1.0 Pre-Qualification Criteria

1.1 The bidder should be a manufacturer/supplier of the product for Rolling stock application of Railways for 3 phase IGBT based Train sets/RRTS/Semi high speed trains/AC EMU/MEMU/Metros in India or any railway systems in the world.

1.2 For supplies made in India, bidder should be approved vendor of Indian Railways /Metro/RRTS.

OR

For supplies made to any railway systems in the world, bidder shall provide approval, authenticated by country's recognized railway organization. Acceptance of such approvals will be at BHEL's discretion.

1.3 The product should have valid type test certificates complying to relevant latest IEC and other standards mentioned in the Reference Technical Specification for rolling stock application on the date of submission of the tender. The bidder shall fully comply with the type and routine test & inspection clause of the technical specification. The bidder shall conduct/repeat type tests either partially or fully **for the offered product** without any price implication to BHEL. Decision to conduct type test shall be at BHEL's discretion.

OR

The bidder shall provide valid type test certificate/reports complying to relevant latest IEC and other standards for similar product supplied as per clause 1.1. Acceptance of such type test certificate/reports will be at BHEL's discretion. In such case, bidder will be considered for technical evaluation. The bidder shall conduct type tests fully **for the offered product**, without any price implication to BHEL.

1.4 Those bidder(s) who are registered with BHEL/ BHEL's customer (as the case may be) shall be considered for technical evaluation, subject to meeting above PQC clauses.

Bidders who are not registered with BHEL/BHEL's customer (as the case may be) can also quote in the tender. However, their credentials will be assessed for consideration in the tender, before price bid opening, subject to meeting above PQC clauses.

2.0 Documents to be submitted

All the relevant documents proof for points referred in 1.0 shall be submitted along with the tender.

Bill of Material of Power cables (Vande Bharat - 80 Train Sets)					
Package-1					
Sl. No.	**Material Code**	**Item Description**	**Qty per Rake in meters**	**Total qty. required for 32 Rakes in meters**	**Remarks**
1	PR2120000182	1 Core X 120 Sq.mm, 3600/6000V	3520	112640	
2	PR2120000190	1 Core X 70 Sq.mm, 3600/6000V	1440	46080	
3	PR2120000174	1 Core X 70 Sq.mm, 600/1000V	3360	107520	
4	PR2120000115	1 Core X 50 Sq.mm, 1800/3000V	192	6144	
5	PR2120000107	1 Core X 35 Sq.mm, 3600/6000V GY	1040	33280	
6	PR2120000166	1 Core X 35 Sq.mm, 600/1000V	480	15360	
7	PR2120000093	1 Core X 25 Sq.mm, 600/1000V	1960	62720	
8	PR2120000085	1 Core X 10 Sq.mm, 1800/3000V	480	15360	
9	PR2120000158	1 Core X 10 Sq.mm, 600/1000V	400	12800	
10	PR2120000140	1 Core X 6 Sq.mm, 600/1000V	400	12800	
11	PR2120000077	1 Core X 4 Sq.mm, 600/1000V	2340	74880	
12	PR2120000204	1 Core X 2.5 Sq.mm, 600/1000V	26000	832000	
13	PR2120000131	1 Core X 2.5 Sq.mm, 600/1000V GY	500	16000	
Package-2					
1	PR2120000123	1 Core X 2.5 Sq.mm, 600/1000V FS	18000	576000	
Note: All vendor must quote as per the quantities mentioned in this table and the quantities mentioned in the specification are for reference purpose only					

ANNEXURE-1

Bharat Heavy Electricals Limited Electronics Division, Mysore Road, Bengaluru

Purchase Specification no - PS4452986

Item - Power Cables

Vendor name - M/s

Price Format for Vande Bharat Train Sets

Sl. No.	Material Code	Item Description	Applicability (Yes/No)	Qty [A1]	Unit Rate in INR [A2]	Total Cost [A3=A1*A2]	Total Qty [A4]	Total Cost [A5=A2*A4]	Remarks
1	**-**	**Equipment cost**		**Per rake**	**Per item**	**Per rake**	**For 32 rakes**	**For 32 rakes**	
1.1	PR2120000182, PR2120000190, PR2120000174, PR2120000115, PR2120000107, PR2120000166, PR2120000093, PR2120000085, PR2120000158, PR2120000140, PR2120000077, PR2120000204, PR2120000131,	Basic Price per unit equipment - PACKAGE 1	Yes	1 Set			32 Set		
1.2	PR2120000123	Basic Price per unit equipment - PACKAGE 2	Yes	1 Set			32 Set		
		Freight & Insurance - PACKAGE 1	Yes				32 Set		
1.3		Freight & Insurance - PACKAGE 2	Yes				32 Set		
							Total of sl no 1		
2		**Maintenance & Spares cost**							
2.1		AOH Spare Kit with consumables for 2 rakes considering 6 years' consumption	No	X	X	X	X	X	
2.2		IOH Spare Kit with consumables for 2 rakes considering 6 years' consumption	No	X	X	X	X	X	
2.3		POH Spare Kit with consumables for 2 rakes considering 6 years' consumption	No	X	X	X	X	X	
2.4		Special Tool Kit (One time)	No	X	X	X	X	X	
2.5		AMC for 4 (four) years post warranty period	No	X	X	X	X	X	
2.6		Spares for annual maintenance (for one year)	No	X	X	X	X	X	
							Total of sl no 2		
3		**Commissioning & Supervision of Erection**							
3.1		Commissioning & Supervision of Erection of Prototype Rake	No	X	X	X	X	X	NA
3.2		Commissioning & Supervision of Erection of All Rakes (Including Prototype)	No	X	X	X	X	X	NA
							Total of sl no 3		

Note -

1. Any item required for functional integrity and commisioning of the item/system and not considered above shall be provided by the bidder without any cost implication to BHEL.
2. Bidder shall quote as per the quantities mentioned in this table only. Quantities mentioned in the specification are for reference purpose.
3. Tender evaluation shall be done on the total of sl. no. 1, 2 & 3. Purchase Order for Items in sl. no. 2 may be placed separately.
4. Each rake consists of 16 coaches.

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Cir. No. **35**/DIV/ CAB/05/ 24th April 2018

To Members of the Cable Division, Utilities, Railways & Listed purchasing organizations

Sub: Correction in PV formulae of LT XLPE Power Cable and addition of factors for HT XLPE Power Cables

We have recently published revised Price Variation Clause for LT&HT XLPE Power Cables and made it effective from 1st November 2017 vide Cir. No.111/DIV/CAB/05 dated 5th December 2017

While replying to a query of a buyer it is observed that the polymer factor for LT XLPE Power Cables (both aluminium and copper) was incorrectly represented by Table P2.

We have now corrected the anomaly by correcting the PV formulae of LT XLPE Aluminium and Copper Insulated Cables (Sl. No. D & E) by representing Polymer factor by Table L2.

We have also worked out factors for XLPE, Copper and Steel for 3 core HT XLPE Power Cables for 500 and 630 sq.mm.

We now enclose complete PV clause of Cable by including all the PV formulae of different types of power cable (Sl. No. A to I), polymer factor Table L2 and updated XL4, H2 and H5 Table of factors for your perusal & record.

We request to replace PV clause of Cable already circulated vide Cir. 111/DIV/CAB/05 dated 5th December 2017 with the enclosed PV clause in your records for future use.

Senior Director

Encl: as above

CIN No. U99999MH1970GAP014629

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Material Price Variation Clause For PVC And XLPE Insulated Cables

The Price quoted/confirmed is based on the input cost of raw materials/components as on the date of quotation, and the same is deemed to be related to the prices of raw materials as specified in the price variation clause given below. In case of any variation in these prices, the price payable shall be subject to adjustment up or down in accordance with the formulae provided in this document.

Terms used in price variation formulae:

P Price payable as adjusted in accordance with above appropriate formula **(in Rs/Km)**

Po Price quoted/confirmed **(in Rs/Km)**

ALUMINIUM

AIF Variation factor for aluminium

AI Price of Aluminiujm. This price is as applicable of first working day of the month, one month prior to the date of delivery.

Alo Price of aluminium. This price is as applicable on first working day of the month, one month prior to the date of tendering.

COPPER

CuF Variation factor for copper

Cu Price of CC copper rods. This price is as applicable on first working day of the month, one month prior to the date of delivery.

Cuo Price of CC copper rods. This price is as applicable on first working day of the month, one month prior to the date of tendering.

PVC COMPOUND

PVCc price of PVC compound. This price is as applicable on first working day of the month, one month prior to the date of delivery.

PVCco Price of PVC compound. This price is as applicable on first working day of the month, one month prior to the date of tendering.

CCFAI Variation factor for PVC compound/Polymer for aluminum conductor cable.

CCFCu Variation factor for PVC compound/Polymer for copper conductor cable.

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XLPE COMPOUND

Cc price of XLPE compound. This price is as applicable on first working day of the month, one month prior to the date of delivery.

Cco Price of XLPE compound. This price is as applicable on first working day of the month, one month prior to the date of tendering.

XLFAL Variation factor for XLPE compound for aluminum conductor cable.
XLFCU Variation factor for XLPE compound for Copper conductor cable.

STEEL

FeF Variation factor for steel

FeW Variation factor for round wire steel armouring

Fe Price of Steel Strips/steel wire. This price is as applicable on the first working day of the month, one month prior to the date of delivery.

Feo Price of steel strips/steel wire. This price is as applicable on first working day of the month, one month prior to the date of tendering.

The above prices and indices are as published by IEEMA vide Circular reference IEEMA (PVC)/CABLE R(1)/--/-- prevailing as on 1st working day of the month i.e. one month prior to the date of tendering.

The date of delivery is the date on which the cable is notified as being ready for inspection/dispatch (in the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes

(a) All prices of raw materials are exclusive of GST amount.
(b) All prices excluding Aluminium & Copper are as on first working day of the month.
(c) The details of prices are as under:

1. Price of Aluminium is LME average Cash SELLER Settlement price of Primary Aluminium in US$ per MT as published by London Metal Bulletin (LME) including Premium for Aluminium Ingot in US$ per MT is converted in Indian Rs./MT.
2. Price of PVC Compound (in Rs/MT) is the ex-works price, as quoted by the manufacturer.
3. Price of XLPE Compound (in Rs/MT) is the ex-works price, as quoted by the manufacturer
4. Price of CC copper rods (in Rs/MT) is ex-works price as quoted by the primary producer.
5. Price of galvanized steel strip / steel wire (in Rs/MT) is ex-works price as quoted by the manufacturer for Round steel Wire and Flat steel strip (the relevant price of steel strip or steel wire is to be selected depending upon the type of armouring of the cable).

