



सत्यमेव जयते

भारत सरकार (GOVERNMENT OF INDIA)  
रेल मंत्रालय (MINISTRY OF RAILWAYS)

**Functional Requirements Specification  
of  
End-of-Train Telemetry (EoTT) System  
for Indian Railways**

FRS No. RDSO/2019/EL/FRS/0025 Rev. '0'

Issued on: 25.6.2019



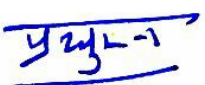
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**ELECTRICAL DIRECTORATE  
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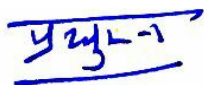
### STATUS OF REVISION

S. N.	Date of Revision	Page No.	Revision	Reasons for Revision
1.	-	All	0	First Issue

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## Chapter 1

### GENERAL



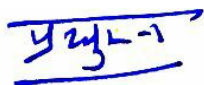
#### 1.1 Introduction:

- 1.1.1 Railway Board vide it's letter number 2018/Elect(Dev)/181/4 dated 20.8.2018 had advised RDSO to finalise the specification of End of Train Telemetry (EoTT) project.
- 1.1.2 As the EoTT is presently not in use over Indian Railways, this Functional Requirement Specification (FRS) is made to develop EoTT for Indian Railways.
- 1.1.3 This FRS covers constructional features, technical requirements and testing procedure for EoTT for Indian Railways.
- 1.1.4 Final Specification for EoTT will be issued based on the experience gained with the EoTT developed as per this FRS.

#### 1.2 Definition of terms:

The following terms and abbreviations are used throughout the Specification.

AAR	-	The Association of American Railroads
AB	-	Air Brake
ALP	-	Assistant Loco Pilot
AMC	-	Annual Maintenance Contract
APN	-	Access Point Name
API	-	Application Program Interface
BP	-	Brake pipe
CLW	-	Chittaranjan Locomotive Works, Chittaranjan
CU	-	Cab Unit. It is another name used for Head of Train (HoT) unit.
DFCC	-	Dedicated Freight Corridor Corporation of India Limited
DPWCS	-	Distributed Power Wireless control System
DLW	-	Diesel Locomotive Works, Varanasi
DTWL	-	Disabled Train Warning Light
DU	-	Display Unit. It is part of HoT device that is fitted in the locomotive. One display unit will be provided in each cab of the locomotive. Total two display units will be provided as part of HoT. Either two identical display units can be provided or one Master & one slave display unit can be provided.
EoT	-	End of Train unit. It comprises of SBU, Radio transmitter & Receiver, battery, Air turbine for battery charging, GPS device etc. It transmits and receives information to/from HoT device fitted in the locomotive. It is also referred as Rear Unit (RU).



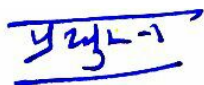
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EOTT	-	End-of-Train Telemetry system. It comprises of Head of train (HoT) device mounted in the locomotive and End of train (EoT) device mounted on the rear end of rearmost vehicle of the train along with other fittings and accessories complete as per this specifications.
FP	-	Feed pipe
FRS	-	Functional Requirements Specification
GAGAN	-	GPS Aided Geo Augmented Navigation
GNSS	-	Global Navigation Satellite System
GPRS	-	General Packet Radio Service
GPS	-	Global Positioning System
GSM	-	Global System for Mobile Communication
HoT	-	Head of Train device. It is also referred as Cab Unit (CU).
HVML	-	High Visibility Marker Light- The marker light portion of the EoT device, flashing light to mark the End of Train (EoT).
IEC	-	The International Electro-technical Commission
IR	-	Indian Railways
KPA	-	Kilo Pascal- (1KPA = 0.145 psig, 1 psig = 0.0704 Kg/cm <sup>2</sup> )
LP	-	Loco Pilot. Term 'Driver' is also used for Loco Pilot.
MMD	-	Maximum Moving Dimensions
RDSO	-	Research Designs And Standards Organisation
RU	-	Rear Unit. It is another name used for End of Train (EoT) unit.
SBAS	-	Satellite-Based Augmentation System
SBU	-	Sense and Brake Unit. It is part of EoT. It is capable of determine status of Brake pipe pressure.
SMS	-	Short Message Service
TFR	-	Transnet Fright Rail
WPC	-	Wireless Planning & Coordination wing of Ministry of Communications & IT

### 1.3 Contractor's Responsibility:

The contractor's responsibility will extend to the following:

- 1.3.1 Supply installation & commissioning of the equipment. For this purpose, the supplier shall depute his engineers/supervisors to CLW/DLW/Sheds/Workshops/Production Units (PUs) for installation of the equipment on locomotive.
- 1.3.2 Provide required instrumentation and carry out detailed tests and field trials jointly with RDSO.

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- 1.3.3 Provide special tools and instruments separately which may be required for maintenance.
- 1.3.4 Details of input & output and corresponding locomotive cable numbers will be provided by RDSO and the same should be incorporated in manual supplied by the firm.
- 1.3.5 Supply the user's manual for maintenance and trouble shooting.
- 1.3.6 Providing Warranty support and AMC support.

#### 1.4 SCOPE OF SUPPLY:

This specification covers design, development, manufacturing, testing and supply of End-of-Train Telemetry (EoTT) System for Electric/Diesel Locomotives. Quantity per locomotive is one set. The details are given under Chapter 5.

#### 1.5 TRAINING:



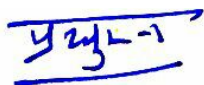
Firm shall arrange for demonstration of equipment and adequate training to Railway personnel of IR in field of its operation, routine checking/testing and in understanding fault diagnostics etc. Training modules shall be first approved by nominated agency of Indian Railways before they are executed by the firm.

#### 1.6 Warranty:

- 1.6.1 The vendor shall be responsible for carrying out improvements and modifications at his own expense on all the equipment during the period of warranty provided such modifications/improvements are decided to be necessary for meeting the requirements of reliability, performance and safety etc.
- 1.6.2 The firm is required to give root cause analysis of all the failures and their corrective actions. In case of any modification (hardware and software), the necessary approval shall be obtained from RDSO.
- 1.6.3 For the purpose of technical decisions on improvements/modifications etc. on equipment, the final authority from the purchaser's side will be RDSO.
- 1.6.4 During warranty period all charges related to server, data transfer etc. shall be paid by vendor.
- 1.6.5 Charges for AMC beyond warranty period shall also be specified by the vendor and shall include the charges related to server, data transfer etc.
- 1.6.6 Warranty period shall be as specified in the tender document.

