



Question Bank of OHE Electrical Departmental Exam



**CENTRAL RAILWAY
PUNE DIVISION**

देवेन्द्र कुमार शर्मा
महाप्रबंधक

Devendra Kumar Sharma
General Manager



मध्य रेल, छत्रपति शिवाजी महाराज टर्मिनस,
मुंबई - 400 001.

CENTRAL RAILWAY
CHHATRAPATI SHIVAJI MAHARAJ TERMINUS
MUMBAI - 400 001



दिनांक : 31.12.2018

संदेश

मुझे यह जानकारी अत्यंत प्रसन्नता हो रही है कि मध्य रेल के पुणे मंडल द्वारा कर्मचारियों की जानकारी एवं लाभ हेतु विभिन्न पुस्तिकाएं जैसे- 'स्थापना प्रश्न-मंच' (Establishment Question Bank), नवनियुक्त कर्मचारियों को रेल संबंधी प्राथमिक नियमों की जानकारी हेतु 'स्वागत पुस्तिका', सेवानिवृत्त कर्मचारियों के लिए 'निपटारा पुस्तिका' एवं 'वरीयता सूची' को प्रकाशित किया जा रहा है। साथ ही, यह पुस्तिकाएँ एवं अन्य सुविधाएँ 'railkarmikseva' App एवं 'www.railkarmikseva.in' पोर्टल पर उपलब्ध कराना पुणे मंडल का Digital India की ओर एक सराहनीय कदम है।

रेल प्रशासन अपने कर्मचारियों के हितों को लेकर सदैव तत्पर रहा है। इन पुस्तिकाओं के माध्यम से नव-नियुक्त कर्मचारी, कार्यरत कर्मचारी एवं सेवानिवृत्त कर्मचारी भी लाभान्वित होंगे। मुझे आशा है कि कर्मचारियों के हित में किए जा रहे इन कार्यों का सभी क्षेत्रों में लाभ मिलेगा।

उक्त पुस्तिकाओं के सफल प्रकाशन के लिए मैं पुणे मंडल का हार्दिक अभिनंदन करता हूँ।

(देवेन्द्र कुमार शर्मा)
महाप्रबंधक

31.12.2018



सत्यमेव जयते

भारत सरकार / Government of India
रेल मंत्रालय / Ministry of Railways
मध्य रेल / Central Railway

एन. स्वामिनाथन आय. आर. पी. एस.
प्रधान मुख्य कार्मिक अधिकारी

N. Swaminathan I.R.P.S.
Principal Chief Personnel Officer

प्रधान कार्यालय / Headquarters' Office,
कार्मिक विभाग / Personnel Department,
मुंबई छ.शि.ट. / Mumbai CST 400 001.



संदेश

कार्मिक विभाग, पुणे मंडल निरंतर कर्मचारियों के हित में विभिन्न योजनाओं के माध्यम से प्रयासरत रहा है। इसी कड़ी में 'स्थापना प्रश्न-संच' का प्रकाशन पुणे मंडल द्वारा किया जा रहा है। यह प्रश्न संच कर्मचारियों को विभागीय परीक्षा के अध्ययन के लिये काफी सहायक होगा।

किसी भी संगठन में पदार्पण करने के पश्चात प्रत्येक कर्मचारी को उस संगठन द्वारा दी जाने वाली सुविधा एवं संगठन के नियमों की संपूर्ण जानकारी होना अत्यंत आवश्यक है। कर्मचारियों की इस आवश्यकता को देखते हुए पुणे मंडल द्वारा नव-नियुक्त कर्मचारियों के लिए 'स्वागत पुस्तिका' का प्रकाशन किया जा रहा है उसी तरह कार्यरत कर्मचारियों की 'वरीयता सूची' एवं सेवानिवृत्त कर्मचारियों की जानकारी एवं उपयोग हेतु 'निपटारा पुस्तिका' का प्रकाशन भी किया जा रहा है।

'स्वागत पुस्तिका' एवं 'निपटारा पुस्तिका' के माध्यम से नव-नियुक्त कर्मचारी एवं सेवानिवृत्त कर्मचारियों को रेल सेवा के नियमों तथा कर्मचारियों को सेवानिवृत्ति के पश्चात प्रदान की जाने वाली सुविधाओं की जानकारी मिल सकेगी जिसका वे भविष्य में लाभ उठा सकेंगे।

पुस्तिकाओं में शामिल जानकारी रेलवे बोर्ड/मध्य रेल मुख्यालय द्वारा समय-समय पर जारी की गई अधिसूचनाओं, परिपत्रों और नियमों पर आधारित हैं।

पुस्तिका प्रकाशन के लिए मैं मंडल रेल प्रबंधक तथा कार्मिक विभाग, पुणे को हार्दिक शुभकामनाएं देता हूं।

(एन. स्वामिनाथन)

प्रधान मुख्य कार्मिक अधिकारी
मध्य रेल, मुंबई छशिमत

मिलिंद देऊस्कर (आईआरएसएस)

मंडल रेल प्रबंधक

MILIND DEOUSKAR (IRSS)
Divisional Railway Manager



मंडल रेल प्रबंधक कार्यालय
पुणे मंडल, मध्य रेलवे, पुणे 411 001.
Office of the Divisional Railway Manager
Pune Division, Central Railway, Pune - 411 001.
Tel (BSNL) : 020 - 26137400 | Rly.: 55000

संदेश



पुणे मंडल का कार्मिक विभाग सदैव ही अपनी विविधतापूर्ण कार्य - शैली से हर क्षेत्र में अग्रणी रहा है। पुणे मंडल में नव-नियुक्त कर्मचारी, कार्यरत एवं सेवानिवृत्त कर्मचारियों के हितों को ध्यान में रख कर बनाई गई 'स्वागत पुस्तिका' 'सेटलमेंट पुस्तिका', 'वरीयता सूची' एवं 'अस्थापना प्रश्न-संच'का प्रकाशन कार्मिक शाखा की एक और उपलब्धि है।

इन पुस्तिकाओं को 'railkarmikseva' App एवं 'www.railkarmikseva.in' पोर्टल पर भी उपलब्ध कराया गया है।

मेरा मानना है कि रेल प्रशासन में रेलों के सुरक्षित संचालन का जितना महत्व है उतना ही महत्व इस संचालन के लिए प्रत्यक्ष एवं अप्रत्यक्ष रूप से कर्मचारियों के हितों के संबंध में आवश्यक और उपयोगी जानकारी को सहजता से उपलब्ध कराना भी है ।

इस कार्य को पूर्ण करके महाप्रबंधक महोदय के कर-कमलों से इस पुस्तिका का विमोचन करने के लिए कार्मिक विभाग के सभी अधिकारी एवं कर्मचारियों को मैं हार्दिक बधाई देता हूं।

हार्दिक शुभकामनाओं सहित ।

(मिलिंद देऊस्कर)

प्रफुल्ल चन्द्रा (भा.रे.वि.इं.से.)

अपर मंडल रेल प्रबंधक

PRAFULLA CHANDRA (IRSEE)
Additional Divisional Railway Manager



मंडल रेल प्रबंधक कार्यालय
पुणे मंडल, मध्य रेलवे, पुणे 411 001.
Office of the Divisional Railway Manager
Pune Division, Central Railway, Pune - 411 001.
Tel (BSNL) : 020 - 26141100 | Rly.: 55002



संदेश

किसी भी संगठन के लिए उसका मानव संसाधन ही उसकी सबसे बड़ी संपत्ति होती है। मुझे प्रसन्नता है कि पुणे मंडल की कार्मिक शाखा द्वारा एक नई पहल करते हुए सेवारत एवं सेवानिवृत्त कर्मचारियों के हित में 'अस्थापना प्रश्न संच', 'स्वागत पुस्तिका' 'सेटलमेंट पुस्तिका' एवं 'वरीयता सूची' का प्रकाशन किया जा रहा है।

डिजिटल इंडिया अभियान तथा कागज रहित कार्यालय की संकल्पना को लागू करने के लिए सभी पुस्तिकाएँ कार्मिक विभाग द्वारा विकसित किए गए 'railkarmikseva' App एवं 'www.railkmarmikseva.in' पोर्टल पर उपलब्ध कराने के यशस्वी कार्य के लिए मैं कार्मिक विभाग के सभी अधिकारी एवं कर्मचारियों की सराहना करता हूँ एवं हार्दिक शुभकामनाएँ देता हूँ।

5402
(प्रफुल्ल चंद्रा) 31/12/18

अपर मंडल रेल प्रबंधक, पुणे



भारत सरकार / Government of India
रेल मंत्रालय / Ministry of Railways

डॉ. शिंदे तुशाबा, आय.आर.पी.एस.
वरिष्ठ मंडल कार्मिक अधिकारी

Dr. Shinde Tushaba, I.R.P.S
Sr. Divisional Personnel Officer



मध्य रेल कार्यालय
पुणे मंडल

Central Railway Office
Pune Division

मनोगत

श्री देवेंद्र कुमार शर्मा जी, महाप्रबंधक महोदय द्वारा वार्षिक निरीक्षण के दौरान नव-नियुक्त कर्मचारियों के लिये 'स्वागत पुस्तिका', 'स्थापना प्रश्न-संच', 'सेटलमेंट पुस्तिका' एवं 'वरीयता सूची' का विमोचन करने के लिए आपको सौंपने का हमें सौभाग्य मिला है इसलिए हम महाप्रबंधक महोदय के अत्यंत आभारी हैं।

हमारे प्रधान मुख्य कार्मिक अधिकारी श्री एन. स्वामिनाथन सर हर समय हमें मार्ग दर्शन करते हैं। इस कार्य के लिए भी उन्होंने हमें मार्गदर्शन एवं प्रेरणा दी है। इसलिये कार्मिक विभाग की तरफ से सर का हम आभार व्यक्त करते हैं।

साथ में श्री मिलिन्द देऊस्कर, मंडल रेल प्रबंधक का मार्गदर्शन हमारे लिए सदैव प्रेरणादायी होता है। इन पुस्तिकाओं के प्रकाशन में भी उनका अमूल्य मार्गदर्शन एवं सहयोग मिला है। इसके लिये हम मंडल रेल प्रबंधक के आभारी हैं।

अपर मंडल रेल प्रबंधक का मार्गदर्शन पुस्तिकाएँ पूर्ण करने में बहुमूल्य रहा। इसके लिये हम अपर मंडल रेल प्रबंधक के भी हम कृतज्ञ हैं।

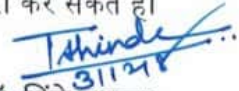
'स्थापना प्रश्न-संच' के प्रकाशन में श्री यू. सी. बोडके, मंडल कार्मिक अधिकारी, 'वरीयता सूची' के प्रकाशन में श्री एस. वी. ठाकूर, सहायक कार्मिक अधिकारी, 'स्वागत पुस्तिका' एवं 'सेटलमेंट पुस्तिका' के प्रकाशन में श्री सुनिल ठाकूर एवं श्री रमेश अय्यर, सहायक कार्मिक अधिकारी का विशेष योगदान प्रशंसनीय है।

इन पुस्तिकाओं के प्रकाशन के लिए श्री विश्वामित्र वरिष्ठ राजभाषा अधिकारी का अमूल्य योगदान रहा है जिसके लिए उनके प्रति भी हम आभार व्यक्त करते हैं।

कार्मिक विभाग के सभी कर्मचारियों के प्रत्यक्ष या अप्रत्यक्ष दिये गये योगदान के लिए मैं आभारी हूँ।

यह सभी पुस्तिकाएँ 'railkarmikseva' App एवं 'www.railkarmikseva.in' पोर्टल भी उपलब्ध कराई गई है जिससे इन पुस्तिकाओं का उपयोग संपूर्ण रेल के कर्मचारी कर सकते हैं।

धन्यवाद,


डॉ. शिंदे तुशाबा
वरिष्ठ मंडल कार्मिक अधिकारी, पुणे

मध्य रेल



पुणे मंडल

“स्थापना प्रश्न - संच”

संरक्षक

श्री मिलिन्द देऊस्कर

मंडल रेल प्रबंधक

मार्गदर्शक

श्री प्रफुल्ल चंद्रा

अपर मंडल रेल प्रबंधक

संपादक

डॉ. शिंदे तुशाबा

वरिष्ठ मंडल कार्मिक अधिकारी

सह संपादक

श्री उत्तमराव बोडके

मंडल कार्मिक अधिकारी

विशेष सहयोग

श्री सुनिल ठाकूर

सहायक कार्मिक अधिकारी (यांत्रिक)

सहयोग

कार्मिक विभाग के समस्त कर्मचारी

एवं अन्य सहयोगी कर्मचारी

Question Bank

1	Expand TRD ----- - Traction Distribution.
2	Maximum distance between two Discharge Rods ----- 1000 mts.
3	Discharge Rods should generally be placed at a maximum permissible distance from the work spot. (True/False) False
4	Is it compulsory to test the line dead by a slight touch of discharge rod at Resister tube prior to placement of discharge rod on OHE wires? (Yes/NO) Yes
5	1 Meter = -----mm. Permit to work.
6	Expand – PTW- -----. 1000
7	Broad Gauge of Railway is -----mm. 1676
8	The minimum permissible OHE voltage at SP is -----KV. 19
9	Cable size of OHE Discharge rod is -----sq.mm. 40
10	The safe working distance for 25KV AC OHE is -----. 2

11	The DJ open caution board comes after the Neutral Section.(True /False). True
12	Height of Height Gauge is -----. 4.67 mts.
13	Height Gauge is used at -----. Level Crossing
14	The caution board that should be displayed on Height gauge is ---- a) No caution board shall be displayed. b) Danger Board. c) Power block Working Limit d) Caution Electrified Section.
15	Name the Caution Board for different Elementary Sections? 15. Power Block working limit.
16	Traffic hauled by Diesel Power may be permitted into the section under Power Block.(True/False). True
17	TI/MI is issued by RDSO. (True/False) 18. Discharge Rods is a safety item.(True/False) 17. True
18	Discharge Rods is a safety item.(True/False) True
19	Fire Extinguisher suitable for an electrical fire/ fire in live electrical equipment? DCP
20	IR value for an OHE elementary section? 25M

21	Track Protection should be done as per G&SR rule No.-----, 15.09 (1) b
22	Expand – ACTM- -----, Alternating Current Traction Manual
23	1 Tone = -----Kg. 1000
24	Codel Life of a Detonator -----, 7
25	Which Tool is used to tackle heavy loads & tensile force- a) Discharge Rod. b) Max-Puller c) Grease Gun d) Power Hack Saw.
26	The Tool named Pull-Lift is used for? a) To earth OHE. b) POH of ATD c) To hold weight of contact wire. d) Non of the above.
27	The tool used to make a perfect gripe on OHE wires is- a) Come along Clamp b) Max-Puller c) Pull-Lift d) Rope pulley block
28	In case of 25KVAC system electrical clearance is greater than working clearance..(True/False) False
29	The Competency Certificate No. for a OHE Lines man is -----, TR-01

30	What is Super Elevation? a) Length of Super Mast. b) Mast more than 9.5mt length. c) The uplift of outer rails on curved tracks. d) Height difference in contact wire at turn-outs.
31	The Caution Board that must be displayed on FOB/ROBs – a) Caution 25000 volts. b) DJ opens board c) Lower Panto d) Danger Men working.
32	Caution Board applicable at Dead-End OHE termination is – a) Caution OHE ahead is alive. b) Restricted Clearance. c) Electric Engine Stop d) Unwired Turn-Out.
33	The section between a TSS and SP is called as ----- Sector
34	The section between a TSS and SSP is called as -----, Sub-Sector
35	The section between a SSP and SP is called as ----- Sub-Sector
36	As per ACTM the section that's supply is controlled by a CB is called as-----, Sector
37	As per ACTM the section that's supply is controlled by a BM is called as-----, Sub-Sector
38	The elementary section supply is controlled by a a)CB b) BM c) Hand operated off load switch. d) BX

39	What is shown in mutually contrast colour in a OHE sectioning diagram? a) Sector b) Sub-Sector c) Elementary Section b) d) Non of the above.
40	According to ACTM ; fire is classified into ----- categories. 4
41	Inflammable liquids like Transformer oil is categorized as group ----- fire. B
42	Which schedule maintenance has a periodicity of four years? a) AOH b) IOH c) POH d) Non of the above. C
43	Which schedule maintenance has a periodicity of twelve months? a) AOH b) IOH c) POH d) Non of the above a
44	Schedule maintenance Foot Patrolling of a section is done by a Lines Man at an interval of 10 to 15 days.(True/False) True
45	The re-tensioning of un-regulated OHE is done at an interval of ----- years. 2
46	Periodicity of Special Check of OHE is – a) 15 days b) 45 days c) 5 years d) No defined periodicity, it depends upon usage and chance of failure of the Equipment.

47	Oliver –G is used for – a) Thickness of OHE b) Sag in OHE c) Height and Stagger of OHE. d) Non of the above.
48	Oliver –G is used for current collection Test.(True /False) True
49	Oliver –G can be used in Day time only and not in the night.(True/False) False
50	Why it is better to use Oliver-G for Current Collection Test.- a) It can be used in day & night. b) No work man is required. c) Indicates exact spark location e) It is modern and so, is better.
51	Distance between track center and mast face is known as ----- Implantation
52	Implantation (min.) of opposite gantry mast is -----. 4.30 mts
53	Clear span of N type portal is -----. 10-20 mts
54	Clear span of O type portal is -----. 20-30 mts
55	Clear span of R type portal is -----. 30-40 mts
56	State the size of BFB 6x6 in mm -----. 152 X 152

57	Normally the length of drop arm is -----. 3 mts
58	The boom of TTC mast is available in -----mts. Lengths 5 & 8 mts
59	Implantation of obligatory mast is -----mts. 3.00 mts
60	Maximum standard span is ----- mts. 72
61	Minimum implantation at Platform is ----- mts. 4.75
63	Leaning mast is painted with _____ colour strap as identification mark. Yellow
64	Mast supporting OHE of different elementary sections should be painted with -----colour strap as identification mark. Red
65	Implantation is also known as setting distance. (True/False) True
66	A mast inclined instead of being normal to the ground level is called as ----- mast. Leaning
67	What is used to declare a mast as leaning mast? a) Measuring tape/Plumb bob b) Plumb bob/Binocular c) Binocular/Measuring tape d) Sprit level.

68	Mast leaning more than ----- cm is not permissible. 15 cm
69	The term Reverse Deflection is associated with -----. Mast Erection
70	Reverse Deflection applicable is ---- to ----- cm. 5 to 8 cm
71	Minimum implantation is ----- mts 2.36 mts
72	Normal implantation as per new standards is ----- mts. 2.80 mts
73	Minimum span length is ----- mts. 27 mts
74	The difference of two consecutive span lengths should not be more than----- mts. 18
75	Tolerance applicable in mast implantation is ----- mm. 30
76	Spans that are multiples of ----- mts. Are known as standard spans. 4.5
77	Spans that are not multiple of ----- mts. Are known as Non standard span. 4.5
78	54 mts span length is a non-standard span. (True/False) False

79	N type portal is suitable for OHE of maximum ----- No. tracks. 4
80	O type portal is suitable for OHE of maximum ----- No. tracks. 6
81	R type portal is suitable for OHE of maximum ----- No. tracks. 8
82	P type portal may be used in place of – a) N portal b) O portal c) R portal d) BFB portal.
83	G type portal may be used in place of – a) N portal b) O portal c) R portal d) BFB portal.
84	Size of up-right for N type portal is – a) 450x450 b) 550x550 c) 600x600 d)400x400
85	Size of up-right for O type portal is – a) 450x450 b) 550x550 c) 600x600 d)400x400
86	Size of up-right for R type portal is – a) 450x450 b) 550x550 c) 600x600 d)400x400
87	Size of up-right for P type portal is – a) 450x450 b) 550x550 c) 600x600 d)300x300
88	Size of up-right for G type portal is – a) 450x450 b) 550x550 c) 600x600 d)250x400
89	Standard BFB mast size -----. 6" x 6"

119	Sheds of the Hybrid Insulator is made-up of.----- Special Rubber
120	9Ton insulator is tested on ----- kg load. 6930
121	Testing load of ST and BT insulators is -----kg. 4900
122	Identify that is not a type of insulator from the given below. a) Bracket insulator b) Stay Insulator c) 9 Ton insulator d) Pedestal Insulator e) Tie Rod insulator f) PTFE g) Non of these.
123	Identify the activity that is done during AOHa) Clean the insulator b) identify the defective and replace it a) Note the make and batch of insulator d) all of the above.
124	What probable defects you would suspect to a given insulator? 1) Dirty surface 2) broken sheds 3) Crack 4) Prohibited make & batch 5) Flash 6) loose GI cap. a) 1,3,5 b) 2,4,6 c) 1,2,3,5,6 d) all of these.
125	For ----- rubber gloves are necessary. Isolator operation / DO fuse operation
126	What would be the No. of Elementary Section that is controlled by SS/216 – a) It may be any thing b) 21600 c) X-216 d) SS-216
127	Clearance between fix and moving contacts when the Isolator is open? 500 mm

137	In course of maintenance of Isolator switch its fix and moving contacts should be shorted by a flexible jumper. (True/False) True
138	What do you mean by earthing heel isolators? a) Isolator mast is connected with an earth electrode. b) Isolator Handel is shorted with mast by a flexible jumper. c) the isolator has two moving contacts. d) The Isolator isolates as well as earth the isolated OHE. D
139	An Isolator mast shall only be connected to earth electrode if duplicate bonding to the mast is not provided.(True/false) False
140	SS rope is treated with ----- oil. Balmerol-100
141	----- mts SS rope is suitable for Winch type ATD. 10.5 mts
142	----- mts SS rope is suitable for 3 pulley ATD. 8.5 mts
143	What would be the suitable length of SS rope in Winch type ATD used for Tram-Way OHE? 10.5 mts
144	What would be the suitable length of SS rope in 3 pulley ATD used for Tram-Way OHE? 8.5 mts

145	How much counter weight shall be required for Winch type ATD used in Tram-way OHE? 250 kg
146	How much counter weight shall be required for 3 Pulley ATD used in Tram-way OHE? 415 kg
147	What is the mechanical advantage of Winch type ATD? 1:5
148	Z value of Winch type ATD at 35°C ? 1.25 mts
149	X value increases and Y value decreases with increase in temperature.(True/False) False
150	What is the mechanical advantage of three pulley type ATD? 1:3
151	Out of Winch Type and 3 Pulley type ATD which one better and why? 3 Pulley type , since chances of SS rope breakage is minimum
152	Which one is reference for ADT? a) 35°C b) 27 °C c) 20 °C d) 30 °C
153	During POH of ATD it is good to reverse the ends of SS rope.(True/False) True
154	TI/MI0028 states about maintenance of -----. Turn Outs, Cross- Over

155	In case of Insulated Overlap the clearance between both the OHE is ----- -----. 500 mm
156	Implantation of obligatory structures ----- -----. 3.00 mts
157	In case of Un- Insulated Overlap the clearance between both the OHE is ---- -----. 200 mm
158	Identify from the given that does not indicate the type of a Turn- Out. 1) PTFE type 2) Regulated type 3) Semi-Regulated type 4) Cross- type a) 4, 2 b) 3, 4 c) 1, 2, 3 d) 1, 4
159	Crossing span should not be more than ----- mts in case of Overlap type Tyrnout. 54
160	In general the Encumbrance is maintained at ----- mts. 1.40
161	Steady Clearance with Drop Bracket Clamp is -----mm. 300
162	Distance between Mast Top and Bottom fitting of a Bracket Assembly? 1.90 / 2.00 mts
163	Size of Bracket tube for Platform location Bracket Assembly? 40/49 mm

164	At support the axial distance between Catenary and contact wire is called as? Encumbrance
165	How much is minimum Encumbrance? 30cm
166	Size of BFB Steady Arm? 32x31 mm
167	Distance of G jumper from support? 5.6 mts
168	Duration of replacement of PG clamp? 4 years
169	How many PG clamps are required for a G jumper? 8
170	Size of Structure Bond? 40 x 6 mm
171	Z bond is provided nearby to track circuit.(True/False) True
172	Distance between two Cross Bonds on main line? 350 mts
173	The minimum permissible size of Bond is? 200 sqmm
174	PTFE neutral section is provided in SSP overlap.(True/False) False

175	What is wrong in connection with Neutral Section? a) It isolates supply of two different phases. b) AC engines pass this section by their momentum. c) It is located corresponding to SP switching station. d) It improves power factor. e) Non of the above.
176	What is the length of short PTFE type Neutral Section? 3.74 mts, 9.40 mts
177	Which one do not requires earth pit? a) Isolator b) PTFE neutral section c) Over line structure d) Over Lap type N/S
178	Stagger of PTFE type Neutral Section? a) 0 b) +100 c) -100 d) +/- 200
179	Stagger of Neutral OHE in Over Lap type Neutral Section is? -50mm
180	No. of Caution Boards applicable to each Neutral Section is? 4
181	The stagger of section insulator should be -----. Zero
182	Encumbrance at Section Insulator should not be less than -----mm 450
183	Clearance between trailing side runner of section insulator and Contact wire is ----- 220mm

184	Size of Section Insulator Runner is ----- X -----, 40 x 8 mm
185	For all conditions of section insulator a speed restriction of 80KMPH shall be applicable.(True/false) False
186	Generally the Tension length of regulated OHE is ----- 1500 mts
187	Anchoring height of Regulated OHE -----, 6.75 mts
188	Cross Sectional area of Catenary Wire is -----, 65 sqmm
189	What we find in current collection test? Spark Locations
190	What is current rating of 25 KV AC OHE in Simple catenary system? 600 Amps
191	Anchoring height of Un- Regulated OHE -----, 6.95 mts
192	Minimum Height of OHE in Loco Shed? ----- 5.80 mts
193	The distance between two consecutive C jumpers in regulated OHE? -----, 350 mts
194	Maximum tension length of Regulated OHE ----- 1600 mts

195	The minimum clearance of 25KV OHE and Over line Structure?----- 250mm
196	Bridle Wire is used for ----- type OHE. Tram-Way
197	Rigid dropper can be used on main line.(True/False) False
198	Periodicity of Current Collection test is 3 months.(True/False) True
199	Tolerance in OHE height is -----mm 20 mm
200	Is the tolerance applicable for minimum height and implantation?(YES/NO) NO
201	General tendency of contact wire parting is ata) ACC b) RRA c) FTA d) BWA
202	djustable Dropper is used for – a) ATD b) RRA c) Section Insulator d) ACA
203	Contact Ending Cone is not used at – a) BWA b) FTA c) ACA d) Non of the above.
204	Cross Sectional area of new contact wire -----, 107 sqmm
205	Diameter of new Contact Wire -----, 12.24 mm
206	Condemning diameter of Contact wire for Main Line ----- 8.25 mm

	PSI
207	Condemning diameter of Contact wire for Yard Line ----- 8.00 mm
208	Unit of Current is -----, Ampere
209	Unit of Voltage is -----, Volts
210	Unit of Resistance is -----, Ohms
211	Ampere is the unit of -----, Current
212	A volt is the Unit of -----, Voltage
213	Ohm is the unit of -----, Resistance
214	Ammeter is used for measurement of -----, Current
215	Voltmeter is used for measurement of -----, Voltage
216	Ohmmeter is used for measurement of -----, Resistance
217	Multimeter is used for measurement of -----, Current, Voltage, Resistance

218	Unit of Insulation Resistance is -----, Mega- Ohms
219	The Meter used for measurement of Insulation Resistance is -----, Megger
220	Megger is used for measurement of -----, Insulation resistance
221	Mega-Ohms is the unit of -----, Insulation Resistance
222	$1\text{M}\Omega = \text{----- ohms.}$ 10 lakhs Ohms
223	In a circuit, the Ammeter shall be connected in -----, Series
224	In a circuit, the Voltmeter shall be connected in -----, Parallel
225	1 Kilometer = ----- meter. 1000
226	1 Meter = ----- centimeter. 100
227	1 Centimeter = ----- millimeter. 10
228	1 Foot = -----inches. 12

229	1 Inch = -----centimeters. 2.54
230	Unit of electrical energy consumption is -----, KWH
231	Unit of Electrical Power is -----, Watt
232	Horse –Power is the unit of -----, Mechanical Power
233	Kilogram-Meter per Second is the unit of -----, Mechanical Power
234	1HP = ----- watts. 746
235	----- Circuit converts AC supply into DC supply. Rectifier
236	----- Circuit converts DC supply into AC supply. Inverter
237	The ideal value of Power Factor is -----, 1
238	In case of Power Factor, out of 8.0 and 0.88, which one shall be better than 0.80? 0.88
239	Maximum voltage for 25 KV AC OHE is -----, 27.5

240	Minimum voltage for 25 KV AC OHE is -----, 19
241	The ideal value of Insulation Resistance is -----, ∞
242	Working Clearance for 25 KV AC OHE is -----, 2 mts
243	A drawing made by viewing the object right from its top is called as ----- -----, Plan
244	A drawing made by viewing the object right from its front is called as ----- Elevation
245	To have complete information of the object from drawing – a) Plan is sufficient. b) Plan & Elevation is sufficient. c) Plan, Elevation & End view shall be required. d) Non of these.
246	According to Ohm's law which relation is incorrect? a) $I = \frac{V}{R}$ b) $R = \frac{V}{I}$ c) $V = I \times R$ d) $V = \frac{I}{R}$ d
247	Which type of material is classified as per temperature? a) Conductor b) Insulating c) Semi conducting d) Magnetic. b
248	For a series connected circuit which statement shall be incorrect? a) Current shall be equal to all loads. b) Current through all loads shall be equal but voltage drops shall be different. c) Current shall different to different points of circuit. d) Circuit current shall depend on total resistance of the circuit.