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Price variation formulae for 'Power Cables'

A. Aluminum conductor PVC insulated 1.1 kV power cables

P = Po + AlF (AL – Alo) + CCFAl (PVCc – PVCco) + FeF (Fe - Feo)

For unarmourd multicore cables (without steel armour); FeF = 0

Table References:

ALP	Aluminium conductor in single core unarmoured & multicore cables
P1	Aluminium conductor aluminium armour in single core armoured cables
P2	PVC compound
P3	Steel armour

B. Copper conductor PVC insulated 1.1 kV power cables

P = Po + CuF (Cu – Cuo) + CCFCu (PVCc – PVCco) + Fef (Fe – Feo) + AlF (Al – Alo)

For steel armoured cables; AlF = 0 For aluminium armoured cables; FeF = 0
For unarmoured cables; FeF, AlF = 0

Tables References:

CUP	Copper conductor
P2	PVC compound
P3	Steel armour
P4	Aluminium armour

C. Copper conductor PVC insulated 1.1 kV control cables

P = Po + CuF (Cu – Cuo) + CCFCu (PVCc-PVCco) + FeF (Fe-Feo)

For unarmoured cables; FeF = 0

Tables References:

CUC	Copper conductor
P5	PVC compound
P6	Steel armour

D. Aluminum conductor XLPE insulated 1.1 kV power cables

P = Po + AlF (AL – Alo) +XLFAL(CC-Cco)+ CCFAl (PVCc – PVCco) + FeF (Fe - Feo)

For unarmourd multicore cables (without steel armour); FeF = 0

Table References:

ALP	Aluminium conductor in single core unarmoured & multicore cables
P1	Aluminium conductor aluminium armour in single core armoured cables
L2	Polymer (CCFAl)
P3	Steel armour
XL1	XLPE Compound (XLFAL)

E. Copper conductor XLPE insulated 1.1 kV power cables

P = Po + CuF (Cu – Cuo) + XLFCU (CC-Cco)+ CCFCu (PVCc – PVCco) + Fef (Fe – Feo) + AlF (Al – Alo)

For steel armoured cables; AlF = 0 For aluminium armoured cables; FeF = 0

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For unarmoured cables; FeF, AIF = 0

Tables References:

CUP	Copper conductor
L2	Polymer (CCFCu)
P3	Steel armour
P4	Aluminium armour
XL1	XLPE Compound (XLFCu)

F. Copper conductor XLPE insulated 1.1 kV control cables

P = Po + CuF (Cu – Cuo) + XLFCU (CC-Cco)+ CCFCu (PVCc-PVCco) + FeF (Fe-Feo)

For unarmoured cables; FeF = 0

Tables References:

CUC	Copper conductor
P5	PVC compound
P6	Steel armour
XL2	XLPE Compound

G. For Aluminium conductor XLPE insulated 3.3 to 33 kV power cables

P = Po + AlF (Al – Alo) + XLFAL(CC-Cco)+CCFAl (PVCc – PVCco) + FeF (Fe – Feo)

For unarmoured multicore cables (without steel armour); FeF = 0

Table Refernces:

ALP	Aluminium conductor in single core unarmoured & multicore cables
H1	Aluminium conductor + aluminium armour in single core armoured cables
H2	Polymer
H3/H5	Steel armour (Flat/Round)
XL3/XL4	XLPE Compound (Single core /Multicore)

H. Copper conductor XLPE Insulated 3.3 to 33 kV power cables

P = Po + CuF (Cu – Cuo) + XLFCU (CC-Cco)+ CCFCu (PVCc – PVCco) + FeF (Fe – Feo) + AlF (Al – Alo)

For steel armoured cables; AlF = 0 For aluminium armoured cables; FeF = 0
For unarmoured cables; FeF, AlF = 0

Table References:

CUP	Copper conductor
H2	Polymer
H3/H5	Steel armour (Flat/Round)
H4	Aluminium armour
XL3/XL4	XLPE Compound (Single core /Multicore)

I. Copper conductor XLPE insulated 1.0 and 1.5 kV Solar PV DC cables

P = Po + CuF (Cu – Cuo)
Table CUsdc Copper Conductor

Authorized Signatory

TABLE ALP

VARIATION FACTOR FOR ALUMINIUM (AIF)
POWER CABLES WITH ALUMINIUM CONDUCTOR
(EXCLUDING SINGLE CORE ARMOURED CABLES)

Nominal Cross Sectional Area (in Sq. mm.)	1 core	2 core	3 core	3.5 core	4 core
2.5	0.007	0.014	0.021	-	0.028
4	0.011	0.023	0.034	-	0.046
6	0.017	0.034	0.052	-	0.069
10	0.029	0.053	0.087	-	0.116
16	0.046	0.091	0.137	-	0.183
25/16	0.073	0.146	0.219	0.262	0.292
35/16	0.101	0.202	0.302	0.345	0.404
50/25	0.137	0.273	0.410	0.478	0.547
70/35	0.197	0.395	0.593	0.687	0.791
95/50	0.274	0.548	0.821	0.949	1.095
120/70	0.346	0.691	1.035	1.221	1.382
150/70	0.425	0.853	1.279	1.464	1.706
185/95	0.533	1.070	1.605	1.861	2.140
225/120	0.655	1.310	1.965	2.287	2.620
240/120	0.703	1.400	2.099	2.421	2.799
300/150	0.879	1.757	2.635	3.033	3.514
400/185	1.126	2.249	3.374	3.873	4.498
500	1.418	2.838	4.256	-	5.675
630	1.828	3.663	5.494	-	7.326
800	2.340	4.679	7.018	-	9.357
1000	2.951	5.890	8.834	-	11.779

TABLE CUP

VARIATION FACTOR FOR COPPER CONDUCTOR (CUF)

POWER CABLES WITH COPPER CONDUCTOR

Nominal Cross Sectional Area (in Sq. mm.)	1 core	2 core	3 core	3.5 core	4 core
2.5	0.023	0.046	0.069	-	0.092
4	0.036	0.076	0.112	-	0.151
6	0.056	0.112	0.171	-	0.227
10	0.095	0.174	0.286	-	0.382
16	0.151	0.299	0.451	-	0.602
25/16	0.240	0.480	0.720	0.862	0.960
35/16	0.332	0.664	0.993	1.135	1.329
50/25	0.451	0.898	1.348	1.572	1.799
70/35	0.648	1.299	1.950	2.260	2.602
95/50	0.901	1.802	2.700	3.121	3.601
120/70	1.138	2.273	3.407	4.016	4.545
150/70	1.398	2.806	4.207	4.815	5.611
185/95	1.753	3.519	5.279	6.121	7.038
225/120	2.154	4.309	6.463	7.522	8.617
240/120	2.312	4.605	6.904	7.963	9.206
300/150	2.891	5.779	8.667	9.976	11.558
400/185	3.703	7.397	11.097	12.738	14.794
500	4.664	9.334	13.998	-	18.665
630	6.012	12.048	18.070	-	24.095
800	7.696	15.389	23.082	-	30.775
1000	9.706	19.372	29.055	-	38.741

TABLE CUsdc

VARIATION FACTOR FOR COPPER CONDUCTOR (CUF)

1.0 & 1.5KV Solar PV DC Cables with Copper Conductor

Cable Size in sq.mm.	Copper content in MT/km
2.5	0.023
4	0.038
6	0.058
10	0.090

TABLE CUC

VARIATION FACTOR FOR COPPER CONDUCTOR (CUF)
CONTROL CABLES WITH COPPER CONDUCTOR

No of Cores	Core size 1.5 sq mm	Core size 2.5 sq mm
2	0.026	0.047
3	0.039	0.070
4	0.052	0.094
5	0.065	0.117
6	0.078	0.141
7	0.091	0.164
8	0.110	0.182
9	0.117	0.205
10	0.130	0.235
12	0.157	0.282
14	0.183	0.329
16	0.209	0.376
18	0.246	0.410
19	0.248	0.446
20	0.260	0.456
24	0.313	0.563
27	0.352	0.634
30	0.391	0.704
37	0.483	0.869
44	0.573	1.033
52	0.678	1.221
61	0.796	1.432

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TABLE P1

VARIATION FACTOR FOR ALUMINIUM (AIF)

ALUMINIUM ARMOURED SINGLE CORE PVC INSULATED 1.1 KV CABLES

Nominal cross sectional area (in Sq.mm)	Aluminium factor for Aluminium armoured cable with aluminium conductor
4	0.0685
6	0.0795
10	0.1017
16	0.1303
25	0.1693
35	0.2090
50	0.2597
70	0.3360
95	0.4567
120	0.5443
150	0.6427
185	0.7743
240	0.9737
300	1.2582
400	1.5502
500	1.8958
630	2.3650
800	2.9306
1000	3.7666

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TABLE P2

VARIATION FACTOR FOR PVC COMPOUND (CCFAI/CCFCu)

PVC INSULATED 1.1 KV POWER CABLES WITH COPPER/ALUMINIUM CONDUCTOR

Nominal cross Sectional Area (in Sq. mm)	1 core	2 core		3 core		3.5 core		4 core	
	Unarm	Unarm	arm	Unarm	arm	Unarm	arm	Unarm	arm
2.5	0.079	0.125	0.139	0.141	0.157	-	-	0.161	0.179
4	0.094	0.140	0.156	0.164	0.182	-	-	0.188	0.209
6	0.101	0.154	0.171	0.179	0.199	-	-	0.198	0.220
10	0.114	0.194	0.216	0.214	0.238	-	-	0.249	0.277
16	0.142	0.234	0.246	0.279	0.290	-	-	0.328	0.345
25	0.171	0.288	0.303	0.364	0.383	0.422	0.444	0.443	0.466
35	0.189	0.321	0.338	0.403	0.429	0.489	0.515	0.498	0.524
50	0.211	0.411	0.433	0.508	0.535	0.613	0.645	0.647	0.681
70	0.241	-	-	0.613	0.645	0.707	0.744	-	-
95	0.284	-	-	0.795	0.811	0.908	0.927	-	-
120	0.339	-	-	0.866	0.884	1.024	1.045	-	-
150	0.388	-	-	1.070	1.092	1.289	1.315	-	-
185	0.450	-	-	1.310	1.337	1.499	1.530	-	-
225	0.521	-	-	1.586	1.618	1.840	1.878	-	-
240	0.534	-	-	1.649	1.683	1.990	2.031	-	-
300	0.653	-	-	2.007	2.048	2.361	2.409	-	-
400	0.770	-	-	2.437	2.487	2.616	2.669	-	-
500	0.936	-	-	3.117	3.181	3.687	3.762	-	-
630	1.175	-	-	-	-	-	-	-	-
800	1.433	-	-	-	-	-	-	-	-
1000	1.642	-	-	-	-	-	-	-	-

IEEMA (PVC)/CABLE(R-1)/2017 **Effective from: 1st November 217**

TABLE P3

VARIATION FACTOR FOR STEEL (FeF)

PVC INSULATED 1.1 KV POWER CABLES WITH COPPER/ALUMINIUM CONDUCTOR

Nominal Cross sectional Area (in Sq. mm)	2 core	Shape	3 core	Shape	3 ½ core	Shape	4 core	Shape
4	0.305	W	0.335	W	-	-	0.363	W
6	0.348	W	0.363	W	-	-	0.407	W
10	0.392	W	0.407	W	-	-	0.293	F
16	0.235	F	0.293	F	-	-	0.323	F
25	0.293	F	0.352	F	0.382	F	0.382	F
35	0.323	F	0.382	F	0.411	F	0.440	F
50	0.382	F	0.440	F	0.469	F	0.499	F
70	0.411	F	0.499	F	-	F	0.587	F
95	0.499	F	0.587	F	0.616	F	0.645	F
120	0.528	F	0.616	F	0.675	F	0.731	F
150	0.587	F	0.675	F	0.731	F	0.790	F
185	0.645	F	0.761	F	0.820	F	0.879	F
240	0.731	F	0.879	F	0.937	F	0.996	F
300	0.820	F	0.966	F	1.055	F	1.113	F
400	0.937	F	1.083	F	1.172	F	1.231	F
500	1.055	F	1.231	F	1.348	F	1.406	F
630	1.172	F	-	-	-	-	-	-

