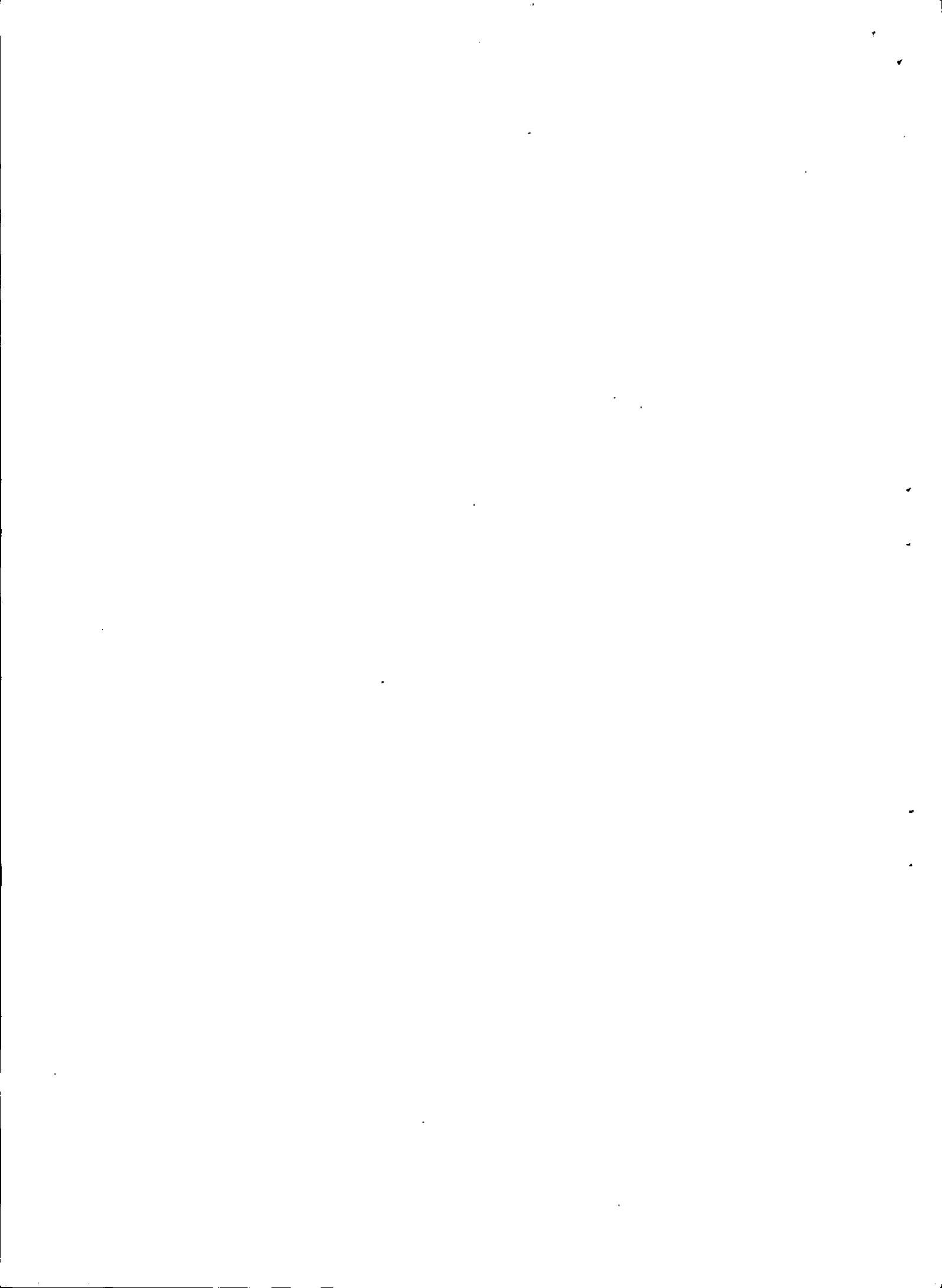




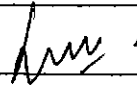
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SPECIFICATION NO. TI/SPC/OHE/CW/WEAR/0030

Amendment Number	Date of Amendment	Total pages including annexure.	Amendment/Revision
0	NA		First issue

	PREPARED BY	CHECKED BY	APPROVED BY
SIGNATURE			
DATE	19-02-08	19-02-2008	19.02.08
DESIGNATION	SSE/CAR	EDTI (OHE)	EDTI (Co-ordination)

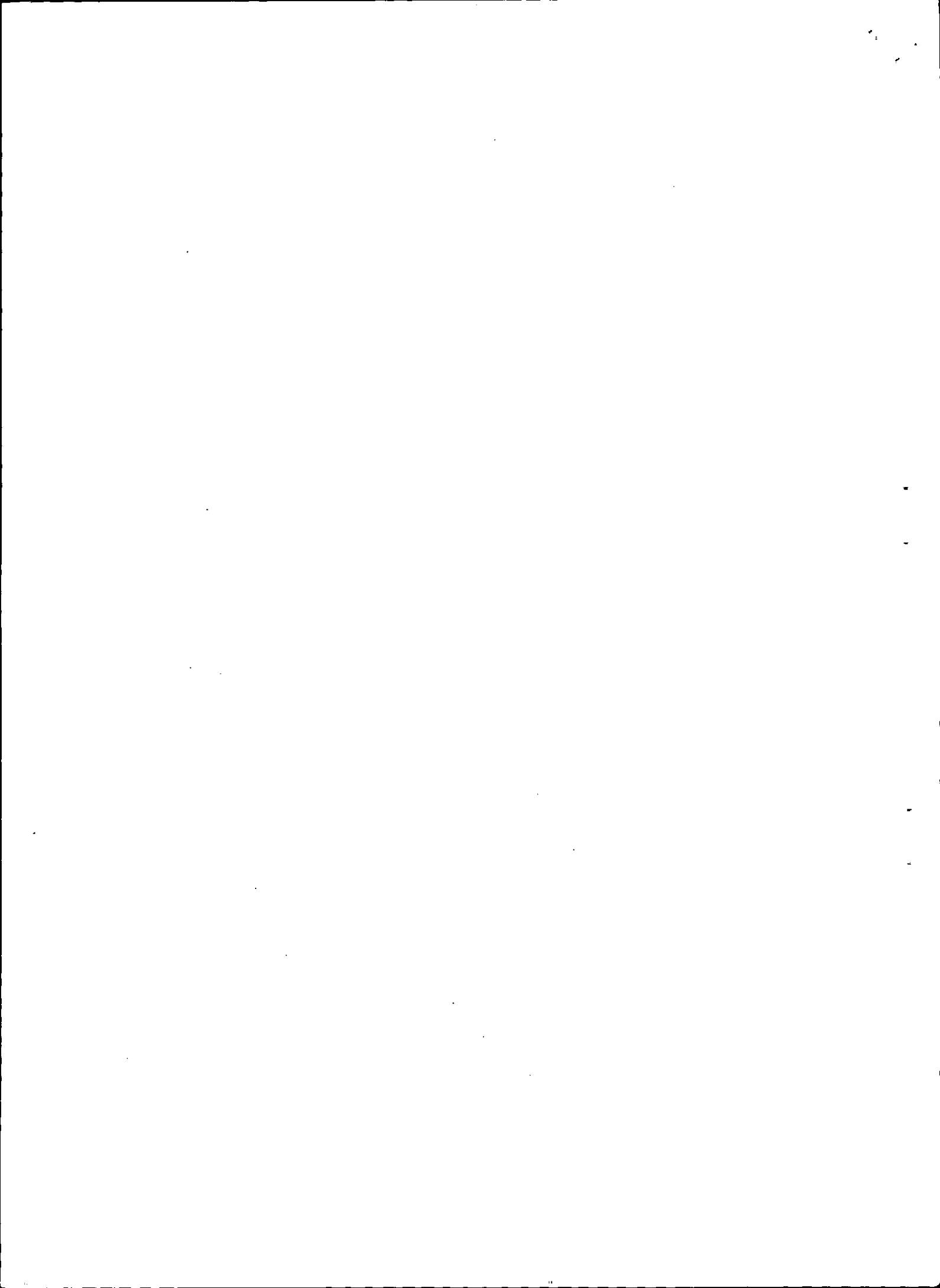
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ISSUED BY SIGNATURE..... DATE.....

ISSUED TO

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Technical specification of on-board equipment for live scanning of thickness of contact wire in 25 kV a.c. Traction

1.0 SCOPE

- 1.1 The Indian Railways employ simple polygonal catenary and contact wire systems for overhead electric traction lines for supplying power to electric locomotives. For ensuring reliable current collection by pantographs of electric locomotives, the geometry of the overhead equipment (OHE) is required to be maintained to prescribed standards. Measurement of contact wire thickness and the geometry of OHE and its restoration is carried out by trained staffs who work under power-off condition on platform of specialized maintenance vehicles called tower wagons.

The IR have decided to employ instruments on the tower wagon roofs so as to obtain and record the geometry of OHE at high speeds and contact wire thickness without having to avail power blocks and obtain information from recorded data for aids in directed maintenance.

- 1.2 This specification covers the requirements of equipments for testing, supply, installation, commissioning on the existing NETRA (Network for Electrification Testing & Recording Apparatus) Car and field trials of contact wire thickness measurement system under energized 25 kV traction lines. Contact wire thickness measurement is required to be carried out for single wire as well as multiple wires at overlaps, turn-outs, cross-overs etc of various sizes used in 25 kV a.c. traction. A brief description of 25 kV OHE system is enclosed at Annexure -I. Profile of different sizes of contact wires and their sizes are enclosed at Annexure-II.

2.0 GENERAL CONDITIONS & DOCUMENTS TO ACCOMPANY TENDER BIDS

- 2.1 Tenderer is advised to acquaint himself with the existing system of NETRA car, if so considered necessary by the tenderer. This may be arranged by prior appointment with Director General (TI) Research Designs & Standards Organisation, Manak Nagar, Lucknow 226 011 (India) for inspection of the car at RDSO/LKO or at any other location on IR, where the NETRA Car may be engaged at that time. Cost of travel, boarding and lodging shall be borne by the tenderer.
- 2.2 Any deviation from this specification, proposed by the tenderer, intended to improve the performance, utility and efficiency of the measurement system or principle of measurement will be given due consideration provided full particulars of the deviations with justification thereof are furnished. In such a case, the tenderer shall quote according to this specification and deviations, if any, proposed by him as an alternative/optional offer.

2.3 The tenderer shall furnish in the bid, the details of the proposed scheme for measurement of contact wire thickness and the proposed methodology for integrating the scheme with the system available in the existing NETRA Car. A comprehensive specification of the system/ instrumentation offered shall also be submitted. Following documents shall also accompany the tender bids.

- Full description of the equipment/system offered
- Drawings & details of complete instrumentation system, connection interfaces required and proposed mounting arrangements.
- Stipulated Clause-by-Clause compliance.
- Proposed upkeep /AMC proposal.
- List of deviations.

2.4 To facilitate examination of the tender offer, the tenderer is required to furnish clause by clause comments of this specification either confirming acceptance of the clause and elaborating its details, where necessary, or indicating deviation there from. In the event of the tenderer being unable to conform to any part of the requirements of this specification, it must be stated specifically that deviation there from is desired by the tenderer. Full particulars of the deviation, including technical details, cost implications and past service performance, if any, shall be given for evaluation.

