105-17

GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS
RESEARCH DESIGNS STANDARDS ORGANISATION

SPECIFICATION NO.ETI/PSI/99 (4/89)

Energy Measurement and Maximum Demand Acquisition (EMMDA) System

1.0 SCOPE

1.1 This specification applies to design, supply, erection and commissioning of Electronic EMMDA system suitable for measuring true energy (Mwh) true power (MW), apparent energy(MVAh), apparent power(MVA), Reactive energy (MVARh). Reactive power(MVAR), maximum demand (MVA), power factor and frequency with the help of Electronic Trivector Meter having facility of indication of these parameters and their transmission to remote control centre(RCC).

1.2 The EMMDA shall be complete with all associated equipment i.e. electronic trivector me ', modems, IBM compatible PC, 14" Mono Chrome CRT, Key Board,132 column 180 cps dot matrix Printer, Ring CT and other equipments considered necessary by the manufacturer for its efficient operation and associate measurements. All such equipments, parts and accessories shall be deemed to be with in the scope of supply irrespective of their being specifically mentioned or not.

1.3 The EMMDA system shall be erected by successful tenderer, associating representative of Indian Railways/ Purchaser, and he shall test and commission the equipment to the satisfaction of the railway representative at site.

2.0 Governing Specifications

2.1 Various components of the EMMDA system shall unless otherwise specified herein, conform to the latest version of Indian/British Standard Specification as indicated below and the Indian Electricity Rules, wherever applicable.

i) IS:590 -	Electrolytic capacitors.
ii) IS:722 -	Electricity meters/Trivector meter.
iii) IS:1765 -	Potentiometers.
iv) IS:2705 -	Current Transformers.
v) IS:3156 -	Potential transformers.
vi) IS:3700 -	Essential ratings and characteristics of semi-conductor devices.
vii) IS:5786 -	Electricity resistors, general purpose, low power

viii) IS:3895 – Monocrystaline semi conductor for rectifier cells and stacks.

ix) IS:4007 – Terminals for electronic equipment.

x) IS:5361 – Polyster film dielectric capactiors.

xi) IS:9521 – Metal clad base for printed circuits for use in electronic and telecommunication equipment.

xii) BS:5685 – Electricity meters

3. Any deviations from this specification proposed by the tenderer, calculated to improve upon performance, utility and efficiency of the equipment shall be given due consideration, provided full particulars of the deviation with justification thereof are furnished. In such a case, the tenderer shall quote according to this specification and deviations, if any, proposed by him shall be quoted as an alternative/alternatives. In case of any contradiction between the provisions of the Indian Standards Specification and this specification, the later shall prevail.

4. SERVICE CONDITIONS.

4.1 Environmental conditions:

Maximum temperature of air in shade	–	45 deg.C
Minimum temperature of air in shade	–	0 deg.C
Maximum relative humidity	–	100%
Annual rainfall	–	Ranging between 1750 mm & 6250 mm.
Number of thunderstorm days per annum.	–	85 (max.)
Number of duststrom days per annum.	–	120 (max.)
Altitude	–	Not exceeding 1000 m.

The electronic Trivector Meter with Maximum Demand Indicator would be subjected to vibrations on account of trains running on nearby railway tracks . The time-period of such oscillations is in the range of 15 to 70 ms and its amplitudes in the range of 30 to 150 microns with the instantaneous peak going upto 350 microns.

5.0 TRACTION POWER SUPPLY SYSTEM.

5.1 General Scheme:

The single phase, 50 Hz power supply for railway traction at 25 kV is obtained from 220/132/110/66 kV three phase grid system through a step down single phase power transformer, the primary winding of which is connected to two of the phases of the three-phase effectively earthed transmission line net-work of the State Electricity Board. In order to reduce the imbalance on the three-phase grid system, the two phases of the three-phase transmission line are tapped in a cyclic order for feeding the successive substations. The distance between adjacent sub-stations is normally between 40 km. and 80 km. depending upon the density of the traffic, gradients in the section, etc.

5.2 One terminal of the 25 kv secondary winding of the traction transformer is connected to the overhead equipment(OHE) and the other terminal is solidly earthed and connected to the Non-track ciruited rail.The load current flows through the OHE to the locomotives and returns through the rail(s) and earth to the sub-station. Where booster transformers and return conductors are used the return current flows through these and partly through the earth in the vicinity of the substation. Approximately midway between two adjacent sub-stations a dead zone known as the "Neutral section" or "Phase break" is provided to separate the different phases. The power to the OHE on one side of the substation is controlled by a feeder circuit breaker while that for each track is controlled by an interruptor. In case of a fault on the OHE, the feeder circuit breaker isolates it. The incoming 220/132/110/66 kV supply voltage may vary between +10% and -12.5% as per I.E. Rule No.54. A schematic diagram No.ETI/PSI/707(Mod.A) showing the general arrangement at a traction substation is at Appendix-A.

5.3 Nature of faults:

The OHE is subjected to frequent earth faults. The fault is isolated by the feeder circuit breaker which operates on either one or more of the following relays:

(1) Distance Mho relay.

(2) Instantaneous over-current relay.

