insulation (No repair permitted)	2. Resistance	CR	Electrical	-do-	-do-	-do-	-do-	-do-	2	-	-	# To be checked at starting & finish end of Extruded Length	
3. Sequence, lay length & Direction		MA	Visual, Meas	Sample	BHEL'S/ Vendor's Spec./ Approved datasheet	BHEL'S/ Vendor's Spec./ Approved datasheet	-do-	2	-	-				
4. Surface Finish		MA	Visual	Sample	-do-	-do-	-do-	2	-	-				
5.Dimension		MA	Measurement	Sample	Appd. Data Sheet	Appd. Data Sheet	-do-	2	-	-				
1. Surface finish		MA	Visual	100%	-	Free from bulging burnt particles lumps, cuts & Scratches.	Inpection Report	2	-	-				
2 Insulation thickness (Min./ Max.)		CR	Measurement	Sample	Appd.data sheet/ Relevant Std.	Appd.data sheet/ Relevant Std.	-do-	2	-	-				
3. Concentricity #		CR	Measurement	Sample	Mfr's Std./Appd. data sheet	Mfr's Std./Appd. data sheet	Inpection Report	2	-	-				
4 Dia over insulation	MA	Measurement	Sample	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-					
5. Core identification	MA	Visual	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-					
6. TS & % Elongation	MA	Mechanical	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-					
2.5	Core pairing, screening (provision of drain wire & laying)	1. Pair identification	MA	Visual	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	Log Book	2	-	-			
2.Wire size & tape size		MA	Measurement	100%	-do-	-do-	-do-	2	-	-				
3.Test for capacitance		CR	Elect. Test	100%	-do-	-do-	-do-	2	-	-				
4. Sequence of lay and lay length		MA	Visual meas	Sample	Appd. Data Sheet & MFRs. Std.	Appd. Data Sheet & MFRs. Std.	-do-	2	-	-				
5. Screen overlap & coverage		MA	Measurement	Sample	-do-	-do-	-do-	2	-	-				
6. Dia over laid up core		MA	Measurement	-do-	-do-	-do-	-do-	2	-	-				
7. Continuity of drain & drain wire with Screen		MA	Elect. Test	100%	<-----No Discontinuity ----->		-do-	2	-	-				
				PARTICULARS		BIDDER/VENDOR								
BHEL				NAME										
				SIGNATURE										
				DATE				BIDDER'S/VENDORS COMPANY SEAL						

	QUALITY PLAN		CUSTOMER :			PROJECT TITLE			SPECIFICATION : NUMBER :				
			BIDDER/ : VENDOR			QUALITY PLAN NUMBER: PE-QP-999-507-E004, REV 0.			SPECIFICATION : TITLE				
	SHEET 4 OF 5			SYSTEM			ITEM :INSTRUMENTATION CABLES			SECTION VOLUME III			
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
1	2	3	4	5	6	7	8	9	10	P	W	V	11
2.6	Inner Sheath Extrusion (if applicable)	1. Surface finish	MA	Visual	100%	--	Free from bulging, burnt particles,lumps cuts & scratches.	-do-	2	-	-		
		2. Sheath thickness	MA	Measurement	Sample			-do-	2	-	-		
		3.Dia over inner sheath	MA	Measurement	Sample	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-		
		4. Colour	MA	Visual	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-		
2.7	Armouring (If Applicable)	1. No.of wires/Strips	MA	Counting	At the start of the process	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-		
		2. Size of wire/ Strip	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-		
		3. Lay Direction	MA	Visual	-do-	-do-	-do-	-do-	2	-	-		
		4. Lay Length	MA	Visual, Meas.	At the start of the process	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	Log Book	2	-	-		
		5. Coverage	MA	Measurement	-do-	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-	-		
		6. Dia over armouring	MA	Measurement	-do-	-do-	-do-	-do-	2	-	-		
2.8	Outer Sheath Extrusion	1. Surface Finish	MA	Visual	100%	-	Free from Bulging Burnt particles, lumps, cuts & scratches	Log Book	2	-	-		
		2.Sheath thickness	MA	Measurement	Sample	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	Log Book	2	-	-		
		3. Dia over outer sheath	MA	Measurement	Sample	-do-	-do-	-do-	2	-	-		
BHEL			PARTICULARS			BIDDER/VENDOR							
			NAME										
			SIGNATURE										
			DATE						BIDDER'S/VENDORS COMPANY SEAL				

