

(k) Advertisement card rack	✓					✓	
(l) Draught screen	✓					✓	
(m) Air diffuser & duct	✓					✓	
(n) Return air grille	✓					✓	
(o) Speaker	✓						
(p) Threshold plate	✓					✓	
(q) Car end fairing	✓				✓	-	
(r) ECU Terminal	✓				✓		
(s) Panty control panel	✓						
(t) Any other item as required by the Engineer	✓						
(vi) Location and performance of the Passenger Information Display System (PIDS), LCD based route maps, Passenger Sabon Surveillance System (PSSS). At least one PID, one route map and one PSSS camera shall be operable in the final version of this mock-up. LCDs for advertisements (as actual)	✓				✓		
(a) Passenger Information Display System(PIDS)	✓					✓	
(b) LCD based route Maps	✓					✓	
(c) Passenger Sabon Surveillance System(PSSS)	✓					✓	
(d) Any other item as required by the Engineer	✓					✓	
(vii) Lighting levels.	✓					✓	
(viii) Location of fire extinguishers	✓					✓	
(x) Quantity and locations of system route maps, advertising cards and other signage.	✓					✓	
(xi) Location of and access to Passenger Alarm device allowing two-way speech channel to be established with train operator.	✓			✓			
(xii) Flooring, embedded stickers on floors including fluorescent types	✓					✓	
(xiii) Stickers & labels	✓					✓	
(xiv) Mounting of display panels	✓					✓	
(xv) FRP modules	✓					✓	
(xvi) Flooring	✓					✓	
(xvii) Window	✓					✓	
(xviii) FRP	✓				✓	✓	
(xix) Display (PID)	✓					✓	
(xx) Location of equipment, access, ventilation, etc.	✓				✓	✓	
(xxi) Seats-Access to equipment	✓					✓	
(xxii) Air circulation arrangement compliance with CFD simulation design (Air duct)	✓					✓	



(xxii) CCTV coverage and blind spots	✓					✓
(xxiii) Interior lighting	✓					✓
(xxiv) Fire detector	✓					✓
TB 2 Car-body Engineering Mock-up						
TB2.1 A Car-body Engineering Mock-up shall be provided for review by the Engineer at the Contractor's manufacturing facility. It shall demonstrate, as a minimum, the following:						
(i) Location and access to light fittings.	✓					✓
(ii) Location of and access to air-conditioning diffusers and ducting.	✓				✓	
(iii) Location of and maintenance access to door drive mechanisms.	✓					✓
(iv) Access for window replacement.	✓					✓
(v) Access to equipment cupboards	✓					✓
(vi) Access to Passenger Information Display system.	✓				✓	
(vii) Gangway to car-end interface.	✓				✓	
(viii) Access to Electrical control (relay and MCB etc.) panels	✓				✓	
TB 3 Cab Mock-up						
TB3.1 All controls and indications shall be those proposed for the final build. The actual train operator's seat shall be installed. The mock-up shall include as a minimum the following:						
(i) Operation and adjustment of Train operator's seat.	✓					✓
(ii) Location of and access to all train operator's controls and instrumentation.	✓					
(a) Driver's Console	✓					✓
(b) Master Controller	✓				✓	
(c) VDU	✓				✓	
(d) Speed Meter	✓				✓	
(e) Brake Valve	✓			✓		
(f) Double Pressure Gauge	✓			✓		
(g) Radio Hand Set	✓					
(h) Operating Panel	✓				✓	
(i) Wiper control switch	✓			✓		
(j) Any other item as required by the Engineer	✓					
(iii) Location of and access to light fittings.	✓					✓
(iv) Location and stowage of, and access to safety equipment.	✓					✓
(a) Fire Extinguisher	✓					✓
(b) First Aid Box	✓			✓		



(c) Any other item as required by the Engineer		✓							
(v) Access to equipment for maintenance.		✓							✓
(a) Front Panel		✓							✓
(b) Inspection Cover, Door Inspection Cover, Back Wall Frames		✓							✓
(c) Side Panel, Ceiling Panel, Foot Rest		✓							✓
(d) Operating Panel (Back Wall)		✓							
(e) Relay Panel		✓							
(f) AVAU		✓							
(g) Water Tank		✓			✓				
(h) TCMS Central Unit		✓							
(i) Train Radio Mobile Unit		✓							
(j) TCMS Display Controller		✓							
(k) Loud Speaker		✓							
(l) MCB Panel		✓							
(m) DC-DC Converter		✓							
(n) ATP System		✓							
(o) Destination indicator		✓					✓		
(p) Passenger Information Controller		✓							
(q) Train identification number indicator		✓					✓		
(r) Master Control Panel for PA sys.		✓							
(s) Auxiliary Control Panel for PA sys.		✓							
(t) PWM Generator		✓							
(u) Any other item as required by the Engineer		✓							
(vi) Location and adjustment of Train operator's sun blind.		✓							✓
(vii) Front and side visibility. (Wind Screen)		✓					✓		
(viii) Lighting levels		✓							✓
(ix) Door into passenger saloon, demonstrating means of access by passengers in emergency.		✓							✓
(a) Saloon to Cab Door		✓							✓
(b) Any other item as required by the Engineer		✓							
(x) Location and access to cab HVAC unit.		✓							
(xi) Colour and form of the cab internal finish.		✓							✓
xii) Space / enclosure for keeping train operator's kit, manuals and log books etc.		✓							



(xiii) Location of Forward Facing and Rear Viewing PSSS camera.	✓					✓
(xiv) Master control panel layout & type.	✓					✓
(xv) Layout of VDU (Video Display Unit)	✓					✓
(xvi) Layout of Operating panel	✓					✓
(xvii) Encapsulation arrangement	✓					✓
(xviii) Cab-saloon partition before & after removal	✓					✓
(xix) Utilisation of additional space released after GOA314, lumber-support, front visibility, etc.	✓					✓
(xx) Equipment location details	✓		✓			✓
TB 4 Cab Front End Mock-up						
TB4.1 The front-end mock-up shall demonstrate, as a minimum, the following:						
(i) Colour and form of the cab car external front end.	✓					✓
(ii) Indication of the crashworthiness structural features.	✓				✓	
(iii) Location of and access to windscreen wipers, lights, horns, and other equipment mounted on the front of the cab car.	✓		✓			✓
(a) Wiper	✓					✓
(b) Wiper Motor Assembly	✓					✓
(c) Head light, Tail Light, Flasher Light	✓					✓
(d) Horn	✓					
(e) Cab Mask, Cab skirts	✓					✓
(f) Hand rail	✓					
(g) Cable	✓				✓	
(h) Any other item as required by the Engineer	✓					
(iv) Location of auto-coupler and associated accoutrements.	✓			✓		
TB 5 Emergency De-trainment Device Mock-up						
TB5.1 The emergency de-trainment device mock-up shall be able to demonstrate, as a minimum, the following:						
(i) Front visibility and aesthetics	✓					✓
(ii) Security when stowed	✓					✓
(iii) Method and force required for deployment of folding ramp and handrails to track level and use for evacuation of passengers to track level	✓					✓
(iv) Method of returning to the stowed position.	✓					✓
(v) Flood lighting & CCTV coverage of infrastructure including track, OHE & detrainment process	✓					✓
TB 6 Underframe Equipment Layout Mock-up						

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TB6.1 An underframe equipment layout mock-up shall demonstrate, as a minimum, the following:									
(i) Location of all equipment, and access to all mounting points.									
(a) Auxiliary Converter - inverter		✓				✓			
(b) Main transformer		✓				✓			
(c) Earth bar, low tension		✓				✓			
(d) Earth bar, high tension		✓				✓			
(e) AC control box		✓				✓			
(f) CM starting box		✓							
(g) AC current transformer		✓				✓			
(h) 74P Jumper coupler		✓				✓			
(i) High tension connection box		✓				✓			
(j) Shore power supply boxes		✓				✓			
(k) Junction box, speed sensor		✓				✓			
(l) ATP Antenna (BS02)		✓							
(m) Air compressor unit		✓				✓			
(n) Air dryer		✓				✓			
(o) Air reservoirs		✓				✓			
(p) Brake control unit		✓				✓			
(q) Aux. Compressor		✓				✓			
(r) Valve boxes		✓				✓			
(s) Battery Box		✓				✓			
(t) Battery control Box		✓				✓			
(u) Converter inverter (C/I)		✓				✓			
(v) Electrical horn		✓				✓			
(w) Flexible hoses		✓				✓			
(x) Semi-permanent coupler		✓				✓			
(y) HT connection layout from roof to Transformer		✓				✓			
(z) Any other item as required by the Engineer		✓							
(ii) Routing of all cables including inspection covers to ensure easy accessibility.		✓						✓	
(a) Cable (Flexible tube) harness duct		✓						✓	
(b) Cable (Flexible tube)		✓						✓	
(c) Any other item as required by the Engineer		✓						✓	



(iii) Routing of all piping including isolation cocks to ensure easy accessibility and proper identification using colour coding.	✓		✓		✓
(a) Air piping (including fitting & cleat)	✓		✓		✓
(b) Valve pressure switch air filter	✓		✓		
(c) Isolation & cut out cock, test fitting	✓		✓		
(d) Any other item as required by the Engineer	✓				
(iv) Location of and access to all routine maintenance activities, including lubrication points, filter changes, monitoring points and pneumatic system test points.	✓		✓		
(a) Oil separator	✓		✓		
(b) Drain cock, drain plug	✓		✓		
(c) Valve boxes	✓		✓		
(d) Any other item as required by the Engineer	✓				
(v) Location of any skirts or covers, and access to equipment behind.	✓			✓	
(vi) Labels and markings of equipment.	✓			✓	
(vii) Cable layout, cleating, provision of additional cables.	✓			✓	
TB 7 Roof Equipment Layout Mock-up					
TB7.1 A roof mounted equipment layout mock-up shall demonstrate, as a minimum, the following:					
(i) Location of all roof mounted equipment, and access to all mounting points.	✓			✓	
(a) Pantograph & insulator		✓		✓	
(b) VCB		✓			
(c) Emergency SW, Surge arrester, Potential transformer		✓			
(d) Antenna, Train radio (BS-14)	✓				
(e) Air conditioner (* One HVAC unit shall be real)	✓		✓		✓
(f) Any other item as required by the Engineer	✓				
(ii) Routing of all cables and piping.	✓			✓	
(iii) Location of and access for all routine maintenance activities, including lubrication points, filter changes and monitoring points.	✓			✓	
(iv) Location of any skirts or covers, and access to equipment behind.	✓			✓	
(v) Water drainage arrangement	✓			✓	
TB 8 Door Equipment Mock-up					
TB8.1 A fully functional mock-up for complete car having 4 doors a side, including the actual door drive, door gear, door track and door leaves complete with sealing arrangements, shall be provided. It shall demonstrate as a minimum:					
(i) The door opening and closing forces and timings.	✓				✓



(i) The means of adjusting them.	✓				✓
(ii) The means of adjusting door leaf location and travel.	✓				✓
(iv) Accessibility for maintenance and adjustment.	✓				✓
(v) Internal and external release mechanism at stations following power loss, etc.	✓				✓
(vi) The means of locking a failed or defective door to prevent use.	✓				✓
(vii) Cycling to release a trapped object.	✓				✓
(viii) Door status indicators (interior and exterior)	✓				✓
(ix) Door seals (Noise reduction)	✓				✓
(x) Dust protection of door machining	✓				
(xi) Access to door machine	✓				✓
TB 9 Shore Supply Mock-up					
TB 9.1 A fully functional mock-up for Shore Supply shall be provided. It shall demonstrate as a minimum:					
	✓				✓

Note

1. The definition of the 'Type of parts used' for the manufacturing of the Mock up i.e. 'Real', 'Imitation' and 'Dummy' is as follows:-

(i) 'Real': Real/Actual parts with full functionality.