(3) Wrong phase coupling relay in case of inadvertent coupling of two phases between adjacent substations at the neutral section or at intermediate switching station.

In the event of the 25 kV feeder as well as transformer breakers failing to operate under fault conditions, the 220/132/110/66 kV circuit breaker on the primary side of the transformer operates.

5.4 Short circuit level:

The three phase short circuit level at present for the different

voltages varies between 1000 MVA to 10,000 MVA depending on the proximity to the generating station.

6.0 REMOTE CONTROL OF TRACTION POWER SUPPLY.

6.1 Computer-based Supervisory Control & Data Acquisition(SCADA) system is used for the remote control of 25 kV a.c. traction power supply. All circuit breakers, interruptors and motor operated isolators installed at the traction and switching stations viz. Feeding posts(FPs).Sub-sectioning and paralleling posts(SSPs) and Sectioning and paralleling posts(SPs) located alongside the track are operated from the Remote Control Centre (RCC) through a suitable communication link described later. Besides the remote monitoring of the status of controlled devices and associated alarms on account of defects, analog parameters such as 25kV feeder voltage, feeder current and average power factor at the traction sub-station are also telemetered for display on th. VDUs in the form of discrete values, bargraphs and trend curves and th se are also logged at the Remote Control Centre.

6. Major equipment of the SCADA system comprises of communication ir erface(modems), Micro/mini-computers with floppy & hard disk memory, f.ont-end processors and Man-Machine Interface through colour VDUs & Key-board console.

6.3 Remote Terminal Unit(RTU) provided at switching stations are equipped with modem, 8/16 bit microprocessor based CPU, digital input/out modules, A/D modules with necessary interposing relays interfaced with I/O modules and transducers for analog inputs for telemetry of measurands are installed at the controlled stations i.e. TSS/FP, SPs & SSPs. The A/D modules can accept 0-5 mA or 4-20 mA analog input from the transducers. The output of the transducers being 0-5 mA or 4-20 mA is proportional to the input from instrument transformers i.e. potential and current transformers.

7.0 COMMUNICATION AND DATA TRANSMISSION.

7.1 For the purpose of remote control of traction power supply, following three types of communication medium are in use for data transmission between RTUs and Master Station Equipment.

I. Voice grade star quad underground communication cable, details of which are at Appendix-I.

II. Dedicated Micro wave channel at carrier frequency of 18 GHz.

III. Optic fibre cable, details of which are at Appendix -II

Modems are used in the RTUs for converting the digital signals to analog signals, which are transmitted over the communication medium using FSK modulation. Modem at master station converts these analogue signals back to digital signals for processing. The transmission frequency for the purpose of SCADA application lies within voice frequency range at a baud rate of either 200 or 600 depending upon the SCADA system design.

8.0 METERING

8.1 Metering for energy consumption is generally done at each supply point of SEB except for a few cases where it is done at the Railway's TSS. SEB's levy two part tariff for the purpose of billing. Thus, apart from charges for the energy consumed, charges for max. demand (MD) recorded at individual metering points, during any integration periods of 15/30 minutes of the month, are also payable by Railways.

8.2 There are many instances/situations where Railways draw power at several points from the same grid of same Electricity Board. For the purpose of billing at present, Railways pay for the MD for the individual TSS/FP, which has been made clear in a typical example given below.

Date	Time	MD in MVA at				Actual MD in SEB transmission grid.
		GSS A	GSS B	GSS C	GSS D	
1	2	3	4	5	6	7= 3+4+5+6
2.1.89	14.00 hrs.	4	<u>9</u>	6	5	24
10.1.89	19.00 hrs.	<u>10</u>	5	7	6	28
19.1.89	09.00 hrs.	4	6	<u>10</u>	7	27
22.1.89	18.00 hrs	8	5	6	<u>10</u>	<u>29</u>

Note:- Above figures are for the purpose of illustration only. Underlined figures indicate maximum demand.

Thus, it would be noticed that Railways have to pay for the maximum demand at each TSS which in this particular example is 10 MVA at GSS A, 9MVA at GSS B, 10MVA at GSS C, 10MVA at GSS D i.e a total of 39MVA, which is not the real value of MD imposed on the grid. It would also be seen from the Table-I above that the MD at all the GSS does not occur on the same day and in the same integration period of 15/30 minutes.

8.3 To obviate this fallacy, it is envisaged to acquire, compute and log the concurrent Maximum Demand imposed by railway traction loads, at the master station with the help of EMMDA system. Referring to column 7 of Table-1 given above, concurrent MD on SEB's grid at 14.00 hrs on 2.1.89 is 24MVA and so on. Thus it would be clear that MD imposed on the SEB's grid by all the Railway's TSS(combined) in a typical month is only 29 MVA, which is the MD on the SEB's grid, and therefore Railways would be paying for the actual MD and not the sum of MD's at each GSS.

9 MASTER & RTU OF EMMDA SYSTEM AND PROTOCOL FOR DATA TRANSMISSION.

9.1 The EMMDA system is proposed to work on similar lines as of SCADA system detailed at Para 6 above. Master equipment of EMMDA system shall be kept at RCC alongwith master equipment of SCADA syster and shall comprise of communication inteface (Modem) IBM capatible PC with floppy disk drive, man machine interface with mono chrome VDU and a key board. A dot Matrix Printer shall be connected to the PC for obtaining hard copy of various parameters, indicated in Para 1.1.