		QUALITY PLAN		CUSTOMER :		PROJECT TITLE			SPECIFICATION : NUMBER :				
				BIDDER/ : VENDOR		QUALITY PLAN NUMBER: PE-QP-999-507-E004, REV 0.			SPECIFICATION : TITLE				
		SHEET 5 OF 5		SYSTEM		ITEM :INSTRUMENTATION CABLES			SECTION		VOLUME III		
SL. NO.	COMPONENT/OPERATION	CHARACTERISTICS CHECK	CAT.	TYPE/ METHOD OF CHECK	EXTENT OF CHECK	REFERENCE DOCUMENT	ACCEPTANCE NORM	FORMAT OF RECORD	AGENCY			REMARKS	
									P	W	V		
1	2	3	4	5	6	7	8	9	10			11	
3.0	Final Inspection	4. Marking/ Colour/ Embossing	MA	Visual	100%	Appd. Data Sheet	Appd. Data Sheet	Test Report	2	-	-	Sequential marking shall be done by printing	
		5. TS & % Elongation	MA	Mechanical	100%	Relevant Standard/ Appd. Data Sheet	Relevant Standard/ Appd. Data Sheet	-do-	2	-			
		1. Finish & Length	MA	Visual	(See remark)	Relevant Standard/ Appd. Data Sheet	Free from Bulging Burnt particles, lumps, cuts & scratches	Inpection Report	2	1	-	One drum in a Lot	
		2. Dimensions	MA	Measurement	Sample Lengths	Appd. Data sheet	Appd. Data sheet	Inpection Report	2	1	-		
		3. Armouring - Coverage No.of Wires/Strips	MA	Visual & Meas.	Sample	-do-	-do-	-do-	2	1	-		
		4. Marking/Colour/ pair identification	MA	Visual	-do-	-do-	-do-	-do-	2	1	-		
		5. Test for screening	CR	Elect. Test	-do-	-do-	-do-	-do-	2	1	-		Refer Annexure to QP for sampling plan.
		6. Acceptance Tests	CR	Phy & Elect. Tests	sample	-do-	-do-	-do-	2	1			
7. Type & FRLS Tests	CR	Measurement	Sample	Appd. Data sheet	Appd. Data sheet	-do-	2	1	-				
NOTES:- (A) JOINTS IN WIRE SHALL BE AS PERMITTED BY REL STD / BHEL SPECIFICATION. VENDOR TO CERTIFY THE SAME. (B) NO REPAIR OF CORE INSULATION PERMITTED (C) CABLE ENDS SHALL BE SEALED AS PER REL. STD./ BHEL SPECIFICATION (D) RECORD OF RAW MATERIAL, PROCESS & ALL STAGES SHALL BE CERTIFIED BY VENDORS QC. AND ARE LIABLE TO AUDIT CHECK BY PURCHASER. (E) FILLERS/DUMMY CORES ETC. SHALL BE AS PER BHEL SPECIFICATION (F) WHEREVER EXTENT OF CHECK FOR STAGE IS MENTIONED AS SAMPLES AND NOT DEFINED IN QP, THE SAME SHALL BE AS PER VENDORS SAMPLING PLAN AGREED BY PURCHASER. (G) VENDOR SHALL FURNISH COMPLIANCE CERTIFICATE TO THE INSPECTION AGENCY CONFIRMING THE PACKING AS PER REL. STD./ BHEL SPECIFICATION. (H) FOR LIST OF TYPE TESTS, ROUTINE TESTS & ACCEPTANCE TESTS; REFER ANNEXURE TO QAP.													
LEGEND : P : PERFORMER W: WITNESSER V: VERIFIER 1- BHEL/CUSTOMER 2-VENDOR 3 SUB VENDOR CHP: CUSTOMER HOLD POINT TC : Test Certificates, Spec. : Specification Mfg. : Manufacturer.													
			PARTICULARS		BIDDER/VENDOR								
			NAME										
			SIGNATURE										
			DATE										
BIDDER'S/VENDORS COMPANY SEAL													

	ANNEXURE TO QP	CUSTOMER:	PROJECT TITLE: 2X600 MW ENNORE TPS	SPECIFICATION NUMBER: PE-TS-412-507-E004
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E004, R0	SPECIFICATION TITLE:
	SHEET	SYSTEM	ITEM: SCREENED CONTROL CABLES (AS PER IS)	DOC. NO.