(ii) 'Imitation': Imitation parts with no functionality but accessibility and maintainability.

(iii) 'Dummy': Dummy parts with no functionality and only for location identification.

2. Real parts, wherever mentioned shall be above, are manufactured with materials which have same function as mass production.

3. Imitation parts shall be manufactured with similar to real products, but can be partially different.

4. Dummy parts shall be manufactured with FRP/composite durable materials.

5. The above detailing and classification of parts to be used as 'Dummy', 'Imitation' or 'Real' is indicative. To be finalized during design stage with the approval of the Engineer.



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.

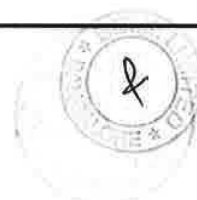
Abbreviation	Description in Full
ASHRAE	American Society for Heating , Refrigeration and Air-conditioning Engineers
ATC	Automatic Train Control (System)
ATO	Automatic Train Operation (System)
ATP	Automatic Train Protection (System)
ATS	Automatic Train Supervision (System)
BCP	Brake Cylinder Pressure
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
DM	Driving Motor Car
DMRC	Delhi Metro Rail Corporation
MMRTS	Mumbai 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
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



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OEM	Original Equipment Manufacturer
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
TCMS	Train Control 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



APPENDIXTD. INTERFACES BETWEEN ROLLING STOCK, SIGNALLING AND TELECOMMUNICATION CONTRACTORS**TD.1. INTRODUCTION****TD1.1 Definitions and Scope**

TD1.1.1 This Appendix describes the interface requirements between Contract MRS1, Rolling Stock Contract for Line 2 and 7 of Mumbai Metro and contracts for Signalling and Train Control, Contract for Line 2 and 7 and also with, Telecommunications Contract for Mumbai Metro.

TD1.1.2 The Contractors as above shall ensure that all requirements of the Specification pertaining to interfaces are properly satisfied. There is possibility of having multiple Contractors for signalling and telecom. RS Contractor shall interface accordingly with more than one signalling /telecom and any other designated Contractor.

TD1.1.3 The Rolling Stock Contractor shall provide equipment, software, functionalities etc. of Train to meet the requirement of Interface. Signalling & Telecommunication Contractor shall provide on board equipment, software, functionalities etc. of S&T, and ground equipment, software, functionalities etc. to meet the requirements of interface. The requirements specified herein are by no means exhaustive and it remains the responsibility of the Contractors to develop and execute an interface plan during execution of the work to ensure that:

- (i) All interface issues between the different contracts are satisfactorily resolved
- (ii) Supply, installation and testing of equipment and software are fully co-ordinated
- (iii) All equipment supplied in the contract are fully compatible with each other
- (iv) UTO mode of operation is achieved with all its inherent features.

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 Rolling Stock Contractor. The ATP system shall be responsible for monitoring of speed and the issuing of braking commands when safety speed limits are exceeded.

TD 1.1.5 Parking brakes shall be provided by the Rolling Stock Contractor. The parking brakes shall be capable of holding a fully loaded stationary train on a 4% gradient under all track conditions, indefinitely.

TD 1.1.6 There shall be two stage commissioning. In the first stage, the train operation shall be by single Train Operator. In the first stage ATP/ATO/RM/ROS/Cut-out modes described below will be made available. In the second stage UTO and associated modes viz standby mode etc. will be commissioned.

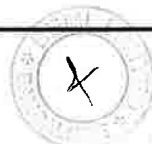
TD 1.1.7 Interface Management

TD1.1.7.1 Each contractor shall establish a structured process to integrate with other E&M systems to ensure safe, reliable and efficient operations under both normal and degraded conditions to the satisfaction of the Employer's Engineer.

TD1.1.7.2 Each contractor shall ensure that the equipment supplied under this Contract are properly interfaced and integrated with other systems in Mumbai Metro.

TD1.1.7.3 Each contractor shall appoint competent and experienced person (Interface Manager), with no fewer than 5 years of similar railway project experience who shall be the single point of contact for all interface design and testing works with the interfacing contractors and the Employer's Engineer.

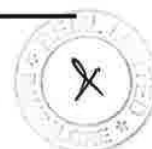
TD 1.1.7.3.1 Full time mobilization of 'Interface Manager (IM)' at site shall be done by RS as well as Signal Contractor within three (3) months of the commencement date. Non mobilization of the 'Interface Manager (IM)' within the stipulated three months would attract penalty (to be solely finalized by the Engineer) for delay of each month or part thereof. The penalty amount shall include the consequential loss on account of non-availability of an approved and experienced 'Interface Manager (IM)'.



- TD 1.1.7.3.2 All Interface Meetings, unless specifically approved by the Engineer shall be held at site and Engineer's representative shall be given sufficient notice to attend the meeting.
- TD1.1.7.4 Each contractor shall be responsible for interface identification, establishment, construction and testing works either in the capacity as the Lead Contractor or Participating Contractor.
- TD1.1.7.5 Signalling Contractor shall be the Lead Contractor. The Lead Contractor will be responsible to initiate, plan, coordinate and produce jointly with the Participating Contractors all the required interfaces and interface design documents and interface progress reports for submission to the Engineer for acceptance. The Lead Contractor will also prepare and issue all interface meeting minutes after incorporating RS Contractor's comments within 3 days of the meeting and provide bi weekly interface progress reports to all the participating contractors for information.
- Later, forwarding of issued minutes of meeting and bi weekly interface progress reports to respective Engineers shall be responsibility of concerned Contractors.
- All the participating contractors shall ensure that copy of the Interface design documents submitted to the Engineer of the Signaling contractor shall also be submitted to their respective Engineer required to participate in the Interface Meetings.
- TD1.1.7.6 Rolling Stock, PSD and the Telecommunication Contractor will be the participating contractors. The Participating Contractors shall collaborate fully with the Lead Contractor in the development and finalization of the interface design, joint production of the interface documents and interface progress reports.
- TD1.1.7.7 The costs for all interface design and testing works shall be deemed to be included in the Contract sum regardless of the actual extent of effort required or expended by the Contractor.
- TD1.1.7.8 The Contractors shall be fully responsible for the management and control of his sub-contractors in relation to all interfacing activities carried out under the Contract.
- TD1.1.7.9 Deleted.
- TD1.1.7.10 The Signalling Contractor shall provide necessary support to resolve all pending or new interface related issues arising during the operation of the trains till completion of Rolling Stock defect liability period. The Rolling Stock Contractor shall provide necessary support to resolve all pending or new interface related issues arising during the operation of trains till completion of Signalling defect liability period. It shall also be noted that changes in the interface specifications such as key alarms, remote commands, interface signals and GUI specifications are to be expected throughout the project execution stage and shall extend up to 6 months after commencement of UTO operation based on operational requirements.
- TD 1.1.7.11 Rolling Stock Contractor shall be responsible for development of the GUI (including hardware) for the RS Controller (RSC) in the OCC (Operation Control Centre)/BCC (Backup Control Centre). Any other GUI(s) in OCC/BCC shall not be the scope of RS contractor. Total number of the distinctively different screens with live buttons may be around ten.
- TD 1.1.7.11.1 Lead contractor shall ensure suitable connectivity between the workstations of the Traffic Controller, RS Controller, CCTV and others as finalized during interface design.
- TD 1.1.7.12 Lead contractor shall provide server for CCTV in the OCC/BCC. RS Contractor shall provide server for TCMS data in the OCC/BCC. These servers shall be networked with the depot server of the RS contractor. All the requirements of server/buffering to be done on the train for live streaming of video shall be the responsibility of RS Contractor.
- TD 1.1.7.13 Lead contractor shall be responsible for enabling and implementing any addition/ deletion of the alarms from the trains to OCC and remote commands from the OCC to train throughout the project execution stage including up to 6 months after commencement of



- UTO operation, as advised by the RS Contractor/Engineer. Separate set of alarms and commands may be required to be reported/executed from the Traffic controller and the RSC workstations. RSC workstation shall be the responsibility of RS Contractor.
- TD 1.1.7.14 Adequate number of workstations (minimum 4) as decided during the Interface finalisation shall be provided in OCC by the lead contractor for passenger communication with OCC on invoking of PAD (Passenger Alarm Device).
- TD 1.1.7.15 In the event of invoking of the PAD, automatic pop up of image from the relevant cameras shall be ensured in the OCC on the Large Video Screen (LVS), screens of traffic controller and RSC.RS Contractor shall interface with Lead Contractor for invoking of CCTV images on RSC workstation.
- TD 1.1.7.16 Signalling Contractor shall be responsible for free supply of cables, duly harnessed for connection of the On-board signal equipment. RS contractor shall be responsible for providing the cables for the train lines and/or Ethernet links required by the Signalling contractor. The Rolling Stock Contractor shall ensure the availability of adequate no. of train lines/ethernet considering the requirement of Signalling Contractor, which shall be discussed and finalized during interface. RS contractor to ensure that adequate number of spare train lines (minimum 10% for each type) shall be available at the end of the DLP. Signaling Contractor shall certify relevant connections, cables to on-board signaling equipment after their assembling in first train at RS contractor's premises.
- TD 1.1.7.17 Deleted.
- TD 1.1.7.18 Deleted.
- TD 1.1.7.19 Lead contractor shall be responsible for providing suitable communication link for live streaming via CCTV network from TCMS to OCC/BCC and for live transmission of the advertisements or other data via CCTV network from OCC/BCC to TCMS. The live video stream transmitted from the train to the OCC/BCC shall be suitably buffered for its onward multicast transmission to other terminals/networks. This buffering arrangement in OCC/BCC via CCTV server shall be responsibility of Lead Contractor. For live video stream from OCC/BCC to train, the buffering on the train shall be responsibility of RS Contractor. The Rolling Stock Contractor shall provide Live Video Players with buffering capability. The RS Contractor shall also provide the advertisement and live video players in hot standby pair per train. The RS Contractor shall also provide redundant suitable arrangement (video controller/player/servers) in OCC/BCC for transmission of live video contents and stored video contents to be played in the train.
- TD 1.1.7.20 The contractors shall ensure that all the requirements of the Metro Railway General Rules are duly met by incorporating appropriate alarms, remote commands and other features.
- TD 1.1.7.21 Lead contractor in close coordination with the RS contractor shall ensure that the ATO/UTO modes of operation designed are optimized for least energy consumption.
- TD 1.1.7.22 It is expected that complete duplication of the TCMS VDU screen with live buttons for executions the requisite commands shall be available on demand in the RSC workstations.
- TD 1.1.7.23 Lead contractor's scope shall be limited to provide Access Point for enabling remote download of TCMS/CCTV data through CBTC/CCTV network. Scope of server along with data bank shall be of RS contractor. This clause shall be read in conjunction with sub-clause TD 3.1.21 of this document.
- TD 1.1.7.24 Both lead as well as RS contractor shall ensure that complete and detailed log of the signals exchanged between VATC and TCMS shall be retrievable on demand for diagnostics.
- TD 1.1.7.25 Interface shall be done to achieve stabling of trains in depot based on corrective and preventive maintenance scheduling to be provided by RS Contractor to Lead Contractor. Lead contractor shall ensure seamless dynamic interface with the outputs of the Depot Maintenance Software package.
- TD 1.1.7.26 Lead contractor shall be responsible for slow speed movement on the Automatic Wash Plant (AWP). Interface will be required to be done with the AWP supplier for ATO/UTO modes. RS Contractor shall provide wash mode facility for other manual modes like ATP/RM/ROS/Cutout.