#### 1.7 ANNUAL MAINTENANCE CONTRACT (AMC):

- 1.7.1 Firm has to quote for Comprehensive AMC - including Data charges, Server maintenance, spares and manpower required to keep the equipment operational at all times.
- 1.7.2 The firm shall also submit their bid for Comprehensive AMC of the EoTT for a period of 7 years after expiry of warranty period. Indian Railways may, based on its experience of the service offered and reliability of equipment, operate the AMC for less than 7 years in which case payment for the AMC will made on pro rata basis.

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- 1.7.3 The EoTT fitting and taking down at sheds shall be included in AMC.
- 1.7.4 Penalty shall be levied on the contractor for maintaining the system uptime below the limit of 98%. Penalty will be calculated as percentage (%) of annual payment due for AMC and will be deducted from the respective quarterly payment. Penalty calculation will be done over annual payment period as mentioned below. The same penalty clause shall also be applicable during the warranty period. Maximum penalty amount will not exceed the 5% of the total payment due for the period of AMC.

SN	Availability Slab	Applicable Penalty
1	Below 98%	0.5% for every 1% (or part thereof) reduction in availability below 98%.

## 1.8 FIELD TRIAL:

- 1.8.1 Field trial shall be done to check EoTT reliability under rigorous environmental and actual train operating condition since this equipment has direct bearing on safety.
- 1.8.2 After successful completion of type tests, EoTT equipments (**five numbers**) shall be subjected to field service trials for a minimum period of six months.
- 1.8.3 The five numbers of trial EoTT equipments and venue shall be as agreed between the purchaser and the supplier. Locomotives provided with all five systems on field trial locomotives shall be preferably based at one loco shed for the ease of monitoring and after sales support.
- 1.8.4 Detailed trial scheme shall have to be drawn up by the supplier jointly along with RDSO.



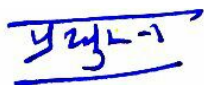
## 1.9 Approval For Design:

The design shall be developed based on the requirements given in this FRS and sound engineering practice. Approval of design means the approval of general design features. Notwithstanding the approval, the vendor shall be wholly responsible for the performance and reliability of the complete system.

## 1.10 Documentation:

The firm shall submit following information for the design approval of EoTT in printed form and in digital format:



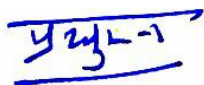
- Details of HOT module, EOT module power supply module & other subassemblies
- System design of EoTT
- Schematic Circuit/Block diagram
- Functional Description
- Protection scheme

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- (f) BOM (Bill of Material), Data sheets for components/devices and other equipment proposed for use.
- (g) Mechanical interface diagram (Outline General Arrangement), assembly drawings of complete unit, mounting arrangement and weight.
- (h) Clause by clause compliance of specification.
- (i) Test protocol with procedure of testing.
- (j) Details of Backup data memory size and battery backup size along with calculations.
- (k) Colour co-ordinates, specified operating parameters as per the specification and minimum guaranteed values achieved by the manufacturer,
- (l) Any other information as deemed fit from user's point of view.

#### 1.11 Important Documents Referred In This Specification:

1.	IEC-60571: 2012-09	General requirements and tests for electronic equipment used on Rail vehicles.
2.	IEC-60077-1: 2017-07	Railway applications – electric equipment for rolling stock Part 1: General service conditions and general rules
3.	IEC-60529: 2013-08	Degrees of protection provided by enclosures (Code IP)
4.	IEC-61373: 2010-05	Railway applications – Rolling stock equipment – Shock and vibration tests
5.	UL 60950	for Safety of mains powered equipment
6.	AAR standard S-9152 . V2.1	AAR Manual of Standards and Recommended Practices – Locomotive Electronics and Train Consist System Architecture – End of Train Communications
7.	TFR BBB 1776 Ver. 4 Rev-'0'	Transnet Freight Rail specification 'Telemeter/End-of-Train (EoT) Equipment for Air and Vacuum Brake Trains
8.	Annexure A to BBB 1776	EOT Protocol Changes and Clarifications
9.	TFR BBF 0334V5	Transnet Freight Rail Annexure B to Specification BBB 1776 Interface requirements Telemeter/EoT and Train Communication system (TCS).

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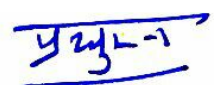
10.	TFR BBD 5420V3	Transnet Freight Rail Specification Telemeter Rear Unit GPRS Tracking document.
11.	TFR BBF 0872 V3	Transnet Freight Rail Specification Fixed Repeaters.
12.	ELRS/SPEC/SI/001 5 OCT '2001 (or latest)	Reliability of electronics used in rolling stock application
13.	IEC-60812:2018-08	Failure modes and effects analysis (FMEA and FMECA)
14.	IEC-61000-4-6	Electromagnetic compatibility (EMC) - part 4-6: Testing and measurement techniques - immunity to conducted disturbances, induced by radio-frequency fields
15.	BS-1376:1974	Specification for colours of light signals
16	EN-50155:2017	Railway applications - Rolling stock -Electronic equipment
17	EN 300 113-1:2011	Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Part 1: Technical characteristics and methods of measurement

**Note : Latest versions of all the standards referred will be used.**

#### 1.12 Infringement Of Patent Rights:



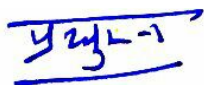
Indian Railway shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of similar components used in design, development and manufacturing of EoTT device and any other factor not mentioned here in which may cause such a dispute. The entire responsibility to settle any such dispute/matters lies with the vendor.

Details/design/documents given by the vendors are not infringing any IPR (Intellectual Property Rule) and they are responsible in absolute and full measures instead of Indian Railways for any such violations. Data specifications and other IP (Intellectual Property) as

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generated out of interactions with Indian Railways shall not be unilaterally used without consent of RDSO and right of Indian railways/RDSO on such IP is acceptable to them.

- 1.13** All the provisions contained in RDSOs ISO procedures laid down its Document No. QO-D-8.1-11 version – '1' dated 12.09.2018 (titled "Vendor Changes in approved status") and subsequent versions/ amendments thereof, shall be binding and applicable on the successful vendor/ vendors in the contracts floated by Railways to maintain quality of products supplied to Railways.