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TABLE P3 (Additional)

VARIATION FACTOR FOR ROUND WIRE 'W' STEEL (FeF)

PVC INSULATED 1.1 KV POWER CABLES WITH COPPER/ALUMINIUM CONDUCTOR

Nominal Cross Sectional Area (in sq. mm)	2 Core	3 Core	3 .5 Core	4 Core
1.5	0.247	0.259		0.288
2.5	0.273	0.289		0.329
4	0.305	0.335		0.363
6	0.348	0.363		0.407
10	0.392	0.407		0.533
16	0.439	0.523	0.014	0.573
25	0.526	0.625	0.664	0.685
35	0.591	0.685	0.729	0.761
50	0.661	0.790	0.864	1.108
70	0.745	1.122	1.200	1.256
95	1.085	1.286	1.376	1.443
120	1.147	1.386	1.479	1.562
150	1.267	1.526	1.684	2.173
185	1.403	2.090	2.315	2.421
240	1.994	2.397	2.641	2.722
300	2.180	2.642	3.670	3.842
400	2.987	3.728	4.126	4.292
500	3.517	4.226	5.958	6.301
630	4.774	6.018	6.737	7.141

TABLE P4

VARIATION FACTOR FOR ALUMINIUM (AIF)
PVC INSULATED 1.1 KV POWER CABLES WITH COPPER CONDUCTOR

Nominal Cross Sectional Area (in Sq. mm)	Aluminium Factor for Aluminium armoured cable with copper conductor
4	0.058
6	0.063
10	0.073
16	0.084
25	0.096
35	0.108
50	0.123
70	0.139
95	0.183
120	0.198
150	0.218
185	0.241
240	0.271
300	0.379
400	0.424
500	0.478
630	0.537
800	0.591
1000	0.816

TABLE P5

VARIATION FACTOR FOR PVC COMPOUND (CCFCu)
PVC INSULAYTED CONTROL CABLES WITH COPPER CONDUCTOR

No of cores	Core size 1.5 sq mm		Core size 2.5 sq mm	
	Unarm	Arm	Unarm	Arm
2	0.118	0.121	0.125	0.139
3	0.121	0.131	0.141	0.157
4	0.137	0.152	0.161	0.179
5	0.157	0.174	0.187	0.206
6	0.179	0.199	0.234	0.260
7	0.179	0.199	0.234	0.260
8	0.193	0.215	0.292	0.325
9	0.216	0.241	0.300	0.335
10	0.236	0.262	0.303	0.337
12	0.249	0.277	0.334	0.371
14	0.311	0.327	0.389	0.409
16	0.344	0.362	0.435	0.458
18	0.352	0.371	0.474	0.500
19	0.375	0.395	0.476	0.501
20	0.391	0.412	0.519	0.546
24	0.457	0.481	0.584	0.615
27	0.491	0.517	0.631	0.664
30	0.529	0.557	0.706	0.743
37	0.615	0.647	0.835	0.879
44	0.739	0.778	1.019	1.026
52	0.845	0.889	1.100	1.158
61	0.952	1.002	1.246	1.312

IEEMA (PVC)/CABLE(R-1)/2017 **Effective from: 1st November 217**

TABLE P6

VARIATION FACTOR FOR STEEL (FeF)

PVC INSULATED CONTROL CABLES WITH COPPER CONDUCTOR

No of cores	Core size 1.5 sq mm	Shape of armour	Core size 2.5 sq mm	Shape of armour
2	0.243	W	0.277	W
3	0.257	W	0.289	W
4	0.277	W	0.314	W
5	0.303	W	0.342	W
6	0.329	W	0.379	W
7	0.329	W	0.379	W
8	0.341	W	0.456	W
9	0.383	W	0.275	F
10	0.408	W	0.325	F
12	0.289	F	0.342	F
14	0.306	F	0.360	F
16	0.317	F	0.372	F
18	0.332	F	0.350	F
19	0.343	F	0.397	F
20	0.368	F	0.400	F
24	0.398	F	0.475	F
27	0.414	F	0.478	F
30	0.425	F	0.503	F
37	0.461	F	0.548	F
44	0.507	F	0.601	F
52	0.556	F	0.641	F
61	0.585	F	0.685	F

TABLE P6 (Additional)

VARIATION FACTOR FOR ROUND WIRE 'W' STEEL (FeF)

PVC INSULATED CONTROL CABLES WITH COPPER CONDUCTOR

No. of Cores	Core size 1.5 sq mm	Core size 2.5 sq mm
2	0.243	0.273
3	0.257	0.289
4	0.277	0.314
5	0.303	0.342
6	0.329	0.379
7	0.329	0.379
8	0.341	0.456
9	0.383	0.508
10	0.408	0.535
12	0.510	0.572
14	0.546	0.625
16	0.581	0.660
19	0.608	0.696
24	0.714	0.819
25	0.679	0.798
27	0.732	0.837
28	0.696	0.815
30	0.758	0.881
33	0.747	0.883
37	0.820	1.217
44	0.926	1.355
48	1.122	1.308
50	1.122	1.308
52	1.149	1.361
56	1.202	1.388
61	1.299	1.520

TABLE L2

VARIATION FACTOR FOR POLYMER (CCFAI / CCFCu)

XLPE INSULATED 1.1 KV POWER CABLES WITH COPPER / ALUMINIUM CONDUCTOR

Nominal Cross Sectional Area (in Sq. mm)	1 core	2 core		3 core		3.5 core		4 core	
	Unarm	Unarm	Arm	Unarm	Arm	Unarm	Arm	Unarm	Arm
2.5	0.055	0.163	0.175	0.166	0.177	-	-	0.177	0.188
4	0.075	0.201	0.204	0.205	0.213	-	-	0.218	0.213
6	0.085	0.213	0.234	0.205	0.230	-	-	0.242	0.232
10	0.082	0.252	0.280	0.217	0.251	-	-	0.285	0.298
16	0.089	0.278	0.341	0.289	0.246	-	-	0.300	0.279
25	0.101	0.307	0.278	0.276	0.247	0.295	0.264	0.331	0.290
35	0.109	0.330	0.319	0.305	0.270	0.328	0.292	0.368	0.319
50	0.124	0.482	0.685	0.348	0.311	0.372	0.335	0.422	0.394
70	0.146	0.354	0.335	0.469	0.397	0.489	0.420	0.528	0.464
95	0.163	0.436	0.389	0.504	0.441	0.544	0.471	0.591	0.523
120	0.176	0.475	0.421	0.556	0.498	0.599	0.538	0.722	0.656
150	0.217	0.510	0.490	0.690	0.611	0.717	0.633	0.840	0.762
185	0.236	0.631	0.608	0.836	0.738	0.854	0.756	1.007	0.899
240	0.273	0.750	0.726	1.002	0.842	1.079	0.952	1.238	1.119
300	0.303	0.919	0.887	1.161	1.012	1.170	1.031	1.457	1.414
400	0.372	1.093	1.040	1.376	1.283	1.545	1.379	1.778	1.626
500	0.413	1.342	-	1.568	1.400	1.806	1.456	-	-
630	0.469	1.546	-	-	-	-	-	-	-
800	0.569	-	-	-	-	-	-	-	-
1000	0.667	-	-	-	-	-	-	-	-

TABLE XL1

VARIATION FACTOR FOR XLPE COMPOUND (XLFAL/XLFCU)

XLPE INSULATED 1.1 KV POWER CABLES WITH COPPER/ALUMINIUM CONDUCTOR

Nominal cross Sectional Area (in Sq. mm)	1 core		2 core		3 core		3.5 core		4 core	
	Unarm	Arm	Unarm	Arm	Unarm	arm	Unarm	Arm	Unarm	arm
2.5	0.007	0.010	0.014	0.014	0.021	0.021			0.028	0.028
4	0.009	0.012	0.018	0.018	0.027	0.027			0.036	0.036
6	0.010	0.015	0.022	0.022	0.033	0.033			0.043	0.043
10	0.013	0.018	0.025	0.025	0.039	0.039			0.053	0.053
16	0.016	0.023	0.034	0.034	0.049	0.049			0.065	0.065
25	0.021	0.030	0.048	0.048	0.070	0.070	0.084	0.084	0.093	0.093
35	0.025	0.035	0.059	0.059	0.084	0.084	0.099	0.099	0.112	0.112
50	0.033	0.044	0.075	0.075	0.108	0.108	0.130	0.130	0.144	0.144
70	0.042	0.054	0.095	0.095	0.137	0.137	0.160	0.160	0.179	0.179
95	0.048	0.062	0.110	0.110	0.160	0.160	0.190	0.190	0.211	0.211
120	0.060	0.076	0.138	0.138	0.200	0.200	0.239	0.239	0.266	0.266
150	0.078	0.095	0.180	0.180	0.259	0.259	0.296	0.296	0.344	0.344
185	0.097	0.116	0.224	0.224	0.324	0.324	0.369	0.369	0.430	0.430
240	0.116	0.137	0.266	0.266	0.388	0.388	0.446	0.446	0.518	0.518
300	0.138	0.164	0.325	0.325	0.467	0.467	0.540	0.540	0.620	0.620
400	0.175	0.214	0.357	0.357	0.536	0.536	0.619	0.619	0.714	0.714
500	0.217	0.260	0.440	0.440	0.660	0.660	0.769	0.769	0.880	0.880
630	0.265	0.318	0.542	0.542	0.814	0.814	0.941	0.941	1.085	1.085
800	0.323	0.389								
1000	0.375	0.444								

TABLE XL2
VARIATION FACTOR FOR XLPE COMPOUND (XLFCU)
XLPE INSULAYTED CONTROL CABLES WITH COPPER CONDUCTOR

No of cores	Core size 1.5 sq mm		Core size 2.5 sq mm	
	Unarm	Arm	Unarm	Arm
2	0.010	0.010	0.012	0.012
3	0.016	0.016	0.018	0.018
4	0.021	0.021	0.025	0.025
5	0.026	0.026	0.031	0.031
6	0.031	0.031	0.037	0.037
7	0.036	0.036	0.043	0.043
8	0.036	0.036	0.043	0.043
9	0.042	0.042	0.049	0.049
10	0.052	0.052	0.061	0.061
12	0.062	0.062	0.074	0.074
14	0.073	0.073	0.086	0.086
16	0.083	0.083	0.098	0.098
18	0.094	0.094	0.110	0.110
19	0.099	0.099	0.116	0.116
20	0.104	0.104	0.123	0.123
24	0.125	0.125	0.147	0.147
27	0.140	0.140	0.165	0.165
30	0.156	0.156	0.184	0.184
37	0.192	0.192	0.227	0.227
44	0.229	0.229	0.270	0.270
52	0.270	0.270	0.319	0.319
61	0.317	0.317	0.374	0.374

