

15.5 Bogie Tests

15.5.1 The bogie shall be subject to static as well as fatigue tests in accordance with UIC 615-4, with the payload as specified in Chapter 5. This shall be a type test.

15.5.2 Tests for clearances in the bogie, and between bogie and body shall be carried out on straight track as a routine test.

15.5.3 Tests for clearances in the bogie, and between bogie and body shall also be carried out by rotating the bogie to simulate a 150m radius curve. This shall be a type test.

15.5.4 The Contractor shall perform a wheel unloading test to verify the calculations submitted. The test shall be conducted in the most disadvantageous combination of unloading and suspension conditions.

15.5.5 A load deflection test and accelerated ageing tests shall be performed to demonstrate that the spring rate of the primary suspension system and the creep rate for the materials used are within the design limits.

These tests shall prove that the primary suspension system behaves as predicted and will not result in excessive deflection or a decrease in bogie clearance above top of rail to less than the minimum specified herein.

15.6 Saloon Passenger Door Type Tests

15.6.1 The body side doors shall be tested for strength in accordance to UIC 566. See also Chapter 4 for relevant parameters which are required to be met.

15.6.2 The following type test shall be carried out on a complete double leaf door and operating assembly equipment with its control gear.

(i) **Endurance**

One million operations. A record of the velocity profile shall be taken at the beginning and the end of the test. It should also be demonstrated that no undue wear or compression of seals has occurred. This test shall be performed under representative dry and wet conditions.

(ii) **Vibration Tests**

Vibration test shall be carried out as defined in IEC 61373.

Cab doors shall also be subjected to an endurance test of 100 thousand operations, during which test it shall be demonstrated that no component fails.



15.7 Saloon Passenger Door Routine Tests

- 15.7.1 These will comprise functional test to verify that performance is consistent with accepted type test results, and shall include tests to IEC 60077 for the electrical portion.

15.8 Cab Front End Emergency Exit Door Type Tests

- 15.8.1 The Contractor shall demonstrate, to the satisfaction of Engineer, that the emergency door is entirely fit for the purposes for which it is intended to form a ramp between cab floor and track
- 15.8.2 The Contractor shall demonstrate to the satisfaction of the Engineer, that the emergency door is entirely fit for the purpose together with the emergency portable bridging device.

15.9 Compressor and Motor Test**15.9.1 Type Test****i) Starting Test**

The motor shall undergo type- and routine-tests in accordance with IEC 60349-2, Electric Traction. Rotating Electrical Machines for Rail and Road Vehicles, Part 2-Electronic Converter Fed Alternating Current Motors.

The compressor shall undergo type- and routine-tests in accordance with ISO 1217: 1996 and BS 1571 : Pt.2 : 1984 Methods for Simplified Acceptance Testing of Air Compressors and Exhausters.

In addition to the above, starting tests shall be performed, five times at the maximum permissible rated voltage, and five times at the minimum rated voltage, the ten tests being performed in succession, at two minute intervals, at the specified reservoir pressure. The machine shall not exhibit a temperature rise higher than the specified maximum permissible.

(ii) Voltage Interruption Test

The supply shall be interrupted and restored, at intervals of one second, five times in succession, allowing the normal load conditions to be re-established between successive interruptions, the motor operating at its maximum voltage and rated load. The motor shall withstand the test without mechanical deterioration.

(iii) Heat Run

The set shall be tested at its rated voltage against the specified pressure for six hours, to show that the motor temperature rise does not exceed the specified limit, based on the class of insulation, and that the permissible temperature rise of the compressor is not exceeded.

15.10 Brake Equipment Type Tests**15.10.1 Tread Brake Unit**

- (i) Following Tests shall be carried out on Tread Brake Unit:
- (a) Functional checks such as working stroke, slack adjuster operation and parking brake action.



- (b) Recording of the relationship of brake block force to cylinder pressure over the full working range.
- (c) Plotting of brake force against pressure curves in all conditions of operation of main cylinder and parking brake.
- (d) Vibration test as defined in IEC 61373.
- (e) Air leakage test.

15.10.2 Brake Blocks

The Contractor shall carry out testing of brake blocks in respect of coefficient of friction with respect to the wheel material under dry and wet conditions, maximum temperature attained during braking, rate of wear etc..

15.10.3 Brake Control Equipment

Individual items of electro-pneumatic equipment shall be type tested as follows:

- (i) Mechanical Operation and Endurance as defined in IEC 60077
- (ii) Vibration and Shock as defined in IEC 61373.
- (iii) Air Tightness generally as in IEC 60077.
- (iv) Electrical Test, generally as in IEC 60077.
- (v) Characteristic Tests
- (vi) Each item of equipment having a pilot or transducing function, shall be tested to confirm compliance with the Contractor's design data. Oscillograms shall be produced in support.
- (vii) Type Tests on Electronic Equipment

The electronic equipment used in brake system shall be tested as laid down in IEC 60571: "Electronics Equipment Used in Rail Vehicles".

15.11 Complete Brake System Type Tests

- 15.11.1 A complete set of brake equipment comprising all items of equipment forming the Brake System shall be assembled. These shall include the Brake Controller and interface with ATO equipment and a transceiver to measure force at the push rod of Tread Brake unit. A complete series of tests shall be carried out on this rig under all service conditions to demonstrate the function of the brake system as a whole, both in manual and auto modes. The Contractor may combine the test of individual items with the system test if agreed by the Engineer.

15.12 Complete Brake System Routine Tests

- 15.12.1 All reservoirs shall be tested to an appropriate international pressure vessel standard and necessary test certificates shall be provided from a recognised test agency.

15.13 Electrical Type Tests

- 15.13.1 The Contractor shall, in addition to type tests carried out individually on all electrical equipment, in accordance with internationally accepted specifications, shall undertake



combined propulsion, braking and TIMS test, using simulated loads on the traction motors. The testing shall reflect, as far as practicable, the layout of equipment on the car. Combined propulsion system testing shall be in accordance with IEC 61287-1 and IEC 61377.

- 15.13.2 Testing shall include simulated service operation, fault handling, including wheel slip/wheel slide control, braking and load weigh interfaces and abnormal operation and failure condition operation.

The Contractor shall perform tests on the TIMS system to verify designed capacity of the systems, functional requirements and correct interfaces as described in Chapter 7. The real interface hardware and software should be used where possible.

- 15.13.3 Testing shall be carried out to demonstrate the ability of the auxiliary power system to provide the required level of standby power under the normal and emergency conditions specified in Clause 9.2.

15.14 Roof Mounted Air Conditioning Package Unit Type Tests

- 15.14.1 The following tests shall be carried out at the manufacture's works or a reputed testing laboratory on the prototype unit in the presence of the Engineer.

- (i) Dimensional and visual inspection.
- (ii) Conditioned air delivery test
 - (a) This test shall be conducted by adjusting static head at 25 mm WG over conditioned room air.
 - (b) Air velocity measurements shall be recorded at both return air filters. Both fresh air filters shall be closed.
- (iii) Fresh Air Quantity Test

Measurements of fresh air quantity shall be made with fresh air openings in (a) fully opened and (b) in the minimally opened condition to assess maximum and minimum air quantities.

- (iv) Cooling Capacity Test

The package unit shall be tested in a climate laboratory capable of simulating the ambient environment and applicable heat loads. This test shall be made in the following conditions keeping static head of supply air at 25mm WG:

Table 15.14.1: HVAC Unit Test Criteria

Test Conditions	Condition of Hot Chamber	Condition of Cold Chamber
Summer	44°C Dry Bulb, 33% RH	25°C Dry Bulb, 60% RH
Monsoon	35°C Dry Bulb, 65% RH	25°C Dry Bulb, 60% RH
Winter	4°C	18°C

Cooling capacity shall be calculated both on the condenser and the evaporator side.



15.14.2 The power input to the module, as well as to each of the motors shall be recorded.

15.14.3 Insulation Resistance Test

Insulation resistance tests under all weather conditions shall be undertaken on all equipment, using a 1kV d.c. Megger tester. The resistance reading shall in no case be less than 100MΩ.

15.14.4 Dielectric Test

The equipment shall withstand a high potential difference of 2kV for a duration of one minute.

15.14.5 Vibration and Shock Tests

This test shall be done as per IEC 61373.

15.14.6 All rotating electrical machines shall be tested in accordance with IEC 60349-2: Electric Traction – Rotating Electrical Machines for Rail and Road Vehicles Part 2-Electronic Converter Fed Alternating Current Motors.

15.15 Complete Car Air Conditioning System Type Tests

15.15.1 One car body equipped with all interior finish and all underframe mounted equipment, shall be tested to demonstrate the effectiveness of the equipment in meeting the specified temperature and humidity conditions inside the car. Heating and humidifying equipment shall be provided in the car for test purposes.

15.15.2 The extent of such test shall be decided by the Engineer, but shall include, as a minimum, the following :

(i) Air Flow Test

Air flow will be checked at the fresh air inlet to the unit, and at the return air inlet.