9.2 Remote terminal unit of EMMDA system shall consist of electronic trivector meter, alongwith its associated modem and other equipments considered necessary by the successful tenderer.

9.2.1 In addition a strip chart dot matrix printer for printing the 15/30 minutes MD in MVA, shall also be provided in the trivectormeter to obtain a hard copy of the values of MD alongwith time and date stamp which have been sent to RCC by RTU. The communication between master and RTU shall be on any of the communication medium mentioned in Clause 7 above.

9.3 Communication speed for data transmission shall be either 50,100 or 200 baud. The successful tenderer shall obtain prior approval of the purchaser before finalising the communication speed and selecting the frequency channel as Indian Railways have already installed SCADA system using the same communication medium. The SCADA system operates either at 200 or 600 baud at different frequency channel approved by purchaser.

The master and RTU shall communicate in a cyclic order every 15/30 minutes wherein on a request from Master station, the RTU shall send the data to the master for loggging and processing purposes. Unless asked for by Master, the RTUs shall remain in listening mode only. A proven error detection code shall be employed for detectin, any error in the messages.

The trivectormeter shall be suitable for accepting a synchronising(Sync) pulse transmitted from the master every 6 hours, for the purpose of synchronisin, the maximum demand integration cycle. On the receipt of the sync pulse,all the trivector meters shall bring their clocks to zero and as an acknowledgement send this time i.e. zero to the master station. The time of the sending of sync pulse and receipt of acknowledgement from varic - RTUs shall also be logged.

9.4 Location of RTUs

Option-I

In this option RTUs shall be installed at all the GSS's, which are on the same grid of SEB. The trivectormeter shall be connected to the tering P.T.owned by SEB. For current source a 1:1 ring CT shall be ovided on one core of metering cable coming from secondary of the .T. owned by SEB. Output of the ring C.T. shall be connected to the rivectometer.

One nominated grid sub-station shall be provided with master

s ation equipment for the purpose of collecting and processing data. Data c mmunication in this case shall be over carrier communication system of the SEB.

OPTION-II

In this option, the RTUs shall be installed at Ra lways TSS which are on the same grid of a particular SEB. Master station equipment shall be kept at the remote control centre. Communication between master and remote shall be on any of the communication medium mentioned in Para 7 above i.e. communication for EMMDA and SCADA will be on the same communication medium but on different frequency channels.

CT & PT connection to the trivector meters shall be as per circuit diagram at Appendix-2.

10.0 RATING AND OTHER TECHNICAL PARTICULARS OF EMMDA SYSTEM.

10.1 Electronic Trivector Meter

.1 Functions

The trivector meter shall be capable of accurate measurement, registration and display of all electrical and maximum demand integration parameters of 25 kV ac single phase traction power supply as mentioned in Clause 1.1, at all load power factors lagging and leading.

.2 System

. Single phase - 2 wire.

.3 Current rating

Option -I

1 Ampere from 132 kV current transformer. Details of the ratio shall be ascertained from the purchaser by the successful tenderer.

Option -II

5 Amps from 200-100/5A,30VA, 220KV, or 132KV, or 110KV current transformer, or 400-200/5A, 66KV current transformer.

.4 Voltage rating

110 V ac, 50 Hz from 220KV, 132KV, 110KV, 66KV potential transformer.

Note:- Salient particulars of the current and potential transformer used in railway's traction substation are at Appendix-III.

.5 Accuracy

Class 0.5(0.5%) to BS 5685.

.6 Dynamic Range

Specified accuracy to be maintained from 2% of full load to 100% overload.

.7 Working Range

2% of full load to 200 % of full load.

.8 Registers and displays

Registers

Three, 5 digit counters for registering MWh, MVAh and MVArh or Kwh, kVAh and kVArh with multiplying factor of 1000.

Displays

A liquid crystal display to display the following line parameters shall be provided on the trivectormeter:

a) Power factor

b) Frequency

c) Instantaneous MVA

d 15 minutes or 30 minutes integrated maximum demand value.

.9 Integration cycle

The EMMDA system shall be suitable for integrating the maximum demand either in 15 or 30 minute integration cycle. The period of integration shall be user selectable.

.10 Parameter Selector Switches

Necessary selector switches or push buttons shall be provided on the trivector meter to select the parameters for individual display or sequential display of various parameters.

.11 The arrangement shall be such that minimum 5 MD values of five previous months can be stored in non-volatile memory and displayed if so desired. The M.D. reading on display shall be the current maximum demand registered till the last integration cycle of the elapsed day of the month. The previous last reading becoming the value of the last month and so on. The MD value registered 5 months ago shall automatically get wiped off when fresh value is registered on the memory.

.12 Strip chart recorder

40 column Alphaneumeric.

10.2 Mechanical

a) Enclosure – Sheet steel.

b) Colour finish:

Exterior: – Any pleasing colour as agreed to between supplier and Purchaser.