2.5 SUCCESSFUL TENDERER'S RESPONSIBILITY

2.5.1 The successful tenderer shall be entirely responsible for the execution of the contract strictly in accordance with the terms of this specification and the conditions of contract, notwithstanding any approval which RDSO or the Inspecting officer may have given on drawing prepared by the successful tenderer or tests carried out either by the successful tenderer, RDSO or a designated inspecting officer. The proposed equipment & system shall be installed & fully commissioned for its proper functioning on the vehicle (NETRA) delivering the correct measurement of parameters & identifying the required locations as per the requirement.

2.5.2 DESIGN DEVELOPMENT

- (a) The successful tenderer shall prepare at his own expense, dimensional drawings in standard size depicting the complete instrumentation system & connection, with brief write-up functional details of each drawing/block schematic, mounting arrangement etc and submit to RDSO for approval. It should be ensured that the proposed design of the system & equipment is safely accommodated in the existing space & layout of the NETRA car where these are to be installed & commissioned.
- (b) Technical details of each sub-system/sensors shall be indicated on the relevant drawing along with an explanatory write-up and copies of such write up shall be supplied to RDSO alongwith drawings for proper appreciation of the system.

2.5.3 APPROVAL OF DRAWINGS

Approval to the drawing means the approval to the adaptability of the design features. The RDSO will not be responsible for the correctness of dimension on the drawing, the materials used, the strength or performance of the components for all of which the successful tenderer will be wholly and completely responsible. The successful tenderer when submitting proposals on designs for approval of the RDSO shall draw specific attention to any deviation or departure from the specification involved in his proposals /drawings.

3.0 TECHNICAL REQUIREMENTS.

3.1 ENVIRONMENT & WORKING CONDITIONS.

3.1.1 The contact wire measuring system to be installed on the roof of NETRA car is expected to be used in continuous operation during the varying atmospheric and climatic conditions at any time of the year. The environment factors are expected to vary in the range as tabulated below.

i)	Ambient air temperature	-2 ⁰ C to +50 ⁰ C
ii)	Maximum temperature in sun.	70 ⁰ C
iii)	Maximum relative humidity	100%
iv)	Annual rainfall	Dry Arid regions and also heavy monsoon affected regions with rainfall ranging from 1750mm to 6250 mm
v)	Maximum number of thunder storm days per annum	85
vi)	Maximum number of dust storm days per annum	35
vii)	Number of rainy days per annum	120
viii)	Basic wind pressure	200 kgf/m ²
ix)	Altitude	Not exceeding 1000m

Equipment intended to be mounted for contact wire thickness measurement system on the roof of NETRA car shall be within the maximum moving dimensions of the NETRA car and they shall not infringe MMD. Tenderer shall confirm this in his offer.

3.2 Operating requirements

The measuring system and instrumentation offered shall be of proven design and should have performed satisfactorily in the tropical climate similar to India. The operating requirements for contact wire measurement systems are tabulated below.

i)	Operation times	The system shall be able to take the measurement during Day & Night
ii)	Variation in Traction supply Voltage	The measurement system shall give satisfactory performance with variation in traction supply voltage from 19 kV to 27.5 kV a.c. (sometimes touching 30 kV)
iii)	Operation duty	The installed measuring system shall be suitable for continuous working on live or non-live OHE under all atmospheric condition throughout the year.
xiv)	Maximum running speed of OHE car for measurements	The system shall be able to take measurement up to speed of 160 kmph of OHE car, presently NETRA car's operating speed is 105 kmph.

3.2.1 The system should be immune to electrical and electromagnetic interferences, interference from the sunlight or other light sources.

3.3 Measurement of contact wire diameter/wear and generation of report

- 3.3.1 The sizes of different types of contact wire in use on electric traction of IR is given at Annexure-II. Normally these contact wires are retained till these wear down to specified limits. These are checked manually under power/traffic block. The proposed measuring system shall be adequately designed to measure, record all measurements for given type of wire in 'New' condition and 1mm lower than the condemning size.
- 3.3.2 The successful tenderer is required to supply a measuring system capable to carryout the measurements in static as well as dynamic condition. Real time display and storage of the measured contact wire diameter/wear on the computer monitor kept inside the coach should be possible. The measured data stored on the computer shall be kept in a file so that preview and print of the same is possible to take as per requirement. The measuring system or the method of measurement should be capable of measuring the contact wire diameter/wear correctly to the accuracy as mentioned in the specification.
- 3.3.3 The software should carry out off line analysis and automatically generate a report in excel format. Report shall display contact wire diameter/ wear along with previous recordings with date of measurement, location of mast etc. so that it should be possible to evaluate wear rate at particular location. Facility in the software should be made available to set the condemning limit and alarming limit so that software can generate the report for the locations on which the size of wire measured has reached to an alarming limit or condemning limit set by user. Report format for contact wire thickness shall be submitted by tenderer. Software should also be capable to generate graphical presentation of the measured data with respect to mast location. It should be possible to initialize the reference kilometers by the

operator at any stage. All the distance measurement shall be with reference to the kilometer initialized till the next initialization by the operator.

- 3.3.4 The pantograph pan is already equipped with load cells, accelerometers, infrared sensors etc. The weight of these sensors is approx.1.2 to 1.3.kg. Provision of additional sensors for measurement of contact wire diameter/thickness would affect the performance of the pantograph or make its movement sluggish and therefore further addition of sensors on pan would not be acceptable. The measurement system shall be preferably non-contact type using laser as media.

3.3.5 Detection of mast position & kilometric progressive position

The system shall provide facility to detect the exact OHE mast/structure location along the track of IR. Based on the software analysis of the acquired data the processing software shall detect and count mast position. The system shall have provision to support calculated mast position by a suitable light/optical/laser sensing device mounted at suitable location on the coach.

The detection of kilometric progressive position of the recorded data shall be determined by GPS system. The kilometric progressive positioning system shall be supported by another means of encoders, where GPS data are not accessible. The encoder will take over to support the GPS information in continuation with GPS kilometric progressive position. The encoders shall be mounted at a suitable place on the recording car and shall be connected by an elastic joint or by means of chain transmission or any other such system. The system shall also allow coded digital entry for manual or automatic acquisition of reference point along the line, in order to automatically align the progressive position. GPS shall have an accuracy of ± 2 meters or even better for identification of exact OHE mast location. If the measurement of contact wire wear is required to be identified for more nos of locations in between two OHE masts, then this location are also to be indicated alongwith the distance from the either end of OHE mast locations. The system shall display mast nos., distance with respect to mast nos location and measured value of contact wire wear.

On electrified sections of IR, OHE masts are numbered with maximum four digits number in numerator indicating kilometers and two digits number in the denominator which indicates OHE mast number. Even numbers are generally indicated for DN line mast numbers and odd numbers are indicated for UP line OHE mast numbers. The GPS mapping of all the mast location will be taken as a reference point to identify the measured data at a location. The kilometric position of vehicle (recording car) shall match / synchronise with the kilometric position of the mast.

The GPS system for mast identification shall be provided by the tenderer as per requirement.

3.4 Specification of contact wire measurement system

3.4.1 The measurement system shall be capable of delivering measurements conforming to the following specification.

SN	Description	Requirement
1	Capability of measuring system	Upto 160 km/h speed of car.
2	No. of wires	Simultaneous detection of 2 wires
3	Sampling frequency/second	Minimum 200 acquisitions/second. There should be provision in software to vary the sampling frequency minimum up to 5 samples/second.
4	System adaptability to varying height of contact wire	The system should automatically adapt to variation in contact wire height. In no case, should scanning be skipped for variation in height.
5	Vertical detection field	1500 mm (Minimum)
6	Horizontal detection field	± 600 mm
7	Accuracy of wire wear measurement system	± 0.3 mm maximum

The complete processing system shall be based on computers installed on board of the NETRA Car and connected by a network. Further an additional computers shall be installed in a fixed position. The processing system installed on board in NETRA Car shall be utilized to carry out following functions.

1. Calculation of data of the catenary/contact wire.
2. Storage of the acquired data.
3. Server functions.

The computer shall have following minimum feature or latest version available.

1. 2.4 kHz Pentium processor.
2. 120 G Byte hard disk
3. 1 GB RAM
4. 17" colour monitor 3 unit.
5. Memory shall have adequate capability to process and store data for minimum 500kms continuous run of NETRA Car.

The following functions are foreseen on the server:

1. Calculation of kilometric progressive position
2. Display of data of the catenary
3. Display of the images of the video inspection
4. Database

5. Writing of data on DVD or on CDROM

3.5 INSTRUMENTATION

- 3.5.1 Main computer shall have adequate memory capable of processing and storing data at least for continuous run of 500 km. The computer shall be provided with RW CD drive for taking back up for recorded data file and laser printer of reports. A suitable recorder shall be provided for on line printing of graphical representation of measured parameter.
- 3.5.2 All control cables shall be segregated from power cables and shall be suitably protected.
- 3.5.3 The measurement system shall be properly earthed and shielded against any damage caused by falling of 25 kV live conductor.
- 3.5.4 As far as possible items like computers, UPS etc shall be of indigenous origin or having servicing/maintenance facilities in India.
- 3.5.5 Necessary software shall be supplied on CDs by the successful tenderer.
- 3.5.6 Copies of maker's test certificates, guaranteeing the performance of the systems shall be supplied in duplicate at the time of commissioning.

4.0 INSPECTION, TESTING & TRAINING

- 4.1 The measurement system shall be inspected and tested by the Director General/TI, RDSO{(DG)/TI/RDSO} or his authorized representative at the firm's work. The system shall be subjected to laboratory tests before acceptance. On successfully withstanding these tests, system will be cleared for dispatch for installation and commissioning and field trial and testing on NETRA car. Field validation test shall be carried out to check accuracy and repeatability of the system. If these tests have already been conducted on the equipments in any internationally recognized test laboratory and system is functioning satisfactorily then all such reports of performance and copy of type tests reports to be submitted to RDSO for assessments.

Tenderer shall submit all test reports of the equipment already conducted on the system supplied for the assessment of purchaser along with relevant specification of the tests conducted to the DG/TI/RDSO for approval. Tests which supplier can carry out in their premises free of cost may also be carried out in presence of purchaser's/ RDSO's representative, if he feels so on a convenient and mutually agreed dates.

4.3 TRAINING

4.3.1 The supplier shall provide adequate training to two nos of RDSO officials for one week (five working days). It shall include both hardware and software training which is required for the smooth operation and maintenance of measurement system. The hardware training shall include calibration, operation & trouble shooting and other requirement of the system. Operational part of training shall cover, recording/measurement of contact wire thickness and analysis/ interpretation of the results, taking printouts and various setting to be carried out by user and storing data on the computer. Software training shall include the explanation of flow charts, source code of the software supplied. Training notes and suitable training material shall be provided.

4.4.1 INSTALLATION, COMMISSIONING, TESTING & TRIAL

The successful tenderer shall provide at his own expense, services of his engineer (s) for installation, testing and commissioning of the equipment of the system on the NETRA car and then carry out the trials of the same on Indian Railways network for its proper functioning. The tenderer shall ensure that equipments installed on the roof of NETRA car shall have minimum electrical clearances as mentioned in para 1.2 of Annexure-I to this specification.

4.4.2 The successful tenderer shall be responsible to install, commission and carry out successful trial and testing of the non-contact contact wire thickness measurement system on the NETRA Car to the full satisfaction of user/purchaser. The contact wire thickness measurement system shall be tested at various speeds in two trial run of about 200kms. Results of recording of at least 50 locations shall be compared with the measurement taken manually by railway staff. After full satisfaction of purchaser the contact wire thickness measurement system shall be accepted.