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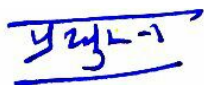
## Chapter -2

**Functional requirements****2.1 Main Functions of EoTT**

- 2.1.1 To provide display of BP pressure of the last vehicle of the train to LP in the cab of the locomotive.
- 2.1.2 To apply emergency brakes from the last vehicle of the train remotely by LP in the cab of the locomotive.
- 2.1.3 To check & detect train integrity. Train parting shall be identified by the EoTT.
- 2.1.4 To broadcast location of EoT device to other trains equipped with EoTT in case of emergency like train parting, derailment etc., on command by LP.
- 2.1.5 To indicate passage of complete train over a particular location when desired by LP.
- 2.1.6 To indicate the GPS location of EoT & HoT over the map on the website.
- 2.1.7 To provide rear end 'High Visibility Marker Light'.
- 2.1.8 To provide rear end 'Disabled Train Warning Light'.



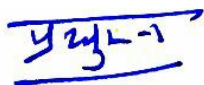
**2.2 Functions Required to be performed by EoTT**

- 2.2.1 The display for the train driver should display the air pressure in the format-NN.n kg/cm<sup>2</sup> i.e. up to one place of decimal.
- 2.2.2 It should be possible to do Emergency brake application from the rearmost wagon using EoT device through SBU in case of train parting. The HoT device should have provision of activating such an event as a positive act by the locomotive crew.
- 2.2.3 EoTT shall have provision of application of emergency brake through EoT device using function programmed into the HoT device if the train driver desires to invoke such function.
- 2.2.4 EoTT should Alert Driver when BP pressure levels of last vehicle move outside specified limits.
- 2.2.5 EoTT should Alert Driver in case of low battery power of the SBU (below 25%) or other alarms or telemetry system failure of any nature.
- 2.2.6 The **EoT** and **HoT** devices must monitor their own health status and immediately show an alarm on the DU screen as well as by means of a red flashing LED on the HoT device so as to catch the attention of the train driver of any malfunction.
- 2.2.7 The EoT device and HoT device must do hand shaking during run with each other so as to acknowledge safe working of the system.
- 2.2.8 Logging of performance of the EoT device and HoT device at nominally every 60 seconds. The same should be stored internally for at least 30 days.

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### 2.2.9 Train Integrity Function

- a. A 'Train Integrity Function' is required, in order to assist the driver in ascertaining / confirming whether the train is "complete" (i.e. has not become "parted"). This may be achieved by employing GPS units in the HoT & EoT and by continuously monitoring the speed and displacement differences between the front & rear of the train.
- b. The following shall be displayed to the driver:
  - "Train OK" - When the system detects no evidence of the train being parted
  - "Caution" - In cases where there is (temporary) doubt of train completeness
  - "Train Error" - When the system detects that the train has become parted
  - "Move" or "Stop" as per AAR S-9152.
  - Speed of the HoT and Speed of the EoT (RU)
  - "Length" / Displacement at start-up, plus relative Deviation (+ or -)
- c. The display should therefore preferably be divided into 2 areas: One for the standard pressure & battery status information, and the other for the Train Complete, speed, distance, etc. information.
- d. The GPS information (from the EoT) to be used for this function is to be transmitted in additional message data blocks after the standard ones as per AAR S-9152. The message format /structure will be as per Annexure A of TFR BBB1776 version 4 (or latest).
- e. After initial switch-on of the EoTT, when both HoT and EoT GPS equipments have satellite fixes, the displacement in meters between the front and rear units shall be displayed to the train driver as "Train Length xxxx m?", whereupon if acceptable to the driver, the value may be accepted by pressing the Enter/Select button. (If not acceptable, the driver should wait for further updates). This value must then be stored, and used as reference for future displacement readings, which are to be displayed as the stored value, together with a deviation (+/-).
- f. Similarly, the RU and CU speeds are to be stored, averaged and compared (10 second moving averages are proposed).
- g. The above 2 parameters are to be monitored as follows:
  - If speeds differ by <10 kmph, AND displacement deviation < 100 meters: **TRAIN OK**
  - If speeds differ by >10 kmph, OR displacement deviation > 100 meters: **CAUTION**
  - If speeds differ by >10 kmph, AND displacement deviation > 100 meters: **TRAIN ERROR**
- h. However, for **TRAIN OK**, the Pressure must be above the alarm levels, or else **CAUTION** must be displayed, but **TRAIN ERROR** must be displayed irrespective of the Pressure levels. The train driver will have to take all factors into account in this case.
- i. The above indications are to be given with a very high degree of integrity, and a very low incidence of false alarms. Vendors are to provide full details of their proposed system, as well as its level of integrity.

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**2.2.10 Emergency Brake application from Rear by LP**

- a. The functionality of braking from rear shall be provided as per clause 3.0 of AAR S-9152.V2.1 (or latest).
- b. The EoTT system shall have capability of applying the brakes, restoring normal brake operation, transmission of status information and testing the communication channel on receipt of command.
- c. The rear emergency valve is regarded as a backup device and not a braking performance improvement device.
- d. A failure of the system shall not cause application of the emergency brakes.
- e. The cab unit shall provide the additional capability of applying the emergency brakes at the rear end of the train via an emergency air dump valve, activated by remote control. The capability of requesting transmission of status information from the rear unit and of testing the communication channels shall also be provided as per clause 3.8 of AAR S-9152.V2.1 (or latest).



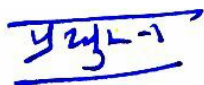
**f. Manual Emergency Brake Activation:**

The cab unit will have a switch that when activated, will initiate a front to rear transmission containing an emergency brake application command. On receipt of this command, the brakes will be applied in the rear unit. The switch, distinctively labeled '*Emergency*' will be protected so that there will exist no possibility of accidental activation.

**g. Automatic Emergency Brake Activation:**

The front to rear transmission and rear-of-train equipment shall provide for application of train emergency air brakes upon emergency train brake application by the loco pilot in the cab.

- h. Delay between receipt of the command to apply rear emergency brakes and the rear valve's activation shall be 1 second or less.
- i. The rear unit on receipt of a properly coded command will open a valve in the brake line and hold it open for a minimum 15 seconds. This opening of the valve shall cause the brake line to vent to atmosphere.
- j. The valve opening shall have a minimum diameter of 3/4inch, and the internal diameter of hose shall be 5/8 inch, minimum to effect an emergency brake application.
- k. Restoring of the brake function (recharging of the air brake system) shall be enabled automatically by the rear equipment, no more than 2 minutes after it has initiated an emergency.

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**2.2.11 Disabled Train Warning Light (DTWL)**

It will be provided as per clause 4.15 of AAR S-9152.V2.1. In the event a train suddenly becomes disabled, such as from an undesired emergency brake application, this option would add a light to warn approaching trains of this situation. This warning light would be illuminated either automatically when train brakes applied in emergency or manually by the loco pilot using a cab control switch. The light would be reset by a control switch. This warning light would not replace the rear end marker device, nor shall the marker device serve this function.