- TD 1.1.7.27 Emergency brake application validation at slow speed (less than or equal to 25 kmph) shall be achieved as a part of the wake up procedure as finalized by the lead contractor.
- TD 1.1.7.28 Lead Contractor to ensure that in the event of deflated condition detection or otherwise, the maximum speed shall not exceed the stipulated speed under such condition as advised by the RS Contractor. This information shall be provided by RS to Lead Contractor on board in a safe manner.
- TD 1.1.7.29 Lead contractor shall provide location information to the RS Contractor. RS Contractor shall use the same for different distance based algorithms provided in the RS.
- TD 1.1.7.30 There shall be a provision for transfer of train operation data in the problematic train on main line to the Roving Attendant Maintenance Terminal at the end of the trip of the train for troubleshooting and analysis purpose. The Roving Attendant Maintenance Terminal and facility to transfer train operation data from problematic train to the Roving Attendant Maintenance Terminal shall be provided by RS Contractor. The RS Contractor must interface with the Signaling Contractor so that this transfer of train operation data to Roving attendant terminal shall not result in CBTC and CCTV communication disruption.
- TD 1.1.7.31 Ground based hot axle box detection for monitoring of axle box temperature shall be provided by Rolling Stock Contractor. The ground equipment shall be provided by RS Contractor. The server in OCC, required software and communication network from way side equipment up to station Telecom Equipment Room (TER) shall be provided by RS Contractor. The Telecom Contractor shall provide Ethernet channel from station TER (Telecom Equipment Room) to CER (Central Equipment Room) of OCC. Data processing, interface equipment on both ends i.e. at wayside station and OCC shall be responsibility of RS Contractor.

TD2 TRAIN OPERATING MODES

TD2.1 General System Description

- TD2.1.1 The train-borne Automatic Train Control (ATC) system will consist of Unattended Train Operation (UTO), Automatic Train Operation (ATO) system and Automatic Train Protection (ATP) on Line #2 and Line#7 of Mumbai Metro.
- TD2.1.2 The Rolling Stock required for these lines shall be fitted with ATP/ATO/UTO system. The UTO system shall conform to Grade of Automation 3 (GoA3) and Grade of Automation 4 (GoA4) as defined in IEC 62290-1 2006.
- TD2.1.3 The Automatic Train Control (ATC) System shall be supplied by the Signalling Contractor, who shall be required to liaise closely with the Rolling Stock Contractor, in regard to the installation, testing and commissioning of the Signalling and Train Control Equipment.

TD2.2 Unattended Train Operation- (UTO Mode)

This mode consists of full driverless unmanned operation and shall be the default mode at stage 2 of commissioning unless exceptional circumstances occur. Train shall be operated unmanned or with attendant under fully automated GoA3 and GoA4 mode. This mode shall be available everywhere on the line and the depot except for the workshop lines. Details shall be finalised during interface and design finalization.

TD2.3 ATO Mode

- TD2.3.1 The onboard equipment shall provide for Automatic Train Operation (ATO) on Line #2 and Line#7. In this mode, the train's speed, motoring, coasting and braking within the parameters dictated by the ATP system shall be performed by the on-board equipment without the train operator's intervention. This operation shall include:
- (i) Automatic operation of trains between stations.
 - (ii) The ATO system shall provide control for acceleration, deceleration and coasting of trains in such a manner that the specified schedule speed is achieved with minimum energy consumption. ATO shall also provide "All-Out Mode" of train operation to make up time loss to the extent possible by reducing the coasting period, in case train is not running in accordance with Time-Table.



- (iii) Receipt of coasting request and passing of request to traction power equipment and also provide for acceleration and deceleration of the train.
- (iv) Automatic stopping of trains at platforms within a tolerance of $\pm 300\text{mm}$ for 99.98% of station stops.
- (v) Automatic opening of doors on the appropriate platform side(s) when the train is berthed.
- (vi) Prevent the train from starting if train doors are detected "not closed".
- (vii) Receipt and implementation of control to skip one or more stations.
- (viii) CBTC system shall allow a train to enter a station platform only if the preceding train has a movement authority that shall allow it to fully leave the platform area and it has begun to move out of the station (i.e., within ATP constraints, train movement shall be controlled to minimize the likelihood of the train coming to a stop when only partially within the station platform limits).

The trains under ATO operation shall always remain under ATP protection. Transfer from ATP to ATO mode shall only be possible at standstill at a station stopping point, however transfer from ATO to ATP mode shall be possible at any time.

- (ix) It shall be possible for train operator to close the doors and start the train in ATO mode even before dwell time at less crowded stations.

TD2.3.2 The ATO mode shall include Automatic Turnback at the terminal stations including the intermediate turnback stations. The Automatic turnback facility will be without driver and shall be provided at (a) platform of the terminal station (b) turnback track at rear of the terminal station (c) platform of intermediate turnback station.

TD2.4 **ATP (or Coded Manual) Mode**

TD2.4.1 The onboard equipment shall provide Automatic Train Protection (ATP) on all lines/ sections. In this mode, the train operator shall perform the control of the train speed and braking within the parameters dictated by the ATP system.

TD2.4.2 The ATP mode shall include:

- (i) Identification and enforcement of maximum speed at which the train may operate, shall be in accordance with the safe speed of 90 kmph.
- (ii) Identification and display of actual speed, target speed, target distance, and the operating speed.
- (iii) Identification and audio-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 respective Signalling and Train Control Contractor.
- (iv) Provision of an audio-visual warning to the train operator, 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 operator to react, and a service brake application should the train operator 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.

TD2.5 **Restricted Manual (RM) and Run on Sight (ROS) Mode**

TD2.5.1 In RM mode, the maximum train speed shall be controlled by the on-board ATP, to a limit not exceeding 25 kmph. This mode shall be available only when the on-board ATP equipment is operational.

TD2.5.2 ROS mode of operation shall be selectable by suitable means. In this mode, the maximum train speed shall be controlled by the on-board ATP, to a limit not exceeding 25km/h. This mode shall be available only when the on-board ATP equipment is operational. The running



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monitoring shall be the same as for RM. The ATP shall give cab signal indications as soon as the train reaches a track position where normal running can be resumed. The ATP authorizes the ROS request.

TD2.6 Cut-out (or By-pass) Mode

TD2.6.1 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 train operator, to a limit adjustable between 15 kmph and 25 kmph. RS Contractor shall provide equipment and means to ensure that the maximum train speed remains within the above limit when the Cut-out Mode is in effect, under all circumstances.

TD2.6.2 The ATP By-pass Mode shall be initiated by the train operator operating a sealed Safety Cut-out Switch (SCS) and simultaneously breaking its seal. The operation shall be recorded by the on-board digital counter and TCMS. The SCS shall be provided by RS Contractor. The on-board digital counter shall be provided by the Signalling Contractor. In this mode, the train doors shall only be enabled and controlled manually.

TD2.6.3 The availability of power supply to the ATC system during this mode will be decided during the design finalization.

TD2.7 Standby Mode (ready, dozing, sleeping), Immobilized mode etc.

A fully initiated train in standstill condition. Traction control shall be inoperative and brake shall be applied during this mode. The details of the mode will be finalised during design stage.

TD2.8 Identification: Train Operating Mode, Train Description and Next Station Information

TD2.8.1 Signalling Contractor shall provide a four digit Train Identification Number (Train ID) to RS Contractor. The first two digits shall identify a destination while the second two digits shall be a service identifier. RS Contractor shall accordingly use the relevant information such as names of intermediate stations, stopping pattern, station stop door opening side information, skipping station information, keep door closed information, train going to depot information etc. for operation of on-train systems.

TD2.8.2 Train ID shall be allocated to train at suitable place and shall be maintained until it finishes its service. It shall be possible by the Employer to amend and / or modify the Train ID, subsequently, to suit the operational requirements. The Signalling and Train Control, and Rolling Stock Contractors shall provide necessary equipment and means for the same. Rolling stock contractor shall provide suitable arrangement for Train Operator to view this information displayed on the Train information panel provided on front and other display information inside the train from his seat.

TD2.8.3 RS and Signalling contractors shall exchange information identifying the effective mode, the active or non-active status of each cab, the door status etc. The inputs shall be categorised as vital and non-vital. The levels and form of these inputs shall be coordinated between the two Contractors.

TD2.8.4 RS Contractor shall provide necessary inputs to the Telecommunications Contractor identifying the required mode and status of active cab etc. The levels and form of these inputs shall be coordinated between the two Contractors.

TD2.8.5 RS Contractor shall log each time the mode is changed using the onboard TCMS equipment.

TD2.8.6 In By-pass/ Cut-out Mode or any other mode, external indication light shall flash or occult which will be finalized during design stage.

TD2.8.7 Signalling Contractor shall provide the necessary input signals (next station information code, platform side information, triggering signal, etc.) to Rolling Stock for displaying and making next station announcements to passengers on-board. RS Contractor shall provide the necessary hardware. Levels and protocols shall be agreed between the contractors.

TD2.8.8 For UTO/ATO operation, the necessary train command digital inputs signals shall be provided by the Signalling Contractor. The ATP/ATO/UTO initiated signal demands shall be redundant. The redundancy shall also be provided on TCMS side by RS Contractor. The form of these inputs shall be coordinated between RS and Signalling contractors.



TD3. INTERFACE REQUIREMENTS BETWEEN SIGNALLING, TELECOMMUNICATION AND RS CONTRACTORS**TD3.1 General**

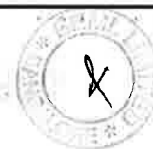
- TD3.1.1 Signalling and Telecommunication Contractors shall provide RS Contractor with the final list of equipment to be provided on the Rolling Stock. The sizes and weights of the UTO/ATO/ATP and radio on-board cab equipment and antennae etc. to be mounted on the Rolling Stock shall also be provided, as applicable. The location of the onboard cab equipment shall be mutually agreed between Signalling and Rolling Stock Contractors so as to optimize seating & standing space duly considering maintainability and easy accessibility, however the onboard cab equipment shall not be placed in the underframe on account of maintainability issues.
- TD3.1.2 Signalling and Telecommunication Contractors shall deliver to the RS Contractor's factories, all train-borne ATC and radio equipment, as applicable, and data to enable fitting and testing.
- TD3.1.3 Signalling Contractor shall supply at RS Contractor's factory pre-wired equipment racks with appropriate connectors for all wiring terminating inside ATC, including wiring between ATC racks. Telecommunication Contractor shall similarly supply all the train radio equipment including the Train Radio Control Panel at the RS Contractor's factory. Signalling and Telecommunication Contractors, with the details provided by RS Contractor shall ensure that the exterior finish and colours of the respective equipment suitably harmonize with that of the cab and the vicinity.
- TD3.1.4 Interfacing wiring for each module provided by Signalling and Telecommunication Contractors including the interfacing wiring between Signalling and Telecommunication Contractors' equipment 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 Signalling and Telecommunication 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 Signalling and Telecommunication Contractors shall provide RS Contractor with the number of wires and/or Ethernet connections required between cars of a married pair and between married pairs to transmit signals from one end of the rake to the other end. The coupler status shall be transmitted to the Lead Contractor in fail safe manner. Provision of redundancy and spares shall be catered for by RS Contractor for Train lines and/or Ethernet connections.
- TD3.1.7 For compatibility, the Rolling Stock and the train detection system (track circuits/axle counters), shall conform to EN 50238.
- TD3.1.8 Vehicle control circuits shall be developed by the RS Contractor. During the design stage, all the vehicle control circuits incorporating the identified interfaces shall be provided to Signalling and Telecommunication Contractors, as applicable. Signalling and Telecommunication Contractors shall provide specific observations on these circuits to RS Contractor. RS Contractor shall suitably incorporate these observations in the design.
- TD3.1.9 Screened cables for train borne signaling equipment shall be properly terminated so as to ensure that no return loops are formed to cause electrical noise.
- TD3.1.10 Train No. between the two systems shall be so designed so as to ensure that requisite information of train / car/ATC/ destination etc. is captured.
- TD3.1.11 Both Signalling and Rolling Stock Contractors to ensure that all input and output signals exchanged between rolling stock equipment and on-board signaling equipment shall be recorded and shall be available for retrieval on demand for analysis / record. All signals (import/export between RS & Signalling) shall generally be routed through TCMS.
- TD 3.1.12 Rolling Stock Contractor to ensure that all doors related and other safety / train control related signals including brakes, position of safety cut out switches, direction related relays, suspensions, obstruction on track etc. are communicated to the Signaling Contractor.