TABLE XL3

VARIATION FACTOR FOR XLPE(XLFAL/XLFCU)

SINGLE CORE ARMOURED /UNARMOURED XLPE INSULATED 3.3 to 33 KV POWER CABLES WITH CU / AL CONDUCTOR

Nominal Cross Sectional Area (in Sq. mm.)	XLPE Factor for Armoured/ Unarmoured Cable with AL /CU Conductor					
	3.3 KV	6.6 KV (E)	11 KV (E)/ 6.6 KV (UE)	11 KV (UE)	22 KV (E)	33 KV (E)
25	0.110	0.131	0.170	0.279		
35	0.122	0.137	0.175	0.284	0.317	0.522
50	0.135	0.151	0.191	0.307	0.341	0.563
70	0.155	0.172	0.215	0.342	0.379	0.615
95	0.174	0.193	0.241	0.377	0.417	0.670
120	0.192	0.212	0.262	0.407	0.449	0.713
150	0.209	0.229	0.283	0.437	0.481	0.757
185	0.228	0.250	0.308	0.471	0.518	0.809
240	0.255	0.279	0.343	0.519	0.569	0.883
300	0.280	0.322	0.372	0.560	0.613	0.943
400	0.326	0.392	0.420	0.625	0.683	1.041
500	0.388	0.461	0.469	0.694	0.757	1.142
630	0.467	0.520	0.529	0.777	0.845	1.265
800	0.567	0.593	0.602	0.874	0.949	1.407
1000	0.656	0.665	0.660	0.955	1.036	1.525

Note : XLPE factors include Semicons for Conductor & Insulation screen

TABLE – XL4

VARIATION FACTOR FOR XLPE (CCF1Al / CCF1Cu)

3 CORE XLPE INSULATED 3.3 to 33 KV POWER CABLES WITH COPPER / ALUMINIUM CONDUCTOR

Nominal Cross Sectional Area (in Sq. mm)	3.3 KV ARM	6.6 KV (E) ARM	6.6 KV (UE) / 11 KV (E) ARM	11 KV (UE) ARM	22 KV (E) ARM	33 KV (E) ARM
25	0.315	0.394	0.511	0.838		
35	0.339	0.427	0.545	0.880	0.982	1.638
50	0.378	0.474	0.600	0.957	1.065	1.751
70	0.435	0.541	0.679	1.067	1.183	1.916
95	0.489	0.604	0.755	1.171	1.295	2.071
120	0.537	0.661	0.822	1.265	1.396	2.210
150	0.585	0.719	0.890	1.359	1.497	2.350
185	0.642	0.784	0.968	1.468	1.614	2.513
240	0.717	0.873	1.074	1.615	1.773	2.732
300	0.781	1.006	1.167	1.744	1.928	2.919
400	0.886	1.227	1.314	1.948	2.130	3.229
500	0.956	1.421	1.445	2.148	2.381	3.538
630	1.129	1.582	1.609	2.382	2.630	3.940

Note : XLPE factors include Semicons for Conductor & Insulation screen

TABLE H1

VARIATION FACTOR FOR ALUMINIUM (AIF)

ALUMINIUM ARMOURED SINGLE CORE XLPE INSULATED 3.3 TO 33 KV CABLES

Nominal Cross Sectional Area (in Sq. mm.)	Aluminium Factor for Aluminium Armoured Cable with Aluminium Conductor					
	3.3 KV	6.6 KV (E)	11 KV (E)/ 6.6 KV (UE)	11 KV (UE)	22 KV (E)	33 KV (E)
35	0.251	0.284	0.301	0.344	0.358	0.473
50	0.312	0.336	0.352	0.397	0.408	0.672
70	0.385	0.409	0.423	0.469	0.501	0.723
95	0.476	0.500	0.518	0.637	0.656	0.856
120	0.561	0.586	0.601	0.726	0.744	0.949
150	0.653	0.678	0.696	0.823	0.842	1.050
185	0.773	0.797	0.893	0.949	0.965	1.183
240	0.997	1.063	1.083	1.139	1.154	1.387
300	1.209	1.271	1.283	1.333	1.307	1.753
400	1.438	1.556	1.565	1.620	1.636	2.046
500	1.873	1.901	1.910	2.110	2.128	2.484
630	2.337	2.361	2.369	2.580	2.595	2.978
800	3.007	3.071	3.080	3.145	3.163	3.588
1000	3.737	3.741	3.749	3.804	3.822	4.565

TABLE H2

VARIATION FACTOR FOR POLYMER (CCFAl / CCFCu)

3 CORE XLPE INSULATED 3.3 to 33 KV POWER CABLES WITH COPPER / ALUMINIUM CONDUCTOR

Nominal Cross Sectional Area (in Sq. mm)	3.3 KV ARM	6.6 KV (E) ARM	6.6 KV (UE) / 11 KV (E) ARM	11 KV (UE) ARM	22 KV (E) ARM	33 KV (E) ARM
35	0.374	0.990	1.142	1.604	1.782	-
50	0.445	1.119	1.260	1.834	2.046	2.864
70	0.547	1.290	1.396	2.011	2.284	3.219
95	0.594	1.440	1.647	2.269	2.428	3.367
120	0.732	1.692	1.877	2.498	2.715	3.646
150	0.812	1.906	2.061	2.767	2.931	3.927
185	0.960	2.086	2.406	3.028	3.180	4.166
240	1.130	2.484	2.744	3.398	3.580	4.589
300	1.219	2.912	3.161	3.840	4.016	5.029
400	1.313	3.530	3.664	4.353	4.666	5.736
500	1.652	3.925	3.971	4.621	4.878	5.913
630	1.949	4.487	4.982	5.225	5.477	6.696

Fillers added in PVC consumption

TABLE H3
VARIATION FACTOR FOR STEEL (FeF)
XLPE INSULATED 3.3 TO 33 KV POWER CABLES WITH COPPER / ALUMINIUM CONDUCTOR

Nominal Cross Sectional Area Sq. mm.	3.3 KV	6.6 KV (E)	11 KV (E) / 6.6 KV (UE)	11 KV (UE)	22 KV (E)	33 KV (E)
25	**0.551**	**0.604**	**0.656**	**0.814**		
35	0.645	0.645	0.731	0.879	0.937	-
50	0.675	0.703	0.761	0.937	0.966	1.181
70	0.761	0.761	0.849	0.996	1.055	1.289
95	0.820	0.849	0.907	1.083	1.113	1.348
120	0.879	0.907	0.966	1.142	1.172	1.406
150	0.966	0.966	1.055	1.201	1.259	1.494
185	1.025	1.055	1.113	1.259	1.318	1.553
240	1.142	1.142	1.231	1.377	1.406	1.641
300	1.231	1.259	1.318	1.465	1.524	1.758
400	1.348	1.406	1.435	1.582	1.641	1.876

TABLE H4

VARIATION FACTOR FOR ALUMINIUM (AIF)

XLPE INSULATED SINGLE CORE 3.3 TO 33 KV POWER CABLES WITH COPPER CONDUCTOR

Nominal Cross Sectional Area (in Sq. mm.)	Aluminium Factor for Aluminium Armoured Cable with Copper Conductor					
	3.3 KV	6.6 KV (E)	11 KV (E)/ 6.6 KV (UE)	11 KV (UE)	22 KV (E)	33 KV (E)
35	0.153	0.187	0.204	0.247	0.258	0.372
50	0.179	0.203	0.220	0.262	0.275	0.425
70	0.196	0.219	0.233	0.278	0.311	0.444
95	0.213	0.237	0.254	0.373	0.392	0.470
120	0.228	0.253	0.268	0.393	0.410	0.488
150	0.243	0.269	0.287	0.414	0.432	0.504
185	0.261	0.285	0.381	0.437	0.455	0.526
240	0.324	0.389	0.410	0.465	0.480	0.556
300	0.365	0.428	0.440	0.490	0.510	0.737
400	0.432	0.471	0.480	0.536	0.552	0.783
500	0.489	0.517	0.526	0.726	0.744	0.844
630	0.544	0.568	0.572	0.787	0.801	0.902
800	0.706	0.787	0.797	0.862	0.880	0.982
1000	0.824	0.865	0.867	0.923	0.940	1.324

TABLE - H5

VARIATION FACTOR FOR STEEL (FeW)

XLPE INSULATED 3.3KV TO 33 KV POWER CABLES WITH COPPER / ALUMINIUM CONDUCTOR

Nominal Cross Sectional Area in Sq. mm	3.3/3.3 KV	3.3/6.6 KV	11 KV (E) / 6.6 KV (UE)	11 KV (UE)	22 KV (E)	33 KV (E)
25	1.258	1.457	1.612	2.509	1.503	--
35	1.361	1.569	1.853	2.644	2.797	2.517
50	1.682	1.687	2.321	2.800	2.921	4.569
70	2.033	1.979	2.503	3.219	3.347	4.809
95	2.202	2.507	2.718	4.019	4.200	5.437
120	2.371	2.675	2.882	4.241	4.416	6.713
150	2.870	2.847	3.265	4.447	4.621	6.976
185	3.121	3.309	4.148	4.726	5.289	7.356
240	3.758	4.227	4.442	5.442	6.651	7.718
300	4.099	5.024	5.182	6.894	7.084	8.187
400	5.750	6.572	6.658	7.433	7.657	8.760
500	6.716	6.777	6.861	7.588	7.797	8.830
630	7.492	7.465	7.477	8.209	8.386	9.413

	BHARAT HEAVY ELECTRICALS LIMITED ELECTRONICS DIVISION Mysore Road, Bangalore	Doc. No : PS4452986 Rev. No : 00 Page : 1 of 3
	CUSTOMER/ USER: BHEL/INDIAN RAILWAYS PROJECT: Manufacturing cum Maintenance of Vande Bharat Trainsets	

Purchase Specification for Power Cable

Rev No.	Date	Altered	Checked	Approved	Revision Details

Issued by: Traction Engg. Dept., BHEL-EDN	Approved Anjul		
	Prepared Shankar Narayanan	Checked David	Date 25.01.2024

1.1 Technical Specification

1.1.1 For the technical requirement, bidder to refer to PS4452986 – Part A.

2.1 Bill of Quantities

2.1.1 Bill of Materials in the technical specification (Part A) is for information only. Bidder to consider & quote for the items as per the quantity mentioned in the RFQ

3.1 Packing Instructions

3.1.1 Successful bidder to mandatorily follow the packing instructions given in Part A

3.1.2 Stack-ability of the packaged boxes & storage worthiness/durability to be ensured

3.1.3 Successful bidder shall ensure that set-wise Packing List be pasted on each Box (Typical format enclosed with this document)

Set wise Packing List to be pasted on each Box

Supplier shall furnish the packing list as per the format given below:

BHEL PO No.	
BHEL Material Code	
Material Description	
Quantity (Set)	
Box No (per set)	

Bill of Materials (Supplier shall list down all the items including loose items and respective quantities):

Main Item:

Sl. No.	Item description	Quantity per Set	Total Sets packed in the Box (applicable in case of multiple sets in one Box)

Loose Items (if any):

Sl. No.	Item description	Quantity per Set	Total Sets packed in the Box (applicable in case of multiple sets in one Box)

Supplier details:

Notes for suppliers:

1) Suppliers shall pack items, set wise in one box. In case of multiple boxes for one set, supplier shall identify box numbers (Set 1/ Box1, Set 1/ Box2 etc.)
2) Packing list shall be pasted on each box, as per actual contents inside the box. This list will be in addition to the supplier's standard packing list.
3) Box wise Packing list shall be shared with BHEL MM and same will be mandatory for dispatch clearance.