249	What is in correct in connection with Ohm's law? a) It states the relation among the voltage, current & resistance in a closed circuit. b) Circuit current is proportional to the voltage imposed. c) Circuit current is inversely proportional to the circuit resistance. d) Temperature has no effect on this relation.
250	BDV value of tr former oil should not be more than 60KV.(true/false) North- South
251	Magnetic poles are generally known as -----. a) North- South b) East- West c) EMF- MMF d) UP-DOWN
252	Which one is incorrect to natural magnet? a) Loss of magnetic properties on heating. b) Similar poles repeal and opposite attract each other. c) A magnet attracts all metals. d) Small pieces of a magnet shall also be a magnet.
253	When current is flown through the wire, wound on a iron piece ,the iron piece becomesa) Natural Magnet b) Electro-Magnet c) Steel d) Mild Steel.
254	How a Electromagnet differs from a Natural Magnet? a) Number of poles may be arbitrarily chosen. b) Magnetic line of force is reversed. c) Strength of poles depends on size of magnet d) Temporary Magnetism.
255	Electromagnetism is not used in ----- a) Compressor motor contactor. b) Battery charger. c) 42 KV LA d) Taret CT
256	----- Works on principle of electromagnetism. a) LA b) Capacitor c) CB d) AT

257	The lowest category of insulating materials as per thermal classification is --- -----. Y
258	According to thermal classification of insulating materials category Y materials are suitable for temperature limit -----. a) 0°C b) 180°C c) 90°C d) 270°C
259	The highest category of insulating materials as per thermal classification is -- -----. C
260	According to thermal classification of insulating materials category Y materials are suitable for temperature limit -----. a) Above 0°C, up to 80°C b) Above 0°C, up to 90°C c) Up to 150°C d) Above 180°C
261	The vital component of a rectifier circuit is? a) Resistor b) Diode c) Capacitor d) Choke Coil
262	Normally generation of electrical energy is done in ----- phases. a) 1 b) 2 c) 3 d) 4
263	ACTM has relation with? a) Maintenance of TRD installations. b) Directives for different departments in electrified section. c) Working of TPC d) All of the above.
264	Direction of electric current flow is – a) From high voltage to low voltage. b) Low voltage to high voltage. c) Between two points that's voltage is same. d) There is no such rule.

273	According to TR-2 a Lines Man is not authorized for a) Work on OHE. b) 25KV isolator operation. c) Switching operation in Switching Station despite of permission granted by TPC. d) Commissioning of new installations.
274	TR-5 permits a PSI artisan for – a) Issuing PTW. b) Receiving PTW of EHV lines c) Commissioning of new installations. d) Shutting down 25KV installations according to instructions of TPC.
275	Which method of safety is generally not adopted during power block on a Sub-Sector? a) PTW b) Prohibition of AC engines to enter in power block section. c) To tripe Feeder CB. d) Application of Discharge Rods.
276	Skilled Artisan of Remote Control is given the Competency Certificate TR-----. TR-7
277	Maximum Permissible distance between two discharge rods is? a) 1 meter b) 10 meter c) 100 meter d) 1000 meter.
278	What care should be considered while clamping a discharge rod on a mast? 1. Cable and lug connection. 2. Availability of discharge rod on both sides of the spot. 3. Availability of Structure bond. 4. Distance between consecutive discharges rods. a) 1, 2 b) 2, 3 c) 2, 4 d) all of the above.
279	Ohm's law states the relation among Voltage, Current & Resistance. (True/False) True
280	Resistance of a wire increases with increase in its length. (True/False) False

281	Resistance of a wire decreases with increase in its length. (True/False) False
282	The resistance of a wire decrease with increase of its thickness. (True/False) True
283	The resistance of a wire increases with increase of its thickness. (True/False) False
284	Resistance of conductors increase with temperature. (True/False) True
285	Resistance of conductors decreases with increase in temperature. (True/False) False
286	Resistance of insulating materials increases with temperature. (True/False) False
287	Resistance of insulating materials decreases with increase in temperature. (True/False) True
288	Resistance of conducting materials varies according to temperature. (True/False) True
289	Conversion of AC supply into DC is possible, but the reverse is not. (True/False) False

290	Value of Insulation Resistance is independent of temperature. (True/False) False
291	Insulation Resistance decreases with increase of temperature. (True/False) True
292	Electrical Clearance and Working clearance are the two different name of the same vary fact. (True/False) False
293	The drawing called as Plan, depicts all the three dimensions (Length,Width,Height) of the object. (True/False) False
294	The poles of a magnet can simply be made separated by cutting the magnet into pieces. (True/False) False
295	A magnet shall always have two poles. (True/False) True
296	Insulating properties of insulating materials get affected by temperature; therefore, these have been classified into temperature groups. (True/False) True
297	Selection of megger shall be done according to rated voltage of the winding under IR test. (True/False) True

298	Winding Resistance and insulation resistance are two different names of the same vary fact. (True/False) False
299	For safety considerations the distance between two discharge rods should not be more than 1 KM. True
300	Discharge Rod should be clamped on that mast only which is having structure bond connected. (True/False) True
301	A combination of cells shall be called as -----. Battery
302	Cell voltage of a lead –acid cell is -----. 2.2 volts
303	Electric cell converts ----- energy into electrical energy. Chemical
304	Supply available from a electric cell is ----- (AC or DC) DC
305	Basically a battery charger is a ----- circuit. Rectifier
306	The cell voltage of a fully charged Leas-Acid cell is ----- 2.2 volts
307	A Lead-Acid cell shall be said fully discharged when its voltage drops down to ----- 1.8 volts

308	Electrolyte of a Lead –Acid Cell is prepared from Sulfuric Acid and ----- -----. Distilled water
309	Electrolyte of a Lead –Acid Cell is prepared from Distilled Water and ----- -----. Sulfuric Acid
310	The SPG of electrolyte of fully charged lead-acid cell is ----- ----. 1.220
311	A Lead-Acid cell shall be said as fully discharged when SPG of its electrolyte drops down to -----, 1.180
312	Unit to indicate battery capacity is -----, AH
313	The battery----- increases if the cells are connected in series. (Voltage, Capacity) Voltage
314	The Battery ----- increase if the cells are connected in parallel.(Voltage, Capacity) Capacity
315	The battery ----- depends upon its size.(Voltage, Capacity) Capacity
316	General maintenance of a battery set is done at an interval of ----- days. 15

317	As a temperature correction ----- shall be added or deducted from the SPG readings of electrolyte taken from hydrometer for per degree temperature variations. 0.0007
318	The reference temperature for Temperature Corrections in SPG readings of electrolyte is -----. 27°C
319	What shall generally be added to maintain the level of electrolyte in a cell? (electrolyte, distilled water, acid) Distilled Water
320	To keep a battery set at very low charging rate is called as? (Boost Charging, Trickle Charging) Trickle
321	To charge a battery set at very high rate for a short period is called as? (Boost Charging, Trickle Charging) Boost Charging
322	To prepare electrolyte which type of pot is suitable? (Stain less Steel, Glass or Porcelain, Cupper) Glass or Porcelain
323	The white aggregate appearing on the terminals of a battery is called as ---- -----. Sulfation
324	Sulfation is a indicator of ----- health of the battery. (Good, Bad) Bad
325	The SPG of electrolyte ----- when the battery gets charge. (Increase, Decrease) Increases

326	The SPG of electrolyte ----- when the battery gets discharge. (Increase, Decrease) Decreases
327	Battery rating for a TSS is -----AH. 200
328	Battery rating for a SSP is -----AH. 40
329	Battery rating for a SP is -----AH. 40
330	----- is used for measurement of SPG of electrolyte. Hydrometer
331	SPG of distilled water is ? a) 1.000 b) 1.180 c) 1.220 d) 2.2 1.000
332	What is true for DC supply and distilled water? a) DC current can not flow through distilled water. b) DC current can flow through distilled water, c) DC current gets stored in distilled water. d) DC gets converted into AC.
333	What you expect from a battery kept on high charging rates for a long time? a) Nothing special. b) Plates may be damaged by getting very hot. c) Change of polarity d) Increased capacity.
334	Electrolyte bubbling heavily, it is a indication of? a) Over charging b) Under charging c) No load d) Discharged

335	What are the conditions for better performance of a battery set? 1. Equal cell voltages. 2. Equal AH 3. Equal SPG of Electrolyte. 4. Correct connection. a) 1, 4 b) 3, 4 c) 1, 2, 3 d) all of the above.
336	What is incorrect for a 40AH capacity battery? a) 1 ampere for 40 hours b) 40 ampere for 1 hours c) 4 ampere for 10 hours d) A rate of current supply as 40 ampere per hour.
337	All types of cells can be used repeatedly by repeated charging.(True/False) False
338	Primary cells can not be recharged after getting discharged. (True/False) True
339	Secondary cells can not be recharged after getting discharged. .(True/False) False
340	DC supply source is required for charging a cell. .(True/False) True
341	A cell can be charged through AC supply. .(True/False) False
342	Electrolyte is an example of insulating material. .(True/False) False
343	Electrolyte is an example of conducting material. .(True/False) True
344	The Electrolyte of Lead-Acid battery is of acidic nature. .(True/False) True

345	The Electrolyte of Lead –Acid Battery is of basic nature. .(True/False) False
346	Distilled water is of Neutral Nature. .(True/False) True
347	To prepare the electrolyte one part sulfuric acid is mixed with three or four part of distilled water. .(True/False) True
348	To prepare the electrolyte one part sulfuric acid is mixed with three or four part of ordinary water. .(True/False) False
349	Battery capacity may be stated as KW. (True/ False) True
350	The voltage increases and the capacity remain constant, if the cells are connected in series. (True/ False) True
351	The voltage increases and the capacity remain constant, if the cells are connected in parallel. (True/ False) False
352	The capacity of cell increases with increase of its size. (True/ False) True
353	The Voltage increases with increase of the size of cell. (True/ False) False

354	To connect positive terminal with the positive one, shall be a parallel connection. (True/ False) True
355	To connect positive terminal with a negative one, shall be a parallel connection. (True/ False) False
356	To prepare the electrolyte, acid shall be poured into distilled water. (True/ False) True
357	To prepare the electrolyte, distilled water shall be poured into acid. (True/ False) False
358	For each degree rise of temperature above 27°C, the hydrometer reading should be added with 0.0007. (True/ False) True
359	The hydrometer reading should be deducted with 0.0007 for each degree rise of temperature above 27°C (True/ False) False
360	The hydrometer reading should be added with 0.0007 for each degree fall of temperature below 27°C. (True/ False) False
361	The hydrometer reading should be deducted with 0.0007 for each degree fall of mtemperature below 27°C. (True/ False) True
362	The gas emerging from a battery may cause explosion. (True/ False) True

363	The orifice at the top of vent plug should normally be open, but should be closed during boost charging. (True/False) False
364	The orifice at the top of vent plug should normally be closed. (True/False) False
365	The orifice at the top of vent plug should normally be open. (True/False) True
366	Unit of specific gravity is gram per cubic centimeter. (True/False) False
367	Specific gravity has no unit. (True/False) True
368	Battery rating for TSS is 200AH. (True/False) True
369	Battery rating for SP, SSP is 40AH. (True/False) True
370	Battery rating for all switching stations has been standardized as 200AH. (True/False) False
371	Battery rating for all switching stations has been standardized as 200AH. (True/False) True
372	Cell voltage of lead-acid cell does not depend on its size. (True/False) True
373	Hydrometer is used for measurement of SPG. (True/False) True
374	The unit of Transformer capacity is -----. Volt-Amperes

375	How many numbers of winding are there in a single phase transformer? (Two, One) Two
376	Healthy silica gels colors is ----- (Pink / Blue) Blue
377	Silica Gel turns ----- (colour) absorbing moisture. Pink
378	BDV of Transformer oil should be ----- KV. 60
379	Colour of New transformer oil is -----. Clear transparent
380	----- is fixed between Bell Tank and Conservator tank. (Buchholtz relay/ Breather) Buchholtz relay
381	The transformer oil should be replaced if it turns----- (colour) Black
382	What is the use of transformer oil? a) Insulation b) Cooling c) Both the above. C

384	Which device is used to protect the transformer from excessive internal pressure? a) PRD b) Buchholtz Relay c) MOLG d) Drain Cork.
385	----- is used for low oil level protection. MOLG
386	What is used for cooling of a transformer? a) Conservator tank b) Radiator c) Breather d) Core
387	The power loss that occurs in transformer winding is called as----- Copper loss
388	The power loss that occurs in transformer core is called as-----, Iron loss
389	The ratio of rated voltage of primary and secondary winding of a transformer is called as -----, Voltage ratio(Transformation ratio)
390	For a transformer, the product of primary side voltage and current is equal to product of secondary side voltage and -----, Secondary side current
391	----- is the unit to express moisture content in transformer oil. Ppm
392	POH of Power Transformer is done after -----.years. 10
393	Insulation Resistance between LV and E at 30°C for a 132KV / 25KV transformer should not be less than-----, 400MΩ

394	Insulation Resistance between HV and E at 30°C for a 132KV / 25KV transformer should not be less than-----, 2000 MΩ
395	Insulation Resistance between LV and HV at 30°C for a 132KV / 25KV transformer should not be less than-----, 2500 MΩ
396	Traction Transformer can be run for ----- minutes at 50% over load. 15
397	Traction Transformer can be run for 15 minutes at -----% over load. 50
398	Traction Transformer can be run for ----- minutes at 100% over load. 5
399	Traction Transformer can be run for 5 minutes at -----% over load. 100
400	Setting for oil temperature alarm is -----°C. 80
401	Setting for oil temperature trip is -----°C. 85
402	Setting for winding temperature alarm is -----°C. 90
403	Setting for winding temperature trip is -----°C. 95

404	Traction Transformer is normally equipped with ----- tap changer. (On load / off load) off load
405	The ratio of number of turns in primary and secondary winding of a transformer is called as -----, Turn Ratio (Transformation Ratio)
406	Transformer Oil is dangerous since it is -----. a) Inflammable b) Toxic c) Hygroscopic d) Unnatural.
407	Out of the following relations , what would be incorrect for a transformer where N indicates number of turns, V voltage and I current. a) $\frac{N_1}{N_2} = \frac{V_1}{V_2}$ b) $\frac{V_1}{V_2} = \frac{I_2}{I_1}$ c) $\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{I_1}{I_2}$ C
408	ONAN / ONAF are the types of – a) Transformer cooling system. b) Winding c) Tap Changer d) Earthing
409	What it indicates, if the terminal connection of a transformer appear bad in colour. a) Abnormal heating of terminals due to loose connection b) Transformer Over load c) Higher EPR. d) Non of the above.
410	Transformer oil sample Crackles on heating ; it is an indication of – a) Increased acid content. b) Too cold sample c) Excessive Water content d) Improved BDV .
411	Oil temperature trip facility is given since at higher temperatures) Transformer oil becomes thick and immovable. b) Insulating properties of insulations impair sharply. c) Buchholtz relay trips. d) It becomes difficult to operate tap changer due thicken transformer oil.

412	What is incorrect in context of Buchholtz Relay? a) It is an electromechanical relay. b) It protects transformer from internal faults. c) It requires collection of gas to operate. d) It is situated between bell tank and conservator tank.
413	In case of transformer bushing ,the value of tan-δ testing should not be more than ----- 0.007
414	In case of transformer bushing ,the value of capacitance should not be more than ---% 110
415	During maintenance, it is found that oil level in OIP Condenser bushing is low from the set value what action should be taken? a) Transformer can be taken on load. b) Bushing shall be replaced. c) On lowest tap transformer can be taken on load. d) Tan-δ and Capacitance test shall be done and action shall be taken according to results.
416	No need to reset OTI/WTI during ----- scheduled maintenance. a) Monthly b) Half Yearly c) Yearly d) Non of the above.
417	OTI indicates? a) Average temperature of transformer oil. b) Maximum temperature of transformer oil. c) Minimum Temperature of Transformer oil d) Maximum permissible temperature of transformer oil
418	WTI indicates? a) Average Temperature of transformer winding. b) Maximum temperature of transformer winding. c) Minimum temperature of transformer winding. d) Maximum permissible temperature of transformer winding.

419	According to TI/MI -38 what action shall not necessarily be done during monthly maintenance? a) EPR testing b) Inspection of Silica gel breather. c) Check OTI/WTI d) To check bus bar connection for bad –colour.
420	Which Instrument is used for PI checking? a) Ammeter , Voltmeter , Watt meter b) Earth Tester c) Megger d) BDV Tester.
421	Winding is said in good health ,if the value of Polarization Index is a) a) Less than 1 b) More than 2 c) Value of Polarization Index does not indicate winding condition. d) More than 1, less than 2.
422	Unit for measurement of Polarization Index. a) Volt per second b) Mega –Ohms per second c) Volt per rotation d) there is no unit.
423	During half yearly maintenance ,oil sample for BDV test should be taken – a) Just after shutting down the transformer. b) After cooling of transformer oil. c) After keeping the transformer at 5 No. Tap for half an hour. d) Sample bottle should be filled by taking small quantities over a considerable time during the maintenance.
424	The symbols R60/R10 and R600/R60 bear the relation with ----- , a) BDV b) PPM c) $\tan-\delta$ d) Polarization Index.

425	What does it mean by R60/R10 in relation with PI? a) Resistance of 60Ω and 10Ω. b) Megger readings after 10 sec. and 60 sec. respectively . c) Megger readings after 10 sec. and 60 sec when rotation of handle has been stopped. d) Non of the above.
426	According to TI/MI 38, what action should be taken if the value of PI test is less than 1.1 . a) Replace transformer oil. b) Transformer is in good condition. c) Oil filtration and again PI test. d) TI/MI38 do not say any thing about PI test.
427	Which test is not performed on transformer oil? a) IR b) DGA c) BDV d) PPM
428	DGA testing is a test of dissolved ----- in transformer oil. Gases
429	----- Test is done to test Electrical Strength of transformer oil. a) IR b) DGA c) BDV d) PPM
430	Which test should be done to know water quantity present in oil sample? a) Crackle Test b) PPM c) Colour Test d) Tan-δ Test.
431	Crackle Test is done to deduce the water quantity in oil sample.(True/false) False
432	Factor that affects insulation resistance? a) Size of winding b) Temperature c) Moisture d) All of the above.
433	While meggering a transformer ,----- temperature should also berecorded along with the megger reading. a) Air b) MOLG c) OTI d) a & c

434	While meggering ,what should also be recorded on the test record along with megger reading? a) Megger Rating. b) Make & Serial Number c) Air & OTI d) All of the above.
435	To megger Traction Transformer 500 volt megger is suitable. (True /False) False
436	What is incorrect about Oil filtration? a) Initially IR falls with rise of temperature. b) With filtering out dirt and moisture BDV improves. c) Oil filtration do not permits dissolved gases to escape out from oil. d) IR value increases with fall of oil temperature when filtration plant is shut-off.
437	Which test shall not be done for OIP condenser bushing during yearly maintenance? a) tan-δ b) Capacitance c) IR d) Crackle
438	Generally spark gap for 25KV bushing of traction transformer is a) 16.5 cm b) 25 cm c) 75 cm d) 1mt.
440	Electrode gap of BDV tester is -----mm. 2.5
441	Bushing CT is associated with? a) Power Transformer b) AT- 100KVA c) AT at SP d) Feeder CB
442	Bushing CT is provided with all bushings of a power transformer. (True / False) True
443	Location of PRD? a) Behind control panel b) below marshaling box c) Above bell tank d) beside conservator tank.

444	Is it true that in the course of usage, acid forms naturally in transformer oil? (Yes/No) Yes
445	Is transformer oil a inflammable liquid? (Yes/ No) Yes
446	Capacity of a transformer is expressed in KW. (True/False) False
447	Buchholtz relay is oil pressure relay. (true/false) False
448	Transformer capacity is expressed in KVA.(true/false) True
449	BDV value of transformer oil should not be less than 60KV.(true/false) True
450	BDV value of transformer oil should not be more than 60KV.(true/false) False

451	In a TSS, concrete wall between both the transformers is known as Baffel – Wall. (true/false). True
452	Transformer oil is a mineral-oil used as fuel .(true/false) False
453	Synthetic oils can also be used as Transformer –Oil.(true/false) True
454	Sampling of transformer oil should be done in dry, hot and clear atmosphere.(true/false) True
455	PRD is used to protect the transformer from high internal pressure.(true/false) True
456	Drain Cork is used to protect the transformer from high internal pressure.(true/false) False
457	In context of transformer, copper loss means wear & tear of winding. (true/false) False
458	In context of transformer, Iron-loss means wear & tear of Core. (true/false) False
459	Step-up transformer increases voltage. (true/false) True
460	Step-down transformer reduces electrical power. (true /false) False

461	Transformer is a device which bridges high and low voltage circuits. (true/fase) True
462	Periodicity of POH of Power transformer is 4 years. (true/false) False
463	New transformer oil is clear and transparent in colour. (true/ false) True
464	Out put voltage of a transformer can be controlled by tap-changer. (true/false) True
465	There is no relation between turn ratio and voltage ratio of a transformer.(true/false) False
466	Transformers may also be classified on number of phases. (true/fase) True
467	In case of Auto transformer, both the primary and secondary terminals are connectedwith the same winding.(true/false) True
468	A transformer works only in one direction that is , imposing voltage to primary voltage appears on secondary terminals but imposing voltage to secondary no voltageappears on primary terminals. (true/false) False
469	Transformer work in both directions, i.e. primary to secondary and vice-versa.(true/false) True
470	If an ONAN transformer is turned to ONAF, its capacity improves.(true/false) True

471	Normally HT bushing is oil filled type. (true/false) True
472	HT bushing is always shield type. (true/false) False
473	On BDV test, if the results are less than the standard one, oil filtration should be done. (true/false) True
474	It indicates some thing abnormal if there is considerable rise in readings of OTI/WTI from that of last readings. (true/false) True
475	That actions are not required during the half yearly maintenance which are done in monthly maintenance.(true/false) False
476	Before meggering it is compulsory to make the bushing free from dust and moisture. (true /false) True
477	In case of single phase traction transformer, it is not compulsory to open terminal connections prior to meggering of the transformer. (true/false) False
478	Tan - δ test indicates the quality of the insulating material. (true/false) True
479	For transformer bushing, value of tan- δ should not be less than 0.007. (true/false) False
480	Capacitance value for transformer bushing should not be less than 110% of factory set value.(true/false) False

481	CB controls the supply of -----.(Sector, Sub-Sector,Elementry Section) Sector
482	BM controls the supply of -----.(Sector, Sub-Sector,Elementry Section) Sub-Sector
483	Isolator controls the supply of -----.(Sector, Sub-Sector,Elementry Section) Elementry section
484	On faults----- trips automatically. (CB, BM, OHE, PT-II) CB
485	OFF load hand operated switch is well known as ----- (CB,BM, MCB,Isolator) Isolator
486	What is not controlled by TPC through remote control? (CB, BM, DPI) DPI
487	What is common among TPI, DPI, SPI and BPI? a) A CB is connected to all of them. b) All of them is used for transformer isolation. c) All are located in a FP. d) Each of them is a type of isolator.
488	When 25KV isolator is in opened condition, what should be the clearance between its fixed and moving contact? 500mm
489	Code ----- is prefixed before number of isolator connected with main line OHE. SM

490	Out of the following, what is not there in the pole unit of CB/BM? a) Fix and Moving Contact. b) Arc quenching medium. c) Main and Arcing Contact. d) Auxiliary contact.
491	Out of the following, what is not the type operating mechanism of a CB or BM? a) Air open/ Air Close b) Spring open / spring close c) Air open / spring close. d) ONAN / ONAF
492	What is not compulsory for maintenance of CB / BM? a) To obtain PTW from TPC. b) To open SPI/DPI from both sides. c) To keep switch gear on local control. d) To keep 110 volt DC supply switched off during the work. e) Non of the above.
493	Normally gas pressure in SF6 type CB/BM is maintained at -----. 5.5 Kg/cm²
494	Low gas pressure alarm operates at ----- kg/cm ² for SF6 CB/BM ,where normal gas pressure is 5 Kg/cm ² 4.5 Kg/cm²
495	SF6 CB/BM(5Kg/cm ²) locks-out at low gas pressure of -----kg/cm ² . 4.0 Kg/cm²
496	Which component of SF6 CB/BM generates low gas pressure alarm/lock-out signals? Gas Density switch
497	Function of Gas Density switch is – a) to check purity of SF6 gas. b) to control total break time . c) to generate signal according to gas pressure in pole unit.