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- TD 3.1.13 Signaling Contractor to define as a part of interface the signals that will be provided by signalling train borne equipment.
- TD 3.1.14 Provision of "Jog and Creep mode" operation with command to operate the train at specified reduced speed under degraded condition (e.g. aligning train in case of undershoot/overshoot of Normal Stopping Point within a limit) shall be addressed in the interface.
- TD 3.1.15 The Rolling Stock Contractor and Signaling Contractor will jointly finalize a list of actionable command and responses for UTO mode of operation which shall be available at Central Automatic Train Supervision (CATS) system at OCC as well as Local Automatic Train Supervision (LATS) system at Station Control Room (SCR). The two Contractors shall also finalize the list of alarms and events for Rolling Stock monitoring and troubleshooting which shall be displayed on the Rolling Stock Controller monitor of CATS system at OCC as well as on other suitable terminals in depot and on the line.
- TD 3.1.15.1 The key alarms, which are related to the events of operation, safety etc. and critical/serious in nature shall be displayed to both Traffic Controller as well to Rolling Stock Controller. All other alarms and events shall be displayed to Rolling Stock Controller.
- TD 3.1.15.2 The list of alarms, events and remote control commands shall be proposed by Rolling Stock Contractor and approved by the Engineer. The implementation of alarms, events and remote control commands shall be ensured by both the Contractors. The packet size should have margin to accommodate additional requirement for future.
- TD 3.1.15.3 The Engineer shall be able to add/delete/modify the alarms, event and remote command up to 6 months after commencement of UTO operation. Necessary training and hands-on shall be provided during execution of project.
- TD 3.1.16 Rolling Stock shall propose a user friendly Graphical User Interface (GUI) for RS Controller in the form of a conceptual schematic/wireframe that shall include page layouts, arrangement of the GUI's content, interface and navigational elements, and a description of how they work together. The features of Rolling Stock Controller GUI shall be as under:
- TD 3.1.16.1 RS Controller GUI shall have the capability to monitor the information of all trains within the network. The GUI shall employ different colors for highlighting different status of trains. The status of various subsystems, MCBs, Relays & Switches, Train Lines shall be displayed on GUI and it shall be possible to acknowledge faulty trains immediately. It shall be possible to identify cause of events/Alarms on GUI.
- TD 3.1.16.2 The GUI shall make available both current faults and historical fault records with provision of sorting and filtering the list.
- TD 3.1.16.3 There shall also be a provision to request on-board TCMS VDU screen on demand for display on RS controller screen with automatic refresh periodically not more than 1 second, with navigation feature and actionable button.
- TD 3.1.16.4 A user friendly Troubleshooting Directory (TSD) shall also be made available in RS Controller GUI.
- TD 3.1.16.5 The GUI shall also make available remote control commands via clickable screen button elements that shall be visibly different from non-clickable icons/shapes. Remote control commands from RS Controller GUI shall be additional to the commands from CATS/LATS.
- TD 3.1.16.6 The screen elements shall be dynamic dropdown menus to make optimum use of screen area.
- TD3.1.16.7 Train Operation Data (TOD) shall contain train status data and faults/alarms/information etc. to be displayed on the RS Controller console. The Signalling Contractor shall ensure that sufficient margin in the data packet size have been kept and the bit mapping of the packet contents are easily editable independent of the ATS software. The TOD shall have a refresh rate of minimum 1 second.
- TD3.1.17 Rolling Stock Contractor shall provide CCTV cameras in the train which will cover cab, saloon, front of train, rear view camera, area for passenger initiated alarm, detrainment door etc. The CCTV cameras shall provide for minimum 24 hrs. of recording onboard. Rolling Stock Contractor and Signalling Contractor shall interface for control and data transfer of CCTV images from the train to OCC/SCR on the ATS terminal and Large Video



- Screen. The hardware interface shall be furnished and installed by RS Contractor. The CCTV signal shall be provided by RS Contractor at a suitable port on board to Signalling Contractor for transmission to OCC/BCC. There shall be no processing of CCTV data by S&T Contractor. At OCC/SCR it shall be possible to select any camera onboard and view the recording live at any terminal/workstation. The Levels and protocols shall be agreed between the two contractors.
- TD3.1.18 The CCTV server shall be provided in OCC and BCC by Signaling Contractor. The Signalling Contractor shall interface with Rolling Stock Contractor for correct assessment of storage of all camera images or a fisheye camera to have virtual view of required area. Facility to transfer historic data (5 min pre and 15 min post recorded CCTV feeds) on demand from train to OCC/BCC manually shall also be possible from OCC/BCC.
- Necessary provision in terms of playing the historic data in OCC/BCC along with sufficient storage capacity of 2 TB shall be ensured in CCTV server.
- Provision shall also be made to retrieve all historic data of last 7 days in one go from CCTV Server at OCC/BCC. The CCTV recordings 5 minutes prior and up to 15 minutes after the event shall be so stored that these are retrievable as a single data file for each event.
- TD3.1.19 CCTV image feed received in OCC/BCC shall support buffering with 10 min pre data stored on memory cache of CCTV server. The GUI for viewing CCTV images shall support rewinding the images up to 10 min before real-time.
- TD 3.1.20 Rolling Stock and Signalling Contractors shall interface to ensure that at least but not limited to following emergency conditions should result in the event based auto popup of CCTV images via CCTV network on RS Controller Terminal. The detail implementation shall be finalized during interface with the approval of Engineers. The utilization of bandwidth of CCTV network shall be managed dynamically.
- PAD activation
 - Detrainment Door Activation
 - ODD activation
 - Side Door Obstacle detection
 - Fire/Smoke Detection
 - CCTV Emergency Button Activation
 - Driving console cover open
 - ADD (Auto-Dropping Device)/track/catenary/infrastructure related events etc. (Refer ERTS Clause 12.2.1(B)(k)).
- Transfer and display of such images from CCTV Server to LVS and Traffic Controller work stations shall be responsibility of Lead Contractor for which RS and Lead Contractor shall interface.
- TD 3.1.21 In depot, Train diagnostic data and CCTV images shall be transmitted over CCTV network from train to the servers in the depot to be provided by Rolling Stock contractor. The sufficient CCTV antennas, bandwidth, network etc. shall be provided by signaling contractor.
- TD 3.1.22 Rolling stock contractor shall make provision CAT7 or latest cable/Optical Fiber, power supply and space & bracket for mounting of Wi-Fi antennas & equipment in the train for Wi-Fi facility for passengers. The equipment for Wi-Fi in the train such as antennas, servers, etc. shall be supplied by Wi-Fi Contractor.
- TD 3.1.23 The Rolling Stock Contractor shall provide necessary signals to the Signalling Contractor for proper functioning of Platform Screen Door (PSD). The Rolling Stock and Signalling Contractor shall interface for exchange of signals and develop protocol for proper working of Platform Screen Door (PSD).
- The Rolling Stock Contractor shall interface with PSD Contractor. Rolling Stock contractor shall provide KE and door drawings of train to PSD contractor for placement of Platform Screen Doors and shall share the location of Emergency Rescue Device (ERD)/Emergency

Access Device (EAD) and parking brake release lever with the Signalling Contractor and also their operating mechanism. The RS Contractor shall also interface with PSD Contractor for synchronization of Train door/PSD opening and closing and for access of PSD Local Control Panel from train operator side.

Rolling Stock, Signalling and PSD Contractors shall exchange the defective/isolated train door and PSD door information so that if a particular train door is defective/isolated, the corresponding PSD shall not open and vice versa. Also, Rolling Stock, Signalling and PSD Contractors shall interface for provision of reclosing the door(s) without opening all doors in case of obstruction detection.

- TD 3.1.24 There shall be 4 separate radio systems for communication between Train and wayside. The system will broadly cater to Train Radio traffic, CBTC traffic, CCTV traffic and Wi-Fi traffic. The details of sharing of the 4 radio systems for sending control and data information, levels and protocols thereof, will be jointly agreed by, Signaling, Telecom, Rolling Stock Contractor and Wi-Fi Contractor. The radio system for Train Radio traffic shall be provided by the Telecommunication Contractor while the radio system for sending CBTC, CCTV and other data pertaining to passenger voice, control, alarm, events etc. shall be provided by the Signaling Contractor including on-board equipment.

The bandwidth allocation on CCTV network shall be dynamically managed. Detailed proposal for the same shall be submitted by Signaling Contractor for Engineer's review and approval.

- TD 3.1.25 Interface plan to address the procedures to be adopted for rescuing the immobile train on line by coupling the failure train with healthy train and clearing the line in Pull/Push mode with healthy train.

- TD3.1.26 Integrated Testing and Commissioning:

The Rolling Stock, Signaling, PSD and Telecommunication Contractors shall perform Integration Test and the tests shall include but not limited to traction and braking control, precision stopping, turn back, jog function, door operation, PSD, train wake up and PA/PIS functioning test, remote command & control for Rolling Stock monitoring & troubleshooting from OCC to train and safety related test etc. All contractors shall jointly produce a protocol document for Integrated Testing and Commissioning.

- TD3.1.27 The Signaling Contractor as a Lead Contractor shall prepare a comprehensive Operating Modes and Principle Document (OMPD). The Rolling Stock Contractor, PSD Contractor and Telecommunication Contractor will assist the Signaling Contractor in preparation of the document. The traction and Tunnel Ventilation Contractors will also assist the Signaling Contractor in preparation of the documents. Employer will provide necessary inputs such as standard operating procedure. The document shall establish the principles related to system and interface design under normal, degraded and emergency modes of operation. For each operating principle, the document shall describe the scenario, action to be taken by operator and system in a structured process flow chart. The additional requirement generated while preparing OMPD document shall be treated as the requirement within the contract without any cost implication.

- TD3.1.28 The Rolling Stock Contractor and Signaling Contractor(s) shall implement automatic 'sleep', 'wake-up', 'testing and dispatch etc. (pertaining to UTO mode of operation)' of trains stabled at depot/siding/main line. Rolling stock will send suitable signal through signaling interface for display of indication and alarm at OCC/SCR/DCC level.

- TD3.1.29 Train Event Recorder shall be provided by the RS Contractor, designed to resist tampering, that monitors and records data on train speed, direction of motion, time, distance, throttle position, brake applications and operations (including service brake, emergency brake) equipped, cab signal aspect(s) etc. Signaling Contractor shall provide the requisite signal to RS for the storage purpose.