4.4.3 In case the performance of system is found unsatisfactory, the successful tenderer shall set right or replace the system within a reasonable time specified by the purchaser and the trial will be conducted again.

5.0 ANNUAL/PERIODIC MAINTENANCE

5.1 Tenderer shall also quote separately for annual maintenance contract for at least five years for the normal schedule/preventive maintenance and breakdown maintenance of the supplied contact wire thickness measurement system. Tenderer shall also furnish performance guarantee bond. The AMC shall indicate the guaranteed up time of 90% (10% down time). The down time will be calculated based on working days/year(240 days). While calculating the down time for each break down, the first 48 hours after lodging the complain will not be counted. In the event of exceeding the specified down time the payment of AMC shall be reduced by annuals as under:

- | | | |
|------|--------------------------|--|
| i) | Upto 10% downtime | :Nil |
| ii) | More than 10% & upto 15% | :97.5% of AMC value |
| iii) | More then 15% & upto 20% | :90% of AMC value |
| iv) | More than 20% | :80% of AMC value with option of terminating the contract. |

Other terms and condition shall be decided at the time of awarding the contract.

6.0 SERVICE AND MAINTENANCE MANUAL

6.1 Three numbers hard copies of maintenance and service manual in English language shall be prepared and supplied free of cost to RDSO. The detailed maintenance and service manual shall also contain the all the required procedures/instructions as recommended by OEM including the troubleshooting instructions, precautions, operating instructions and procedure for periodical testing to check the soundness of the system and calibration of the measurement system. The draft manuals shall also be submitted to RDSO for approval before they are finally printed. Apart from these three copies of spare parts catalogues shall also be supplied to RDSO.

6.2 Documentation of system hardware shall be supplied comprising of details of circuit diagrams, electrical and electronic designs with descriptions, component materials/part number, equivalent internal part number, component specifications etc along with explanatory notes and comments where ever necessary.

7.0 SPARES

7.1 Successful Tenderer should be able to supply spares at free of cost for atleast five years for maintenance of measurement system. The spare parts required shall be detailed in a separate list indicating description, part number, rate, quantity and whether imported or indigenous. The manufacturer should guarantee for the subsequent availability of spare components to ensure trouble free service for 15 years. For spare parts, the source and other technical details shall be supplied.

7.2 All tools required for emergency and normal maintenance should be supplied as a complete kit. The list of tools, name of supplier along with instructions for use of special tools should be provided.

8.0 CALIBRATION

8.1 The procedure for calibration of the measurement system shall be included in the operational and maintenance manual.

9.0 WARRANTY

9.1 The system for measurement of contact wire diameter/wear supplied against this contract shall be guaranteed for trouble free and satisfactory performance for a period of 12 months from the date of acceptance of the contact wire thickness

measurement system by the purchaser after commissioning and successful trial. Date of acceptance means the date on which the system is commissioned after successful field validation of the system and commissioning certificate shall be issued by RDSO, Lucknow.

10.0 Existing system on NETRA Car

- 10.1 Since the above measurement system is required to be installed on the NETRA Car and hence a brief description of the equipment presently installed on the NETRA Car is given below. The present NETRA Car of IR is capable of measuring stagger, height, contact force, accelerations, hard spots, speed, distance etc.
- 10.2 The Pantograph of the NETRA Car is AM-12 Stone Faiveley pantograph. 2 Nos. of load cells are mounted beneath the plungers on either side of the panto graph (below the pan). 3 Nos. of accelerometers are mounted beneath the center of the panto pan. 2 nos. Infra-red sensors are mounted on the 2 horns on either side of pantograph. One number linear potentiometer is installed on the base frame of the pantograph. All the signals of eight channels are fed to transducer cards (4 Nos.) (2-channels in each card) which along with a micro-controller card are kept in an electronic box. The electrical output from the box is transmitted to the computer through an optic fiber link.
- 10.3 On the roof of the coach of NETRA Car, there are 2 Nos. of structure detector mounted on the roof, on either side of the center line of track. One Capacitor-Voltage divider is also mounted on the roof for measurement of OHE voltage.
- 10.4 The transducer cards get auxiliary supply of 5V from regulated battery supply. There are two sets of batteries of 12V each, which are charged by Solar panels. (4 nos.)
- 10.5 Speed & distance signals are received in the coach from a speed sensor (tachometer) mounted on the axle box.
- 10.6 A dedicated software exist to generate exceedance/alarm report and on line (real time) plotting on chart recorder. There are 2 Nos. of computers, 2 Nos. of 5 k VA UPS and 2 Nos. 50 kVA DG sets installed on the NETRA Car for recording and of other OHE parameters and ensuring uninterrupted power supply.
- 10.7 A schematic diagram of NETRA instrumentation system is enclosed at Annexure-III.

LIST OF ENCLOSURES

SN	Annexure nos	Descriptions
1	I	Brief description of 25kV a.c. overhead equipment system
2	II	Configuration of contact wire
3	III	Schematic diagram of NETRA instrumentation system
4	IV	Riding quality indices of NETRA Car

ANNEXURE-I

BRIEF DESCRIPTION OF OVERHEAD EQUIPMENT

1.0 25kV a.c. , 50Hz single phase Traction system on Indian Railway.

1.1 Simple polygonal type overhead equipment, comprising of single catenary and contact wire is automatically tensioned. The catenary has 19 strands made of cadmium copper with a cross-section of 65 mm^2 . The grooved contact wire is hard drawn electrolytic copper of 107 mm^2 cross section. Solid copper droppers, 5 mm in diameter, with a normal spacing of 9m support the contact wire from the catenary. The spans between structures are 72m. maximum and reduced to 27m. in steps of 4.5m according to degree of curvature. On straight track , the contact wire is registered at the supports on the contact plane by 200mm. transverse on either side of the centre line of track. The stagger is limited to 300 mm. on curves. Maximum displacement of contact wire in current collecting zone may be up to 420 mm on either side from the track center /center of pantograph pan.

On secondary lines regulated tramway type construction consisting of contact wire only tensioned at 1200 kgf with bridle wire provided at support points to reduce sag, is used.

Normal system voltage of overhead Contact wire is 25 kV a.c., single phase, 50Hz.

1.2 Normal vertical and lateral electrical clearance of 320 mm. has been adopted, with passing clearances i.e. of short time duration of 270 mm and 220 mm respectively, as per Chapter – V-A Electric Traction of Schedule of Dimensions 1676mm gage (BG) 2004.

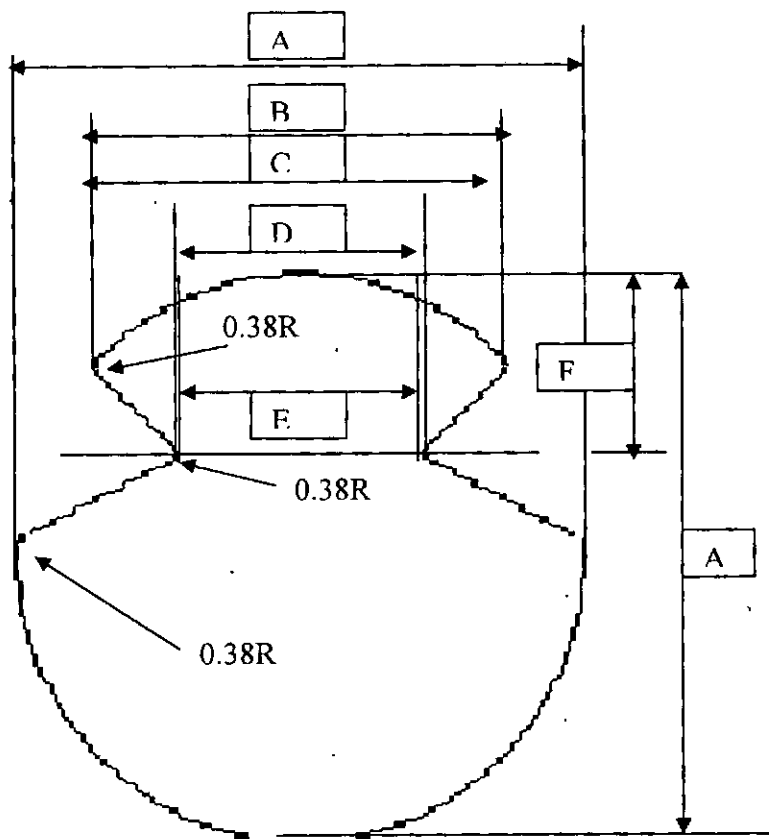
1.3 The normal height of the contact wire above the rail level is 5.50 m but at loco sheds and inspection pits, the height is kept as 5.8m. On constraint locations, such as tunnels, road over bridges the contact wire height is kept as low as 4.65 m. minimum. Any change in the height of the contact wire is made gradually and the maximum gradient does not normally exceed 3mm/m on main lines and the 10mm/m elsewhere. The variation of gradient on adjacent spans is not more than 1.5mm/m for main lines and 5mm/m on secondary tracks.

1.4 The vertical distance between the catenary and the contact wire (called encumbrance) is 1.4 m at support and is maintained except at turnouts, overlaps and near over line structures and tunnels, where it is suitably reduced. The distance from the centre of the track to the nearest face of an overhead equipment support mast is normally 2.50m on straight track. This distance is increased by necessary curve allowance on the curves. This distance is also more than the normal 2.5m in the vicinity of signals for better visibility.

- 1.5 A cantilever assembly mainly comprising of high tensile steel tubes and solid core porcelain insulators is attached to the traction mast with suitable mast fittings, the catenary is freely suspended from the cantilever assembly and the contact wire is registered at the required position by an aluminum steady arm. The complete cantilever assembly upto solid core porcelain insulator is live at 25kV, 50Hz a.c. system.
- 1.6 In tunnels due to restricted head rooms, the encumbrance is reduced as required, the minimum being 250mm approximately.
- 1.7 The tension length of the catenary and contact wires are normally 1500m and distance between overlaps being 1300m (approx.) An anti-creep i.e. a fixed point is provided on the catenary approximately at the mid point of each tension length. In a regulated equipment as adopted on Indian Railways, a constant tension of 1000 kgf is maintained on the catenary and the contact wire by counter weights through an auto tensioning device. Unregulated OHE is also in use, but normally in yards. The contact wire tension for tramway OHE used in secondary lines is 1200 kgf.
- 1.8 At un-insulated overlaps, the air gap between the two wires is 200mm. At insulated overlaps, similarly the two overhead equipments are separated by an air gap of normally 500mm.
- 1.9 Turnouts and crossover are equipped with separate OHE and the take off points are invariably arranged in such a way so as to have smooth passage of pantograph. The turnouts and crossing from secondary tracks are provided with similar arrangement or with crossed type of equipments where the OHE has no overlapping span.