Interior: – White enamel.

c) Fixing – Screw Brakets top and bottom or Panel mounted type as agreed to between supplier and purchaser.

d) Cable Entry: – From bottom face of unit in case screw bracket type or from back connected in case of panel mounting type through 20 mm cable glands.

10.3 Environments:

Should withstand vibrations, shock and temperature mentioned in clause No. 4. hereof.

11.0 Tests

All tests on prototype trivectormeter shall be conducted as per relevant IS/BS.

12.0 Technical data and drawings

12.1 Tenderer shall furnish alongwith their tender offer, in the proforma attached as annexure 'A', the guaranteed performance data and other technical particulars for the equipment offered. The tenderer shall also furnish evidence in the form of type test reports for the tests conducted on the system.

12.2 Tenderer shall indicate their compliance or otherwise against each clause and sub-clause of the technical specification. The tenderer shall for this purpose enclose a separate statement, indicating the clause reference and compliance or otherwise. Whenever the tenderer deviates from the provision of the clause, he shall furnish detailed remarks for seeking such deviation.

12.3 Tenderer shall submit along with his offer a detailed writeup, describing working of the EMMDA system giving details of the Master station equipment, Remote Terminal Unit and communication protocol.

12.5 Tenderer shall submit along with his offer necessary dimensioned

drawings giving detailes of various equipments proposed to be supplied.

12.6 The successful tenderer shall be required to supply at least 3 copies of the Instruction Manaual for the EMMDA system to each consignee(s) and two copies to Director General(TI), RDSO, Lucknow.

13. Erection, Testing and Commissioning

The trivector meter shall be erected by the successful tenderer associating representatives of the purchaser. The Trivector meter shall be subjected to the specified proving/pre-commissioning tests (to be decided after mutual discussion between RDSO and the successful tenderer) by RDSO's representative(s), with which the supplier/manufacturer shall also be associated. For this purpose, a prior intimation regarding the date and location of tests shall be given by the purchaser.

14. Warranty

EMMDA system supplied against this contract irrespective of origin/(imported or indigenous) shall be guaranteed for trouble-free and fully satisfactory performance for a period of 18 months from the date of supply or 12 months from the date of commissioning on the traction sub-station on Indian Railways, whichever be earlier. Details of warranty clause, the extent of responsibility on the part of the supplier and other relevant aspects will be included in the contract. The tenderer may furnish his detailed terms in this regard in his offer.

16. List of spares

Tenderer shall furnish a list of spares to be kept in the users maintenance depot and quote separately for each item.

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ANNEXURE-I TO SPECIFICATION
NO. ETI/PSI/99(4/89).

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

SOGP

SN	Full particulars	Data
1.	Maker's name & country of Manufacture:	
2.	Manufacturer's type designation:	
3.	Conforming specification(s):	
4.	Accuracy class:	
5.	Dynamic range for accuracy:	
6.	Rated current(Amp):	
7.	Rated max. current(Amp):	
8.	Minimum operating current(Amp):	
9.	Rated Voltage(Volts):	
10.	Frequency(Hz.):	
11.	Registers provided to record following parameters	(yes/No)
	KWH	
	KVAh	
	KVArh	
12.	Multiplying factor(if any):	
	for KWH	
	KVAh	
	KVArh.	
13.	Type of registers(Counters):	
14.	No. of digits per counter:	
15.	Whether the counters register consumption in whole units or Decimal multiples:	

16. Number of Power Parameters displayed:

    MW
    MVA
    MVAr
    Power factor
    Frequency

17. i) Method of display, whether continuous or on demand:

    ii) Method of getting the display on demand:

18. Is integration period for max. demand user selectable ?

19. Number of monthly max. demand values stored in non-voltaile memory.

20. i) Arrangement provided for resetting the MD value to 0:

    ii) Arrangement provided to prevent inadvertent re-setting of MD:

21. Provision for accepting Sync. Pulse for resetting the timer to zero.

22. Size of strip chart for printing.

23. Text of data printed on the strip chart(attach sample).

24. Dimensions mounting arrangement:
    a) Dimensions:
       i) Height(mm):
       ii) Width(mm):
       iii) Depth(mm):
    b) Surface finish:
       i) Exterior:
       ii) Interior:
    c) Mounting arrangement:
       i) Wall mounting :
       ii) Panel mounting:
    d) Weight(Kgs)

25. Type of computer:

26. Manufacturer's name, type & designation:

27. Memory capacity :

    i) On board:
    ii) On floppy(s):

28. Power supply required for operation:

29. Permissible voltage & frequecy variation for satisfactory working of computer:

30. Give detailed particulars & Technical pamphlets:

31. Visual Display Unit:

    i) Make & type
    ii) Size of screen
    iii) Pixel resolution
    iv) No. of column/page.
    v) No. of lines/page.
    vi) Power supply required for operation(alongwith variation which it can withstand):
        a) Voltage:
        b) Frequency:

    vii) Give detailed tech. particulars & pamphlets.

32. Key board for VDU:

    i) Make and type
    ii) Give detailed particulars and technical pamphlets.

