SPOORNET

A division of Transnet limited

ENGINEERING & TECHNOLOGY
TECHNOLOGY MANAGEMENT

SPECIFICATION

SPECIFICATION FOR SURGE ARRESTERS FOR 3kV DC ELECTRIFICATION

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Engineering &Technology: Infrastructure Maintenance
Engineering &Technology: Infrastructure Engineering
Engineering &Technology: Technology Management

1.0 SCOPE

This specification covers Spoornet's requirements for the supply of outdoor surge arresters required for the protection of 3kV direct current electrical equipment against surges caused by lightning and switching surges.

2.0 REFERENCES

Except where otherwise provided for in this specification all equipment offered must comply with the requirements of the relevant standard specification for surge arresters of the S.A. National standards, otherwise with the relevant international standards effective at the time of tendering.

2.1 South African National Standards

SANS 60099-4 : Metal Oxide surge arresters without gaps for ac systems.

SANS 121 : Hot dip galvanized coatings for fabricated iron or steel article.

2.2 The following Spoornet drawing is referred to herein: -

CEE-TLE-6: Adapter plate, Surge arrester.

3.0 TENDERING PROCEDURE

3.1 **Tenderers shall indicate clause by clause compliance with the specification.** This shall take the form of a separate document listing all the specification's clause numbers indicating the individual statement of compliance or non-compliance. This document can be used by tenderers to elaborate on their response to a clause.

3.2 Tenderers shall motivate a statement of non-compliance.

3.3 Where equipment offered does not comply with standards or publications referred to in the specification, tenderers shall state which standards apply and submit a copy in English.

3.4 Tenderers shall submit descriptive literature consisting of detailed technical specifications, general constructional details and principal dimensions, together with clear illustrations of the equipment offered.

3.5 The "Technical Data Sheet" - Appendix 1 to this specification shall be fully completed by tenderers. Failure to submit fully completed data sheet(s) may preclude a tender from further consideration.

4.0 APPENDICES

Appendix 1 - Technical Data Sheet.
This appendix calls for specific technical information to be submitted by the tenderers.

5.0 ATMOSPHERIC SERVICE CONDITIONS

5.1 The arresters shall be designed for outdoor installation and rated for continuous operation under the following service conditions:

Altitude	-	0 to 1800m above sea level
Ambient temperature	-	minus10 °C to plus 45 °C
Relative humidity	-	10% to 90%
Atmosphere	-	Heavy polluted environment: salt laden industrial and locomotive fumes, and severe dust conditions.
Lightning conditions	-	12 Ground flashes per square kilometre per annum .

5.2 The arresters are to be installed on 3kV DC electrification structures and shall be exposed to direct sunlight.

6.0 ELECTRICAL SERVICE CONDITIONS

6.1 The arrester shall be suitable for operation on DC supply, obtained from silicon diode rectifiers, which contain a superimposed alternating current ripple due to harmonics.

6.2 The operating voltage is 3kV DC nominal, but varies during normal operation between 2,3kV and 3,9kV for sustained periods.

7.0 MECHANICAL SERVICE CONDITIONS

The arrester shall be subjected to severe vibration.

8.0 SURGE ARRESTER REQUIREMENTS

8.1 GENERAL

8.1.1 The arrester shall be of the metal oxide type.

8.1.2 The arrester shall be station class with a line discharge class 3 in accordance with SANS 60099-4.

8.1.3 The arrester shall be contained in an enclosure made of the insulating material, porcelain that is non-flammable and non-hygroscopic and so designed as to prevent the ingress of dirt and moisture. This material shall be resistant to UV radiation, corrosion and electric erosion and tracking under normal operating conditions.

8.1.4 To verify the seal integrity the manufacturer shall indicate the leakage rate of the arrester and what type of leakage test method has been used. The Integrated Helium Mass Spectrometer or the Membrane method is the preferred method.

8.1.5 All ferrous parts of the arrester i.e. terminals, connecting clamps, nuts and bolts shall be stainless steel, or mild steel galvanised in accordance with specification SANS 121 for " Hot dip galvanised coatings for fabricated iron or steel article".

8.1.6 In the event of an internal flash-over of which the surge energy exceeds the energy discharge capacity of the arrester, provision should be made to relieve the pressure and prevent the arrester from exploding, scattering porcelain fragments over a wide area with the consequent possible damage to equipment and injury to staff.

8.1.7 The arrester shall be designed to give a clear visible indication in the event of failure, in order to easily identify faulty arresters. The visual indication shall be visible from ground level. The visual indication shall be visible from ground level. A description of the visual indication system shall be given in the "Technical data sheet" Appendix 1.

8.1.8 The minimum outdoor earth clearance between the line connection and any other part of the arrester that is connected to earth, shall be 150mm.

8.1.9 The arrester shall be pedestal mounted, with an adapter plate according to drawing number CEE-TLE-6.

8.2 ARRESTER RATINGS

8.2.1 Rated voltage of the arrester Ur - 4,8kV DC.

8.2.2 Rated nominal discharge current - 10kA.

8.2.3 Discharge current withstand capability (4/10 µs two shots) - 100kA.

8.2.4 Continuous operating voltage (Uc) - 4,0 kV.

8.2.5 Pressure Relief Capability - 40kA/0,2 secs.

8.2.6 Line Discharge Class in accordance with SANS 60099-4 - Class 3

8.2.7 The residual peak voltage shall not exceed the insulation level of the traction substation. The substation is capable of withstanding a test voltage of 10,5kV (rms) 50Hz AC for one minute.

9.0 MARKING

Each arrester shall be legibly and indelibly marked with the following information in a position where the information can readily be seen.

- Manufacturer's name.
- Year of manufacture
- Rated DC Voltage.
- Continuous operating Voltage. (Uc)
- Serial Number
- The words "Metal Oxide" and "Outdoor" - type
- Insulating medium
- The word "Live" on or near the connecting terminal if the arrester has a metal casing that is connected to the earth terminal, and the word "Earth" on or near the earth terminal.

10.0 TESTS

10.1 Test certificates to verify requirements shall be submitted with tender documents.

10.2 The required tests shall be performed according to the S.A. National Standards for surge arresters or relevant international standards.

10.3 Spoornet reserves the right to carry out any check tests on data submitted. However, the successful tenderer will still be responsible for efficient operation of the equipment in service and its compliance with the specification.

10.4 Spoornet reserves the right to inspect the equipment at any stage during or after manufacture and be represented at any tests, and shall have full power to reject any item that is considered defective or inferior in quality of material, workmanship or design to that required by this specification.

11.0 PACKING

All equipment shall be packed in such a manner that it will be adequately protected against damage during handling and transport.

END

APPENDIX 1

TECHNICAL DATA SHEET
(To be completed by tenderer)

1.0	Type of arrester	.....
2.0	Manufacturer	.....
3.0	Rated DC voltage (Ur)	.....kV
4.0	Continuous operating DC voltage	.....kV
5.0	Nominal discharge current	.....kA
6.0	High current impulse withstand capability (4/10μs)	.....kA
7.0	Maximum residual voltage at steep or lightning impulse current.	.....kV
8.0	Long duration current impulse	.....A / .....μs
9.0	Pressure relief withstand	.....kA / .....s
10.0	Energy discharge capability	.....kJ/kV$_{Ur}$
11.0	Vibration resistance	.....g
12.0	Mechanical bump strength	.....g
13.0	Creepage distance	.....mm
14.0	Height	.....mm
15.0	Mass	.....kg
16.0	Temperature range	.....°C
17.0	Altitude	.....m
18.0	Visible indication - description	.....
	.....	
	.....	
	.....	
19.0	Additional information	.....
	.....	
	.....	
	.....	

SOUTH AFRICAN TRANSPORT SERVICES

DISTRIBUTION	ELECTRICAL ENGINEERING INSTRUCTION	POWER
A, B, C	STEP-DOWN POINTS FROM TRANSMISSION LINES FOR SIGNAL RELAY ROOMS WHERE TELECONTROL IS PROVIDED	P.3

1.0 SCOPE

1.1 This instruction covers the arrangement of step-down points on transmission lines which provide electricity supplies to signal relay rooms on Centralised Traffic Control (C.T.C.) sections where telecontrol is provided for the control of high voltage switchgear.

1.2 The instruction applies to all new signal supply lines to be erected which have telecontrol, and existing telecontrolled signal supply lines that are being rebuilt.

1.3 The instruction is not applicable to supplies from 25 kV AC electrification.

NOTE :

This instruction provides a means of rapidly isolating a faulty section of overhead line and changing over from a faulty step-down to a healthy stand-by transformer.

The above facilities will reduce the outage time of the supply that would otherwise result, but necessitates additional costs to extend the telecontrol equipment, to provide telecontrolled switches, to double up on the number of step-down transformers required, and to provide change-over equipment.

Where the signalling equipment has stand-by batteries capable of maintaining supplies to relay rooms for a reasonable period to enable manual sectioning to take place - and furthermore where the reliability of power supplies and the prevention of train delays is not of paramount importance, and the funds to provide the above-mentioned additional equipment are not justified or not available, this additional equipment need not be supplied. Each case should be considered on its merits, considering local conditions and signalling requirements.

DISTRIBUTION	ELECTRICAL ENGINEERING INSTRUCTION	POWER
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2.0 REQUIREMENTS

2.1 The transmission line voltage is usually 11 kV, 6,6 kV or 2,2 kV. However, 11 kV is the preferred voltage and should be adopted for all new signal supply lines, unless load conditions dictate that a higher voltage is necessary. The next higher preferred voltages are 22 and 33 kV. Changing to 11 kV should be considered when an existing lower voltage line has to be rebuilt and the technical advantages outweigh any additional cost.

2.2 Step-down points for signal supplies should be arranged as shown on the attached circuit diagrams Nos. CEE-PEB-73 and CEE-PEB-74. Drawing No. CEE-PFB-20 is a general arrangement of equipment mounted on a H mast. This arrangement may be modified to suit a particular type of equipment available, and also to meet any contingencies.

2.3 The above-mentioned drawings show telecontrolled high-voltage switches for isolating sections of line between step-down points, duplicate step-down transformers for supplying the signal relay rooms with both signalling power requirements and local power and lighting supplies, and automatic change over between the low-voltage supplies from one transformer to the other. An advantage to be gained from this arrangement is that "Control" is able to rapidly isolate any section of the high-voltage line between relay rooms with only momentary interruption of supplies to signal relay rooms.

2.4 A telecontrolled switch is provided at each step-down point. The switch should be of the load-break, fault-make type, preferably of the oilless type, suitable for being opened and closed by telecontrol.

2.4.1 The switch should be suitable for opening and closing from a 110 V single phase AC supply. In order to reduce the instantaneous magnitude of this supply, the switch should preferably be equipped with a motor-operated spring charging mechanism to provide closing and tripping energy. The operations will be triggered from remote only, and no provision need be made for "local" closing or tripping other than the usual manual open and close at the switch.

2.4.2 The Chief Engineer (S & T) will make available a 110 V AC single phase supply from the "no-break" supply in the relay room for operating the switch (opening and closing).

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2.5 Manually-operated three phase HV isolating links are provided to isolate sections for permit working etc.

2.6 Duplicate step-down transformers should be provided, each one adequately rated for the combined signalling as well as signal relay room power and lighting load of the building, fuse-protected on the HV side. One transformer should be 100 % standby to the other.

2.6.1 Each transformer should be adequately rated for the full load as determined above and should in addition have adequate spare capacity for likely future expansion. If this expansion is not known, 25 % of the full load should be allowed as spare capacity and the next higher standard size adopted.

2.6.2 In the interests of standardisation no HV step-down transformer shall be rated less than 16 kVA.

2.6.3 The transformer secondary voltage shall preferably be 400/231 volt three phase. When only a few 110 Volt supplies are required for signalling etc., these shall be obtained from separate transformers of 380 or 220/110 capacity.

2.7 An automatic change-over arrangement shall be provided in the relay room, changing from the selected transformer to the other in the event of the former failing or being de-energised. A separate cable shall be run from each transformer to the relay room.

No other outside electricity power supplies need to be taken into the signal relay room.

3.0 ASSOCIATED DRAWINGS

3.1 The following drawings accompany this instruction :-

CEE-PEB-73	-	Circuit Diagram - Step-down Point For Signal Supplies On CTC Sections With Telecontrol
CEE-PEB-74	-	Supply Change-over Panel, Circuit Diagram
CEE-PFB-20 sheet 1 of 2	-	H Mast For Dual Transformer And Sectioning Switch Mounting At Midspan Universal Column Structure.
CEE-PFB-20 sheet 2 of 2	-	Material List H-mast For Dual Transformer And Switch Mounting At Midspan Universal Column Structure. Sectioning

DISTRIBUTION	ELECTRICAL ENGINEERING INSTRUCTION	POWER
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3.2 It is the responsibility of all users to ensure that they are in possession of the latest issue of all applicable drawings.

4.0 AMENDMENTS AND SUPERSESSION

4.1 Clause 1.0 has been amended to include a "NOTE".

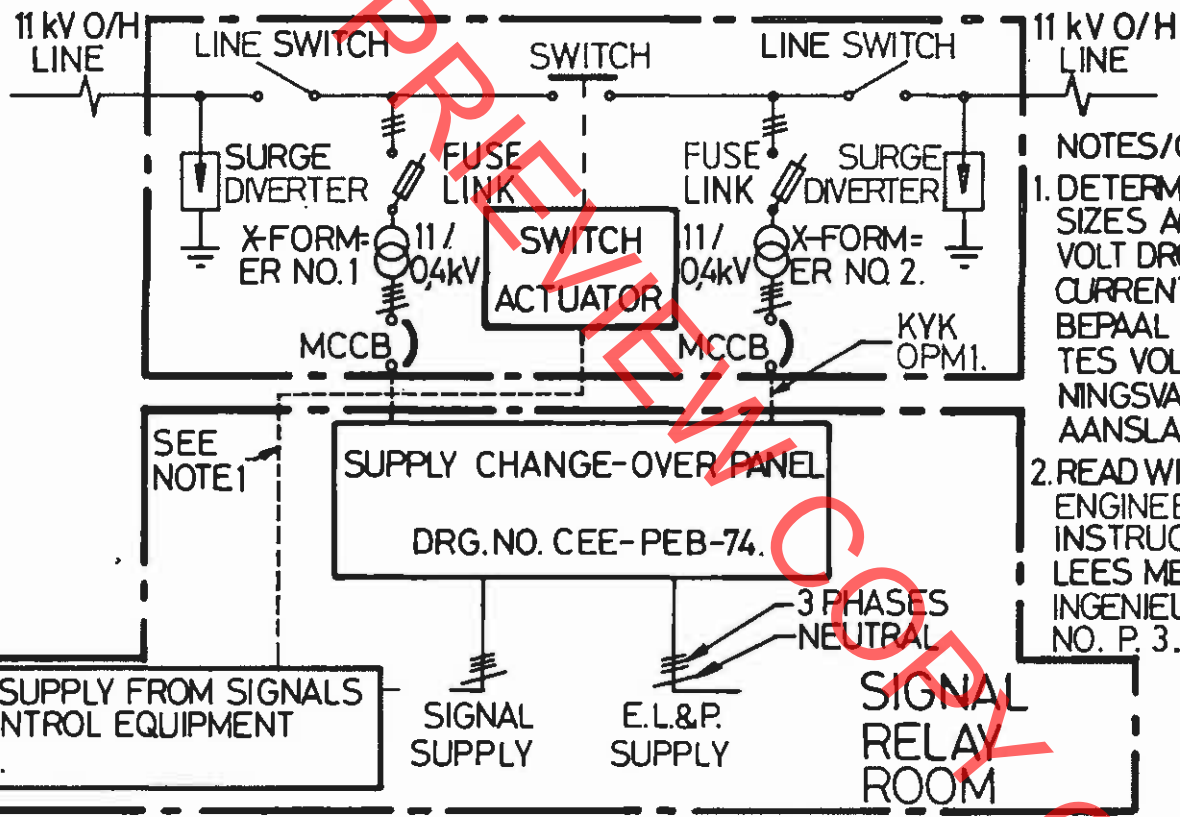
4.2 This instruction supersedes Electrical Engineering Instruction P3, issue 1 of February 1982.

E N D

for CHIEF ELECTRICAL ENGINEER

'H' FRAME.

(DRG. NO. CEE-PFB-20)



NOTES/OPMERKINGS.

1. DETERMINE CABLE SIZES ACCORDING TO VOLT DROP AND CURRENT LOADING. BEPAAL KABELGROOTTES VOLGENS SPANNINGSVAL EN STROOMAANSLAG.
2. READ WITH ELECTRICAL ENGINEERING INSTRUCTION NO. P.3. LEES MET ELEKTRIESE INGENIEURSINSTRUKSIE NO. P. 3.

AMENDMENTS WYSIGINGS		
NO.	NAME NAAM	DATE DATUM
1.	E. Louw.	82-04-03

REDRAWN AND REVISED.
OORGETEKEN EN HERSIEN.
D.O. REF. TK.VERW. P82/37.

2.	K.P.Moss	85-11-22

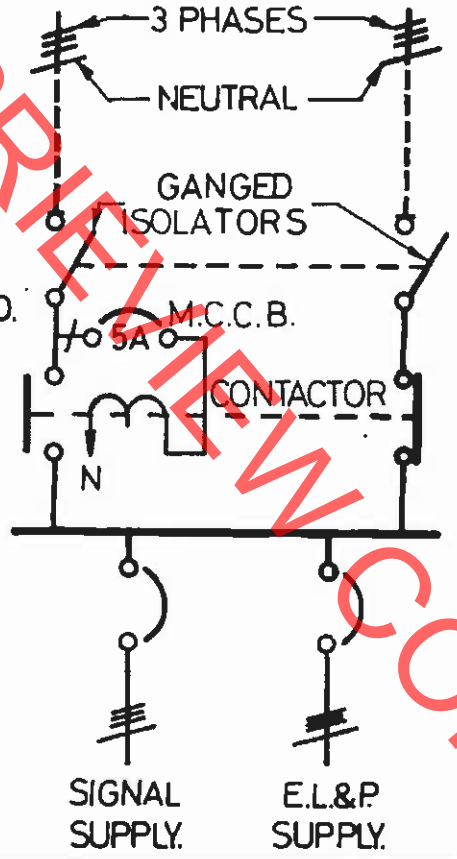
"FUSE LINKS" WERE/WAS "FUSE SWITCHES".
D.O. REF. TK-VERW. P2/85/166

DRN. GET. L.MARAIS.	AMENDMENT WYSIGING	1.	2.
TRCD. NGT. L.MARAIS.	D.O. REF. TK.VERW. P82/37	ENG. IR.	
CKD. NGS. E. Louw.	DATE DATUM 82-04-24	M. Alsweyd	
CHIEF ELECTRICAL ENGINEER ELEKTRIESE HOOFINGENIEUR		JOHANNESBURG.	
SOUTH AFRICAN TRANSPORT SERVICES. SUID AFRIKAANSE VERVOERDIENSTE.			