498	----- is used to check gas pressure in pole-unit. (Gas density switch, Gas pressure gauge, Compressor) Gas Density switch
499	Normal working air pressure for 25KV CB/BM is -----. 15 Kg/cm²
500	Air pressure alarm, for 25KV CB/BM, operates at -----. 13 Kg/cm²
501	25KV CB/BM locks out due to low air pressure at ----- 12 Kg/cm²
502	In a 25KV CB/BM air pressure is maintained by ----- a) Compressor b) Air pressure limit switch c) Safety valve d) TPC
503	In 25KV CB/BM, ----- is used for safety of Air Cylinder. Safety Valve
504	-----°C is taken as Standard for determination of Gas Pressure in 25KV CB/BM. 20
505	Only a competent railway servant can operate the 25KV Isolator switch. (True/False) True
506	Operation of 25KV Isolator switch is permitted to all railway servants. (True/False) False
507	In open state ,the clearance between fix and moving contact of an 25KV Isolator should be 500mm. (True/False) True

508	In open state ,the clearance between fix and moving contact of an 132KV Isolator should be more than 500mm. (True/False) True
509	On-Load operation of an 25 KV isolator switch should not be done. (True/False) True
510	An elementary section can be isolated by isolator switch. (True/False) True
511	Nitrogen Gas is filled in the pole unit of Vacuum type CB. (True/False) False
512	Any type of Gas or Air is not filled in the pole unit of Vacuum type CB/BM, (True/False) True
513	Total Break time of 25KV single pole SF6 Circuit Breaker should not be more than 65 milli-seconds. (True/False) True
514	Total Break time of 25KV single pole SF6 BM should not be more than 80 Mili-seconds. (True/False) True
515	In no condition SF6 gas can convert into liquid state. (True/False) False
516	At some specific high pressure and low temperature, SF6 gas converts into liquid state. (True/False) True
517	PTW must be obtained from TPC for the maintenance of CB/BM. (True/False) True

518	It is safe to keep the CB/BM on local control while its maintenance is in progress. (True/False) True
519	It is safe to switch off 110 volt DC supply of CB/BM while its maintenance is in progress. (True/False) True
520	Gas density switch generates alarm according to gas pressure in the pole unit. (True/False) True
521	It is impossible to check the settings of gas density switch. (True/False) False
522	Combined earth pit resistance of a TSS should not be more than ----- 0.5Ω
523	Combined earth pit resistance of a SSP should not be more than ----- 2.0Ω
524	Combined earth pit resistance of a SP should not be more than ----- .. 2.0Ω
525	Single earth-pit resistance should not be more than -----. 10.0Ω
526	The ideal value of EPR would be -----. 0
527	As per ACTM, earth electrodes should be ----- meters long. 4
528	As per ACTM, bore of earth electrodes should be ----- cm. 4

529	As per ACTM, minimum separation between two earth pits is -----, 6
530	Treatment by mixture of salt-charcoal should be done if the EPR is less than 10..(true/false) False
531	Treatment by mixture of salt-charcoal should be done if the EPR is more than 10.(true/false) True
532	It is good to pour water in earth pit at a regular interval. (true/false) True
533	Over a year, EPR should be checked during dry and hot season. (true/false) True
534	In a switching station, all earth electrodes are connected in ----- connection. (series/parallel) Parallel
535	Earth pit for remote control equipment should not be connected with earth pits/ earth grid of switching station. (true/false) True
536	Earthing for RCE should not be connected with earthing of switching ,because- a) Traction current may harm to RCE equipments. b) RCE equipments work on DC supply. c) There is no such restriction.
537	LA rating for 25KV system is -----, 42kv
538	LA rating for 110KV system is -----, 98kv

539	LA rating for 132KV system is -----. 120kv
540	LA rating for 220KV system is -----. 198kv
541	The abnormal conditions ,LA protects from, is --- a) Short circuit b) Open circuit c) Low voltage d) Voltage surge.
542	LA may be tested from Megger. (true/false) True
543	Prior to erection, LA should be tested from -----. Megger
544	POH of LA should be done after 4 years. (true/false) False
545	There is no POH schedule for LA. (true/false) True
546	42KV LA should be Meggered by 500 volt megger. (true/false) False
547	Megger value for 42KV LA should be? (2500M. , 1G. , 10G., 200K.) 1GΩ
548	Megger value for 198KV LA should be? (2500M. , 1G. , 10G., 200K.) 10GΩ
549	LA is connected between line and earth. (True / False) True

550	In three phase system (132 KV) , LA is connected between any two phases. (True / False) False
551	Within a TSS, the minimum height of 25KV bus-bar from ground level is ----- -----. 3.80mts
552	Control circuits for switching stations works on ----- volts DC. 110
553	In a TSS, voltage ratio of 100KVA AT is --- a) 100KV /230 volt b) 100KV/440 volt c) 25KV/230 volt d) 25KV/ 440volt.
554	Electrical Clearance for 25KV system is -----. A
555	Catenary indication is a must for Closing Operation of ----- a) Doors of control penal of TSS. b) Sectioning BM of SSP c) HV CB d) Bridging BM.
556	At voltage ,lesser than 19 KV – a) Bridging BM gets open, if already closed. b) Air compressor of CB gets stop. c) HV/LV CB trips d) Non of the above
557	On a SSP over lap, which side of OHE gets parallel by the paralleling BM of that SSP? a) TSS b) SP c) middle d) both side
558	Bus –bar connection gets bad in colour, what it indicates for? a) Bus Bar is getting hot due to bad connection. b) Connection is alright and bus bar do not getting hot. c) General climatic effect on bus-bar. d) Poor quality of bus- bar material.

559	Bus-bar connection should be opened, cleaned and retighten if - a) CB trips on WTI indication. b) Pre-monsoon is being done. c) Bus –bar is bad in colour. d) Non of the above.
560	To deduce average PF of a TSS over a month, what items of meter reading of that TSS for the month shall be used? a) KVAH, KVARH b) KVAH, KWH c) KVA, KVAR d) KVA, KW.
561	What is meant from Earth-Screen, in context of a TSS? a) Under Ground earth-grid. b) Earthed fencing around TSS. c) A caution –board. d) Earth wire hanging on TSS gantry.
562	Under voltage relay is related with – a) All BM of TSS b) Paralleling BM of SP and SSP. c) Sectioning BM of SSP d) Bridging BM of SP.
563	A lair of ballast, used in switch-yard, serves as insulation. (True/False) True
564	In a Traction Transformer ,Bushings CT is used for – a) OCR b) DPR c) EFR d) DFR

565	For a 132KV/25kV traction transformer, how many CT are required to Differential Protection? a) 2 No LV taret CT b) 2No. HV taret CT c) HV Gantry-CT, LV taret CT d) HV and LV taret CT
566	Differential protection works against which type of fault? a) Internal faults b) Over voltage c) Over current d) Low oil level.
567	OCR –T is protection from? a) Sustained over Currents due to over load. b) Sudden rise of current due to earth fault. c) Over current due to earth fault away from TSS. d) Sudden rise of current by 200% of normal current due to any reason.
568	DPR is Protection from? a) Sustained over Currents due to over load. b) Sudden rise of current due to earth fault. c) Earth fault away from TSS. d) Sudden rise of current by 200% of normal current due to any reason.
569	Which relay gets its input from both the CT and PT? a) OCR b) DPR c) EFR d) DFR b)
570	Delta-I relay is said as back-up to DPR. (True/False) True
571	Every type of CB is having the facility to alter the setting of its tripping current.(true/false) False

572	What would you do, if you want to change the tripping current of a CB? a) It might not be done; the CB would have been replaced. b) CT would have been replaced. c) Relay setting should be adjusted. d) Battery voltage should be changed.
573	WPC relay is placed in SP. (true/false) False
574	WPC relay is placed in TSS. (true/false) True
575	What is correct about WPC relay? a) One No in SP b) two No. in SP c) one No. in TSS d) two No. in TSS
576	Earth –Screen is a protection against – a) Touch Voltage b) Step Voltage c) Lightning Stroke d) Earth Fault.
577	CTD is an interlock arrangement – a) It is a false statement b) CB tripping and 110 volt DC supply c) CB tripping and auto recloser. d) High voltage and alarm.
578	OCR-I is a protection against - a) Sustained over Currents due to over load. b) Sudden rise of current due to earth fault. c) Over current due to earth fault away from TSS. d) Sudden rise of current by 200% of normal current due to any reason.
579	ITR is a fault sensing relay. (true/false) False

580	ITR is a auxiliary relay for transformer protection. (true/false) True
581	It is not the auto –reset type relay- a) OCR b) DPR c) WPC d) ITR
582	Is it necessary to check the transformer before putting on load if it was out from circuit due to Differential relay? (Yes/No) Yes
583	Voltage ratio of PT type I -----, 25kv/100 volts
584	Voltage ratio of PT type II -----, 25kv/110 volts
585	KVA rating of AT normally used for CLS is -----, 10
586	Voltage ration of AT normally used for CLS is -----, 25kv/230 volts
587	Rating of AT normally used in SP/SSP is -----KVA 10
588	-----No of AT is used in TSS. (1, 2, 3, 4) 2
589	100KVA AT of TSS is used for- a) Yard Lighting b) Stand by c) Filtration Plant d) Power Factor correction.
590	Rating of PT normally used for catenary indication is ----- 25kv/100 volts

591	DO fuse rating for 10 KVA AT is -----, 1 amp
592	Rating of KIT- KAT fuse for 10KVA AT is -----, 63 amp
593	Minimum permissible Megger value between HT- E for a CT is -----M. 200 MΩ
594	Minimum permissible Megger value between LT- E for a CT is -----M. 2 MΩ
595	Minimum permissible Megger value between HT- LT for a CT is -----M. 200 MΩ
596	Minimum permissible Megger value between HT- E for a PT is -----M. 200 MΩ
597	Minimum permissible Megger value between LT- E for a PT is -----M. 2 MΩ
598	Minimum permissible Megger value between LT- E for a PT is -----M. 200 MΩ
599	Minimum permissible Megger value between LT- E for a PT is -----M. 200 MΩ
600	Minimum permissible Megger value between LT- E for a PT is -----M. 2 MΩ
601	Minimum permissible Megger value between HT- LT for a AT is -----M. 200 MΩ
602	In case of CT, number of turns in primary is ----- than number of turns in secondary. Less

603	In case of PT number of turns in primary is ----- than number of turns in secondary. More
604	The secondary winding of a CT should not be open circuited if primary is charged- a) There is no such restriction. b) Primary becomes Over-Voltage c) CT winding will burn –out. d) CB can not be closed
605	Most suited place for cable storage is – a) Moist and Dark b) Moist and Sun light c) Dry and dark d) Dry and Sun light.
606	What is used to indicate the position of under ground cable?----- Route Indicter/ Cable Marker
607	Cable laying should be done in cable trenches ;due to a) Ease of maintenance. b) Mechanical protection c) Eases of identification during maintenance. d) all of the above.
608	While storing cables ,its ends should be properly covered by something like plastic etc.- a) It is of no use. b) Such action is wrong. c) It must be done. e) It is sufficient to cover only one end.
609	To protect the cable from the effects of moisture its free ends should be covered by something like plastic etc. (true/false) True
610	What you understand about size of a cable if it is said 70 Sq mm two core cable- a) Cross sectional area of the cable is 70 sq mm. b) Size of each core is 70 sq mm c) Size of one core is 35 sq mm d) Cable is to be used for CLS purposes.
611	There is a fuse in the secondary of the CT. (true/false) False

612	There is a fuse in the secondary of the PT. (true/false) True
613	Some times ,there is only secondary winding in CT. (true/false) True
614	DO fuse is protection for ----- . (OHE , AT) AT
615	Can DO-fuse be used for protection of CT. (Yes/ No) NO
616	230 volt AT winding should be meggered from 500 volt megger. (true/false) True
617	Size means length of the cable used for.(true/ false). False
618	Aarmor is meant for mechanical protection of the cable.(true/false) True
619	Cable size of discharge –rod used in 25KV OHE is – a) Multi-core 40 sq. mm b) Single Core 40 sq. mm c) Multi-core 20 sq. mm d) Single Core 20 sq. mm

620	To crimp a lug properly on the cable core, how many strands are permitted to cut? a) 0 b) 1 c) 2 d) 3
621	The insulation resistance of a cable depends on – a) Condition of insulation b) length c) Thickness of insulation d) all of the above.
622	Hand tool used to put the lug on cable core tightly is – a) Torque Rinch b) Ring Spanner c) Crimping tool d) LN key
623	The maximum permissible limit of variation on HT supply as per I.E. rules; a) $\pm 10\%$ b) $\pm 15 \%$ c) $\pm 20 \%$ d) ± 5
624	A circuit having two sets of series connected resistance 5 & 10 ohm each are connected in parallel the effective resistance will be ; a) 7.5Ω b) 15Ω c) 10Ω d) 5Ω
625	As per the IE rules the variation permissible in the frequency of domestic supply is ; a) 2.5% b) 3% c) 5% d) None of these

626	An electric bell works on the principle of ; a) Electromagnetic induction b) Electrostatic induction c) Mutual induction d) None of the above
627	A 6-pole synchronus motor working at 400 V and 50 c/s will run at ; a) 1000 rpm b) 1500 rpm c) 800 rpm d) 1200 rpm
628	A 6-pole synchronus motor working at 400 V and 50 c/s will run at ; b) 1000 rpm b) 1500 rpm c) 800 rpm d) 1200 rpm
629	If the line voltage of a star connected transformer is 400 volts. Voltage of each phase in a fully balanced load circuit will be ; a) 230 volts b) 270 volts c) 210 volts d) 290 volts
630	The iron core of transformer is built mainly of laminated construction to reduce ; a) Eddy current loss b) Copper loss c) Iron loss d) None of these

640	Maximum SF6 gas pressure of ABB make 25 kv single pole CB is ; a) 700 Kpa b) 620 Kpa c) 600 Kpa d) 720 Kpa
641	Line impedance of one OHE without BT and RC ; a) $0.40 < 70^\circ$ ohms/km b) $0.39 < 70^\circ$ ohms/km c) $0.41 < 70^\circ$ ohms/km d) $0.24 < 70^\circ$ ohms/km
642	Integrated vectorial delta-I relay protect OHE from ; a) TSS-TSS b) TSS-SP c) TSS-SSP d) SSP-SP
643	Type-II PT is used for a) Protection b) Metering c) Indication d) Protection & Indication
644	Maximum neutralisation value of new transformer oil is ; a) 0.03 mg KOH/g b) 0.003 mg KOH/g c) 0.3 mg KOH/g d) 0.0003 mg KOH/g

645	In TSS length of buried rail is ; a) 15 meter b) 13 meter c) 10 meter d) 20 meter
646	Which type of fire extinguisher is used to extinguishing electric fire ; a) Co₂ type b) DCP type c) Foam type d) Co₂ & DCP type
647	What is the Circuit breaker contact resistance when circuit breaks in closed condition is ; a) <200 $\mu\Omega$ b) <300 $\mu\Omega$ c) <100 $\mu\Omega$ d) <150 $\mu\Omega$
648	In TSS 110 Kv HT side earthing strip size is ; a) 40 × 6 mm b) 50 × 6 mm c) 75 × 6 mm d) 75 × 8 mm
649	What is the capacity of battery used in TSS as per ACTM ? a) 120 AH b) 200 AH c) 300 AH d) 48 AH

650	Ratio of H_2SO_4 & distilled water in lead acid cell is ; a) 1:4 b) 4:1 c) 2:3 d) 3:2
651	Fully charged lead acid cell specific gravity is a) $1240 + 0.005$ corrected to $27^{\circ}C$ b) $1180 + 0.005$ corrected to $27^{\circ}C$ c) $1200 + 0.005$ corrected to $27^{\circ}C$ d) $1210 + 0.005$ corrected to $27^{\circ}C$
652	What should be the OHE voltage is well above the minimum at the farthest point on the system even when it is heavily loaded? a) 18 kv b) 20 kv c) 19 kv d) 18.5 kv
653	What is the overhaul schedule of operating circuit breaker and interrupter? a) Once in 15 years b) Once in 20 years c) Once in 10 years d) Once in 5 years
654	Which gas is generated when arcing inside the transformer is formed? a) CO_2 b) CO c) Ethylene d) Acetylene

655	Which communication channel is used in SCADA as per specification 0130 Rev-2 ? a) E channel b) C channel c) E₁ channel d) C₂ channel
656	The buried earth electrode inclination to the vertical may be ; a) 28° b) 30° c) 45° d) 60°
657	Embedded earth electrode as far apart as possible from each other & separation between them shall be ; a) 5 meter b) 3 meter c) 2 meter d) 6 meter
658	The clearance from ground level to 25 kv line bus should be ; a) 4 meter b) 3.8 meter c) 3.5 meter d) 4.6 meter
659	The clearance from ground level to 110 kv line bus should be ; a) 5.5 meter b) 3.8 meter c) 15 meter d) 4.6 meter

660	The potential difference between two points on the earth surface separated by a distance of pace is called ; a) Touch potential b) step potential c) touch potential & step potential d) none of these
661	Which of the relays are used for protection of CB in TSS? a) IDMT relay b) ADDR Relay c) Delta-I relay d) REF Relay
662	What is the rating of lightening arrestor on 25 KV side of power transformer? a) 132 KV b) 25 KV c) 42 KV d) 12 KV
663	What is the rating of lightening arrestor on 110 KV side of power transformer? a) 132 KV b) 25 KV c) 42 KV d) 96 KV
664	What is the rating of current transformer on 25 KV side of 21.6 MVA power transformer? a) 200-400/5 Amp b) 750-1500/5 Amp c) 1500-3000/5Amp d) 800-1600/5 Amp

665	What is the rating of current transformer on 110 KV side of 21.6 MVA power transformer? a) 200-400/5 Amp b) 750-1500/5 Amp c) 1500-3000/5Amp d) 800-1600/5 Amp
666	What is the isolating distance in air for 132 KV double pole isolators used in TSS? a) 1800 mm b) 2000 mm c) 1600 mm d) 500 mm
667	What is the rated breaking capacity of 132 KV HV Circuit Breaker used in TSS? a) 5800 MVA b) 5200 MVA c) 4800 MVA d) 550 MVA
668	What is the rated breaking capacity of 25 KV Circuit Breaker used in TSS? a) 550 MVA b) 520 MVA c) 450 MVA d) 5800 MVA
669	What is the rating of 25 KV Bushing CT used in 30/42 MVA traction transformer in TSS? a) 400/5 Amp b) 1500/5 Amp c) 3000/5Amp d) 1600/5 Amp

670	A neutral section is provided in OHE between two 25 kV, single phase , 50 Htz. traction substations due to ; a) To separate the zones, which fed by the adjacent substation of different phase b) To increases the current carrying capacity of the OHE c) To minimize the voltage drop in OHE conductors d) All of the above
671	Normally, power generation & transmission system of the supply authorities are of ; a) Single phase (b) Two phase (c) Three phase (d) Three phase & neutral wire
672	25 kV traction system needs the supply of ; b) Single phase (b) Two phase (c) Three phase (d) Three phase & neutral wire
673	The distance of OHE section between FP & SSP or SSP & SSP or SSP & SP is called; c) Feeding length (b) Feeding zone (c) Sector (d) Sub sector
674	The distance of OHE section between FP & SP is called ; a) Feeding length (b) Feeding zone (c) Sector (d) Sub sector

Choice and Location of a site for Traction Substation

The basic consideration in locating a TSS is to ensure satisfactory voltage conditions in the OHE under the normal and extended feed conditions.

Normal 22.5 kV

Extended feed – 19kV

- i) It should permit bringing and taking out the incoming EHT and outgoing 25kV feeders.
- ii) Access from public road to TSS to handle equipments.
- iii) Railway siding shall also helped especially during construction and during breakdown of heavy equipments.
- iv) Control room (control eqpt.. protective relays, instruments, battery chargers, SCADA equipment and testing eqpt.) and rest room for maintenance 'personnel')
- v) Nearness to Rly. Station where inspection staff can reach in shortest possible time.
- vi) Proximity of SEB grid to keep the requirement of EHV tr. lines from grid S/s to TSS to bare minimum.
- vii) TSS to be preferably located on Rly. Land, minimum land acquisition should be required.
- viii) Availability/provision of a siding for convenience of loading & unloading of heavy equipment in case of non availability of all weather road access.
- ix) Area should be away from pollution.
- x) High and firm soil.
- xi) It should have a neutral section, which should be preferably located in a trough like location so that trains can pass without power with least loss of speed.
- xii) Voltage drops at the farthest points fed by the substations are within permissible limits under normal and emergency feed conditions.
- xiii) It should be convenient and useful for extension for further electrification in the area.

Voltage unbalance

Current unbalance

Instantaneous 5%

1 min 45%

2 hrs. 3%

10 min 12%

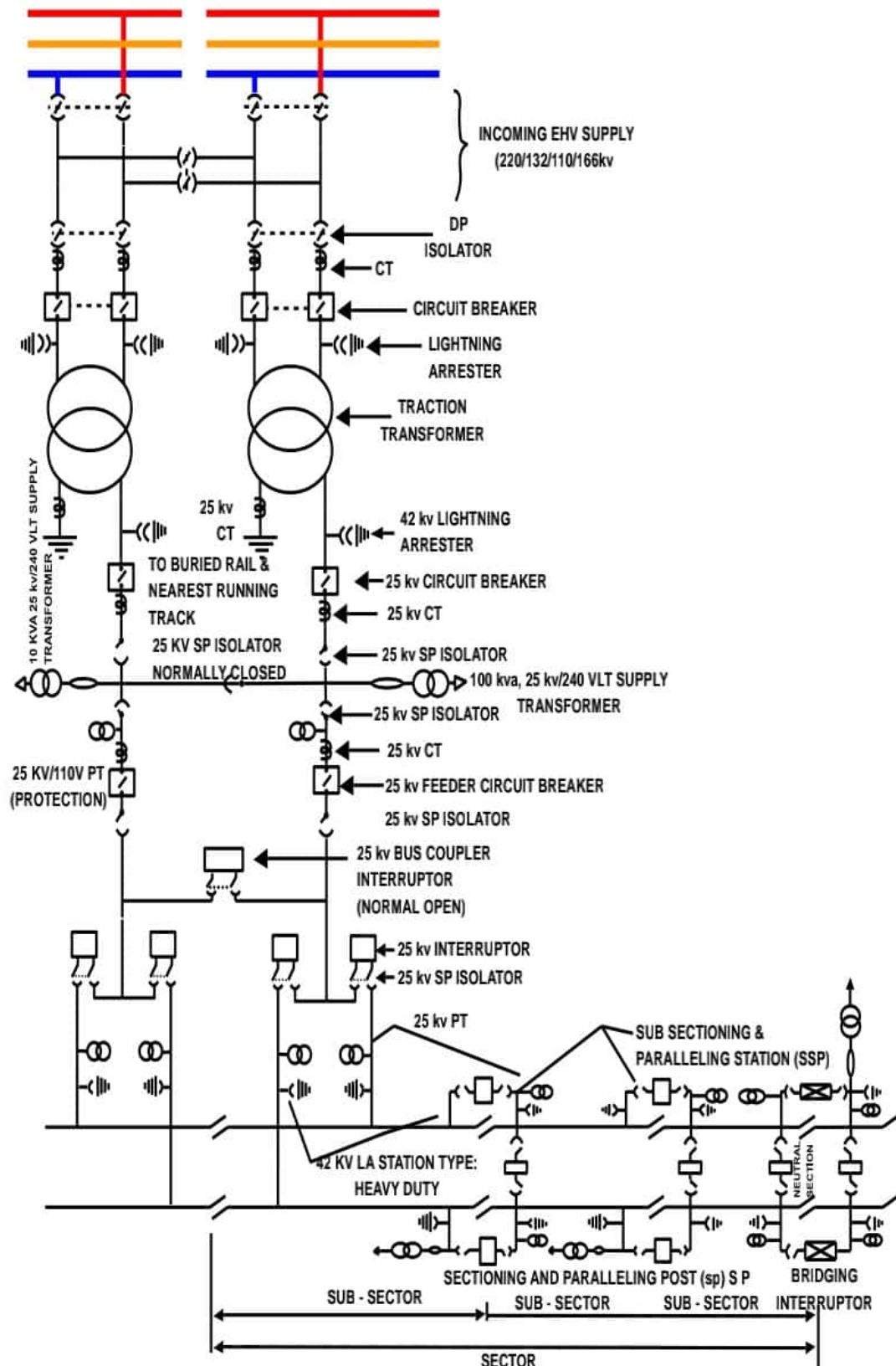
continuous 2%

continuous 8%

Current unbalance = -ve sequence current +ve sequence current

Voltage unbalance = single phase load short ckt MVA

TYPICAL SCHEMATIC OF TRACTION POWER SUPPLY FEEDING ARRANGEMENT



Protective Relays in TSS.

I. Transformer protection:

i) Differential Relays :

Protection against internal faults with necessary restraining features to avoid frequent tripping due to inrush of the magnetising current when transformer is charged/switched on.

Protection against internal faults by means of single pole differential relay.

It is of high speed type and operation in less than two cycles (1/25 seconds)

It has following features.

- i) Setting of relay need not be changed if transformer tap is changed.
(Transformer taps - 15% to + 10%)
- ii) Necessary harmonic restraining feature are provided to prevent its false operation when transformer is charged.
- iii) The relay shall not operate for maximum through fault current.
- iv) Current setting of the relay should be adjustable between 20% to 80% Current setting should be as low on possible so that maximum sensitivity is achieved.
- v) Adjustable bias setting should be provided. The bias at minimum operating current shall be 20%, 30%, 40% to suit the tapping range of Tr. transformer and other design considerations.