- TD3.1.30 In case of resumption of traction supply after failure/otherwise and when number of trains are standing in the section, ATS shall be capable of issuing sequential/staggered power on command and sequential/staggered starting of the train to avoid overloading of the traction supply.

- TD3.1.31 The Signalling Contractor shall provide trigger command for Neutral Section Detection, the requirement for the trigger points/locations shall be shared by Rolling Stock Contractor with Signalling Contractor. In manual mode like Cut out/RM/ROS/ATP modes, Rolling Stock Contractor shall generate a trigger command.



TD3.1.32 The continuous train location information also shall be communicated from Signalling to Rolling Stock.

TD3.2 Rolling Stock Characteristics to be used by Signalling Contractor

TD3.2.1 The signaling system will work on moving block principle and the system shall be so designed to meet the headway requirements of 6-car trains, based on the characteristics of the vehicles to be furnished (Annexure 1/TD) and the track geometry. The back-up (line-side) signaling (in ROS/RM/cut-out mode) shall use the same track circuits/axle counter as designed for the ATP working. RS Contractor shall provide traction and braking characteristics of the actual vehicles and Signalling Contractor must co-ordinate with RS Contractor to fine-tune the system 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. Brake capacity of the Rolling Stock shall be used optimally to ensure its maximum utilization when full brake equipment is operational. In case of isolation of any brake system or bogie/car, Rolling Stock Contractor shall furnish requisite information to Signaling Contractor. However, Guaranteed Emergency Brake Rate (GEBR) shall never be compromised.

TD3.2.2 When operating in ATP Mode, a delay of 2s (programmable) shall be provided for the Train Operator to acknowledge a reduction in speed and begin to apply the brakes.

TD3.2.3 The model for calculating the Safe Braking Distance (SBD) shall identify and take into account various system's response times and Train Operator's reaction times and shall be in accordance with IEEE 1474.1 standard. The design of CBTC system shall also take into account the effect of track geometry on the traction and braking characteristics. The RS Contractor shall furnish the guaranteed braking rate at the normal braking efficiency, including brake deterioration to Signalling Contractor. RS Contractor shall also provide the speed/acceleration curves and speed/tractive effort curves, for all loading conditions.

TD3.2.4 RS Contractor shall furnish as a minimum the Rolling Stock parameters to be used by Signalling Contractor for designing the CBTC system, as set out in the attached Table no. TD.1. RS Contractor shall also furnish a reasonable tolerance band for the identified performance parameters. RS Contractor shall ensure that all the trains supplied perform within the tolerance band.

TD3.2.5 For any other information required by Signalling Contractor, he shall co-ordinate with RS Contractor.

TD3.2.6 The Rolling Stock Contractor and the Signalling Contractor shall share all the interface signals and shall log /record these signals/data by either of them.

TD3.2.7 The Rolling Stock Contractor shall provide optimized energy efficient run curve pattern to Signalling Contractor for incorporation in the ATO/UTO mode of operation. All associated information as requested by Signalling Contractor shall be duly handed over by Rolling Stock Contractor. The efficacy of the finalized run curves shall be jointly demonstrated by means of simulations as well as line trials.

Optimization of energy efficient mode shall consider different TE (Tractive Effort) /BE (Braking Effort) curve for different loads as well. Contractor shall demonstrate optimization of energy with respect to different TE (Tractive Effort) /BE (Braking Effort) curve for different loads.

TD3.3 Signalling and Telecommunication Details to be used by RS Contractor

TD3.3.1 The following data shall be provided:

- (i) The maximum power consumed by Signalling and Telecommunication Contractor's equipment from the 110V DC supply under all specified operating conditions.
- (ii) The number of train wires/ Ethernet connections 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 EMC /EMI requirements including the limiting value of psophometric current, to obviate interference in the operation of telecommunication equipment
- (viii) Details of the provisions required to enable the bidirectional transference of data from the train to the wayside.

TD3.4 ATC and Radio Equipment Cubicles

- TD3.4.1 RS 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 coordinated between Signalling and Telecommunication Contractors and RS Contractor to ensure secure mounting, and access. The cubicle(s) shall be resiliently mounted. For housing of ATC and active Radio equipment, suitable enclosed environment (minimum IP-52) needs to be provided by the RS contractor.
- TD3.4.2 To achieve the ATC control functions, Signalling Contractor shall identify any interfacing circuits specifically required for ATC operation and liaise with RS Contractor. These include but not be limited to start, door control, motoring, coasting, braking and emergency brake commands. Door control circuit design shall allow opening of doors in stand by position of mode selector under manual responsibility in case of non-availability of door opening authorization from ATP without losing the ATP mode.
- TD3.4.3 For train control circuits, Signalling and Telecommunication contractors shall respectively identify the voltage free contacts to be provided by RS Contractor, including the number and type of electrical signals required between the ATP/ATO equipment and the equipment provided by RS Contractor. The contractors shall co-ordinate to agree on levels and protocols for each such signal.
- TD3.4.4 As a minimum, all electronic equipment to be mounted on rolling stock, including those provided by Signalling and Telecommunication contractors shall comply with IEC 60571: Electronic Equipment used on Rail Vehicles, for design, manufacture and testing, and shall use components purchased against an internationally recognised quality assurance and reliability certification procedure.

TD3.5 Antennae

- TD3.5.1 Signaling and Telecommunication 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, as applicable.
- TD3.5.2 Signalling and Telecommunication contractors, for their respective scope, 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.
- TD3.5.3 RS Contractor shall provide the antenna mounting brackets, conduits, support or clamping arrangements to ensure security and reliability.
- TD3.5.4 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.

TD3.6 Speed Measurement Devices

- TD3.6.1 For each ATC equipment set (per driving cab), Signalling contractor shall supply to the RS Contractor for installation, 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 TD3.6.2 below in fail safe manner. The speed measurement devices shall be mounted on the axles which shall be non-powered and brake free axles.
- TD3.6.2 Signalling contractor shall ensure that the speed measurement devices produce a signal which reflects the true speed of the train (within ± 1.0 kmph) under any operational, weather and track conditions including gradient, curvature, wheel spin/slide. The error in the speed measurement due to wear in wheel diameter, up to laid down limits shall be mitigated by automatic means or other safe methods.
- TD3.6.3 Signalling contractor 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. The signaling contractor will supply all the mechanical fixing items like odometer, Antenna, Pick up coil and cables required for ATC like cables for odometer, Antenna, Pick up coil etc.

- TD3.6.4 RS Contractor shall provide for each speed measurement device mounting brackets, support or clamping arrangements to ensure security and reliability.
- TD3.6.5 Signalling contractor shall furnish the zero velocity detection apparatus (ZVR relay).
- TD3.6.6 Signalling contractor shall furnish RS Contractor with full mounting details, apertures, fixing holes, etc.

TD3.7 Train operator's Display

- TD3.7.1 The equipment on driver's console used for UTO/ATO/ATP/RM/ROS modes shall be ergonomically placed.

Indications to the train operator shall be displayed on the ATC Cab Display supplied by Signalling contractor. The train operator's display will be composed of an integrated display screen. 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/UTO failure indications
- (xi) Skip Stop indication
- (xii) Door Open Indication
- (xiii) Maximum Permissible Safe Speed (MSS) in ATP, UTO 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 are mounted
- (xvii) Door release available; indicating on which side(s) of the train the doors may be opened.
- (xviii) Operating Mode

During design stage, RS and Signalling contractors may have to interface to integrate TCMS/DMI inputs, if considered necessary to optimise the driving console in the cab for operation under GoA3/GoA4 keeping in mind that there will be 2 stages of commissioning. Also, Signalling Contractor shall interface with RS Contractor, to provide required inputs, like current speed, target speed, advisory speed, Normal Stopping Point (NSP) distance and mode of the train, as a minimum, to RS HMI for display purposes.

TD3.8 Interface between TCMS and on-board signalling Equipment and OCC

- TD3.8.1 The Rolling Stock Contractor shall provide an on-board Train Control Management System (TCMS), to log the information from the ATP/ATO/UTO and Train Radio equipment supplied by Signalling and Telecommunication contractors respectively, in addition to the information shown in the Rolling Stock specification.

- TD3.8.2 Data stored in the TCMS shall be password protected. Levels and protocols shall be agreed between the Contractors. Software for downloading the data from TCMS to maintenance terminal shall be provided by RS Contractor. Signalling and Telecommunication contractors, as applicable, shall provide Windows compatible software for maintenance terminals for viewing the data logged in TCMS. It shall be possible to extract the data remotely from TCMS to a suitable terminal at OCC.
- TD3.8.3 All the commands by the on-board ATP, UTO and ATO systems to Rolling Stock equipment and the responses of the rolling stock equipment to these commands, shall also be recorded in TCMS.
- TD3.8.4 The signals to be supplied from the TCMS to the equipment of Signalling and Telecommunication contractors shall be decided jointly between the Contractors.
- TD3.8.5 TCMS shall be able to communicate data to OCC/SCR/DCC on the Rolling Stock terminal of ATS system. The data shall contain identified train alarms. Signalling and Telecommunication contractors shall interface to make the data available to its destination in OCC/SCR/DCC.
- TD3.8.6 The interface shall ensure that TCMS receives necessary inputs from the on-board ATP system to enable TCMS to synchronize its clock with the system master clock. All the microprocessor/ micro-controller based on-train systems shall synchronize respective clocks with TCMS clock.
- TD3.8.7 Deleted.

TD3.9 Power Supply and Earthing Arrangements

- TD3.9.1 Independent 110V DC power supply circuits, including positive and negative poles, at least three for ATC and one for Train Radio Equipment shall be provided by RS Contractor and there shall be no physical or electrical links between these power supply circuits.
- TD3.9.2 RS Contractor shall provide dedicated earthing arrangements for the train borne ATC and radio equipment. Signalling and Telecommunication contractors shall specify the earth impedance required.
- TD3.9.3 The power supply cable between the train power supply and the ATC and radio train borne equipment shall be segregated, as short as possible and directly connected to the supply without any intermediate connection.

TD3.10 Telecommunications

- TD3.10.1 Telecommunication contractor shall furnish RS Contractor with the interface required between the train radio system and the on-train public address system to allow on-board announcements to be made from the OCC. The interface shall provide the necessary means to enable OCC to initiate triggering of pre-recorded messages in the on-train public address system.
- TD3.10.2 The complete on-train public address system, and interface hardware, including the transmission link, and a communication panel shall be furnished by RS Contractor. Levels and protocols shall be agreed between the two contractors.
- TD3.10.3 RS Contractor shall provide Train ID to train radio through TCMS-Train Radio interface.
- TD3.10.4 Telecommunication contractor shall furnish RS Contractor with the interface required between the train radio system and the TCMS for recording the initiation, termination, and success or failure of emergency calls initiated by the train operator and/or OCC on the radio. The hardware interface shall be furnished and installed by RS Contractor. Levels and protocols shall be agreed between the two contractors.
- TD 3.10.4.1 There shall be a provision of roving attendant to make the passenger announcement through his/her mobile handset (Tetra) inside a particular train through train radio network using radio identification number. The interface between train radio and on board communication (PA/PIS) system shall be done by rolling stock and telecommunication contractor.
- TD3.10.5 Telecommunication contractor and Rolling stock contractor shall interface for initiation, termination and success or failure of emergency calls initiated by passengers to OCC. The initiation of this passenger call shall automatically focus a CCTV camera on the passenger



and raise a prompt on a suitable terminal of OCC/BCC. The hardware interface shall be furnished and installed by RS Contractor.