CIRCUIT DIAGRAM.-STEP DOWN POINT FOR SIGNAL SUPPLIES ON C.T.C. SECTIONS WITH TELECONTROL
BAANDIAGRAM.-VERLAGINGSPUNT VIR SINJAALTOEVOERE OP G.V.B. SEKSIES MET TELEKONTROLE.

DRAWING. NO. TEKENING. NO. CEE-PEB-73

A4



NOTES/OPMERKINGS

1. CONTACTS TO BE MECH. INTERLOCKED. KONTAKTE IS MEG. GEKOPPEL.
2. READ WITH ELECTRICAL ENGINEERING INSTRUCTION NO. P. 3. LEES MET ELEKTRIESE INGENIEURS= INSTRUKSIE NO. P. 3.

SIGNAL RELAY ROOM.
SINJAALRELÊ= KAMER.

AMENDMENTS WYSIGINGS		
NO.	NAME NAAM	DATE DATUM
1.	E. Louw	82-05-07

REDRAWN AND REVISED.
OORGETEKEN EN HERSIEN.

D.O.REF. TK.VERW. P82/37.

DRN. GET. L.MARAIS.	AMENDMENT WYSIGING	1.	
TRCD. NGT. L.MARAIS.	D.O.REF. TK.VERW. P82/37	ENG. IR.	
CKD. NGS. E. Louw.	DATE DATUM 82-04-24	M. Oswald	

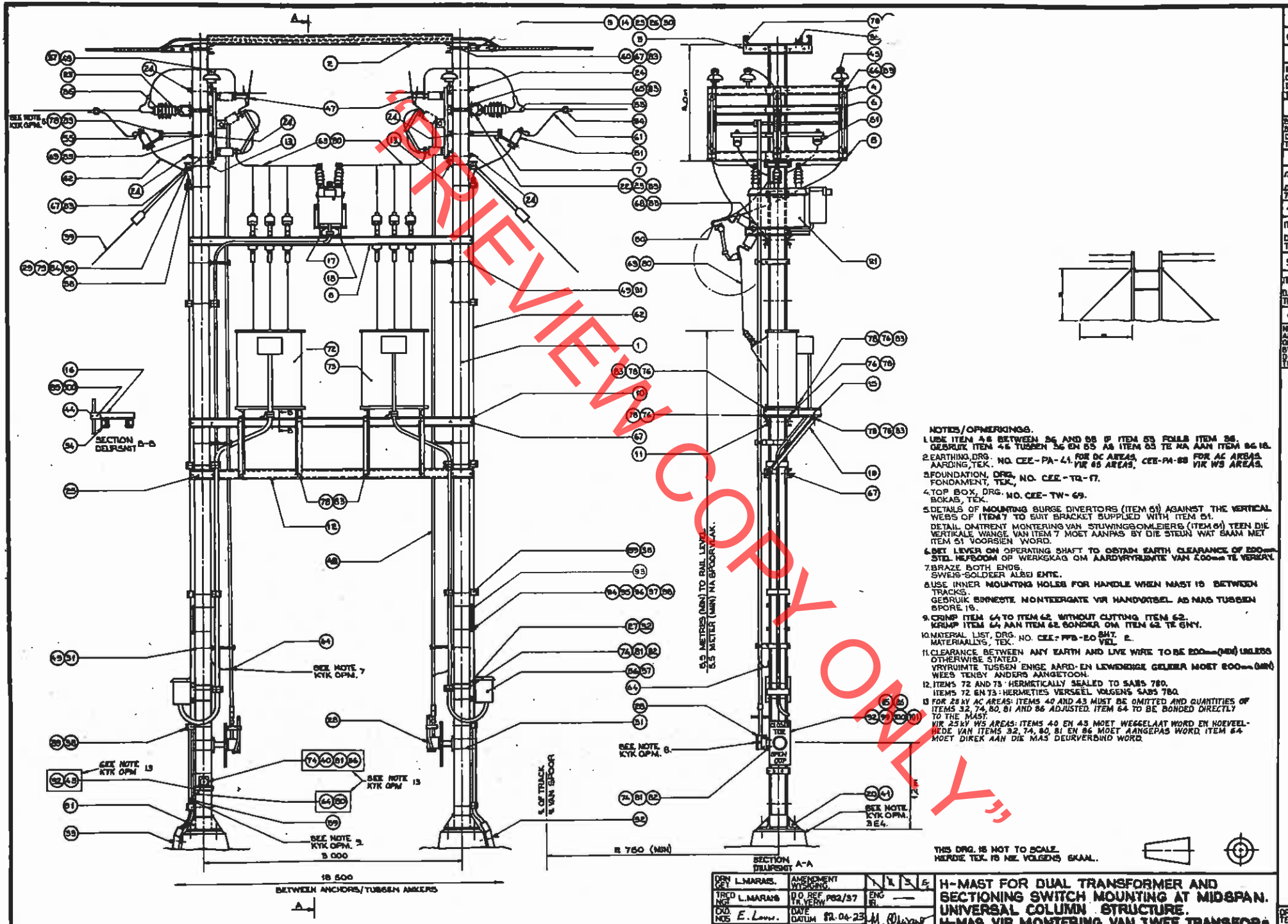
CHIEF ELECTRICAL ENGINEER
ELEKTRIESE HOOFINGENIEUR
JOHANNESBURG

SOUTH AFRICAN TRANSPORT SERVICES.
SUID AFRIKAANSE VERVOERDIENSTE.

SUPPLY CHANGE OVER PANEL, CIRCUIT DIAGRAM.
TOEVOEROORSKAKELPANEEL, BAANDIAGRAM.

DRAWING. TEKENING. NO. CEE-
PEB-74

A4



THIS DRG. IS ALSO ON MICROFILM
HIERDIE TEK. IS OOK OP MIKROFILM

NOTES/OPMERKINGS.

1. USE ITEM 46 BETWEEN 36 AND 85 IF ITEM 85 FOLLS ITEM 36.
   GEBRUIK ITEM 46 TUSSEN 36 EN 85 AS ITEM 85 TE NA AAN ITEM 36 IS.
2. EARTHING, DRG. NO. CEE-PA-41. FOR DC AREAS, CEE-PA-88 FOR AC AREAS.
   AARDING, TEK. VIR 85 AREAS. VIR WS AREAS.
3. FOUNDATION, DRG. NO. CEE-TR-17.
   FONDAMENT, TEK.
4. TOP BOX, DRG. NO. CEE-TW-69.
   BOKAS, TEK.
5. DETAILS OF MOUNTING SURGE DIVERTORS (ITEM 61) AGAINST THE VERTICAL WEBS OF ITEM 7 TO SUIT BRACKET SUPPLIED WITH ITEM 61.
   DETAIL OMTRENT MONTERING VAN STUWINGSOMLEIERS (ITEM 61) TEEN DIE VERTIKALE WANGE VAN ITEM 7 MOET AANPAS BY DIE STEUN WAT SAAM MET ITEM 61 VOORSIEN WORD.
6. SET LEVER ON OPERATING SHAFT TO OBTAIN EARTH CLEARANCE OF 200mm. STEL HEFBOOM OP WERKSKAG OM AARDVRYRUIMTE VAN 200mm TE VERKRY.
7. BRAZE BOTH ENDS.
   SWEIS-SOLDEER ALBEI EINDE.
8. USE INNER MOUNTING HOLES FOR HANDLE WHEN MAST IS BETWEEN TRACKS.
   GEBRUIK BINNESTE MONTEERGATE VIR HANDVATSEL AS MAS TUSSEN SPORE IS.
9. CRIMP ITEM 64 TO ITEM 62 WITHOUT CUTTING ITEM 62.
   KRIMP ITEM 64 AAN ITEM 62 SONDER OM ITEM 62 TE SNY.
10. MATERIAL LIST, DRG. NO. CEE-PFB-20 SHT. 2.
    MATERIAALLYS, TEK. VEL.
11. CLEARANCE BETWEEN ANY EARTH AND LIVE WIRE TO BE 200mm (MIN) UNLESS OTHERWISE STATED.
    VRYRUIMTE TUSSEN ENIGE AARD- EN LEWENDIGE GELEIER MOET 200mm (MIN) WEES TENSY ANDERS AANGETOON.
12. ITEMS 72 AND 73 HERMETICALLY SEALED TO SABS 780.
    ITEMS 72 EN 73 HERMETIES VERSEEL VOLGENS SABS 780.
13. FOR 25 kV AC AREAS: ITEMS 40 AND 43 MUST BE OMITTED AND QUANTITIES OF ITEMS 32, 74, 80, 81 AND 86 ADJUSTED. ITEM 64 TO BE BONDED DIRECTLY TO THE MAST.
    VIR 25 kV WS AREAS: ITEMS 40 EN 43 MOET WEGGELAAT WORD EN HOEVEELHEDE VAN ITEMS 32, 74, 80, 81 EN 86 MOET AANGEPAS WORD. ITEM 64 MOET DIREK AAN DIE MAS DEURVERBIND WORD.

THIS DRG. IS NOT TO SCALE.
HIERDIE TEK. IS NIE VOLGENS SKAAL.

AMENDMENTS. WYSIGINGS.

NO	NAME NAAM	DATE DATUM
1	E. Louw.	83-09-07
NOTE 12 ADDED. OPM 12 BYGEVOEG. D.O. REF TK-VERW P82/113		
2.	T. Mouton	84-11-22
BOLT DETAILS REVISED. BOUT DETAIL HERSIEN. D.O. REF. TK-VERW. P83/263		
3.	E. Louw	84-04-19
ITEM 13 ADDED. BYGEVOEG. D.O. REF. TK-VERW. P84/63		
4.	T. Mouton	84-10-30
ITEM 92 ALTERED. VERANDER. D.O. REF TK-VERW. P84/206		
5.	K. Maas	85-08-21
ITEM 101 ADDED BYGEVOEG D.O. REF TK. VERW. P2/85/124		
6		87-05-13
NOTE 2 ALTERED. NOTE 13 ADDED. OPM 2 VERANDER. OPM 13 BYGEVOEG. D.O. REF TK-VERW P2/87/29		

DRN DET	L. MARAIS.	AMENDMENT WYSIGING	1	2	3	4	5
TRCD INGT	L. MARAIS	D.O. REF. TK. VERW.	P82/37	ENG ING.	—
CKD. NGS	E. Louw.	DATE DATUM	82-04-23	M. Oliver
CHIEF ELECTRICAL ENGINEER. ELEKTRIESE HOOFINGENIEUR.				JOHANNESBURG	
SOUTH AFRICAN TRANSPORT SERVICES. SUID-AFRIKAANSE VERVOERDIENSTE.					

H-MAST FOR DUAL TRANSFORMER AND SECTIONING SWITCH MOUNTING AT MIDSPAN. UNIVERSAL COLUMN STRUCTURE.
H-MAS VIR MONTERING VAN TWEE TRANSFORMATORS EN VERDEELSKAKELAAR BY MIDDELSPAN. UNIVERSELE KOLOMSTRUKTUUR.

DRAWING TEKENING NO CEE-PFB-20
SHT VEL 1 OF VAN 2

A1

ITEM	DESCRIPTION – BESKRYWING	STORES MAG.	ITEM Nº	QTY. HVLD.		DRG. TEK. Nº
1	MAST 206÷216 LENGTH 10 000 MAS LENGTE		399	2		
2	BEAM, TOPMOST MEMBER. BALK, HEEL BOONSTE ONDERDEEL			2		CEE PFC 110
3	CROSS ARM, EARTH WIRE DWARSARM, AARDDRAAD			2		" " 86
4	" " , TOP OF DISCONNECTS " " , BOKANT VAN AFSONDERSKAKELAARS			2		" " 78
5	" " , BOTTOM OF DISCONNECTS " " , ONDERKANT VAN AFSONDERSKAKELAARS			2		" " "
6	" " , TRANSMISSION LINE. " " , TRANSMISSIELYN			4		" " "
7	BRACKET, SURGE ARRESTOR. STEUNSTUK, STUWINGSOMLEIDER.			2		" " 103
8	BEAM, EXPULSION FUSE AND ACTUATOR SWITCH. BALK, UITWERPSEKERING EN DRYWINGSSKAKELAAR.			2		" " 118
9	THIMBLE OOGRING			2		" TN 232
10	BEAM, TRANSFORMER MOUNTING. (TOP) BALK, TRANSFORMATORMONTERING. (BOONSTE).			1		" PFC 91
11	" " " " " "			1		" " "
12	" " " " (BOTTOM). (ONDERSTE)			1		" " 92
13	BACK ANGLE, STAY WIRE CONSTRUCTION. TEUNHOEKSTUK, ANKERDRAADKONSTRUKSIE.			2		CEE-TMHA-154
14	SUPPORT EARTH WIRE, MAKE-OFF STEUN, AARDDRAADAFHEGTING.			2		CEE-PFC-84
15	" , TRANSFORMER " , TRANSFORMATOR.			4		" " 93
16	" " AND CABLE CLEAT " " EN KABELKLAMP.			2		" " 96
17	" , ACTUATOR SWITCH (LEFT HAND / LINKERHAND) " , DRYWINGSSKAKELAAR.			1		" " 119
18	" " " (RIGHT HAND / REGTERHAND)			1		" " "
19	BRACE, TRANSFORMER SPANSTUK, TRANSFORMATOR			4		" " 98
20	BOLT GROUP. BOUTGROEP			2		" TQ-29
21	ACTUATOR SWITCH DRYWINGSSKAKELAAR.			1		
22	MAKE-OFF STRAP AFMAAKBAND		(M)84/2259	18		CEE 54/112217
23	CLEVIS PIN ASSEMBLY Ø16 VURKPENSAMESTEL		(M)84/4020	10		" TX-68
24	BACK ANGLE, DISCONNECTS CROSS-ARM TEUNHOEKSTUK, AFSONDERSKAKELAARSDWARSARM			6		" TMHA 90
25	BACK CHANNEL, TRANSFORMER MOUNTING BEAM. TEENKANAAL, TRANSFORMATORMONTEERBALK.			2		" PFC 100
26	LINK STRAPS SKAKELSTROKE		(M)84/2171	4		TN-361
27	BRACKET, L.V. SWITCH STEUNSTUK, L.S. SKAKELAAR			4		" PFC 101
28	" , H.V. SWITCH HANDLE " , H.S. SKAKELAARHANDVATSEL			2		" 102
29	STAY WIRE ATTACHMENT ANKERDRAAD HEGSTUK			8		" TMF-123
30	CLAMP STRAIN. KLAMP SPAN.			2		" TN-143
31	U BOLT M16 BOUT			10		CEE TX8 ITEM 38Q
32	U - M12 *			8		" TX8 - 38Q
33	CABLE GUARD KABELSKUT.			2		" TMA 15
34	U BOLT M16. BOUT			4		" TX8 ITEM 8 Q
35	EARTH WIRE CLAMP AARDDRAADKLAMP		(M)84/2203	2		" TN-371
36	INSULATOR, SUSPENSION Ø254 — HANGISOLATOR		(M)84/1177	24		
37	SUPPORT PIN, INSULATOR. STEUNPEN, ISOLATOR.		84/102121	6		
38	CABLE CLEAT ASSEMBLY KABELKLAMPSAMESTEL.			19		CEE PFC 113
39	STAY WIRE CONSTRUCTION. ANKERDRAADKONSTRUKSIE			2		" PFD 24
40	ARRESTOR, ELECTRICAL SURGE, ASSEMBLY. (SPARK GAP) 33kV DC CS * STUWINGSWEERDER, ELEKTRIES, SAMESTEL. (VONKBRUG)			1		" TU-120
41	MAST BASE INSULATION MASVOETSTUKISOLASIE			12		" TU 30
42						
43	BRACKET, SPARK GAP. * STEUNSTUK, VONKBRUG.			1		CEE-TMHA 83
44	CABLE CLAY. KABELKLAMP.			2		" PFC 6
45	INSULATOR, PIN TYPE ISOLATOR, PEN TIPE		54/102120	6		
46	CLEVIS FITTING. (SEE NOTE 4) VURKVERBINDING. (KYK OPM. 4)		(M) 84/821	AS REQ.		CEE-TN-251
47	DISCONNECTS (WITH OPERATING HANDLE AND EARTHING) AFSONDERSKAKELAARS (MET WERKHANDVATSEL EN AARDOORLEIDING)		54/102370	2 SETS STELLE		
48	DISCONNECT ROD (SUPPLIED WITH ITEM 47) AFSONDERSKAKELAARSTANG (VERSKAF MET)		54/102370	—		
49	" " GUIDE " " LEISTIK			6		CEE-PFC-99
50	FUSE CUT-OUT TYPE L.E.L. SEKERING UITSKAKEL TIPE			6		
51	SURGE ARRESTOR. STUWINGSOMLEIDER.		(M)84/1217	6		
52	SHIELD, EXPANSION SKERM, UITDET		(M)41/58124 (M)59/54426	2		
53	STRAIN CLAMP SPANKLAMP		(M)54/4752	6		