The relay is connected to bushing CTs. But interposing CT of suitable ratio of knee point voltage, excitation current etc. should be provided with differential relay so that the bushing CT secondary current at full load has a value equal rated current.

Setting: 40 - 100% of 5 A, Bias setting -.20%, 30% or 40% of 5 A

2) Earth leakage protection: (Restricted earth fault protection)

Back up protection for internal earth faults is provided by a sensitive high speed earth fault relays. They are provided separately on primary and secondary side and are connected on a separately mounted CTs. The current setting for the relay can be adjusted between 20% and 40% of 5 Amps, in equal step of 5%.

(The relay shall be of T10 class with operating time not more than 10)

Setting 10 -40% of 5A.

3) Over current protection :

It is provided by means of a single pole non directional over current relays with IDMT characteristic, both on primary and secondary side also an additional instt O/current relay is provided on primary side.

On primary side, OCR is connected to a separately mounted CT. On secondary side, it is provided on the unearthed leg of the secondary terminals through a separate CT. The secondary side OCR serves as back up protection against any fault. The primary side OCR will serve as back up protection to earth leakage relay and differential relay against heavy faults.

IDMT OCR on primary and secondary side has current setting from T10 class with operating time not more than 10 ms at 5 times the current setting.

setting 80 - 320 % of 5A, 400 - 1600 % of 5 A

Scheme of Protection for OHE.

It has the following functions.

- i) It detects all the short circuit over the zone of OHE fed by the feeder CB and opens the CB in minimum time.
- ii) It discriminates between the maximum load current and short circuit current even if the load current is sometimes more than the fault current specially when the faults are at a large distance from TSS. (Is it because of impedance and phase angle setting)
- iii) It detects and isolates the faults due to coupling of wrong phases from adjacent TSSs.
- iv) It achieves auto reclosing of the feeder C/B once with an adjustable time period of 0.5 Sec to 30 Sec.
- v) Relay for an impedance of 20-25 ohms and a phase angle of 70 degree for protection against the earth faults.

OHE Protection Relays :

1) Distance protection relay :

It discriminates between the phase angle of fault impedance and the working impedance of the system.

Relay type directional distance protection relay (DPR)

2) Instantaneous Overcurrent protection Relay :

It provides primary protection to the OHE during earth faults in the vicinity of FP. The current setting can be 200 % of current setting of Tr. transformer.

100 to 800 % of 5A

3) Wrong Phase Coupling Relay.

Relay with RCA of 70 degree is not adequate for wrong phase coupling protection at neutral section or at FP when feed is extended..

Other protections:

The differential relays and earth leakage relays on primary and secondary sides and also OCR on the secondary side open the HV and LV side circuit breakers for the transformer. These CBs are also opened due to other faults in the transformer, due to action of Buchholz relay.

- * Protection against low oil level.
- * Protection against high oil temp.
- * Protection against high winding temp.
- * Protection against high voltage surges by means of L.A.
- * Protection against direct lightning stroke by means of shielding wires and spikes.
- * Protection of adjustable arcing horns.

Loop impedance with earth return for the OHE at 70 degree phase angle

i) Single track OHE	0.41 per Km.
ii) Double track OHE	0.24 per Km.
iii) Single track OHE with return conductor	0.70 per Km.
iv) Double track OHE with return conductor	0.43 per Km.

Specification for protective scheme.

i) Electrical Relays for power system protection	IS	3231	-	1965
ii) Static protective relay	IS	8686	-	1977
iii) Electrical indicating instruments	IS	1248	-	1968
iv) Control cable	IS	694	-	1977
v) Interposing CT	IS	2704	-	1981

All the relays are out draw out (plug in switch board) type, back connected and suitable for semi flush mounting having dust proof covers.

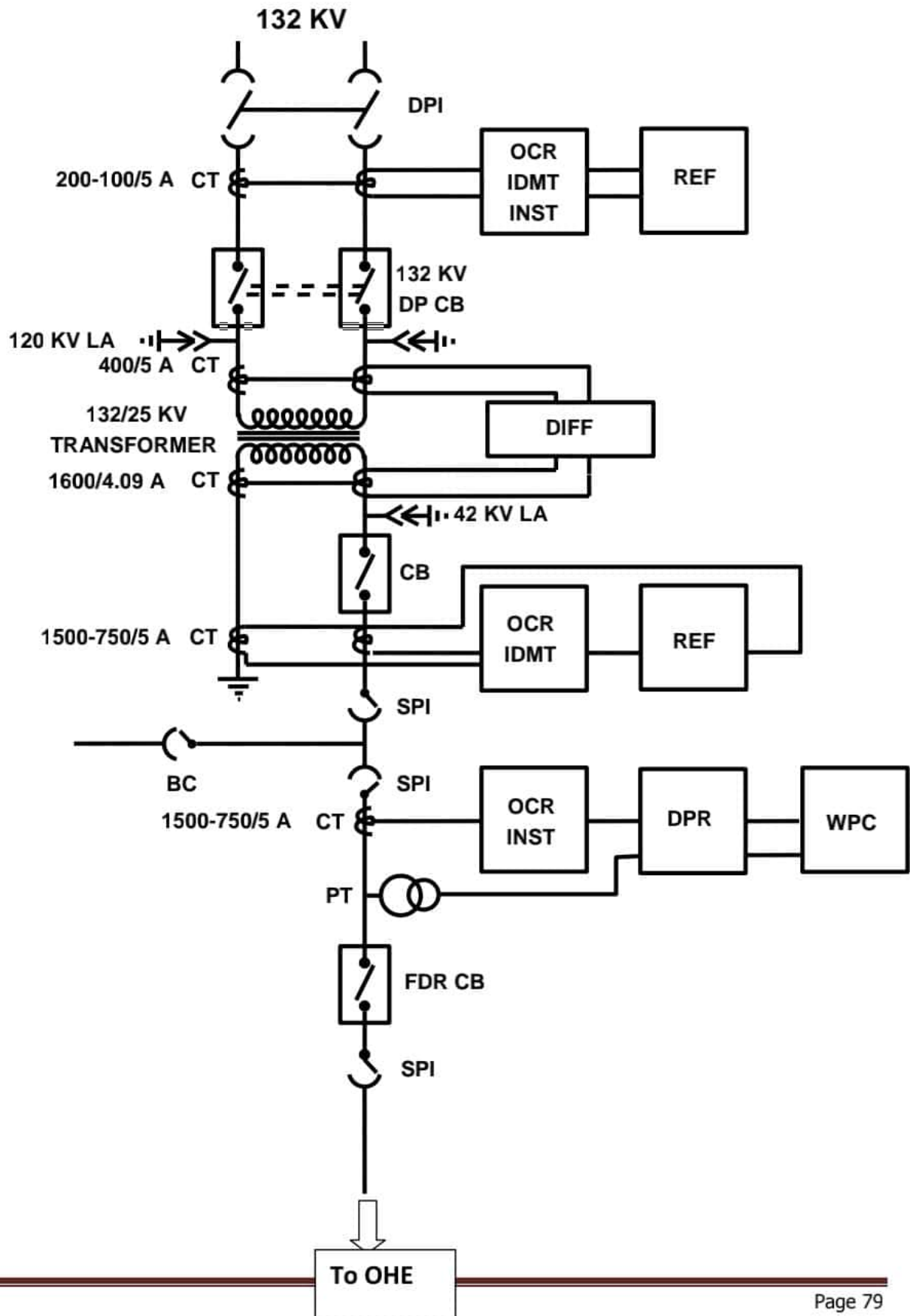
The terminal connections inside the relay housing are such that the current terminals of CT secondaries get shorted automatically when the relay is drawn out. The relays have flag type operation indications.

The current coils are rated for a continuous rating of 5 A and the voltage of withstanding 20% of overload for 8 hrs.

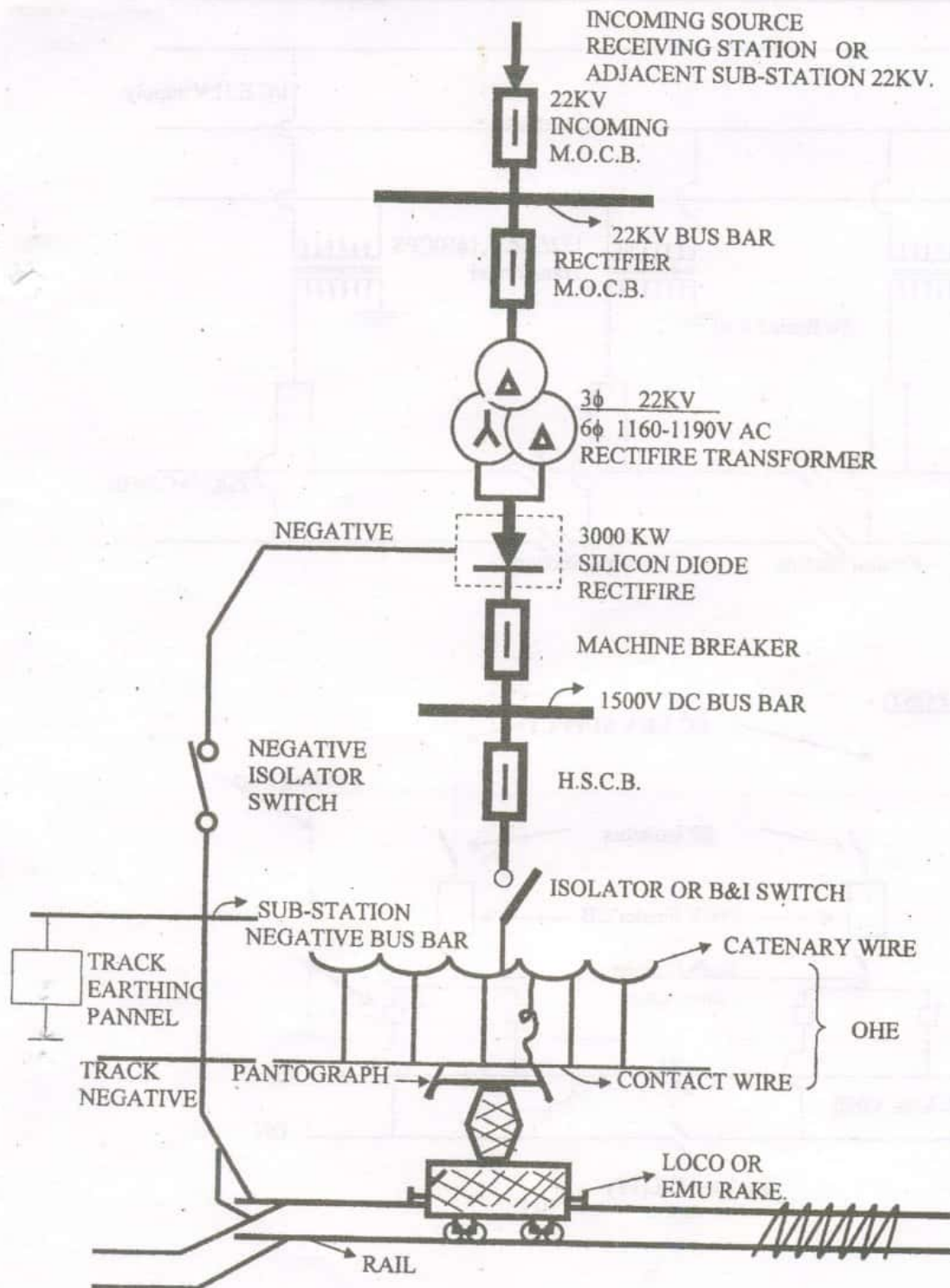
The relay housing are such that the current terminals of CT secondaries get shorted automatically when the relay is drawn out. The relays have flag type operation indications.

The current coils are rated for a continuous rating of 5 A and the voltage of with standing 20 % of overload for 8 hrs.

PROTECTION SCHEME



SINGLE LINE DIAGRAM OF 1500V DC TRACTION DISTRIBUTION



REQUIREMENT OF GOOD EARTHING SYSTEM

1. It stabilizes circuit potentials with respect to ground and limit potential rise.
2. It should protect men and materials from injury or damage due to over voltage.
3. It should provide low impedance path to fault current to ensure prompt and consistent operation of protective devices during ground faults.
4. It should keep the maximum voltage gradient along the surface inside and around the substation within safe limits during earth faults, i.e. to limit touch potential and step potential.

For 25 kV traction installation limits of combined earth resistance in OHMs are: -

1.	Traction Substation	05
2.	Switching Station (SP, SSP)	2.0
3.	Booster Transformer Stn.	2.0
4.	Auxiliary Transformer Stn.	10.0

Factors influencing Earth Resistance

1. Condition of soil
2. Temperature of soil
3. Moisture content of soil
4. Size and spacing of earth electrodes
5. Depth at which the electrode is embedded.
6. Material of conductor
7. Quality of coal, dust, charcoal and salt in the earth electrode pit.
8. No. of electrode in parallel.

Methods of Reducing Earth Resistance

1. Cleaning the surface of earth plate or pipe, Remove dust, inspect joints, filling of charcoal, soaked in salt solution.
2. Increasing plate areas, pit depth, increasing no. of electrodes in parallel.

But electrodes should be so spaced in parallel so as not to overlap the earthing region covered by the individual electrodes.

Bonding for 25 kv a.c. 50 hz.

Single phase Traction system

Bond means an electrical connection between two or more conductors of non-current carrying metallic parts of traction masts or structures or supports and rails.

"Earth" means a connection to the general mass of earth by means of an earth electrode.

Rail length means a continuous length of rail with or without welded joints but with no fish plate joints

Rail-bond means an electrical connection across a rail joint between consecutive lengths of rails. It is also called a 'Longitudinal bond'

Cross bond means a bond between two rails of a track or two rails of adjacent tracks. It is also called a transverse bond

"Structure bond" means a bond connecting for non current carrying metallic parts of a traction mast or structure or support to the traction rail.

Impedance-bond is a bond, installed by the Signal and Telecommunication Department, which provides a low impedance path for the traction return current and a relatively high impedance path for track circuit current

"Signal bond" means an electrical connection across a rail joint, provided by the Signalling & Telecommunication Department, to facilitate flow of track circuit current

Return current flows mostly through the earth leaving the traction rail except in a zone extending over a few hundred metres on both sides of the electric rolling stock in operation in the section or in the vicinity of a feeding station and returns to the traction sub-station. Bonding of all rails is, therefore, not absolutely essential unlike in the case of d.c. traction where practically the whole traction return current flows through the rail and hence bonding of rails is essential

Bonding in Single Rail-Track-Circuited Sections -- The traction rail in a single rail-track-circuited section shall be provided with rail bonds not only over the entire length upto which the track circuited rail exists but also for a distance of 50 m on both sides of the track circuited length. In addition, the traction rail shall be cross bonded to the traction rails. If any, of adjacent tracks wherever they exist at intervals of not less than 100m. The traction rails of such adjacent tracks shall also be provided with rail-bonds over the entire length of the track circuits and for further 50 m on both sides. In case the length of a track circuited rail is not more than 350 m, a cross bond shall be provided between the rails of the track immediately outside the track circuited length at both of its end.

Bonding in Double Rail-Track-Circuited Sections.

In a double rail-track-circuited section, both the rails shall be provided with rail-bonds. At insulated joints of the double rail-track-circuit an impedance bond shall be provided. Since no traction rail is available for structure bonding, an earth wire shall be run on the traction mast or structure or support. In case, the length of the earth wire exceeds 1000 metres it shall be made electrically discontinuous by providing a cut-in-insulator so that no section of the earth wire is greater than 1000 metres electrically. Each such section of the earth wire shall be connected to an earth at two traction masts or structures or supports at a distance not exceeding 500 m apart

No cross bond shall be provided between the rails of the same track or between the rails of different tracks in a double rail-track-circuited section

Bonding Adjacent to Traction Sub Station/Feeding Post -- all the traction rails shall be provided with rail-bonds for a distance of 1000 metres on either side of the traction sub-station/feeding post. In addition, these traction rails shall be cross-bonded at approximate distances of 300, 500, 700 and 1000 metres from the traction sub-station/feeding post

Bonding of Traction in Loco sheds and Loco/EMU stabling sidings -- All traction rails of loco sheds and loco/EMU stabling sidings shall be provided with cross bonds at distance of not more than 100 m apart. Further all sidings and/or dead ends, whether wired or not, shall be connected by rail bonds. The rails on wooden or concrete sleepers/supports in loco/EMU inspection pits shall be provided with rail-bonds for the entire length of the pit and also upto a length of 50 m on both sides and connected to an earth.

Bonding of Rails in a Tunnel -- In a tunnel all the traction rails shall be provided with rail-bonds not only over the entire length inside the tunnel but also for a length of upto 50 m on both sides outside the tunnel. Besides, a cross bond shall be provided between the traction rails at either ends of the tunnel.

Bonding at a Level Crossing -- All the traction rails shall be provided with cross bonds at only one location which shall be within five metres from either of the transverse edges of the level crossing

Bonding of Girder Bridge -- Steel structures of a girder bridge shall be connected to a traction rail or to an earth by means of two mild steel strips/flats of cross section not less than 200 mm² each. The traction rails (where there are two or more such rails) on the bridge shall be connected by cross bonds at distances not exceeding 100 metres apart.

Bonding of Metallic Parts inside a tunnel -- An earth wire connecting all non-current carrying metallic parts which form parts of the supports for the overhead equipment, shall be run inside the tunnel. The earth wire shall be connected to an earth as well as to the traction rails at both ends just outside the tunnel. In case, all the rails are track circuited, the earth wire shall be connected to an earth at both ends just outside the tunnel

Bonding of Over line Structure -- The metallic parts of foot or road over bridges or other over-line structures over wired tracks shall be connected either to a traction rail or to an earth by means of two mild steel strips/flats of cross-section not less than 200 mm² each.

Bonding of Exposed Metallic Parts -- All exposed metallic parts such as platform structures/sheds, metallic fencing, wires, pipes and such other items, not likely to come into direct contact with the 25 kV ac overhead equipment and located with a distance of 20 m from the nearest electrified track and running parallel to it for a distance of more than 20 m but less than 350 m shall be connected to an earth or traction rail. If parallelism with the nearest electrified track exceeds 350 m all such exposed metallic parts shall be connected to a separate earth at distances not exceeding 350 m apart.

No special precaution is required in case such metallic parts are fitted on metallic supports directly buried in the ground if the earth resistance of such metallic support is less than 10-Ohm.

Bonding of Earthing Heel of Isolator Switch -- The earthing heel of an isolator switch shall be connected by two mild steel flats of cross-section not less than 200 mm² each to the supporting metallic traction mast or structure or support. The connection shall be as short and as direct as possible. Such a traction mast or structure or support shall, in turn, be connected to a traction rail or an earth wire and, in addition, to an earth.

INSPECTION MANUAL

1.0 General:

- 1.1. Inspection are conducted at different levels viz. Senior Managers – middle managers and supervisory levels. One has to go down the line to ensure effectiveness of extant orders and system. Following guidelines in general are mentioned for making inspection effective and fruitful:-

-
- a) Review of last inspection of self & those below in respect of quota, quality & compliance.
 - b) Observe whether the systems of working are as pr laid down policy and rules. If any amendments are required, necessary action is to be initiated. **Availability and updated Codes, manuals, guidelines, resisters with latest correction slips are** essential for this objective to be achieved.
 - c) Store & Financial matters are in order and necessary books, records, last overhauling reports, stock sheets, accounts and audit inspection help in achieving this end.
 - d) Local orders to suit local conditions of weather, terrain, culture, law and order etc. for improving efficiency with safety must be there – if not, these should be organized at appropriate levels.
 - e) During office inspection, Maintenance of records and handling of various types of correspondence, pending letters etc. if any, reasons for non-compliance and remedy the same through appropriate steps.
 - f) Redressal of Staff complaints should be done with utmost dedication. Human resource is the most valuable one in any organization.

1.0 Feed back:

- a) All inspections carried out by Senior Supervisors & AEEs are to be reviewed by Branch Officers (DEE/Sr.DEE) and concerned Headquarter HOD. The attitude and purpose will vary from supervisory to managerial level.
- b) At Supervisor and Officer (AEE/DEE/Sr.DEE) level, reporting compliance has to be of utmost emphasis. Sr.DEEs has to ensure through their official machinery and personal check in office and field (as and when required or possible) that Senior Supervisors, AEE/DEE are carrying out full quota of inspections. However, 100% review of quota of specified inspections is a must to ensure proper and safe working at different levels. It will help in pinning down the individual responsibility – an essential requirement for quality and safe output.
- c) For divisional officers feedback must be given as one of the items of the PCDO from Sr.DEE to CEE in the proforma given at page 7. For headquarter officers, feedback is to be given as one of the items of the PCDO from CEE to ML in the proforma given at page – 8.

3.0 Recording and transmission of Inspection Notes:

Inspection notes can be recorded in three ways:

- a) Recording of observations in the site book/document: In the depot, office, site, there has to be a system of recording observations in this book, contents of which should be explained to the official/staff in local language. In case of important matters, even the acknowledgement to this effect be recorded in the site book itself. However, it is very essential to keep a vigil that the book or its pages are not lost and its custodian is well defined and the transmission of book, if at all required, is done through proper delivery and receipt memo. This style can be most effective for supervisors. There is lot of wisdom in this

style of recording inspections as these are not only binding on the officials who would comply with them but also on the inspecting officials who are recording them.

- b) By handing over a memo by inspecting officials at site of inspection itself: This can be usefully employed by higher supervisory and low managerial levels. This system will save time and energy, which is spent in making out an inspection note after reaching the headquarters and then sending it back to the site officials. A duplicate book, which produces carbon copy immediately, will prove to be handy for this purpose. It will also help in reviewing one's own inspections done in the past.
- c) Issue of Inspection Notes after reaching headquarter Office. This is suitable for Junior and Senior Administrative Grade officers. Frequently, it is observed that while divisional or zonal headquarter officials conduct the inspection, lot of deficiencies of their won offices come to notice in the form of delay in approval of plans, arranging of materials, according sanctions to Field proposals, staff redressals, which would invariably require action in the office of inspecting official and the above his own, rather than by the side officials. Hence, such a note is very useful, especially it is marked to the officers of headquarters, who are responsible to dispose of the case brought from site by the inspecting official, who can chase the matter for appropriate timely disposal.

4.0 Benefits of Site Inspections: Inspections at all levels are multi-purpose and broadly following items can be covered during these:

- Fault detection/and correction.
- Feel of the site conditions
- Decision making
- Feed back regarding systems efficiency – availability of Codes/Manuals, publications
- Grievance redressals of staff
- Human Resource development – on spot training and quality assurance
- Builds the team
- Protection of Railway assets (help watching)

- 4.1 The utility of an inspection, basically at senior levels, can get increased multifold, with little prior preparation.

5.0 Special Emphasis Areas of Inspection

- a) Availability of codes, Manuals and existing policy directives: - This must be ensured though physically checking the availability of Codes/Manuals and the

assurance that the concerned staff is up-date with the knowledge required for his functioning. Needless to emphasize that this exercise should lay as much stress as possible on items related with safety and security.

- b) **Review of inspections of those working under the inspecting officers including review of action taken on earlier inspection notes** while conducting field inspections requires more emphasis to ascertain effectiveness of his inspections.
- c) **Office Inspection** – Record Keeping etc. : - Efficient functioning of an office (at any level) forms the back bone of bureaucracy. Proper maintenance of various records and handling of dak, files must be inspected and ensured, especially in case of subordinate offices.
- d) **Inspection to be objective oriented and planned:** Inspection if carried out as fault remedying instruments can help achieve substantial improvement in the system. Needless to say that, this would be true only when the inspections are carried out in an expert and efficient manner.
- e) **Effectiveness of inspection should be the key word** for the Inspection for which enough time should be devoted to establish systems.

CONDITION MONITORING OF TRACTION TRANSFORMER (Dissolved Gas Analysis)

Condition Monitoring involves monitoring of certain parameters of traction transformer. Based on the prescribed parameter values certain maintenance activities can be decided and carried out.

Normally, any equipment is maintained in three ways viz.

- a) Routine Maintenance
- b) Periodic Maintenance
- c) Condition based Maintenance

In Routine maintenance, activities involved which are essential for day to day working like checking of Oil level, colour of silica Gel in Breather etc.

In Periodic maintenance, activities involved are that type of maintenance activities which are not necessary to be done so frequently and ensures the working of the transformer over a longer period such as Oil testing, measuring IR value etc.

It is established that over maintenance of any equipment leads to more number of failures. Hence the present trend is to minimise the maintenance which can be achieved through condition based monitoring.

Failure of a transformer leads to lot of inconvenience and anxiety which can be avoided if proper measures are taken before its failure takes place.

A transformer never fails all of a sudden except due to short circuit or lightning surges. Always a fault is developed gradually and may lead to its failure and consequently to be shut down for repairs if not detected in its incipient stage. Such faults can be of following nature.

- i) A local fault developing over days and weeks.
- ii) Deterioration of insulation comparatively over a longer period.

When such faults are detected and diagnosed at the early stage, necessary steps can be taken to plan the shut down of the transformer conveniently for its repairs and procurement of the necessary spares.

Major causes of failures of the transformer are

- i) Insulation
- ii) Hot spots
- iii) Core faults
- iv) Short circuit faults
- v) Switching surges
- vi) Manufacturing defects

The transformer oil acts as a coolant and insulating medium. It absorbs heat from the core and dissipates it to atmosphere. Also it insulates various parts of the

transformer which are at different potentials. The oil should possess the properties as specified in IS – 335. Condition of the oil indicates the health of the transformer. If deviation in the properties of the oil takes place, cause for this can be found out and necessary measures can be taken accordingly. Dissolved analysis is a very powerful tool to achieve this.

- i) It assesses the internal condition of the transformer. It is performed by Gas Chromatography
- ii) The knowledge of solubility of Hydro-carbons and fixed gases at different temperatures in the oil helps to gas analysis.
- iii) The absolute concentration of fault gas indicates status of insulation whereas relative concentration provides a clue to the type of the fault.

Formation of gases takes place in oil filled transformer due to following reasons.

- i) Oxidation
- ii) Vaporization
- iii) Insulation decomposition
- iv) Oil breakdown
- v) Electrolytic action.

For DGA generally Roger's Method is used which analyses proportion of one gas with respect to the other gas. The gases involved are

- i) Methane (CH₄) and Ethane (C₂H₆)- at 120° c
- ii) Ethylene (C₂H₄) - at 150°c
- iii) Acetylene(C₂H₂) - at very high temperatures.

The absolute condition of the fault gases gives the status of the transformer insulation whereas the relative concentration of these gases provides an idea of the type of the fault e.g. Conductor over heating by CO or CO₂, oil over heating by Ethylene. Partial discharge by Hydrogen. Arcing by Acetylene.