TD3.11 Factory Installation and Testing

- TD3.11.1 All the special equipment associated with the train borne ATC and radio system, including the interface cables / wires between the train borne ATC and Train Radio shall be designed and supplied by Signalling and Telecommunication contractors, as applicable, to RS Contractor's factory. Each contractor shall be aware of the locations of manufacturing plants, which could concurrently be manufacturing cars.
- TD3.11.2 Signalling and Telecommunication contractors shall be responsible for providing all data and training of RS Contractor's staff in all aspects of ATC and train radio installation and testing wherever applicable. The first set of ATC equipment and also Train Radio equipment shall be installed by RS Contractor, under the supervision of Signalling and Telecommunication contractors' representatives, including the wiring for the interface of the ATC equipment with Rolling Stock.
- TD3.11.3 RS Contractor shall be responsible for installing wiring and equipment and it's testing on each car to the functioning standard agreed with Signalling and Telecommunication contractors.
- TD3.11.4 Testing of each car shall comply with the accepted international standards agreed between the contractors as agreed with the Engineer. Initial integration tests (static) shall be done at the rolling stock factory and carried out by the test personnel of respective contractors jointly. Further main line integration tests (static and dynamic) 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 RS, Signalling and Telecommunication contractors at site in Mumbai. The test certificate subsequently shall be issued jointly by RS, Signalling and Telecommunication contractors. The certificates will pertain to the respective areas of the contractor's responsibility and shall be decided during the interface.
- TD3.11.5 RS Contractor shall provide facilities for comprehensive static and interface tests between the Rolling Stock, Signalling and Telecommunications systems at his premises. Signalling and Telecommunication contractors shall be responsible for the provision of special test equipment and instrumentation.
- TD3.11.6 In case of UTO & ATO, the Integration test between RS and Signalling contractors shall include tests on mainline to confirm the realisation of demanded acceleration and deceleration rate by the UTO/ATO under various conditions.
- TD3.11.7 Should the need arise for modifications in the configurations of respective equipment or systems as a result of Integration Test or otherwise, the scope of work and division of responsibility shall be jointly agreed amongst the contractors and detailed procedure shall be developed. RS Contractor shall provide the requisite manpower to monitor and/or implement the modifications on the rolling stock for work involving scope as identified in clause TD3.11.3 above.
- TD3.11.8 The rolling stock contractor and signaling contractor(s) shall fully associate and render all necessary support during type testing of the respective systems. Rolling stock type tests may require "All-Out" mode of operation in GoA4 as per approved test specifications, the rolling stock contractor & signaling contractor(s) will jointly finalize such test plan and schemes/operational modes and ensure the satisfactory completion of type tests.

TD3.12 EMC/EMI Interface

- TD3.12.1 Regarding electromagnetic interference, Signalling contractors shall provide a list of frequencies and other sensitive requirements to the RS Contractor, to enable RS Contractor to avoid such frequency bands in design, and to provide devices to isolate the source of emission wherever required. The Signaling Contractor will have first right of use for radio frequency 2.4GHz/5.8 GHz for CBTC application.
- TD3.12.2 RS, Signalling and Telecommunication Contractors shall ensure that the emission and immunity level of their respective equipment meet the requirements of EN50121-3-1 & EN50121-3-2.
- TD3.12.3 RS Contractor shall ensure that the return current in the track at the specified frequencies does not exceed the value specified by Signalling Contractor.

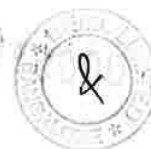
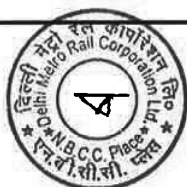
- TD3.12.4 The Contractors shall also jointly develop a test plan for verification of electromagnetic compatibility of traction and signalling and also telecommunications systems. The contractors shall work together to assure that all electronic and electrical equipment on the rolling stock works properly without interfering with signalling, or telecommunications sub-systems.
- TD3.12.5 The cable layout of the signalling and communication system in the cable ducts provided by RS Contractor shall be jointly agreed. The separation between signalling and communications cables and power cables of 25kV, 415 V three phase AC, 230 V AC single phase, 110 V DC rating shall be in accordance with accepted international practice and jointly agreed.
- TD3.12.6 The cable ducts shall be earthed at notionally at every 2 m and also at the ends and shall be in accordance with accepted international practices.

TD4. INTERFACE- Division of Responsibility

- TD4.1.1 RS Contractor shall coordinate with Signalling and Telecommunication Contractors in order to achieve the functional and operational requirements of the system. The roles and activities of the Contractors shall broadly include minimum but not limited to those mentioned in table TD.1 below.

Table TD.1 Division of Responsibility

Item	Signalling	Telecommunication	Rolling Stock
1. On board VATC equipment 2. Deleted 3. Antennae for ATP, ATS and TWC 4. Speed measuring sensors and speedometer for non-ATC mode. 5. ATC Cab Displays (Train operators MMI). including special cables etc.	To supply the equipment to the Rolling Stock Contractor's Works		To provide space in the vehicle design for fixing and installation at the manufacturer's facility, by the Rolling Stock Contractor, under the supervision of the Signalling and Train Control Contractor. The speed measuring sensor and odometer for non-ATC mode will be provided by Rolling Stock Contractor.
6. On board radio equipment 7. Antennae for CBTC, CCTV & train radio including special cables etc. 8. Train lines/Ethernet connection	To supply the equipment to the Rolling Stock Contractor's Works. Furnish the requirement	To supply the equipment to the Rolling Stock Contractor's Works	To provide space in the vehicle design for fixing and installation at the manufacturer's facility, by the Rolling Stock Contractor, under the supervision of the Signalling and Train Control and Telecommunication Contractor. To provide train lines/Ethernet Connection as per signalling requirement.
9. Power supply and earthing for on board ATP/ATO/UTO and train radio equipment.	Furnish required voltage values and earthing requirements to Rolling Stock Contractor for respective scope.		To provide the required voltages and earthing



10. Logging of on-board information from ATP/ATO/UTO	Signalling and Train Control Contractor to co-ordinate with Rolling Stock Contractor for signal levels and protocols.		Provide the on board data logger TCMS. All to and fro signals shall be logged in TCMS.
11. Interface between ATP/ATO/UTO with train braking and propulsion systems for automatic braking, acceleration and deceleration.	ZVR & redundant EBR relays to be supplied by the Signalling and Train Control Contractor		Rolling Stock Contractor shall co-ordinate with the Signalling and Train Control Contractor to agree on levels and protocols for interface signals. There shall be no delay in braking from RS during the transition from ED to friction brake at slow speed.
12 System master clock	Signalling and Train Control Contractor to provide necessary inputs.		Rolling Stock Contractor to synchronize TCMS clock with the system master clock. All sub-systems clock in RS shall be synchronised with the TCMS clock.
13. On board next station information to the passengers	Shall provide necessary signals on-board to Rolling Stock Contractor.		Shall provide for necessary hardware interface, display for on-board P.A. system inside the cars.
14. On board announcement from OCC including triggering of pre-recorded messages.		Shall provide necessary signals on-board to Rolling Stock Contractor	
15 Climatic requirements for on board ATP/ATO/UTO and radio cab equipment.	Signalling and Train Control Contractor to specify at an early date, the total heat load wattage, and maximum permitted temperature		Rolling Stock Contractor to provide Cab Air Conditioning installation to maintain a nominal temperature of 25°C. Suitable ventilation shall be provided by the contractor for the backside area of the console. Rolling Stock Contractor to provide conditioning air from the saloon to all relevant signal & telecom installations to maintain a nominal temperature of 25°C. Conditioned air ventilation shall be provided by the Contractor for the console.
16 Climatic requirements for on board Train Radio cab equipment.		Telecommunication s Contractor to specify at an early date, the total heat load wattage, and maximum permitted temperature	
17. EMI/EMC interface between the Rolling Stock and Signalling and Train Control, and Telecommunications.	Signalling and Train Control, and Telecommunications Contractors shall advise EMI/EMC plan for ATP/ATO & radio equipment to Rolling Stock Contractor at early date.		Rolling Stock Contractor shall ensure the compliance of the requirements of Signalling and Train Control, and Telecommunications Contractors for on board ATP/ATO and radio equipment.



18. Train Integrity Information		Train integrity information will be provided by Rolling Stock to ATC onboard.
19. Data transmission methodology for control command	Signalling Contractor to interface with Rolling Stock Contractor for selection of best suited methodology i.e. bit by bit, code(1 byte) or any other.	Rolling Stock Contractor to provide details for VATC to TCMS communication.
20. The polling cycle and delay times assessment between OCC and onboard VATC/CCTV	The Signalling Contractor shall assess and furnish to Rolling Stock Contractor the polling cycle time, data transmission time(rate) between OCC and onboard VATC/CCTV under best and worst case scenarios for both CBTC and CCTV networks.	The Rolling Stock Contractor to provide TCMS to VATC/CCTV interface requirements to Signalling Contractor to comply with functionality as specified in the Rolling Stock contract.
21. Deleted		
22. Standalone door operation	Signaling to give standalone door operation command to allow driver/cleaning staff to enter/exit the train from designated door in designated Depot area/Main line siding.	Rolling Stock Contractor shall give the necessary support to the Signalling contractor.
23. Ground based hot axle box detection for monitoring of axle box temperature	The Telecom Contractor shall provide Ethernet channel from station TER (Telecom Equipment Room) to CER (Central Equipment Room) of OCC.	The ground equipment shall be provided by RS Contractor or third party. The server/work station/terminal with suitable application software and interface equipment if any in OCC shall be provided by Rolling Stock Contractor.
24. Graphical User Interface (GUI) for RS controller	Signalling contractor shall be responsible for providing necessary support during interface finalization to the RS contractor	Rolling Stock Contractor shall be responsible for development of the GUI (including hardware) for the RS controller (RSC) in the OCC. Any other GUI(s) in OCC/BCC shall not be the scope of RS contractor.



25. Guaranteed Emergency Brake Rate(GEBR)		Rolling Stock Contractor shall furnish value of GEBR to Signalling Contractor.
26. Emergency Brake application validation at low speed (≤ 25 kmph) as a part of wake up procedure	Signalling Contractor shall validate the EB Test based on details furnished by RS Contractor.	RS Contractor shall furnish the pass/fail criteria based on the speed achieved and gradient of the track to the Signalling Contractor.
27. Live streaming from TCMS to OCC/BCC and Live transmission of advertisements from OCC/BCC to train via CCTV network.	Signalling Contractor shall provide suitable buffering arrangement for live video streaming transmitted from the train to the OCC/BCC via CCTV network and for its onward multicast transmission to other terminals/networks.	RS Contractor shall provide - <ul style="list-style-type: none"> • Suitable Buffering arrangement on the train for live video streaming. • Live video players with buffering capability. • Advertisement and Live video players in hot standby per train. • Redundant suitable arrangement (video controller/player/server s) in OCC/BCC for transmission of live video contents and stored video contents to be played in the train.
28. Signals for neutral section	Will protect the entry of train in neutral section in ATP/ATO mode. Also, will provide necessary signal to TCMS for Panto management around Neutral Section.	In case, signal for Panto management fails, the RS Contractor will ensure that the information about neutral section is available on TCMS.