**2.2.12 Authorization for Two way Telemetry system**

Two way telemetry system authorization will be as per clause 3.10 of AAR S-9152.V2.1.

It is to provide additional security to prevent unauthorized application of emergency braking feature by a party or parties external to the control cab of train.

**2.2.13 Repeater function**

- a. In certain situations it may be necessary to repeat the signal between HoT and EoT, by means of an On Train repeater, or by means of Track Side (Fixed) repeaters. Both versions are to display at least the following when messages are repeated: EoT ID number, and Time (hh:mm:ss) with at least the last 5 messages being continuously displayed.

**b. On-Train Repeater**



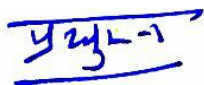
In this case the HoT is to be configured such that during switch-on / powering up, the HoT may be switched into “repeater mode”. The user shall thus have the option of selecting either normal “HoT” or Repeater” mode, so that a HoT may either function as a cab unit, or as a repeater when required. The repeater shall also be “matched” to the EoT in the same way as the HoT, and shall only repeat valid messages from its matched EoT or HoT, after a delay of 500 milliseconds.

Vendors are to clearly and in detail indicate how their repeater is to function, so as to ensure that secure and reliable repeated communications are to be effected, without communication collision problems (e.g. between paired HoT/EoTs, OR with other HoTs, EoT's or repeaters). The “switch-on / start-up” procedure must also be fully described, and must be easy to perform, bearing in mind the possible logistical problems due to long distances between equipment units.

**c. Track-Side / Fixed Repeater**

This repeater function must also be incorporated in the HoT software, and only be activated in the Sheds/workshop when required. In this case, the matching function is not required, but only valid messages from the HoT or EoT are to be repeated, after a 500 millisecond delay. GSM GPRS tracking functionality is also required as an option, to allow remote monitoring of operation.

Vendors are to clearly and in detail indicate how their repeater is to function, so as to ensure that secure and reliable repeated communications are to be effected, without communication

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collision problems (e.g. between paired HoT/EoT's, OR with other HoT's, EoT's or repeaters).



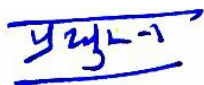
#### 2.2.14 Alarms

An audible alarm, together with an appropriate flashing message display and red indicator light must be provided in the display unit to indicate following :

- a. Pressure alarm must be sounded and displayed on the DU when pressure drops below 3.0 Kg/cm<sup>2</sup>.
- b. Communication alarm must be sounded and displayed on the DU to indicate loss of radio communication as defined in AAR S-9152.
- c. Battery alarm must be sounded and displayed on the DU to indicate available battery power less than 25% in either HoT or EoT.
- d. Train Integrity alarm, when GPS derived parameters are outside the defined range.
- e. Complete Passage Alarm to indicate passage of complete train over a particular location.
- f. Train Integrity alarm shall be latched on until acknowledged. The other audio alarms will be for 5 seconds.
- g. Audio Alarm volume must be adjustable and adequate to be heard in noisy environment of the locomotive.
- h. The visual alarm message display must continue until the pressures/parameters are within the specified range, or reception is restored or the unit is switched off.
- i. Alarm can be acknowledged by the LP using specified key. It will suppress the current audible alarm but the visual display will continue till the values normalize. When the alarm values change

#### 2.2.15 Logging of Alarms and Performance on both HoT and EoT

- a. The EOTT performance must be continuously monitored and logged by the EoTT against time & GPS position (latitude, longitude) , and stored in memory, so as to be available for down-load at the end of the trip via the USB port or other means. Both HoT & EoT must make use of a GPS unit so as to track its position against real (GPS) time.
- b. All communication messages received by the HoT, as well as alarms, are to be logged versus time & GPS position (latitude, longitude).
- c. The HoT time must be synchronised with that of the EoT and GPS time.
- d. Other data / parameters to be recorded are:
  - Start Up / Switch On date & time
  - Position and ID/Serial Numbers of EoT and HoT at start up
  - During the trip, periodic readings of pressure, battery voltages and alarms, e.g.
    - Low Battery
    - Low BP pressure
    - Communication Failure.
    - Emergency brake application from rear
    - Train parting Etc.

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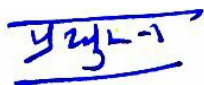
- Speed
- Train stopped
- Train moving
- Received signal strength, if possible

#### 2.2.16 Web Server



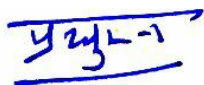
- a. In order to provide a tool for the effective asset management of EoTT equipment, tracking of both EoT & HoT by means of GSM/GPRS is required.
- b. EoTT device data, alarms and performance & GPS position of both EoT & HoT will be transmitted to web server at approximate interval of 1 minute (in normal operation when battery supply is available to HoT and Air generator supply is available to EoT) / 20 minutes (when battery/Air generator supply not available) subject to availability of GSM coverage. If no GSM coverage is available, then the un-transmitted data shall be transmitted as soon as GSM coverage is obtained. For transferring data from device to server, both devices (EoT & HoT) shall be equipped with SIM cards and use 3G/4G technology for data transfer. Two SIM cards of different operators shall be used for data transfer in EoT as well as HoT.
- c. **Vendor Server & website:** Vendor shall have its own server which will be located in India for safety and security reasons with specific static IP address. There shall be flexibility in upgrading the server configuration such that more locomotives can be added to the system as and when more locomotives are fitted with EoTT system. EoTT system shall be configured to communicate with the vendor server.
- d. Webpage layout of the vendor server for accessing the EoTT data will also be approved by RDSO. Dashboard approach will be followed to list all the locomotives/HoT/EoT at a glance. Filtering based on the Holding Railway/Shed and working Railway/sheds shall be possible. Detailed information will be available after selecting a particular locomotive/HoT/EoT. Locomotive/HoT/EoT position shall also be displayed on map.
- e. It shall also be possible to access the information by specifying unique ID of EoT/HoT/train number /locomotive number/ crew ID.
- f. Webpage will have some colour coding for identifying the systems which are running, stopped and in dead condition.
- g. Authorized users can access the EoTT device information through internet by connecting to vendor server through their own desktop/laptop/mobile devices.
- h. **Railway Server:** Railway may decide to setup its own server for accessing the EoTT information of locomotives. It shall be possible to configure the EoTT device to transmit data to Railway server if required. Vendor shall provide communication protocol from EoTT device to server and other necessary details to transfer EoTT data from device to Railway server. It shall also be possible to transfer GPS data to Railway server only and stopping the data transmission to vendor server if required by Railways.