33. Dot Matrix Printer

    i) Make & type
    ii) No. of ASCII characters
    iii) Number of characters/line
    iv) Speed in characters per second:
    v) Power supply required for operation(alongwith varition which it can withstand):
        a) Voltage:
        b) Frequencey:

vi) Give detailed particulars & technical pamphlets:

34. Modem

i) Make & Type:
ii) Transmission Speed:
iii) Channel frequency adopted:
Mark frequencey:
Space frequency:
iv) Type of modulation:
v) Suitability to work satisfactory with the carrier communication system of state electricity board:
vi) Suitability to work alongwith SCADA equipment:
vii) Output signal level on send side:
a) Maximum:
b) Nominal:
c) Minimum:

viii) Input signal level for satisfactory operation of EMMDA system.
a) Maximum:
b) Minimum:

ix) Threshold value of input signal level to modem to receive side:
a) Maximum:
b) Minimum:

x) CCITT Recommendation to which Modem conforms:

35. i) Telegram structure/protocol adopted for acquiring data from RTUs(Trivectormeter):

ii) Hamming distance adopted:

36. Up-date time of Data Acquisition from each RTU:

37. Give detailed write-up on scheme of EMMDA system with drawings, illustrations, typical examples & data printouts:

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VOICE GRADE STAR QUAD UNDERGROUND COMMUNICATION CABLE.

Salient technical particulars/characteristics of Star quad communication cable made available for SCADA system are as under:-

a)	Dia. of Copper conductor	0.9 mm
b)	Type of insulation	Paper
c)	Nominal loop resistance at 20 degree C.	55.2 ohm/km
d)	Resistance unbalance between two conductors of a pair.	Not more than 1% of nominal loop.
e)	Nominal mutual capacitance of the pairs of paper insulated VF quads.	0.041 micro-farad/km.
f)	Capacitance unbalance after balancing of full loading section of 1.83 km.	
	(i) Between pairs within the same quad.	Less than 40 pf
	(ii) Between pairs of adjacent quad.	Less than 40 pf
g)	Chacteristic impedance of paper insulated pairs at 800 Hz, when loaded.	1120 ohm
h)	Insulation resistance when measured at 550V.	Not less than 10,000 M-ohm/Km
i)	Loading at interval of 1.33 km.	33 milli-Henry
j)	Attenuation at 800 Hz when loaded.	0.25 dB/km

Technical parriculars of tapping, terminating and sectionalising transformers.

a)	Impedance ratio.	1120:1120 +2%
b)	Insertion loss from 300 Hz to 2500 Hz.	Less than 0.9 dB
c)	Bridging loss with secondary open from 300 Hz to 2500 Hz.	Less than 0.015 dB

d)	Attenuation distortion from 300 Hz to 2500 Hz.	Less than + 0.1 dB
e)	Dielectric strength.	2000V ac(r s) for 1 minute
f)	Return loss in frequency range of 300 Hz to 2500 Hz	More than 20 dB

Isolation transformeer will be installed at every 10 to 20 km by the Railway to limit the induced voltage.

Voice frequency repeaters will be provided by the Railways at intervals of 40 to 50 km to boost the signal level.The amplifier gain will be about 20 dB with an equiliser incorporated to compensate upto 0.02 dB/kc/km. The EMMDA system shall, however, incorporate an amplifier having a minimum gain of 30 dB to compensate for any signal level variation at different points in the system.

The repeater section far-end cross talk attenuation (equal level cross talk) beyween any two voice frequency pairs at a frequency of 800 Hz will be not less than 65 dB and that at the near-end not less than 61 dB.

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OPTIC FIBRE CABLE

Salient technical particulars/characteristics of Optic Fibre cable made available for SCADA system are as under:-

a)	The cable consists of six/eight mono mode fibres.	
b)	Mono mode fibre:	As per CCITT Recommendation No. G652).
c)	Optimised wave length band:	1300 nm +/- .25nm.
d)	Nominal mode-field diameter:	9 to 10 micro-meter +/- 10%.
e)	Nominal cladding diameter:	125 microns +/- 2.4%.
f)	Cut-off wave length:	1120 to 1280 nm.
g)	Attenuation:	Less than 0.5 dB/Km at 1300 mm band measured at the worst wave length.
h)	Total dispersion:	Less than 7.0 ps/nm/km(Fibre optimi ed for 1300 nm band).
i)	Splicing loss including splicing protection:	Less than 0.15 dB/ joint.

Technical Particulars of Optical Line terminting equipment

i)	Electrical Interfaces:-	
	a) Line bit rate:	2048 kB/s.
	b) Line code:	HDB-3.
	c) Line Impedance:	75 ohms unbalanced or 120 ohm balanced CCITT. Rec. G703.
ii)	Optical interfaces:	LED for trans-mission & SI-APD reception.

a) Line Bit Rate:	2048 kB/s.
b) Line code:	CMI(Coded mark Inversion).
c) Modulation:	Im(Intensity modulation).

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Appendix-III to
Specification No.ETI/PSI/99(4/89).