- i) If Methane / Hydrogen ratio is 1, slight over heating below 1500 C.
- ii) If Methane / Hydrogen ratio is 1 and Ethane to Methane is 1, over heating between 150°c -200°C.
- iii) If Ethane to Methane is 1, over heating between 200°-300°C.
- iv) If Ethylene to Ethane is 1, normal conductor over heating.

- v) If Methane to Hydrogen and Ethylene to Ethane are 1, circulating currents and/or over heated joints.
- vi) If Acetylene to Ethylene is 1, flash over without power follow through.
- vii) If Ethane to Methane and Acetylene to Ethylene are 1, Tap changer selector breaking current. (Not Applicable for Tr. Transformer)
- viii) If Ethylene to Ethane and Acetylene to Ethylene are 1, Arc with power follow through or persistent arcing.

Guideline for the characteristics of oil to be obtained before energising New Transformer.

Sr. No	Characteristics	Test Method	Requirement
1	Appearance	IS 335-1983	The oil shall be clear & transparent & free from suspended matter of sediments
2	Density at 27 ⁰ C Max	IS 1448-1977	0.89 g/cm ³
3	Kinematic viscosity at 27 ⁰ C Max	IS 1448-1977	27 CST
4	Inter Facial tension at 27 ⁰ C Max	IS 6104	0.300 N/m
5	Pour point (Max)	IS 1448-1970	-60 ⁰ c
6	Flash point (Max)	IS 1448-1970	140 ⁰ c
7	Neutralisation value(Max)	IS 335-1983	0. 3 mg KOH/g
8	Corrosive sulphur	IS 335	Non- corrosive
9	Electric Strength (BDV)min. with 2.5 mm Gap.		
	(a) 72.5 KV and less than 145 KV	IS 6792-1972	50 KV (rms)
	(b) 145 KV and above	IS 6792-1972	60 KV (rms)
10	Power dissipation	IS 6262-1971	0.002

	factor- tan delta		
	at 90° C (max)		
11	Specific resistance		
	a) at 90° C (min)	IS 6103-1971	35×10^{12} ohm-cm
	b) at 27° c (min)		1500×10^{12} ohm-cm
12	Oxidation stability	IS 335-1983	0.40 mg/KOH/gm
	a) Neutralisation		
	value after oxidation (max)		
	b)total sludge after	IS 335-1983	0.10% (by weight)
	oxidation (max)		
13	Ageing characteristics after accelerated ageing test		
	(a) Resistivity at 27 °C	IS 6103-1971	2.5×10^{12} ohm-cm (min)
	(b) Resistivity at 90 °C	"	0.2×10^{12} ohmcm (min)
	(c)Dietectric loss factor	"	0.2
	(tan delta) at 90 °C max.		
	(d) Neutralisation value	IS 1448-2-1967	0.05
	(e)Sludge content max	-	0.05%
14	Presence of	Oil shall not contain anti oxidation additive.	
	oxidation inhibitor	(IS 335)	
15	Water content	IS 335	
	(a) 72.5 KV and less		20 PPM
	than 145 KV		
	(b) 145 KV and		
	above.		15 PPM
	(All concentration in PPM)		

Gas	0-4 Years	4-10 years	10 years
Methane	10 to 30	30 to 80	30 to 130
Ethane	10 to 30	30 to 50	30 to 110
Ethylene	10 to 30	30 to 50	50 to 150
Acetylene	10 to 16	10 to 30	10 to 40
Hydrogen	20 to 150	150 to 300	200 to 500
Carbon Monoxide	200 to 300	300 to 500	500 to 700
Carbon Dioxide	3000 to 4000	4000 to 5000	4000 to 10000

Gas Levels for Different Fault Conditions
(All concentration in PPM)

TABLE III

GAS LEVELS FOR DIFFERENT FAULT CONDITIONS
(All concentrations are in PPM)

Fault Gases	Hydrogen H_2	Methane CH_4	Ethane C_2H_6	Ethylene C_2H_4	Acetylene C_2H_2	Carbon dioxide CO
Arcing	500-1000	20-130	10-30	10-30	40-100	3000-4000
Partial Discharge	500-1000	20-130	10-30	10-30	10-15	3000-4000
Hot Spot	20-150	10-30	10-30	150-200	10-15	3000-4000
Gradual Overheating	20-150	10-30	150-200	10-30	10-30	3000-4000

TABLE - IV

GAS COMPOSITION BY VOLUME (%) WITH REFERENCE TO VOLUME OF OIL DUE TO
ARCING FAULTS

Insulation	H_2	CO	CO_2	CH_4	C_2H_6	C_2H_4	C_2H_2	O_2	H_2
Oil only	60	0.1	0.1	3.3	0.05	2.1	2.1	2.4	6.3
Oil/Kraft paper	52	14	0.2	3.8	0.05	8	12	3	6.7
Oil/Press board laminate	48	27	0.4	5	-	5	6	2	6.2
Oil, Alkyl paint	55	20	0.2	4	-	5	8	2.4	7
Oil/Polyurethane enamel	60	1	0.1	9	-	11	10	2	6
Oil/P.V.A enamel	61	5	0.1	6.0	-	14	5	2.5	6.5
Oil/Epoxy glass clothes.	57	2	0.1	14	-	10	8	2.5	6.5
Oil/Isophthalate Cotton tape.	55	11	4	8	-	8	5	-	-

TRANSFORMER OIL TESTING

TERMINOLOGY

1. Flash point : The temperature at which the oil gives off so much vapour that this vapor when mixed with air forms an ignitable mixture and gives a momentary flash on application of a small pilot flame under the prescribed conditions of the test.
2. Pour Point : The lowest value of temperature expressed as a multiple of 30 C at which the oil is observed to flow when cooled and examined under prescribed conditions.
3. Total sludge value : The percentage by weight of insoluble matter formed when the oil is heated and oxidized under specified conditions and subsequently diluted with n-heptane.
4. Total Acidity : It is the measure of free organic and inorganic acids present together and is expressed as milligrams of Potassium Hydroxide required to neutralize the total free acids in one gram of the oil.
5. Inorganic Acidity : It is the measure of inorganic acids present and is expressed as milligrams of Potassium Hydroxide required to neutralize these acids in one gram of the oil.
6. Electrical Strength (BDV) : The voltage at which the oil breaks down when subjected to an AC electric field with a continuously increasing voltage contained in a specified apparatus. The value is expressed in KV.
7. Specific Resistance (Resistivity) : It is the ratio of the DC potential gradient in volts per centimeter parallel the current flow within the specimen, to the current density in amps per square centimeter at a given instant of time and under prescribed conditions. This is numerically equal to the resistance between opposite faces of a centimeter.
8. Dielectric Dissipation Factor : (TAN DELTA) : It is the tangent of the angle (delta) by which the phase difference between applied voltage and resulting current deviates from 90 degrees, when the dielectric of the capacitor consists exclusively of the insulating oil.
9. Inter Facial Tension : It is the force necessary to detach a planar ring of platinum wire from the surface of the liquid of the higher surface tension that is upward from the water-oil surface. It is expressed in N/m.

SAMPLING

Sampling of the oil shall be done in accordance with BIS : 6855

Requirements for taking sample:

1. Sample of oil should be taken when it is warm.
2. The outlet of the drain valve should be clean.
3. The sample pot must be properly cleaned and rinsed.
4. The test must be carried out as soon as possible.

Main testes to be performed for testing of the oil :

1. Dielectric strength test
2. Crackle test
3. Acidity test.
4. Sludge test
5. Flash point test

Dielectric Strength Test

Procedure :

1. Take sample as per BIS : 6855.
2. Fill the cell of the apparatus with sample oil above 40 mm of electrode.
3. Wait for 20 minutes for escaping of air bubbles etc.
4. Apply gradually increased voltage across the electrode placed 2.5 mm apart in steps. At a certain voltage discharge takes place.
5. Note the reading.
6. Repeat the process for at least three times.

Crackle Test

Procedure :

1. Fill the cell with 250 ml sample oil.
2. A steel rod of 12.5 mm dia is heated till red hot.
3. Red hot steel rod is lowered in the sample oil gradually.
4. No hissing or crackling sound should appear.

Acidity Test

Procedure :

1. Fill the flask with 50 ml of Methaleted spirit.
2. Add a few drops of Phenolphthelen.
3. Mix the solution properly.
4. Fill the burette with 0.01 N KOH solution.
5. Neutralise the mixture in the flask with the burette.
6. As indicator changes the colour, note the burette reading.
7. Add 10 ml of the sample oil in to the flask.

8. Again neutralise the mixture of the flask. (OIL)

9. Note the reading of the burette.

10. Calculate the amount of the KOH solution.

11. Calculate the acidity by following formula :

Acidity in ml KOH per gram of oil = $0.664 \times \text{No. of ml of KOH}$

SLUDGE TEST

1. Dilute the sample oil with n-heptane.
2. Diluted solution is filtered with white filter paper.
3. Wash the same filter paper with only n-heptane free from oil.
4. Prepare a solution of 3 part of Oxylene + 1 part of Acetone.
5. Pour the solution on the same filter paper.
6. If filter paper turns to brown, shows the presence of sludge.

KINDS OF TARIFFS:

The different kinds of tariffs in common use are as under:

- **Simple tariff**
- **Flat rate tariff**
- **Block rate tariff**
- **Two – part tariff**
- **Maximum demand tariff**
- **Power factor tariff**
- **Three part tariff**
- **Off peak tariff**

SIMPLE TARIFF

This is the simple kind of tariff. Here, the cost of energy is charged on the basis of unit consumed. The rate per unit can be calculated as, under.

$$\text{Charges per Kwh} = \frac{\text{Annual fixed charges} + \text{Annual running charges}}{\text{Total number of units supplied the consumers}}$$

This method has following drawbacks although the procedure for fixing the rates is very simple for the supplier and calculation verification by the consumer. The cost per Kwh delivered is higher. There is no discrimination among the different categories (such as domestic, commercial and Industrial) of consumers.

The simple tariff can be made suitable by having some modifications mentioned below:

- By allowing a discount to the consumer who consumes more electricity than an average consumer.
- Special tariff for different categories of consumers such that the domestic consumers may be charged higher rates than in case of industrial consumer and commercial consumers.
- By encouraging the consumers of electric energy to use electricity during of peak load period thereby giving them a special discount. Its use is restricted to industrial loads only.

FLAT RATE TARIFF

This kind of tariff differs from the former (simple tariff) one in the sense that the different categories of consumers are charged at different rates. In this case the flat rate is slightly higher for domestic (light and fan) load than for industrial (power) loads. The rate for each category of consumers is derived by taking into account its load factor and diversity factor. This method is very popular with the consumers since it can be easily understood by the consumers and the calculations at the supplier's end are very simple. If the energy consumed by an industrial consumer is 'x' unit and the flat rate per unit is Rs.'a' per unit then the total charges of the bill are Rs.'Ax'. The disadvantage of the tariff is that separate meters are required for different types of supply.

In some public utilities for certain categories of supplies, e.g. agricultural load, flat demand rate based on per KW or BHP connected load is charged. Here the main advantage of this tariff is the elimination of the metering equipment, meter reading, billing and accounting costs. This tariff is that there is a tendency on the part of consumers to keep their appliances on even when not required. But the tariff can be used where number of hours of use are known and energy consumption is readily predictable such as street lighting, sign lighting and signal lighting etc.

BLOCK RATE TARIFF

The disadvantage of the flat rate tariff is that the charge is made for the total quantity of energy consumed at the same rate irrespective of the magnitude of energy by the different consumers. The fixed charges are spread over a greater number of units generated or consumed thus lowering the rate per unit. This shortcoming is removed in block rate tariff in which a given block of energy is charged at higher rate and succeeding blocks of energy are charged at progressively reduced rates. For example.

The first 50 units may be charged at the rate of 75 paise per unit.

The next 25 units may be charged at the rate of 60 paise per unit.

TWO-PART TARIFF:

The charges include fixe charges independent of energy consumed and proportional to per KW of maximum demand and the running (operating) charges per Kwh of the total energy consumed. The tariff can be expressed as,

$$C = \text{Rs.}(a.KW + b.KWh)$$

Where Rs. a is the charge per KW of maximum demand assessed and Rs.B is the charge per Kwh of energy consumed. This tariff is mostly applicable to the medium industrial consumers.

Here, the charge made on the maximum demand covers the fixed charges such as interest and deprecation on the capital cost of building and equipment, taxes and insurance charges and operating cost which is dependent of energy supplied by it. the charge varies with the variation in energy supplied. There is a disadvantage of this tariff to the consumers because they have to pay also the fixed charges unnecessarily during the month in which their industry is closed.

MAXIMUM DEMAND TARIFF

This tariff is very similar to the two-part tariff except that in this rate the maximum demand is actually measured by a maximum demand indicator instead of merely assessing it on the basis of predetermined value. Thus the drawback of two-part tariff is removed. This tariff is applicable to large industrial consumer and bulk consumers.

POWER FACTOR TARIFF

The equipment and plant efficiency depends on the power factor of the load. In order to increase the utility of the plant and equipment to the maximum, the plant must be operated at the most economical power factor. Because of this reason, power factor tariffs are applied. By applying power factor tariffs, the consumers are penalized for keeping poor power factor of their loads.

Kwh and kVarh Tariff

In this type of tariff the consumer is charged separately on the basis of Kwh and kVarh consumption. With the improvement of power factor the kVarh decreases and thus the consumer tries to improve power factor of his load in order to decrease the charges on account of less kVarh registered by the kVarh meter.

Average power factor tariff or sliding scale tariff

In this type of tariff, some reference power factor, say 0.8 lagging, may be taken and for every decrease of 0.01 over the average power factor (0.8), the consumer is levied surcharge. Similarly a discount may be allowed for each 0.01 by which the average power factor rises above 0.8. Such types of tariff, are rarely used.

Three – part tariff

In this type of tariff, the cost consists of the fixed charges, semi fixed charges and the running or operating charges. Thus three-part tariff is composed of three elements and is mathematically represented by the equation.

$$\text{Total cost} = a + b \text{ (kW or kVA)} + \text{kWh.}$$

Constant charges 'a' are also called consumer charges and are on account of giving service connection and expenses incurred in connection with metering and office establishment. Semi-fixed charges are proportional to kW or kVA maximum demand. These are variable charges and include the initial cost of plant as well as the operating cost which is independent of total energy supplied by it. The charges vary with the maximum demand.

Part 'c' is the variable charges based on energy consumed and recovers the cost of fuels and other operating charges etc.

This type of tariff is generally applicable to bulk supplies.

Off peak tariff

The load on the power station is very low during night hours (10 P.M. to 6 AM.) while in the evening peak loads occur. During the off peak period, the transmission and distribution system equipment will be lying idle. In order to encourage the consumer to use electric energy during off-peak load period, the energy can be supplied without incurring any extra capital investment and thus is profitable. This tariff is advantageous for processes as water heating by thermal storage, refrigeration and pumps etc.

Other Clauses

The tariffs in some cases contain provision for adjustment of prices having regard to cost for fuel, minimum charge on the contract demand etc. This automatically compels the customer to maintain as high a load factor as possible.

MAINTENANCE SCHEDULE OF TRACTION SUB-STATION

FORTNIGHTLY MAINTENANCE

GENERAL INSPECTION B A PSI SUPERVISOR

1. Go round the whole area of the substation, inspect for general cleanliness, proper drainage, road and rail access. The surface of the roadway and pathways in the sub-station should be firm and sufficiently elevated to prevent water logging. Remove any undergrowth of vegetation around the outer periphery; cut any tree branches likely to come in the vicinity of live lines.
2. If lubricating or transformer oil is stored, inspect for security and fire risk and see that no combustible material is in the vicinity.
3. Examine all "Caution," "Danger", "Shock Treatment", and other boards, whether they are clean and well secured, inspect fire extinguishers, fire buckets and First Aid Boxes, if they are intact and serviceable.
4. Inspect structure and plant foundations for any sinking or cracking. Go round the structural work for checking tightness of various bolts and nuts.
5. Inspect all indication lamps on control panels for correct working.
6. Carry out inspections as indicated at Annexure 2.01.
- 7.

BATTERY

1. Check all cells generally in accordance with Para 20220.
2. Take specific gravity and cell voltage of pilot cell and record in register. If any significant change is noticed, specific gravity and voltage for all cells should be taken to identify any weak cells. Then top up with distilled water exactly to the correct level for every cell.
3. Check operation of battery charger and note charging rate in register.
- 4.

MONTHLY MAINTENANCE

BONDING AND EARTHING

Visually inspect all earth connections and see that they are in order and that every equipment has duplicate earths. Tighten connecting bolts and nuts as necessary. Where the sub-station and feeding post are close by, ensure that sub-station structures are properly bonded with the feeding post and the track by two independent connections.

OIL LEVEL IN TRANSFORMERS, CIRCUITS BREAKERS, CTS ETC.

Check oil level in sight gauge glass and examine all joints, valves, plugs etc. for all leakages in each equipment, rectify leaky parts if found and restore the oil level.

INSULATORS

Clean all insulators with dry cloth and look for any flashover marks, cracks and chippings. Insulators, which are badly chipped, should be replaced. Minor chippings can be rendered impervious to moisture by a light coating of Araldite or similar epoxy resin.

TRACTION TRANSFORMERS

Clean externally the tank, conservator, radiator, bushings, oil level indicator, gauges etc. with dry cloth.

Make a note in the register of the maximum temperature of transformer oil on dial indicator; reset indicator.

Check explosion vent diaphragm for any damage and presence of oil.

Check silica-gel breather. If turning pink in appearance, replace it with dry gel (blue colour) and recondition the old silica gel. If the silica gel is too wet, check di-electric strength of transformer oil.

Check for gas collection, if any, in Buchholz relay

Check for oil leakage on transformer body, conservator tank, oil drain valve and foundations. If leaking, take corrective action by tightening the bolt; replace gaskets, if necessary.

Check if heater in the marshalling box is functioning property, and if all terminal connections are in order.

OPERATING MECHANISM OF CIRCUIT BREAKERS AND INTERRUPTORS

1. Open the cover of control box. Examine the interior and remove the accumulated dust. If any part of the interior is badly rusted indicating entry of moisture, find out the cause, plug the holes and repaint the rusted parts. Check in particular if the weatherproof gaskets are in good condition; if not, replace them to make the control box watertight and dust-tight. Examine if the leading in pipe connections are properly brushed, sealed and watertight. Check if all pins and check nuts are in place. Check also tie-rod nuts for tightness.
2. Operate the mechanism at least twice manually. Have it operated on remote control from RCC; keeping the control door open, observe whether the mechanism functions smoothly without any rubbing or obstruction, and also if the shock absorber functions properly when circuit breaker is tripped.
3. Examine the commutator of the motor and clean with muslin cloth. Examine carbon brushes and replace if necessary.

-
4. Check breather and breather holes for clogging.
 5. Check gear-oil level in the mechanism and replenish it, if required.
 6. Check if heater is functioning properly.
 7. Check interlocks of the equipment and associated isolators.
 8. Check local position indicator and remote semaphore indicator for operation. Observe for the correct operation of recording counter.

After complete checking, close the cover and test the breaker for operation under remote, local and manual control.

ISOLATORS

1. Manually operate isolator several times and observe if it operates smoothly and correctly. Check interlocks and integral lock, lubricate moving parts as necessary with appropriate lubricant.
2. If isolator is motor-operated, check commutator of motor and clean with dry mull cloth, and check carbon brushes for proper bedding and wear. Check if motor is working smoothly. Clean limit-switch and auxiliary switch contacts and check tightness of wiring connections. Examine contactor box and signal box; clean thoroughly and lubricate all gears, shafts, bearings, contacts etc.

BUSBARS, CLAMPS AND CONNECTORS

Immediately after switching off the power supply and earthing the lines, feel by hand all connectors and clamps on bus bars and equipment terminals which carry heavy currents to see if they are too hot. If any connection is too hot, it indicates poor contact. Open up the connector; carefully clean the contact surfaces, touch up the high spots on the contact surfaces so that the mating surfaces bed well together; apply a very light coat of Vaseline, refit and tighten up. Wherever applicable, replace bi-metallic strip.

CONTROL AND RELAY PANELS

1. Make a note of flag indications, if any, then reset.
2. Check if all indicating and recording instruments are working normally and the pointers are not sticky.
3. Note and record in the Register the range of voltage and current variations during a 15-minute period at the time of the day when inspection was carried out. Abnormal voltage or current should be noted for corrective action.
4. Clean the panels externally.

QUARTERLY MAINTENANCE

BATTERIES AND BATTERY CHARGES

1. Take specific gravity and cell voltage of every individual cell and enter in the register.
2. If the battery is not in a fully charged condition, boost charges should be given as required and trickle charging rate increased to the extent required. This should only be done by a supervisory official after investigating the causes for excessive discharge.
3. Make a general examination of battery charger. Check earth connection to the body.

PTS AND CTS

These should be maintained generally on lines similar to that of traction transformers except for items, which do not obviously apply. In addition, for PT check the fuse holders on the LV side to see if they are in order.

AUXILIARY TRANSFORMERS

1. Measure insulation resistance of transformer winding and record values along with temperature.
2. Test a sample of oil for BDV.
3. Check that the 25 kV fuse-holder drops out freely on raising the spring latch. Check rod gap setting. Measure earth resistance of neutral conductor.

Annual maintenance and periodical overhaul are to be carried out, generally as indicated for the traction transformers.

HALF YEARLY MAINTENANCE

GENERAL

SR. S.E.(PSI) should visit the grid sub-station and ascertain whether any significant change in the EHV grid network has occurred during the past six months or are expected shortly.

TRACTION TRANSFORMERS

1. Test oil sample from tank bottom for crackle test, acidity and BDV. If BDV is below the prescribed value, oil should be dried out.
2. Check whether the rod gap settings on bushings of transformers are in order, as per Maker's drawings.
3. Measure and record insulation resistance of all windings to earth and other windings with a 2500 V megger, along with temperature of windings and ambient temperature.
4. Check all alarm and trip devices for proper functioning.

ISOLATORS

1. Observe for any signs of overheating and check the wipe of contact blades. Clean blade tips and fixed-contact fingers and lightly Vaseline the contact making surfaces.
2. Clean all articulated joints, sliding and bearing surfaces thoroughly.
3. Check all split pins, lock nuts and check nuts for proper condition.
4. Check for correct setting and alignment of arcing horns.
5. Operate the isolator slowly; check for simultaneous operation of the blades on the poles and correct alignment of blade tips in the fixed contact jaws of the poles. Adjust if required to ensure that the blades are fully home between the contacts when handle is in closed position.
6. Check locking arrangements.

CONTROL AND RELAY PANELS

1. Check tightness of all connections, remove cobwebs and wipe off accumulated dust with dry cloth.
2. Check if tap and time settings of the relays are in order.
3. Examine fuses for signs of overheating or aging, springiness and cleanliness of contact making parts. Clean up and lightly Vaseline to ensure proper contact.

YEARLY MAINTENANCE

GENERAL

1. Inspect the fence all-round the sub-station and bonding between metal fencing panels and to earth. Put a drop of oil in the hinges of all doors. Repaint any of the structural parts as necessary.
2. Open all the trench cover and clean them completely. Clean all culverts and remove cobwebs; check possibility of lizards or other insects gaining entry into enclosed control equipment, and make them insect-proof.
3. Arrange for paintings of walls and metal-works as necessary.
4. Check all explosion vent diaphragms for any damage.

-
5. Check rod gap setting.

LIGHTNING ARRESTORS

1. Check earthing terminals and earth strips for proper condition. Check connection to the line.
2. Where lightning arrestors are provided with discharge counters, record the counter reading.

BONDING AND EARTHING

1. Check physically the soundness of bonding and earthing connections to every electrical equipment, structural steel, lightning arrestor etc. and inter-panel connections.
2. Record earth resistance to body of electrical equipment as well as to all parts of the fencing and structural steel work.
3. Check if the terminations of the overhead shield wire covering the whole sub-station are in good physical condition and properly bonded electrically to the structures.
4. Check and record resistance of each group of earth electrodes, after disconnecting it from common earth system. Improve if necessary.
5. Check condition of connections to the buried rails.

TRACTION TRANSFORMERS

1. Send samples to approved laboratory for all tests listed at Annex.2.03B (IS 1866) including dissolved gas analysis.
2. Check oil level in bushings.
3. Inspect bushing gaskets for leaks and tighten bolts.
4. Move the tap-setting switch up and down the full range a few times so that by self-wiping action good contact is assured. Set the tap finally at the correct position making sure that tap-indication corresponds to position of main contacts.
5. Paint transformer tank on such parts as required.

ISOLATORS

1. Smoothen burrs, if any on the blade tips and fixed contact fingers with fine emery paper and smear Vaseline.
2. Measure clearance of blade in open position and record and adjust crank mechanism, if found necessary.
3. Check the adjustable stop setscrews for proper condition and correct positioning.
4. If the isolator is motor-operated, measure and record insulation resistance of motor windings and contactor coils using a 500 V megger.

BUS BARS AND CONNECTORS

Measure with a 'Ductor' or other low resistance-measuring instrument the contact resistances of all connections, which are carrying heavy currents.

CONTROL AND RELAY PANELS

1. Carry out maintenance on relays as detailed in Para 20221.
2. Check and clean up control switches and push-button contacts for burnt or corroded marks; polish the surfaces. Check also if the contact springs has the correct springiness.

BATTERIES AND BATTERY CHARGES

If the battery is not in a healthy condition or if there is excessive accumulation of sediment, the whole battery should be replaced with a new set.

BATTERY CHARGER

Open out the covers of the battery charger and blow out all dust. Check tightness of all connections, bolts, nuts and screws. Measure and record the insulation resistance of the transformer windings of the battery charger with 500 V megger.

PTS AND CTS

1. Test oil samples if possible.
2. Check rod gap setting, if provided.
3. Measure insulation resistance.
4. Check conditions of fuses of PTs and terminal connections for CTs

SPECIAL MAINTENANCE SCHEDULES FOR MINIMUM OIL **CIRCUIT BREAKERS AND INTERRUPTORS**

This schedule will apply to minimum oil circuit breakers and interruptors with the following proviso:

32 kV CBs	6 trippings on fault
25 kV CBs	30 trippings on fault
25 kV Interrupters	250 openings on normal current for minimum oil type and 500 openings on rated current for bulk oil type.