(ii) Air Distribution Tests

Saloon air ducts shall be checked to ensure even distribution of air along each duct.

15.16 Complete Car Air Conditioning System Routine Tests

15.16.1 Every roof mounted AC package unit shall be subjected to routine test at the manufacturer's works as given below:

(i) Dimensional & Visual inspection

(ii) Conditioned air-delivery test

(iii) Fresh air quantity test

(iv) Measurement of power

(v) Electrical test.



15.17 Emergency Operation

- 15.17.1 After delivery of two trains, the ability of one healthy train to rescue a disabled train in section as specified in Clause 3.26.1 (i) shall be tested.

15.18 Noise and Vibration Verification

- 15.18.1 The Contractor shall perform noise and vibration tests on at least one complete 8-car consist or 'T+M' unit on both the Rail and Metro Corridors, to demonstrate compliance with Clause 2.18. All test procedures, data and results shall be submitted to the Engineer for acceptance.

15.19 Fire Performance Verification

- 15.19.1 Type tests according to the relevant ASTM, NFPA or EN 45545, Latest Editions shall be undertaken to establish fire ratings for all materials proposed. However, test certificates from any Testing Agency of international repute may be accepted in lieu by the Engineer at his sole discretion.

15.20 EMC Testing

- 15.20.1 The Contractor shall perform measurements to demonstrate EMC requirements specified in Chapter 2, have been achieved. Demonstration of EMC compliance shall be considered a type test requirement.



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EMPLOYER'S REQUIREMENTS

TECHNICAL SPECIFICATION

APPENDIX TA

INTERNATIONAL

STANDARDS



APPENDIX TA.

INTERNATIONAL STANDARDS

TA1 General

TA1.1 Standards are set out in alphabetical order of the Standards Organization (in English) in tables TA1.1 to TA1.17. Many of the standards included in the listing are suggested as guidance only.

Table TA1.1: American Society for Testing and Materials Standards

Standard Organization	Standard Reference Number	Title or Description of the Standard
ASTM	A 480	Standard specification for general requirements for flat rolled stainless and heat resisting steel plates

Table TA1.2: British Standards Institution

Standard Organization	Standard Reference Number	Title or Description of the Standard
BS	88	Cartridge Fuses for Voltages up to and including 1000V a.c. and 1500V d.c.
BS	476-7	Flame Spread Requirements for Paint
BS	476-15 : 1993 ISO 5660-1 : 1993	Fire Test on Building Materials and Structures : Method of Measuring the Rate of Heat Release of Products
BS	857:1990	Specification for Safety Glass for Land Transport
BS	1571 : Pt. 2 1984	Methods for Simplified Acceptance Testing of Air Compressors and Exhausters : Part 2 : Simplified testing of reciprocating and rotating types, including permissible deviations pressure and temperature measurements and arrangement of tests, form of test report and gives adjustment of test result to guarantee conditions.
BS	1725 Pt. 1	
BS	3100:1991	Specification for Steel Castings for General Engineering Purposes. Chemical Composition Heat treatment and Mechanical Properties of Cast Steels.
BS	3682 Pt.1: 1994	Specification for Compressed Air Brake Hose
BS	3900:1980	Methods of Test for Paint.
BS	4066	Cable Tests in Fire Conditions
BS	4360 :	Steel Used in Welded Structures
BS	4579: Pt.1 1970	Compression Joints in Copper Conductors. Covers requirements for the performance of



		general application compression joints for use with copper and copper alloy conductors up to 1000mm ² cross sectional area operating below 85°C.
BS	4743	Specification for Safety Requirements for Electronic Measurement Apparatus
BS	4870	Specification for Approval Testing of Welding Procedures.

Table TA1.2 British Standards Institution (Continued)

Standard Organisation	Standard Reference Number	Title or Description of the Standard
BS	4870 : Pt.3 1985	Arc Welding of Tube to Tube-Plate Joints in Metallic Materials. Welding procedure tests, approval & its extent, test joints, examination and testing, results.
BS	4870 : Pt.4 1988	Specification for Automatic Fusion Welding of Metallic Materials including Welding Operator Approval. Approval testing of procedures, programmes, systems, and operators for automatic or robotic welding. Items in welding procedure test, changes affecting approval, extent of approval, examination and testing.
BS	5135:1984	Specification of Arc Welding of Carbon and Carbon Manganese Steels. Parent metals, welding consumables, butt and fillet weld details, preparation and assembly, procedures to avoid cracking, welding procedure details, approval of welders, inspection and testing. Appendices on design, typical weld details, avoidance of hydrogen cracking, solidification cracking, lamellar tearing and guidance on acceptance levels.
BS	6656	Prevention of inadvertent ignition of flammable atmospheres by radio frequency radiation
BS	7371 Pt. 10 : 1994	Specification for Organic Coatings (The Deltaseal Process)

Table TA1.3: British Standards Institution/Euro Normes

Standard Organisation	Standard Reference Number	Title or Description of the Standard
BS-EN	3	Portable Fire Extinguishers
BS-EN	286-3:1995	Simple Pressure Vessels designed for Air Braking and Auxiliary Pneumatic Equipment for Railway Rolling Stock.
BS-EN	286-4:1995	Simple Unfired Pressure Vessels Designed to Contain Air or Nitrogen. Aluminium Alloy Pressure Vessels for Air Braking Equipment



BS-EN	287-1 : 1992	and Auxiliary Equipment for Rolling Stock. Specification of Approval Testing of Welders Working to Approved Welding Procedures : Pt. 1 Fusion Welding of Steel
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Table TA1.3: British Standards Institution/Euro Normes (Continued)

Standard Organization	Standard Reference Number	Title or Description of the Standard
BS-EN	288-3 : 1993	Fusion Welding of Steel
BS-EN	10025	Hot Rolled Products of Non-Alloy Structural Steels. Technical delivery conditions. Requirements for long and flat products.
BS-EN	10210	Hot Finished Structural Hollow Sections of Non-Alloy and Finer Grain Structural Steels.
BS-EN	24014 : 1992	Hexagon Head Bolts. Product grades A, B
BS-EN	24017 : 1992	Hexagon Head Machine Screws. Product grades A and B
BS-EN	30042 : 1994	Arc Welded Joints in Aluminium and its Weldable Alloys. Guidance on quality levels for imperfections.
BS-EN	50081	Electromagnetic Compatibility. Generic emission standard.
BS-EN	60529 : 1992	Specification for Degrees of Protection Provided by Enclosures (IP Code). Gives uniformity in methods of describing protection provided by enclosures and in tests to prove protection. Provides an optional extension of the IP code by an additional letter A – D, if the actual protection of persons against access to hazardous parts is higher than that indicated by the first characteristic numeral.

Table TA1.4: CISPR

Standard Organisation	Standard Reference Number	Title or Description of the Standard
CISPR	16 am1 (1997-08)	Specification for Radio Disturbance and Immunity Measuring Apparatus and Methods : 1 Radio Disturbance and Immunity Measuring Apparatus

Table TA1.5: Defence Standards

Standard Organisation	Standard Reference Number	Title or Description of the Standard
DEF-STD-	00-56	Hazard Analysis

Table TA1.6: German Standards / Deutsches Institut für Normung

Standard Organisation	Standard Reference Number	Title or Description of the Standard
DIN	2353 : 1998	Compression fittings and couplings

Table TA1.7: Euro Normes

Standard Organisation	Standard Reference Number	Title or Description of the Standard
EN	10155	Structural Steels with improved atmospheric Corrosion
EN	50082	EMC
ENV	50121	Railway Application – Electro-Magnetic Compatibility – Rolling Stock
EN	50121-1 : 1996	Railway Application – Electro-Magnetic Compatibility Part 1. General
ENV (DD)	50121-2 : 1996	Railway Application – Electro-Magnetic Compatibility Part 2. Emission of the Whole Railway System to the Outside World.
EN	50121-3	Railway Application – Electro-Magnetic Compatibility – Rolling Stock
EN	50264	Railway Application- Railway Rolling Stock cables having special fire performance
EN	50126	Railway Application – Specification and Demonstration of RAMS
EN V	50121-3-1	Railway Application – Electro-Magnetic Compatibility – Rolling Stock Pt. 3-1 : Train and Complete Vehicle, traction stock, train sets and independent hauled stock. Covers the frequency range d.c. to 400GHz.
EN	50121-3-2	Railway Application – Electro-Magnetic Compatibility – Pt. 3-2 : Rolling Stock Apparatus. Specifies emission and immunity requirements for electrical and electronic apparatus for use on rolling stock. Covers the frequency range d.c. to 400GHz.
EN	50124-1	Electrical Enclosures
EN	50126-2	Railway Applications – Dependability for Guided Transport System - Pt. 2 : Safety
EN	50128	Railway Applications : Software for Railway Control and Protection Systems
EN	50129	Safety Related Electronic Railway Control and Protection Systems
EN	50155	EMC
EN	50163	Lightning Arrestors
EN	50207	Power Converters for Rolling Stock
ENV		Software for Railway Control and Protection Systems