* SEE NOTE 13 ON DRG NO CEE-PFB-20 SHT 1
KYK OPM 13 OP TEK VEL 1

THIS DRG. IS ALSO ON MICROFILM
HIERDIE TEK. IS OOK OP MIKROFILM

ITEM	DESCRIPTION – BESKRYWING	STORES MAG.	ITEM Nº	QTY. HVLD.		DRG. TEK. Nº
54	"C" TYPE CRIMP FERRULE "C" TIPE KRIMPLASHULS.		54/102021	6		
55	SIMETALLIC LUG SIMETAALJOR		54/102011	6		
56	BOX KAR			2		
57	2 POLE M.C.B., RUPTURING CAP. (PLUG-IN / DRAW-OUT TYPE) POOL M.E.B., BREEKVERMOË. 8 A, 6, 6, 2,5 kA (INPROP- / UITTREKTIPE)			2		
58	CRIMPING FERRULE (3 WIRE GRADE) KRIMPLASHULS			2		
59	" " (2 " ")			1		
60	WATER PIPE, GALVANISED Ø25 I.D. B.D. ×206 (SPACER FOR CROSS ARMS, AFSTANDSTUK VIR DWARSARMS) WATERPYP, GEGALVANISEER			8		
61	STRANDED ALUMINIUM WIRE, 50 mm² STRINGALUMINIUMDRAAD.		(M) 61/12845	LENGTH TO SUIT / LENGTE OM TE PAS.		
62	EARTH WIRE P.V.C. INSULATED 50 mm² AARDDRAAD, GEÏSOLEER		(M)61/58843			
63	CABLE, SINGLE CORE, 11kV STRANDED HARD DRAWN COPPER COND. PVC INSULATED 50 mm² KABEL, ENKEL-AAR, HARDGETREKTE KOPERSTRINGGELEIERS. GEÏSOLEER					
64	BOND, FLEXIBLE COPPER 50 mm² MIN. * GEVLVERBINDER, BUIGSAME KOPER			8		
65	BOLT AND NUT, STEEL, GALV. HEXAGON HEAD, ROUND, HEXAGON NUT. M20×150L. BOUT EN MOER, STAAL, GEGALV. SESKANTKOP, ROND, SESKANTMOER.		(M)/32069	6		
66	" " " " " " " " " " M20×75L.		(M)/32028	12		
67	" " " " " " " " " " M20×250L			96		
68	" " " " " " " " " " M20×230L			4		
69	" " " " " " " " " " M20×330L			8		
70						
71						
72	TRANSFORMER, L.E.T. TRANSFORMATOR, LINKER.			1		
73	" , RIGHT. " , REGTER.			1		
74	SET SCREW, STEEL, GALV. HEX. HEAD. M12×25L. * KLEMSKROEF, STAAL, GEGALV. SESK. KOP			13		
75						
76	BEVEL WASHER " " ROUND M20. SKUINS WASTER " " ROND			36		
77						
78	BOLT AND NUT, STEEL, GALV. HEXAGON HEAD, ROUND, HEXAGON NUT M20×40L BOUT EN MOER, STAAL, GEGALV. SESKANTKOP, ROND, SESKANTMOER		(M)/31976	30		
79	" " " " " " " " " " M24×255L		(M)/26719	4		
80	CRIMPING LUG 50 mm² WIRE * (SHT 1 VEL 1) KRIMPOOR DRAAD			29		CEE-PA 14
81	NUT, STEEL, GALV. HEX. M12. * MOER, STAAL, GEGALV, SESK.			13		
82	WASHER, LOCK, STEEL, SINGLE COIL SQ. SECTION, GALV. M12 WASTER, SLUIT, STAAL, ENKELSPRONKEL, VK. DOURSNIT, GEGALV.		(M)01/33850	13		
83	WASHER, STEEL, GALV. ROUND NORMAL DIA. M20. WASTER, STAAL, GEGALV. ROND, NORMALE DIA.		(M)/39672	82		
84	" " " " " " " M24			4		
85	" " " " " " " M10		(M)/33647	12		
86	" " " " " " " M12 *			5		
87						
88						
89	24 mm "BAND IT" STRAP BAND:			AS REQ.		
90	CLEVIS PIN Ø24 × 70 mm VURKPEN		(M) 84/4007	2		CEE-TX-89
91	MAST BASE ASSEMBLY MASVOETSTUKSAMESTEL			2		" TMB-68.
92	INDICATING PLATE. AANWYSPLAAT.			2		" 84/112496
93	DANGER WARNING PLATE. GEVAARWAARSKUPLAAT.			2		" TA 196
94	U-BOLT (M12) BOUT			4		" TX8/ITEM 38Q
95	STRAP: DANGER WARNING PLATE. BAND: GEVAARWAARSKUPLAAT.			4		" PFC-104
96	SCREW, MACHINE, STEEL, SLOTTED CHEESE HEAD. M4 × 12. MASJIENSKROEF, STAAL, GESLEUFDE DIKKOP.		(M)/3237	8		
97	NUT, STEEL HEX. M4. MOER, STAAL, SESK.		(M)/13766	8		
98	WASHER, SPRING, STEEL, GALV. ROUND, NORMAL DIA. M4 VEERWASTER, STAAL, GEGALV. ROND, NORMALE DIA.			8		
99	BRACKET, INDICATING PLATE. STEUNSTUK, AANWYSPLAAT.			2		CEE-PFC-131
100	BOLT & NUT, STEEL, GALV. HEX HEAD, ROUND, HEX NUT. M10 × 25. BOUT EN MOER, STAAL, GEGALV. SESK. KOP, ROND, SESK. MOER			8		
101	SCREW AND NUT, STEEL, HEXAGON HEAD, ROUND, HEXAGON NUT M12 × 25 SKROEF EN MOER, STAAL, SESKANTKOP, ROND, SESKANTMOER		(M)1/ 13391	4		

DIMENSIONS: MILLIMETRES
AFMETINGS: MILLIMETER

DRN. GET.	L. MARAIS.	AMENDMENTS WYSIGINGS	7
TRCD. NGT.	L. MARAIS	D.D. REF. TK-VERW.	P82/87
CKD. NGS.	E. Louw.	DATE. DATUM	82-04-23
CHIEF ELECTRICAL ENGINEER ELEKTRIESE HOOFINGENIEUR. JOHANNESBURG.			
SOUTH AFRICAN TRANSPORT SERVICES. SUID-AFRIKAANSE VERVOERDIENSTE.			

MATERIAL LIST.
H-MAST FOR DUAL TRANSFORMER AND SECTIONING SWITCH MOUNTING AT MIDSPAN. UNIVERSAL COLUMN STRUCTURE.
MATERIAALLYS.
H-MAS VIR MONTERING VAN TWEE TRANSFORMATORS EN VERDEELSKAKELAAR BY MIDDELSPAN. UNIVERSELE KOLOMSTRUKTUUR.

AMENDMENTS. WYSIGINGS.

NO.	NAME. NAAM	DATE. DATUM.
1.	E. Louw.	82-04-23

ITEM 66: REFERENCE TO NOTE 12. REINDEXED. ITEM 84: KLAWERSNR NA OPM 12. HERWYDER. DO REF TK-VIEW P82/193.

2.	T. Hanekom.	84-8-21

ITEM TO REMOVE: ITEMS 65, 66, 67, 75, 78 & 83 QTYS CHANGED. ITEM 70 VERWYDER. ITEMS 65, 66, 67, 75, 78 EN 83 HOEVEELHEDE VERANDER. D.O. REF. TK-VIEW. P83/263

3	E. Louw.	84-04-19

ITEM 13 ADDED. BYGEVOEG. ITEMS 8 & 24 QTYS ALTERED ITEMS 8 & 24 HOEVEELHEDE VERANDER. DO REF. TK-VIEW. P84/63

4.	T. Hanekom	84-10-30

ITEM 82: ITEM NO. WAS 54/112434. D.O. REF. TK-VERW. P84/206

5	K. Moore	85-07-12

ITEMS 14, 15, 16, 17, 18, 19 DRAWING NOs REVISED. ITEMS 14, 15, 16, 17, 18, 19 TEKENING NOs HERSIEN. DO REF TK-VERW P2/85/108

6.	K. Moore	85-08-21

ITEM 101 ADDED AND ORG. NO. ADDED TO ITEM 99. ITEM 101 BYGEVOEG EN TEK NO. BYGEVOEG BY ITEM 99. D.O. REF. TK-VERW. P2/85/124. SHT 1 VEL 1

7	[illegible]	86-12-11

ITEM 5, 22, 23, 28, 29, 38, 40, 48, 51, 53 AND 60 UPDATED. ITEMS 22, 23, 28, 29, 38, 40, 48, 51, 53 EN 60 BYGEWERK. DO REF TK-VERW. T86/196

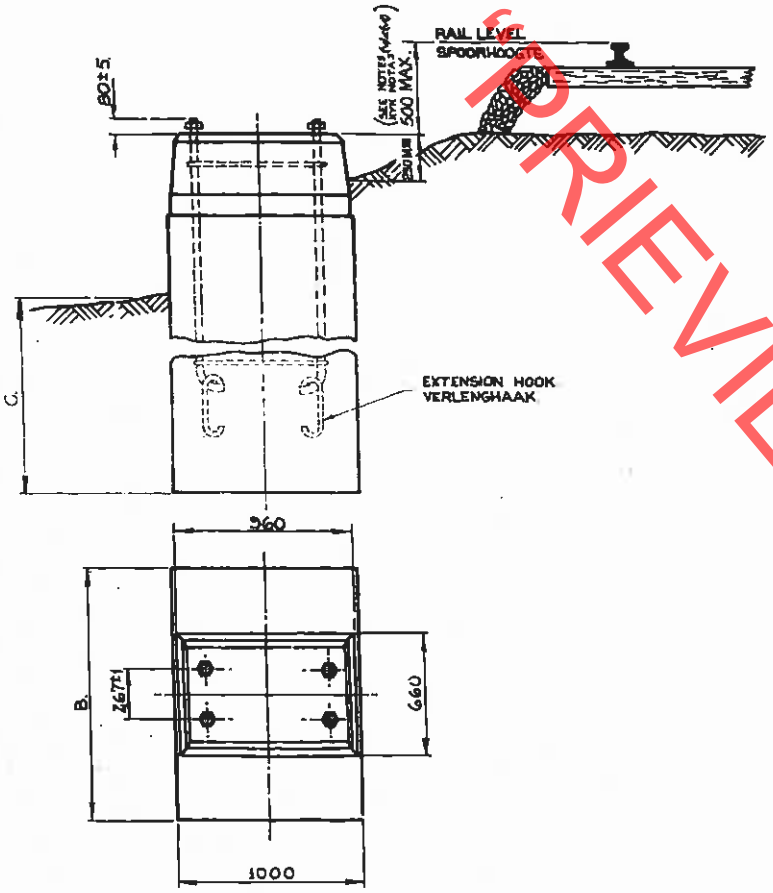
8	[illegible]	87-09-17

* ADDED. BYGEVOEG. DO REF. TK-VERW. P2/87/29

DRAWING NO. TEKENING NO. CEE-PFB-20
SHT. VEL. 2 OF VAN 2

A1

ORIGINAL FRAME SIZE
OORSPRONKLIKE RAAMGROOTTE 654 × 380



TYPE OF GROUND / TIPE GROND	FOUNDATION DIMENSIONS mm / FONDAMENT AFMETINGS					
	CURVED TRACK & ANCHOR MASTS / KROMSPOOR EN ANKERMASTE			TANGENT TRACK / REGUITSPOOR		
	-A-	B	C	-A-	B	C
COMPACT (SAND, GRAVEL OR CLAY) / VERDIGTE (SAND, GRUIS OF KLEI)	1000	1000	1800	1000	1000	1500
SILTY SAND OR SOFT CLAY. / SLIKAGTIGE SAND OF SAGTE KLEI.	1000	1400	2100	1000	1400	1800

NOTES/ NOTAS

(I) SPACE MASTS IN ACCORDANCE WITH DRG.CEE TV 31
SPASIEER MASTE OOREENKOMSTIG TEK. CEE TV 31

(II) LOADING OF MASTS: 161 mm² CONTACT, 80mm CATENARY, 800mm² ALUMINIUM FEEDER, 3×50/8 mm² PHASE - AND 2×50/8 mm² EARTH WIRES (ACSR)
BELASTING VAN MASTE: 161mm² RYDRAAD, 80mm DRAKABEL, 800mm² ALUMINIUMVOERDER. 3×50/8 FASE- EN 2×50/8 AARDDRADE (ACSR)

(iii) FOUNDATION SIZES ARE BASED ON MAX. OT. MOMENTS OF 93 kN-m. MAX. PERMISSIBLE (WORKING) PRESSURE OF SOIL = 500 kPa FOR COMPACT - AND 200 kPa FOR LOOSE GROUND.
RESISTING MOMENT = 0,064B d² w Fb max.
WHERE d = DEPTH, w = WIDTH OF FOUNDATION AND Fb max IS PERMISSIBLE WORKING PRESSURE.
FONDAMENTGROOTTES IS BEREKEN MET MAKS OMKEERINGSMOMENTE VAN 93 kN-m MAKS. TOELAATBARE (WERK) DRUK VAN GROND = 500 kPa VIR VERDIGTE EN 200 kPa VIR LOS GROND.
WEERSTANDSMOMENT = 0,064B d² w Fb max
WAAR d = DIEPTE, w = WYDTE VAN FONDAMENT EN Fb max. IS TOELAATBARE WERKDRUK.

(IV) THE TOP OF THE FOUNDATION BLOCK MUST BE COMPLETELY LEVEL AND OF A GOOD FINISH. MAST TO BE ERECTED ON FOUNDATION BLOCK WITHOUT ANY WEDGING. TOP OF MAST MUST NOT DEVIATE MORE THAN 10 mm FROM THE TRUE VERTICAL.
DIE BOKANT VAN FONDAMENTBLOK MOET SUIWER WATERPAS EN GOED AFGEWERK WEES. MAS MOET OP FONDAMENTBLOK OPGERIG WORD SONDER ENIGE WIG. BOKANT VAN MAS MOET BINNE 10 mm VAN VERTIKAAL WEES.

(V)

TYPE OF MAST - TIPE MAS.	FOUNDATION HEIGHT - FONDAMENT HOOGTE.
RAIL MAST WITH CLAMP-ON FITTINGS. SPOORMAS MET AANKLAMPTOEBEHORE.	500 mm MAX. BELOW RAIL LEVEL. MAKS. ONDERKANT SPOORHOOGTE.
RAIL MAST WITH WELDED CLEATS SPOORMAS MET GEWEISDE KLAMPE	AT RAIL LEVEL + ALLOWANCE FOR FUTURE RAISING OF TRACK. (WHERE REQUIRED.) OBSERVE MINIMUM HEIGHT. GELYK MET SPOORHOOGTE. + TOELATING VIR TOEKOMSTIGE SPOORVLAK-VERHOGING (WAAR BENODIG) KOM MIN. HOOGTE NA

(M) FOR 3 kV DC AND 25 kV AC AUTO TENSIONED CONSTRUCTION : THIS DIMENSION IS 400 mm (FIXED)
VIR 3 kV GS EN 25 kV WS OUTOMATIESE SPANNINGKONSTRUKSIE : HIERDIE AFMETING IS 400 mm (VAS.)

CONCRETE
MIX:- 1:3:6
MAX. STONE SIZE:- 38 mm.
MIN. CRUSHING STRENGTH AT 28 DAYS:- 17250 kPa.
GRADE:- F2
TYPE:- PBFC

BETON
MENGSEL:- 1:3:5
MAKS. GROOTTE KLIP:- 38 mm
MIN. BREEKSTERKTE NA 28 DAE:- 17250 kPa.
GRAAD :- F2
TIPE :- PHSB

ASSOCIATED DRAWINGS - VERWANTE TEKENINGE	
T.O. BOX / BOKAS.	CEE TW 147
JIG: 4×M36 BOLT GROUP / SETMAT: 4×M36 BOUTGROEP	CEE TW 120
BOLT GROUP / BOUTGROEP	CEE TQ 28
MAST BASE ASSEMBLY / MASVOETSTUKSAMESTEL	CEE TMB-35.
EXTENSION HOOK. / VERLENGHAAK.	CEE TQ-30.

DIMENSIONS : MILLIMETRES
AFMETINGS : MILLIMETER

GENERAL TOLERANCES / ALGEME TOLERANSIES: LIN ± 10, ANG —

DRN / GET G. NEL	CKD / NGS. JA BOTHMA	ENG / IR.
D.O. REF / T.K. VERW J73/40	DATE / DATUM 24-8-73	
CHIEF ELECTRICAL ENGINEER / ELEKTROTEGNIESE HOOFINGENIEUR	S.A.R. / S.A.S.	JOHANNESBURG

0 1000 2000

FOUNDATION
RAIL MASTS
FONDAMENT
SPOORMASTE

AMENDMENTS / WYSIGINGS

Nº	NAME / NAAM	DATE / DATUM
1		20/2/74

POSITION OF FOUNDATIO ALTERED. TOP WAS AT RAIL LEVEL TOP BOX JRG Nº WAS ENW E15 2.
POSISIE VAN FONDAMENT VERANDER. BOKANT WAS GELYK MET SPOOR-HOOGTE. BOKAS TEK Nº WAS ENW E15 2.
D.O REF. C19/74
TK. VERW.

2		7-10-74

NOTE V AND DRG NO CEE TMB 35 & TQ 30 ADD
NOTA V EN TEK. NO CEE TMB 35 EN TQ 30 BYGEVOEG.
DIMENSIONS CHANGED.
AFMETINGS VERANDER.
D.O.REF.
TK-VERW. T74/83.

3.	J.SWIEGERS.	80-06-30.

NOTE/OPM. (VI) ADDED/ BYGEVOEG.
D.O.REF.
T.K-VERW. T80/86.

4.	B.Stewart	80-12-09.

ASSY. DRG. NOS ADDED.
SAMEST. TEK. NOS BYGEVOEG.
D.O. REF.
T.K-VERW. T1/80/15.

5.	B.Stewart	81-08-21.

NOTE VI ALTERED.
OPMERKING VI VERANDER.
D.O. REF.
TK-VERW. T1/81/44.

6.	J.SWIEGERS	81-10-30

NOTE OPM. (vi) REVISED. HERSIEN.
D.O. REF.
TK-VERW. T2/81/54.

CEE-TMB-35 & 101
CEE-TMB-108 & 110.

DRAWING / TEKENING Nº CEE
TQ 27

A2
A3

ORIGINAL FRAME SIZE
OORSPRONKLIKE RAAMGROOTTE 33" x 20"

ITEM.	DESCRIPTION —— BESKRYWING	QTY HVLD.	STORES MAGASYN Nº	DRG. TEK. Nº CEE
1	BOLT, FOUNDATION M36. BOUT, FONDAMENT	4	——	TQ-50
2	RING, RETAINING. RING, KEER-	2	11/21527	TQ-49

AMENDMENTS. WYSIGINGS.		
Nº	NAME. NAAM.	DATE. DATUM.
5.		78-08-11

BOLT HOOK ALTERED.
HAAK VAN BOUT VERANDER.
D.O. REF. TK-VERW. Y78/63.

6.		80-01-09

BOLTS WERE ZINC COATED.
BOUTE WAS VERSINK.
D.O. REF. T 79/93.
TK-VERW.