Annexure-II

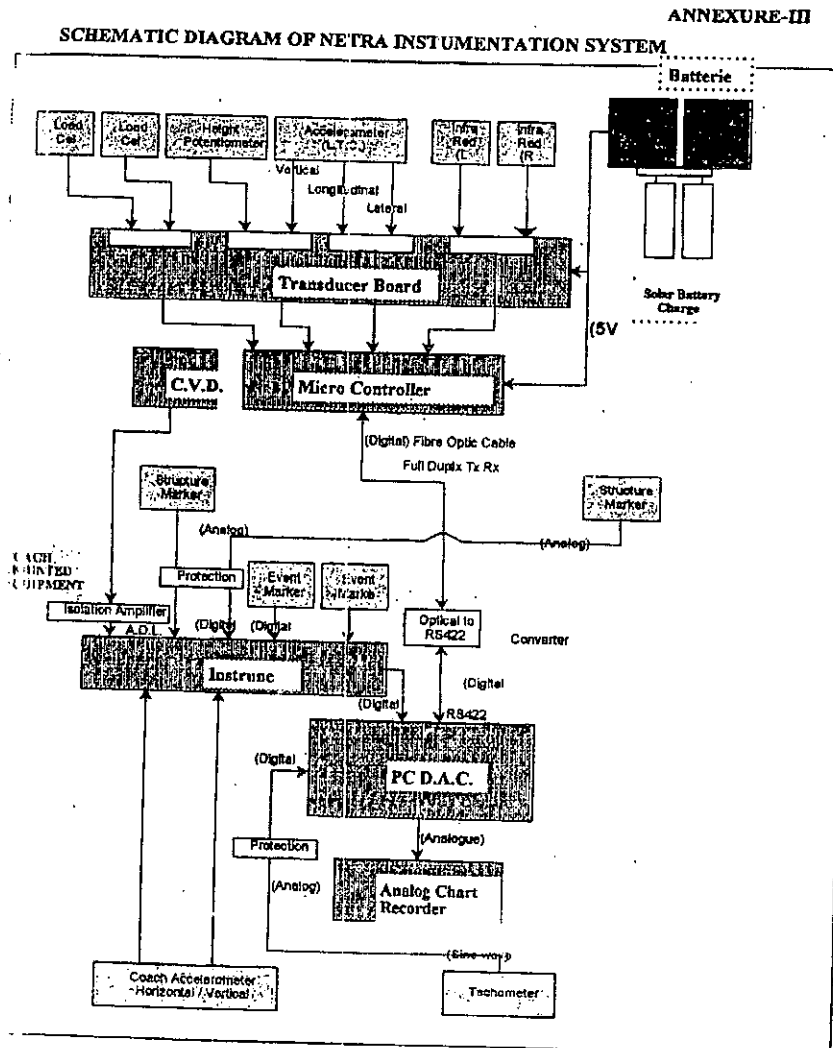
CONFIGURATION OF CONTACT WIRE



Configuration of contact wire

Cross section of contact wire (mm ²)	Dimension (mm)						Dimension in Degree		
	A	B	C	D	E	F	L	M	N
107 mm ²	12.24 ± 0.18			6.92 ± 0.15	6.50	4.43	+1 27 -0	+1 51 -0	+2 78 -0
150 mm ²	14.50 ± 0.20			6.92 ± 0.15	6.50	4.00	+1 27 -0	+1 51 -0	+2 78 -0
161 mm ²	15.00 ± 0.15	12.20	12.00 ± 0.25	+0.18 6.50 -0.30	8.10	5.75	+2 27 -0	+1 51 -0	+3 78 -0
193 mm ²	16.40 ± 0.15	12.20	12.00 ± 0.25	+0.18 6.50 -0.30	8.10	5.3	+2 27 -0	+1 51 -0	+3 78 -0

Annexure-III



Annexure-IV

SUMMARY OF REPORT

1. REPORT NO. MT- 121 (FEBRUARY 1998)
2. UNIT RM-II
3. TITLE Oscillation Trials on IRY/IR-20 Power Car Coach upto a maximum test speed of 115 km/h on Rampur - Bareilly section of Northern Railway on track maintained to main line standards.
4. FILE REFERENCE RM2/C/44 (IR-20)
5. CODE/DESCRIPTION IRY/IR-20
6. NATURE OF TRIAL Oscillation Trials
7. TEST PERIOD JANUARY 1998
8. SPONSOR Carriage Directorate
9. DESIGN FEATURE High Speed Coaching stock.
10. TEST OBJECTIVE & RESULTS To assess the riding quality characteristics of the prototype power car coach upto the maximum test speed of 115km/h on track maintained to main line standards. The test vehicle exhibited satisfactory riding characteristics upto 115 km/h on tangent track, station yard and 2 deg. curve.
11. TEST SITE RAMPUR - BAREILLY
12. COST OF TRIALS 30 lakhs

SUMMARY OF RESULTS

1. Wedge Tests

Mode	Empty Coach	Loaded Coach
Bouncing (Hz)	4.28	5.26
Pitching (Hz)	3.84	4.00
Rolling (Hz)	0.62	0.62
Damping factor	0.22	0.34

2. Detailed trials - Peak Values

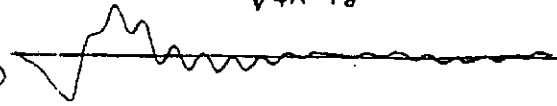
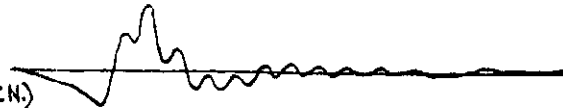
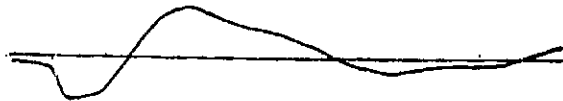
Test Condition : Wear adopted new profiles

S. No.	Parameters	EMPTY CONDITION			LOADED CONDITION		
		Max. Value	Speed Km/h	Location	Max. Value	Speed Km/h	Location
1.	Max. Vert. Accn - g (Test Coach)	0.18	100	S.Y.	0.20	115	S.Y.
2.	Max. Vert. R.I.(TC)	3.00	115	S.Y.	3.03	115	S.Y.
3.	Max Pri. Load-mm(TC)	13	105	2 ^o Curve	14	90	S.Y.
4.	Max.Pr.O/L - mm (TC)	17	105	2 ^o Curve	19	105	2 ^o Curve
5.	Max.Sec.Load-mm (TC)	32	115	S.Y.	30	115	S.Y.
6.	Max.Sec.O/L - mm (TC)	31	115	S.Y.	32	115	S.Y.
7.	Max. Lat. Accn. - g (TC)	0.30	115	S.Y.	0.29	100	S.Y.
8.	Max. Lat. R.I. (TC)	3.48	115	S.Y.	3.42	105	2 ^o Curve
9.	Max. Lat. Movement mm (TC)	40	105	2 ^o Curve	52	105	S.Y.
10.	Max.Bogie Rom -Deg (TC)	0.79	105	2 ^o Curve	0.82	90	2 ^o Curve

RD.50
(RM)MECHANICAL TESTING
REPORT NO.

$$d = \log_e \frac{x_1}{x_2} = \frac{12}{3} = 1.3859$$

$$D.F. = \frac{d}{\sqrt{4x^2 + d^2}} = 0.22$$

1. BOUNCING
(VERTICAL ACCN.)2. PITCHING
(VERTICAL ACCN.)3. ROLLING
(TRANS. ACCN.)

4. TIMER

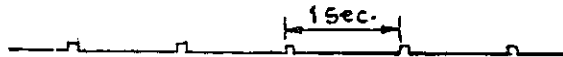


FIG.10(a). SPECIMEN OSCILLOGRAMS OF WEDGE TEST OF
IR-20 POWER CAR (NR 97852/A) IN EMPTY -
CONDITION

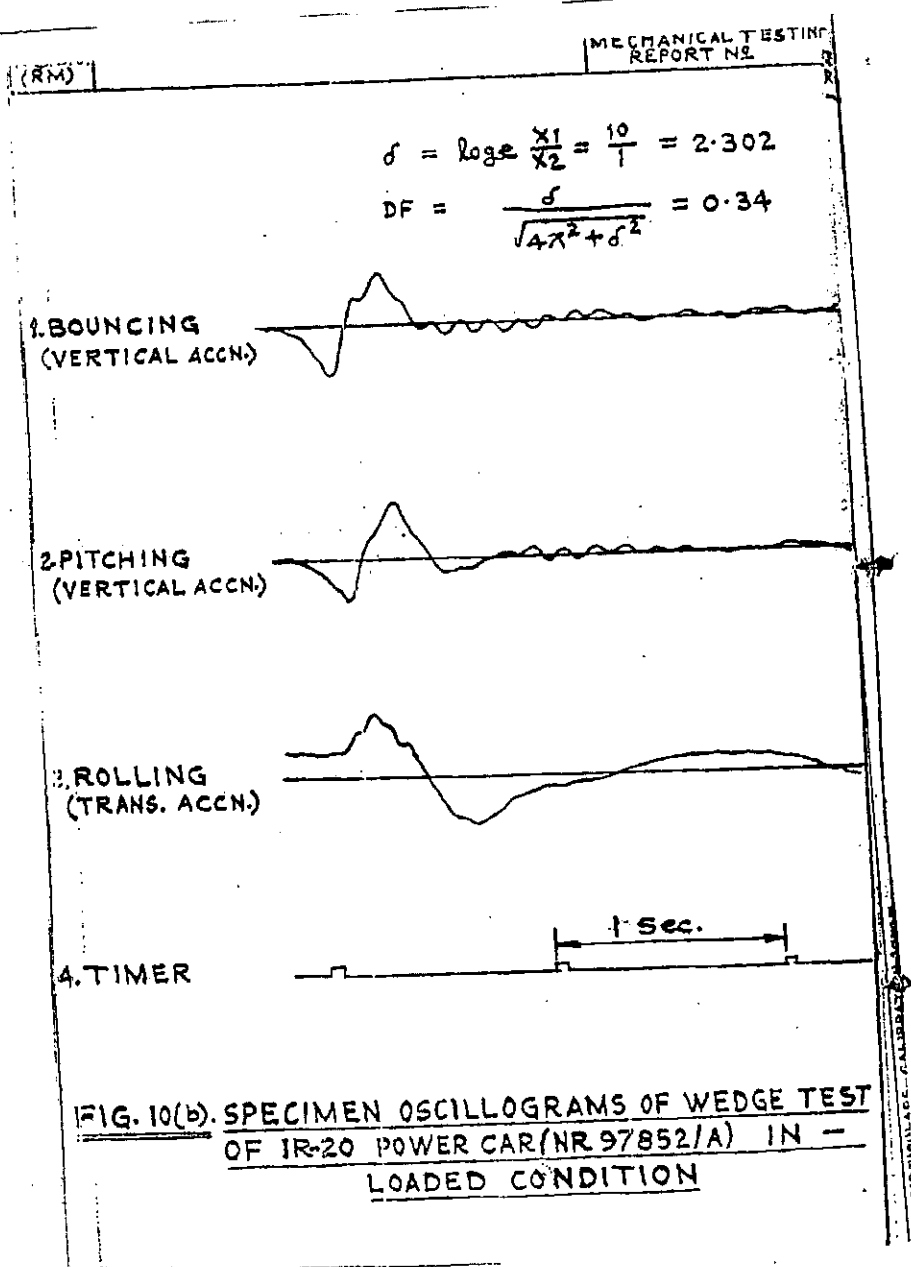


FIG. 10(b). SPECIMEN OSCILLOGRAMS OF WEDGE TEST OF IR-20 POWER CAR (NR 97852/A) IN - LOADED CONDITION

MECHANICAL TESTING REPORT NO.

R.M)

MECHANICAL TESTING
REPORT No.