Table TA1.8: International Electro-technical Commission

Standard Organisation	Standard Reference Number	Title or Description of the Standard
IEC	60034-1 : (1996-12)	Rotating Auxiliary Machines : Pt. 1 Rating and



	60034-1 : am1 (1997-06)	Performance Amendment No.1
IEC	60034-7	Rotating Auxiliary Machines : Pt. 7 Rating and Performance
IEC	60056 (1987-03) 60056 am3 (1996-10)	High Voltage Alternating Current Circuit Breakers Amendment No.3
Table TA1.8: International Electro-technical Commission (Continued.)		
IEC	60068-2	Environmental Testing
IEC	60076	Power Transformers
IEC	60077 (1968-01)	Specification for Electric Traction Equipment. Motive power units of 600-3000V d.c. or high-voltage a.c. or independent power source, also for control trailers or multiple unit trains. Can be applied to d.c. rolling stock at voltages below 600V.
IEC	60099-4 (1991-11)	Surge Arrestors – Pt.4 Metal Oxide, without Gaps for A.C. Systems
IEC	60115-1	Smaller Resistors
IEC	60228	Cables
IEC	60268-1 (1985-01) 60268-1 60268-1 (1988-01)	Sound System Equipment : Pt. 1 General Amendment 1 Amendment 1
IEC	60268-16 Part 16	The Objective Rating of Speech Intelligibility in Auditoria by the "RASTI" Method
IEC	60269-1 1998-12	Low Voltage Fuses Pt. 1 : General Requirements
IEC	60269-2 am1 (1995-11)	Low Voltage Fuses Pt. 2 : Supplementary Requirements for Fuses for Use by Authorised Persons (Fuses mainly for Industrial Applications)
IEC	60300-1 (1993-04)	Dependability Management – Pt. 1 Dependability Programme Management
IEC	60300-2 (1995-12)	Dependability Management – Pt. 2 Dependability Programme Elements and Tasks
IEC	60300-3-1 (1991-11)	Dependability Management – Pt. 3 Application Guide Sct. 1 Analysis Techniques for Dependability. Guide on Methodology
IEC	60300-3-2 (1993-10)	Dependability Management – Pt. 3 Application Guide Sct. 2 Collection of Dependability Data from the Field.
IEC	60300-3-3 (1996-09)	Dependability Management – Pt. 3 Application Guide Sct. 3 Life Cycle Costing
IEC	60310 1991-11)	Traction Transformers and Inductors
IEC	60319 1978-01	Presentation of Reliability Data on Electronic Components (or Parts)
IEC	60326-3 : 1991 BS 6221 : Pt.3 : 1991	Guide for the design and use of printed wiring boards. Design and application of printed boards, irrespective of their method of manufacture. Recommends design, specification, and application.
IEC	60332-1 1993-04	Tests on Electric Cables under Fire Conditions – Pt.1 :Test on a Single Vertical Insulated Wire or Cable
IEC	60332-3 1992-03	Tests on Electric Cables under Fire Conditions – Pt.3 : Tests on Bunched Wires or Cables



IEC	60349 1991-12	Electric Traction. Rotating Electrical Machines for Rail and Road Vehicles
IEC	60349-1	Electric Traction – Rotating Electrical Machines for Rail and Road Cars
IEC	60349-2 1993-04	Electric Traction – Rotating Electrical Machines for Rail and Road Vehicles Pt. 2 Electronic Converter-fed A.C. Motors
IEC	60349-2 1993-04	Electric Traction – Rotating Electrical Machines for Rail and Road Vehicles Pt. 2 Electronic Converter-fed Alternating Current Motors
IEC/TR2	60349-3 1995-08	Electric Traction – Rotating Electrical Machines for Rail and Road Vehicles Pt. 3 Determination of the Total Losses of Converter-fed Alternating Current Motors by Summation of the Component Losses
IEC	60384-1	Electrolytic Capacitors
IEC	60384-4	Electrolytic Capacitors
IEC/TR	60411-2 (1978-01)	Power Convertors for Electric Traction Pt. 2 Additional Technical Information
IEC	60494 1974-01	Rules for Pantographs of Electric Rolling Stock
IEC	60502	High Voltage Cables
IEC/TR	60505 1975-01	Guide for the Evaluation and Identification of Insulation Systems of Electrical Equipment
IEC	60529	IP Codes, etc.
IEC	60563	Permissible Limiting Temperatures in Service for Components of Electrical Equipment of Traction Vehicles
IEC	60571 1998-02	Electronic Equipment Used on Rail Vehicles
IEC	60571-1	Electronic Equipment Used on Rail Vehicles
IEC	60571-2	Electronic Equipment Used on Rail Vehicles
IEC	60571-3	Electronic Equipment Used on Rail Vehicles
IEC	60605	Reliability and maintainability Requirements in Equipment
IEC	60617	Graphical Symbols For Diagrams
IEC	60617-1 (1985-01)	Graphical Symbols For Diagrams : Pt. 1 General Information, General Index. Cross Reference Tables
IEC	60617-2 (1996-05)	Graphical Symbols For Diagrams : Pt. 2 Symbol Elements, Qualifying Symbols and Other Symbols Having General Application
IEC	60617-3 (1996-05)	Graphical Symbols For Diagrams : Pt. 3 Conductors and Connecting Devices
IEC	60617-4 (1996-06)	Graphical Symbols For Diagrams : Pt. 4 Passive Components
IEC	60617-5 (1996-06)	Graphical Symbols For Diagrams : Pt. 5 Semiconductors and Electron Tubes
IEC	60617-6 (1996-05)	Graphical Symbols For Diagrams : Pt. 6 Production & Conversion of Electrical Energy
IEC	60617-7 (1996-05)	Graphical Symbols For Diagrams : Pt. 7 Switch gear, Control gear, and Protective Devices
IEC	60617-8 (1996-05)	Graphical Symbols For Diagrams : Pt. 8 Measuring Instruments, Lamps and Signalling Devices
IEC	60617-9	Graphical Symbols For Diagrams :



	(1996-05)	Pt. 9 Telecommunications Switching & Peripheral Equipment
IEC	60617-10 (1996-05)	Graphical Symbols For Diagrams : Pt. 10 Telecommunications Transmission
IEC	60623 1990-03 60623 am1 1992-04	Vented Nickel Cadmium Prismatic Rechargeable Single Cells Amendment No. 1
	60623 am2 1992-07	Amendment No. 2
IEC	60631	Electro-dynamic Braking
IEC	60664	Surface Creepage and Electrical Clearance
IEC	60747-6	Electrical Type Test
IEC	60749	Mechanical and Climatic Test Methods
IEC	60754-1 1994-01	Tests on Gases Evolved During Combustion of Materials from Cables Pt. 1 : Determination of Amount of Halogen Acid Gas
IEC	60754-2 1991-08	Tests on Gases Evolved During Combustion of Materials from Cables Pt. 2 : Determination of Amount of Halogen Acid Gas
	60754-2 1997-04	Amendment No. 1
IEC	60850 (1988-03)	Supply Voltages for Traction Systems
IEC	60871-1 (1997-10)	Shunt Capacitor for A.C. Power Systems having a Rated Voltage above 1000V – Pt. 1 General Performance, Testing and Rating – Safety Requirements – Guide for Installation and Operation
IEC	60913 (1988-12)	Electric Traction Overhead Lines
IEC	60947-1 (1998-11)	Low Voltage Switch Gear and Control Gear Pt.1 General Rules
IEC	60947-2 (1998-03)	Low Voltage Switch Gear and Control Gear Pt.2 Circuit Breakers
IEC	60947-3	Circuit Breakers
IEC	60947-4	Circuit Breakers
IEC	60993 (1989-08)	Electrolyte for Vented Nickel-Cadmium Cells
IEC/TR3	61000-1-1 (1992-05)	Electro-magnetic Compatibility EMC) Pt. 1 : General
IEC	61000-4-2 (1995-01) 61000-4-2 am1(1998-01)	Testing and Measurement Techniques Pt. 4, Sct. 2 : Electrostatic Discharge Immunity Test Amendment No. 1
IEC	61000-4-3 (1995-03) 61000-4-3 am1(98-06)	Testing and Measurement Techniques Pt.4 Sct 3 : Radiated Radio Frequency Electromagnetic Field Immunity Tests Amendment No. 1
IEC	61000-4-4 (1995-01)	Testing and Measurement Techniques Pt.4 Sct. 4 : Electrical Fast Transient/Burst Immunity Test
IEC	61000-4-5 (1995-03)	Testing and Measurement Techniques Pt.4 Sct. 5 : Surge Immunity Test
IEC	61000-4-6 (1996-04)	Testing and Measurement Techniques Pt.4 Sct. 6 : Immunity to Conducted Disturbances Induced by Radio Frequency Fields
IEC	61000-4-8	Testing and Measurement Techniques Pt.4 Sct.8 :