#### 2.2.17 Reliability & Availability

- a. The system must work reliably on a train of up to 200 wagon or 2.5 km length and train travelling at a speed of up to 120 kmph on straight track free from obstructions (like rocks, tunnels etc.) in clear weather conditions.



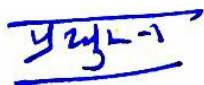
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- b. All functions are to be performed with an extremely high degree of reliability, and must not result in unnecessary train delays or stoppages.
  - c. The equipment must be extremely reliable, with a minimum mean time between failures (MTBF) of 10000 hours per system/equipment pair. The integrity of the equipment must be such that the probability of a "Train OK" indication being false is less than one in  $10^7$ .
- 2.2.18 Maximum weight of the EoT with associated devices like couplers, pressure transducers, internal battery and air turbine/generator etc. fitted shall not exceed 12.5 kg.
- 2.2.19 Fixing arrangement of the EoT device should be quick to fit with adequate vandal-proofing arrangements to the satisfaction of Indian Railways.
- 2.2.20 Locking arrangement of the EoT device should be theft proof and should be pre-approved by nominated agency of Indian Railways before supply. Any modifications to be done in the same, based on service experience, shall be at the cost of the supplier upto a period of six months from the date of first supply including modifying those units which have already begun service in the field.
- 2.2.21 If a locomotive has to be detached from a working train and taken to haul another train, then the EoT shall be carried to the locomotive and shall be put on charging on the Locomotive itself. EoT device and HoT device need to be designed to cater to this mode of working. For interoperability, it is desirable that all makes of EoT devices can be charged in the locomotive with same connection. For this, it is proposed that EoT device can be connected in the locomotive to locomotive battery for charging with Bayonet type circular connector with crimped pins (similar to connector no. 97B-4-101-A-20-24-S or equivalent). Dummy receptacle for charging plug will also be provided in the locomotive. Equivalent Charging socket, cover for active socket and dummy receptacle for cover may be provided on the EoT. It will be standardized during design approval stage.
- 2.2.22 The design and layout of the DU including the operating keys which shall be built into it shall have to be approved by nominated agency of Indian Railways before supplying the same.
- 2.2.23 The software programs of the EoTT shall be on a non-volatile reprogrammable storage on both devices HoT & EoT.
- 2.2.24 In case of failure of either the HoT device or the EoT device or the radio communication module or all three systems, the system shall not interfere with the safe working of the train. The EOTT system shall not cause any damage to the equipment and systems connected to it on either the locomotive or the train. Failure Mode Effects and Criticality Analysis of the

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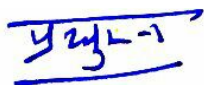
equipment shall have been done during equipment's design process as per IEC 60812 or similar standard and same should be available for scrutiny by nominated agency of IR.

- 2.2.25 In the operational event of using an intermediate locomotive for hauling long-haul trains, the HoT device of the intermediate locomotive should have the capability to be used as a repeater HoT device and the system architecture and programming should be designed accordingly.
- 2.2.26 The complete EoT device including the integrated air generator should be compliant to IP 54, antennae to IP 66 & remaining equipment like connectors etc. shall be compliant to AAR S-9152 except for the minimum temperature which should be reckoned as -10°C.
- 2.2.27 In case of mishap of train like derailment etc., it should be possible to give a command from HoT device by LP to EoT device to broadcast an Emergency message from EoT device which shall be received by all makes of HoT devices of other trains within the range of radio communication and displayed on their Display Unit indicating distance from the disabled last vehicle which shall be calculated based on GPS coordinates of disabled last vehicle. EoT device of disabled last vehicle shall continue to broadcast the message every 10 seconds to other HoT devices till the emergency mode is reset either automatically by build up of BP pressure or manually by a reset switch on EoT or by a command from LP through paired HoT. Protocol of communication for this shall be as per norms specified by AAR/TFR and will be submitted to RDSO. The detailed working of this system shall have to be submitted.
- 2.2.28 When the EoT device has to be taken off and carried on the locomotive, suitable arrangement has to be made on the locomotive so that the EoT device, when stowed on the locomotive, is put on trickle charge. The stowing arrangement of the EoT device on the locomotive must be compatible with the locking arrangement already built into the EoT device for fixing it to the last vehicle's coupler of the train. This system shall be pre-approved by nominated agency of Indian Railways before supplies are initiated by the qualified supplier(s). It will be desirable if EoT device can also be fixed on the locomotive CBC to drawing no. SK.DL-3430 and SK.62724 in addition to fixing on the CBC of the wagons.
- 2.2.29 The EoTT shall be required to check if the Last Vehicle has cleared the Fouling Mark/Caution order location. It shall then be possible for the driver to query the EoTT device for this information and the EoTT device shall send appropriate message to DU of HoT device if the Fouling Mark is "**Cleared**" or "**Not Cleared**" by displaying the same on the DU of HoT device. Necessary hardware and software shall be built into the EoT device and HoT device for achieving this functionality. This feature will be an aid to Loco Pilot.

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## 2.3 Other Functional requirements of EoTT

- 2.3.1 The EoTT shall work satisfactorily on Electric/Diesel Locomotives which have electrical and electronic equipment complying with following specifications:-
- UL 60950 - for Safety of mains powered equipment.
  - IEC:60571 – Rules for Electronic Equipment used on Rail Vehicles.
  - ELRS/SPEC/SE/0015: - Reliability of electronics used on Rolling Stock application.
- 2.3.2 The EoTT shall be used on Electric/Diesel Locomotives on electrified and non-electrified sections. Therefore EoTT shall be capable of working in 25KV and 2 X 25 KV electric traction and non-electrified system of Indian Railways.
- 2.3.3 EoTT brake interface module shall be capable of interfacing with air brake circuits of diesel and electric locomotive and shall not interfere with the operational braking initiated by driver. **Firms are free to design their methodology to detect the emergency brake application in the locomotive and have to submit details of methodology adopted by them at the time design stage.**
- 2.3.4 EoTT brake interface shall not adversely affect the brake application and release timings.
- 2.3.5 Brake application and release characteristics in each mode of operation of EoTT with standard parameters and details of brake testing and reliability of brake equipment should be submitted to RDSO for verification and validation. Final clearance of fitment of braking unit on loco from RDSO would be essential.
- 2.3.6 A status indication of the EoT device marker light is also required to be displayed on the DU of HOT as per AAR S-9152. (Marker light ON, OFF or Defective).
- 2.3.7 EoTT equipment shall be designed for a service life (Codal life) of 12 years. One of the governing documents for such design shall be AAR S-9152. The air turbine of the SBU shall also be designed as per AAR standard S-9152.
- 2.3.8 The rear unit shall be fitted on Centre Buffer Coupler of wagons to drawing no. WD-81010-S-03.