NO. PARTICULARS CALIBRATION ICM=

VERTICAL ACCN. 0-2g
RG. BOGIE

TRANSVERSE 0-2g
CCN. RG. BOGIE

SEC. SP. DEF. (LEFT) 2cm
RG. BOGIE

SEC. SP. DEF. (RIGHT) 2cm
RG. BOGIE

BOGIE ROTATION 0-48°
RG. BOGIE

AT. DISPLACEMENT 4cm
RANS. BEAM RG. BOGIE

15cm

TIMER

VENT

km/h

RECORD NO. = 105
DATE = 22-1-98

AV. SPEED = 115 km/h
SECTION = MB - BE

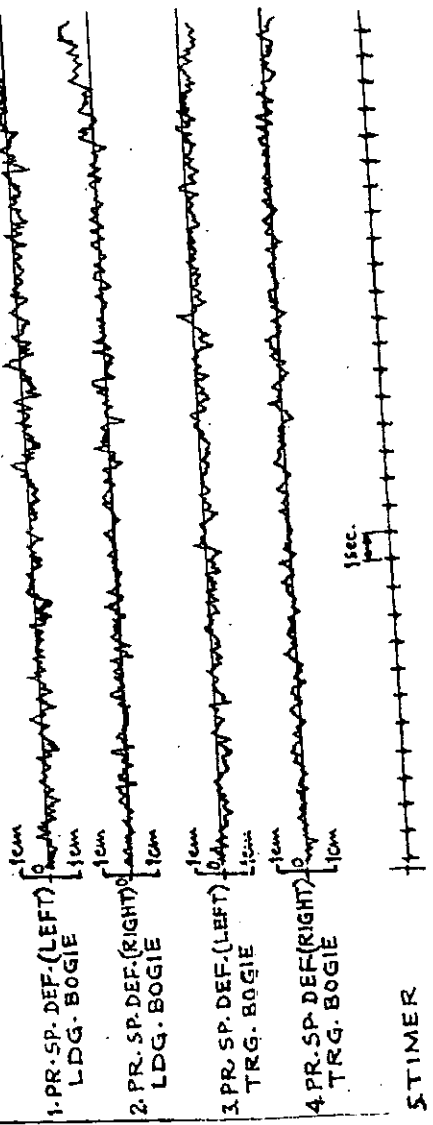
CONDITION = EMPTY

IG.11(c). SPECIMEN OSCILLOGRAMS OF IR-20 POWER CAR NR.97852 A AT A SPEED OF 115 km/h ON STRAIGHT SECTION IN EMPTY CONDITION

MECHANICAL TESTING
REPORT No. _____

(RM)

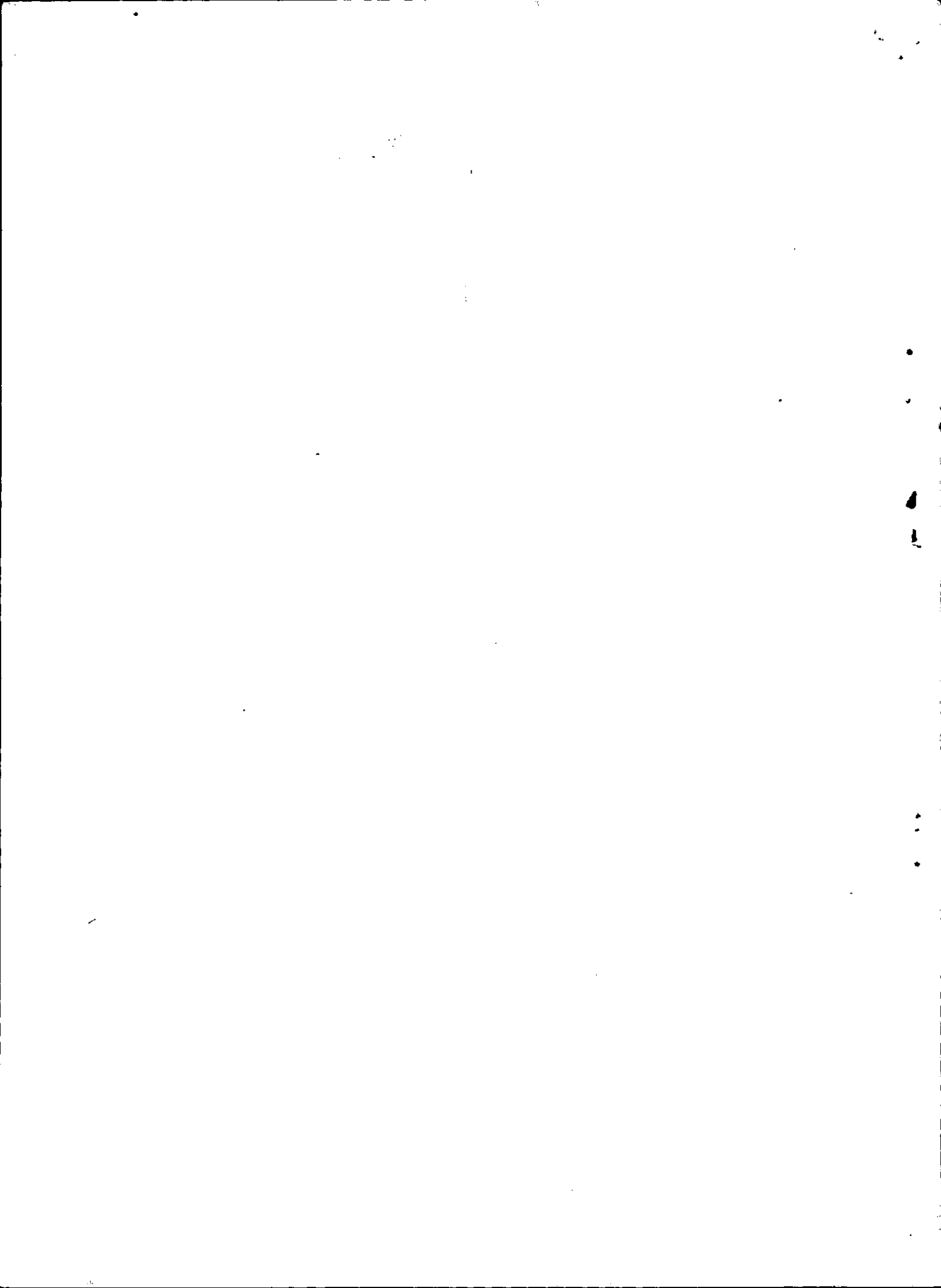
ISI. NO. PARTICULARS CALIBRATION ICM=



6. EVENT Km. 1519
Km. 1518

RECORD NR = 105
 DATE = 22-1-98
 AV. SPEED = 115 Km/h
 SECTION = MB - BE
 CONDITION = EMPTY

FIG. 11(b). SPECIMEN OSCILLOGRAMS OF IR-20 POWER CAR NR-97852A AT A SPEED OF 115km/h ON STRAIGHT SECTION IN EMPTY CONDITION



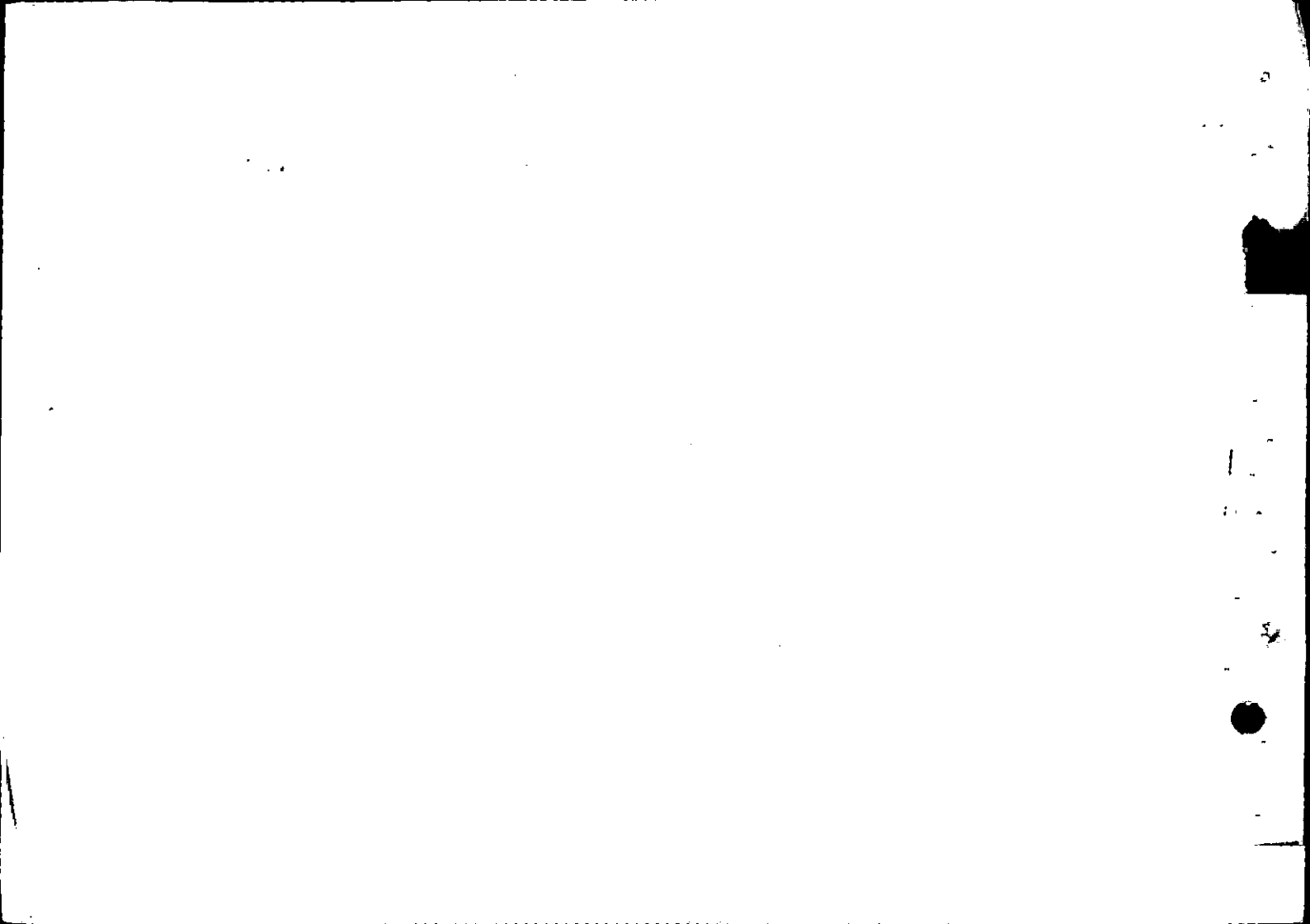
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ADDENDUM & CORRIGENDUM SLIP No. 1
TO
SPECIFICATION FOR GALVANIZED STEEL STRANDED WIRE FOR
TRACTION BONDS
FOR
25KV A.C. ELECTRIC TRACTION SYSTEM

Incorporate the following corrections in the specification as given below.:

- i. In clause nos. 11.1, 11.2, 11.3, 11.6, & 13.2, Director General(Traction Installation)/Research Designs & Standards Organisation(RDSO) shall be replaced by Director General (Traction Installation) RDSO, Lucknow /CORE, Allahabad
- ii. In clause no. 11.3, second sentence may be read as “ The bond shall be inspected and tested at manufacturer’s work by RDSO/CORE representative”.