	(1993-06)	Power Frequency Magnetic Field Immunity Test
IEC	61000-4-9 (1993-06)	Testing and Measurement Techniques Pt.4 Sct. 9 : Pulse Magnetic Field Immunity Test
IEC	61000-4-10 (1993-06)	Testing and Measurement Techniques Pt.4 Sct. 10 : Damping Oscillatory Magnetic Field Immunity Test
IEC	61000-4-11 (1993-06)	Testing and Measurement Techniques Pt.4 Sct. 11: Voltage Dips, Short Interruptions and Voltage Variations Immunity Test
IEC	61000-4-12 (1993-06)	Testing and Measurement Techniques Pt.4 Sct. 12 : Oscillatory Waves Immunity Test
IEC	61000-5-1 (1996-12)	EMC Pt. 5 :Installation and Mitigation Guidelines Sct. 1 General Considerations
IEC	61000-5-2 (1996-12)	EMC Pt. 5 :Installation and Mitigation Guidelines Sct. 2 Earthing and Cabling
IEC	61034	Cables
IEC	61071-1	Power Electronic Capacitors
IEC	61133 (1992-11)	Electric Traction – Rolling Stock – Test Methods for Electric and Thermal/ Electric Rolling Stock on Completion of Construction and Before Entry into Service
IEC	61287-1 (1995-07)	Power Converters Installed on Board Rolling Stock – Pt. 1 Characteristics and Test Methods
IEC	61373	Requirements for Vibration and Shock Testing of Equipment for Railway Cars
IEC	61377 (1996-05)	Electric Traction – Rolling Stock –Combined Testing of Inverter Fed Alternating Current Motors and their Control
IEC	61508-1 1998-12	Functional Safety of Electrical/Electronic/Programmable Electronic Safety- Related Systems : Part 1. General Requirements.
IEC	61508-3 1998-12	Functional Safety of Electrical/Electronic/Programmable Electronic Safety- Related Systems : Part 3. Software Requirements.
IEC	61881	Power Electronic Capacitors used on Rolling Stock

Table TA1.9: Institution of Electrical and Electronics Engineers

Standard Organisation	Standard Reference Number	Title or Description of the Standard
IEEE	304	Thermal Endurance of Insulation
IEEE	429	Sealing Against Moisture

Table TA1.10: Indian Railways Standards

Standard Organisation	Standard Reference Number	Title or Description of the Standard
IRS	R16	Unpowered Axles for Broad Gauge Vehicles
IRS	R19	Wheels for Broad Gauge Vehicles
IRS	R43	Powered Axles for Broad Gauge Vehicles

Table TA1.11: International Standards Organisation

Standard	Standard Reference	Title or Description of
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Organisation	Number	the Standard
ISO	281/1	Steel for Railway Wheels
ISO	1553	Methods of the Determination of Copper, Lead, Iron, Aluminium and Nickel in Copper Alloys
ISO	1554	
ISO	1810	
ISO	2631 (1985)	Mechanical Vibration and Shock – Evaluation of Human Exposure to Whole Body Vibration
ISO	3095	Acoustics – Measurement of Noise Emitted by Railbound Vehicles 1 st Edition
ISO	3381	Acoustics – Measurement of Noise Inside Railbound Vehicles 1 st Edition.
ISO		Fire Tests – Reaction to Fire – Pt.1

Table TA1.12: International Standards Organisation

Standard Organisation	Standard Reference Number	Title or Description of the Standard
ISO	9000	Design Management and Control. Quality Systems : Model for Quality Assurance in Design, Development, Production, Installation and Servicing
ISO	9001	
ISO	9002	
ISO	9662	Information Processing – Volume and File Structure of CD-ROM for Information Exchange

Table TA1.13: Japan Industrial Standards

Standard Organisation	Standard Reference Number	Title or Description of the Standard
JIS	G 3114	Hot rolled atmospheric corrosion resisting steels for welded structure
JIS	G 3459	Stainless steel pipes

Table TA1.14: Military Standards

Standard Organisation	Standard Reference Number	Title or Description of the Standard
MIL-HDBK-	454 (1)	General Guidelines for Electronic Equipment
MIL-I-	46058	Insulating Compound (for Coating Printed Circuit Assemblies)
MIL-STD-	882 C	Hazard Analysis
MIL-STD-	883 E (1)	Test Methods Standard Microcircuits
MIL-STD-	889 B (3)	Dissimilar Metals

Table TA1.15: French Standards (Normes Françaises)

Standard Organisation	Standard Reference Number	Title or Description of the Standard



NF-F	63-808	Halogen Free Cables for Low Voltage Applications
NF-F	63-826	Halogen Free Cables for High Voltage Applications

Table TA1.16: Research and Study Organisation (ORE)

Standard Organisation	Standard Reference Number	Title or Description of the Standard
ORE	C116/RP8	DB WZ Ride Index : Frequency Weighting Curves

Table TA1.17: International Railway Union

Standard Organisation	Standard Reference Number	Title or Description of the Standard
UIC	410 O	Composition and Calculation of the Weight and Braking of Passenger Trains
UIC	515-3 OR	Rolling Stock – Bogies – Running gear – Axle design calculation method
UIC	515-4 O	Passenger rolling Stock – Trailer bogies – Running gear – Axle design calculation method
UIC	518 OR	Testing and Approval of railway Vehicles from the Point of View of their Dynamic Behaviour, Safety, Track fatigue and Ride Quality
UIC	534 OR	Signal lamps and signal lamp brackets for locomotives, railcars and all tractive and self propelled stock
UIC	541-5 O	Brakes – Electropneumatic brakes for passenger trains and freight trains
UIC	541-6 O	Brakes – Electropneumatic brakes test programmes for passenger trains and freight trains
UIC	555 OR	Electric lighting in passenger rolling stock
UIC	555-1 OR	Transistorised inverters for supplying fluorescent lamps (1)
UIC	560 OR	Doors of coaches and luggage vans
UIC	564-2 OR	Regulations Relating to Fire Protection and Fire Fighting Measures in Passenger Carrying Railway Vehicles
UIC	566 OR	Loadings of coach bodies and their components
UIC	615-1 OR	Tractive units – Bogies and running gear – General conditions applicable to component parts
UIC	615-4 OR	Motive power units - Bogies and running gear – Bogie frame structure strength test
UIC	651	Layout of driver's cabs in locomotives, railcars, multiple unit trains and driving trailers.
UIC	811-1 OR	Technical Specification for the Supply of Axles



		for Tractive and Trailing Stock
UIC	812-2 OR	Solid Wheels for Tractive and Trailing Stock Tolerances (1)
UIC	812-3	Technical Specification for the Supply of Solid Wheels for Trailing Stock
UIC	813 O	Technical Specification for the Supply of Wheelsets for Tractive and Trailing Stock : Tolerances and Assembly

1. All sub-systems including major equipments, assemblies and complete car/train must comply with the latest international standards.
2. The above list is for guidance only. Wherever updated standard is released, the same shall be applicable.
3. The contractor shall provide the relevant Standard in soft copy to DMRC for reference.



**EMPLOYER'S REQUIREMENTS
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APPENDIX TB

CAR BODY MOCK UPS- Deleted.



EMPLOYER'S REQUIREMENTS

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APPENDIX TC

ABBREVIATIONS



APPENDIX TC: ABBREVIATIONS

TC1 General

TC1.1 Various abbreviations used in this document are set out in alphabetical order in table TC1.1

Table TC1.1 Abbreviations.