29.Platform Screen Doors	Signalling and PSD Contractor shall exchange the defective/isolated train door and PSD door information with RS Contractor.	<ul style="list-style-type: none"> • Rolling Stock contractor shall provide KE and door drawings of train to PSD contractor for placement of Platform Screen Doors. • Shall share location of ERD/EAD and parking brake release lever along with their operating mechanism with Signalling Contractor. • Shall interface with PSD Contractor for synchronization of train door/PSD opening and closing. • Shall exchange the defective/isolated train door information with Signalling and PSD Contractor. • Shall interface with Signalling and PSD Contractors for provision of reclosing the door(s) without opening all doors in case of obstruction detection.
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Annexure 1/TD: Rolling Stock Characteristics

Table TDA1.1 : Rolling Stock Characteristics

Train composition	DM-T-M-M-T-DM
Minimum Design Average Acceleration rate for fully loaded (AW3) train on level tangent track shall be as under: 0 kmph to 40 kmph 0 to 60Kmph 0 to 80Kmph	1.0 m/s ² 0.75 m/s ² 0.40 m/s ²
Minimum Operational Average Acceleration rate for AW2 loaded train on level tangent track shall be as under: 0 kmph to 35 kmph 0 to 60Kmph 0 to 80Kmph	1.20 m/s ² 0.80 m/s ² 0.45 m/s ²
Average Service braking rate from 80kmph to standstill for fully loaded (AW3) train on level tangent track	1.0 m/s ²
Average Service braking rate from 80kmph to standstill for AW2 train on level tangent track	1.1 m/s ²
Average Emergency braking rate from 80kmph to 0 kmph for fully loaded train on level tangent track	1.3 m/s ²
Jerk rate (Maximum) [#]	0.75 m/s ³
The Emergency braking distance of 6- car train set with all bogie working under fully loaded condition	245m
*Service Brake Response Time	2.0s
*Emergency Brake Response Time	1.5s max
*Service and Emergency Brake Release Time	2.5s
Resistance to motion (formula, curve, starting resistance)	TR = 21.96 + 0.4222V + 0.00876V ² N/t for Underground Section. TR = 14.01 + 0.264V + 0.00191V ² N/t for Elevated/At grade Section. (V in kmph)
Maximum wheel diameter	860mm
Minimum wheel diameter	780mm
Safe train speed	90 kmph
Door opening and closing times	Open 2.5 s (Max.) Close 3.5 s (Max.)
Tare weight of a unit	126T for 3-car unit with weight of any car not exceeding 42T.
No of axles per Car	4
Presence of non service brake and non powered axles	All DM & M axles are powered while axles of T cars are non-powered. All axles are equipped with friction brake mechanism.
Maximum Axle Load	17 tonne
Train length – 6 Car Train	136m approximately
Maximum Length over couplers for all cars	23000 mm
Maximum Length over Body(including end-fairings)	22,010mm
Maximum Width over Body	3,200 mm
Maximum Vehicle Overhang	3630 ± 175 mm

Note :

- 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.
- For the items marked *, the maximum timings are for a brake application from initiation of brake application command from BECU to 90% of full Brake Cylinder Pressure (BCP) and for brake

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release from initiation of brake release command from BECU to 10% of BCP.

3. For the item marked #, the Rolling Stock Contractor as well as Signalling Contractor shall comply EN 13452-1 or equivalent international standards for jerk determination and methodology shall be finalized during design stage with the approval of Engineer.



APPENDIX TE. DRAWINGS AND DOCUMENTS**TE1 General**

TE1.1 The list of drawings and documents is furnished in table TE.1.

Table TE.1 List of Drawings

S. No.	Description	Drawing / Document reference
1*	Kinematic Envelopes(6 no. drawings)	Attached in Part-II :Section 6D
2	General Alignment drawings:	
(i)	General Alignment drawings Dahisar East to Mandala	Attached in Part-II (In Compact Disk)
(ii)	General Alignment drawings Dahisar East to Andheri East	Attached in Part-II (In Compact Disk)
3	Proccedure for Safety Certification and Technical Clearance of Metro Systems	Attached in Part-II :Section 6E
4	Guidelines for Noise and Vibrations for Metro Rail Transit Systems	Attached in Part-II :Section 6F
5	The Metro Railways General Rules	Attached in Part-II :Section 6G

TE1.2 Documents and drawings marked * are enclosed within the Employer's Requirements: Technical Specification.

TE1.3 In case speed restrictions are not mentioned in the General Alignment Drawings, Bidders may refer Appendix-1 of SOD: Permissible Speed, Cant and Minimum Track Spacing on Curves.

APPENDIX TF. SUBMITTALS**TF1 General**

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

Table TF.1.1 Submittals by Tenderer

S. No.	Description	ERTS Clause Reference
Chapter 2		
1.	Expected MDBCf of Major Systems	2.8.2 (xi)
2.	Specific exceptions for LRU's, whose replacement is not achievable in 30 minutes	2.12.9
3.	Expected MTTR for Major Systems as listed in Table 2.3 of ERTS.	2.12.10
Chapter 3		
1.	Designs along with Technical Data based on specification, sound proven and reliable engineering practices	3.2.1
2.	Confirmation of provenness of equipment / sub-system / system and exceptions thereof	3.2.2
3.	Confirmation of provenness of propulsion equipment	3.2.3
4.	Confirmation of Kinematic Envelope	3.20.3
5.	Cars Conform to the Latest version of SOD	3.20.6
6.	Train Resistance and guaranteed performance	3.21.5
7.	Performance Characteristics	3.22
Chapter 4		
1.	Details on technique of joining modular elements of shell	4.1.1
2.	Details of Manufacturing process	4.4.5
3.	Proposal on structural arrangement	4.8.5
4.	Predicted values towards cash worthiness of cars	4.8.6
5.	Means of uncoupling a semi-permanent coupler	4.15.1
Chapter 5		
1.	Details on provenness of bogie along with performance certificates from end user	5.1.1
2.	Detailed comprehensive proposal on the Brake system along with the proof of provenness.	5.12.1
Chapter 6		
1.	Brief description of the proposed brake system along with the expected life of brake pads.	6.13.13
Chapter 7		
1.	Time required to replace, adjust and test a door leaf	7.2.1 (xv)
2.	Proposed design for sealing of the guides	7.2.1 (xii)
3.	Details of locking device for door leaves	7.2.4.3 (i)
Chapter 8		
1.	Mounting details of transformer	8.7.5
Chapter 10		
1.	The proposed standards on Data protocols	10.1.9
Chapter 11		
1.	Specific measures taken to minimise energy consumption for HVAC	11.1.7
Chapter 14		
1.	Details on latest internationally accepted practice for Soldering of electronic components	14.15.3



Table TF.1.2 Submittals by Contractor

S. No.	Description	ERTS Clause Reference
Chapter 2		
1.	CV of Interface Manager	2.2.8
2.	Quality Assurance Plan	2.3.1
3.	Safety Assurance Plan	2.4.1
4.	Hazard Analysis	2.5.3
5.	Fire Safety Design Report	2.5.8
6.	Reliability, Availability and Maintainability Plan	2.7.3
7.	Reliability Model	2.7.6
8.	Reliability Apportionment and Prediction Report	2.7.8
9.	Pattern Failure Targets	2.8.1 (iv)
10.	EMC Control Plan	2.15.1
11.	Noise and Vibration Assurance plan	2.18.2 (i)
Chapter 3		
1.	List items for Engineer's approval of vendors	3.2.5
2.	IMP and detailed interface documents	3.6.1
3.	Copies of the applicable standards along with design documents	3.7.1
4.	Design Review Schedule	3.8.2
5.	Static vehicle profile of the proposed cars to suit the Kinematic Envelope	3.20.2
6.	Detailed calculations showing lateral and vertical shifts due to each factor indicated in clause 3.20.1	3.20.3
7.	Detailed calculation for minimum clearance between the carbody exterior and platform edge as per clause 3.20.5	3.20.5
8.	Declared value of Specific Energy Consumption (SEC)	3.24
Chapter 4		
1.	Calculations of Carbody's Camber	4.6.4
2.	Fatigue life assessment of Carbody structure	4.6.6
3.	Proposal for Roof and Roof-mounted equipment	4.16.1
4.	Calculations related to Obstacle Detection Device	4.18.2
Chapter 5		
1.	Calculations supporting selection of axles & bearings	5.1.3
2.	Calculation of Derailment Quotient (Y/Q)	5.2.5
3.	Proposal for vehicle dynamic analysis & it's model	5.2.7
4.	Calculations for Bogie Frame strength	5.3.2
5.	Corrosion Protection Plan for Bogie Frame	5.3.6
6.	Proposal for primary suspension system of proven helical coil steel springs	5.4.1
7.	Calculations of proposed secondary suspension	5.4.2
8.	Safety Factor used for Bogie-Body connection	5.5.2
9.	Detailed Calculation of Natural Frequency of motor suspension system	5.9.3
10.	Test procedure for gearbox	5.10.4
11.	Ultrasonic Testing for powered and non-powered axles	5.15.5
Chapter 6		
1.	Calculations of Compressor's capacity to meet worst condition	6.2.2
2.	Letters from actual users indicating experience with compressors on their system	6.2.4
3.	Technical details of proposed Air Dryer	6.4.4
4.	Calculations for reservoir's size	6.5.1

5.	Detailed plan for pneumatic circuit isolation arrangement	6.7.11
6.	Brake Calculations & EBD under dry & wet conditions.	6.13.14
7.	Certificates for SIL levels of Brake System	6.13.20
8.	Proposal for Brake blending logic	6.14.2
9.	Brake effort vs. Speed Characteristics	6.14.5
10.	Guaranteed maximum Braking distance and guaranteed deceleration rate	6.16.9 & 6.16.10
11.	Brake control interface with VCC	6.17.2
12.	Brake operating Timing Diagram	6.19.1
13.	Details for WSP scheme & equipment	6.22.2
14.	Exhaustive documentation & animations on complete pneumatic system	6.24
Chapter 7		
1.	Door control system test procedure	7.2.1(v)
2.	Details of microprocessor based DCU	7.2.1(xvi)
3.	Documentation for flow charts, Signal flows and interpretation of signal etc.	7.2.1(xvii)
4.	Relevant SIL Certificates for Door system	7.2.1(xxii)
5.	Comprehensive proposal for door mechanisms	7.2.2(iv)
6.	Door control push button details and schematic	7.2.4.4 (ii)
7.	All details of other metros for proposed design of Front end emergency door	7.3.2
8.	Detailed proposals of operation of detrainment doors	7.3.7(iv)
9.	Detailed evacuation plan	7.3.9
Chapter 8		
1.	Complete roof layout along with clearance between roof equipment	8.1.6
2.	Expected frequency for replacement of Panto strip in terms of kilometers earned by car	8.2.7
3.	Supporting calculations for width & profile of pantograph and wind tunnel test results	8.2.8
4.	Declaration of vendors for transformer sub-assemblies and undertaking and commitment from vendors for direct procurement in future	8.7.9
5.	Test report & design life of gasket & sealant	8.7.14
6.	Details for roof end and transformer end terminations	8.8.1
7.	Design calculations for power converter-inverter	8.9.7
8.	Quality specifications of regenerated energy including harmonic analysis, detailed documentation on interlacing strategy and harmonic reduction measures	8.9.11
9.	Detailed report on minimum substation capacity based on operational requirements	8.9.18
10.	Detailed document for by pass ground switch used in CI box	8.9.20
11.	Detailed document for 24VDC LED based lighting arrangement in CI box	8.9.21
12.	Calculation for choice of bearings of Traction Motor	8.10.7
13.	Power Ramping Characteristics for Neutral Section Detector	8.11.2
Chapter 9		
1.	Detailed document for additional by pass ground switch in SIV Box	9.2.13
2.	Detailed document for 24V DC LED based lighting arrangement for SIV box	9.2.15
3.	Design calculation for sizing of Battery	9.4.5
4.	FEM and fatigue report of battery box	9.5.5
Chapter 10		
1.	Comprehensive list of capabilities of TCMS	10.1.1