	BHARAT HEAVY ELECTRICALS LIMITED **ELECTRONICS DIVISION** **Mysore Road, Bangalore**	**DOC. NO: PS4452986-part A** **REV. NO: 00** **Page 1 of 31**

CUSTOMER/ USER	**BHEL/INDIAN RAILWAYS**
PROJECT	**Manufacturing cum Maintenance of Vande Bharat Trainsets**

TECHNICAL SPECIFICATION

Power Cables

Rev No.	Date	Altered	Checked	Approved	Revision Details

Issued by:
Traction Engg. Dept.,
BHEL-EDN

APPROVED

Anjul

PREPARED	CHECKED	DATE
Shankar Narayanan	David J	02.02.2024

Table of Contents:

SECTION – 1
SCOPE, QUANTITIES & ELIGIBILITY

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Power Cables.

The equipment is required for the following project.

Name of the customer : BHEL/INDIAN RAILWAYS
Name of the Project : Manufacturing cum Maintenance of Vande Bharat Trainsets

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of E-Beam power cables. Items covered in this specification are mentioned at Section-1.2 of this document. All the cables should be proven and suitable for Traction/ Rolling Stock Application. The cables covered are of limited fire hazard type i.e. low flame spread, low smoke emission and less toxic fume emission. The cables should be manufactured by Electron beam irradiated cross linked process. The cables should be suitable for ambient temperature range of -10 deg C to +50 deg C.

Cables mentioned in this Purchase Specification are single core unscreened power cables of various cross sections which is required to be used in Vande Bharat Train Sets.

The supply of complete documentation for approval of design, relevant drawings and calculations to the satisfaction of purchaser and RDSO and support documentation associated with the operation and maintenance of the equipment supplied.

The supplier shall submit list of equipment and facilities required for maintenance and overhaul of equipment offered.

1.2 BILL OF MATERIAL (for 1 Train of 16 Cars)

Sl. No.	Cable Size	Voltage Grade	Length (metre)
1	1C X 120 Sq.mm	9 GKW	3520
2	1C X 70 Sq.mm	9 GKW	1440
3	1C X 70 Sq.mm	3 GKW	3360
4	1C X 50 Sq.mm	4 GKW	192
5	1C X 35 Sq.mm GNYE	9 GKW	1040
6	1C X 35 Sq.mm	3 GKW	480
7	1C X 25 Sq.mm	3 GKW	1960
8	1C X 10 Sq.mm	4 GKW	480
9	1C X 10 Sq.mm	3 GKW	400
10	1C X 6 Sq.mm	3 GKW	400

11	1C X 4 Sq.mm	3 GKW	2340
12	1C X 2.5 Sq.mm	3 GKW	26000
13	1C X 2.5 Sq.mm GNYE	3 GKW	500
14	1C X 2.5 Sq.mm Fire Survival	3 GKW	18000

Note: There shall be tolerance of +2% in the lengths indicated in above table.

1.3 ELIGIBILITY CRITERIA

The Bidder should be a regular supplier to Indian Railway Projects and should have supplied the offered equipment for Indian Railways projects of 3 phase IGBT Based AC EMU/MEMU/ /Trainsets/Locomotives operating in India.

1.4 CLAUSE BY CLAUSE COMPLIANCE

Vendor to submit clause by clause compliance to complete technical specification along with the technical bid.

1.5 REFERENCE SPECIFICATIONS

This purchase specification has the reference of Railway Specification No. ICF MD SPEC-398 Rev-01 dated: 05/11/2022.

SECTION – 2
TECHNICAL SPECIFICATION

2.1 TECHNICAL SPECIFICATION OF POWER CABLE.

1. This specification covers the requirement of design, manufacture, supply, testing & dispatch of Power Cable for Trainsets of Indian Railways.

2. The cables shall use high grade electrolytic copper stranded conductors tinned in accordance with Good Industry practices.

3. Electron beam, irradiated, thin walled, halogen free, low smoke and less toxic cables according to relevant international standards and the Good Industry Practice for rolling stock application, shall be used. The insulation/sheathing material shall be EPDM/EVA.

4. All the Power cables shall conform to international standards for fire retardant, fire survival characteristics suitable for the EMU/Train Set applications.

5. Following standards are to be generally followed for the Power Cables.

   IEC-60228: Conductors for insulated cables
   IEC-60502: Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV
   IEC-50264: Railway applications - Railway rolling stock power and control cables having special fire performance
   IS 10810: Method of test for cables

6. Specifically, Power Cables shall be manufactured and tested complying to following IT standards.

   a) 600/1000V and 1800/3000V grade unscreened cables as per RDSO specification no. ELRS/SPEC/ELC/0019, 'REV'- '4', dated. 22.02.2018 (latest).

   b) 3600V/6000V voltage grade unscreened cables as per CLW specification no. CLW/ES/3/0458.

7. The Cables shall be de-rated to take care of the adverse ambient conditions. All de-rating factors shall be applied, together with the maximum permissible conductor temperature for the particular insulation type. In no case the conductor continuous temperature shall exceed 90 deg C. The maximum short circuit temperature shall not exceed 250 deg C. The cable insulation shall be capable of withstanding these temperatures.

8. The material of insulation and sheath of each core and layer in the cable must be mentioned in the datasheet of the cable. The thickness of insulation and sheath of each core and layer in the cable must be mentioned in the datasheet of the cable.

9. The Cables in the multi-core cables shall be provided with multi colours for ease of wiring. The colour details of cables shall be decided in consultation with RDSO/ICF/RCF. Fire Survival Cables shall be generally of Orange/Red Colour.

10. Design and manufacturing of complete Power cables shall be in accordance with EN45545-2. The applicable Hazard level will be HL 3.

11. At locations in the Train, where high temperatures are likely to be encountered, special cables shall be used. The supplier shall submit details of cables conforming to EN 50264 for fire retardant, fire survival characteristics.

12. Fire survival cables (as indicated in BOM) according to EN 50200 shall be used for PA/PIS, ETB circuit, Passenger Alarm, supply and other essential circuits of Fire detection system, Brake system and Door system for their continued functioning to the extent possible in the event of fire. Survivable duration classification of PH30 (30 minutes) or higher shall be suitable.

13. The following operational and environmental factor will be specially kept in view while selecting the cable:

    (i) Excessive vibrations that are experienced because of prevalent track conditions in India.
    (ii) Prevalence of high temperature and humidity for the most part of the year.
    (iii) Operation of the Train over a humid and salty terrain in which the climate varies from high rainfall for 4-5 months and extremely dusty atmosphere during rest of the year.
    (iv) Loading of power cables will not be more than 75% of its capacity.
    (v) Power cable terminal connections will have only crimped joints. However, control cable terminations can be cage clamp/ push-in type.
    (vi) Suitable cable Layout to bring down EMI interference levels within acceptable limits.

2.2 EQUIPMENT TESTING:

(a) Cables shall be Type tested as per RDSO spec. no ELRS/SPEC/ELC/0019, 'REV'- '4'or latest, CLW specification no. CLW/ES/3/0458, as applicable.

(b) Valid Type test report is to be submitted for the equipment along with offer, if the equipment is already type tested. In case, ultimate customer insists to repeat the type tests due to any reason, the type test shall be conducted again by the supplier, for which test procedure shall also be submitted by the supplier for approval before conducting the type test. In case ultimate customer desires to witness the type tests, the supplier shall have no objection. The supplier is required to quote for the type test charges if any, separately in commercial offer. These charges will be loaded in the equipment price at the time of final evaluation. If Type Test charges are not quoted separately in the commercial offer, then it will be presumed that offer is inclusive of type test charges and no extra payment will be done in case of type test conducted due to any reason.

(c) Acceptance and Routine tests on Cables shall be as per respective RDSO/CLW/IEC specs.

(d) Supplier to submit Routine test certificates and inspection certificate of equipment as per QAP along with equipment.

(e) Type and routine test will also confirm to clause 3.13 of section 3 of technical specification.

2.3 DESIGN REQUIREMENTS TO BE PROVIDED BY SUPPLIER:

Write-up/ description of each equipment	To be provided by Supplier
Datasheet of equipment	To be provided by Supplier.
Circuit diagram, connection & wiring diagram, equipment drawing with mounting details, weights, center of gravity, etc. and any other relevant drawings	To be provided by Supplier

Type test protocol & procedure/ Type test reports	Supplier to submit the complete reports of type test already conducted on the proposed/offered equipment. In case type test is required to be done, supplier to submit the detailed test procedures for approval.
Routine test protocol & procedure/ Routine test reports	Supplier to submit Routine test certificates and inspection certificate of equipment as per QAP along with equipment.
Details of proven design	To be provided by Supplier
Performance statement	To be provided by Supplier in the attached format.
Performance certificate	To be provided by Supplier in the attached format.
RDSO Approval letter (conforming to the latest RDSO spec as applicable)	To be provided by Supplier
Project specific AUTO CAD drawing-2D and 3D model	To be provided by Supplier after order placement
Project Specific Drawings in A3 size	To be provided by Supplier
Technical Manual	To be provided by Supplier
Installation, Operational and Maintenance Manual	To be provided by Supplier
MTBF/MDBF Values along with the method of calculation	To be provided by supplier
Quality assurance plan (QAP)	To be provided by supplier

SECTION – 3
PROJECT DETAILS AND GENERAL SPECIFICATIONS

3.1 GENERAL

This section stipulates the General Technical Requirements under the contract and forms an integral part of the Technical Specification. The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections and are not exclusive.

However, in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

The Train shall be Distributed Power type which shall have Driving Cabs on its both ends and shall be capable of running in either direction without the requirement for any change in its composition. Configuration of 16-car rake shall be two End Basic Units and two Middle Basic Units.

The configuration of Vande Bharat express (Trainsets) is as under (for reference):

DTC-MC-TC-MC-MC-TC-MC-NDTC-NDTC-MC-TC-MC-MC-TC-MC-DTC

Where,

DTC: Driving Trailer Coach

MC: Motor Coach

NDTC: Non-Driving Trailer Coach

TC: Trailer Coach

3.2 INSTRUCTION TO BIDDERS

The bidders shall submit the technical requirements, data and information as per the technical specification, provided in Section-2.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc. in English language, fully in conformity with the technical specification.

Whenever required, the bidder shall depute his technical experts to RDSO / nominated agency for design discussions and approval.