Abbreviation	Description in Full
ASHRAE	American Society for Heating , Refrigeration and Air-conditioning Engineers
ASIC	Application Specific Integrated Circuits
ATC	Automatic Train Control (System)
ATO	Automatic Train Operation (System)
ATP	Automatic Train Protection (System)
ATS	Automatic Train Supervision (System)
BCC	Back-up Control Centre
BCP	Brake Cylinder Pressure
BP	Brake Pipe
CATC	Continuous Automatic Train Control
CCTV	Close Circuit Television
CCITT	Consultative Committee on International Telegraphy and Telephony
CD	Commencement date
CI	Converter Inverter
CM	Coded Manual (Driving Mode)
DFF	Direct Fixation Fastener
DIN	German Industrial Standards
DLP	Defect Liability Period
DT	Driving Trailer Car
DMRC	Delhi Metro Rail Corporation
DMRTS	Delhi Mass Rapid Transport System
EER	Energy Efficiency Ratio
EMC	Electro-magnetic Compatibility
EMI	Electro-magnetic Interference
EMU	Electric Multiple Unit Train
EP	Electro-Pneumatic
FFT	Fast Fourier Transform
FMEA	Failure Modes Effects Analysis
FMECA	Failure Modes Effects and Criticality Analysis
FRACAS	Failure Reporting And Corrective Action System
GS	Employer's Requirements : General Specification
HSCB	High Speed Circuit Breaker
HVAC	Heat, Ventilation and Air Conditioning
IC	Integrated Circuit
IEC	International Electro-technical Commission
IGBT	Insulated Gate Bi-Polar Transistor
IMP	Interface Management Plan
ISO	International Standards Organisation
kmph	kilometer per hour
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LRU	Least Replaceable Unit
M	Motor Car



MCB	Miniature Circuit Breaker
MRTS	Mass Rapid Transit System
MDBF	Mean Distance Between Failures
MDBCF	Mean Distance Between Component Failures
MTBF	Mean Time Between Failure
MRTS	Metro Rail Transit System
MSS	Maximum permissible Safe Speed
MTTR	Mean Time To Repair
MWI	Maintenance Works Instruction
NFPA	National Fire Protection Association
OCC	Operations Control Centre
OCS	Over-head Catenary System
OEM	Original Equipment Manufacturer
OHE	Over Head Electric (System)
OHL	Over Head Line
O & M	Operation and Maintenance
PA	Public Address (System)
PCB	Printed Circuit Board
PEA	Passenger Emergency Alarm
PLC	Programmable Logic Control
PSSS	Passenger Saloon Surveillance System
PWM	Pulse Width Modulation
RAM	Reliability, Availability and Maintainability
RDSO	Research Design and Standards Organisation (Ministry of Railways)
RH	Relative Humidity
RI	Ride Index
RM	Restricted Manual (Driving Mode)
SBD	Safe Braking Distance
SCS	Safety Cut-out Switch
SMD	Surface Mounted Devices
T	Non Driving Trailer Car
TIMS	Train Integrated Management System
TR	Train Radio
Train ID	Train Identification Number
TS	Employer's Requirements : Technical Specification
VCB	Vacuum Circuit Breaker
VDU	Video Display Unit
VVVF	Variable Voltage Variable Frequency
ZVR	Zero Velocity Relay



EMPLOYER'S REQUIREMENTS
TECHNICAL SPECIFICATION

APPENDIX TD

INTERFACES BETWEEN ROLLING
STOCK, SIGNALLING AND TELECOMMUNICATIONS CONTRACTORS



TD1 INTRODUCTION**TD1.1 Definitions and Scope**

TD1.1.1 This Appendix describes the interface requirements between Signalling and Train Control and Telecommunications contracts and Contract RS15.

TD1.1.2 The Signalling and Train Control and Telecommunications contracts and Contract RS15 shall ensure that all requirements of the Specification pertaining to interfaces are properly satisfied.

TD1.1.3 The requirements specified herein are by no means exhaustive and it remains the responsibility of Signalling and Train Control and Telecommunications contracts and Contract RS15 to develop and execute an interface plan during execution of the work to ensure that :

- (i) All interface issues between the two contracts are satisfactorily resolved
- (ii) Supply, installation and testing of equipment and software are fully co-ordinated
- (iii) All equipments supplied in the contracts are fully compatible with each other.

TD1.1.4 The Automatic train Protection (ATP) system shall issue the braking commands to the Rolling Stock when safety limits are exceeded or when over-speed is detected. The removal of traction power and the correct application of brakes shall be the responsibility of RS15 Contractor. The ATP system shall be responsible for monitoring of speed and the issuing of braking commands when safety limits are exceeded.

TD1.1.5 Parking brakes shall be provided by the RS15 Contractor. The parking brakes shall be capable of holding a fully loaded stationary train on a 4% gradient under all track conditions, indefinitely.

TD1.2 Rolling Stock Characteristics to be used by Signalling and Train Control and Telecommunication Contractors.

TD1.2.1 The size and location of track circuits for determining the ATP blocks shall be designed to meet the headway requirements of 4-car, 6-car and 8-car consists, based on the characteristics of the vehicles to be furnished (Annexure I) and the track geometry. The back-up (line-side) signalling (in cut out mode) shall use the same track circuits as designed for the ATP working. The signal designer must co-ordinate with the rolling stock supplier to fine-tune the block design based on the traction and braking characteristics of the actual vehicles furnished. Acceptance tests of the signal system will use the actual vehicles supplied.

TD1.2.2 When operating in ATP Mode, a delay of 2s (programmable) shall be provided for the train driver to acknowledge a reduction in speed and begin to apply the brakes.

TD1.2.3 The model for calculating the safe braking distance (SBD) shall identify and take into account various systems' response times and drivers' reaction times. The design of ATP blocks shall also take into account the effect of track geometry on the traction and braking characteristics. The RS15 Contractor shall furnish the assured braking rate at the normal braking efficiency, and at the lowest braking efficiency permitted in service, including brake deterioration, to the Signalling and Train Control and Telecommunication Contractors. RS15 Contractor shall provide the speed/acceleration and speed/tractive effort curves, for all loading conditions.

TD1.2.4 The RS15 Contractor shall furnish as a minimum the rolling stock parameters to be used by the Signalling and Train Control and Telecommunications contractors for designing the target distance based ATP system, as set out in the attached Table.

For any other information required by the Signalling and Train Control and Telecommunications contractors, they shall co-ordinate with the RS15 Contractor.



TD1.3 Signalling and Telecommunication Details to be used by RS15 Contractor

TD1.3.1 The following data shall be provided :

- (i) The maximum power consumed by the Signalling and Train Control and Telecommunications Contractor's equipment from the 110V d.c. supply under all specified operating conditions.
- (ii) The number of train wires required, and the function of each.
- (iii) All control logic outputs.
- (iv) Electrical characteristics of the interconnection cabling and wiring.
- (v) Sensitivity levels, and frequencies which must be avoided.
- (vi) The specific heat load for air conditioning purposes.
- (vii) The limiting value of psophometric current, to obviate interference in the operation of telecommunication equipment
- (viii) Details of the provisions required to enable the transference of data from the train to the OCC.

TD2 TRAIN OPERATING MODES**TD2.1 General System Description**

TD2.1.1 The train-borne Automatic Train Control (ATC) system will consist of an Automatic Train Protection (ATP) system and an Automatic Train Operation (ATO) system.

TD2.1.2 The rolling stock required for the Metro Corridor shall be fitted with redundant ATO and ATP systems, complete in all respects, whereas rolling stock for the Rail Corridor shall be provided with a redundant ATP system only.

TD2.1.3 The Automatic Train Control (ATC) System will be supplied by the Signalling and Train Control and Telecommunications Contractors, who will be required to liaise closely with the RS15 Contractor, in regard to the installation, testing and commissioning of the Signalling and Train Control Equipment.

TD2.2 ATO Mode

TD2.2.1 The onboard equipment shall provide for Automatic Train Operation (ATO) on the Metro Corridor. In this mode, the train's speed, motoring, coasting and braking within the parameters dictated by the ATP system will be performed by the on-board equipment without the driver's intervention. This operation shall include:

- (i) Automatic operation of trains between stations.
- (ii) Receipt of coasting request and passing of request to traction power equipment and also provide for acceleration and deceleration of the train.
- (iii) Automatic stopping of trains at platforms within a tolerance of $\pm 300\text{mm}$ for 99.5% of station stops, and $\pm 500\text{mm}$ for 99.98% of station stops.
- (iv) Automatic opening of doors on the appropriate platform side(s) when the train is berthed.
- (v) Prevent the train from starting if train doors are detected "not closed".
- (vi) Receipt and implementation of control to skip one or more stations.



It shall be possible for the train driver to transfer from ATO to ATP modes on the Metro Corridor, at any time. Transfer from ATP to ATO shall only be possible at standstill at a station stopping point.

TD2.3 ATP (or Coded Manual) Mode

TD2.3.1 The onboard equipment shall provide Automatic Train Protection (ATP) on both corridors. In this mode, the control of the train speed and braking within the parameters dictated by the ATP system, shall be performed by the Train Operator.

TD2.3.2 The ATP mode shall include:

- (i) Identification and enforcement of maximum safe speed at which the train may operate, as deduced from the most restricting ATP condition.
- (ii) Identification and display of actual speed, target speed, target distance, and the maximum safe speed.
- (iii) Identification and audible and visual warning when train is operating at a speed higher than the maximum safe speed. The equipment to provide audible and visible warnings shall be provided by Signalling and Train Control and Telecommunications contractors.
- (iv) Provision of an audible and visual warning to the driver, when the system identifies that the train is operating at a speed in excess of the maximum safe speed; recognition of a delay of 2s for the train driver to react, and a service brake application should the driver fail to reduce the speed below the maximum safe speed in a specified time. In the event of the service braking rate being inadequate, an irrevocable Emergency Brake application shall be made, automatically.
- (v) Identifying the platform side of the train with the train berthed at a station. The system shall then enable the doors to be opened on that side.
- (vi) Receipt of a door closed signal indicating that all doors are closed and locked before the train may start. Loss of this signal shall cause the ATP system to initiate a brake application.