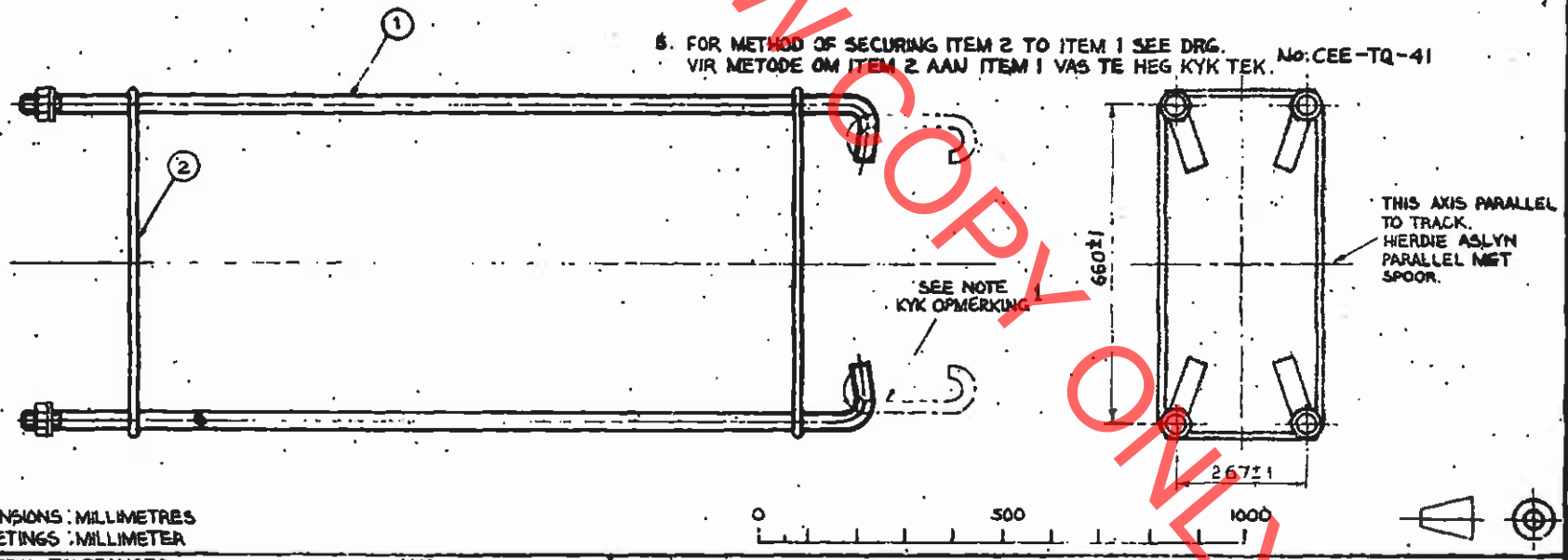
7		80-11-03

ITEMS 1&2 DRG. NO'S ADDED. NOTES 2&4 AND ITEMS 3&4 REMOVED. DRG. REVISED.
ITEMS 1 EN 2 TEK. NO'S BYGEVOEG. OPM. 2 EN 4 VERWYDER. TEK. HERSIEN.
D.O.REF. T 2/80/15
TK-VERW.

NOTES: OPMERKINGS:
1. BIND EXTENSION PIECES (CEE TQ30) ONTO FOUNDATION BOLTS WHEN REQUIRED TO BRING REINFORCEMENT WITHIN 300mm OF BOTTOM OF FOUNDATION HOLE.
BIND VERLENGINGSTUKKE (CEE TQ 30) AAN FONDAMENTBOUTE WAS WANNEER VEREIS OM VERSTERKING BINNE 300mm VAN BODEM VAN FONDAMENTE TE BRING.

3. COAT THREADS WITH ANTI-CORROSIVE PASTE TO SPEC. BEDEK SKROEFDRAAD MET KORROSIEWERENDE PASTA VOLG. SPES. CEE - T - P4A - 9. STORES/MAGASYN ITEM NO. 9/2.545.

5. FOR METHOD OF SECURING ITEM 2 TO ITEM 1 SEE DRG. No: CEE-TQ-41
VIR METODE OM ITEM 2 AAN ITEM 1 VAS TE HEG KYK TEK.



DIMENSIONS: MILLIMETRES
AFMETINGS: MILLIMETER

GENERAL TOLERANCES. ALGEMENE TOLERANSIES	LIN. ± 5	ANG. HOEK.	——
DRN. GET. C.G DAVIDSON.	CKD. NGS. F.HEYL.	ENG. IR.	
D.O.REF. TK VERW. J73/40	DATE DATUM. 24-8-73		
CHIEF ELECTRICAL ENGINEER. ELEKTROTEGNIESE HOOFINGENIEUR	S.A.R. S.A.S.	JOHANNESBURG.	

A3
A4

M36 FOUNDATION BOLT GROUP RAIL MASTS

M36-FONDAMENTBOUTGROEP SPOORMASTE

ASSOCIATED DRG
VERWANTE TEK.

CEE TQ 27 FONDATION FONDAMENT
CEE TW 120 J16 SETMAAT
CEE-TW-147 TOP BOX BOKAS
CEE TMB 35 MAST BASE MASVOETSTUK

DRAWING TEKENING Nº CEE
TQ 28

SOUTH AFRICAN RAILWAYS

ELECTRICAL ENGINEERING DEPARTMENT

This specification cancels specification T-T6E-4 of August 1979

SPECIFICATION NO. T-T6E-4
JANUARY 1980

SPECIFICATION FOR 3 KILOVOLT DC ELECTRIFICATION OVERHEAD TRACK EQUIPMENT

1.0 SCOPE

1.1 This specification covers the survey, design, supply (except where otherwise stated) and erection of 3 kV DC electrification overhead track equipment for railways as specified in the documents herewith. In certain sections an 11 kV transmission line will be required on the same structures which carry the 3 kV DC equipment. This will also be indicated in the Annexure to this specification. After completion of the contract the completed detail designs shall be owned by the Administration for their further use under any conditions deemed necessary.

1.2 Since this specification covers inter alia the design and supply of a special type of equipment which only firms with special knowledge and experience can perform to the Administration's satisfaction, tenders will only be considered from firms who have designed and supplied similar equipment to other railways, and furthermore can prove that the equipment supplied has proved completely satisfactory over a period of years.

2.0 GENERAL INFORMATION

2.1 The Tenderer will be provided with a single line diagram of the open route, and plans of the station layouts showing the extent of electrification. Details of all physical features are not always shown.

2.2 The dimensions shown on individual drawings of the Administration may be either in imperial or metric measurement units. Where necessary, conversions shall be made. However, all drawings submitted by the Contractor for approval shall only be dimensioned in metric units.

2.3 Designs for steelwork and linework requirements shall be based on the following criteria :

Factor of safety for	: line conductors and fittings	: 2,0
	: iron or steel	: 2,5
	: reinforced concrete	: 3,0
	: insulators	: 2,5

Wind pressure 750 Pa on projected surface area at right angles to wind.

Equivalent area for wind pressure on round steelwork and conductors : 0,6 of projected area.

2/....

Equivalent area for wind pressure on lattice sections : 1,5 x projected surface area.

Ambient temperature range : -5 °C to 50 °C
Maximum operating temperature of wiring : 80 °C

2.4 Tenderers shall offer designs for insulated droppers to support the contact wire. Droppers below 600 mm in length shall be free to slide on the catenary wire and the insulating medium between dropper and catenary shall therefore be abrasion resistant and have a low coefficient of friction. Tenderers are free to offer their own design of dropper attachments. Tenderers may offer their own designs for overhead track-equipment fittings providing these are interchangeable with existing Administration's designs, but the design of steelwork and general design of the overhead track equipment (span lengths, catenary sag, etc.) shall be as shown on the drawings provided, or as herein specified. See also 14.2.2 and 14.5.1.

2.5 An 11 kV transmission line when specified, shall be erected on track equipment structures where physical features permit. The section between make-off points shall be cabled, but this work is not covered under this specification. The steel-work design for main line structures shall take into account the provision of a 11 kV transmission line on these track structures whether specified as required or not required. See also 12.6 and 16.3.1 hereof.

2.6 For the purpose of design of the contact wire system the maximum speed of trains may be taken as 120 km/h .

2.7 Service conditions are as follows :

Altitude : 0 - 1 800 m above sea level
Ambient temperature : -5 °C to 50 °C
Relative humidity : Up to 86%
Lightning conditions : Severe

In addition atmosphere may be polluted by steam or diesel locomotives and/or atmospheric or industrial sources and this shall be allowed for by the tenderer in his tender.

3.0 CONTRACTOR'S SURVEY AND ELECTRICAL CLEARANCES

3.1 The Contractor is required to undertake a preliminary survey to find out and set down all the physical features including bridges, water columns, transmission line and level crossings, signal structures, telecommunication routes and all obstructions which may have a bearing on the electrification of the line on the single line diagram.

3.2 The minimum clearances permissible for transmission and communication lines crossing the overhead track equipment under the most adverse conditions of wind and temperature are as follows :

	Description	Clearance
3.2.1	Any wire not normally "alive" and the overhead track-equipment steelwork.	2,5 m
3.2.2	Any high voltage transmission line conductor and the overhead track-equipment steelwork.	2,5 m + the normal outdoor earth clearance.
3.2.3	Any wire not normally "alive" and any "live" portion of the overhead track equipment.	1,8 m + the normal outdoor earth clearance.
3.2.4	Any high voltage conductor and the overhead track-equipment earth wire.	600 mm + the normal outdoor earth clearance.
3.2.5	Any high voltage conductor and any "live" portion of the overhead track equipment.	1,8 m + the normal outdoor earth clearance for the higher voltage.

3.2.6 The outdoor earth clearances that shall be observed for voltages at any altitude are as follows :

Voltage	Clearance
650	75 mm
2 200	75 mm
3 300	75 mm
6 600	150 mm
11 000	200 mm
22 000	300 mm
33 000	430 mm
44 000	530 mm
66 000	760 mm
88 000	990 mm
110 000	1,2 m
132 000	1,4 m
165 000	1,4 m
220 000	2,0 m
275 000	2,3 m
400 000	3,2 m

3.3 Transmission lines and/or 3 kV DC feeders erected on the overhead track equipment and which are independently switched shall be located outside the confines of the overhead track equipment steelwork and shall maintain the following clearances under all atmospheric conditions :

4/....

	Description	Clearance
3.3.1	Any high-voltage transmission line conductor and/or separate 3 kV feeder and any "live" portion of the overhead track equipment.	1,8 m + the normal outdoor earth clearance for the higher voltage.
3.3.2	Any high-voltage conductor and the overhead track-equipment earth wire.	600 mm + the normal outdoor earth clearance.
3.3.3	Minimum height allowable for any high-voltage conductor not positioned further than 2,5 metres plus the normal outdoor earth clearance to any portion of the overhead track equipment steelwork.	Not below the highest point of the adjacent "live" track equipment.

3.3.4 The minimum clearance permissible between any high-voltage transmission line conductor and a separate 3 kV feeder, both run on overhead track-equipment structures shall not be less than 1,8 metres plus the normal outdoor earth clearances for the higher voltage.

3.4 The minimum clearance that shall be maintained when transmission and/or communication lines cross transmission lines and/or separate 3 kV feeders or overhead track structures under all atmospheric conditions is as follows :

Between the transmission line and/or separate 3 kV feeder on overhead track-equipment structures and the other transmission line or communication circuit : 1,8 m plus normal outdoor earth clearance applicable to the higher voltage.

3.5 In cases where low-voltage transmission and communication lines cross electrified tracks, protection to the overhead track equipment shall be afforded by means of a suitable cradle installed on the sides and underneath the crossing, or another approved method used. Where such devices are not existing, the Contractor shall refer these crossings to the Engineer for his further attention.

3.6 After the preliminary survey all instances where crossings are under clearance, shall be referred to the Engineer, so that he may make arrangements to provide the necessary clearance or cable the intermediate section affected.

3.7 Subsequent to the preliminary survey, the Contractor shall again check through the route and tentatively fix the structure positions either by appropriate markings on the rail or by staking. The structure positions will be dictated mainly by the permanent way and physical features. Allowance shall be made for future doubling on single line sections by positioning masts opposite to the side of the proposed future track. (Unless this is to be at 5,5 m to the existing track.)

3.8 If foundations are required on rail bridges, these shall be referred to the Engineer, for further attention. The requirements for bracket mounting facilities under overhead bridges, shall be based on drawing BE 7595M. Where this drawing is not applicable, the matter shall be referred to the Engineer.

3.9 From the survey (clause 3.7 refers) a preliminary lay-out plan shall be developed, recording the positions of all structures and lay-out of equipment between them. Standard electrification symbols shown on drawing CEE-TA-62 shall be used for plotting the lay-out on scale plans. The sections between stations and station lay-outs shall be prepared on separate scale plans and the division between station to station sections and stations shall be taken as the overlaps situated on either side of the station.

3.10 As soon as the preliminary lay-outs become available inspection "walk-outs" shall be arranged through the Engineer in order that the Departments of the Administration concerned may agree finally to the positions of structures. No installation work shall commence prior to the approval of lay-outs by the Engineer.

3.11 The Contractor will be required to :

(a) Co-ordinate switch structure positions relative to the traction substations and tie-stations with the traction substation Contractor (through the Engineer).

(b) Co-ordinate transformer H-mast positions relative to electric light and power and signalling supply points with the Engineer.

4.0 OVERHEAD TRACK-EQUIPMENT STRUCTURE POSITION REQUIREMENTS

4.1 Electrification structure clearances to be maintained for masts shall be as follows :

4.1.1 Single and multiple track :

In general mast to track centres shall be at 3,2 m except where otherwise provided in the following clauses :

4.1.2 Single track : signal approach

Whenever possible masts shall be located at 3,2 m centres on the left hand side of the track approaching the station in order not to obscure signal visibility. In cases where masts are situated on the right hand side of the track and at any location where signal visibility is likely to be impaired the centres shall be increased to 3,7 m . The distance between centres as well as the number of masts decided upon shall be in agreement with the Administration's Signal and Telecommunication Department.

4.1.3 Multiple track ; signal approach

Mast to track centres shall be retained at 3,2 m but where this will interfere with signal visibility the mast shall be moved out to 3,7 m centres. Alternatively, if colour-light signals are to be provided, signal gantries may be used.

4.1.4 Cuttings

Where possible mast to track centres shall be at 3,7 m to avoid table drains, or otherwise comply with the Chief Civil Engineer's requirements. Tenderers shall include a unit price for table drain re-establishment on a metre length basis.

4.1.5 Banks

3,2 m mast to track centres shall be used. Refer to clause 4.1.6 for clearances to be observed for curves.

4.1.6 Curves

In all cases the clear distance from mast to centre line of the respective track shall in no instance be less than the dimensions laid down in the Chief Civil Engineer's drawing type D361M. (The distance shall not be less than 3,2 m in any particular case on sections between stations, or 2,75 m if centre masts are employed on double track.)

4.1.7 Station Platforms

Masts on station platforms including goods road platforms shall be positioned such that there is a minimum clearance of 3,0 m from edge of mast to edge of platform. In the case of island platforms, structure supports shall be positioned on the centre line of these platforms. The foundation height on platforms shall be 1 100 mm above rail level. Masts which are readily climbable shall be equipped with anti-climbing devices.

4.1.8 Anchor masts behind stop blocks

The minimum clear distance between the anchor mast and stop block shall be 6 m . Insulation shall be introduced into the contact and catenary wires immediately above the stopblock and the wiring between the stopblock and the anchor mast shall be connected to rail.

4.1.9 Minimum clearance

Structures shall not be positioned nearer than 2 465 mm clear of the track centre line plus the clearance to be observed on curves where applicable, as laid down on drawing D361M. This minimum clearance shall only be resorted to when there is no alternative, and with the approval of the Engineer.

4.2 The maximum span length permissible on tangent track is 67 metres. In sections particularly exposed to wind it may prove necessary to decrease the span lengths. These sections shall be established by the Contractor and so marked on scale plans. The funneling effect of certain ground formations as well as the upward deflection of wind by high banks shall be taken into account in determining reduction of span lengths. Particular attention shall be given to the safe design of supporting structures in such sections.

5.0 PARTICULARS OF MAIN LINE OVERHEAD TRACK EQUIPMENT

5.1 On sections between stations and main line/s through stations the overhead track equipment shall consist of a simple catenary, contact wire, (with a tension device) and an aluminium feeder suspended above the catenary. Particulars of the conductors are as follows :

Description	Catenary	Contact	Feeder
Make-up of wire.	80 mm^2 (7/3,75 stranding)	161 mm^2 solid	800 mm^2 (61/4,25 stranding)
Material	Hard-drawn copper. SABS 182	Hard-drawn copper. BS 23	Hard-drawn aluminium. SABS 182
Remarks	Alternatively special make-up of ACSR or other suitable wire may be offered in inland areas.		
Maximum span	67 m		67 m

The maximum continuous current rating of these wires will be 2 000 amps. Higher current up to 3 000 amps will also be experienced for periods not exceeding 30 minutes. Such over-current periods will be separated by intervals of not less than 30 minutes when the normal maximum continuous current will flow. Short-circuit currents will be experienced at infrequent intervals, with short-circuit currents of 20 000 amps flowing for 3 periods of 60 milleseconds each within a cycle time of 45 seconds. This cycle may be repeated once only after an interval of one minute.

Connection between feeder, catenary and contact wire, of cross-section 160 mm^2, shall be provided at every suspension point on main lines, and on crossing loops adjacent to main lines. Connections between catenary and contact wire of 50 mm^2 cross-section shall be provided at every suspension point on tracks other than the abovementioned.

5.2 The tensioning of the contact wire only, on main lines, shall be effected by means of a weight tensioning device. The catenary wire/s in this case shall be at a fixed tension and its tension will vary with temperature.

Turnbuckles having a take up of 460 mm shall be incorporated in the fixed anchor assemblies. In addition, in the case of the feeder wire only, link plates of 460 mm hole centres shall be placed in tandem with the turnbuckle.

The tenderer shall indicate in his tender how it is intended to compensate for a reduction in the cross-sectional area of the contact wire due to wear (i.e. a minimum thickness) when a weight tensioning device is used, and the successive sizes of wire at which weights must be reduced, is to be stated also.

Where the contact wire is also fixed tensioned as in station yards a maximum tension length of 1 830 metres will be permitted.

The maximum tension length of a contact wire, tensioned by a weight tensioning device shall be 1 610 m or approximately 24 spans between anchor points on tangent track.