- a) Open the extinction chamber, examine the contact-rod arcing-tip, upper and lower contact fingers and fixed arcing-contacts or burring or pitting. Check contact springs for loss of temper, breaks or other deterioration; replace wherever necessary. Remove any beads of fused metal from arcing-tips and clean pitted surfaces. Change the contacts when the wear reaches the limits prescribed by the manufacturer. Tighten up all bolts and current carrying parts. Check contact rod for correct alignment and setting.
- b) Test oil sample for BDV. If it falls below the prescribed value the oil should be purified or replaced.
- c) Clean the explosion chamber with dry and clean cloth. Remove the carbon deposits if any; wash out all traces of moisture from all parts with fresh oil having high di-electric strength and refill with good oil.
- d) In addition, the operating mechanism of circuit breakers and interruptors should be attended to annually as under-
 1. Lubricate bearing surfaces of rollers, bearings and sliding surfaces with good quality machine oil. Since oil tends to collect dust and dirt, it should be used sparingly and any surplus should be wiped off with a clean cloth.
 2. See that all links and levers move freely. Operate the mechanism slowly by hand to see that all parts move freely and no undue friction is noticeable. Observe the mechanism to see that everything is in working order.
 3. Check all pins, latches, etc. for binding and misalignment. Check latch carefully to see that it is not getting worn so as to cause unlatching from vibration or sticking and failure to trip.
 4. Check that the mechanism operates with 80% of the nominal operating voltage. Check and record the insulation resistance.
 5. Observe operation of trip coil during electrical tripping and the plunger for action and freedom from any stickiness. The plunger should have sufficient travel to ensure an adequate impact that will positively release the breaker latch. Check insulation resistance of the coil.
 6. Check if the breaker mechanism operates smoothly and freely without binding. Check that the contact rod is not binding against its guide.
 7. Wash out bearings, pivots, etc. with carbon tetra-chloride if they are dirty, and lubricate very lightly.
 8. Examine the accelerating spring and see that adjusting nuts are locked tight.

9. Measure the length of the breaker stroke and check and adjust in accordance with Manufacturer's instructions.
10. Check opening and closing position of the auxiliary contacts with respect to the main contacts. Adjust where necessary. Check the condition of the contacts and refinish with fine file if burnt or corroded. Ensure that good contact is made without excessive friction. Check operating rods and levers to ensure that they are secure and move freely. Smear auxiliary contacts surfaces lightly with Vaseline or petroleum jelly. Drain oil from gearbox of the spring charging motor and refill to correct level with the right grade of oil. Measure the duration for which the motor runs to charge the spring and compare with Maker's instructions.

PRE-MONSOON CHECKS

Before onset of monsoon season, it should be ensured that for every equipment no scheduled maintenance work is overdue. In the scheduled inspection just preceding the monsoon, special attention should be paid to the vulnerable points likely to permit ingress of moisture resulting in reduction in dielectric strength of the equipments and rusting of parts.

OVERHAUL SCHEDULE FOR EQUIPMENT

1.	Transformers.	In case of an internal fault or once in 7-10 years.
2.	Operating mechanism of Circuit Breaker and Interruptors	Once in 10 years or as and when any major part like springs have to be replaced or the mechanism is sluggish, and needs shop attention and overhaul

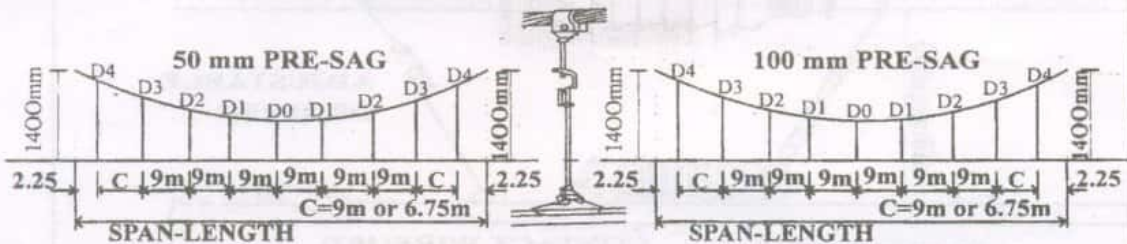
IMPORTANT OHE PARAMETERS

- Normal height of contact wire at support point = 5.60 (pre sag of 100mm)
for regulated OHE
- Normal height of contact wire at support point = 5.55m (pre sag of 100mm)
for regulated OHE
- Normal height of contact wire at support point = 5.75 (temp. Range 4° to 65 °c)
for unregulated OHE
- Normal height of contact wire at support point = 5.65m (temp. Range 15 to 65 °c)
for unregulated OHE
- Minimum height of contact wire at loco inspection pit = 5.80m.

-
- Minimum height of contact wire at level crossing = 5.50m
 - Height of the height gauge at level crossing = 4.67m.
 - Minimum height of contact wire at over line structure = 4.92m
 - Dia of new contact wire = 12.24mm
 - Condemned dia of contact wire on main line = 8.25mm
 - Condemned dia of contact wire on loop line & yard line = 8.00mm
 - Stagger of contact wire on tangent track = ± 200 mm
 - Stagger of contact wire at curve track = ± 300 mm
 - Stagger of catenary wire on tangent track at support = 0
 - At un insulated over lap, the distance between two Parallel running contact wire = 200mm
 - At insulated overlap, the distance between parallel running Contact wire = 500mm
 - The contact wire of turnout OHE is 5cm above that of the main line OHE
 - The minimum desirable length where pantograph Touches both the OHE = 6 to 9m for High speed
min 2 to 3m
 - Normal implantation (standard) = 2.50m
 - Minimum implantation = 2.50m
 - Minimum implantation or implantation of platform = 4.75m
 - Normal encumbrance = 1.4m for 72m span
 - On main line, maximum permissible slope of contact = 3mm per m wire
 - In yard line maximum permissible slope of contact wire = 10mm per m
 - Short time Vertical electrical clearance = 270mm
 - Short time Horizontal electric clearance = 220 mm
 - Long time vertical electrical clearance = 320mm
 - Long time horizontal electrical clearance = 320mm
 - Stagger of contact wire at section insulator = 0 or ± 100 mm
 - Stagger of contact wire at PTFE neutral section at = 0. support
 - Earthing resistance of traction sub station = 0.50 ohm
 - Earthing resistance of Switching station = 2.00 ohm
 - Earthing resistance at AT supply station/FOB/ROB/ Fencing/Platform structures = 10.0 ohm
 - Cross section area and length of C jumper wire = 50 mm², 1.7m
 - Cross section and length of F jumper wire = 50 mm², 1.6m
 - Cross section area and length of G jumper wire = 105 mm², 3.5m
 - Distance of G jumper from mast onwards overlap side = 5.6m
 - Fixed length of the dropper wire = 105mm
-

-
- The distance of the first dropper from support = 2.25m
 - The distance between runners of section insulator = 4.40m
 - Standard tension length for regulated OHE = 1600m
 - Normal sag of regulated OHE = 100 mm
 - Maximum span length on tangent track for regulated OHE = 72 m
 - Minimum span length for curved track for regulated OHE = 18 m
 - Maximum tension length for unregulated OHE = 2000m
 - Maximum span length for unregulated OHE = 67.5m
 - ZY value of winch type ATD at half tension length 750m at 35° C Z = 1250
Y = 2500mm.
 - XY value of 3 pulley ATD at half tension length 750m at 35° C. X = 1050mm,
Y = 2300mm (Old) & X = 1300mm, Y = 2300 (New)
 - Catenary wires/ all other stranded wires like jumpers, anti creep wire should be replaced if more than 20% strands are broken
 - On main line, the difference in length of adjacent span should not be more than 18 m.
 - Minimum length of dropper in the span = 150mm.
 - At cross type OHE facing turn out, the anchor span should not be more than 54 m.
 - At level crossing, the maximum span should be 58.5m
 - Half tension length on curved line should not be more than 600m.
 - PTFE neutral section should be provided on tangent track at minimum 400 m distance after stop signal and 200 m before stop signal.
 - Leaning of mast at top should not be more than 15 cm.
 - The distance between male and female contact of isolator in open position should be 500mm $\pm$ 50 mm.
 - Track separation 150 to 720 mm at obligatory structure.
 - Track separation of section insulator
 - I. If runners are towards T/O point = 1.65m
 - II. If runners are away from the T/O point = 1.45m

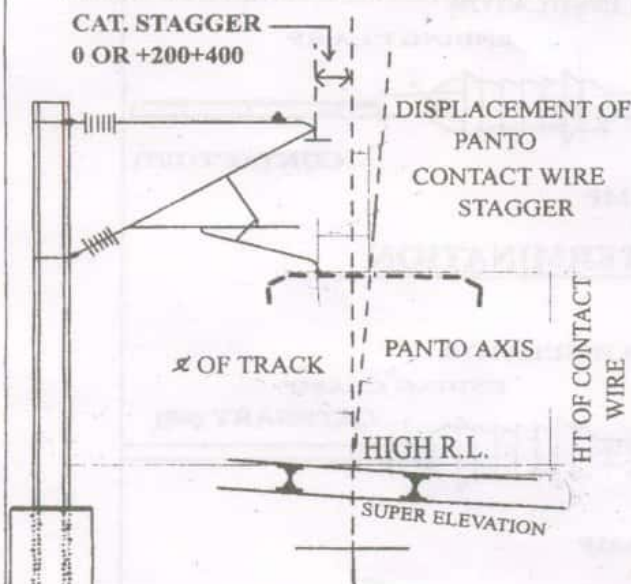
DROPPER SCHEDULE FOR REGULATED OHE WITH EQUAL ENCUMBRANCE 1.40/1.40 m



FOR 50 mm PRE SAG-OHE		DROPPER LENGTHS IN mm (L)				
SPAN INNO. OF METERS	NO. OF DROPPERS	D4	D3	D2	D1	D0
72	9	1272	985	702	532	475
67.5	8	1280	940	713	600	—
63	8	1280	1044	817	704	—
58.5	7	—	1296	1013	843	786
54	7	—	1305	1102	932	876
49.5	6	—	1313	1086	972	—
45	6	—	1321	1161	1048	—
40.5	5	—	—	1329	1159	1102
36	5	—	—	1337	1220	1163
31.5	4	—	—	1345	1232	—
27	4	—	—	1353	1279	—
22.5	3	—	—	—	1361	1305

FOR 100 mm PRE SAG-OHE		DROPPER LENGTHS IN mm (L)				
SPAN INNO. OF METERS	NO. OF DROPPERS	D4	D3	D2	D1	D0
72	9	1273	1018	767	617	566
67.5	8	1281	980	778	678	—
63	8	1288	1071	870	770	—
58.5	7	—	1298	1046	896	845
54	7	—	1305	1126	975	925
49.5	6	—	1313	1112	1011	—
45	6	—	1321	1180	1079	—
40.5	5	—	—	1329	1178	1128
36	5	—	—	1337	1233	1183
31.5	4	—	—	1345	1245	—
27	4	—	—	1353	1287	—
22.5	3	—	—	—	1362	1311
18	3	—	—	—	1370	1342

SPAN AND STAGGER CHART



RADIUS OF CURVATURE (m)	MAX. SPAN IN (METRES)		CONTACT WIRE STAGGER AT SUPPORT (mm)	MAX. PERMISSIBLE MID-SPAN STAGGER (mm)	
	WIND LOAD (kg/sq.m)	HT OF CONTACT WIRE (mm)		WIND LOAD (kg/sq.m)	HT OF CONTACT WIRE (mm)
≥ 5000	72	72	200	25	50
≥ 400	72x	72	100	50	50
≥ 3000	72x	72	150	72x50	50
≥ 2500	72x	72	150/200	50	50
≥ 2200	72x	72	200/250	50	50
≥ 1900	72x	72	250/300	50	150
≥ 1600	67.5x	67.5	300	100	100
≥ 1400	63x	63	300	150	150
≥ 1150	58.5x	58.5	300	150	150
≥ 850	54x	54	300	150	150
≥ 700	49.5	49.5	300	160	160
≥ 550	45	45	300	160	160
≥ 400	40.5	40.5	300	200	200
≥ 300	36	36	300	200	200
≥ 200	31.5	31.5	300	200	200
≥ 200	27	27	300	240	240

MAX. SPAN CONSIDERED ON NON MOVEMENT OF ELEC. LOCO FOR WP > 75 kg/sq. mm

OVER DIMENSIONED CONSIGNMENTS

DEFINITION

When a consignment has length, width and height such that one or more these infringe Standard moving dimensions at any point from start to destination, then the consignment is said to be Over Dimension Consignment.

Standard moving dimensions are as follows :

	For BG	For MG
1. Length	13716	12192
2. Height		
a. At centers	2743	2540
b. At corners	2134	2134
3. Width	2997	2540
4. Top width	610	610

1 CLASSIFICATION OF OVER DIMENSION CONSIGNMENT

Over dimension consignments are classified on the basis of the clearance measured in the stationary condition and from the fixed structure.

Class A ODC

If the gross clearance of 228.6 mm and above from the fixed structures but infringes the Standard Moving Dimensions

Class B ODC

If the gross clearance of less than 228.6 mm but more than 152.4 mm and above from the fixed structures but infringes the Standard Moving Dimensions

Class C ODC

If the gross clearance of less than 152.4 but more than 76.2 mm and above from the fixed structures but infringes the Standard Moving Dimensions.

PRECAUTIONS FOR THE MOVEMENT OF ODC's IN 25 Kv ELECTRIFIED SECTION

1. Movement of ODC should be undertaken only after sanction of competent authority.
2. Staff accompanying the ODC should remember that the OHE is "LIVE" except when power block has been obtained from the traction officials. Even after the power block other lines than the ODC movement should be treated as "LIVE".
3. Speed restriction should be followed in addition to them mentioned by PWI and other departments as per the clearance from the OHE contact wire.

CLEARANCE OF CONTACT WIRE	SPEED RESTRICTION
More than 390 mm	No speed restriction
390 to 340 mm	15 Km/H without Power Block
340 to 100 mm	15 Km/H with Power Block
Less than 100 mm	No ODC movement is permitted

4. A representative of OHE staff should accompany all ODC having clearance lesser than 390 mm.
5. A representative of OHE staff should accompany all ODC having width more than 1981 mm for BG and 1910 for MG from centre of the track.
6. Section controller & TPC must co-ordinate with an ODC move in order to ensure that the masts are not damaged where the clearance is critical.
7. A list of update clearance made by Operating and Engineering department will help the Operating department to permit movement of ODC.

MAINTENANCE SCHEDULE OF OHE

1. FOOT PATROLLING.
2. TROLLEY INSPECTION
3. CURRENT COLLECTION TESTS
4. SPECIAL CHECKS
5. ANNUAL MAINTENANCE AND TOWER WAGON CHECK
6. PERIODICAL OVERHAUL
7. RETENSIONING OF UNREGULATED OHE

FOOT PATROLLING ONCE IN A WEEK IN SUBURBAN SECTION AND ONCE IN A FORTNIGHT IN NON SUB-SECTOR TO COVER SECTION.

MATERIAL AVAILABLE WITH L/M DURING PATROLLING

1. SPANNER 24 x 27 RING AND FLAT
2. EMERGENCY TELEPHONE
3. DETONATOR
4. HAND FLAG SET
5. INPLANTATION GUAGE
6. NUT BOLTS FOR BOND
7. MESSAGE BOOK ALONG WITH PVT NO SHEET

LINEMAN ON PATROL SHOULD LOOK FOR

1. CHIPPED OR DAMAGED INSULATORS
2. DISPLACED FITTINGS AND DROPPERS
3. EXCESSIVE SAGGING OR HOGGING OF CONTACT WIRE
4. CHECK WHETHER EQUALISING PLATE IS TILTED
5. FREE MOVEMENT OF ATD, COUNTER WT POSITION
6. PRESENCE OF PROTECTIVE SCREENS AND CAUTION BOARDS/ WARNING BOARDS.
7. STRUCTURAL SOUNDNESS OF HT. GUAGE AT LEVEL CROSSING
8. LOOK FOR BIRD NESTS STRAY WIRES, TREE BRANCHES
9. DEFECTIVE BONDS AND EARTH CONNECTIONS
10. DEFECTS IN RETURN CONDUCTORS OF BOOSTER TRANSFORMER WHEREVER AVAILABLE.
11. NOTICE ANY SPARKING ON PASSAGE OF TRAIN
12. POSITION OF ISOLATORS, THEIR LOCKING ARRANGEMENTS
13. TILTING OF MASTS IF ANY
14. NUMBER PLATES IN SECURED AND GOOD CONDITION.

TROLLEY INSPECTION	- DAY TIME
DEPOT INCHARGE OF SECTION	- ONCE A MONTH
SR.SE/AE	- ONCE IN 3/6 MONTHS
DEE/TD WILL ALSO INSPECT CONVIENITLY	
CURRENT COLLECTION TESTS –	
DEPOT INCHARGE OF SECTION	- ONCE IN 3 MONTHS
SE.SE/AE	- ONCE IN 3/6 MONTHS
DEE/TD WILL ACCOMPANY CONVINIENTLY	
CLEANING INSULATORS	- ONCE IN A YEAR OR MORE
SECTION INSULAORS	- ONCE A MONTH
ISOLATING SWITCHES AT WATERING SECTION	- ONCE A MONTH
BIMETALLIC CLAMPS	- ONCE IN 3 MONTHS
EARTH CONNECTIONS	- ONCE IN 6 MONTHS

ANNUAL MAINTENANCE & CHECKS USING T.W.

- A) MASTS, PORTALS AND CANTILEVER SUPPORTS PERMISSIBLE SETTING DIST
 VARIATION 30 MM
 RAIL LEVEL – 20 MM
- B) CONTACT AND CATENARY WIRES CHECK
 C) DROPPERS
 D) TURN OUTS CHECKS
 E) SECTION INSLATORS CHECKS
 F) ISOLAORS – CHECKS
 G) OVERLAPS – CHECKS
 H) CONTACT WIRE THICKNESS
 I) OVER LINE STRUCTURES CHECKS
 J) NEUTRAL SECTION

-
- K) LEVEL CROSSINGS
 - L) REGULATING EQUIPMENT CHECKS
 - M) BONDS AND EARTH (N) MASS (O) OTHER ITEMS

- A) SINGLE CANTILEVER LOCATIONS INSTEAD OF ANNUAL MAINTENANCE (IOH) – ONCE IN 18 MONTHS
- B) MAINTENANCE OF TURN-OUTS / CROSS-OVER, OVERLAPS, NEUTRAL SECTION AND LOCATIONS WITH MULTIPLE CANTILEVER AOH – AFTER 12 MONTHS POH OF OHE – AFTER 4| YEARS

OHE PARTING DUE TO OPENING OF SILVER BRAZED JOINTS AND AT PG CLAMP LOCATIONS CAN BE AVOIDED BY

- 1. CHECKING SILVER BRAZED JOINTS IN CONTACT WIRE ONCE IN THREE MONTHS
- 2. IN POLLUTED AREA JOINTLESS LESS CONTACT WIRE TO BE USED.
- 3. PG CLAMPS TO BE REPLACED DURING POH

G – JUMPER LOCATION – ALL 8 CLAMPS TO BE REPLACED DURING POH – 4| YRS.

CONTACT WIRE ENDING CLAMP FITTING VISUAL INSPECTION – ONCE IN 4 YERS

CATENARY ENDING CLAMP FITTING VISUAL INSPECTION – OCE IN 4 YRS.

VISUAL INSPECTION – ONCE IN 4 YEARS

REPLACE – ONCE IN 9 YEARS

CONTACT WIRE SPLICE REPLACE – ONCE IN 9 YEARS NO REUSE.

CONTACT WIRE ENDING CLAMPS OF SI REPLACE – 9 YEARS – NO REUSE.

OVERLAPS

General

In the overhead equipment the tension length i.e. the length between two anchor points is restricted. If therefore become necessary to overlap the overhead equipment of one tension length and the subsequent tension length for certain distance to allow smooth passage of pantograph from one tension length to the other. In the overlapping zone , the two OHEs should be minimum 2 m.

Un-insulated overlap

Un-insulated overlap means an overlap in which the two OHEs are made electrically continuous by electrical connection through annealed stranded copper large jumpers. A physical clearance of 200 mm is maintained between the two OHEs by suitably staggering the contact wire at support. To facilitate anchoring of OHE reduced encumbrance of 900 mm (standard) and raising the contact wire to 400mm(standard)are adopted at the structure preceding the anchor support. It should be ensured that with the raising of the contact wire at the support, two contact wires overlap each other for a distance of 2 m minimum.

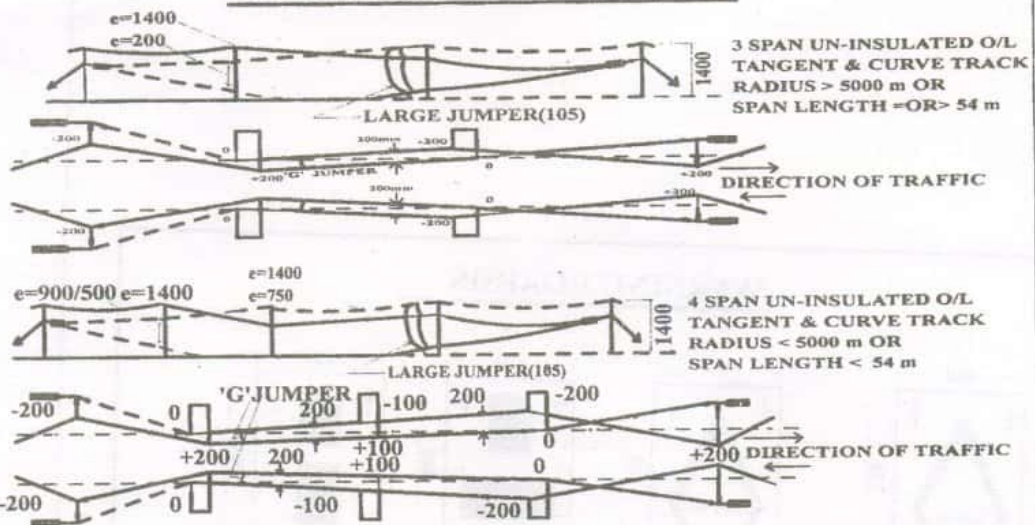
Depending upon the permissible spans over the section either 3 span or 4 span un-insulated overlaps are adopted. The principles for formation of 3 span or 4 span overlap are same. For details of general arrangement refer RDSO Drg. No.ET/OHE/G/02121 Sheet 4 for conventional OHE.

Insulated Overlap

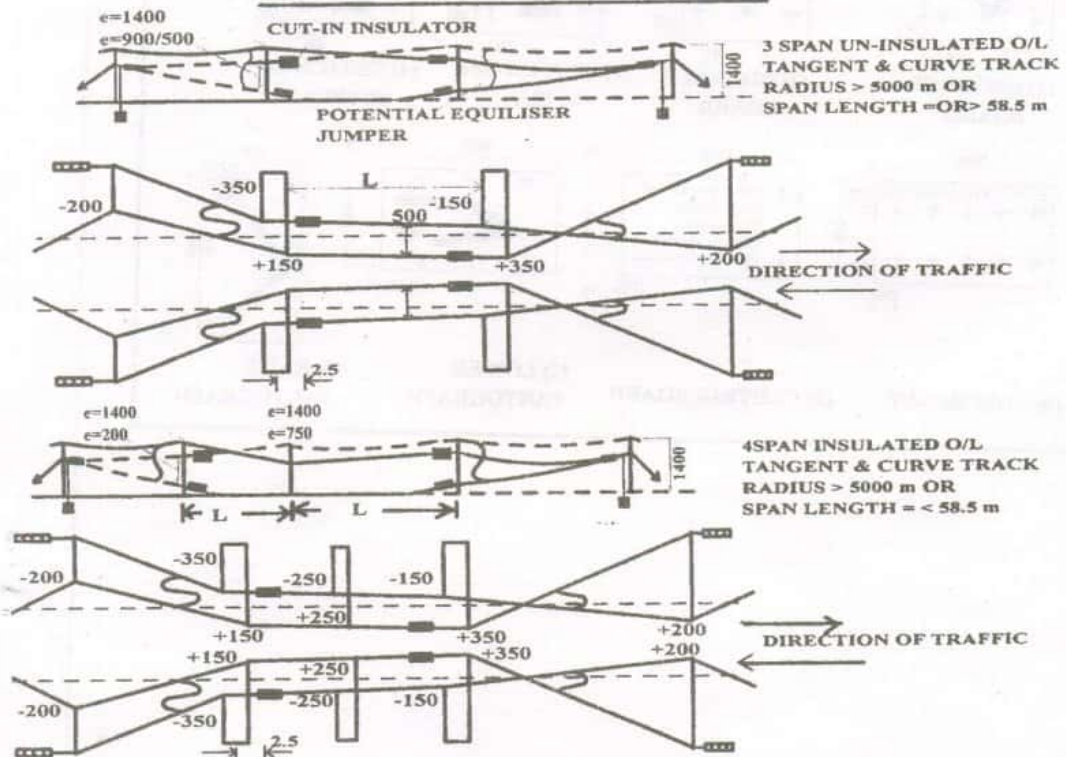
The general principles for formation of insulated overlaps are same except that the physical clearance between the two OHEs is 500 mm (minimum) and the two OHEs are insulated from one another by inserting cut-in-insulator (9 t insulator).In the catenaries and contact wires of two OHE at a distant of 3 m from the support preceding the anchor mast. In case of insulated overlaps the rise contact wires at the support preceding the anchor mast is 500 mm (minimum).

Depending upon the permissible spans over the section either 3 span or 4 span insulated overlaps are adopted. The principles for formation of 3 span or 4 span overlap are same. For details of general arrangement refer RDSO Drg. No. ETI/OHE/G/02131 Sheet 3 for conventional OHE.

UN-INSULATED OVERLAP



INSULATED OVERLAP



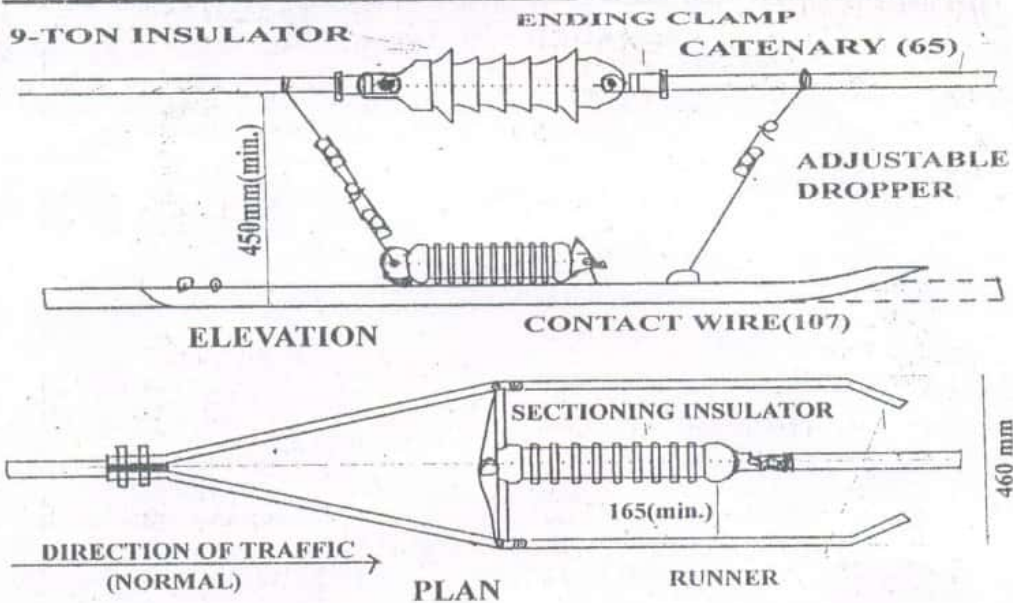
SECTION INSULATOR

It is a device installed in the contact wire for insulating elementary sections from each other while providing a continuous path for pantograph without break of current.