TD2.4 Restricted Manual (or Yard) Mode (RM)

TD2.4.1 In this mode, principally for use in depots, the maximum train speed shall be controlled by the on-board ATP, to a limit adjustable between 15km/h and 25km/h. This mode shall be available only when the on-board ATP equipment is operational.

TD2.5 Cut-out (or By-pass) Mode

TD2.5.1 By-pass Mode shall be provided for use in the event of failure of the ATP system. In this mode, the train speed shall be controlled entirely by the driver, to a limit adjustable between 15km/h and 25km/h. The RS15 Contractor shall provide equipment that limits speed to the above limit when the Cut-out Mode is in effect.

The ATP By-pass Mode shall be initiated by the train driver operating a sealed Safety Circuit Switch (SCS) and simultaneously breaking its seal. The operation shall be recorded by the on-board digital counter and TIMS. The SCS shall be provided by RS15 Contractor. The on-board digital counter shall be provided by the Signalling and Train Control and Telecommunications contractors. In this mode the train doors shall only be enabled and controlled manually.

TD2.6 Identification: Train Operating Mode, Train Description and Next Station Information

TD2.6.1 The Signalling and Train Control and Telecommunications contractors shall provide electrical signals to the RS15 Contractor identifying which mode is in effect. The levels and form of these signals shall be co-ordinated between the two Contractors.

TD2.6.2 The RS15 Contractor shall log each time the mode is changed using the onboard TIMS equipment.

TD2.6.3 In By-pass or Cut-out Mode, the external indication light shall flash or occult.

TD2.6.4 The Signalling and Train Control and Telecommunications contractors shall provide the necessary input signals (next station information code, triggering signal, etc.) to RS15 for displaying and making next station announcements to passengers on-board. RS15 Contractor shall provide the necessary hardware. Levels and protocols shall be agreed between the two Contractors.

TD3 INTERFACE REQUIREMENTS BETWEEN SIGNALLING AND TRAIN CONTROL AND TELECOMMUNICATIONS AND RS15 CONTRACTORS**TD3.1 General**

TD3.1.1 The Signalling and Train Control and Telecommunications contractors shall provide the RS15 Contractor with the final sizes and weights of the ATO/ATP and radio on-board cab equipment and antennae to be mounted on the rolling stock.

TD3.1.2 The Signalling and Train Control and Telecommunications contractors shall deliver to the RS15 Contractor's factories, all trainborne ATC and radio equipment and data to enable fitting and testing.

The predicted quantities of Signalling and Train Control and Telecommunications contractors supplied equipment per cab indicated below are subject to change :

Item	Unit	Item	Unit
ATC Cubicle	1 set	Tacho-generator (Speed	2 sets
ATO Antenna	2 sets	Sensor)	
ATO System	2 sets	Train Radio Antenna	1 set



ATP Antenna	2 sets	Train Radio Driver Control	1 set
ATP System	2 sets	Panel	
Axle Mounted Speed Sensors	2 sets	Train Radio Transceiver	1 set
Emergency Brake Relay	2 sets	Train to Wayside Antenna	1 set
Speedometer	2 set	Zero Velocity Relay	1 set



D3.1.3 The Signalling and Train Control and Telecommunications contractors shall supply at RS15 Contractor's factory pre-wired equipment racks with appropriate connectors for all wiring terminating inside ATC and train radio enclosures, including wiring between ATC racks. The Signalling and Train Control and Telecommunications contractors shall supply the Train Radio Driver Control Panel

TD3.1.4 Interfacing wiring for each module provided by the Signalling and Train Control and Telecommunications contractors shall terminate in a quick disconnect robust plug connector suitable for traction applications, with direct cable connection as far as possible. All cable connectors shall be identified within the cubicle using robust cable markers with distinctive colours for identification of e.g. safety function cables.

TD3.1.5 For all relay contact interfaces the Signalling and Train Control and Telecommunications contractors shall provide auto-contact jam detection and contact bounce elimination function to ensure proper operation of the system. Relays for safety functions shall comply with the appropriate internationally accepted standard specification.

TD3.1.6 The Signalling and Train Control and Telecommunications contractors shall provide the RS15 Contractor with the number of wires required between cars of a married pair and between married pairs to transmit signals from one end of the rake to the other end through an automatic electrical coupler.

TD3.1.7 For compatibility, the rolling stock and the train detection system (track circuits), shall conform to EN 50238.

TD3.2 ATC and Radio Equipment Cubicles

TD3.2.1 The RS15 Contractor shall supply the ATC and Train Radio equipment cubicle enclosure(s). All supports, braces, mounting holes, cabling apertures, etc. required for mounting the cubicle and its equipment shall be properly co-ordinated between the Signalling and Train Control and Telecommunications contracts to ensure secure mounting, and access. The cubicle(s) shall be resiliently mounted.

TD3.2.2 To achieve the ATC control functions, the Signalling and Train Control and Telecommunications contractors shall identify any interfacing circuits specifically required for ATC operation and liaise with the RS15 Contractor. These include but not be limited to start, door control, motoring, coasting, braking and emergency brake commands.

TD3.2.3 For train control circuits the Signalling and Train Control and Telecommunications contractors shall identify the voltage free contacts to be provided by the RS15 Contractor, including the number and type of electrical signals required between the ATP/ATO equipment and the equipment provided by the RS15 Contractor. The two Contractors shall co-ordinate to agree on levels and protocols for each such signal.

TD3.3 Antennae

TD3.3.1 The Signalling and Train Control and Telecommunications contractors shall identify roof-, bogie-, and underframe-mounted antennae, and associated disconnection box mounting brackets and location requirements to identify cable and conduit routes required to antennae.

TD3.3.2 The Signalling and Train Control and Telecommunications contractors shall supply the necessary disconnection boxes, terminal blocks, cables and adaptation mounting brackets, flexible conduit assemblies complete with connectors and cables from antennae to the junction boxes.

TD3.3.3 The RS15 Contractor will provide the antenna mounting brackets, conduits, support or clamping arrangements to ensure security and reliability.



TD3.3.4 The antenna system shall not contravene the kinematic envelope and fully meet the radio coverage requirements both for normal and reverse directions of train working.

TD3.4 Speed Measurement Devices

TD3.4.1 For each ATC equipment set (per driving cab), the Signalling and Train Control and Telecommunications contractors shall supply to the RS15 Contractor for installation, two sets of axle mounting speed measurement devices and couplings, to be configured, and the data from them processed in such a way as to achieve the objectives of D3.4.2 below.

TD3.4.2 The Signalling and Train Control and Telecommunications contractors shall ensure that the speed measurement devices produce a signal which reflects the true speed of the train (within $\pm 1.0\text{km/hr}$) under any operational, weather and track conditions including gradient, curvature, wheel spin/slide and error in the speed measurement due to wear in wheel diameter.

TD3.4.3 The Signalling and Train Control and Telecommunications contractors shall supply the necessary disconnection and terminal blocks, device mounting brackets and plates, flexible conduit assemblies complete with connectors and cables from speed measurement devices to the junction boxes.

TD3.4.4 The RS15 Contractor shall provide for each speed measurement device mounting brackets, support or clamping arrangements to ensure security and reliability.

TD3.4.5 The Signalling and Train Control and Telecommunications contractors shall furnish the zero velocity detection apparatus (ZVR relay).

TD3.4.6 Deleted.

TD3.4.7 The Signalling and Train Control and Telecommunications contractors shall furnish the RS15 Contractor with full mounting details, apertures, fixing holes, etc.

TD3.5 Driver's Display

TD3.5.1 Indications to the driver shall be displayed on the ATC Cab Display supplied by the Signalling and Train Control and Telecommunications contractors. It shall incorporate as a minimum, but need not be limited to the following information :

- (i) Train description, (ID) including crew identification
- (ii) Target Distance
- (iii) Target Speed
- (iv) Service and Emergency Brake Initiation
- (v) Train docked
- (vi) Train hold status
- (vii) Station dwell time available
- (viii) Departure order
- (ix) In ATP zone or not
- (x) ATP/ATO failure indications
- (xi) Skip Stop indication



- (xii) DOOR OPEN Indication
- (xiii) Maximum Permissible Safe Speed (MSS) in ATP and ATO Modes
- (xiv) Train stopped outside of expected stopping window
- (xv) Depot indication, when the train is identified as being in a depot
- (xvi) Axle locked indication, for axles on which ATC speed sensors
- (xvii) Door release available; indicating on which side(s) of the train the doors may be opened.
- (xviii) Operating Mode

TD3.6 Interface Between TIMS and Train

TD3.6.1 The RS15 Contractor shall provide an on-board Train Information Management System (TIMS), to log the information from the ATO and ATP equipments supplied by Signalling and Train Control and Telecommunications contractors, in addition to the information shown in the RS15 specification.