RDSO/Lucknow
August-2005



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76

SPECIFICATION NO. TI/SPC/OHE/GALSTB/0040

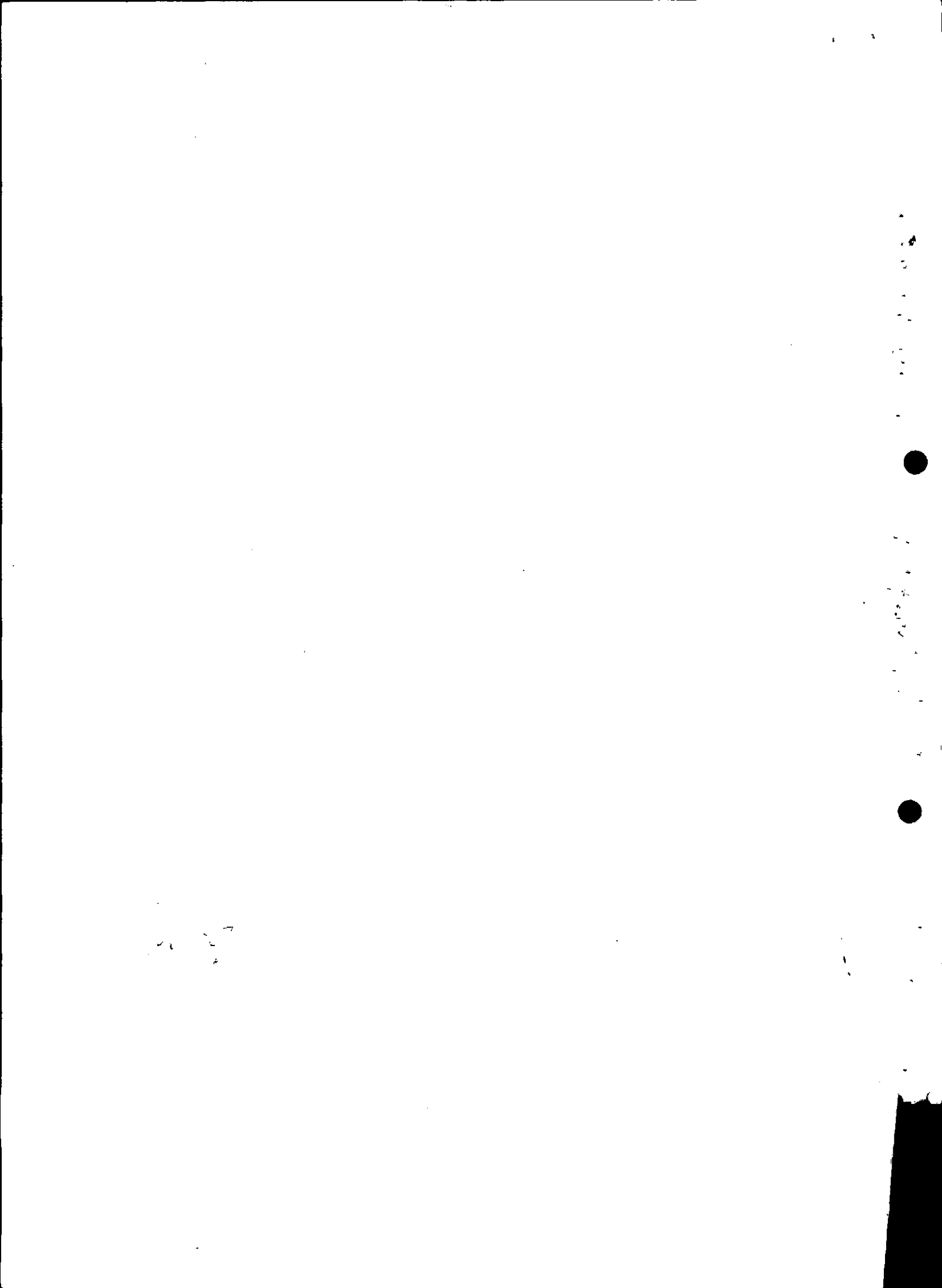
**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

**TECHNICAL SPECIFICATION
FOR
GALVANIZED STEEL STRANDED WIRE FOR
TRACTION BONDS
FOR
25 kV a.c. ELECTRIC TRACTION SYSTEM**

Issued by:

**RESEARCH DESIGNS & STANDARDS
ORGANISATION
MANAK NAGAR, LUCKNOW-226011**

(For Official Use Only)



TECHNICAL SPECIFICATION FOR GALVANISED STEEL TRACTION BOND

1.0 Scope :

This Specification covers the scope of manufacture, supply and testing of galvanised steel flexible traction bond. for use in 25 kV a.c. 50 Hz Electric Traction System on Indian Railway.

2.0 Service Conditions :

The bond is intended to be used as traction bond i.e. structure bond, longitudinal bond and cross bond, not being under tension, for electrically connecting the traction mast/structure, overhead line structure to rail/earth, two rails of a track, one rail of a track to the other rail of track .

3.0 Environmental Conditions :

The Bond is intended for openline use generally in moist tropical climatic conditions. The areas where bond is used may have heavy rainfall, salinity and industrial pollution and may have severe lightnings. The generally limiting weather conditions that the Bond has to withstand in service are indicated below :

(A)	Maximum ambient temperature	65 °C
(B)	Average Ambient temperature during day	35 °C
(C)	Maximum Relative Humidity	100%
(D)	Annual Rainfall Range	1750 mm to 6250 mm
(E)	Maximum number of thunder storm days per annum	35
(F)	No.of rainy days per annum	120
(G)	Average Wind Pressure	200 kg/mm ²
(H)	Altitude	Max.1000 m

4.0 Governing Specifications

4.1 Reference Specifications :

Reference has been made to the following Indian Standards in this specification:

IS:2363/1981 : Glossary of terms relating to Wire Ropes.

IS:6594/2001 : Technical Supply Conditions for Steel Wire Ropes and Strands.

IS:4826/1979 : Hot Dipped Galvanized Coatings on Round Steel Wires.

IS:1608/1995 : Mechanical Testing of Metals – Tensile Testing.

IS:6745/1972 : Methods for determination of Mass of Zinc Coating on Zinc Coated Iron & Steel Articles.

IS:2633/1986 : Methods for Testing Uniformity of Coating of Zinc Coated Articles.

IS: 279-1981 : Galvanized steel wire for telegraph and telephone purposes.

- 4.2 In case of any conflict or disparity between the contents of the above specifications and this specification, the latter shall prevail.
- 4.3 Any deviation from this specification calculated to improve the performance, efficiency and utility of the equipment proposed by the tenderer will be given due consideration provided full particulars with justification thereof are furnished. In such a case the tenderer shall quote according to this specification and indicate the deviations(s) separately in a "Statement of Deviations".

5.0 Material of bond :

Resistivity of Galvanised Steel Wires used in making Bond shall not exceed 14.5×10^{-6} Ohm-cm at 20 °C. The material shall have the composition as given below.

Carbon	: 0.10% Max
Silicon	: 0.03 Max
Manganese	: 0.38% to 0.62%
Phosphorous	: 0.03% Max
Sulphur	: 0.03% Max

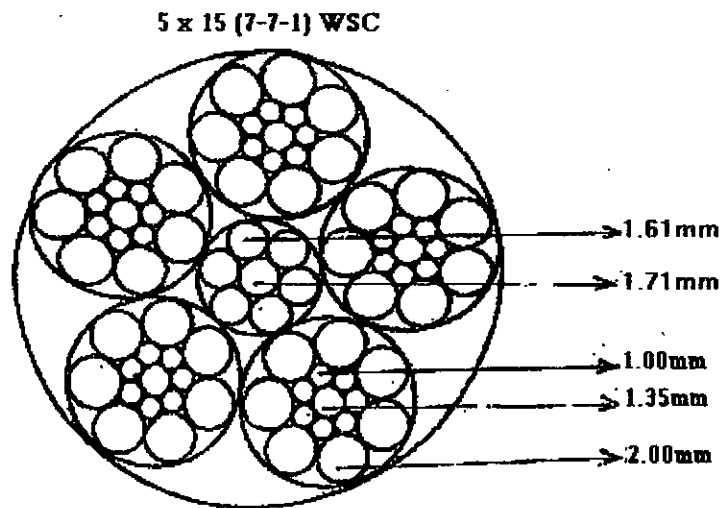
6.0 Diameter of Bond & Wire :

The nominal diameter of bond shall be 18 mm with a tolerance of + 4%, - 1%. Ovality shall not exceed 4%. The diameter of individual wires of covering strands and that of core strand shall be as per table-1 and table-2 respectively.

7.0 Construction & Laying :

Bond shall consist of 5 covering strands laid over central strand (Core strand). Each of the covering strands shall have 15 wires laid as 7-7-1 and core strand shall have 7 wires laid as 6-1.

Cross Section of bond is shown for reference as under :



Nominal sizes of wires used in Bond shall be as per Table 1 & 2.

Table 1

7.1 Covering Strands.

	No. of wires	Nominal dia (mm)	Tolerance (mm)
Outer layer	7	2.00	+ 0.050, - 0.030
Middle layer	7	1.00	+ 0.040, - 0.030
Core wire	1	1.35	+ 0.040, - 0.030

7.2 Core Strand

Table 2

	No. of wires	Nominal dia (mm)	Tolerance (mm)
Outer layer	6	1.61	+ 0.040, - 0.030
Core wire	1	1.71	+ 0.040, - 0.030

7.3 **Laying :**

- 7.3.1 The axial length of one complete turn of the helix formed by the strands is lay length.
- 7.3.2 Lay of bond shall be ordinary i.e. all the five covering strands shall be laid up over core strand in Right Hand direction. All the 15 wires in each covering strand shall be laid up in one operation only, in Left Hand direction. Direction of 6 covering wires of core strand over core wire shall be Right Hand.
- 7.3.3 Lay length of bond shall not exceed 126 mm.
- 7.3.4 Bond shall be preformed.

7.4 **Joints in wires :**

Joints in wires to be used in bond shall be avoided as far as possible, but, where necessary, those shall be as widely apart as far as possible, but, in no case more than one wire shall be joined in any length of 10 meter of Bond.

The joints shall be either brazed or welded. If the joint is brazed, it shall be properly scarfed. If joint is welded it shall be properly annealed. Localised damage to zinc coating in the process of brazing or welding, shall be restored by cold galvanizing or by using zinc paint.

Strength of joint shall be not less than 90% of the original strength of wire.

8.0 **Galvanising of Individual Wires :**

- 8.1 Wires used in Bond shall be hot dip galvanised and shall meet the requirements of Heavily Coated Wires as per IS:4826 as under :

Nominal dia (mm)	Before stranding			After stranding		
	Mass of coating (gm/m ²) Minimum	No. of dips		Mass of coating gm/m ² Minimum	No. of dips	
		1 min.	½ min.		1 min.	½ min.
1.00	170	2	-	162	1	1
1.35	200	2	-	190	1	1
1.61	230	2	1	219	2	-
1.71	230	2	1	219	2	-
2.00	240	3	-	228	2	1

- 8.2 Wires shall also pass Adhesion Test as per IS:4826 of 1979 satisfactorily.
- 8.3 On demand, record should be made available to inspecting officer in respect of results of galvanising tests done on wires before stranding.

9.0 **Tensile strength of individual wires :**

Tensile Strength of wires from Bond shall be minimum 45 kgf/mm² and maximum 75 kgf/mm². Tensile Test shall be carried out on samples of wires from outer layer and middle layer of Covering Strands and outer layer wires of Core Strand. However, tensile strength of Core Wire of Covering Strands and Core Strand and that of outer layer wires of Core Strand shall be the same.

10.0 **Resistance, Mass & Breaking Strength of Bond :**

The maximum Resistance, Approximate Mass and Minimum Breaking Strength of Bond shall be as per Table 3.