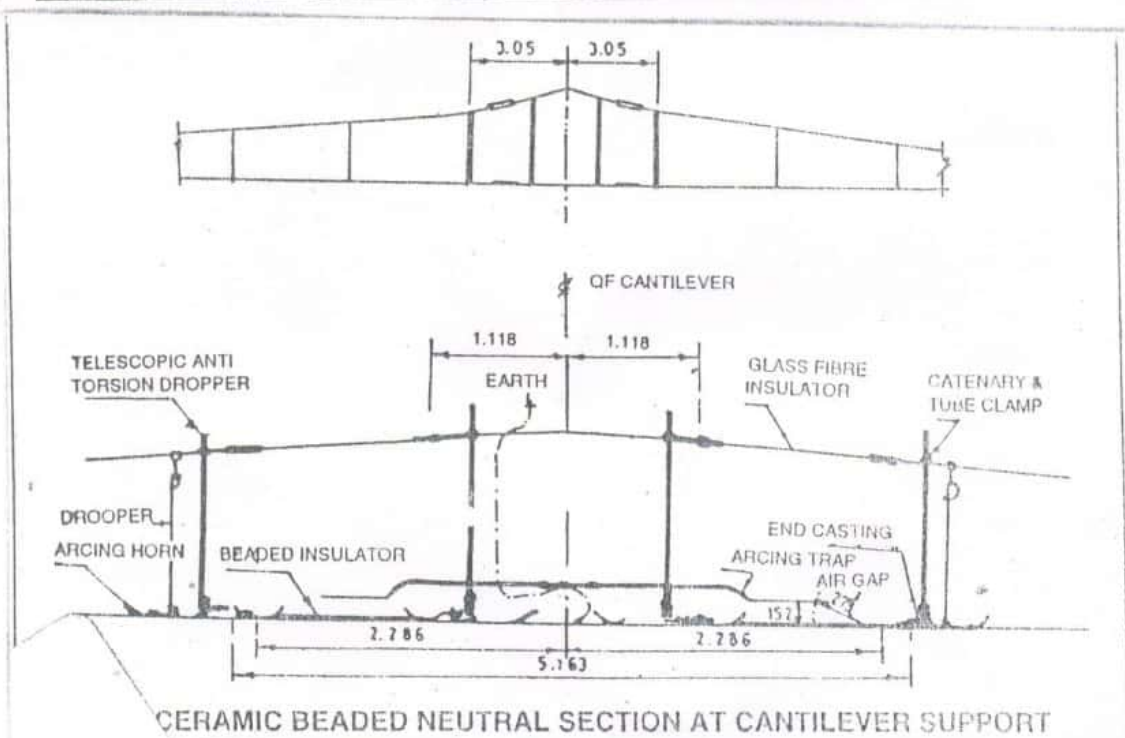
- At the location of section insulator the axial distance between the catenary & contact wires shall not be less 450 mm.
- The stagger of the section insulator should normally be zero, but in no case it should exceed + / - 100 mm.
- The distance between the edge of runner and outer face of the core insulator is 165 mm
- The distance between the contact wire and each outer face should not be less than 230 mm.
- On loops the section insulator shall as far as possible be located close to the first support of the OHE for loop.
- The preferred location of section insulator on main running track is 2 to 10 mtr from support in the direction of traffic.
- The section insulator is to be located beyond the point where the centre distance between the two track is equal or more than 1.65 meter. If runners of si are towards turnout point.
- It can be reduced to 1.45 m if runners are away from the turnout point.
- Minimum mechanical clearance of the 9 tonne insulator and solid core s.i. must be 350 mm.
- In double line section, the runners should be in the trailing direction.
- In case of runners of section insulator are in facing direction & section insulator is located beyond $1/3^{\text{rd}}$ of the span length the speed should not exceed 80 kmph.

If the runners are in trailing direction & located between $1/10^{\text{th}}$ & $1/3^{\text{rd}}$ of span length than speed can be 120 kmph.

STANDARD SECTION-INSULATOR ASSEMBLY



OHE TERMINATION AT BUFFER END SIDING AND



CERAMIC BEADED NEUTRAL SECTION AT CANTILEVER SUPPORT

— AC TRACTION MANUAL - VOLUME II PART II

(240)

NEUTRAL SECTION

Introduction

Neutral sections are provided to isolate different phases of power supply in adjoining overhead equipment fed by adjacent substations which are normally connected to different phases of supply. Thus neutral section is insulated dead section of OHE which is used to separate the feed of different substations. The neutral sections maintain mechanical but not electrical continuity of OHE.

The following type's neutral sections have been adopted by the Indian Railways.

- a) Overlap type,
- b) Short neutral section comprising of composite insulators,
- c) Short neutral section comprising of section insulators assembly.

OVERLAP TYPE NEUTRAL SECTION

The neutral length of overlap type neutral section is 41 m. In this type of neutral section a short length of OHE regulated at one end and fixed at other is erected. The central span is 49.5 m. long while one span each on either side of central span is 36 mts long. This overlaps are insulated overlaps. The overlaps type neutral section is designed in such a manner that the dead length of overhead equipment, for which the locomotive will get no power is 41 metres. The speed limit of overlap type neutral section is same as that of the overhead equipment. The conventional overlap type neutral section is used on main lines except in suburban and heavily graded sections where its not adopted.

SHORT NEUTRAL SECTION COMPRISING OF SECTION INSULATOR ASSEMBLY

On heavily graded section and suburban areas and neutral section of 5 metres length comprising of two section insulator assemblies may be adopted. Speed under such neutral sections shall be restricted to 100 km/hour if the runners are in trailing direction otherwise to 70 km/hour in single line working.

This neutral section suffers from drawbacks – heavyweight, speed restrictions and frequent maintenance requirements.

Short neutral section comprising of composite insulators

Short neutral section comprising of composite insulators have been imported from M/s BBP.C:U.K. and have been erected on selected locations of Indian Railways.. The short neutral section assembly is erected symmetrically on either side of the support and the mid point which is dead is connected to earth. Contact wire insulator comprises of resin bonded glass fibre insulators covered with ceramic beads. Catenary insulator comprises of resin bonded glass fibre insulators covered with PTFE sleeves or silicone or any other suitable covering.

MAINTENANCE SCHEDULE OF PTFE TYPE NEUTRAL SECTION

- 1) Fortnightly patrolling- by lineman consisting visual inspection.
- 2) Monthly comprises inspection by section engineer in stationery and moving train and to inspect.
 - A. Grease deposits over ceramic bead ,arc horn and end fitting .
 - B. Hitting of pantograph during train passing.
 - C. Sticky movement of telescopic and torsion member during train passing.
 - D. Any twisting of ceramic bead assembly.
 - E. Loose connections.
 - F. Displacement of arcing horns and arc traps.
 - G. Checking of any breakage observed to ceramic beads and electrometric bellows.
 - H. Checking of structure bond and earth connection of PTFE with the mast.

THREE MONTHLY SCHEDULE-

- A} Through cleaning of ceramic bead collars and spacers with nylon scouring pad and soap liquid detergent and water. The detergent may be used to clean the neutral section. The bead thoroughly washed should be dried with cloth not with jute or cotton waste.
- B) Apply capitol protectilo 56/57" to minimize the corrosion effect over the fitting.
- C) Check panto sweeping zone.
- D) Check verticality of anti torsion member and keep slight hogging of contact wire.
- E) Clean the catenary 9 tone insulator.
- F) Check arcing horn gap.
The vertical gap. Should be 152 mm and lateral gap should be between 240 mm to 250 mm.
- G) Check all connections with nut and bolts for its tightness.
- H) Check cross clamp of anti torsion rod for over tightening. Over tightening should be avoided.
- I) Check encumbrance at cantilever of PTFE mast.
- J) Ensure the touching of third bead with pantograph while negotiating the neutral section .
- K) Measure the insulation resistance value of ceramic bead in dry condition after cleaning. The value should be in between 15 to 20 M ohm with 2.5kv meggar.If found lower then specified value ceramic beads should be cleaned again and also check for thin film coating inside the beads, if found shorted.
- L) Circuit of spacers with thin film coating for more than 7 beads the ceramic bead should be replaced.
- M) "A" dropper of both ends of PTFE and V dropper should be checked by opening catenary and contact dropper clips.
- N) Check that portion of anti-torsion tube above catenary wire is not more than 152mm..
- O) Check rubber bellows, if cracked.
- P) If burning of arcing horn takes place it should be replaced or reshaped.
- Q) Checking of undue wear of runners if any.

-
- R) Check the pantograph hit marks on the inside of compression ferrules and examine the ceramic bead spacers for its corrosion if it is more than 1.6mm deep for more than 7 number. The ceramic bead should be changed.

YEARLY SCHEDULE-

- Check earth continuity and overall earth resistance should not be exceed 0.5 ohm.
- Replacement of A dropper
- Cleaning of PG clamp
- Check the rubber bellows.

TWO YEARLY SCHEDULE-

- Replace the cross clamp
- Replace the PG clamp

FOUR YEAR SCHEDULE-

- Replace arcing horn (skid assembly) if necessary.
- Replace arcing trap.
- Replace anti torsion member if up and down movement is sluggish.
- Replace the earthing jumper.

ESSENTIAL POINTS DURING MAINTENANCE:

- Cracked beads .
- State of cleanliness of insulators.
- Burning of arcing horns and arc trap.
- Pantograph hit mark on end fitting of the contact wire insulator.
- Freedom of movement of telescopic anti-torsion droppers.
- Electrometric bellows for cracks.
- Insulation resistance.

MAIN DEFECT OF PTFE:

- Breakage of ceramic bead insulator.
- Increasing of gap in arcing assembly.
- Deposition of grease/smoke/dust on ceramic bead insulator.

Cause of failure of ceramic beaded insulator:-

- Incorrect skid setting, excessive wear on insulator metal ferrules and consequent edge impact damaging ceramic beads from pantograph collector strips.
- Power arcs drawn by pantographs, collecting current while passing through the neutral section with power on.
- Excessive deposit of graphite grease from pantographs.
- Skid setting:- The main cause of damage of PTFE insulator bead is on account of improper adjustments on two runners.

- Power arcs:-The flash marks on arcing horn and runner indicates that drivers are not switching off the DJ While passing the neutral section. Power arc damages the ceramic beads.
- To overcome the problem the arcing horn gap should be adjusted in such a way that the passage of pantograph the arc current generated is passed immediately to earth.
 - Moreover to improve the earthing, the earth jumper and structure bonds may be welded to the mast to ensure perfect continuity otherwise two earths in parallel may be provided.
 - Grease deposition:-Grease deposition on contact wire insulator is more if neutral section is situated on coved portion. This should be routinely cleaned.

On Indian Railways two types of short neutral section assembly are in use namely

1. B.B.P.C.L.U.K. MAKE
2. Arthur Flury AG Switzerland make.

LOCATION OF NEUTRAL SECTION:

- Overlap type avoided in suburban and heavily graded sections (Heavy Traffic).
- Located away from stop signal and level crossing , should be on Tangent Track.
- If provided before stop signal should be at a sufficient distance so that negotiating train does not overshoot the signal.
- Neutral Section if provided after signal should be at a distance, that train pick up sufficient speed to negotiate Neutral section.
- Short Neutral Section with S.I. TYPE should be avoided on mainlines.

Location of Short Neutral Section(SI type)

if provided on mainline:-

400 M beyond (After) Signal.

And 600 M in front of signal.

Location of PTFE Neutral Section-

In Tangent Track after signal(a) =400M, before signal(b)=200M.

In gradient Track after signal (a) =1600M, before signal (b)=1600M.

➤ NEUTRAL SECTION(SI TYPE)

Effective neutral length-2.968 Mts.

Length of Contact Wire cut at 3.736 Mts.

➤ PTFE(POLYTETRA FLUORO ETHYLENE)

Effective Neutral Section Length- 4.62 Mts.

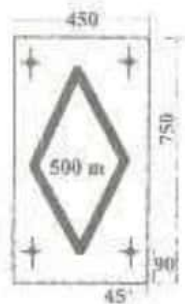
Length of Contact Wire cut-5.2 Mts.

➤ PTFE (9.4Metres)

Effective Neutral Length=6.5m,

- Length of Contact Wire cut-7.8 Mts.

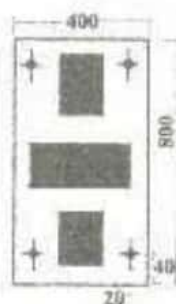
WARNING BOARDS



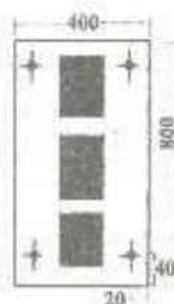
(1) DISTANCE BOARD



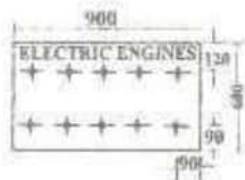
(2) DISTANCE BOARD



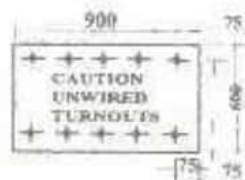
(3) SWITCH OFF SUPPLY



(4) SWITCH ON SUPPLY



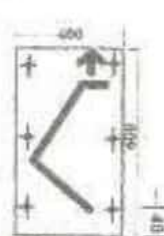
(5) STOP BOARD



(6) CAUTION BOARD



(7) LOWER PANTOGRAPH



(8) RAISE PANTOGRAPH

AUTO TENSIONING DEVICE

The function of ATD is to maintain a constant tension in OHE conductors i.e contact wire and catenary's wire under varying temperature conditions, so that profile of OHE is maintained for better current collection.

MECHANICAL ADVANTAGE:

Mechanical advantage or total tension on OHE conductors

$$\text{Ratio of regulating equipment} = \frac{T_1 + T_2 \text{ (in kgf)}}{\text{Counter weight in kg.}}$$

Thus for a constant tension of 1000kg each for contact wire (T_1) and catenary wire(T_2). Counter weight for 3:1 ratio pulley block is $2000/3$ I.e. 667 kg. Hence 665 kg has been chosen.

Counter Weight for 5:1 ratio pulley block is $2000/5$ I.e 400kg.

TYPE OF AUTO TENSIONING DEVICES

- 5:1 ratio pulley block type or two pulley block type
- 5:1 ratio Winch type ATD
- 3:1 ratio pulley type or Three pulley type ATD

MAIN DEFECT IN ATDS:-

- Breakage of stainless steel wire rope.
- Jamming of ATD pulley/ drum due to seizure of needle bearing or ball bearing.
- Rubbing or grazing of stainless steel wire rope over drum/ pulley and riding on the Helical groove of which type ATD.

Breaking of SS wire rope:

1. Corrosion, bad quality of material
2. Pollution, saline whether
3. Improper attention to broken strands
4. Bird cogging, pitting etc.

Jamming of ATD wheels due to seizure of bearings:-

ATD's are provided with: – 1) Needle bearings & 2) Ball bearings.

Bearings get damaged due to ingress of dirt and moisture as well due to deterioration in grease, drying of grease.

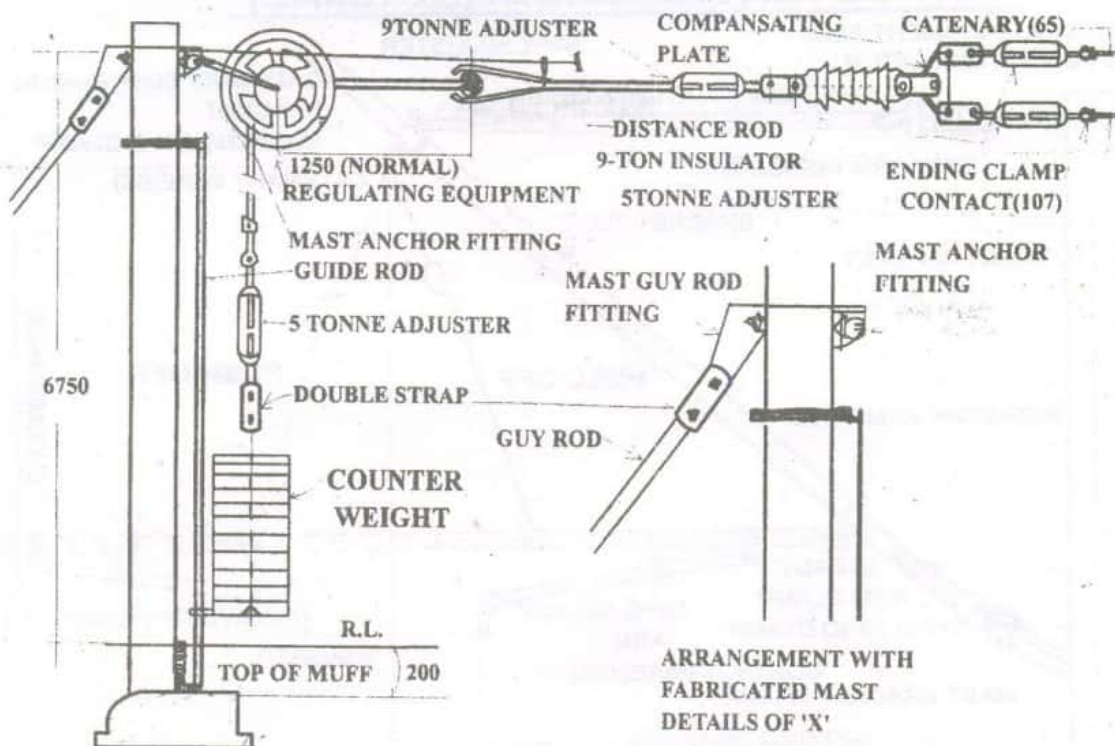
PANTOGRAPH/ OHE ENTANGLEMENT DUE TO WIRE ROPE FAILURE

The entanglement at turn out, cross over and overlaps mostly occurs due to wire rope failure. The effect of ATD is to make the OHE unregulated which will result in sagging of contact wire at high temp thus changed profile resulting in entanglement. The change in profile of contact wire due to ATD failure also leads to poor current collection and effect is wear of contact wire.

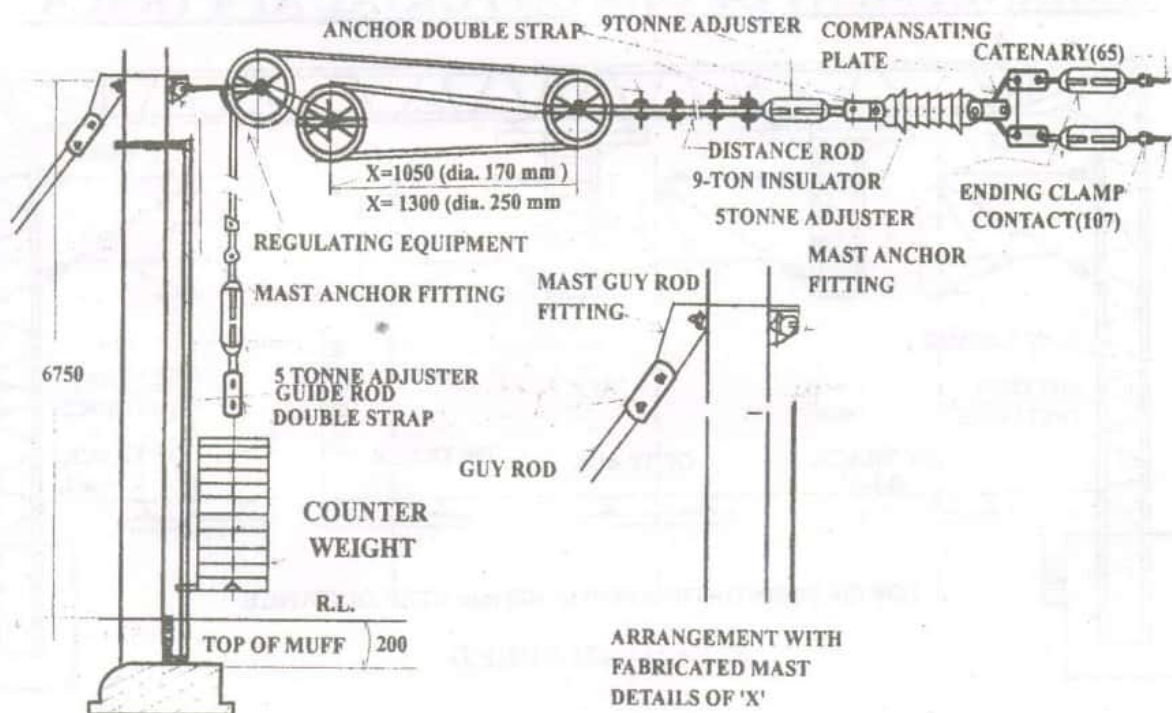
Check free movement of ATD:

- SS wire rope to be checked once in a month.
- Lithium base grease with lead soap for ATD greasing.
- Better quality seals to prevent ingress of water in bearings.
- At curved locations leaning of masts to be checked.
- While foot patrolling compensating plate to be observed.

TERMINATION OF REGULATING OHE (PULLEY BLOCK TYPE)



TERMINATION OF REGULATING OHE (PULLEY BLOCK TYPE)



Sanction of CEE and Electrical Inspector to the Railway
(EIG Sanction)

1. Application shall be submitted at least a fortnight before energization to CEE and Electrical Inspector to the Railway for the following:-

(a) Formal approval, if not already received to the design and layout of all high voltage equipment including traction sub-stations, transmission lines, 25 kV feeders, switching stations, booster stations etc.

(b) Approval for energization of HT installations mentioned above including OHE,

2. The following documents shall accompany the application for EI's sanction.

(a) Copies for Press cuttings of the Public notification as mentioned in para 21008.

(b) Certificate regarding OHE (proforma 10-03).

(c) Certificate regarding bonding and earthing (proforma 10-04).

(d) Certificate regarding safety instructions and precautionary measures
(Proforma.10-05).

(e) Certificate by DRM regarding safety precautions (proforma 10-06).

(f) Copies of insulation resistance test results of OHE.

(g) Insulation test results values for auxiliary and booster transformers.

(h) Test results for equipment in switching stations and sub-stations and their safety certificates, if earlier sanction for the energizing this is not obtained separately.

(I) Clearance certificates form Deptt. of Telecommunication.

(J) Any other data, test results and certificates required by the Electrical inspector.

The sanction of the Electrical inspector may be issued in the Performa 10-07.

Maintenance Blocks

There are generally two types of blocks required for maintenance work on electric traction installations:

(a) Traffic Block: Where a line is blocked against movement of vehicles whether steam, electric or diesel locomotive hauled. This will be required whenever heavy repairs have to be carried out. A traffic block will be granted by the Section Controller in consultation with the TPC.

(b) Power Block: Where a section of line is blocked against movement of electric locomotive hauled vehicles or EMUs only i.e., a section where 25 kV electric supply to the OHE is switched off and the section made dead, Power block will be required whenever repairs to or maintenance of the OHE has to be carried out and the nature of the work is such that traffic block is not necessary. Power blocks are granted by TPC in consultation with the Section Controller. whenever a power block is granted by TPC, movement of vehicles hauled by other than electric power, i.e., steam or ' diesel may be permitted, provided a caution order is Issued as per General and Subsidiary Rules drawing the attention of the Driver to the fact that the OHE staff are working at the kilometerage specified and he should exercise caution when passing over the section and obey signals displayed at the place of work.

Power Blocks

Power blocks are of three different types:

(a) Emergency power block,

(b) Pre-arranged power block,

(c) Locally arranged power block.

Emergency Power Block

An Emergency Power Block" shall be arranged by the TPC and 25 kv supply to the OHE affected shall be switched off by him immediately on receipt of an advice of any break-down of the OHE or injury to persons or damage to property particularly in the following cases :

(a)The whole or part of the OHE or a feeder Or a cable falling down land or persons or animals or

falling trees or vehicles coming in contact with or likely to come in contact with live equipment

(b) A damaged catenary or contact wire fouling the vehicle gauge;

(c) A damaged electric locomotive getting damaged to rectify which the Driver requires the permit-to-work;

(d) Derailment or any other traffic accident on the electrified lines, whe I re cutting off of 25 kV power supply is considered necessary by TPC or the Section Controller, in the interest of safety.

Pre-arranged Power Block

After a pre-arranged power block has been agreed to be granted and an advice to this effect circulated to all the concerned, the following gives the detailed procedure to be adopted by the Section Controller and the TPC for granting the power block. Assume that power block is required on the Up line between station and on Elementary Section No . at 10-00 hours after the passage of a specified Up train (say 'X'):

1. On the scheduled day about two hours before the block period, i.e., at about 8.00 hours, TPC will obtain confirmation from the Section Controller concerned that the trains are running to time and power block will be available as scheduled, after the Train No. X Up has passed station at about 10-00 hrs,

2 The TPC will pass on information to the Chargeman of the maintenance gang that the **power block, as** already arranged, **will** be available in time.

3.The maintenance gang should arrange to leave the depot in time with all materials and tool\$ **so as to be ready** at site at about 9.30 hrs. The OHE staff (in charge of the work) on arrival at site should immediately contact the TPC and inform him of their arrival. Any person detailed to open an isolator switch for switching off power supply shall also report to TPC of hit arrival at site at the required location.

Local Block

Power supply for sidings which do not affect movements of trains on the main lines, for loop lines and reception and dispatch yards, is controlled by manually operated isolators. Keys for these isolators are usually in the custody of the Station Master concerned. Power blocks on such sidings can be arranged when required by an authorized official subject to the following :

(i) The Station Master, Cabin Assistant Station Master, and others responsible for the movement of traffic, should take measures detailed in para 20621, 20622 and 20625.