3.3 GENERAL DESIGN REQUIREMENTS

i) The stock fitted with the supplied equipment shall meet the operating, service conditions and performance requirements of this specification and shall be suitable for operating conditions on IR.

ii) All equipment shall be vandal proof and incorporate necessary anti-pilferage features without compromising aesthetics / maintainability.

iii) Notwithstanding the contents of this specification, the Supplier shall ensure that the equipment supplied by them is complete in all respect so as to achieve the efficient operation & optimum performance of the Train set.

iv) The equipment design shall incorporate all essential features necessary to yield high traffic use, low maintenance requirements, easy maintainability, high regeneration, high efficiency, light in weight, user & environment friendly and high reliability in train operation. The design shall also facilitate easy erection, inspection, maintenance and replacement of the sub-units/ assemblies of all the equipment.

v) The entire equipment shall be designed to ensure satisfactory and safe operation under the running conditions mentioned in this specification duly taking care of sudden variations in load, voltage etc. under abnormal working conditions due to faulty operation, short circuits & earth faults etc.

vi) Wherever applicable: Airflow inlet/ arrangement for forced cooled equipment shall be designed in such a way that cloth, polythene, papers etc., which may get sucked, either do not block the airflow or get removed during halts. Moreover, filter should be easily cleanable.

vii) All working parts of the control and auxiliary circuit specifically electronics and PCBs, shall be suitably covered to keep them free from moisture, mold growth and dust. The protection level shall be furnished by the Supplier during design approval.

viii) All the electrical equipment shall comply with the latest edition of governing IEC specifications unless otherwise specified. The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with the limits specified and the ambient conditions defined in the Specification.

ix) All equipment shall be adequately earthed, insulated, screened or enclosed. They shall be provided with essential interlocks & keys as may be adequate to ensure the protection of the equipment and the safety of those concerned with its operation and maintenance.

x) Wherever applicable: Supplier shall to the extent feasible employ the currently available lubricants/cooling oils in India. Full lubrication scheme and schedule for the equipment shall be submitted. If use of imported lubricants or cooling oil is inevitable, supplier shall furnish details of equivalent Indian lubricants/oil.

xi) Supplier shall submit 3D models of offered equipment including associated sub-assemblies, etc. in. stp formats.

xii) The design of the equipment shall be based on sound, proven and reliable engineering practices. The equipment used in different sub systems shall be of proven technology and

design. The supplier shall submit the supportive document for each of the assembly/sub-assembly for its proven performance under the environmental conditions prevalent in India.

xiii) The supplier shall design the mounting arrangements suitable for coaches. The accessories for mounting the equipment shall be part of the scope of supply. The hardware for mounting, safety links for underslung equipment, the termination hardware also will be in the scope of supply for all equipment.

xiv) SOFTWARE (WHEREVER APPLICABLE)

a. Software shall be written in a structured manner and fully documented during all stages of its design and development. This shall meet the requirements of EN 50126-2: The specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 2, EN 50128: Railway Applications: Software for Railway Control and Protection Systems, and EN 50129: Safety-related Electronic Railway Control and Protection Systems.

b. The Supplier shall submit the values of parameters, list of fault messages, their environmental data, hierarchy of fault display, fault categorization, trouble shooting of each fault by way of Changes in parameters shall be demonstrated with their effect on the results.

c. Parametric changes shall be possible in the software in order to meet the future requirements. While listing out the values of various parameters, the Supplier must provide a range within which any change can be made without jeopardizing the functionality of the system. Supplier shall submit the licensed software to the purchaser.

d. Software shall be fine-tuned through simulations & real life working conditions based on the extensive trials, associating BHEL / user Railways before putting the rake in commercial services. As it requires, instrumentation and expertise of Software Design Professionals, software expert(s) of Supplier shall be based at the work place along with commissioning engineers so that all software related issues are expeditiously resolved before putting the rake into commercial service.

e. Quality and efficacy of trouble shooting manual, software tools and software documentation shall be validated during extensive field trials. Final version of these documents shall include the changes required based on the service trials, commercial service operation, experience of operating Railways.

f. All the changes, thereafter, in software shall be approved by RDSO / nominated agency in consultation with user Railways before actual implementation and the Supplier must give software release, which shall include brief description of the problem, earlier as well as

modified logic, explanation, parametric changes etc. to the satisfaction of RDSO / nominated agency.

g. The Supplier shall submit Software Quality Plan for review before work commences on software design. The software quality plan shall clearly state the controls and practices used in the software life cycle from specification through to in-service operation.

h. Internal independent review, verification & testing, using real & synthetic data, shall be performed at the software module and system level. RDSO/ nominated agency / BHEL / user Railway may audit the Supplier against the **Software Quality Plan** at any stage during the Contract. The Supplier shall ensure that all software is fully de- bugged prior to the final review by RDSO/user Railway.

i. Sufficient software documentation shall be provided to give the full understanding of the software function, logics, parameters and operation. Documentation shall be complete, clear and concise, and include all modifications up to the final acceptance. Documentation shall clearly explain the software logics, associated parameters, include software block diagram showing signal flow, logic and hardware interfaces etc. A top level flow diagram and description of detailed operation shall be provided.

xv) Notwithstanding the contents of this specification, the supplier shall ensure that the equipment supplied by them is complete in all respect so as to enable the desired operation of the Train fitted with their equipment.

xvi) Supplier shall deliver the executable files of all developed software along with necessity tools to upload / download and carry out fault analysis.

3.4 INGRESS PROTECTION

i) All equipment shall be suitably protected from dust and water. As a minimum, equipment shall be sealed to the standards stated below:

Under frame & externally mounted equipment (other than traction/ auxiliary converter/Traction Motor)	IP65
Battery Box and Brake Chopper	IP20
Equipment mounted inside the Car body	IP54

ii) It may be necessary to protect some equipment to IP 67 in order to meet the requirements of Clause 3.5 of this Specification.

3.5 AMBIENT CONDITIONS / OPERATING CONDITIONS

The equipment shall be designed to work satisfactorily under following environmental conditions: -

Atmospheric temperature	Maximum temperature: 50 degrees Celsius Maximum touch temperature of metallic surface under the Sun: 75 degrees Celsius and in shade: 55 degrees Celsius Minimum temperature: - 10 degree Celsius
Humidity	100% saturation during rainy season
Solar radiation	1 kW/m2
Altitude	1000 meter above mean sea level
Rain fall	Very heavy and continuous rainfall in certain areas (up to 2500 mm during rainy season)
Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m3. In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system
Coastal area	Humid and salt laden atmosphere. The equipment shall function in accordance with this Specification when subjected continuously to a humid and salt laden atmosphere with maximum pH value as per IEC 60571, sulphate content of 7 mg per litre, maximum concentration of chlorine 6 mg per litres and maximum conductivity of 130 micro Siemens / cm.
Vibration	The vibration and shock levels recorded on various Sub-systems in existing Trains of IR are generally more than the limits given in IEC 61373 particularly at axle box, and traction motor. Accelerations over 50g have been recorded at axle box levels during run. Vibrations during wheel slips are of even higher magnitude. High level of vibrations above 30g have been measured at traction motor on IR's Trains, which increase up to 50g with worn gear- pinion.
Wind speed	High wind speed in certain areas, with wind pressure reaching 216 kg/m2 as per IS:875 Part 3(2015)
Flood level	The Train shall function in accordance with these Specifications and Standards in the event of flooding up to 203 mm above Rail Level as follows: • In the event of flooding at any level below Rail Level, the Train shall operate in full compliance with these Specifications and Standards. • In the event of flooding at a height between Rail Level and 203 mm above Rail Level, the Train shall operate in full compliance with these Specifications

	and Standards with the exception that it is permissible to restrict the operation of the Train to a maximum of 8 km/h. Allowance is to be made in addition for increase in the height of water level due to the "bow wave" effect of the Train passing through the water.
Flood Proofing of the under slung Equipment	Waterproofing test will be conducted on Traction and Auxiliary Converter by dipping them up to a height equivalent to 650 mm from rail level (under fully wheel worn condition) in stationary water for 12 hours. There should be no water ingress and Converters shall function normal after the test. Traction Motor with gearbox shall be tested for waterproofing as defined in clause 3.4.6.10.1 of specification ICF MD SPEC-398, issue status-01, rev 01. Other underslung equipment shall have IP protection as mentioned in clause 3.4 of this specification. However, even in case of flood levels more than the mentioned above, the equipment shall not get damaged and it should be possible to rejuvenate the equipment with minor attention without any adverse effect on their performance. Axle box shall be adequately flood proof.

3.6 STANDARDS

(a) The standards applicable and relevant to the complete Train and to the various Sub-systems and systems shall be:
- (i) IEC publications;
- (ii) EN;
- (iii) UIC;
- (iv) AAR;
- (v) IEEE;
- (vi) BS;
- (vii) RDSO specifications;
- (viii) ICF/RCF specifications;
- (ix) NF-F;
- (x) ORE;
- (xi) VDE;
- (xii) UL;
- (xiii) JIS
- (xiv) IS; and
- (xv) Any other standards referred to in this Schedule.

(b) In the event of any contradiction in the aforesaid standards, the following standards shall have priority in the order listed:
- (i) Standards mentioned in these Specifications and Standards set forth herein;
- (ii) EN/IEC/UIC/AAR and
- (iii) IS.

(c) For avoidance of any doubt, in case of any conflict between the requirements of these standards, the stipulations of Specifications and Standards in this Schedule shall have precedence.

(d) The temperature rise shall be measured according to the procedure stipulated by IEC and shall comply with the limits specified and the ambient conditions defined in the Specification. Specified temperature rise of equipment shall be calculated after taking into account at least 25% choking of air filters and radiator fins etc.

3.7 ENGINEERING DATA

(a) The contactor shall necessarily submit all the drawings/ documents unless anything is waived. The contactor shall submit drawings/ design documents/ data/ test reports as may be required for the approval of the purchaser. All drawings submitted by the Manufacturer including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required, dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

(b) Each drawing submitted by the Manufacturer shall be clearly marked with the name of the Customer and Project, the unit designation, the specifications title, the specification number, date of revision (if any), duly signed by the concerned technical person. If standard catalogue pages are submitted, the applicable items shall be indicated therein and should be made project specific. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

(c) The title block of drawings shall contain the following information incorporated in all contract drawings

1. Customer : BHEL /Indian Railways
2. Project: Manufacturing cum Maintenance of Vande Bharat Trainsets
3.Contract No./LOA No./ Ref no.: 2022/RS(WTA)-527/Vande Bharat Trains/874/1 dated 14/06/23
4. Main Contractor : Bharat Heavy Electricals Limited

3.7.1 SIZE OF DRAWINGS

The drawings of the following parts shall be to the sizes indicated below

I. Equipment details – full size or half size
II. Motor Assemblies – 1:5
III. General Assemblies- 1:10

Further, the scaling of drawings should be as per applicable standards.

3.7.2 METHOD OF FILING OF DRAWINGS

To facilitate filing of drawings, it is essential that each drawing submitted for approval is marked so that it can be identified. The supplier is, therefore, required to ensure that all prints are marked legibly at the right hand bottom corner. The following information is required in respect of each drawing:

I. Supplier's drawing number.
II. Supplier's name and date of submission.
III. Contract no. given by the purchaser.
IV. Description of drawings.
V. Relevant Specifications

3.8 MARKING OF EQUIPMENT & RATING PLATE

(a) All main assemblies of the equipment shall bear serial number, year of manufacture and symbol/ identification of the purchaser. Where the sub- assemblies/components of the main assemblies are not inter-changeable, the sub-assemblies shall also be marked with the serial nos. of the main assembly of which they form a part.