Table 3

Maximum Resistance Ohm/km @ 20 °C	Minimum Breaking Load (kgf)	Approx. Mass kg/meter
1.021	6230	1.3

11.0 **Tests :**

- 11.1 Any changes required in the process of manufacture or the prototype as desired by Director General(Traction Installation)/Research Designs & Standards Organisation(RDSO) shall be carried out expeditiously by the manufacturer.
- 11.2 Type testing schedule:- Prior to giving a call to the Director General (Traction Installation)/ Research Designs & Standards Organisation for inspection and testing of the prototype, the manufacturer shall submit a detailed test schedule for each of the tests and the number of days required to complete all the tests at one stretch. Once the schedule is approved, the tests shall invariably be done accordingly. However, during the process of type testing or even later, the purchaser reserves the right to conduct any additional test (s) besides those specified herein, to his satisfaction or for gaining additional information and knowledge. In case any dispute or disagreement varies between the manufacturer and representative of the Director General (Traction Installations)/ RDSO during the process of testing as regards the procedure for type tests and/or the interpretation and acceptability of the results of type test, it shall be brought to the notice of the Director General (Traction Installations) /RDSO as the case may be, whose decision shall be final and binding.
- 11.3 The manufacturer shall offer prototype for approval as per the direction of Director General(Traction Installation)/RDSO within the period stipulated. The bond shall be inspected and tested at manufacturers works by RDSO representatives. The manufacturer shall arrange all the necessary machinery, apparatus, labour and assistance required for conducting the tests without any extra cost.

11.4 Sampling :

Outer layer wires of Covering Strands shall belong to one heat of steel only and shall be drawn under identical conditions. Likewise, middle layer wires of Covering Strands shall also belong to one heat of steel only and drawn under identical conditions. All the reels/coils of the Bond made from such wires manufactured under one closing shall constitute a lot. The manufacturer shall give undertaking conforming to heat number.

11.4.1 Sample Size for acceptance tests :

11.4.1.1 Bond :

Sample from each lot shall be selected at random to ascertain lots' conformity to the requirements of this specification. The number of reels/coils per lot to be selected for tests shall be as per Table 4.

Table 4

No. of reels/ coils in the lot	No. of samples to be selected	No. of reels/ coils in the lot	No. of samples to be selected
Upto 3	1	41 to 75	5
4 to 10	2	76 to 100	6
11 to 20	3	101 to 150	7
21 to 40	4	151 to 250	8
		Above 250	10

11.4.1.2 Sampling of individual wires from Bond :

From each sample of bond selected as above, approximately one-meter length of bond shall be utilized for conducting tests on individual wires. All the outer layer wires and middle layer wires of all the covering strands of bond shall be separately grouped and well mixed.

Out of total 35 wires belonging to outer layer of strands, 6 wires at random shall be selected for visual examination, measurement of diameter and same 6 wires shall be utilized for conducting tensile test. Of remaining 29 wires, 6 wires at random shall be selected for conducting galvanizing tests. Similarly, out of 35 wires belonging to middle layer, 6 wires at random shall be selected for measurement of diameter and same 6 wires shall be utilised for conducting Tensile Test. Of remaining 29 wires, 6 wires at random shall be selected for conducting galvanizing tests.

11.5 Sampling for type test:

Each test shall be conducted on individual wires from three samples of Bond. Selection of wire samples shall be as per clause 11.4.1.2. Similarly all the type tests shall be conducted on three samples of bond except short circuit test which shall be conducted on two samples of bond.

11.6 Type Tests

The following type tests shall be carried out in the presence of representative of Director General(Traction Installation)/RDSO.

11.6.1 Tests on wires:

- (i) Visual Examination
- (ii) Measurement of diameter of individual wires
- (iii) Tensile test on wires
- (iv) Galvanising tests
- (v) Chemical composition

11.6.2 Tests on Traction Bond:

- i) Visual Examination
- ii) Measurement of Diameter
- iii) Measurement of Lay Length
- iv) Preforming Test
- v) d.c. Resistance Test
- vi) Breaking Strength Test
- vii) Approximate Mass
- viii) Short Circuit Test

11.6.3 In case test facility for short circuit test is not available with the manufacturer, after satisfactory type test results on other tests, identified samples for short circuit test be sent to an independent laboratory.

12.0 Test Methods

12.1 Visual Examination:

Bond shall be free from laying defects like loose wires or overlapped wires or unevenly laid wires in the strands or likewise in strands, in rope. The laying shall appear to be consistent and regular. Wires used in bond shall appear to be sound, free from splits, surface flaws, rough, jagged and imperfect edges. The zinc coating on wire surface shall be uniform, adherent, reasonably smooth, free from flux, ash and dross inclusions and also free from bare patches, black spots, pimples, lumpiness, runs, rust stains, blisters and bulky white deposits. Laying in bond shall be as per clause 7.3.2.

12.2 Measurement of diameters :

The measurement of diameter of individual wire shall be done with a micrometer having a minimum sensitivity of 0.01mm. Average of two measurements at same points approximately at right angles to each other shall be the actual diameter of wire. The values shall be as per Table-1 and Table 2 of clause 7.

The diameter of bond shall be measured in accordance with Annex-A of IS : 6594/2001. The value of the diameter shall be as per clause 6.0.

12.3 Tensile test on wires:

The tensile test on wires shall be conducted in accordance with IS:1608 of 1995 and the value shall be as per clause 9.0

12.4 Galvanising test on wires :

Wires shall be tested for mass of zinc coating as per IS:6745 of 1972, uniformity of zinc coating as per IS:2633 of 1972 and adhesion of zinc coating as per clause 5 of IS:4826 of 1979 and shall meet the requirement of clause 8.0.

12.5 Chemical composition:

Chemical analysis shall meet the requirement of material specified in clause 5.0.

12.6 Preforming test :

Preforming test on the bond shall be carried out by unlaying at one end of the bond, two strands opposite to each other for approximately two lay lengths. When these two strands are re-laid into the bond the strands shall resume their position in the bond.

12.7 Measurement of lay length:

Lay length shall be measured for the complete bond by taking out lay print. The value shall be as per clause 7.3.3.

12.8 d.c. Resistance test:

Measurement of resistance shall be done by Kelvin Bridge or Digital Micro Ohmmeter. For converting measured resistance at ambient temperature to resistance @ 20°C, Annex -A to this specification be referred to. The value shall be as per Table 3 of clause 10.0.

12.9 Breaking strength test:

Breaking strength test on bond shall be carried out as per Annex B of IS:6594/2001 . The value shall be as per table-3 of clause 10.0

In case, sample of Bond for Breaking Strength Test is prepared by Ferrule Secured Eye Terminals (Mechanical Splicing) as per IS:5245 (Part II)/1971 a reduction in test result upto 7% of specified breaking strength can be considered.

12.10 Approximate mass:

Measurement of weight shall be done by taking a sample of one meter length using standard weight. The value shall be as per table- 3 of clause 10.0

12.11 Short Circuit Test:

Short Circuit Current of $6kA_{rms}$ shall be applied for a duration of 1 second on 3 meter long bond with lugs crimped at each end.

The sample should withstand the current without any arcing or flashover. No current interruption shall be observed during test.

The maximum temperature measured immediately after short circuit test should not exceed $91^{\circ}C$ if ambient temperature is between $15^{\circ}C$ to $30^{\circ}C$ and $101^{\circ}C$ if ambient temperature is above $30^{\circ}C$.

13.0 Acceptance criteria for prototype

13.1 The samples offered for type tests in accordance with clause 11.6 shall pass all the type tests.

13.2 Only after clear written approval of the results of the tests on the prototype is communicated by Director General (TI), RDSO to the manufacturer, he shall take up bulk manufacture of the galvanized stranded wire which shall be strictly with the same material and process of manufacture as adopted for the prototype. In no circumstances shall material other than those adopted during the manufacture of prototype be used for bulk manufacture.

14.0 Acceptance tests:

14.1 All the tests in clause 11.6 shall be carried out except short circuit test in the presence of representative of Director General/TI/RDSO or to the purchaser.

14.2 The tests shall be conducted as laid down in the relevant clauses thereof.

14.3 Retest :

If more than one wire fails in any of the tests, two more samples of wire drawn from surplus wire samples selected as per clause 11.4.1.2 shall be tested. Retest shall be restricted to test in which failure occurred. During retest both the samples shall pass the test. If both the samples do not pass the test, lot shall be considered not acceptable.

If the sample of bond fails in any of the tests, two more samples of Bond from the same lot shall be drawn and tested. Retest shall be restricted to test in which sample of bond failed. During retest both the samples shall pass the test. If both the samples do not pass the test, lot shall be considered not acceptable.

15.0 Packing :

The bond shall be delivered to the consignee properly wound on transit worthy wooden reel generally conforming to IS:1778 in specified length unless otherwise coil packing of specified packing length or weight is specified or unless supply of Bond is specified to be in specified cut lengths. Coil/reel as the case may be must be securely wrapped with polyethylene wrapper. In case of supply in reel, the minimum ground clearance should be 50 mm.

Each coil/reel should be suitably labeled or stenciled, as the case may be which should contain following information:

1. Description :
2. Diameter :
3. Construction :
4. Length of wire :
5. Weight of wire(Net weight) :
6. Gross Weight :
7. Production Sr.No. :
8. Manufacturers name :
9. Month and year of manufacture :
10. Purchase order no. and name of
11. consignee :

16.0 Oiling :

During stranding stage, while being laid each strand shall get oiled. Double refined linseed oil or mineral oil with suitable additives, which resist white rust formation, may be used. Corrosion protective oil to IS 1154 shall be applied on the traction bond to protect the bond from corrosion during service.

17.0 Greasing:

Before crimping of lugs with the galvanized bond, a grease manufactured out of low volatile virgin mineral oil using over based calcium sulphonate complex thickener having NLGI grade-2 and shear table characteristics with age resistant and inherent water resistant property containing copper shall be applied on the galvanized bond to protect the galvanized film on the wires.

18.0 End Lugs :

End Lugs shall be in accordance with Annex-B to this specification.