New contact wire when automatically weight tensioned shall have a designed constant tension of 14,5 kN . By alteration of the weights it shall be possible temporarily to increase this value by 10% if required.

Tension in worn contact wire may be permitted to increase to the maximum permissible working load (ultimate strength 2) before the weight is reduced.

5,15 The contact wire height at the tensioning position will normally be approximately 5,0 metres above rail level and this will be the available space for the mounting attachments and movement of the weights.

The mast to which the weight tensioning device is attached shall be either :

a 203 x 152 mm or 229 x 178 mm I section
or
a 204 x 206 x 52 kg/m or 206 x 216 x 71 kg/m Universal Column section.

In order that standard components are supplied, brackets for attachment to the above mast sizes shall be suitable for attachment to each of the I section masts specified.

5.3 The weight tensioning device shall be of the wheel and barrel type and shall incorporate a device to prevent displacement of the weights in the event of a broken conductor. The mechanical advantage shall be 3:1 or 4:1 or have suitable intermediate

values. The maximum contact wire length from anchor to the midpoint contact wire anchor location shall be 805 metres. Full details of the tensioning device, including the weights required and recommended mounting and guide arrangements are to be supplied by the tenderer.

The flexible wire rope which is attached to the weights and to a standard tension insulator fitting shall be fully detailed in the tender and shall include the measures taken to afford protection against fatigue and corrosion. Special attention shall be given to the prevention of attack by atmospheric corrosion.

The strength of all fittings and wire ropes shall be sufficient for the purpose with an adequate factor of safety and the ultimate strength of all components shall be detailed by the tenderer.

The weight tensioning device shall be provided with a swivel arrangement to allow the contact wire to anchor at various angles to the mast and suitable arrangements to prevent twisting of the pulleys are also to be incorporated in the design. The pulley bearings shall be ball or roller bearings of the sealed type.

The fittings used with the weight tensioning device shall be capable of carrying the full short-circuit currents specified and suitable arrangements for bonding the device to the traction rail via the anchor mast shall be provided.

A means of preventing unauthorised handling of the weights, such as a protective cage surround, shall be included in the design.

All metal components shall be non-ferrous or hot dipped galvanised to SABS Specification 763 or equivalent national specification.

5.4 Contact and catenary wire overlaps shall be positioned on tangent track or may be positioned on curves of radius not less than 500 m, providing the masts are situated on the outside of the curve. See drawing CEE-TP-124 sheet one, general arrangement drawing. The 25 kV insulation in the catenary system shown on this drawing shall be changed to 3 kV insulation however.

5.5 On main line single or double track, overhead track-equipment for each track shall be separately supported from a cantilever with the insulators suspended in such a manner as to allow along the track movement of the conductors, under abnormal conditions such as a broken conductor. Switched overlaps shall be generally to drawing No. CEE-TP-120 sheet one with the exception that 3 kV insulation shall be substituted for 25 kV insulation. Only at overlaps for

multiple track with no suitable track centres shall the overhead wires for each track be suspended from common steelwork. In the case of the main line through stations, overhead track equipment may be suspended from steelwork common to the yard or loops.

5.6 The feeder wire shall be run over all main lines including the main line through station precincts and, where indicated by the Engineer, on the station loop adjacent to the main line.

5.7 The support arrangement under bridges shall comprise a transverse span wire to support the catenary, together with a contact wire registration steady arm, free to traverse horizontally. A suitable design is included in the schedule of drawings herewith, but the Contractor may offer an alternative design.

The support arrangement on steel box girder river bridges shall comprise suspension brackets for the catenary and feeder wires, attached above the bridge, with horizontally traversing steady arms for contact wire registration as shown on drawings Nos. BE-TP-40 and BE-TMF-45. Spacing between supports shall not exceed 9 m .

The steel crossarm for attaching the 11 kV line to box girder bridges shall be insulated both electrically and against vibration and shall be generally as indicated on drawing No. BE-TMG-6. Spacing between supports shall not exceed 50 m .

(Note: The mounting arrangements may require to be adapted to the particular dimensions of the box bridges.)

5.8 All overbridges shall have profile drawings prepared by the Contractor showing the position of supports, contact and catenary wire heights at suspension points, and the grading of the contact wire relative to the track if applicable, on scale plans. Certain bridges have already been provided with bridge bracket mounting facilities either by bolts or nuts cast in the underside and these may be used where suitable and the brackets required shall be securely fixed by the Contractor. Contact wire shall run parallel to tracks under bridges and to the first structure on each side of the bridge. On overhead bridges with clearance to rail level of 4 930 mm the contact wire height shall be 4,5 metres. With a clearance to rail level of 5 080 mm the contact wire height shall be 4,650 metres. Holes may be drilled in bridges only after approval of the Chief Civil Engineer has been obtained through the Engineer.

5.9 Tunnel fittings, if required, shall be of Contractor's own design and shall be approved by Chief Electrical Engineer. Overlaps shall be positioned immediately outside both entrances to all tunnels and must be installed in long tunnels where the tension length encountered requires an overlap.

5.10 The following specifications shall apply to line conductors unless the tenderer offers equipment complying with other National Standard Specifications and these specifications are acceptable to the Administration :

Hard-drawn copper contact wire	BS 23
Other hard-drawn copper conductors	SABS 182
Hard-drawn aluminium conductors	SABS 182
Aluminium conductors, steel reinforced	SABS 182

6.0 STATION AND YARD OVERHEAD TRACK EQUIPMENT PARTICULARS

6.1 In yards the overhead equipment shall consist of a simple catenary of 80 mm^2 cross-section (7/3,75 stranding) hard-drawn copper and a solid 161 mm^2 contact of hard-drawn copper. Sufficient current-carrying connections of suitable cross-sectional area for the purpose shall be provided between the catenary and contact wires. For ease of adjusting tensions afterwards turnbuckles of 460 mm length are to be provided with these wires at anchor points.

6.2 Cantilever masts shall be used for two tracks on tangent track where the spacing between track centres is 5,5 m, and in other instances portal or separate cantilevers where suitable. For more than two tracks, portal structures shall be used, namely booms or lattice bridges. Alternatively, cross catenary construction of design acceptable to the Chief Electrical Engineer may be used. The support wire and fittings shall be of a corrosion-resistant material acceptable to the Chief Electrical Engineer.

6.3 The structures for main line/s shall, wherever lay-outs permit, form part of the yard steelwork. The structures across yard roads shall preferably be in line and in line with main line structures where applicable.

6.4 On portal structures cross-span wires for supporting the registering arms shall only be used across yard roads where no electrical overhead-track separation is necessary, otherwise the contact wire shall be registered separately with respect to the track it serves, the steady arm arrangement being attached to vertical steel members supported from the portal bridge. Cross-span wires to be installed to drawing No. CEE-TP-153.

6.5 Pull-off arrangements shall be provided in yard spans where it is necessary to pull the contact wire on gauge. Pull-off masts (i.e. with catenary wire not suspended) shall not be used on main lines between stations.

6.6 The contact wire on the main line/s through the station shall be tensioned with a suitable device, and acceptable arrangements shall be made where the wires with automatic tensioning device meet wires which have no such device installed. See also 5.2 to 5.4.

6.7 Signal gantries for colour-lights shall be provided, when required, in yards or loops. The positions shall be established from the Administration's Signal Engineer's designs to fit particular locations. The installation shall be carried out by the Contractor. These gantries will be similar to that shown on drawing No. CEE-TP-28.

6.8 All sidings or goods roads shall have structure masts positioned opposite the side on which loading and unloading is undertaken, where physical lay-outs permit. In the case where 8 m track centres are intended for access roads in yards, no masts shall be positioned between these tracks.

7.0 GENERAL OVERHEAD TRACK-EQUIPMENT PARTICULARS

7.1 The normal contact wire height above rail level shall be 5,0 m . However, to allow for the future lifting of tracks, structure heights shall where necessary be increased by 150 mm minimum above this normal height where applicable. This 150 mm extra height shall also be provided at level crossings. The minimum contact wire height shall be not less than 4,5 m unless approved of by the Chief Electrical Engineer and in this instance it shall not be less than 4,2 m . The contact wire shall be maintained at a minimum height of 5,5 m above rail level, over proclaimed roads at level crossings.

7.2 The contractor shall erect warning height gauges on each side of all level crossings and also where a road gives access to an area traversed by electrified track and to which the public has legitimate access, such as a goods shed area.

A height gauge shall comprise :

Two poles connected by two galvanised steel span wires of size 7/4,0 mm and approximately 285 mm apart. The lower wire shall be X mm above the crown of the road, where X = contact wire heights minus 300 mm .

Two in-line stay wires to counteract the tension of the span wires. The stay bolts shall be of an approved light duty design with galvanised 16 mm diameter staybolts and galvanised anchor plates.

One or more "Danger" signboards to drawing No. CEE-54/112400 affixed between upper and lower span wires.

Poles may be either galvanised steel, reinforced concrete, or wooden poles vacuum impregnated with creosote. Poles shall be buried 1 200 mm in the ground. Attachment of span and stay wires to the poles shall be in such a manner as to preclude slipping. The poles shall be erected clear of the shoulders of the road, and approximately 2 000 mm inside the Administration's boundary fence. Care shall be exercised however, as important communication and signal cables are frequently buried in this vicinity, and the Engineer shall approve all height gauge positions before excavation commences.

7.3 Arcing horns shall be fitted at ± 0,8 km spacing on the whole route as well as on each side of a switch structure at feeding points at substations and tie-stations. Drawing CEE-TP-70, which depicts a type in use by the Administration, is enclosed as a guide. Contractors may use their own design which need not be installed at the steady arm insulators as shown on this drawing, but preferably on the top of the cantilever/portal.

The Engineer shall approve the Contractor's design of arcing horn.

8.0 SECTIONING

8.1 On the main line electrical sectioning shall be provided on either side of a station by means of switched overlaps or suitable high speed section insulators. These overlaps are to be sited in collaboration with the Signal and Telecommunication Department so that signals are not obscured and subject to the proviso that the first structure of the overlap is a minimum distance of 100 m to the facing points. The placing of these overlaps shall take into account the tension length through the station, which should not exceed that for which the tension device on the contact wire is designed. However, when a substation is situated in close proximity, namely, within 5 spans of the overlap, the overlap need not be switched, as sectioning will be provided by the switching arrangement at the substation. In this instance the non-switched type of overlap shall be retained. A substation switch structure shall be located at least three spans away from an overlap. No further sectioning of the main line is required except where normally provided at stations and by section insulators at the switch structures provided at substations. If tie-stations are provided, sectioning shall be similar to the arrangement required at substations.

8.1.1 If a high-speed section insulator is offered as an alternative to a switched overlap, it shall incorporate the following features :

8.1.1.1 The running surface of the insulator shall be in the same plane as that of the contact wire, and means shall be provided readily to adjust such running surfaces.

8.1.1.2 The tension member/s of the insulator shall either have the axis/axes in the same plane as that of the contact wire, or if offset, shall have a compensatory compression insulator.

8.1.1.3 The insulator shall have a transverse stabilising device and the overall width perpendicular to contact wire shall be as small as possible compatible with the specified clearance.

8.1.1.4 The dynamic characteristics of the insulator shall approximate as closely as possible those of normal contact/catenary wire construction.

8.1.1.5 The composition of insulating components shall be completely non-tracking under the specified atmospheric conditions.

8.1.1.6 The balance of the insulator shall not be disturbed by the differential movement of contact and catenary wires with thermal variation.

8.1.1.7 Components likely to be eroded by arcing shall be readily replaceable.

8.1.1.8 Arcing horns shall be fitted capable of clearing the full fault current.

8.2 Sectioning shall be provided between yards and main lines and also between yards; for example, up and down arrivals yards. All goods roads where loading and offloading is undertaken shall be switched by means of an isolating and earthing switch with a rating of 1 000 amps. Water columns situated between electrified roads or adjacent to an electrified track where watering is undertaken shall be protected by means of sectioning and switching arrangements as per drawing CEE-TLC-4.

8.3 At loops, sectioning and switching shall be provided in the loop roads. Section insulators shall be provided at each end of the loop, and the loop shall then be connected to the adjacent track by means of an overhead track switch. Alternatively on long loops an insulated type of overlap with an overhead track switch is to be installed and a section insulator at the opposite end of the loop.

9.0 SPLICING INTO EXISTING OVERHEAD WIRES

9.1 The Contractor shall take into consideration existing electrification lay-outs when positioning overlap spans and terminating wires, to calculate the tension lengths required.

9.2 The Contractor, during the course of his survey, shall plot and include the position of 4 to 5 spans of the existing electrification structures and the lay-out of equipment between them on his scale plans. Splicing in of new overhead track wires shall be undertaken by the Contractor under the necessary work permit requirements.

10.0 FOUNDATIONS

10.1 Design

10.1.1 The design of the foundations shall be the responsibility of the Contractor.

10.1.2 Whatever the design used, the resistance between the mast steelwork (supported on the foundation by means of bolt groups or as an integral part of the foundation) and earth shall have a minimum resistance of 50 ohms.

10.1.3 If the mast is bolted down on a foundation, then insulating pads, washers and bushes of an acceptable grade and thickness of glass fibre material shall be used for providing a high level of insulation. The concrete cover on the foundation bolts shall be not less than 150 mm for the purpose of preventing leakage currents as far as possible. See under "erection of steelwork" for method of protecting insulating washers and bushes by use of sealing material.

10.1.4 Tops of foundations shall be at heights as specified below to minimise possibility of loose earth collecting on the top surface and thus causing leakage of current. The heights required generally are as follows :

(a) Standard I-beam or universal column bolt group foundations not less than 150 mm above formation level and not more than 500 mm below rail level, except in station yards or where otherwise directed and in these cases the foundation height shall be raised to rail level or as directed by the Engineer.

Where the foundation is an integral part with the mast as in the case of core type foundations, the foundation will be level with the formation and a collar shall be cast around the mast to not less than 150 mm above formation level or not more than 500 mm below rail level. In station yards the collar shall be continued to the rail level as directed by the Engineer.

(b) Standard rail mast foundations with bolt groups as per bolt group foundations in (a) above.

(d) Cross-catenary mast foundations with bolt groups are to be cast level with the highest rail of the group of rail tracks to be spanned by the cross-catenary wire, except where otherwise directed by the Engineer.

10.1.5 Foundation design shall be such that the maximum loads will be carried without movement of the foundation in the ground. On completion of the installation the excavation shall be filled back and the fill consolidated to at least the density of the undisturbed soil.

10.1.6 Where back guys (stays) are required the contractor shall excavate for and plant the anchor foundation. The stay rod shall include insulation as depicted on drawing No. CEE-TQ-31 which is issued as a guide to the Administration's requirements. A cast foundation which conforms generally to this drawing may be offered if desired and will be subject to the approval of the Engineer. Unit prices in this case are to be included in the schedule of prices. Stays which constitute an obstruction or hazard shall be protected with stay guards, which shall be protected with one coat of a suitable primer plus two coats of white oil paint.

10.2 Excavations for foundations and payment

10.2.1 Excavations for foundations shall be suitably covered whenever work is not actually in progress and side drains shall not be blocked. The cover used shall be capable of withstanding a mass of 100 kg .

10.2.2 The Schedule of Prices provides for separate unit rates for various types of material excavated.

10.2.3 "Soil" shall mean material which can be excavated by means of pick and shovel only.

10.2.4 "Non-cohesive material" shall mean material in which it is not possible to excavate a hole with vertical sides by reason of the sides collapsing. This shall apply whether the material collapses in the dry state or as a result of water-logging.

10.2.5 "Soft rock" shall mean broken, friable or soft rock which can be excavated by means of a mechanical excavator, paving breaker or moil point.

10.2.6 "Hard rock" shall mean material which can only be excavated by blasting or drilling and splitting. This shall include non-reinforced concrete.

10.2.7 Excavations for all types of foundations will be measured according to the dimensions shown on the relevant drawings, unless otherwise instructed by the Engineer. Overbreak will not be paid for.

10.2.8 Excavated material will be classified and measured separately in the categories indicated in the Schedule of Items, Estimated Quantities And Prices, and the Contractor will be paid according to the rates applicable to, and volume of, each component material.

10.2.9 Should cuttings require to be widened to accommodate foundations or deviations of the table drains, the cutting shall be set back for its full depth and at the same slope as the original cutting. Excavation of this material will be measured separately from the foundation excavations. (This will apply only to cuttings in soil or friable material.)

10.2.10 Excavations shall be concreted as soon as possible and under no circumstances may excavations be left near running lines without adequate precautions.

10.3 Concrete in foundations

10.3.1 The specification for concrete to be used for foundations shall be in accordance with specification E8 included in these documents. The strength shall be adequate to suit the tenderers design and in accordance with clause 2.3 of this specification and shall not be less than 15 MPa . As regards curing of the concrete, clause 12.1(V) of the specification E8 shall apply. The tenderer shall furnish the designed strength of the concrete at 28 days to the Administration with his tender.

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11.0 STRUCTURES AND MASTS FOR SUPPORT OF OVERHEAD TRACK EQUIPMENT

11.1 Structural steel for supports, bridges and other fittings shall comply with BS 4360, or equivalent, if mild steel is to be used. Tenderers may, however, offer structures of high-tensile steel to BS 548 or equivalent. Alternatively, rust-resisting steel "Corten" or similar can be offered in which case painting or galvanizing will not be required.

11.2 All items of mild steel or high tensile steel including masts shall be hot-dip galvanized in accordance with SABS 763 or equivalent specification. Electroplating or sherardising of steelwork items will not be acceptable.

11.3 The deflection of structures and masts must be such that under the maximum working loads plus load due to wind, the pantograph shown on drawing CEE-TJN-129 attached, will not leave the contact wire in the middle of the span, when also taking into account the stagger of the contact specified. In addition sufficient allowance must be made for other factors such as locomotive motion sway and track inaccuracies. Vertical deflections of the structures shall also be taken into account for this purpose.

11.4 To prevent corrosion in the welded joints all welding shall be continuous with no gaps or blowholes.

11.5 If masts are of the type which is bolted down on the foundation then allowance shall be made for using mast base insulating washers and bushes as described under section 10 of this specification.

11.6 Design of structures and associated fittings shall take into account that painting of these will eventually be required, consequently an open type of design is required so that a paint brush can reach all corners easily.

11.7 Drawings of all items of structures, masts and fittings shall be submitted with the tender to give a clear conception of the tenderer's proposals.