(b) All equipment/cubicles shall contain non-detachable rating plates of anodized aluminium with embossed letters and fitted in a visible position. The rating plate will give detailed rating specification and identification of equipment.

3.9 INFRINGEMENT OF PATENT RIGHTS

BHEL and Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, components used in design, development and manufacturing of propulsion system & other equipment and any other factor which may be a cause such dispute. The responsibility to settle any issue lies with the manufacturer.

3.10 DOCUMENT SUBMISSIONS

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Purchaser would be discussed and finalized at the time of award. The following schedule shall be followed generally for approval:

Sl.no.	No. of copies	Schedule

i)	Initial Submission Drawings, Data sheets, Type test Reports	At the time of submission of offer.
ii)	Furnishing of drawings in hard / soft copy format	Approx 2 to 3 weeks from the date of award of contract.
iii)	Furnishing of type test reports in hard / soft copy format	Hard / soft copy to be submitted immediately after the completion of the test.
iv)	Furnishing of routine test reports	Hard / soft copy to be submitted immediately after the completion of the test.
v)	All documents including Installation, Operation & Maintenance manuals.	Approx 2 to 3 weeks from the date of award of contract.

3.11 QUALITY ASSURANCE PROGRAMME

(a) To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Manufacturer's Works or at his Sub-manufacturer's premises or at the Purchaser's site or at any other place of Work, are in accordance with the specifications, the Manufacturer shall adopt a suitable quality assurance program to control such activities at all points, as necessary. Such program shall be outlined by the Manufacturer and shall be finally accepted by the Purchaser

(b) A quality assurance program of the manufacturer shall generally cover the following:

I. Manufacturer's organization structure for the management and implementation of the proposed quality assurance program:
II. Documentation control system;
III. Qualification data of bidder's key personnel;
IV. The procedure for purchases of materials, parts components and selection of sub-Manufacturer's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
V. System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
VI. Control of non-conforming items and system for corrective actions;
VII. Inspection and test procedure both for manufacture and field activities;
VIII. Control of calibration and testing of measuring instruments and field activities;
IX. System for indication and appraisal of inspection status;
X. System for quality audits;
XI. System for authorizing release of manufactured product to the Purchaser
XII. System for maintenance of records;
XIII. System for handling storage and delivery; and

XIV. A quality plan detailing out the specific quality control measures and Procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

(c) The Purchaser or his duly authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Manufacturer/'his vendor's quality management and control activities.

3.12 QUALITY ASSURANCE DOCUMENTS

The Manufacturer shall be required to submit the Quality Assurance Documents as stipulated in the quality plan at the time of purchaser's inspection of equipment/ material.

3.13 TYPE AND ROUTINE TESTING & INSPECTION

1. The individual prototype equipment, systems and sub- systems shall be type and routine tested in accordance with the relevant IEC/UIC/EN publications inclusive of the mandatory and optional tests along with the special tests as specified.

2. All type tests shall be conducted by Supplier or such other agency or person agreed by RDSO / Nominated Agency at the Supplier's cost where ever performed in presence of and to the satisfaction of RDSO/ Nominated Agency, who reserves the right to witness any or all of the tests. All tests set forth in this specification shall be conducted by the Supplier or other agency or competent person as agreed by the purchaser/ RDSO/ Nominated Agency.

3. RDSO / Nominated Agency may waive some of these tests in case of equipment/ sub-assemblies where the manufacturer can establish to the satisfaction of RDSO that such tests have already been carried out earlier. In such a case, manufacturer shall submit complete test reports along with necessary certification.

4. Wherever any equipment, system, sub system is not specifically covered by an international recognized specification or test procedure, the tests which are acceptable to both to Supplier and to the IR's representative shall be devised.

5. Without prejudice to any provisions of the contract, the purchaser reserves the right to witness any or all of the type tests and to require submission of any or all test specification and reports.

6. In case any bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

7. The Purchaser, his duly authorized representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractors premises or Works and shall have the power, at all reasonable times to inspect and examine the materials and workmanship of the works during its manufacture or erection if part of the Works is being manufactured or assembled at other premises or works, the Manufacturer shall obtain for the Engineer and for his duly authorized representative permission to inspect as if the works were manufactured or assembled on the Manufacturer's own premises or works. Inspection may be made at any stage of manufacture, dispatch or at site as the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

8. Supplier to depute qualified person for supervision of installation and commissioning of the equipment in the prototype rake. During the prototype tests/trials of train, if a technical problem arises with the equipment, qualified supplier representative should be deputed to attend the same.

9. During the prototype tests/trials or service of train, if any problems arise or feedback information is obtained, which warrants a re-check of the design/manufacture/quality of the equipment and components, action will be taken as may be necessary by the Supplier to carry out the required investigations and to incorporate the improvements considered most appropriate to reach compliance with the specification without any extra costs to the Purchaser and in a manner approved by the RDSO/Nominated Agency on equipment/components already supplied as well as those to be supplied later.

10. The prototype rakes fitted with the supplied equipment, shall be subjected to pre-revenue service trials. Service trials are intended to prove the satisfactory running performance of the supplied Train set equipment and evaluate their reliability in service, ease of maintenance and operations. The performance of the equipment shall be assessed based on the experience gained during the service trials. Necessary modification as required and also as desired by the RDSO/ Nominated Agency / Indian Railway shall be implemented in the series production without any extra costs to the Purchaser.

11. **Type tests on electronic equipment and control electronics**

    The electronic equipment and Control Electronics shall be tested as per IEC 60571/EN50155, IEC 60068, EN 50121, IEC 60721-2-5 and IEC 61373 including both compulsory and optional tests. Dry heat test, as specified in IEC 60571, shall be conducted for testing power and control electronic equipment at 80 degrees Celsius. LCD display units shall be tested at 70°C.

3.14 MATERIALS AND WORKMANSHIP

Equipment materials and components shall be new, of high grade and good quality and be to the latest engineering practice. The material and workmanship throughout shall be

in accordance with the purpose for which they are intended. Each component shall be designed to be consistent with its duty.

3.15 PACKING, STORAGE AND HANDLING INSTRUCTIONS

All the equipment shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at site till the time of erection. The manufacturer shall also submit packing details/ associated drawing for any equipment/ material before equipment dispatch.

All coated surfaces shall be protected against abrasions, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device.

Storage requirements shall be clearly defined by the supplier. Packing shall be such that if required, long time storage at site should not deteriorate the performance of the equipment.

3.16 FIRE PREVENTION

i) The design of equipment shall incorporate all measures to prevent fire, and will be such that should any fire take place, the effects shall be minimized and no spread of fire should take place. Materials that are not fire retardant shall not be used.

ii) Materials used in the manufacture of equipment shall be selected to reduce the heat load, rate of heat release, propensity to ignite, rate of flame spread, smoke emission and toxicity of combustion gases.

iii) The fire protection on Train shall be designed and constructed in accordance with EN 45545.The applicable Hazard level will be HL3.

iv) Contractor shall furnish the relevant data, fire load calculations, certifications etc. of the items considered in fire load calculations separately for Above & Below the floor level. The calculations and validation shall conform to the standard adopted by the contractor for fire strategy.

v) Relevant provisions stipulated in Central Electricity Authority (Measures related to Safety and Electric Supply) Regulations, 2010, shall be followed in the interest of safety of passenger/staff as well as for equipment / instruments provided in the coaches.

SECTION – 4
RELIABILITY, AVAILABILITY, MAINTAINABILITY AND SAFETY (RAMS)

4.1 KEY PERFORMANCE INDICATORS

Performance indicators comprises of Availability, Reliability and upkeep of Cars. The bidder must ensure RAMS parameters for the offered equipment and its sub-assemblies supplied to at least maintain the overall fleet availability and reliability targets given below. In case, fleet reliability drops on account of poor reliability of subassemblies supplied, the supplier will be required to improve the quality of subassemblies to match the availability & reliability targets.

a) Availability

Sum of Available Hours as a proportion of the total hours (Available Hours + Non-Available Hours) in the Fleet in any Accounting Year, shall be considered as “Availability”. Guaranteed Availability in every Accounting Year shall be at least 95%.

b) Reliability

Average Mean distance travelled between two Failures for the fleet in any Accounting Year shall be considered as “Reliability”. Guaranteed Reliability shall not be less than 200,000 km.

c) Upkeep

For the offered equipment, there shall be no such conditions during the operation of trains that affects the reliability, safety and passenger amenities. Any maintenance shall be conterminous with the train maintenance schedules as given in Cl 4.5 of this section.

List of Conditions affecting Upkeep (As applicable) is enclosed as Annexure-A of this section.

4.2 RELIABILITY AVAILABILITY MAINTAINABILITY AND SAFETY (RAMS)

a) The supplier shall ensure that, Guaranteed Reliability, Guaranteed Availability and High Degree of Safety in order to provide a dependable service, forms an integral element of the offered products.

b) The plan for Reliability, Availability, Maintainability and Safety shall conform to EN 50126/ IEC 61709/ IEC 62278. Reliability of electronic components shall conform to IEC 61709.

c) The supplier shall develop and provide RAMS targets (MTBF/MDBF/MTBSF) for the offered equipment both for the complete system and for the major Sub-systems at ambient temperature up to 50°C.

d) After rectification of any failure / fault, the concerned equipment / system should resume its original performance / function.

e) Components critical for safety shall fall into safe operating mode in case of malfunctioning. The system safety plan shall identify and list safety critical components and this list shall be updated periodically and intimate to the purchaser.

f) Supplier shall submit the basic maintenance schedules of the proposed equipment. Minimum interval between two maintenance schedules in the depot for the equipment supplied should not be less than 90 days except for activities which can be done outside the base depot (such as cleaning of filters mounted in the under-frame, for which the periodicity shall not be less than 15 days) and 3 years for major works in workshop/major depot. Average running distance of a rake may be considered as 2000 kilometer per day. Please refer Cl 4.5 below in respective planning of maintenance schedule for the supplied equipment.

g) All systems, components and structural areas serviced as part of inspection or periodic preventive maintenance shall be conveniently accessible for service and inspection.

4.3 RAMS DOCUMENTATION

Vendor shall agree to submit following documents pertaining to RAMS analysis:

- Functional breakdown + inherent failure analysis
- Mission critical failures Analysis (Fault Tree Analysis)
- FMECA (Failure Mode Effects and Criticality Analysis)
- System/Sub-Systems Hazard Analysis
- Hazard Log + SIL data (if applicable)
- List of critical components
- Preventive Maintenance Analysis
- Corrective Maintenance Analysis

4.4 SERVICE LIFE OF EQUIPMENT/SYSTEM

Vendor shall specify the service life of the offered equipment / system based on life cycle calculations after which the equipment / system shall call for complete replacement to maintain the required reliability & availability of fleet.

Annexure-A

List of Conditions affecting Upkeep of Trains.