Salient Technical particulars of Current and Potential Transformers

A) Current Transformers

i) Type	Single phase oil filled natural air cooled.			
ii) (a) Nominal system voltage.	220kV	132kV	110kV	66kV
(b) Highest (euipment) system voltage.	245kV	145kV	123kV	72.5kV
iii) Frequency:	50 Hz +/- 3%.			
iv) Rated primary current:	200-100A	400-200A	400-200A	800-400A
v) Rated secondary current:	5 Amp.	5Amp.	5Amp.	5Amp.
vi) Rated Transformation ratio.	200-100/5	400-200/5	400-200/5	800-400/5
vii) Rated burden	30VA	30VA	30VA	30VA
viii) Accuracy class	5P	5P	5P (to IS:2705-1981 Part-III).	5P
ix) Rated accuracy limit factor.	15	15	15	15
x) Rated short-time thermal current(for one second).	31.5kA	25kA	31.5kA	31.5kA
xi) Rated dynamic current.	78.75kA	62.5kA	78.75kA	78.75kA

B) Potential Transformer

i) Type	--- Oil immersed, self cooled, core type.	--- Oil immersed self-cooled core/shell type.	
ii) Rated primary voltage	220k/$\sqrt{3}$	132kV/$\sqrt{3}$	110kV/$\sqrt{3}$ 66kV/$\sqrt{3}$
iii) Frequency	----------50hZ----------		
iv) Type of connection	------between phase & earth----		

v)	Highest system voltage	245	145	123kV	72.5kV
vi)	Rated secondary voltage	–	110/ 3	110/ 3	110/
vii)	Rated burden	–	100VA	100VA	100VA
viii)	Class of insulation	–	'A'	'A'	'A'
ix)	Rated voltage factor	–	1.5 for 30 Sec.	–	1.2 Continuous & 1.5 for 30 Sec.

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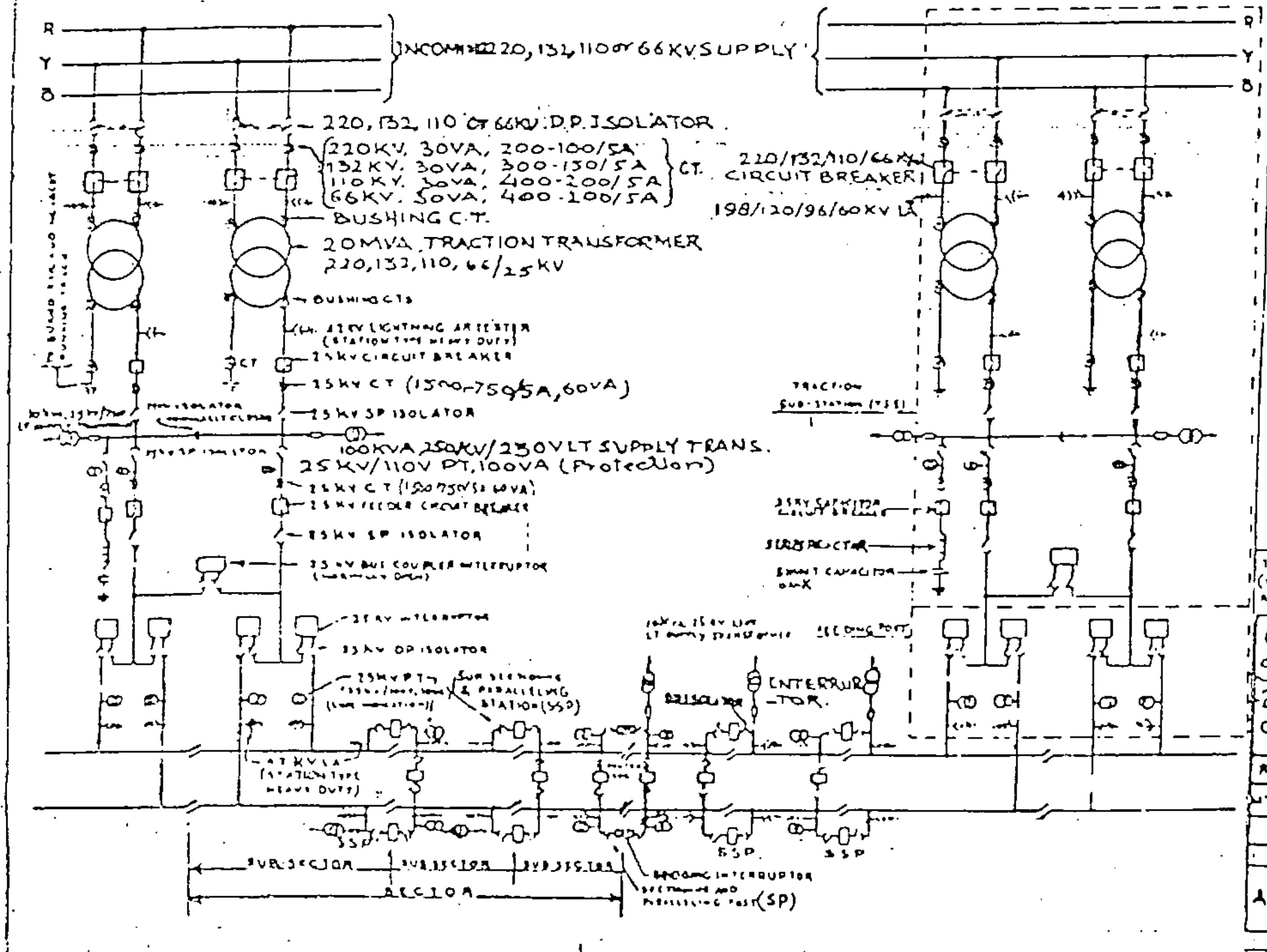
APPENDIX-A



NOTE.