11.8 Prestressed concrete structures and masts may be offered by tenderers if desired, but in this case the problem of electrolytic corrosion of the reinforcing steel and minimizing of leakage currents shall not be overlooked. Full details of the design shall be given and corrosion protection methods fully outlined. In this case all steel brackets on the concrete supporting high-voltage insulators shall for purposes of safety, be earthed to the negative return of the system or to earth, as the case may be.

12.0 ERECTION OF STEELWORK

12.1 The sequence of erection of masts, fittings, etc., will be left to the contractor to determine, except that the sequence of actual mounting the mast on its foundation shall be as follows :

The material used for sealing the underside of the mast base shall be as follows, to specification No. T-P4A-9 :

(a) Petroleum jelly paste equal to Denso paste.
(b) Petroleum jelly impregnated nylon fabric tape equal to Denso tape.

The foundation top surface shall be coated with the paste over the area where the mast base will be placed, extending this by approximately 50 mm right around. This paste shall also be applied to the underside of the mast base and the protruding bolts.

The tape shall be used double thick and shall be cut to a size approximately 500 x 200 mm (2 pads per foundation) for I-beams and 830 x 200 mm for rail masts. These pads must be placed over the foundation bolts in such a manner that the mast base angles will be completely covered underneath, after erection of the mast onto the foundation with the pad protruding approximately 25 mm right around which must be smoothed down onto the concrete to form a seal. Some of the jelly will be squeezed out of the tape by the mass of the mast and must be trimmed around each base angle.

Please note that the above procedure obviates the installation of the square insulation pads as used previously.

After the erection of the mast, a ferrule must be inserted over each bolt and into the hole in the mast base, followed by filling the hole with petroleum jelly paste, then the placing of the round insulating washer, the round steel washer and finally the nut, all as shown on drawing No. CEE-TU-30.

12.2 The nuts shall be tightened as tightly as possible by one man only using a spanner not longer than 500 mm . Under no circumstances shall the spanner be lengthened by a pipe, or another device used.

12.3 The mast base around each bolt as well as the nuts and bolts must be coated with the paste and a square of tape folded over the bolts and smoothed down to form a seal which will cover the bolts and nuts and an area of approximately 25 mm around the nuts on the mast base.

12.4 During the erection of masts special care shall be exercised by the Contractor to avoid damage to foundations, bolt screw threads, insulation pads, ferrules and washers, and the base.

12.5 After erection each mast shall be tested to ensure that the insulation between the mast and the bolt group is sound. Any mast failing the test shall have all ferrules removed by the Contractor to ascertain the cause. If necessary, the whole mast shall be lifted and the insulation renewed.

12.6 Provision shall be made for running an 11 kV transmission line on overhead track structures. With this in mind, masts and structures in such positions that they will be required to support an 11 kV line if run, shall have sufficient strength to take the extra loading of the transmission line even though it may not be specified as being required at this stage. Masts provided shall be long enough for attachment of a cross arm (either at present or in the future) with the earth wire positioned above the cross arm (see also clause 16.3.1 hereof.) Where restricted vertical clearances exist the transmission line may be carried on separate cantilever arms to the side of the mast but the phase wires shall not be below the level of the adjacent 3 kV DC equipment.

12.7 Certain station yards will require street lighting type luminaires suitable for 400 watt high-pressure mercury-vapour lamps, to be erected on traction masts. The height of the luminaire to be approximately 15 metres above the ground. With the above in mind masts shall be provided which are capable of accepting an extension for these lights either initially or in the future. The extension shall be provided with suitable climbing rungs and safety hoops for maintenance purposes. As a guide drawing CEE-PTT-8 of an extension used by the Administration is included. Provision of the luminaire and wiring is not part of this tender. Yard lights will not be erected on masts carrying a transmission line or a track switch.

13.0 PAINTING OF MASTS

13.1 Paints and primers

13.1.1 The primer used shall be calcium plumbate to specification CSS 183/5.01/C57 in the case of painted surfaces.

In the case of anti-corrosive tape systems a structural steel primer to specification No. T-P4A-8 shall be used.

In coastal areas and inland up to 8 kilometres from the sea the masts shall be treated with an anti-corrosion tape system (equal to Denso tape) to specification T-P4A-10 (latest issue.)

From 8 kilometres upwards and up to 20 kilometres inland from the sea filled bituminous paint to SAR specification CSS 183/7.26 shall be applied as the intermediate and final coats.

From 20 kilometres upwards in inland areas high-gloss enamel, slow drying dark Admiralty Grey paint to specification CSS 183/8.00/G12 shall be applied, over a tie coating to specification CSS 183/6.01/G22.

13.2 Preparation of surfaces

13.2.1 All masts after fabrication shall be blast-cleaned to white metal. Abrasives and dust shall be removed by brushing and afterwards shall be primed within 8 hours.

13.2.2 The masts shall be shop primed with calcium plumbate primer at a spreading rate to give a dry film thickness of 0,02 - 0,04 mm . The primer shall be allowed to dry for a minimum period of 48 hours before the initial coating.

13.3 Painting

13.3.1 Primed masts shall be coated with two coats of filled bituminous paint, where this is specified. The initial coating shall be shop painted and the final coat site painted as follows :

Shop painting

Filled bituminous paint shall be applied at a spreading rate of 1,5 - 2,5 m^2 per litre to give a dry film thickness of 0,250 - 0,500 mm . The paint shall be allowed to dry for not less than 1 day under ideal temperature conditions. During transport of the masts to site special care shall be exercised in preventing damage to the painted surfaces.

Site painting

Surface paint defects, rusted patches and damaged areas shall first be restored with the specified primer and initial over coat and allowed to dry. Before applying the finishing coat, all surfaces shall be thoroughly cleaned and brushed down. An overall coat of filled bituminous paint shall then be applied to give a total dry film thickness of 0,550 - 0,800 mm . The painting shall be carried out on erected masts. All switch structure masts shall be given a final coat of aluminium paint to specification CSS.183/7.20 of suitable thickness on site over the filled bituminous paint.

Admiralty Grey paint

Where this is specified the primed masts shall be coated with two coats at a spreading rate to give a total dry film thickness of 0,200 - 0,500 mm .

13.4 Cleanliness

13.4.1 Cleanliness in applying paint is essential as paint shall not be spl ed onto insulators, wires, fittings and foundations. Any paint splashes shall be removed.

13.5 Stencilling and numbering of structures

13.5.1 All structures shall be sequentially numbered with letters approximately 75 mm high in black on a yellow coloured background. Alternatively, suitable plastic stick-on or transfer type of letters and numbering with a yellow background may

be used. The letter and number that shall be stencilled on the mast will be advised to the Contractor after approval of the lay-out plans. The number of letters and numbers per mast will range from between 4 and 10, and the height above foundation level will be 2 m .

14.0 OVERHEAD TRACK FITTINGS AND WIRING INSTALLATION

14.1 General

14.1.1 All fittings and wire on the "live" side of the overhead equipment including the insulators and clevis pin for attaching them to the steelwork shall be regarded as overhead wiring.

In the case of a separate aluminium earth wire, provision shall also be made under this section for the erection thereof. For earth wires forming part of the transmission line on overhead track structures, refer to subclause 14.10.1 and clauses 16.0 and 16.2.

14.2 Design of fittings on the "live" side of the overhead equipment.

14.2.1 Fittings on the wiring, for example, steady arms, swivel clips, dropper clips, contact splicers, strain clamps, feeding clamps, anchoring clamps for contact wire, etc., shall be made of materials which have been proved by tenderer's previous experience to be suitable for the purpose taking into account local conditions in the Republic of South Africa. They shall also be designed for ease of installation and shall be relatively maintenance free as possible.

14.2.2 Contact suspension droppers shall include insulation to prevent transference of current via the dropper, and shall be capable of holding a mass of 100 kg . The design shall be such that in the event of breakage the lower position of the dropper shall remain in an upright position and shall not foul a pantograph. The dropper may be of one-piece construction, but shall incorporate a means to prevent a compression load on the dropper due to uplift caused by a pantograph. Stainless steel wire is preferred.

14.3 Insulators

14.3.1 The insulators shall be porcelain and of the solid core type complying with Class A SABS 177 specification or equivalent where applicable.

The porcelain sheds shall be of the open profile type to minimise deposits from polluted atmosphere. The sheds shall also have sufficient mechanical strength, the ultimate mechanical strength in tension shall be not less than 54 kN .

The leakage path shall not be less than 530 mm .
Minimum dry flash-over value to be 128 kV .
Minimum wet flash-over value to be 90 kV (vertical).

Insulators made of other types of material, e.g. glass fibre covered with Teflon may be offered but full details and proof of its successful use elsewhere for similar purpose shall be given at the time of tendering.

14.4 During construction all overhead wires shall be temporarily earthed to the traction rail, at both ends of the section on which construction work is being undertaken.

14.5 Sagging and tensioning of overhead wires

14.5.1 Unless otherwise specified, the sagging and tensioning of conductors to suit the tenderers design shall be stated in the tender. The contact wire shall preferably be sagged on main line and loops midspan an amount of 75 mm at the average working temperature (± 38°C). If the Contractor offers a different design he shall furnish full reasons for so doing.

14.6 General requirements for erection of overhead wires

14.6.1 The portion of copper wire on which current-carrying clamps, namely parallel, feeder, double-ended strain, contact wire splicers, and T-clamps are attached shall be thoroughly cleaned with a wire brush.

14.6.2 All aluminium wire shall be cleaned with a wire brush and the compression and clamp fittings and the corresponding portion of the wire shall be treated with Penetrox A or equal before crimping or bolting down. After crimping or bolting down, the entrance of the aluminium wire into fittings shall be effectively sealed by greasing with "NO-OXID" grease or equal up to a distance of approximately 75 mm from the entrance.

14.7 Adjustment of contact wire/s

14.7.1 On tangent track the contact wire shall be staggered 200 mm ± 10 mm on alternative sides from the centre line of the overhead track at successive structures. On curves the stagger shall be 300 ± 10 mm from the centre line of the overhead track towards the outside rail at all structures and shall be on the centreline at midspan.

REFER TO S 14

14.7.2 The contact wires shall not be graded more than 5 ‰ (per mil) with respect to rail level on main lines and loops where speeds of 120 km/h apply. In yards this grading may be increased to 8 ‰ .

14.7.3 All kinks and twists in the contact wire shall be removed on the initially tensioned contact wire, before the contact wire is finally tensioned.

14.8 Isolating and switching arrangements

14.8.1 Section insulators shall only be cut into the overhead wires provided the minimum clear distance between contact and catenary wires is not less than 750 mm after installation of the section insulator. Whenever section insulators are required to be positioned in midspan, the span length shall be reduced accordingly to give this clearance.

14.8.2 All switch contacts shall be designed for a minimum continuous rating of 3 000 amps for section switches and 1 000 amps for earthing type switches. Insulators on switches to have at least the same electrical properties as that for overhead wires. Section switches shall be able to be locked in both the open and closed position. Earthing type switches shall only be lockable in the "off" position. Arcing horns shall be fitted to all switches. All contacts shall be of a conducting material resistant to forming an oxidised layer which can result in poor contact being made after a period of time.

14.8.3 The Contractor shall arrange for the operating handle of the earthing type isolating switches to be interlocked by the key exchange box shown on drawing CEE-TLB-3. The cylinder lock and glass-fibre box with slide will be supplied by the South African Railways. Alternatively, the Contractor may design his own key exchange box if this is more suitable for the type of switch offered, but in this latter case the South African Railways will supply the cylinder lock. The interlock mechanism shall be very robust and be subject to approval by the Chief Electrical Engineer.

14.8.4 Switches may be mounted on any overhead track-equipment structure provided it is bonded with a double bond to the rail. No 'live' part on a switch structure may be closer than 4,5 m to the ground. Switch operating handles shall be mounted at a suitable height to facilitate their operation. At switch structures used for feeding the overhead wires at substations and tie-stations a Thyrite type lightning arrester in accordance with specification number T-S1A-11 and a capacitor type lightning arrester in accordance with specification T-S1A-10 shall be mounted. The Thyrite arrester shall be connected between the 3 kV overhead wires and a deep spike earthing system, whereas the capacitor type shall be connected between the 3 kV equipment and the negative return circuit. The earth connection between the Thyrite arrester and the earth spike shall not pass inside any closed securing steel loop such as a U-bolt and back strap and shall follow as straight a path as possible. Where changes of direction are essential, large radii curves shall be used. The earth resistance of the spike earth system shall be not more than 5 ohm. A spark gap shall be bolted to the mast and the down conductor from the Thyrite arrester shall be connected to the other terminal of the spark gap. Drawing No. CEE-TU-49 of the spark gap is attached. The Contractor may use a suitable device of his own design provided it is approved by the Chief Electrical Engineer.

14.8.5 To isolate the overhead equipment serving oil sites, a special switching arrangement similar to that shown on drawing No. CEE-TMG-70 is required.

14.8.6 To enable steam engines to take in water at water columns on electrified lines an isolating switch interlocked with the water-column trunk shall be provided at certain localities. The arrangement shall be similar to that shown on drawing CEE-TLC-4 (See also paragraph 8.2.) The Contractor may offer an alternative design incorporating a standard earthing type switch.

14.9 Splicing overhead wires

14.9.1 Contact-wire splicers shall be of Cu-Ni-Si, manufactured in two halves with serrated cheeks and bolted together for clamping purposes. The installation procedure for obtaining the correct torque on the bolts shall comply with the requirements of the manufacturer.

14.9.2 The copper catenary wire shall be spliced with a suitable preformed wire type splice.

14.9.3 Aluminium feeder wire shall be spliced with a suitable presplicer in accordance with the manufacturer's recommendation. The ends of aluminium feeder wires shall be thoroughly cleaned with a wire brush and, including the splice, be treated with Penetrox A before crimping. The Contractor shall ensure that the ends of the wires are inserted 'fully home' before crimping.

14.9.4 The aluminium earth wire shall be spliced with a suitable preformed wire type splice.

14.10 Erection of earth wire

14.10.1 A 250 mm^2 aluminium earth wire shall be run on overhead track structures over the route. In the case of overhead track-equipment structures supporting an 11 kV transmission line this earth wire shall be required in addition to the earth wire which forms part of the 11 kV line. For individual structures see clause 17.3.2 for bonding requirements.

14.11 Track occupations

14.11.1 In order that timeous arrangements may be made for the running of wiring trains and track occupations, the Contractor shall make application to the Engineer at least 3 weeks in advance of such trains or occupations being required.

15.0 WARNING AND INSTRUCTION BOARDS

15.1 General

Warning and/or instruction boards shall comply with the requirements scheduled on the respective drawings.

Drawings showing the size, finish and installation details are scheduled in Annexure No. 1.

15.2 Provision of warning boards.

Warning boards shall be provided in the following instances :

15.2.1 Goods sidings and loading banks.

At all sidings and loading banks warning notices (drawing CEE 54/112418) shall be erected defining the limits within which loading and offloading may be undertaken.

At sectioning points the board shall be positioned not less than 3 metres in the horizontal direction from the nearest "live" equipment on the siding end. The board shall be erected facing the siding either at eye level 2,6 m clear of the track, or on the overhead wires, depending on physical features. In the case where a section insulator is installed in the wires above a cross-over track between a siding and an adjacent track opposite the loading and offloading area, a minimum horizontal distance of 3 metres between the nearest live portion of the section insulator and the centre line of the siding track is permissible, provided a danger warning notice (drawing CEE 54/112400) is installed on the siding end of the section insulator. A second danger warning notice shall be installed on the overhead track-equipment where the two contact wires are approximately 2 m apart. Refer to drawing CEE-TP-67.

On the respective switch masts an isolating and earthing switch precautions board (drawing CEE 54/112414) shall be erected as well as the "Power-on" - "Power-off" board (drawing CEE 54/112434) for switch handle positions.

A no-entry sign to drawing CEE 54/112422 shall be suitably erected not less than 3 m from the relevant siding. Physical features will determine the mounting arrangements.

15.2.2 Water columns

On the water column side of the section insulators, warning notices (drawing CEE 54/112412) shall be erected at a horizontal distance of not less than 3 m from the nearest "live" portion of the section insulator. These boards with limits of watering, trimming, etc., shall either be erected in the overhead wires or 2,6 m clear of the track at eye-level.

An operating instruction board (drawing CEE 54/112438) shall be affixed to the water column switch mast as well as the "Power-on" - "Power-off" boards (drawing CEE 54/112434) for indicating switch handle positions.

The minimum permissible distance along the overhead wires from a point opposite the water column switch to the respective section insulator/s is 40 m .

15.2.3 Oil siding

A "non-electrified" sign (drawing CEE 54/112428) shall be erected opposite the point where the overhead wires are no longer on gauge for the siding. A non-entry warning board for electrified sidings shall be erected not less than 3 m from the respective section insulator. Physical features will determine the position which shall be established on site.

An oil site switch operating instruction board (drawing CEE 54/112432) and an oil site danger board (drawing CEE 54/112416) shall be suitably affixed to the respective mast in accordance with drawing CEE-TMG.35. A "Power-on" - "Power-off" board shall be provided for indicating the switch handle positions.

15.2.4 Non-electrified roads

Warning boards (drawing CEE 54/112428) indicating non-electrified roads shall be positioned either on separate structures 2,6 m clear of the track or on the overhead wires or on masts depending on physical features. The "non-electrified" board shall be situated at the limit to which locomotives may proceed along the electrified road, where applicable.

15.2.5 Separately switched feeders

All conductors which run on overhead track structures and are independently switched shall have skull and cross-bones warning boards (drawing CEE 54/112400) attached at each point of suspension and shall face the likely access way to the conductor. From the point of view of clearances to other wires and fittings a switched feeder shall be treated in the same way as transmission lines in the regulations.

15.2.6 Track switches and 11 kV isolating switches

"Open" - "Closed" boards (drawing CEE 54/112436) shall be suitably affixed to indicate the switch handle positions.

16.0 11 KILOVOLT TRANSMISSION LINE ON OVERHEAD TRACK STRUCTURES

16.1 General

16.1.1 The Contractor shall be required to survey the 11 kV transmission line route and supply and install all the 11 kV transmission line components required on overhead track structures

or on separate structures where this is applicable. This clause shall apply when a 11 kV transmission line is specified in the Annexure attached hereto.

16.1.2 All work on the transmission line shall comply with the requirements of the latest issue of the S.A.I.E.E. Code of Practice for Overhead Power Lines for conditions prevailing in South Africa.