2.	Basic architecture & hardware of TCMS	10.1.2
3.	Details of all UTO specific design functionalities	10.1.6
4.	TCMS configuration details	10.1.8
5.	Switchover and recovery times of redundant processors	10.2.5
6.	Failure redundancy matrix for TCMS	10.2.6
7.	Detailed proposal for spare capacity of TCMS components	10.2.7
8.	Proposal for labelling of TCMS interconnections, cabling & terminals.	10.2.11
9.	Verification report to ensure maximum CPU loading	10.2.12
10.	Details of network integrated systems	10.3.1
11.	Details of communication protocols	10.3.3
12.	Detailed clock synchronisation protocol	10.3.5
13.	Technical details of TCMS control system	10.4.3
14.	List of functions /features proposed to be controlled through TCMS	10.4.5
15.	Detailed scheme for protective controls	10.4.6
16.	Details of TCMS self –diagnostic tests	10.6.1
17.	Proposed scheme for fault diagnostic	10.7.1
18.	Details of failure management actions	10.7.3
19.	Detailed proposal for auto-upgradation of frequent faults	10.7.6
20.	Graphics and animation for operator mode of TSD	10.8.3
21.	Naming convention for all different data file types	10.10.7
22.	Detailed arrangement at test points for measurement of energy consumption	10.12.3
23.	Detailed information of the TCMS-OCC interface as implemented in at least two recently executed UTO projects.	10.13.3
Chapter 11		
1.	Measures to prevent unloading of HVAC units under train stoppage conditions due to high condenser temperature.	11.1.3
2.	Estimated weight, power requirements & heat load calculations for the parameters of HVAC	11.1.7
3.	Calculations for inside conditions with one HVAC unit out of operation	11.2.5
4.	Proposal for HVAC air discharge velocities	11.2.6(i)
5.	Proposal for temperature distribution	11.2.6(ii)
6.	EER for offered system for HVAC, record of proven system in any metro with specified COP, expected power consumption of HVAC per car for peak summer, monsoon and winter for AW0, AW1, AW2 and AW3 passenger loads	11.2.14
7.	Declaration of weight of complete roof mounted unit	11.4.3
8.	Proposal for earth fault protection of HVAC	11.13
Chapter 12		
1.	List of control equipment and manufacturers	12.4.1
2.	Specification, voltage grade size and type of cable for different applications	12.5.6
3.	List of indicators including function, control & display	12.6.2
4.	Detailed protections scheme	12.7.1
5.	Earth Fault Detection System	12.7.5
6.	Design of heat dissipation arrangement with simulated results for interior illumination system	12.9(4)
7.	Complete light and energy simulation calculations	12.9(6)
8.	Details of control logic to maximize utilization of the natural light and maintain desired illumination level	12.9.1(vii)
9.	Service life of LED lamp	12.9.1(viii)
10.	Layout of fittings and control circuit	12.9.1(ix)

11.	Details of the system configuration and components for windscreen wiper	12.10.5(iii)
12.	Technical details of horns	12.10.6
Chapter 13		
1.	Full details for announcement in train by roving attendant with the provision of communication with OCC.	13.2.4
2.	Details of speaker/mic panel provided for PEA	13.3.9
3.	Full details of integrated main communication panel	13.4.1
4.	Details of microphone	13.4.3
5.	Full details of power amplifiers required for PA system	13.4.6
6.	Full details of saloon loudspeakers along with simulation	13.4.7
7.	Full details of software/hardware configurator	13.4.8
8.	Full details of outside speaker	13.4.11
9.	Fire and smoke compliance for complete PA/PIS and PSSS	13.4.13
10.	Procedure and full details for cab to cab communication	13.5.4
11.	Full details for AVAS	13.6
12.	Details of available size of display for PIS	13.7.1(i)
13.	Proposal for destination indicator	13.7.1(ii)
14.	Details of size, location of destination indicator, external side indicator and train no. indicator	13.7.1 (ix)
15.	Details of programmable split screens of PIS and DRM display	13.7.2
16.	Full details for planned and unplanned skip station functionality	13.8.1(iv)
17.	Full details for Wi-Fi internet facility in train	13.11.4
Chapter 14		
1.	Details of all preparatory and post welding procedures for spot welding	14.3.4
2.	Fault discriminating characteristics	14.10.3
3.	Earthing scheme	14.10.7
4.	Apparatus coding and cable & wire designations	14.11.2
5.	Voltage and/or waveform expected at each critical test point of PCBs	14.12.6(i)
6.	Instructions for carrying out testing and troubleshooting and the function of each circuit block of PCBs	14.12.6(ii)
7.	Component layouts of PCBs and assemblies	14.12.6(iii)
8.	Connection or interfacing diagrams for the PCBs and assemblies	14.12.6(iv)
9.	Software quality plan	14.14.3
10.	PCB and connectors: Detailed maintenance and troubleshooting procedures	14.15.6
11.	Technical particulars of lubricants	14.8.1
Chapter 15		
1.	Set of inspection hold points in inspection, testing and commissioning plan	15.3.1
2.	Detailed test procedures for each of the equipment, subsystems, system	15.4.1
3.	Test reports for each identified test	15.4.5
4.	Test and test procedures for integrated testing and commissioning	15.6.2
5.	Service trial procedure	15.7.3
6.	Statement confirming safety and readiness of Rolling Stock	15.7.8
7.	Proposal for combination of test of individual items with system test	15.16.1
8.	Detailed test procedure of instrumented tests carried out at train level both at tare and loaded conditions	15.16.2
9.	Test procedure for TCMS type test	15.20.1



10.	Test procedure, data & results for Noise & Vibration test	15.25.1
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TF1.2 The Tenderers shall include the above information / documents in their bid, as a minimum. Notwithstanding the above, the Tenderers/Contractors shall submit all the required documents / information as specified in various clauses even if the same do not figure in above mentioned table.

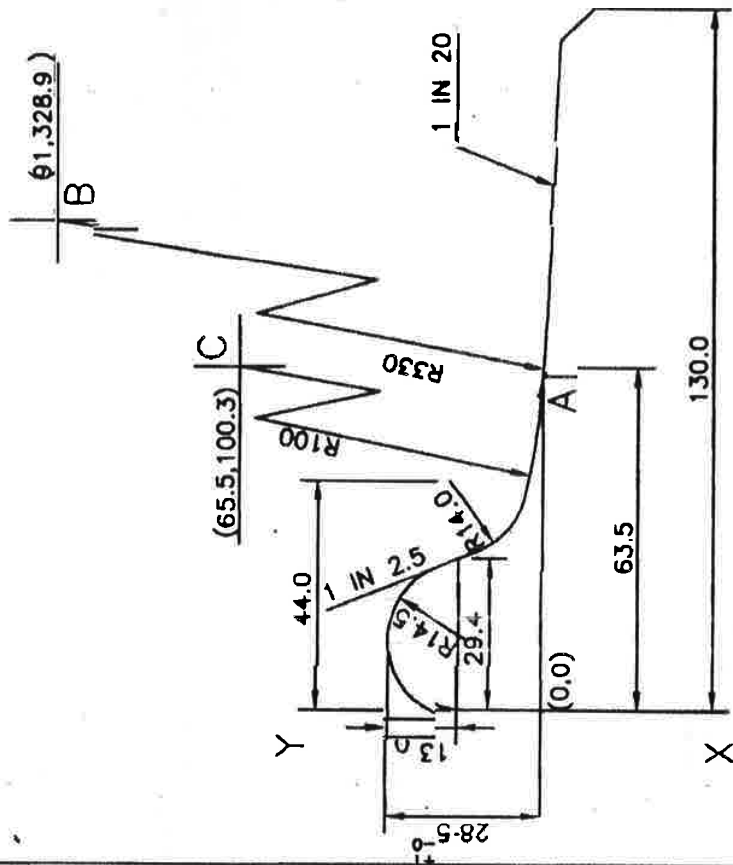
Appendix-TG Train Withdrawal Scenarios for 6-car Trains

S. No.	System name	Withdrawal Condition
1	Windscreen Wiper and Washer System	- Rainy weather, defective wiper in any cab.
2	Front window	- Broken/cracked front window in the cab - Breakage due to stone throwing / vandalism shall not be on contractor's account.
3	Couplers (any type)	- Any defect.
4	Suspension	- Any defect in primary / secondary suspension resulting in passenger safety, comfort or performance.
5	Wheel	- If wheel flat is > 40 mm or as finalised in design. - Any abnormal hammering as reported by the TO.
6	Pantograph	- Isolation of any pantograph
7	Transformer	- Isolation of any one main transformer.
8	Battery charger	- Battery Charger of one unit isolated.
9	Mechanical drive system	- Any defect resulting in high temperature / isolation - Abnormal Noise from underframe.
10	Traction Motors	- Isolation of more than 4 motors.
11	Traction converters	- As per the consequential effect as defined in Item 10 above.
12	Main compressor unit	- Main Compressor Unit of one unit (3-car) isolated.
13	Air leakage	- Any leakage which necessitate continuous running of compressor. - Any leakages which may lead to incorrect brake application. - Any leakages from brake valves, pantograph, circuit breaker.
14	Auxiliary converter-inverter	- Auxiliary Converter-Inverter unit(s) on one unit (3-car) is isolated.
15	Brake system (mechanical)	- If isolation of an additional bogie (mechanical) leads to speed restriction.
16	Exterior lights	- Failure of any head light / marker light.
17	Driver's desk	- If master controller prevents the train from moving. - Any defect in master controller even if no delays are reported. - Any defective cab switch leading to unsafe operation.



PROCEDURE OF DRAWING:-

1. DRAW A VERTICAL LINE X-Y.
2. DRAW SEMI-CIRCLE OF 14.5R TANGENTIAL TO LINE X-Y.
3. DRAW LINE 1:2.5 TANGENTIALLY TO 14.5R SEMI-CIRCLE.
4. DRAW A HORIZONTAL LINE AT 28.5mm FROM THE TOP OF THE FLANGE. AND LOCATE PT. 'A' AT 63.5mm FROM THE LINE X-Y.
5. FROM PT. A LOCATE CENTRE 'B' OF ARC OF 330 ON A VERTICAL LINE AT 91mm FROM X-Y.
6. DRAW ARC OF 330R FROM CENTRE 'B' LOCATE CENTRE 'C' ON VERTICAL LINE AT A HORIZONTAL DISTANCE OF 65.5mm FROM THE LINE X-Y SUCH THAT BC= (330-100) ie 230mm.
7. DRAW ARC OF 100R WITH CENTRE AS 'C'.
8. DRAW ARC OF RADIUS 14mm TANGENTIALLY TO 100R ARC AND LINE 1:2.5.
9. DRAW LINE 1:20 TANGENTIALLY TO 330R ARC.
10. DRAW A VERTICAL LINE AT A DISTANCE OF 130mm FROM THE FLANGE END.



NOTE:

CO-ORDINATES OF POINTS B & C ARE BASED ON NOMINAL DIMENSION OF 28.5mm.

SUPERSEDED BY:

SUPERSEDES:

SCALE 1:1

1:1

C

D G.V. RAMAN

T

U.S.

WORN WHEEL PROFILE

SKETCH-91146

SS/24/04	DIMENSION	73.7 DELETED	9/04
③	J.S.	CO-ORDINATES OF POINTS B & C	3/94
②	CO-ORDINATES OF POINTS B & C	3/92	3/92
①	CO-ORDINATES OF POINTS B & C	3/92	3/92
ALT. AUTH.	DESCRIPTION	DATE	

GROUP

XXX

R.D.S.O.

(C)

B.G.