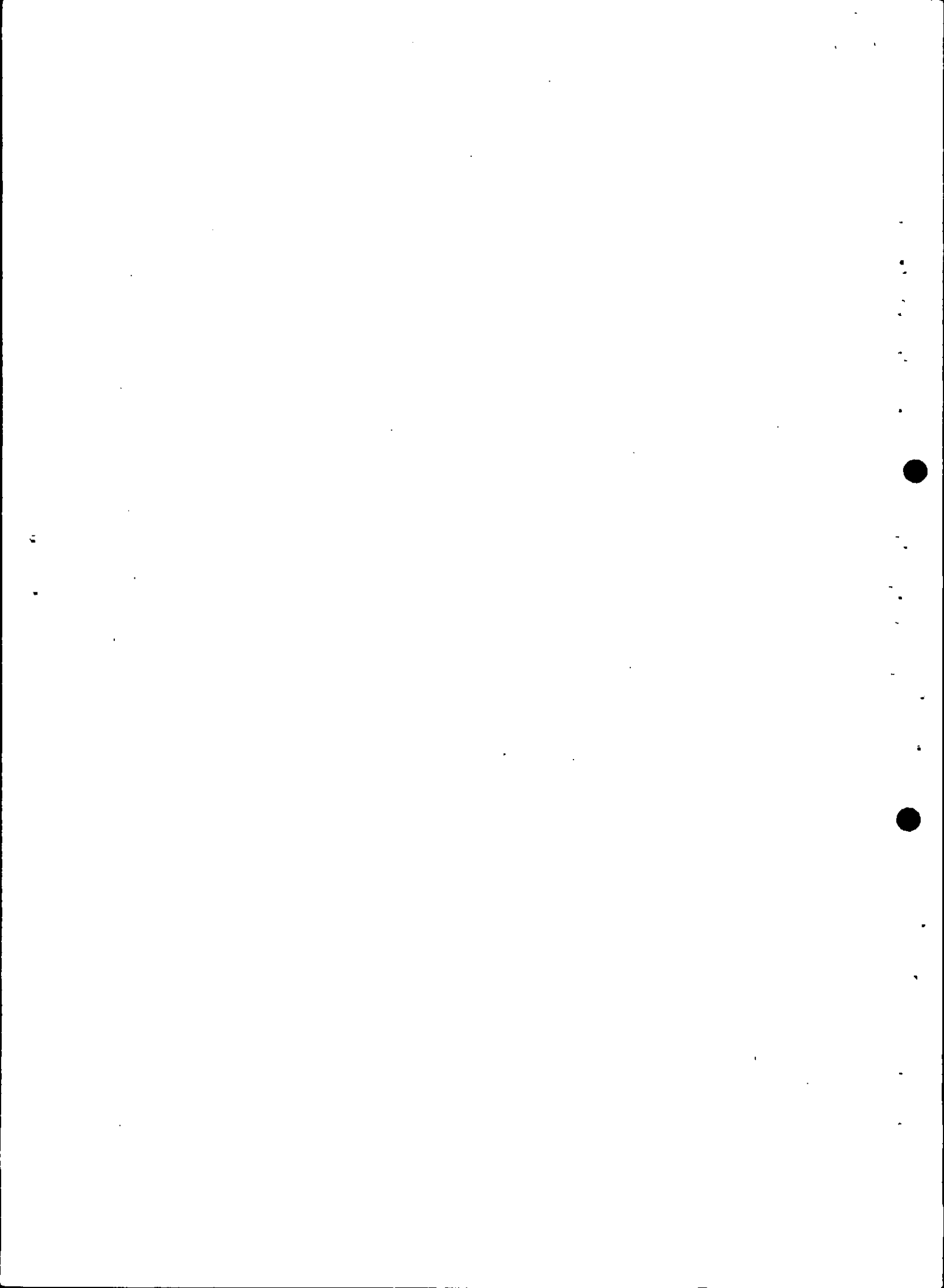
Wherever enquiry specifies supply of bond with Lug, offer tendered should be deemed to be with supply of Lugs duly crimped or loose as the case may be.

If lug is specified to be supplied duly crimped, slipping strength of crimped lug shall not be less than 1200 kgf. Only one sample per lot, minimum 2 meter long duly crimped with lug at each end shall be subjected to Slipping Strength Test.

Unless otherwise specified clearly, the supply of Bond shall be with plain end only.

19.0 Crimping:

End lugs shall be crimped with Dowell's hand operated hydraulic tools SYE-150/HCT-150 with dies model no. JER-12 at about crimping pressure of 450kg/cm^2 . Minimum three crimps on barrel portion of lugs shall be made to get proper joint.



Annex - A

Formula for converting Resistance measured at ambient temperature to Resistance at 20 °C

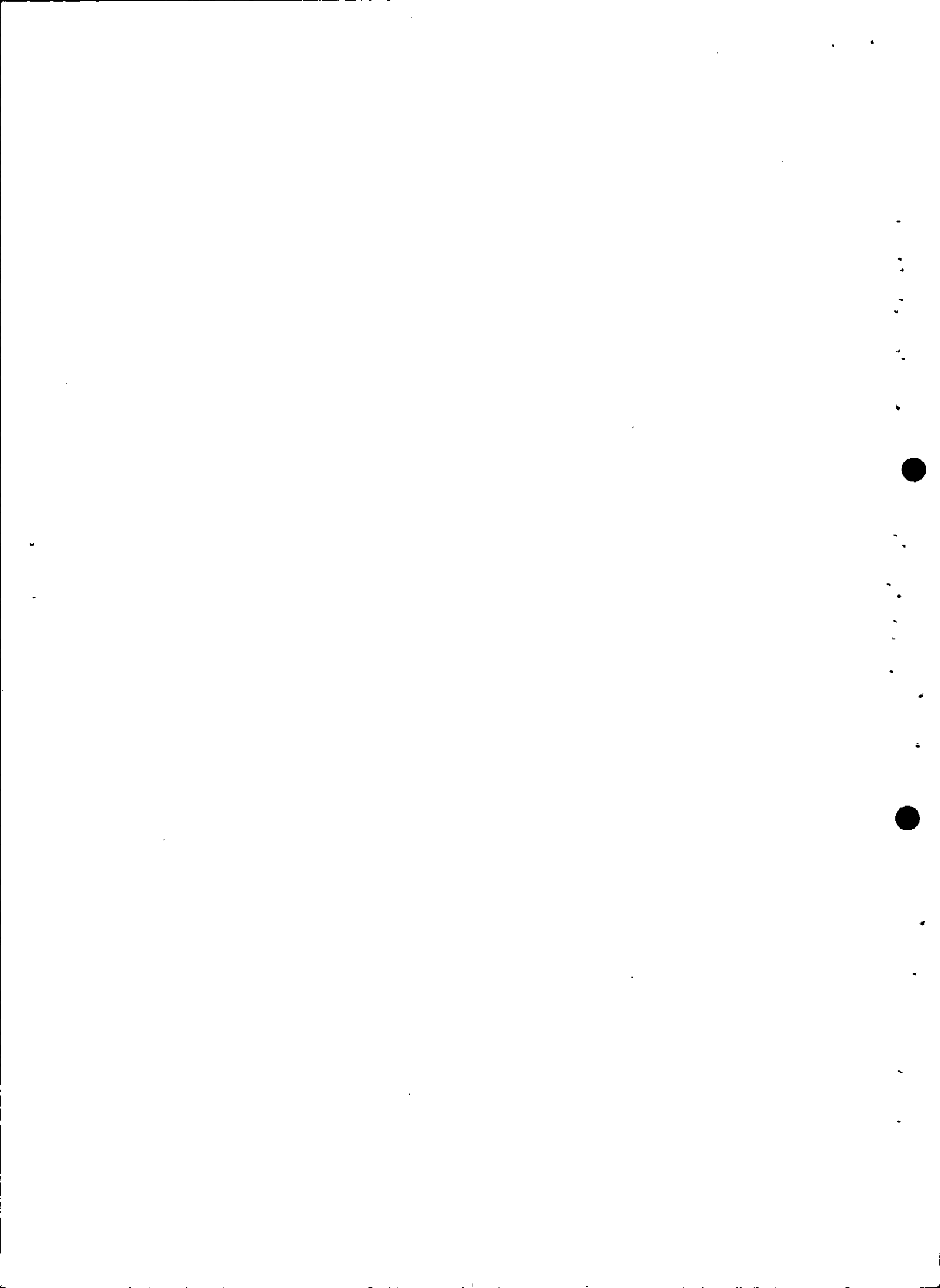
$$R_{20} = R_t \times \frac{1}{1 + 0.00403 (T-20)}$$

Where,

R_{20} = Resistance at 20 °C

R_t = Measured Resistance at ambient temperature.

T = Ambient temperature during measurement.



REF.	DESCRIPTION	PART NO.	MATERIAL	SPECIFICATION	NUMBER OFF
1	18mm LUG (FORGED)	SB-16	FORGED STEEL GALV. STEEL/IS/13	IS-2004 CLASS 2	2

NOTES :-

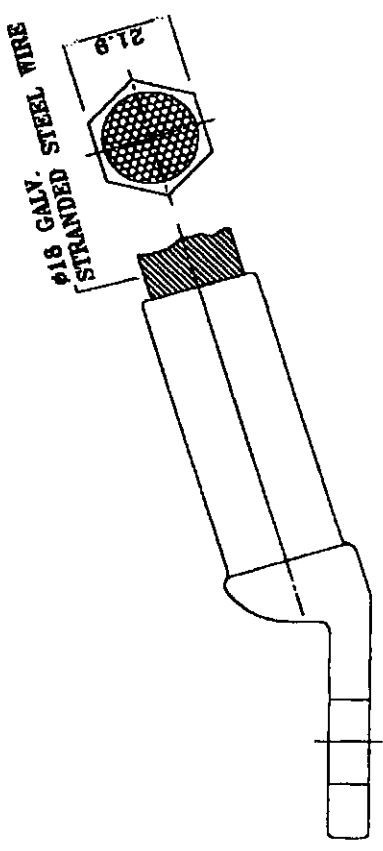
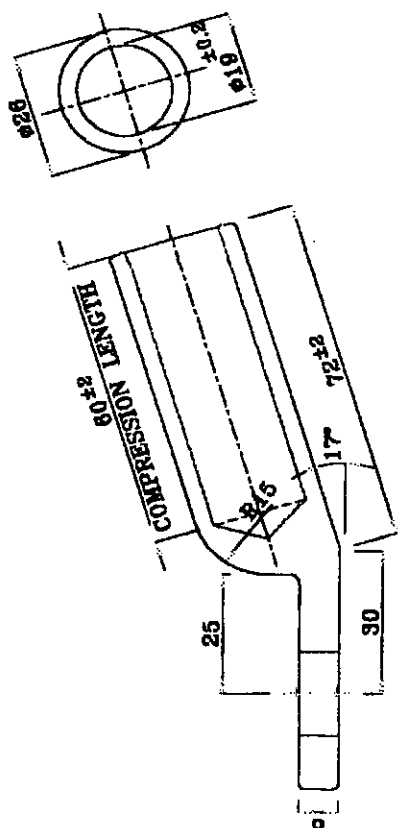
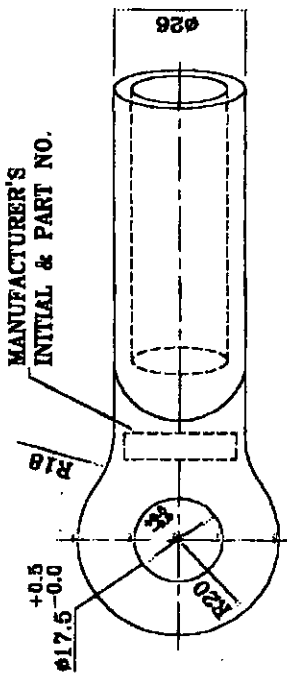
1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE STATED.
2. DIMENSIONAL TOLERANCE SHALL BE AS PER IS:2000 SPECIFICATION NO. IS:1000/49.
3. CONDITION - ANNEALED
4. SLIPPING STRENGTH - MINIMUM 1200 Kg.
5. THE LUG TO BE COMPRESSED WITH HYDRAULIC COMPRESSOR FROM ROUNDED TO HEXAGON.
6. COMPRESSIVE LOAD - 80 t (APPROX.)
7. ZINC RICH PAINT OR SPUT PAINT SHALL BE APPLIED AT THE COMPRESSED PORTION OF THE LUGS LUG AFTER COMPRESSION FOR PROTECTION FROM RUSTING.
8. USAGE : THE LUG SHALL BE USED WITH 6X16(7/7) 1) GALV. STEEL STRAIN WIRE FOR TRACTION BOND.
9. MANUFACTURER'S INITIAL & PART NO. SHALL BE PROVIDED AS SHOWN AND SHALL BE INDISTINGUISHABLE AFTER GALV.

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18mm LUG (FORGED)
(Compression Type)

ADE/TI-II *AWD*
DTI-II *AWD*

CROSS REF:-



ASSEMBLY AFTER COMPRESSION

DATE	MOD.	NATURE OF MOD.	INITIALS	DATE	NAME	T/NO/REG./OFF/CTRL/DES/ISS/00001/04/0
				DR	DR S. O. A. K. PAL	
				TC		
				CK	DR S. O. A. S. RIVT.	

R.D.S.O.

SCALE:- 1:1
SUB-SCALE