16.2 Survey

16.2.1 The Contractor shall during the course of his survey of the line for the 3 kV overhead track equipment requirements also locate and position the 11 kV H-masts independent of the overhead track structures, while maintaining not less than the minimum horizontal clearances specified to the track centre line and "line" 3 kV DC equipment, in close proximity to all supply points taken from the 11 kV transmission line, such as signal relay rooms, etc., and also at 11 kV sub-stations which may be required for station and yard supplies. H-masts shall not be positioned on station platforms.

16.2.2 The proposed route of the 11 kV transmission line on overhead track structures through station areas as well as terminal and H-mast positions shall be shown on electrification lay-out plans.

16.2.3 In stations where footbridges are provided the 11 kV line shall, if practical, be routed round the bridge or otherwise maintain a minimum of 4,5 m clearance above the walkway under all atmospheric conditions.

16.2.4 At 3 kV substation switch structures the 11 kV transmission line shall be separately supported either by means of an H-mast or an independent cantilever mast suitably positioned. The minimum clearances shall be observed. Also all masts carrying 3 kV switches shall not support the 11 kV line and a separate structure shall be installed to support the 11 kV lines at these locations, if necessary.

16.2.5 11 kV line terminations at bridges, supply and end points and tunnels or other obstructions, if required, shall either be undertaken on the overhead track structure or on an independent structure, depending on their suitability and the switching requirements. If an 11 kV line is terminated on an overhead track structure, no live 11 kV equipment shall be erected below cantilever or double boom level.

16.2.6 In the case of tunnels where it is practicable for the transmission line to be run on separate structures on the surface within the Railway servitude over the tunnel it shall be so indicated on plans.

16.2.7 The 11 kV transmission line shall be suitably terminated in close proximity to existing 6,6 kV lines on electrification structures at stations or junction points. The proposed route on existing structures to the terminal point in stations shall be shown on the plans.

16.2.8 On completion of the preliminary survey, and the submission of the plans, "walk-outs" shall be organised through the Engineer of the Administration's various Departments concerned, so that agreement to the proposals may be expedited.

16.3 Erection details

16.3.1 The transmission line comprises 3 phase conductors with one earth wire supported above. Particulars of the conductors are as follows :

		Phase Wires and Earth Wire
Make up of wire	50/9 mm^2	(6/1/3,35) A.C.S.R. or
	50 mm^2	(7/3,30) Aluminium Alloy
Material	To SABS 182 and BS 342 respectively	

Tenderers may design the transmission line configuration and steelwork as desired but the earth wire shall be so placed above the phase wires as to afford adequate lightning protection to these conductors. If desired the arrangement shown on drawing CEE-PFC-34 may be utilized for sections of electrification with and without the transmission line. Horizontal placing of the three phases need not necessarily be adhered to. The phase wires shall be transposed at equal intervals approximately 3 times per 10 km .

16.3.2 Pin insulators shall comply with the requirements of specification SABS 177 latest issue. Suspension insulators used in strain shall also comply with the requirements of specification SABS 177 latest issue and shall be 255 mm dia. and two in series are to be used at strain points.

16.3.3 Where conductors are supported on pin insulators armour rods of acceptable type are to be used for protection. Binding in of the conductors shall be undertaken in accordance with drawing No. CEE-PA-10. "Preformed" type tie-in binders may be employed if desired. The top tie shall be used where the angle of deviation is zero and the side tie where a deviation exists. A deviation angle of 20° on pin insulators shall not be exceeded.

16.3.4 Stays for transmission line structures other than those carrying traction conductors shall be constructed in accordance with the SAIEE Code of Practice for Overhead Lines for Conditions Prevailing in the Republic of South Africa.

16.3.5 Suitable compression type splicers shall be used for splicing the phase and earth wires where necessary. The ends of the wires shall be thoroughly cleaned with a wire brush and then, including the splice, treated with Penetrox A before crimping. The finished splice is to be treated with 'NO-OXID' grease. Alternatively preformed wire splicers of strength at least equal to the breaking strain of the conductors may be used. All splice joints shall be made in accessible positions. Preformed type fittings may be employed for make off of wires and stays.

16.3.6 Contractors are required to design, supply and erect H-mast structures, for mounting transformers, isolating switches, operating rods and handles, fuse cut outs and surge diverters. The design may be based on drawing CEE-PFB-9. Since the traction earth wire is common with the transmission line earth wire and transformer neutral it is necessary that the H-frame structure be insulated from its concrete base in a manner similar to that used for the traction masts.

16.3.7 The 11 kV transmission line spans crossing all proclaimed roads shall be erected with duplicate conductors as follows :

The duplicate conductors shall be supported by double insulators and tied together at intervals not exceeding 1,5 metres.

Binding wires or clips of the same composition as the conductors shall be used for the ties.

The tied-in conductor shall extend for at least 1,5 m beyond the support at each side of the crossing.

The sag shall be appropriately increased to allow for an even tension.

16.3.8 The Administration will supply and arrange for the installation of all items of high voltage and low voltage equipment and wiring on all H-frames.

17. BONDING OF RAILS AND MASTS TO RAILS

17.1 General

17.1.1 Information regarding the length and size of the rail between stations and in station areas shall be obtained from a survey of these areas. The number of rail joints in a particular area shall be established by the Contractor, during the period of the contract.

17.1.2 Whenever one rail of the track is required for signal circuitry it shall first be established by the Contractor which rail is affected, as in this instance no cross bonding between rails is permitted. Both rails shall be continuously bonded whether or not one rail is used for signal track circuitry.

17.1.3 Mechanized track tamping machines are used for maintenance of tracks and the positioning of all bonds shall take this into account, to prevent bonds being broken off the rail during tamping operations by these machines.

17.2 Type of bonds and bonding

17.2.1 Rail continuity bonds across fish plated joints shall be of acceptable length and flexibility for the purpose required and shall be of annealed copper wire of sufficient cross-sectional area (minimum 100 mm^2) to carry the maximum currents flowing in the rails and also such that resistance of return circuit is not increased excessively.

17.2.2 Mast to rail bonds shall be provided not more than 335 m apart or roughly at every 5th structure. Mast to rail bonds shall be a 96 mm^2 PVC sheathed stranded flexible galvanized steel wire installed as shown on drawing CEE-TU-35. The sheath must have adequate thickness for the purpose and shall be not less than 2 mm nominal thickness.

17.2.3 All rail continuity bonds and mast to rail bonds shall be to rails or masts by means of the exothermic welding process. The preparation of mast, rail and rod surfaces shall comply with the requirements of the manufacturer for the type of exothermic weld product used.

17.2.4 Alternative methods of bond attachment such as electric pin brazing or exothermally bonded threaded studs or other approved methods may be used but the tenderer shall give full details of the type/s he proposes to use. Their use shall be subject to the approval of the Chief Electrical Engineer.

17.2.5 Bonds used between switch operating rods and switch frames shall be affixed by means of exothermic welding. The bonds shall be 50 mm^2 copper nominal.

17.2.6 Where the signal and traction rails are transposed, then at these double block joints two x 150 mm^2 copper stranded diagonal bonds shall be used to inter-connect the two traction rails.

17.2.7 Where bonds are run on track concrete sleepers they shall be affixed thereto by means of a suitable clamp, as shown on drawing No. CEE-TU-50. No holes shall be made in these sleepers.

17.3 Description of installation procedure

17.3.1 Rail to rail bonds

On sections between stations the traction rail/s only shall be bonded with 2 x 84/0,85 mm flexible traction bonds.

17.3.1.1 For siding and station loops only one rail shall be bonded for the return current path. The choice of rail to be bonded

is left to the discretion of the Contractor. However, for ease of installation it is suggested that the rail nearest the respective structure is selected where possible, but the Contractor shall ensure that the continuity of the negative circuit return current path is completed.

17.3.1.2 All turn-outs, from main lines, yard roads or sidings, shall have bonds installed in accordance with drawing CEE-TU-45 sh. 1 - 6 to ensure a return current path for the negative circuit.

17.3.1.3 Cross bonds shall be provided at both ends and in the centre of yards or loops.

Cross bonds shall mutually connect all the current return rails together. Cross bonds are to be 96 mm PVC covered galvanized flexible stranded wire. Bare ends of bonds are to be kept clear of the ground to minimize leakage of return current through the earth.

17.3.2 Mast to rail bonds

17.3.2.1 To reduce leakage currents from the negative return circuit to a minimum, all bonds of this type shall be kept out of contact with the ground and care shall be exercised where the PVC covering is removed at ends of the bond that these ends are also kept clear of the ground.

17.3.2.2 All masts not supporting at least one earth wire shall be provided with two mast to rail bonds. These bonds shall be separated by one sleeper spacing to minimise the possibility of simultaneous breakage.

17.3.2.3 Anchor masts on which the earth wire is terminated shall be provided with a single bond between the mast and current return rail.

17.3.2.4 All masts carrying switches shall be double bonded to rail irrespective of whether the earth wire is attached to them or not. Bonds shall be separated as in 17.3.2.2.

17.3.2.5 On all main lines when both rails are used for return current paths, cross-bonds shall be installed between adjacent rails of a track and between tracks whenever mast to rail bonds are provided. These bonds shall be 96 mm^2 PVC covered galvanised flexible stranded wire. They shall be run on track sleepers and suitably fixed thereto. They shall be kept clear of mechanical track tamping machines.

17.3.2.6 On manganese type rail turn outs and hard steel rails for example UICA, UICB and UICC the bonds are to be connected to the web of the rail only. In the case of other types of rail to the flange of the rail.

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17.4 3 kV substation negative return connections

17.4.1 The current return rail/s shall be exothermally bonded with 6 x 160 mm^2 copper conductors, either of suitably stranded copper wires or solid 161 mm^2 contact wire, equally apportioned between the traction rails and terminated as shown on drawing number CEE-TU-41. The connection between these negative return current conductors and the traction rail/s shall be made by means of two 12 x 7/0,85 mm flexible copper bonds (50 mm^2 nominal) exothermally welded to each conductor and rail.

The position of the negative return cable termination box in relation to the track centre line and the substation shall be established on site and the installation procedure is as directed on drawing No. CEE-TU-41. The 120 mm^2 crimping lugs required in the case of the conductors stated above are depicted on drawing CEE-PA-14 sheet one and in the case of the 500 mm^2 negative cables drawing CEE-TU-[illegible]. The negative return conductors to the traction rail/s are to be painted red. The lugs are to be crimped to the conductors using the crimping tool and dies shown on drawing CEE-PP-19.

17.5 Block joints

17.5.1 All non-electrified tracks connected to 3 kV DC electrified tracks shall have block joints installed in both rails at suitable rail joints. The position shall be determined on site. The block joints supplied shall be as used for signalling purposes and shall fit the particular size of rail and fish plated joint. On track sections where block joints are required they shall be installed by the Administration's Civil Engineering Department and arrangements are to be made through the Engineer.

17.6 Bonding of overhead track switches

17.6.1 Track switches shall have their operating rods bonded to the switch frame, by means of exothermal welding.

17.8 Steelwork requiring bonding

17.8.1 All steel bridges over electrified tracks and steel railway line bridges over roads, rivers, etc. shall be double bonded to rail through separate spark gaps. The two outermost steel members of the bridge shall be connected to rail through spark gaps similar to that on drawing CEE-TU-49. The traction earth wire shall be lightly insulated from the structure which in turn shall be connected to a suitable earth mat of not more than 5 ohms resistance.

17.8.2 Corrugated iron roofs and structural steel assemblies in close proximity to any live portion of the overhead wiring shall be double bonded to rail through sprak gaps. 25 mm x 3 mm copper straps shall connect the extremes of the roof or assembly to respective spark gaps mounted below the platform coping. In the case of vertical sided goods shed platforms, the spark gap shall either be recessed flush into the wall, or mounted below rail level, to maintain the mini-

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mum fixed structure gauge. A 96 mm^2 PVC covered stranded flexible galvanized steel wire shall connect the spark gap to the rail. Goods shed roofs shall be treated in the same manner as clause 17.8.1 when electrification wires are supported from the roof members.

18.0 ALTERNATIVE DESIGNS

18.1 Tenderers may submit designs as alternatives to their main design for consideration, provided such alternatives have proved themselves in practice and are fully substantiated in the tender. Tenderers are advised however to submit their main offer in terms of this specification and any alternative offer shall be in the form of tenders for the complete works.

19.0 COMPLIANCE

19.1 The tenderer shall indicate clause by clause whether his tender complies in all respects, and where alternative offers are submitted these shall be indicated. The successful tenderer shall submit drawings of the designs for retention by the Administration.

20.0 PLANT HIRE

20.1 A wiring train which is made up of reel trucks and several flat-top vehicles may, if available, be hired from the Administration. Motive power with operating personnel will be provided to haul the wiring train. All costs involved shall be borne by the Contractor. (See notes to Contractor regarding rate of charges.)

21.0 SPARES FOR MAINTENANCE PURPOSES

21.1 The Contractor shall be required to supply overhead track equipment spares for maintenance purposes. All overhead wiring fittings, steelwork and equipment designed by the Contractor or others shall be listed and priced separately, and be submitted with the tender documents. These spares will not form part of the main contract but will be paid for separately by the Administration.

21.2 The quantity and type of spares required will be advised to the successful tenderer. Spares shall be delivered to the Administration before the proposed commissioning date.

21.3 A separate price list for spares to be quoted on is given in Annexure 4.

22.0 GUARANTEE AND DEFECTS

22.1 Notwithstanding anything contained in the specifications and documents included in this tender, the Contractor shall guarantee the satisfactory operation of the complete electrical work supplied and installed by him and accept liability for maker's defects which may appear in design, materials and workmanship for a period of 12 calendar months

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after acceptance by the Administration of the completed and commissioned asset. If any urgent repairs have to be carried out during the guarantee period by the Administration on any such work the Contractor shall inspect such repairs to ensure that the guarantee period is not affected

One percent of retention money deductible in terms of clause 45(b) of the "Conditions of Contract" and clause 12.1 of the "Special Conditions of Contract" - Part 1 shall be retained by the Administration for the 12 months guarantee period.

22.2 The equipment shall be designed to be as far as practicable maintenance free during the 12 month guarantee period.

23.0 AS BUILT DRAWINGS

23.1 All "as built" electrification lay-out drawings shall be supplied in microfilm form to SAR specification CEE-M5A-1 (latest issue.) A suitable index listing all drawings shall be supplied in A4 booklet form. Sample index forms are available in the Chief Electrical Engineer's Drawing Office

24.0 GENERAL

24.1 The tenderer shall accept responsibility for the clearing of any imported materials through the docks and the subsequent forwarding of these materials to site. The tendered price shall allow for these costs.

24.2 The dates from which escalation will be calculated for material and labour shall be stated by the tenderer.

24.3 The tenderer shall allow for all transport costs in the tendered price. No exemptions, reduced tariffs or free railage will be granted by the Administration other than provided for in the E5(E) agreement or the Special Conditions of Contract - Part One.

24.4 The successful tenderer shall make all the necessary arrangements with the suppliers/manufacturers of the material supplied for all the necessary sampling and testing required to be carried out by recognised testing authorities or consulting engineers. He shall ensure that all the material supplied meets with the requirements of the specifications referred to in this specification No. T-T6E-4.

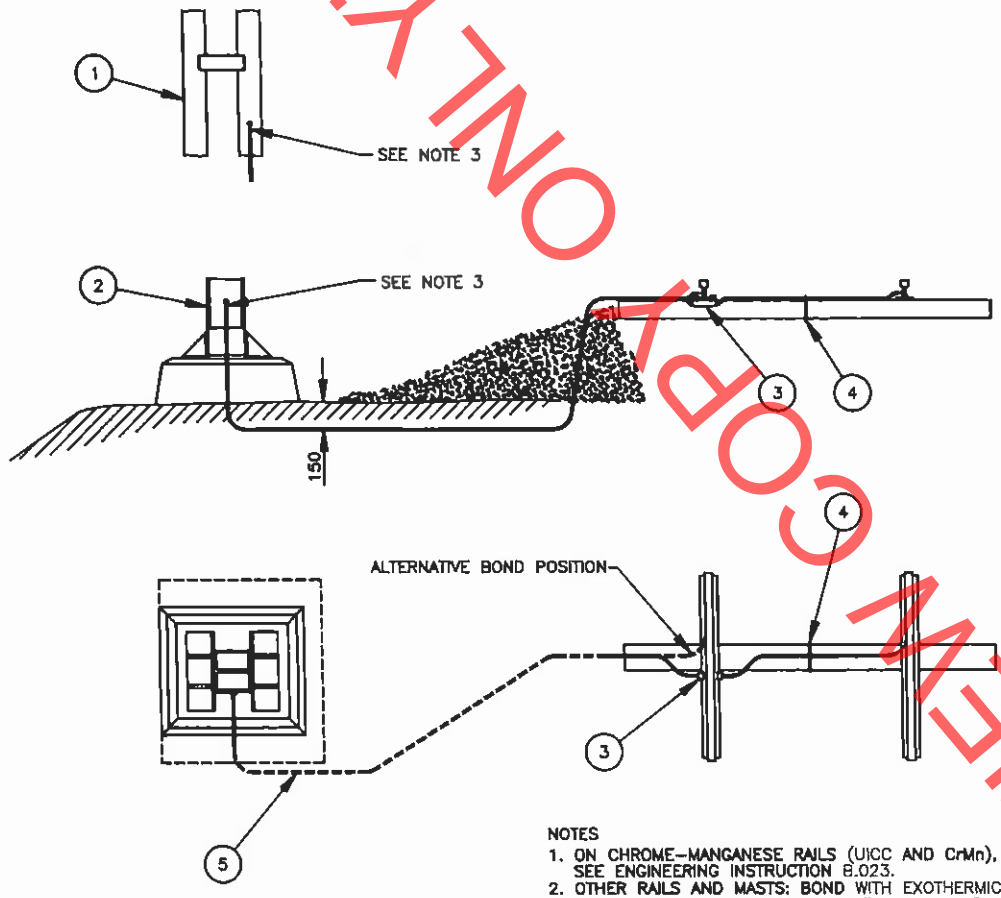
The cost of such sampling and testing is to be included in the tendered price.

ITEM	DESCRIPTION	QTY	STORES ITEM NO	DRG NO CEE–
1	MAST, RAIL	1	———	———
2	MAST, UNIVERSAL COLUMN OR I–BEAM	1	———	———
3	CABLE SUPPORT FOR TRACK BOND	*	54/11833	TU–46
4	CLIP, RETURN CURRENT BONDING (SEE NOTE 4)	*	———	TU–50
5	WIRE, ELECTRICAL STEEL, GALV, PVC SHEATHED, 96mm²	*	54/19365	———

* AS REQUIRED.