(ii) TPC shall be informed before and after the shut-down is effected

Procedure for Obtaining Traffic or Power Blocks and Permits-to-work

Officials in the electrified area who require pre-arranged traffic blocks, power blocks or permits-to-work in the danger zone of traction equipment, or who require OHE and or bonding staff to be present at site for scheduled maintenance works, shall deliver at the office of Sr.DEE (TRD) not later than 10 hours on the first working day of the week statements in the prescribed form showing

(i) The nature of the work and the date on which it is to be performed;

-
- (it) By whom the work is to be carried out;
 - (iii) Location of the work and the section of the lines to be blocked;
 - (iv) The trains between which the block is required; and
 - (v) Whether the track will be available for steam or diesel traffic.

2. The requirements of all departments will be co-ordinated in the office of Sr. DEE (TRD) and a consolidated statement forwarded to the Senior Divisional Operating Manager concerned, by 12 hours on every Wednesday, for inclusion in the weekly programme of traffic and power blocks.

3. Works of an urgent nature shall be attended to by obtaining emergency blocks and permits-to-work from TPC

4. A weekly programme of work involving traffic blocks, power blocks and permits-to-work shall be prepared in the office of Sr. DOM and dispatched to all concerned (TPC, TLC, Loco Sheds, Station Masters/Yard Masters concerned and Traffic Controller in addition to the departmental officials who asked for the blocks).

PANTO ENTANGLEMENT

OHE FAILURES

Broadly OHE failures are divided in to following; -

- Failures due to internal causes.
- OHE mast hitting due to derailment and other reasons.
- Failure due to other external causes.
- Panto entanglement.

PANTO ENTANGLMENT

Out of this 50% of failures are on account of panto entanglement.

Therefore in view of this maintenance of OHE as well as pantograph plays a very important role.

Reduction in the cases of panto entanglement can be achieved by taking suitable remedial action.

REASONS FOR PANTO ENTANGLEMENT

Panto entanglement generally occurred due to following reasons-

1-Defect in OHE

2-Defect in pantograph

3-Other causes, such as

- a) Storms
- b) Bird hitting,
- c) Tree branches/foreign material hanging on OHE & roof of the loco motive.
- d) Vandalism & theft causing damage to OHE.
- e) Overshooting of locomotive beyond engine stop limit.
- f) Non observance of temporary caution order.

DEFECT**IN****OHE**

PROBLEM	Action to be taken
1).Improper adjustment of Turnout/crossover stagger and height.	1. Ensure that height of turnout and crossover contact wire is kept 5cm above than m/line contact wire at obligatory location.
2).Malfunctioning of ATD	2. Ensure that panto is not touching Turn Out & crossover contact while going On M/line.
3. Failures of OHE components, like Insulators dropper parting of contact Wire etc.	3. Half yearly checking of turn out & Cross Over should be carried out by the SSE's and yearly by officers. 4. The height & stagger should be strictly As per SED.

OTHER DEFECT IN OHE & REMEDIAL ACTION TO BE TAKEN

- Ensure free movement of ATD of turn out & crossover
- Check insulators droppers and other OHE components for any crack
- Ensure provision of double PG clamp On 'G' jumpers and feeder wire location
- Check frequently the joints in the polluted area and provide splice, if need

DEFECTS IN PANTOGRAPH

DEEFFECTS	ACTION TO BE TAKEN
1.Improper pressure on OHE	Adjust the panto to ensure uniform pressure on contact wire, irrespective Of the height of contact wire.
2.Worn out wearing strip	Ensure worn out strip is not allowed on the panto pan (new- 7mm.

3. Split pin missing. 4. Copper shunts broken missing 5. Improper lubrication 6. Crack on plunger balancing rod/ articulation tube etc. 7. Improper leveling of panto pan. 8. Excessive push up on OHE due to Multiple loco working on high Speed. 9. Securing of damaged panto. 10. Breakage of panto & 9 T Insulator. Due to Loco going beyond stop limit & Damaging both panto and 9 ton Insulator	condemned -2mm}Sharp edges should be filled. Ensure split pin at all critical locations. Ensure copper shunts to avoid current Passing through the bearings. Ensure lubrication of plungers . Replace hard graphite grease. Red Dye penetration test (RDPT)to be Carried out on all critical locations at Specified intervals (preferably during IC) Leveling of panto pan to be ensured During every insp.& also whenever pan Is changed. Double headed locos for Rajdhani, Shatabdi Should be avoided. Drivers should be trained to take Power Block & how to earth the OHE so that he can secure Damaged panto without waiting for OHE Party. ▪ Ensure stop board at correct location ▪ Drivers should be more vigilant. ▪ ASM should be trained for posting on electrified section. ▪ Sectioning diagram should be updated in ASM's rooms cabins
--	--

EXTERNAL CAUSES

1. Storm	1. Driver should observe speed restriction & observe for any abnormality.
2. Bird hitting Monkey Electrocution	2. Incase of any dead animal lying in the vicinity of track. Driver should inform ASM /TLC/TPC at the earliest. 3. In case the loco passes a location where birds /vultures are collected, the driver should check the panto for any damage.
3. Tree branches/ foreign materials on OHE	1.TLC/TPC/ASM should arrange Cleaning of track. 2.Driver should immediately lower the panto in case of any obstruction in OHE & Inform the TPC/TLC/ASM from the next emergency socket.
4.Theft	1.Cast iron balance weight should be replaced by concrete BW in theft prone Areas. 2.Copper anti creep should replaced by steel wire. 3.Out of run (OOR) centenary & contact wire should be replaced by steel wire or anti theft jumpers should be provide.
5. Track Defect	1 .PWI should be trained for posting in Electrified section. 2 Joint checking of implantation should be done by depot in charge &PWI of the section yearly. 3 In case of excessive stewing the depot In-charge should ensure the parameters of OHE and do necessary adjustment to avoid panto entanglement. 4 Loose packing & joint should be checked to avoid lurching.

PANTOGRAPH- ITEM OF CHECK

ITEM OF CHECK	ITEM OF CHECK
Wearing strip fastening	1) Proper Fastening 2) No loose fastener 3) No bend strips 4) No deep groves 5) Smooth strip joints 6) No hindrance to smooth riding of contact wire on pan.
Grease plate	1) Property fastened 2) Standard deigns.
Bow plunger	1)free sliding while pressing 2) Availability of all spilt pins
Split pins	All splits intact
Pantograph frame	1) No signs of bending 2) No cracks on spring
Broken cracked fitting	1) No old crack 22) No fresh crack
Panto pan	1) Horizontal (check it with spirit

(Transverse flexibility of panto pan by pulling transversely at middle of cross member with 50 kg force. Displacement of the pan at the middle cross member should not exceed 36+-5mm	level) 2) Free vertical movement 3) Transverse flexibility of pan.
Positioning link	1) No bend 2) No crack 3) No dislocation from fixing pivots

OHE ITEMS OF CHECK

<u>Srno</u>	<u>Items of check</u>	<u>Standard</u>
1.	M/line cont wire height.	4.8 M to (5.60+ 0.02)M
2.	Contact wire height-turn out/cross over 50mm above main line	
3.	Contact wire stagger-main line (Tangent/curve track)	Push off-200/300mm Pull off-200/300mm
4.	Contact wire stagger- turnout/ cross over	300mm (max.)
5.	Steady arm length of contact wire – main line/Turn out/cross over	0.75M, 0.95, 1.35M
6.	Register tube	Horizontal
7.	Register arm dropper clip	No displacement
8	Track separation at obligatory point	150-700mm
9	Position at which horn of pantograph jumped over contact wire.	Should not jump
10	Vertical height of steady arm contact clamp from register arm	0.25m-0.3M
11	Steady arm, Register arm, PG clamp, dropper clip splice & jumper.	No hitting mark, loose, breakage or crack
12	Steady arm vertical movement	Free movement

JOINT PROCEDURE ORDERS TO DEAL WITH

PANTO ENTANGLEMENT CASES

1. As soon as OHE breakdown or panto entanglement case occurs, TPC on duty shall alert OHE breakdown Supervisor from both the ends of breakdown site immediately. The tower wagon with gang shall be ready within 35"by day&45" by night after the message by TPC.
2. In case of OHE breakdown or panto entanglement tower wagon shall be treated as breakdown vehicle and shall be given priority over other movements so as to reach at breakdown site within shortest possible time.
3. Driver of the affected train shall lower the damaged pantograph immediately and raise the front panto only once. In case of tripping of OHE on raising the front panto , he shall not raise it again unless instructed to do so by TPC/TLC/TRD inspector at site.
4. Drive & guard of the train shall repeat to TPC/SCOR the first hand information of site condition along with the actual location of the breakdown within 15" through emergency field telephone, gate or station whichever is nearest.
5. Driver or any other railway staff shall not go or the roof of electric loco without ensuring that OHE has been made dead and earthed on both sides of locomotive by OHE staff in accordance with the procedure laid down in ACTM for power blocks.
6. In the affected block section no electric locomotive shall be allowed to enter from rear of the affected portion. The rear of affected section shall be treated as unsafe for electric traction till it is certified fit by TRD supervisor at site.
7. Preferably diesel engine shall be given as assisting engine in case diesel engine is not available and OHE is holding, AC locomotive may be given as assisting engine. however in both the cases, assisting engine shall be given from front side to pull the train into next station.
8. In case of Loco staff reporting at site prior to TRD/TRS staff, TPC shall not grant POWER BLOCK unless& until permitted by TLC with proper authority.
9. TLC will also inform to Sr. DEE (TRS) about the incident and will arrange to send LI immediately to the site preferably along with tower wagon for joint measurements. Joint measurements of electric locomotive & OHE shall be recorded by TRD &TRO/TRS supervisor .

-
10. The sketch and joint OHE measurements of the affected portion shall be done before starting OHE restoration work. The OHE measurements in rear to the location of panto entanglement for 5 to 6 location shall also be recorded. In case the culprit location is noticed in some other block section, the OHE measurements of 5 to 6 location in rear to this culprit location shall also be recorded.
 11. As soon as the joint sketch & joint measurements of affected portion are recorded the OHE shall be restored quickly by TRD staff and traffic allowed permanently fit subsequently.
 12. Damaged engine shall be detached at a suitable station for joint inspection by TRD & TRO/TRS supervisors.
 13. Complete joint report shall be sent to Sr. DEE (TRO) under a copy to Sr. DEE (TRD) & SR DEE (TRS) further action.

SMI for OHE to Avoid Panto-entanglement on Turn Outs & Cross overs.

1.TI/MI/0028(Rev-2)

The following parameters to be maintained at turnout & Crossover to avoid Panto Entanglement

- | | | |
|----|---|--------------------|
| 1. | Height of contact wire at obligatory mast | |
| | · Main Line OHE (mm) | H |
| | · Turn out OHE | H + 50 |
| 2. | Turn out span (m) | 54(Max.) |
| 3. | Height of contact wire in overlapping zone | |
| | · Main line contact wire (mm) | H ₁ |
| | · Turn out contact wire (mm) | H ₁ +50 |
| 4. | Stagger of contact wire at obligatory structure | |
| | · Main line contact wire (mm) | 200 |
| | · Turn out contact wire (mm) | 300 (max.) |

5.	Sag of Section Insulator of T/out or C/over	Zero		
6.	Stagger of Section Insulator at T/out or C/over	$\pm$	100	mm.
7.	Movement of Tower Wagon			
	· Main line to turn out point (take off) (from center line of pantograph)		650 mm to 720 mm	
	· Turn out to Main line point(take on) (from center line of pantograph)		650mm to 720 mm	
8.	Track separation at the location of section insulator			
	· Runners towards the center of turn out	1.65	M	min.
	· Runners away from the center of T/O	1.45 M	min.	
9.	Condition of ATD of T/O / mainline OHE	free	to	move.
10.	Setting distance of obligatory mast	3.0	M	min
11.	Track separation at obligatory mast	150	to 700	mm
12.	Distance of 'G' jumper from obligatory mast	5.6 M		
13.	Length of 'G' jumper	4.0		M

REGULATIONS FOR POWER LINE CROSSINGS

The regulation applied to overhead electrical line (Power line crossing) crossing over the Railway tracks. The regulation does not apply to Railway traction system (1500DC or 25kvAC) .

Important Regulation are as under:

Approve of work by Railway

Before commencement of work the owner shall obtain the approval of Railway Authority for the proposed loc. Detailed design & method of execution of work.

Bringing Crossing into use: The owner shall notify the Railway 15 days in advance of the date of commissioning of the power line crossing. Only after getting approval from Railway crossing shall be energized & brought into service.

Protection of Communication Line:

The crossing shall no way interfere Railway Communication lines & DOT & other communication lines in regard to the protection of their communication lines.

Angle Of crossing:-

An overhead line crossing shall normally be right angle to the Railway track. In special case a deviation of up to 30 degree may be permitted. Devotion more than 30 degree can be approved by the electric Inspector of Railways in special circumstances.

Structure: Steel poles, fabricated steel mast, semi forced or pre-stressed concrete pole, either of the self supporting or guyed type shall be used in either side of the track to support crossing span.

Distance: The minimum distance of the structure from the center of the nearest Railway track shall be equal to the height of structure from ground plus 6 mts.

The crossing Span shall be restricted to 300m or 80% of the normal span (which every is less) for which the structures are designed.

Clearance between the overhead line and Railway Track:

- The crossing over electrified Railway track shall be located at the middle of OHE span. The distance between overhead conductor & the nearest traction mast or structure under the most adverse condition should not be less than 6m.
- No overhead line crossing shall be located over a TSS, SWS, or Track cabin in an electrified area.
- Vertical Clearance: Separate guarding shall be provided above the power line in all cases except when the voltage of higher line is 33kv & above.

(iv) Clearance from guard wire to the lower line shall not be less than 2m & the upper power line not less than 1.5m.

Insulator:

A double set of strain insulator strings shall be used in crossing span. The factor of safety of each string of Insulator under the worst condition shall not be less than 2.

EARTHING

- 1) Each structure shall be earth (either side of crossing) with two separate earth electrodes.
- 2) If earth resistance higher than 10 ohms, the owner shall take all necessary measures to improve the earth resistance. Method of earthing shall be approved by Railway.
- 3) The earth shall be inspected & tested Annually on a hot dry day & furnished to Railway for verification & record.

Maintenance of Power Line Crossing

1) Patrolling from ground:-

Before & after monsoon.

The frequency of patrolling for the rest of the period will depend on local conditions.

Point to be checked :-

- Structures
- Foundation
- Insulators & Fitting
- Conductors & Jumpers
- Earthing equipment
- Foreign Objects

2) Special & Emergency Inspection :- After severe wind/ storms, quack forest falls, flood or heavy rains or sabotage.

3) Maintenance test:- Earth resistance of structure & earth electrodes should be carried out in an interval not exceeding 12 months.

ELECTRICAL SAFETY

The objective being to ensure the safety of personnel and equipment under all circumstances.

1. No work shall be carried out on live electrical equipment. After making equipment dead, it shall be effectively earthed, before work is started.
2. The responsibility devolving on different officials should be clearly defined and only "authorized person" may work on electrical equipment.
3. The procedure for effecting shut down and resuming supply should be clear cut and foolproof.
4. Machinery to ensure that the rules prescribed are actually observed by the staff concerned.
5. As far as possible, repair work should be carried out during day light hours. If work has to be done during night hours, sufficient artificial lighting should be provided.
6. Staff working on overhead lines should use proper ladders safety belts etc., to ensure they won't fall down.

Objectives – 100% safety and 0% accidents.

- A.** Who is an "Authorized Person"? Who is specially empowered by the administration to carry out a specified task or duty

Authority given in the form of a "Certificate of competence" which clearly defines the responsibility resting on each person, by virtue of his holding any particular category of post.

Examples:

Unskilled Labourer: Assist electric fitters to carry out work on electrical equipment

Skilled Electrical Fitter: Authorised to effect shut down, test, earth and issue line clear certificate.

Sub-station Operator: Authorised to effect shut down on any feeder, on receipt of requisition and issue "Permit to work" and to energise the feeder after receiving this line clear certificate, from the party concerned.

Sr.SE/SE/JE: Authorised to effect shut down test and earth the lines and issue "permit to work" supervise the work of subordinate staff.

A register of authorised person should be maintained in every office.

1. In case of Power Block:

TPC shall put red warning caps on control switches corresponding to interrupters which are kept open for isolating the section.

Warning boards shall be fixed on all manually operated switches opened locally for isolating the section.

2. Isolator Switch

Not meant for breaking a current, but only to break a circuit when no current is passing through.

An isolator switch shall not be opened when current is passing through it. TPC first dead the sub-sector. The person operating the isolator switch shall not open it, unless specifically asked to do so by TPC by a clear message or receipt of a separate permit to work.

3. At the time of Emergency Power Block.

- No work on the affected lines shall be commenced until an authorised OHE official arrives at site and earths the OHE at two points.
- Power supply shall not be restored by TPC until authorised official at the site issue a message.

SAFETY TO BE OBSERVED WHILE WORKING IN ELECTRIFIED SECTION

1. Persons authorised to open interrupters and isolator switches.
 - No staff or rank lower than a linesman working under Sr.SE (OHE) is authorised to open or close the interrupters or isolators controlling power supply to be overhead traction wires in the watering section.
 - A list of the authorised person on duty signed by CTFO (OHE) shall be exhibited in the office of the ASM and the TXR. Each authorised person should carry an identity card with photograph or specimen signature.
 - The keys of interrupter/isolator are kept in the personal custody of the ASM on duty.
2. General Precautions:
 - No work shall be done above or within a distance of 2 M from the live OHE without a "permit to work".
 - No part of a tree shall be nearer than 4 meter from the nearest live conductor.
 - No fallen wire or wires shall be touched unless power is switched off and wires suitably earthed.
3. Continuity of track:
 - During maintenance or renewal of track, continuity of the rails serving electrified tracks shall invariably be maintained.
 - In case of a rail fracture, the two ends of the fractured rail shall be first temporarily connected by a temporary metallic jumper of approved design.
 - In all cases of discontinuity or rails, the two parts of the rail shall not be touched with bare hands.
 - Before fishplates are loosened or removed, temporary connection shall be made.

4. Precautions in the event of breakage or wires:

Catenary or contact wires snaps and falls on the running track, it is possible that the fault current may damage signaling equipment.

5. Precautions for movement of ODC (over dimensioned consignments) in electrified sections.

- When a consignment whose length, width and height are such that one or more of these dimensions at any point during the run from start to destination.
- Movement of ODC shall be undertaken only after sanction of competent authority has been obtained.
- No consignment with less than 100mm clearance from the contract wire will be permitted.
- Speed must be restricted to 15 kmph when the clearance is between 390mm and 340mm.
- When an ODC is permitted to be moved in an electrified section with the OHE power off, it will be the responsibility of the section controller to arrange with the TPC for power to be cut off before admitting the ODC into the section.

6. Restoration of supply after a permit to work is returned.

On completion of the work, the person who received the permit to work shall ensure that:

- All men and materials have been withdrawn from the electrical equipment and its vicinity.
- All earthed provided for the protection of the working plates have been removed.
- All staff, who have been deputed to work, are warned that the power supply is to be restored.

7. Safety measures to be observed in case of unusual occurrences on electrified sections:

In the event of an OHE fault, the TPC after segregating and isolating the faulty section immediately switch off the power to the healthy section on the adjacent line over the same route length as the faulty section. The TPC shall promptly inform the section controller details of the isolated faulty section as well as the adjacent healthy section temporarily isolated.

8. In case of electric shocks with 25 kV OHE supply:

TPC shall arrange to cut off 25 kV OHE supply of concerned sub-sector and also sub-sector of adjacent line to reduce the effect of induction and shall advise all concerned.

9. Earthing of feeder lines:

After the feeder is made dead, it shall first be discharged by throwing an earthed chain over the conductor. The feeder line is then connected to earth by means of a stranded copper cable of adequate size securely connected to earth and the conductor.

10. Issue of caution orders:

Before commencing work on OHE or in cases of breakdown of OHE, when it is necessary for a train to proceed cautiously, the Sr.SE/SE(OHE) responsible for such notification.

11. In the event of Hot Axle:

In case any hot axle or any abnormalities is seen in a running train in block sections, power supply to OHE (up & down) of the affected section shall be switched off immediately by TPC on advise from section controller.

ENERGY CONSERVATION

Monitoring of Energy Conservation

1. The Staff connected with electric traction shall make every effort to avoid wastage in use of electricity through constant vigil.

2. One Senior Administrative Grade Officer of Electrical Department shall be nominated by Chief Electrical Engineer to be in charge of matters pertaining to Energy Conservation. The officer shall :

- Monitor pattern of consumption of electrical energy on electrified divisions based on the reports from Divisions;
- Plan for Energy Conservation measures and monitor their implementation;
- Provide guidance to Divisional Officers;
- Arrange for training of officers and supervisors;
- Discharge other related functions.

3. Sr. DEE (TrD) and Sr. DEE (OP) shall hold monthly meetings to analyze energy consumption and maximum demand for the preceding month vis-à-vis earlier months. The figures should have a relation to the traffic moved. In the event of maximum demand and energy consumption being found disproportionately high, a detailed investigation should be made and corrective action, if any, should be advised to concerned departments.

Energy Conservation Measures

While development of better designs and use of energy efficient equipment will bring about reduction in energy consumption, yet on the existing systems the following measures listed below will contribute to conservation of electrical energy in traction. While working to these recommended measures no compromise shall be made with the safe and reliable operation of equipment and train services.

Energy Conservation Measures for Traction Installations

1. Shunt capacitor banks shall be provided at traction sub-stations, where not done, to reduce maximum demand and line losses. Priority should be given to the sub-stations feeding large marshalling yards.
2. Standby traction transformers should be kept de-energized to save on no load losses.
3. Demand monitoring equipment, wherever provided, shall be maintained in the working order.
4. Traction Power Controller should co-ordinate with the Section Controller to avoid simultaneous starts of trains, as far as practicable. Bunching of the train in the event of breakdown has to be avoided to the extent feasible.
5. Wherever standby emergency power supply is also derived from OHE, the associated auxiliary transformer should be kept isolated from 25 kV side to avoid no load loss. This, however, shall not be applicable for power supply to signals where changeover has to be immediate.
6. Ensuring of good electrical contact to attain low resistance at conductor joints (splices) and parallel groove (PG) clamps through periodical inspection and maintenance.
7. Connections to buried rail opposite sub-stations for return current are prone to corrosion leading to increased resistance and loss of energy. These connections should be inspected periodically and maintained to obtain good electrical connection.

Energy Conservation Measures for Rolling Stock

1. Drivers/Motormen are expected to be well - conversant with the road to make the best use of down gradients to effect maximum possible saving in energy consumption.
2. In level sections and particularly in suburban sections, coasting should be resorted to as much as possible and brake applied only when essential to control the speed or stop the

train. To help Drivers and Motormen "Coasting Boards" are fixed at appropriate points on suburban sections. In some Railways, time totalizers have been provided in EMUs.

3. In the undulating terrain, speed may be allowed to drop down when going up a short up-gradient. After passing over the crest, the train will automatically pickup the speed with power off when going down- hill, so that it attains maximum permissible speed on the section when it arrives at the foot of the next up-gradient. This feature should receive special emphasis during learning the road period.

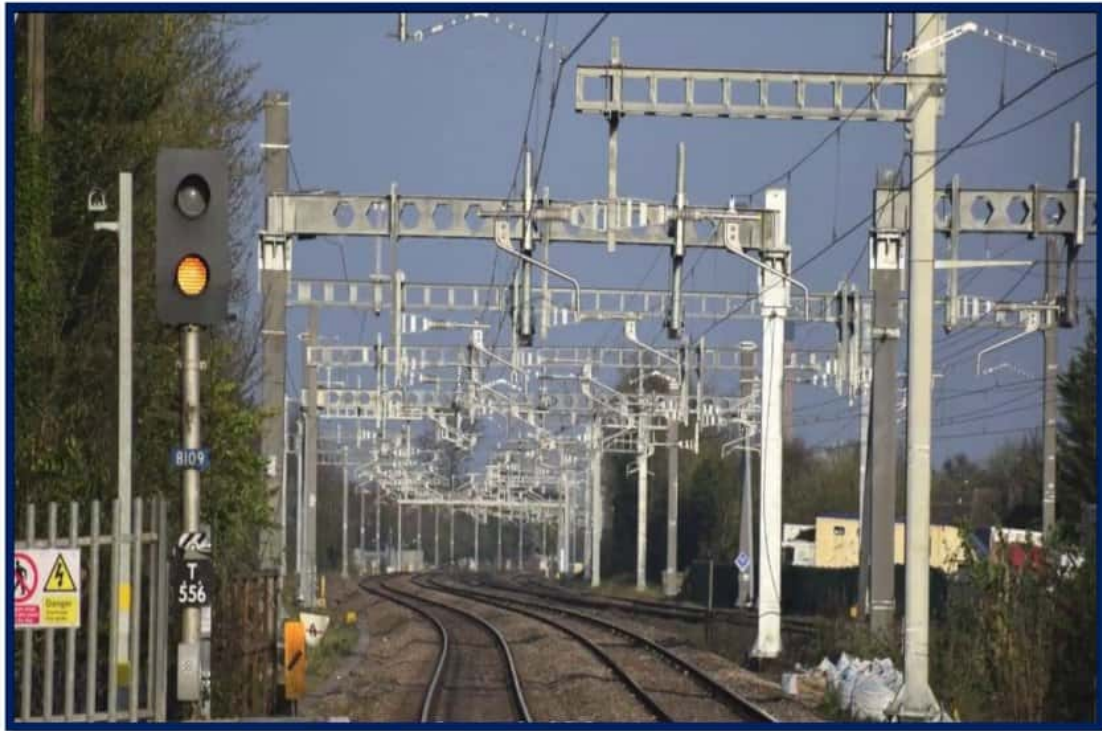
4. Re-scheduling of booked speed of EMU to help conservation of energy.

Energy Conservation Measures for Maintenance Installations

1. Switch off lights, fans and air conditioners when not required.
2. Keep standby transformers deenergized from HV side.
3. Check idle running of machines.
4. Check leakage and misuse of compressed air.
5. Check leakage and wastage of water.
6. Maximize use of natural day light in service building to reduce need for electric light.

New Developments

1. The traction staff should keep themselves fully abreast of technological developments like 3 phase drive Electric locos being made elsewhere, within the country and abroad, in respect of efficient utilization of electric power in traction applications and try to derive benefits from such developments.
2. Electric locomotives simulator : Training of Drivers on simulator can help drivers in running of trains with optimum consumption of energy.
3. On Board Power factor correction Equipment on Electric Locomotive.



Ghorawadi Railway Station

**CENTRAL RAILWAY
PUNE DIVISION**