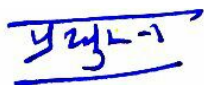
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## Chapter -3

## Technical details

**3.1 End of Train Telemetry (EoTT) System:**

- a. The EoTT system shall have features of self-test, diagnostic and corrective actions built in the design to ensure the reliability and safety level to run the train with such electronic equipment.
- b. All software must be installed on non-volatile reprogrammable memory via suitable port .
- c. The GPS modules used in EoTT shall support Multi GNSS and SBAS (GAGAN) and shall have position accuracy of approximately 10 meter.
- d. Unique ID of EoT/HoT, GPS location information, time stamp and speed will be included in GPS data packets transmitted to the server.
- e. EoTT system shall be suitable for working under 25 kV AC and 2 x 25 KV AC traction systems.
- f. EoTT system shall be suitable for working on Indian Railway Tracks as well as DFCC tracks and shall be within MMD. MMD of Indian Railways is given in Annexure – I. MMD for Eastern Corridor of DFCC is given in Annexure II. MMD for Western Corridor of DFCC is given in Annexure III.
- g. Antenna modules of EOTT shall have IP 66 protection and other modules (EoT/ HoT) shall have IP 54 protection.
- h. Adequate provisions shall be made in the design for suppression of internal transients, spikes and to withstand external transients, spikes and surges as per limits laid down in IEC-60571 ed-3 or latest.
- i. In the electronic equipments to be supplied to this specification, the vendors shall use industrial grade components, backup battery and systems of high reliability, suitable in every way for the application on rolling stock. In this connection, vendor is advised to refer to "Rules for Electronic Equipments used on Rail Vehicles IEC-60571".
- j. Minor deviations from the specification if any, can be mutually sorted out with RDSO during development stage if supported by justification on ground of cost and/or technical superiority.
- k. All electronic components and ICs used shall be selected after proper burn in and screening tests and shall be adequately rated to withstand the service requirements. A quality assurance scheme shall be submitted by the vendor for approval of RDSO. All the connecting wires, cables used on PCB in the sub units should be properly laid out with suitable connector. The cable used inside the sub unit shall be properly supported with stiffeners. No soldering shall be done on the PCB for inter connection.
- l. System shall have real time clock for recording date & time which is updated from GPS system.

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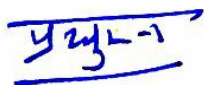
- m. The device shall function satisfactorily under 25 kV and 2 X 25 kV ac electric traction. It shall not be susceptible to malfunction due to interference from overhead traction power supply lines or under abnormal conditions such as overloads and faults in the electrical traction circuits of the locomotives.
- n. IP address to which EoTT system shall transmit its data shall also be configured through its keypad/port/Over the air (OTA) by authorized persons.
- o. Each unit of EoTT will comprise of the following:-

### 3.2 Head of Train (HoT) device or Cab Unit (CU):

- 3.2.1 Location of installation of HoT device shall be finalized and standardized by RDSO after development.
- 3.2.2 HoT device is part of EoTT to be provided in the locomotive. It will comprise of two display units equipped with suitable keyboard, Radio transmitter and receiver, GPS module, GSM module etc. Both the display units can be identical or can be in Master-Slave mode.
- 3.2.3 Locomotive number shall be the unique identifier for the HoT device. It must be programmable by the user shed, so that a HoT unit can be shifted from one locomotive to another if required.
- 3.2.4 Train number and crew ID can also be fed on the display unit by the LP for monitoring of the train and further analysis on website.
- 3.2.5 HoT device should be securely fitted in both cabs in the locomotive and shall be designed to work with locomotive battery (nominally min. 50V DC, nom. 110V DC and max. 137.5V DC). HoT device should not go blank or malfunction when OHE are shut down. The relevant reference documents are IEC60571 & AAR S-9152.
- 3.2.6 Fixing arrangement of the HoT including electrical wiring shall be discussed and finalized by the firm in consultation with RDSO.
- 3.2.7 Suitable Ethernet/USB port shall be provided on HoT for its programming. USB Port will be provided for downloading the data directly to the pen drive.
- 3.2.8 HoT device consists of following units.

#### 3.2.9 Display unit (DU)

- a. The Display icons, display numbers and display fonts on the DU should be readable by the locomotive crew.
- b. The display unit (DU) must have an integrated industrial grade display panel to display all the requisite information in bright daylight (Daylight readable) as well as in the night.
- c. Train status function like brake pipe pressure readings at the last vehicle, speed of the last vehicle, train integrity information, integrity of the radio communication, health of the SBU and DU, battery percentage of both the cab unit and rear units, etc. shall continuously be displayed on DU.
- d. Provision shall be made for entry of the rear unit identification code by Loco Pilot each time a new rear unit is installed on the rear of train as per clause 2.2.7 of AAR S-9152.

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- e. Provision shall also be made for entry of the Train number and Crew Id for further analysis.
- f. Automatic & manual backlight brightness adjustment of display is required.
- g. Integrity checking of the display is required.
- h. It will have required number of keys to carry out the assigned functions.
- i. The operating keys interface of EoTT shall be AAR S-9152 compliant barring the minimum temperature clause that should be reckoned as -10°C.
- j. Following parameter will be shown in HoT display, when no EoT device is paired with HoT device.
  - a. Loco Number (up to 6 digits numeric value)
  - b. Train Number (up to 10 digits alpha-numeric value)
  - c. Crew ID (up to 10 digits alpha-numeric value)
  - d. Date & time of HoT device
  - e. Speed of locomotives
  - f. Battery percentage of HoT
  - g. Status of EoT pairing (not connected to any EoT)
- k. Following parameter will be shown additionally in HoT display, when an EoT device is paired to HoT device:
  - a. Unique ID of EoT paired
  - b. BP Pressure of rear wagon
  - c. Battery Status in (%) percentage of EoT
  - d. Speed of EoT
  - e. Date & time of EoT device
  - f. Various Alarm Status & messages sent by EoT
  - g. Status of HVML & DTWL
  - h. Train Length
  - i. Train Integrity Indication
  - j. Integrity of the radio communication



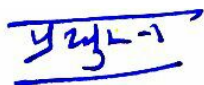
### 3.2.10 GPS/GSM Module

GPS system of EoTT shall have Position accuracy of approximately  $\pm 10$  Meters.