I. Type Test:

The type tests shall be carried out on one drum out of every 10 drums or less for each size of cable in each lot, in presence of Owner's representative as per applicable standards in Govt. approved Laboratory if adequate testing facility is not available at works of the supplier.

Sr. No.	Name of Test	Governing standard	Special requirements as per owner's specification.
For Conductor			
1	Annealing test (for copper)	IS : 8130/84	As per IS: 8130/84
2	Conductor resistance test & Diameter test	IS : 10810	As per approved G.T.P.
3	Per sulphate test (for tinned copper wire)	IS : 8130/84	As per IS: 8130/84
For Armour Wire/ Strip			
4	Test for measurement of dimensions	IS : 3975	As per approved G.T.P.
5	Tensile test and elongation at break of armouring material.	IS : 3975	As per IS:3975 & IS: 1554 (I)
6	Torsion test on galvanised steel round wire for armouring	IS : 3975	As per IS:3975 & IS: 1554 (I)
7	Test for measurement of DC resistance & resistivity of armour	As per IS:3975 & IS: 1554 (I)	As per IS:3975 & IS: 1554 (I)
8	Uniformity of zinc coating on steel armour	IS : 3975	As per IS:3975 & IS: 1554 (I)
9	Mass of zinc coating on steel armour	IS : 3975	As per IS:3975 & IS: 1554 (I)
10	Adhesion test on galvanised steel round/ formed wire	IS : 3975	As per IS:3975 & IS: 1554 (I)
For PVC Insulation & Sheath			
11	Test for measurement of thickness of insulation & sheath & other dimensions.	IS : 1554 (I)	As per approved G.T.P.
12	Measurement of volume resistivity of HRPVC insulation	IS : 5831-1984	i. 3.5×10^{14} Ohm-cm at 27°C / room temp. (Min). ii. 3.5×10^{11} Ohm-cm at 85°C (Min.)
13	Tensile strength and elongation test for insulation & sheath.	IS:5831/1984	As per IS:5831/84
14	Ageing test for insulation & sheath. Loss of mass test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
15	Shrinkage test for PVC insulation & sheath.	IS:5831/1984	As per IS:5831/84
16	Hot deformation test for PVC insulation & sheath	IS:5831/1984	As per IS:5831/84
17	Cold bend test for PVC insulation.	IS:5831/1984	As per IS:5831/84
18	Cold impact test for PVC sheath.	IS:5831/1984	As per IS:5831/84

	ANNEXURE TO QP	CUSTOMER:	PROJECT TITLE: 2X600 MW ENNORE TPS	SPECIFICATION NUMBER: PE-TS-412-507-E004
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E004, R0	SPECIFICATION TITLE:
	SHEET	SYSTEM	ITEM: SCREENED CONTROL CABLES (AS PER IS)	DOC. NO.

19	Heat shock test for PVC insulation & sheath.	IS:5831/IEC-502	IS:5831/IEC-502
20	Thermal stability test for PVC insulation and sheath.	IS:5831/ IEC-60811_405	IS:5831/ IEC-60811_405
21	Test for bleeding and blooming of pigments for PVC insulation and sheath.	IS:5831/1984	As per IS:5831/84
22	Colour fastness to water.	IS:5831/1984	As per IS:5831/84
23	Colour fastness to day light.	IS:5831/1984	As per IS:5831/84
24	High voltage test (water immersion test)	IS:1554(I)	IS:1554(I)
25	Test for rodent & termite repulsion property of sheath.	-	Presence of lead shall be detected.
26	Oxygen index test on inner & outer sheath material.	ASTM:D-2863/77	Min.29
27	Temp. index test on inner & outer sheath material	ASTM:D-2863/77	Min. 250° C
28	Acid gas emission test on inner & outer sheath material.	IEC-754-1	Acid gas generation shall be less than 20% by weight.
29	Smoke Density test on inner & outer sheath material	ASTM-D-2843/77	Min. 40% light transmission during test.
30	Flammability test on finished cable samples as per following methods: i) Swedish chimney test ii) Vertical tray flame propagation test. iii) Single vertical cable fire resistance test.	i) SS-424-14-75 Cl. F-3 ii) IEEE-383 iii) IEC-332-1	i) SS-424-14-75 Cl. F-3 ii) IEEE-383 iii) IEC-332-1
31	Tests for all electrical properties at 20oC & maximum operating temp. as per GTP.	As per GTP	As per approved G.T.P.
32	Oxygen index test & Acid Gas generation test for Fillers	ASTMD – 2863, IEC 60754-1	As per approved GTP
33	Continuity test, Shield thickness, Overlap test of Al Mylar shield	As per GTP	As per approved GTP
34	Noise interference test, Cross talk test, Mutual capacitance, Drain wire continuity test.	IEEE Transaction, VDE 0472	As per approved GTP
35	Capacitance unbalance between any two pairs of different cabling elements.	IEC-60189 Part 1 & 2.	Max. 400 PF/500m (as per approved GTP)