All the vital commands by the on-board ATP and ATO systems, to Rolling Stock equipment and the responses of the rolling stock equipment to these commands, shall be recorded in TIMS. Data stored in the TIMS shall be password protected. Levels and protocols shall be agreed between the two Contractors.

TD3.6.2 The signals to be supplied from the TIMS to the equipment of Signalling and Train Control and Telecommunications contractors shall be decided jointly.

TD3.6.3 The TIMS shall be able to communicate data to the wayside, the OCC or BCC, using a data link supplied by Signalling and Train Control and Telecommunications contractors.

TD3.7 Power Supply and Earthing Arrangements

TD3.7.1 Two independent power supply circuits, including positive and negative poles, one for ATC and one for Train Radio Equipment will be provided by the RS15 Contractor and there shall be no physical or electrical links between these power supply circuits. Both Contractors shall co-ordinate to agree the power supply voltages.

TD3.7.2 The RS15 Contractor shall provide dedicated earthing arrangements for the train borne ATC and radio equipment. The Signalling and Train Control and Telecommunications contractors shall specify the earth impedance required.

TD3.7.3 The power supply cable between the train power supply and the ATC and radio train borne equipment power equipment shall be segregated, as short as possible and directly connected to the supply without any intermediate connection.

TD3.8 Telecommunications

TD3.8.1 The Signalling and Train Control and Telecommunications contractors shall furnish the RS15 Contractor with the interface required between the train radio system and the on-board public address system to allow on-board announcements to be made from the OCC.

The complete on-board public address system, and interface hardware, including the transmission link, and a communication panel shall be furnished by the RS15 Contractor. Levels and protocols shall be agreed between the two Contractors.



TD3.8.2 The Signalling and Train Control and Telecommunications contractors shall furnish the RS15 Contractor with the interface required between the train radio system and the on-board TMS for recording the initiation, termination, and success or failure of emergency calls initiated by the train driver and/or OCC or BCC on the radio. The hardware interface shall be furnished and installed by the RS15 Contractor. Levels and protocols shall be agreed between the two Contractors.

TD3.9 Factory Installation and Testing

TD3.9.1 All the special equipment associated with the train borne ATC and radio system shall be designed and supplied by the Signalling and Train Control and Telecommunications contractors to the RS15 Contractor's factory. Each contractor shall be aware of the locations of manufacturing plants, which could concurrently be manufacturing cars.

TD3.9.2 The Signalling and Train Control and Telecommunications contractors shall be responsible for providing all data and training of RS15 Contractor's staff in all aspects of ATC and train radio installation and testing where applicable. The first set of ATC equipment shall be installed by the RS15 Contractor, under the supervision of the Signalling and Train Control and Telecommunications contractors Contractor's representative.

TD3.9.3 The RS15 Contractor will be responsible for installing wiring and equipment, and its testing on each car to the functioning standard agreed with the Signalling and Train Control and Telecommunications contractors

TD3.9.4 Testing of each car shall comply with the accepted international standards agreed between the two Contractors as agreed with the Employer's Representative. Initial integration tests (static and dynamic) shall be done at the rolling stock factory and carried out by the test personnel of both Contractors jointly. Further main line integration tests will be required to be carried out to ensure all train control functions and telecommunications between OCC and Train which will be required to be done jointly by the two contractors, RS15 & Signalling and Train Control and Telecommunications contractors at site in Delhi. The test certificate for on board signaling equipment will be issued jointly by both RS15 & Signalling and Train Control and Telecommunications contractors.

TD3.9.5 The RS15 Contractor shall provide facilities including test track for comprehensive static, dynamic, and interface tests between the Rolling Stock, Signalling and Telecommunications systems at his premises. The Signalling and Train Control and Telecommunications contractors shall be responsible for the provision of special test equipment and instrumentation.

TD3.10 EMC/EMI Interface

TD3.10.1 Regarding electromagnetic interference, the Signalling and Train Control and Telecommunications contractors shall provide a list of frequencies and other sensitive requirements to the RS1 Contractor, to enable him to avoid such frequency bands in his design, and to provide devices to isolate the source of emission wherever required.

The two Contractors shall also jointly develop a test plan detailing how the electromagnetic compatibility of traction and signalling and telecommunications systems will be verified. The two Contractors shall work together to assure that all electronic and electrical equipment on the rolling stock works properly without interfering with signalling, or telecommunications sub-systems.

TD4 SCOPE OF INTERFACE

TD4.1 Division of Responsibility



Item	Signalling and Train Control and Telecommunication Contractors	RS15
1. On board ATP equipment 2. On board ATO equipment (Metro Corridor only) 3. On board radio equipment 4. Antennae for train radio, ATP, ATS and TWC 5. Speed measuring sensors and speedometer. 6. ATC Cab Displays (Drivers MMI).	To supply the equipment to the RS15 Contractor's Works	To provide space in the vehicle design for fixing and installation at the manufacturer's facility, by the RS15 Contractor, under the supervision of the Signalling and train Control and Telecommunication Contractors. The speedometer to be supplied by SYS1 AND 3SO3.
7. Power supply and earthing for on board ATP/ATO and train radio equipments.	Furnish required voltage values and earthing requirements to RS15 Contractor.	To provide the required voltages and earthing
8. Logging of on-board information from ATP/ATO	Signalling and Train Control and Telecommunication Contractors to co-ordinate with RS15 for signal levels and protocols.	Provide the on board data logger TMS.
9. Interface between ATP/ATO with train braking and propulsion systems for automatic braking, acceleration and deceleration.	ZVR & EBR relays to be supplied by the Signalling and Train Control and Telecommunication Contractors	RS15 shall co-ordinate with the Signalling and Train Control and Telecommunication Contractors to agree on levels and protocols for interface signals.

TD4.1.1 The Signalling and Train Control and Telecommunication contractors shall co-ordinate interactively in order to achieve the functional and operational requirements of the system. The roles and activities of the two Contractors shall include minimum following but not limited to :



Communications Equipment and Systems

Item	Signalling and Train Control and Telecommunication Contractors	RS15
10. On board next station information to the passengers 11. On board announcement from OCC.	Shall provide necessary signals on-board to RS15.	Shall provide for necessary hardware interface, display for on-board P.A. system inside the cars.
12. Data transmission link from one end of the rake to another.		RS15 Contractor shall provide car/train lines and auto-coupler spare pins

Environmental Issues

Item	Signalling and Train Control and Telecommunication Contractors	RS15
13 Climatic requirements for on board ATP/ATO and radio cab equipments.	Signalling and Train Control and Telecommunication Contractors to specify at an early date, the total heat load wattage, and maximum permitted temperature	RS15 Contractor to provide, incorporated with Cab Air Conditioning installation.
14 EMI/EMC interface between the RS15 and Signalling and Train Control and Telecommunication Contractors	Signalling and Train Control and Telecommunication Contractors Contractor shall advise EMI/EMC plan for ATP/ATO & radio equipments to RS15 Contractor at early date.	RS15 Contractor shall ensure the compliance of the requirements of Signalling and Train Control and Telecommunication Contractors for on board ATP/ATO and radio equipments.



Annex 1/TD Rolling Stock Characteristics

Acceleration on Tangent Track at Peak Load	0.82 m/s ² ± 5%
Deceleration with full service brake	1.0 m/s ²
Guaranteed emergency braking rate	1.3 m/s ²
Jerk rate (maximum)	0.75 m/s ³
*Service Brake Response Time	2.0s
*Emergency Brake Response Time	1.5s max
*Service and Emergency Brake Release Time	2.5s
* Brake Assurance Time	
Length of car over couplers	22.1 m approximately
Maximum Vehicle Overhang	3625mm ± 125mm approximately
Maximum wheel diameter	860mm
Minimum wheel diameter	780mm
Maximum train design speed	90km/h
Maximum train service speed	80km/h
Tare weight Motor Car	42 tonne maximum.
Tare weight Trailer Car Rail Corridor	42 tonne maximum.
Tare weight Trailer Car Metro Corridor	42 tonne maximum.
Axle Load	17 tonne maximum.
Train length – 4 Car Train	89m approximately
Train length – 6 Car Train	134m approximately
Train length – 8 Car Train	178.5m approximately

Note : 1. All of the data in the above table are notional, and should be confirmed between the Contractors. The above data is not exhaustive, and full co-operation between Contractors is required.

2. For the four items marked *, the timings are for a brake application from full release to 90% of full brake cylinder pressure, and for brake release from full brake cylinder pressure to 10%.