S.No.	System name	Condition
1	Windscreen Wiper and Washer System	- Rainy weather, defective wiper in any cab.
2	Couplers (any type)	- Any mechanical/electrical/pneumatic fault and/or any dimensional misalignment and/or any damage to any part which does not allow the coupler to guarantee the fulfilment to its assigned mission, in accordance to the technical requirements, performance and safety set out in this specification.
3	Suspension	- Any defect in primary / secondary suspension resulting in passenger safety, comfort or performance.
4	Wheel	- If wheel flat is > 40 mm or as finalised in design. - Any abnormal hammering as reported by the TO.
5	Pantograph	- Isolation of any pantograph
6	Transformer	- Isolation of any one main transformer.
7	Battery charger	- Battery Charger of one unit isolated.
8	Mechanical drive system	- Any defect resulting in high temperature / isolation
9	Traction Motors	- Isolation of more than 25%motors.
10	Traction converters	- As per the consequential effect as defined in Item 10 above.
11	Main compressor unit	- Isolation of any Main Compressor Unit
12	Auxiliary converter-inverter	- Isolation of any Auxiliary Converter-Inverter unit.
13	Brake system (mechanical)	- If isolation of an additional bogie (mechanical) leads to speed restriction.
14	Exterior lights	- Failure of any head light / marker/tail light.
15	Driver's desk	- If master controller prevents the train from moving. - Any defect in master controller even if no delays are reported. - Any defective cab switch leading to unsafe operation.

16	TCMS & Vehicle circuits	- If HMI display fails & functionality is not transferred to redundant HMI. - Any failure in TCMS component / equipment /circuit element / software/communication system etc. resulting in loss of intended function. - Further cases will be included based on TCMS redundancy and configuration.
17	PIS & CCTV	- If both automatic and manual announcements fail - If announcements in Car is not audible - if ≥ 1 unit exterior side view CCTV not working - If >1 PEA in any car is defective - One saloon CCTV, including its backup if any, is isolated. - If ≥ 1 unit for rear cab and front cab camera, cameras on the roof
18	Passenger doors	- If ≥ 1 (one) door per train side is isolated.
19	HVAC (passenger area)	- Failure of any one HVAC in any car leading to increase in inside temperature ≥28^{0}C - Failure of two HVAC's in one car. - Noisy Air Conditioner: Interior Noise >+2dB than the one recorded and validated during the type test at standstill)
20	Ground fault in DC Circuit	- Train to be withdrawn in case of single ground fault if it leads to unsafe operation as per the design.
21	A failure or symptom which may endanger safe and/or normal operation of train	- Failure in safety interlock or protection circuit such as door loop - Abnormal noise in underframe - Wheel flat - Arcing in pantograph - Failure of emergency equipment - Failure which may disable train's push out duty. - Train which that requires more than 2 instances of reset within 30 minutes - Jerky movement (The details shall be finalized in design stage). - Others to be decided during design stage

Note: *The above list shall be further reviewed and updated during design stage.*

4.5 TRAIN MAINTENANCE SCHEDULE (TENTATIVE)

Sl. No.	Schedule	Place of maintenance	Permissible time per schedule	Periodicity
1	Minor maintenance	Light maintenance at Depot	8 hours	3 months
2	AOH	Light maintenance at Depot	7 days	18 months
3	IOH	Heavy maintenance at Depot	10 days	36 months
4	POH	Heavy maintenance at Depot	20 days	72 months

SECTION -5

SPARES AND CONSUMABLES FOR MAINTENANCE

5.1 SPARES AND CONSUMABLES

i) Supplier shall provide complete list of items/materials which get consumed during normal course of operation of the Train as applicable for the equipment/system (the **"Consumables"**).

ii) Supplier shall provide complete list of parts or equipment/system ensuring fleet availability of 95% or better, which would be necessary for efficient operation and maintenance of the (the **"Spares")**.

iii) Supplier shall provide detailed spare parts catalogue / data-sheet listing all components manufactured or purchased by the supplier along with their rating, source, type / model no., schematic, position, etc.

iv) Price for above spares and consumables to be shared separately as part of commercial offer.

5.2 SCHEDULED MAINTENANCE

a) Scheduled (Preventive) maintenance consists of operations to maintain an assembly/subassembly or components in its specific operating conditions by performing:

i) periodical inspection and diagnostic tests for prevention of malfunctioning.
ii) scheduled replacement of components.
iii) checks to be performed at specified time intervals, whose outcome determines whether or not replacements will be required.
iv) routine operations, such as filling, topping up, change oil, greasing, adjustments, etc.
v) general overhaul of systems and subsystems.

b) The preventive maintenance schedules required to keep the supplied system in good fettle with requisite reliability and availability would be coterminous with the train maintenance schedules and it should be possible to comfortably complete such maintenance during the time provided for respective train maintenance schedule and in the facility provided (refer Chapter Reliability, Availability, Maintainability and Safety).

c) Details of Schedule of Periodic / preventive maintenance (the **"Scheduled maintenance")** shall be submitted in following sample format:

Nature of inspection / maintenance	Periodicity / Interval	Items to be replaced

d) Scheduled Maintenance shall ordinarily not be required before a travel of 40,000 km (forty thousand kilometres).
e) Supplier shall provide plan / activities for periodical inspection and diagnostic test for prevention of malfunctioning
f) List of facilities including tools & tackles required for carrying out all scheduled maintenance activities to be provided by vendor.
g) All systems, components and structural areas serviced as part of inspection or periodic preventive maintenance shall be conveniently accessible for service and inspection.

5.3 UNSCHEDULED MAINTENANCE

Unscheduled (Corrective) maintenance consists of maintenance operation which is not scheduled (part of preventive maintenance) as a result of an in-service failure.

The supplier shall be required to provide repair & maintenance instructions to put back the equipment / system back in service.

List of facilities including tools & tackles required for carrying out all unscheduled maintenance activities to be provided by vendor.

5.4 EPIDEMIC DEFECT WARRANTY

(a) If any identical defect or deficiency affecting Safety, Reliability and Availability of the trains on more than 20% (twenty per cent) of equipment or parts in any rolling period of 36 (thirty-six) months commencing from the second Year of the Supply Period, such defect or deficiency shall be deemed to be an epidemic defect (the "Epidemic Defect") and the supplier shall cover such Epidemic Defect under an epidemic defect warranty.

(b) In case, the Government (Railways) notifies an Epidemic Defect on account of the supplied assembly, the supplier shall remedy such Epidemic Defect on all such Trains where equipment or parts of that particular design or lot are provided, subject to limitation of period elapsed since commissioning as mentioned above in this para.

5.5 OPERATION AND MAINTENANCE MANUAL

i) Supplier shall provide an operation manual (the "Operation Manual") for the offered equipment / system in soft copy format in English and Hindi language. The Operation Manual shall include (but not limited to):

a) Instructions for troubleshooting;
b) Rating and layout of equipment;
c) Operating limits of installed systems;
d) Control and safety features of the Equipment/System;
e) Instructions to Loco Pilots for operation of the Train (if applicable);
f) Do's and don'ts for Loco Pilots (if applicable);
g) Safety precautions to be taken by the Loco Pilots (if applicable);

ii) The Maintenance Manual to be provided by supplier shall include:

(a) All maintenance activities and their periodicities that are required to keep the Train safe and ensure that the prescribed tolerances of systems and components are not exceeded at any time, including any systems relevant to the maximum moving dimensions;
(b) The inspection program for regularly checking that the Train is safe to continuing in service;
(c) Assembly & disassembly sequences for the supplies with pictorial playbook guide
(d) The engineering facilities (such as pit facilities, special tools etc.) necessary for the mandated maintenance;
(e) Minimum competencies required by staff for the maintenance activities.

iii) The Maintenance Manual shall ensure that safety critical systems and components on the Train are identified specifically and the minimum testing requirements that must be invoked in the event of their disturbance at examination or repair are defined.

iv) Preparation of the Maintenance Manual shall give consideration to inspections, tests and maintenance of the following that have a bearing on safety:

(a) inter-vehicular couplers.
(b) fire prevention system including safe working of pantry/ sub pantry equipment.
(c) Auxiliary electrical machines: Integrity and security, earthing condition and integrity, condition of safety labelling.
(d) Passenger Information System
(e) Cleaning: Ventilation ducts, filters, bogies and underframe equipment
(f) Power systems (including protection systems): Integrity and security earthing condition and integrity, condition of safety labelling.
(g) Pantographs: Integrity and security - dimensions and condition of pantograph head, over-height protection, earthing condition and integrity, condition of safety labelling.
(h) Train structures and underframes: Integrity and condition of all load bearing members or panels, integrity, operation and security of doors, openable and removable panels, integrity and security of all body mounted equipment, alignment, gangway.
(i) Safety systems (e.g. Vigilance control device): Functional tests;
(j) Hydraulic and pneumatic systems: Condition and integrity of hoses, pipework, valves, etc.
(k) Fire protection systems: Integrity and condition.
(l) Lighting Systems & Visibility: Headlight, flasher and marker lights, adjustment, intensity
(m) Speedometers; headlights and marker lights; horn; doors; cattle guard; and bio-vacuum toilets

(v) The instructions within the Maintenance Manuals shall be such as to protect staff working on the Trains, with particular reference to safety precautions and implementing a specified safety condition of the Train prior to starting work.

5.6 OBSOLESCENCE MANAGEMENT

Supplier is required to manage obsolescence of all equipment, spares and consumables to enable the trains to continue in service for 35 years. This obsolescence management service must include:

i) Timely identification of any obsolete items of equipment;

ii) Development of mitigation strategies to minimize the impact of the imminent obsolescence of any item within the offered equipment / system including:

- Establishing alternative supply paths;
- Provision of equivalent or interchange parts or equipment
- Development of replacement products or design modifications to accept market available alternatives.

5.7 TRAINING ON MAINTENACE ASPECTS

Suppler to provide training to undertake scheduled and unscheduled maintenance to purchaser and its designated persons to handle the maintenance of train for 35 years. The duration of training shall be 12 man days.

PERFORMA FOR PERFORMANCE CERTIFICATE

Name of firm: .....

TO WHOMSOEVER IT MAY CONCERN

Sub : Confirmation letter for service performance

Dear Sir,

We hereby confirm that We ..... have manufactured _____ number of sets of .....(Name of Equipment with Model No.) for 3 Phase IGBT based EMUs/MEMUs/Metros/trainsets/LOCOs.
We further confirm that …… number of sets of .....(Name of Equipment with Model No.) for 3 Phase IGBT based EMUs/ MEMUs/Metros/trainsets/Locos are in satisfactory operation for railway rolling stock application.
Proforma for performance statement confirming above is also attached.

Yours faithfully

For (Name of Firm)

PERFORMA FOR PERFORMANCE STATEMENT

IGBT BASED 3-PHASE DRIVE TRAINSETS
PROFORMA FOR PERFORMANCE STATEMENT

Name of the Equipment:
Name of Firm :

S. No.	Order placed by (full address of Purchaser)	Order No. and Date	Description of Quantity of ordered equipment	Details of System for which equipment was supplied at Sr. No. 4 above to be given as follows			Value of Order	Date of Completion of Delivery		Remarks indicating Reasons for late Delivery, if any	Qty. in Satisfactory Service on 3 Phase IGBT based EMU's/MEMUs/ Locos/Trainsets /Metros
				Supply System	Unit Formation	Speed Potential		As per Contract	Actual		
(1)	(2)	(3)	(4)	(5)			(6)	(7)	(8)	(9)	(10)

REVISION HISTORY

Rev No.	Date	Description/Update