25 KV SHUNT CAPACITOR BANKS COMPLETE WITH CONTROL GEAR, PROTECTIVE RELAYS, SERIES REACTORS AND ACCESSORIES NECESSARY FOR ITS EFFICIENT OPERATION SHALL ALSO NEED TO BE PROVIDED AT THE RAILWAYS TRACTION SUB STATIONS (TSS) WHEN IT IS SPECIFICALLY MENTIONED BY THE PURCHASER.

REFERENCE COPY

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GENERAL SCHEME OF SUPPLY FOR 220/132/110/66 25KV 50Hz SINGLE PHASE AC TRACTION SYSTEM

JD/TI

ADE/TI

3.3.91

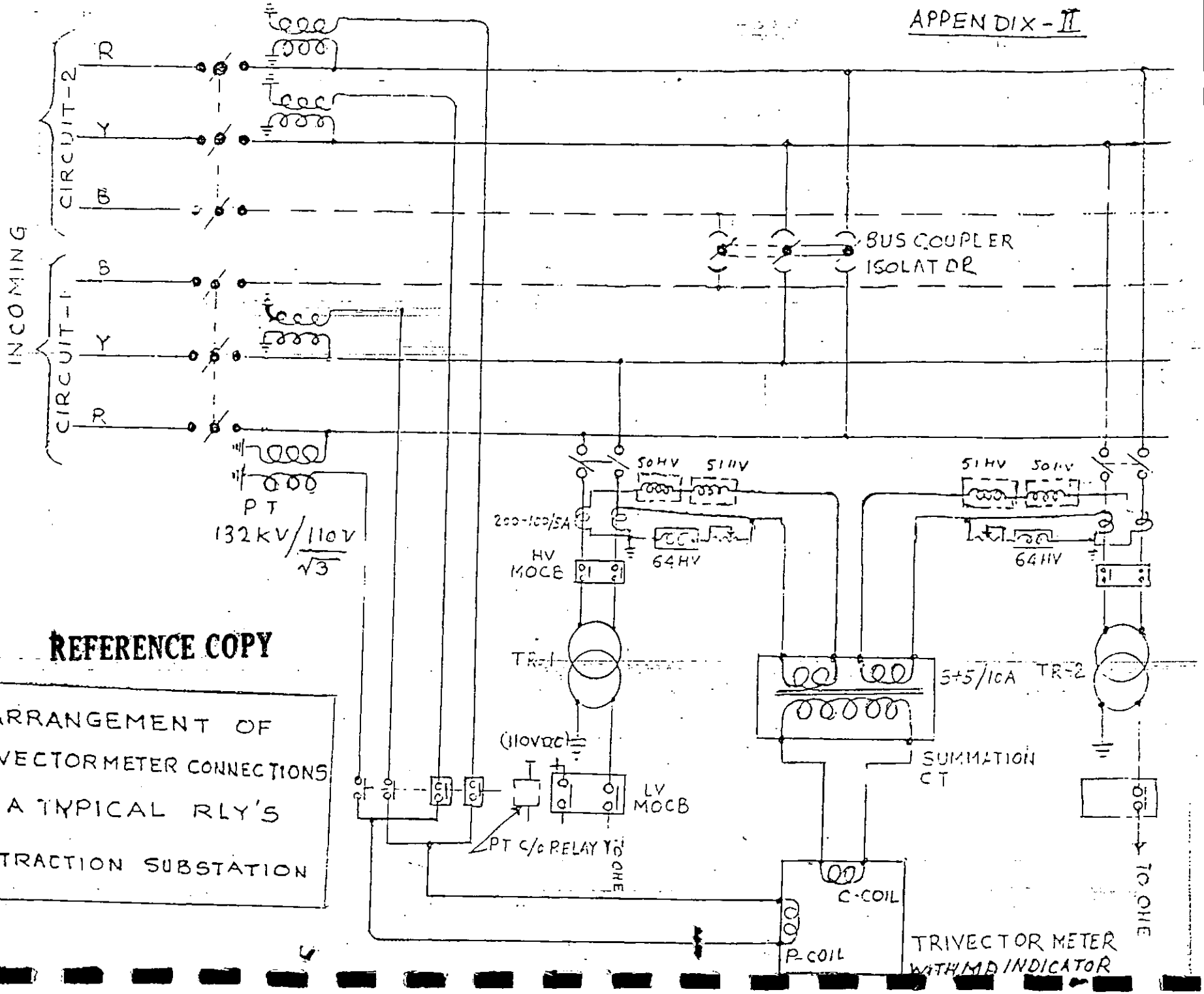
REF.

R D S O

ETI/PSI/707

SCALE: N.T.S.