EMPLOYER'S REQUIREMENTS

TECHNICAL SPECIFICATION

APPENDIX TE

DRAWINGS



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000563

APPENDIX TE

LIST OF DRAWINGS

Sequence No.	Description	Drawing No.
1	General Alignment Drawings : Shahdra to Tis Hazari Section of Rail Corridor	DMRC/RC/ENGG/1998/9 Sheets 1 to 9 inclusive
2	General Alignment Drawings : Tis Hazari to Tri Nagar Section of Rail Corridor	RC/C/TN/Alignment
3	Alignment plan and Profile for Vishwa Vidyalaya to Central Secretariat of Metro Corridor	MC/C1A/GENL/PP/001 Sheets 1 to 18 inclusive
4	Shastri Park Depot cum Workshop Conceptual Layout Plan for Rail Corridor	RC/Depot-cum-Workshop Layout 001
5	Khyber Pass Depot cum Workshop Conceptual Layout Plan for Metro Corridor	MC/Depot-cum-Workshop Layout 001
6	Trinagar – Barwala Corridor Longitudinal Section	GGM/C/UT/PTB/L Section
7	Shahadra – Nangloi Corridor Longitudinal Sectional	8830/RC/C/L Section/93
8*	Kinematic Envelope on Level Tangent Ballasted Track Broad Gauge	A3 Sketch No. RS/99/001
9*	Kinematic Envelope on Level Tangent DFF Track of Metro (Inside Tunnel) (Broad Gauge)	A3 Sketch No. RS/99/002
10*	Kinematic Envelope on Level Tangent Ballasted Track (Standard Gauge)	A3 Sketch No. RS/99/004
11*	Kinematic Envelope on Level Tangent DFF Track of Metro (Inside Tunnel) Standard Gauge – 1500V d.c.	A3 Sketch No. RS/99/005
12*	Kinematic Envelope on Level Tangent Ballastless Track (Standard Gauge)	A3 Sketch No. RS/99/007



	25 kV a.c. System	
13*	Kinematic Envelope on Level Tangent DFF Track (Ballastless) – 25 kV a.c. System	A3 Sketch No. RS/99/008
14*	Worn Wheel Profile	A4 RDSO Sketch No. 91146

Note : Drawings marked * (Nos. 8 – 14 inclusive) are enclosed within the Employer's Requirements : Technical Specification



APPENDIX TE

Volume	Page, Clause, etc.	Location	Amendments
Volume 3 TS Appendix TE	Sketch No. RS/99/002	Note No.**3	Replace Note No. **3 with the following sentence: "75mm is minimum clearance allowed for bogie mounted equipment from rail level for fully loaded static coach with fully worn wheel on diameter for a width of 1220mm on either side of centre of Broad Gauge track with the exception of wheels and its attachments from a distance of 51mm inside to 216mm outside of the gauge face of the wheel.
Volume 3 TS Appendix TE	Sketch No. RS/99/005	Note No.**3	Replace Note No. **3 with the following sentence: "75mm is minimum clearance allowed for bogie mounted equipment from rail level for fully loaded static coach with fully worn wheel on diameter for a width of 1100mm on either side of centre of Standard Gauge track with the exception of wheels and its attachments from a distance of 51mm inside to 216mm outside of the gauge face of the wheel.
Volume 3 TS Appendix TE	Sketch No. RS/99/001, RS/99/008	Note No.**2	Replace Note No. **2 with the following sentence: "75mm is minimum clearance allowed for bogie mounted equipment from rail level for fully loaded static coach with fully worn wheel on diameter for a width of 1220mm on either side of centre of Broad Gauge track with the exception of wheels and its attachments from a distance of 51mm inside to 216mm outside of the gauge face of the wheel.
Volume 3 TS Appendix TE	Sketch No. RS/99/004, RS/99/007	Note No.**2	Replace Note No. **2 with the following sentence: "75mm is minimum clearance allowed for bogie mounted equipment from rail level for fully loaded static coach with fully worn wheel on diameter for a width of 1100mm on either side of centre of Standard Gauge track with the exception of wheels and its attachments from a distance of 51mm inside to 216mm outside of the gauge face of the wheel.
Volume 3 TS Appendix TE	Sketch No. RS/99/001, RS/99/004, RS/99/008.	Underlined Note i.e. before "1.TRACK ALIGNMENT..."	Delete " REDUCED" & delete "FOR DFF TRACK ON METRO"



EMPLOYER'S REQUIREMENTS

TECHNICAL SPECIFICATION

APPENDIX TF

SUBMITTALS



APPENDIX TF.**SUBMITTALS****TF1 General**

TF1.1 As per various clauses of this Employer's Requirements: Technical Specification, the Tenderers are expected to submit relevant information. A list of the required documents / information is given in table TF.1 along with the respective clause reference.

Table TF.1 Submittals with tender

S.N.	Description	TS Clause reference
1	Expected MDBCf for major systems	2.8.2
2	Specific exceptions for LRU's, whose replacement is not achievable in 30 minutes	2.12.9
3	Expected MTTR for major systems	2.12.10
4	Confirmation of provenness of equipment / sub-system / system and exceptions theroff	3.2.2
5	Confirmation of provenness of propulsion equipment	3.2.3
6	Kinematic Envelope	3.20
7	Train Resistance formulae	3.21.5
8	Performance Characteristics	3.22
9	Estimated Specific Energy Consumption	3.24.1
10	Quality specification of the regenerated energy including its harmonic analysis	3.24.4
11	Details on technique of joining modular elements of shell	4.1.1
12	Porposal on structural arrangement	4.8.5
13	Predicted values towadrs crashworthiness of cars.	4.8.6
14	Means of uncoupling a semi-permanently coupled pair of cars.	4.15.1
15	Details on provenness of bogie alongwith performance certificates from end user	5.1.1
16	Brief description of the proposed disc brake system alongwith expected life of brake pads and discs on the wheels	6.13.13
17	Time required for replacement of door leaf	7.2.1
18	Details of locking device for door leaves	7.2.4.3
19	Mounting details of transformer	8.7.5
20	TIMS system architecture	10.2.1
21	The proposed standards on Data protocols	10.2.6
22	Specific measures taken to minimise energy consumption for HVAC	11.1.6
23	Details on latest internationally accepted practice for Soldering of electronic components	14.15.3

TF1.2 The Tenderers shall include the above information / documents in their bid, as a minimum. Notwithstanding the above, the Tenderers shall submit all the required documents / information



as specified in various clauses even if the same do not figure in table TF.1.

EMPLOYER'S REQUIREMENTS

TECHNICAL SPECIFICATION

APPENDIX TG



APPENDIX TG: Details Regarding Vendors/Sub-Vendors in Existing 'RS1', 'RS6' Type Stocks vis-a-vis those Proposed in RS15 Tender.

S.No.	Item	Existing Vendor/Sub-Vendor	Proposed Vendors/Sub-Vendors in RS15
A	Bogie	Rotem/Korea BEML/India	Compatible.
	Primary Suspension	TOKAI	Compatible.
B	Gangway Systems	M/s Dellner	M/s Dellner
C	Coupler		
1	Automatic Coupler, Intermediate Automatic Coupler, Semi Permanent Coupler	Voith Turbo Scharfenberg Gmbh, Co.KG, Germany	Voith Turbo Scharfenberg Gmbh, Co.KG, Germany
D	Brake System & Pneumatic	Knorr Bremse	Knorr Bremse
E	Door System	IFE	IFE
F	Communication System		
	PA/PIS	AAL	AAL
G	HV and Propulsion System		
1	Traction Motor	Mitsubishi Electric Corporation Ltd. Japan	Mitsubishi Electric Corporation Ltd. Japan
2	Converter Inverter	Mitsubishi Electric Corporation Ltd. Japan	Mitsubishi Electric Corporation Ltd. Japan
3	Transformer	Mitsubishi Electric Corporation Ltd. Japan	Mitsubishi Electric Corporation Ltd. Japan



4	VCB	Schneider Electric Infrastructure Limited India (AREVA T&D India Ltd.)	Compatible.
5	Anti Burst type Potential transformer (PT)	RITZ	Compatible.
6	AC Current Transformer	Mitsubishi Electric Corporation Ltd. Japan	Compatible.
7	Surge Arrestor	OTOWA Electric Industrial Co. Ltd. Japan, Tridelta	Compatible.
F	Auxiliary Power System	Mitsubishi Electric Corporation Ltd. Japan	Mitsubishi Electric Corporation Ltd. Japan
G	TIMS	Mitsubishi Electric Corporation Ltd. Japan	Mitsubishi Electric Corporation Ltd. Japan
H	HVAC	Sidwal	Compatible.



EMPLOYER'S REQUIREMENTS

TECHNICAL SPECIFICATION

APPENDIX TH



APPENDIX TH**EMPLOYERS REQUIREMENTS****TECHNICAL SPECIFICATION FOR RS1 TYPE STOCK - ERTS – RS15**

The 'RS15' type Rolling Stock shall conform to the Employer's Requirements – Technical and general specifications of contract 'RS1, RS6 & RS13' along with all approved/would be approved variations, modifications and Hardware/Software Engineering Change Proposals that may be implemented in contract 'RS1, RS6 & RS13' cars in line with ERTS. In case of any contradiction between ERTS and approved/would be approved modifications (Hardware/Software Engineering Change Proposals) against the contracts 'RS1, RS6 & RS13', the later will prevail.



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