AMENDMENTS		
NO	NAME	DATE
7	W BRIGHT	94–04–25

REDRAWN AND ITEM NO'S UPDATED. NOTES AND TITLE REVISED. MATERIAL LIST ADDED.
D O REF T93/034



NOTES
1. ON CHROME–MANGANESE RAILS (UICC AND CrMn), BOND WITH RING GROOVED REVIT. SEE ENGINEERING INSTRUCTION 8.023.
2. OTHER RAILS AND MASTS: BOND WITH EXOTHERMIC BONDING PROCESS.
3. BARE WIRES TO BE SEALED WITH "AUTO COAT " OR SIMILAR APPROVED.
4. IN CASE OF WOODEN SLEEPERS, SADDLES SHALL BE USED.
5. BONDS TO PASS UNDERNEATH TABLE DRAINS.
6. FOR APPLICATION OF EXOTHERMIC BONDING EQUIPMENT SEE DRG NO CEE–TU–61.

DO REF: Y75/20	GEN TOL: LIN± ———	ANG± ———
DRN: B.D.T.	CKD: S MOUTON	DATE: 76–03–17
ENG: ———	T C BROOK	for CHIEF ENG

INFRASTRUCTURE
ECTRICAL)
SPOORNET

BONDING: MAST TO RAIL (SINGLE BOND)

3kV DC AND 25kV AC.

STORES ITEM NO ———

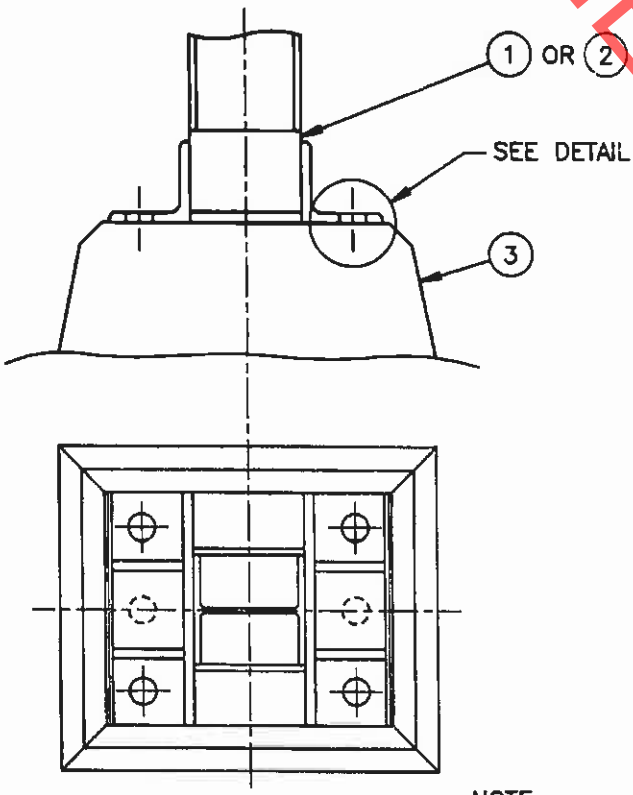
DIMENSION: mm
SCALE: 1:20

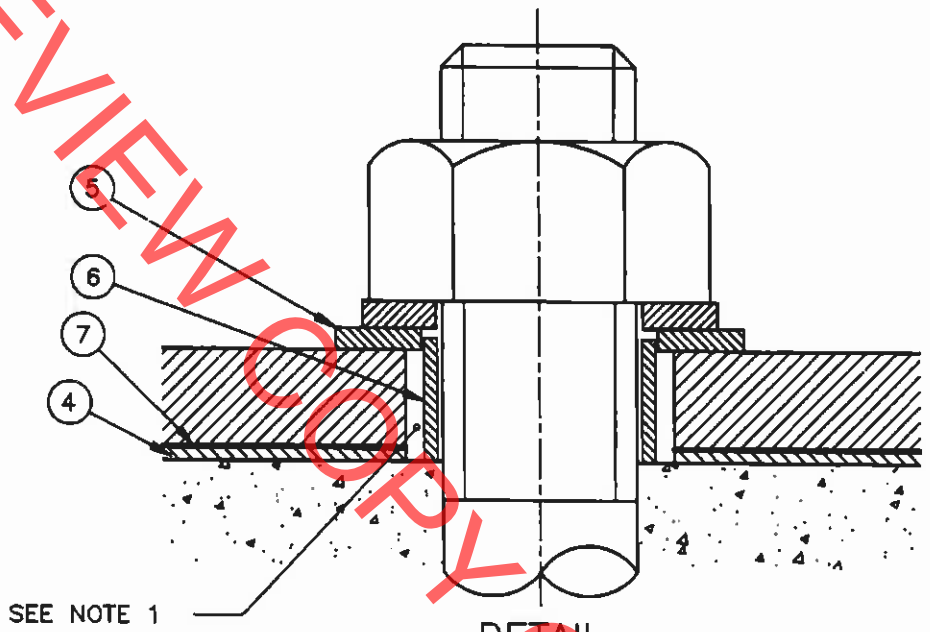
A2

DRAWING NO CEE–TU–35
SHEET — OF —

ITEM	DESCRIPTION	QTY	STORES ITEM NO	DRG NO CEE–
1	MAST BASE ASSEMBLY (4 BOLT GROUP)	1	——	TMB–67
2	MAST BASE ASSEMBLY (6 BOLT GROUP)	1	——	TMB–68
3	FOUNDATION	1	——	TQ–17
4	INSULATING PAD	2	——	TU–143 SH 2
5	INSULATING WASHER	*	——	TU–143 SH 3
6	INSULATING BUSH	1	——	TU–143 SH 4
7	ANTI–CORROSIVE TAPE TO SPEC T–P4A–9	*		

* AS REQUIRED





DETAIL
SCALE 1:1

NOTE
1. AN APPROVED ANTI–CORROSIVE SYSTEM SHALL BE APPLIED TO ALL VOIDS AND OUTER SURFACES OF THE MAST BASE INCLUDING BOLTS, NUTS & WASHERS.
2. THIS DRAWING TO BE READ IN CONJUNCTION WITH SPECIFICATIONS CEE.0166 & CEE.0242.

AMENDMENTS		
NO	NAME	DATE
1	JVT	95–04–13
SPECIFICATION IN NOTE 2 WAS CEE–13B–4. DO REF: G95/008.		
2	HA SLIER	98–07–01
NOTE 2 REVISED AND ITEM 7 ADDED. DO REF: T98/031		

DIMENSION: mm
SCALE: 1:10

A3

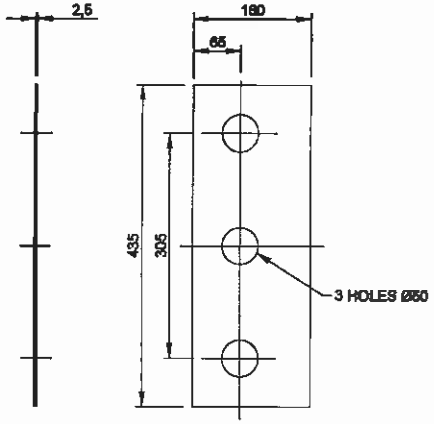
DO REF: T94/031	GEN TOL: LIN± —— ANG± ——	
DRN: C DE KOKER	CKD: JVT	DATE: 94–07–06
ENG: F SLIER	L O BORCHARD	for CHIEF ENG
INFRASTRUCTURE (ELECTRICAL)	SPOORNET	

MAST BASE ANTI–ELECTROLYSIS ARRANGEMENT

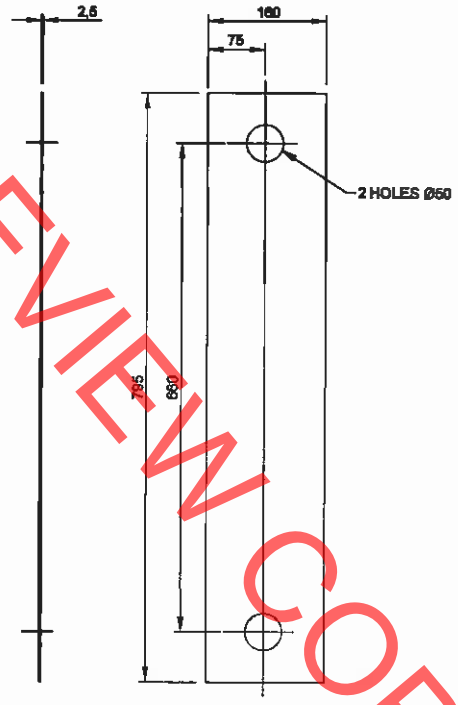
4 OR 6 X M36 BOLT GROUP
UNIVERSAL COLUMN MASTS

DRAWING NO CEE–TU–143
SHEET 1 OF 4

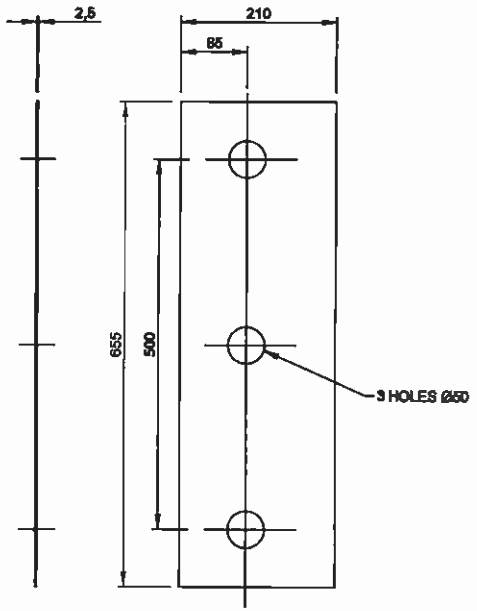
T0000610



MAST	SIZE	BOLT GROUP	MAST BASE ASSEMBLY	INSULATION PAD ITEM NO
I-BEAM	203 x 152	4 BOLT	TMB-31	54/31713
I-BEAM	229 x 178	6 BOLT	TMB-37	
UC	206 x 204	4 BOLT	TMB-67	
UC	216 x 206	6 BOLT	TMB-68	



MAST	BOLT GROUP	MAST BASE ASSEMBLY	INSULATION PAD ITEM NO
RAIL	4 BOLT	TMB-35	54/32807



MAST	SIZE	BOLT GROUP	MAST BASE ASSEMBLY	INSULATION PAD ITEM NO
UC	254 x 254	6 BOLT	TMB-105	54/32819
UC	260 x 256			

AMENDMENTS		
NO	NAME	DATE
3		

REDRAWN, I-BEAM AND RAIL MAST PADS ADDED, DATA TABLES ADDED AND TITLE CHANGED.
DO REF CDO/977

MATERIAL: SYNTHETIC RESIN BONDED GLASS-FIBRE FABRIC (WOVEN) TO SPEC BS 3396 OR EQUAL AND APPROVED

DO REF: T94/031	GEN TOL: LIN ± 0,5	ANG ± -	
DRN: C de KOKER	CKD: JVT	DATE: 94-07-06	
ENG: F SLIER	L O BORCHARD	for CHIEF ENG	

CENTRAL DRAWING OFFICE
INFRASTRUCTURE (ELECTRICAL)
SPOORNET

INSULATING PADS

MAST BASE ANTI-ELECTROLYSIS ARRANGEMENT

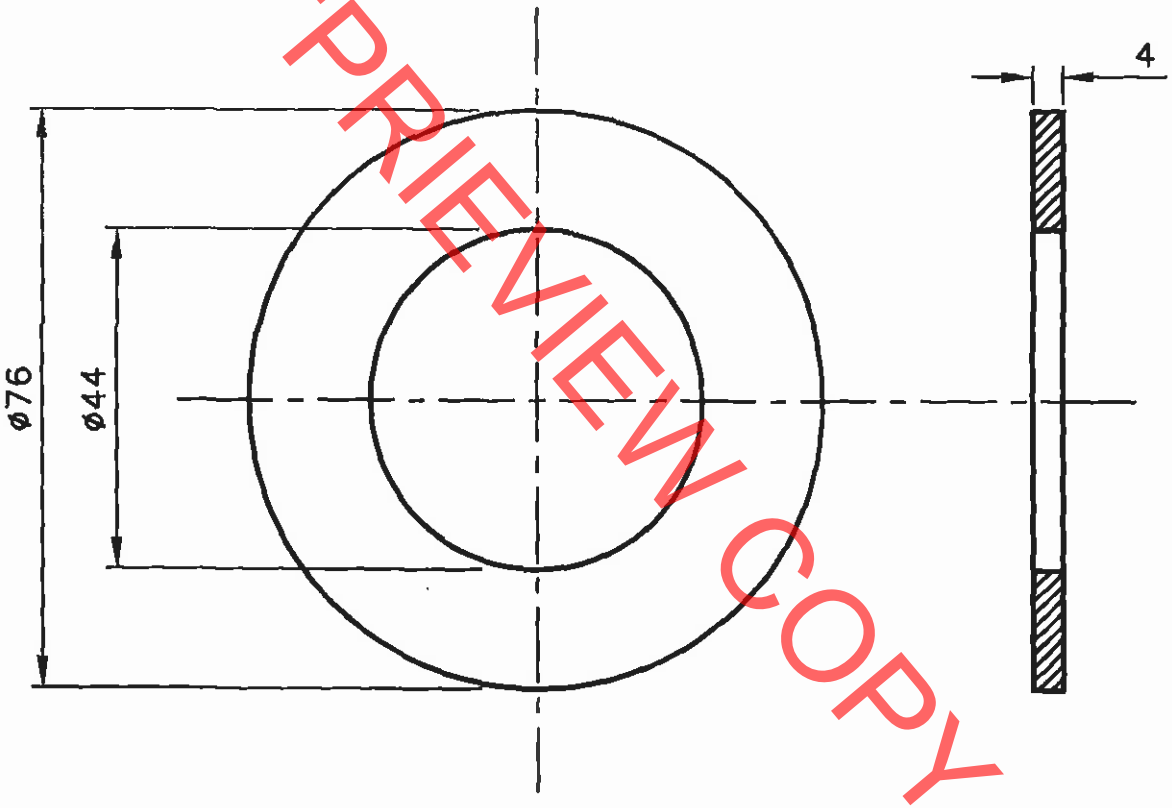
4 OR 6 x M36 BOLT GROUP UC , RAIL AND I-BEAM MASTS

DIMENSIONS: mm
SCALE: 1:5

A2

DRAWING NO CEE-TU-143

SHEET 2 OF 4



NOTE
THIS DRAWING TO BE READ IN CONJUNCTION WITH SPECIFICATION CEE.0166.

AMENDMENTS		
NO	NAME	DATE
1	JVT	95-04-13

SPECIFICATION IN NOTE WAS CEE-13B-4.
DO REF: C95/008.

2		16/11/2000

STORES ITEM NO ADDED.
DO REF: CDO/977

STORES ITEM NO. 54/414

DIMENSIONS: mm
SCALE: 1:1

MATERIAL: SYNTHETIC RESIN BONDED GLASS-FIBRE FABRIC (WOVEN) TO SPEC BS 3396 OR EQUAL AND APPROVED

DO REF: T94/031	GEN TOL: LIN± 0,5	ANG± ——
DRN: C de Koker	CKD: JVT	DATE: 94-07-06
ENG: F SLIER	L O BORCHARD for CHIEF ENG	

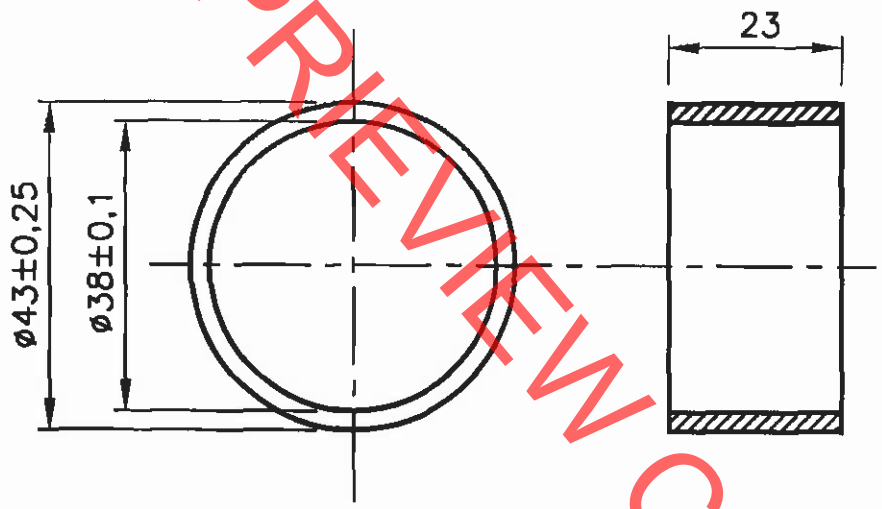
CENTRAL DRAWING OFFICE
INFRASTRUCTURE (ELECTRICAL) SPOORNET

INSULATING WASHER

MAST BASE ANTI-ELECTROLYSIS ARRANGEMENT
4 OR 6 x M36 BOLT GROUP UC MASTS

A4

DRG NO CEE-TU-143
SHT 3 OF 4



NOTE
THIS DRAWING TO BE READ IN CONJUNCTION WITH SPECIFICATION CEE.0166.

AMENDMENTS		
NO	NAME	DATE
1	JVT	95-04-13

SPECIFICATION IN NOTE WAS CEE-138-4.
DO REF: G95/008.

2

STORES ITEM NO ADDED.
DO REF: CDO/977

STORES ITEM NO. 54/438

DIMENSIONS: mm
SCALE: 1:1

MATERIAL: SYNTHETIC RESIN BONDED GLASS-FIBRE FABRIC (WOVEN) TO SPEC BS 3396 OR EQUAL AND APPROVED

DO REF: T94/031	GEN TOL: LIN± 0,5	ANG± ——
DRN: C de Koker	CKD: JVT	DATE: 94-07-06
ENG: F SLIER	L O BORCHARD for CHIEF ENG	

CENTRAL DRAWING OFFICE
INFRASTRUCTURE (ELECTRICAL) SPOORNET

INSULATING BUSH

MAST BASE ANTI-ELECTROLYSIS ARRANGEMENT
4 OR 6 x M36 BOLT GROUP UC MASTS

A4

DRG NO CEE-TU-143
SHT 4 OF 4