	ANNEXURE TO QP	CUSTOMER:	PROJECT TITLE: 2X600 MW ENNORE TPS	SPECIFICATION NUMBER: PE-TS-412-507-E004
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E004, R0	SPECIFICATION TITLE:
	SHEET	SYSTEM	ITEM: SCREENED CONTROL CABLES (AS PER IS)	DOC. NO.

II Routine Test:

Routine test shall be carried in presence of owner's representative for all types of cables.

Sr. No.	Name of Test	Governing standard	Special requirements as per owner's specification.
1	High voltage test	IS:1554 (I)	2 KV (RMS) for one minute (as per GTP)
2	Conductor Resistance	IS:8130/84	As per GTP

III Acceptance Tests:

Following tests shall be carried out on 1 drum out of every 10 drums or less for each size of cables in each lot, in presence of owner's representative.

Sr. No.	Name of Test	Governing standard	Special requirements as per owner's specification.
1	High voltage test	IS:1554 (I)	2 KV (RMS) for one minute (as per GTP)
2	Conductor Resistance	IS:8130/84	As per GTP
3	Measurement of volume resistivity of HRPVC insulation	IS : 5831-1984	i. 3.5×10^{14} Ohm-cm at 27°C / room temp. (Min). ii. 3.5×10^{11} Ohm-cm at 85°C (Min.)
4	Measurement of Mutual capacitance at 0.8 KHZ	As per approved GTP	100 NF/Km (max)
5	Calculation & Verification of Characteristic impedance on the basis of value obtain for mutual capacitance at 0.8 KHZ with the help of following formula $Z = R/2fC$ where Z = characteristic impedance in ohm R = Loop resistance of cable per km in ohms at 20°C. f = Frequency of test in Hz (800) C c = mutual capacitance per km.	As per approved GTP	320 Ohms (nominal)
6	Measurement of thickness of insulation and sheath & other dimensions	IS:1554 (I)	As per approved GTP
7	Tensile test and elongation at break of insulation & sheath	IS:5831/1984	As per IS:5831/84
8	Oxygen index test on inner & outer sheath material.	ASTM:D-2863/77	Min.29
9*	Temp. index test on inner & outer sheath material	ASTM:D-2863/77	Min.250°C

	ANNEXURE TO QP	CUSTOMER:	PROJECT TITLE: 2X600 MW ENNORE TPS	SPECIFICATION NUMBER: PE-TS-412-507-E004
		BIDDER/VENDOR:	QUALITY PLAN NUMBER : PE-QP-999-507-E004, R0	SPECIFICATION TITLE:
	SHEET	SYSTEM	ITEM: SCREENED CONTROL CABLES (AS PER IS)	DOC. NO.

10*	Acid gas emission test on inner & outer sheath material.	IEC-754-1	Acid gas generation shall be less than 20% by weight.
11	Smoke Density test on inner & outer sheath material	ASTM-D-2843/77	Min. 40% light transmission during test.
12	Flammability test on finished cable samples as per following methods: i) Swedish chimney test ii) Vertical tray flame propagation test. iii) Single vertical cable fire resistance test.	i) SS-424-14-75 Cl. F-3 ii) IEEE-383 iii) IEC-332-1	i) SS-424-14-75 Cl. F-3 ii) IEEE-383 iii) IEC-332-1

* (If no. of drums selected for acceptance test for a particular cable size are more than one, the tests marked with * i.e. Sr. no. 9 & 10 under acceptance tests shall be carried out on one drum only).