### 3.2.11 Antenna for HoT



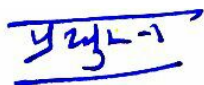
- a. The radio antenna shall be placed outside the driver cabin and shall be designed and fitted in such a manner so as not to infringe the Maximum Moving Dimensions (MMD) of Indian Railways & DFCC.
- b. Combo antenna may be used for GPS & GSM antenna.

## 3.3 End of Train (EoT) device or Rear Unit (RU)

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- 3.3.1 It comprises of suitable housing, pressure transducers, associated electronics, SBU, Radio transmitter & Receiver, battery, Air turbine for battery charging, GPS device, GSM device, brake pipe coupling, ON/OFF switch, visual ON/OFF indication, High Visibility Marker, suitable display etc. It transmits and receives information to/from HoT device fitted in the locomotive and to the web server.
- 3.3.2 An illuminated display is required on rear unit, which at switch on must display atleast software version number, battery voltage and brake pipe pressure readings.
- 3.3.3 Rear unit must be designed for continuous duty service on rear of the train where it will be subjected to severe vibration and shocks. EoTT will be tested for Shock and Vibration levels specified in clause 2.1.4.4 of AAR S-9152.V2.1.
- 3.3.4 Each EoT device shall have a unique ID which will be assigned by the RDSO and will be programmed in the EoT. This unique ID will be used for pairing EoT with HoT.
- 3.3.5 The unique identification code or address shall be as per clause 2.1.7 of the AAR S-9152. It shall be in the range 00000 to 99999 and be established in the rear unit electronics by permanent and secure means. The identification code shall also be indicated on the exterior of the rear unit enclosure.
- 3.3.6 The unique identification code will be transmitted along with the data to the cab unit. This code ensures that only data transmitted from the assigned unit will be accepted by the cab unit. In this way, rear unit messages from adjacent trains will be rejected by the cab unit.
- 3.3.7 In order to maintain the interchangeability between rear unit and cab units, the identification code must be reported and selected at the cab unit prior to start of any trip.
- 3.3.8 The EoT device shall be designed *as portable as lightweight as small as possible* which may be easily carried by one person by suitable handle.
- 3.3.9 EoT must be able to withstand rough handling / tampering and must be robustly constructed.
- 3.3.10 EoT must be splash proof, impervious to ingress of dust and moisture and suitable for mounting on rear coupler of the train.
- 3.3.11 EoT must be capable of withstanding high levels of shocks and vibrations.
- 3.3.12 Suitable Ethernet/USB port shall be provided on EoT for its programming. USB Port will be provided for downloading the data directly to the pen drive.
- 3.3.13 The rear unit must incorporate following 3 power modes:
- 'ON' : Full functionality available
  - 'Sleep' : Radio transmission OFF, Pressure transducer ON, Radio Receiver ON, GPS ON, GPRS ON, Functionality of High Visibility Marker Light and Disabled Train Warning Light will be available during sleep mode.
  - 'OFF': All electronics switched off with no drain on battery.

3.3.14 Following ON/OFF functionality is required :

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- a. The Rear Unit must only switch **ON** when in the vertical position, irrespective of pressure value.
- b. Must switch to **Sleep Mode** (by means of a “tilt-switch”) after 15 minutes when moved to the horizontal position, provided that the pressure is zero, *or when connected to a charger.*
- c. Whilst upright, and the pressure drops below 10 kPa (0.1 Kg/cm<sup>2</sup>) The Rear Unit must switch to **Sleep Mode** after a 15 minute delay, *but should first update the Cab Unit.*
- d. When the pressure rises to above 10 kPa (0.1 Kg/cm<sup>2</sup>), the rear unit must automatically switch its transmitter **ON** again.
- e. Additionally, whilst in “**Sleep Mode**”, normal transmission must resume when a button on either the Cab Unit or the Rear Unit is pressed.
- f. However, if disabled train warning light is not activated and the pressure continues to remain below the above-mentioned limits, the Rear Unit must switch **OFF** completely after 10 hours.
- g. When the pressure is above the specified limits, it must not be possible to switch the Rear Unit off.
- h. The Rear Unit must protect itself against damage to its battery due to deep discharge by switching itself **OFF** if the battery voltage drops too low, but should first send an appropriate message to the Cab Unit.

3.3.15 The rear unit must be mounted on the last vehicle of the train in a manner such that:



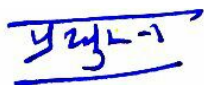
- It can fit any vehicle without adapter brackets for mounting purposes, and by means of a simple procedure without requiring any special tools.
- The risk of theft and vandalism is minimised.

3.3.16 The Rear Unit must be designed such that it may be locked in place so as to minimise the risk of it being stolen or vandalised while mounted on the last wagon of the train. An integral lock with captive key is the preferred option, to prevent removal by means of readily available tools or spanners. If a separate / loose lock is proposed, the lock, key and attaching chain or cable, etc. must be included as part of the equipment. The key and lock must be pre-approved by RDSO.

3.3.17 The RU must be supplied complete with flexible connecting air pipes/hoses, suitable for air-brake. The coupling mechanism shall also cater for airbrake connections on wagons, and loose components or adapters are not acceptable. The pipe & coupler must be attached to the Rear Unit body with a 3/4” BSP thread. It must also be available as a separate item.

### 3.3.18 **Sense and brake unit (SBU)**

- a. Automatically and continuously, monitor BP pressure of the locomotive as well as the last vehicle on train every 60±5 seconds and to provide its accurate readings within ±0.21 kg/cm<sup>2</sup> to driver at regular randomized intervals of 60±5 seconds with randomization as per clause 2.1.2 of AAR S-9152.V2.1.

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- b. The SBU must have provision to go into sleep mode in case the system is not receiving brake pipe pressure for more than one hour. Upon getting the brake pipe pressure thereafter, the SBU must wake up and resume its full functional state within 60 seconds.
- c. Rear Unit must be Capable of measuring the brake pipe pressure on the rear vehicle from  $0 - 6.5 \text{ kg/cm}^2$  and display the same to the one place of decimal with least count of  $0.1 \text{ kg/cm}^2$  using sensor level output and not using software interpolation.
- d. A means of locally inspecting the brake pipe pressure outside of the enclosure is required. Either an integral air pressure indicating device or quick-disconnect coupling for an external indicating device could be used as per clause 2.1.1.2 of AAR S-9152.V2.1.
- e. At the test bench, the accuracy of the measurement should be  $\pm 0.21 \text{ Kg/cm}^2$  and it should be demonstrated that variations in brake pipe pressure of  $\pm 0.21 \text{ Kg/cm}^2$  can be measured and displayed.
- f. In case of having to take off the SBU while there is sufficient pressure in the brake pipe of the train, suitable design arrangement must be made without compromising the safety of the train.
- g. An internal failure of the measurement device shall not cause an undesired emergency brake application.