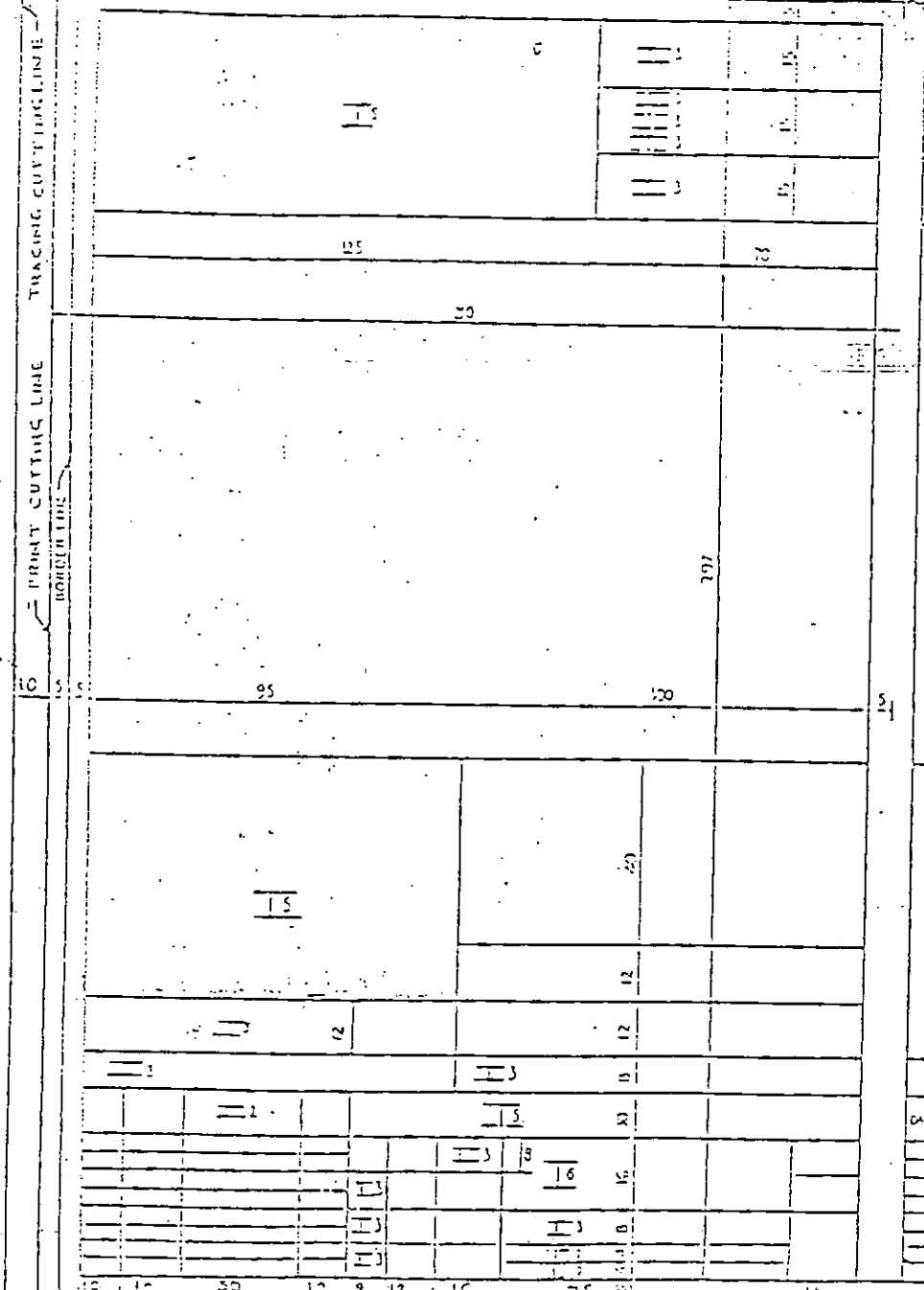
APPENDIX - II



REFERENCE COPY

ARRANGEMENT OF TRIVECTOR METER CONNECTIONS AT A TYPICAL RLY'S a.c TRACTION SUBSTATION

ANNEXURE-2



HOLDING PAPER

CONTRACTOR'S NAME

GROUP NO.

CONTRACTOR'S DRG. NO.

DATE

FORM-S

NOTE:-

THIS TITLE SHEET IS APPLICABLE TO ALL CONTRACTOR'S DRAWINGS

* COL. FOR IDENTIFICATION NO. TO BE FILLED UP ONLY FOR COMPONENT OR FITTING DRAWINGS

TITLE OF DRAWING

APPROVED IN PRINCIPLE

FOR DIRECTOR GENERAL (TI)
R.D.S.O.

SIGNATURE OF RESIDENT ENGINEER (CONTRACTOR)

SIGNATURE OF DESIGN ENGINEER (CONTRACTOR)

WORKING				CROSS REF.
DATE	HOD	NATURE OF MOD.	INITIALS	

INDIAN RAILWAYS

	DATE	NAME
DR	5.5.78	
TC	5.5.78	
CM	6.5.78	

IDENT NO. *

SCALE:- 1:1

SHEET NO.

SHEET SIZE