### 3.3.19 Air Turbine/Generator unit

- a. Air Turbine/Generator unit is required for EoT unit battery charging when locomotive is attached to the train.
- b. Air Turbine/Generator is to consume no more than 2.5 cubic feet per minute (at 80 PSI) from brake pipe air as per clause 4.17.1 of AAR S-9152.V2.1.
- c. The Air Turbine/Generator equipped bit will be set to indicate that the EoT on the train is equipped with an Air Turbine/Generator as per clause 4.17.2 of AAR S-9152.V2.1.

### 3.3.20 GPS/GSM Module



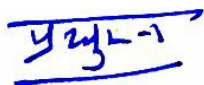
GPS system of EoTT shall have Position accuracy of approximately  $\pm 10$  Meters.

### 3.3.21 Antenna for EoT

- a. The antenna shall be of such type that when fitted, they shall not infringe the MMD (Maximum Moving Dimensions) of the Indian Railways & DFCC.
- b. Combo antenna may be used for GPS & GSM antenna.

## 3.4 Battery for EoTT system

- a. Both HoT & EoT devices must be supplied with integrated rechargeable sealed batteries.

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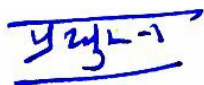
- b. EoTT should have continuous charging facility of End of Train Unit by an established method of charging using Air Turbine/Generator unit for rear unit battery charging when locomotive is attached to the train. Similarly HoT battery will be continuously charged from locomotive battery.
- c. Suitable protections like overvoltage, over current, short circuit, over charge & over discharge, surge, incorrect insertion of connector, over temperature etc. shall be provided in charging/discharging circuit.
- d. The battery must be protected against irreversible damage due to excessive deep discharges.
- e. A battery status indication shall be provided for both EoT & HoT units in the display unit to continuously indicate the remaining capacity of the batteries in hours. The battery status information transmitted by the EoT unit must be used to determine the remaining battery life and display in percentage in cab unit. It will also be transmitted to the server.
- f. If the battery charging facility of HoT fails but locomotive battery is available, then even after the failure of the charging unit the battery of HoT must ensure normal EoTT working for at least 48 hours.
- g. If locomotive battery is not available, than EoTT functionality of HoT will not be required, but GPS monitoring of dead locomotive is required. Battery backup of the HoT device shall be adequate such that it can work for at least 20 days when locomotive is in dead condition (HBA in OFF condition).
- h. If the battery charging facility of EoT fails, then even after the failure of the charging unit the battery of EoT must ensure normal EoTT working for at least 48 hours.

S. No.	Parameters	Operating period
1.	Minimum normal battery life with built in battery up to low battery indicator (LBI), with charging disconnected, for a continuously operated marker device with normal working of EoTT.	$\geq 36$ Hours
2.	Min. operating battery life after low battery indicator (LBI) with charging disconnected.	$\geq 12$ Hours
	Total	$\geq 48$ Hours

- i. No deterioration in illumination is permitted during normal battery life. For specified minimum operating battery life after low battery indicator (LBI), 25% drop in illumination from its original value is permitted.

### 3.5 High Visibility Marker light (HVML)

- a. End of Train device should also perform the task of High Visibility Marker light

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(HVML) flasher device as per Indian Railways requirement.



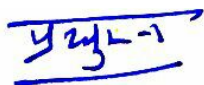
- b. Automatic switching ON & OFF of HVML is required based on the ambient light condition.
- c. Power requirements of HVML shall have minimal impact on battery life of EoT unit.
- d. A status indication of HVML on Display unit in locomotive cab is also required as per clause 4.1.3.5 of AAR S-9152.V2.
- e. **Colour Co-ordinates:** Red Aspect: Class 'C' of BS: 1376.

S. No.	Parameters	Flashing Red Aspect
1.	No. of flashes per second	$2 \pm 10\%$ for foggy weather $\leq 4$ for normal weather
2.	Pulse duty cycle	$\geq 38\%$ for foggy weather $\geq 20\%$ for normal weather
3.	Minimum illumination measured at 1.5m in axial direction (LUX)	110
4.	Radiating area (Approx.)	3850 sq. mm
5.	Dispersion angle	$4^0$ to $7^0$
6.	Number of LEDs used	shall not be less than 6 with display area of about 70 mm diameter
7.	Visibility :	1.6 Km along longitudinal axis and 100 m at 6 degree angular displacement from longitudinal axis. For testing, Tail lamp to be placed 1.5 m above rail level and viewed at local sun set time under condition of clear weather.

- f. Illumination shall be measured in steady mode. To enable the measurement in steady mode, suitable provision/switch shall be provided in the lamp housing which shall not be visible or easily accessible to the user. Normally lamps shall be provided with flashing colour aspect and steady mode shall be operated for measurement only.
- g. **Loco Pilot will activate the fog condition from HoT either by way of switch or through menu option.**

### 3.6 Disabled Train Warning light (DTWL)

- a. End of Train device shall also perform the task of Disabled Train Warning Light



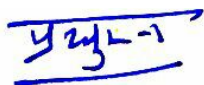
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(DTWL).

- b. Power requirements of DTWL shall also have minimal impact on battery life of EoT unit.
- c. A status indication of DTWL on Display unit in locomotive cab is also required.
- d. **Colour Co-ordinates:** Amber yellow colour with dominant wave length of 590 to 595 neno meters shall be used for DTWL.

S. No.	Parameters	Flashing Amber colour Aspect for DTWL
1.	No. of flashes per second	0.66 flashes per second or 40±5 flashes per minutes
2.	Pulse duty cycle	≥38% for foggy weather ≥20% for normal weather
3.	Minimum illumination measured at 1.5m in axial direction (LUX)	110
4.	Radiating area (Approx.)	3850 sq. mm @70 mm diameter
6.	Number of LEDs used	shall not be less than 6 with display area of about 70 mm dia.
7.	Visibility :	1.6 Km along longitudinal axis and 100 m at 6 degree angular displacement from longitudinal axis. For testing, Tail lamp to be placed 1.5 m above rail level and viewed at local sun set time under condition of clear weather.



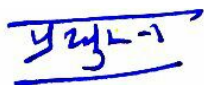
- e. Illumination shall be measured in steady mode. To enable the measurement in steady mode, suitable provision/switch shall be provided in the EoTT housing which shall not be visible or easily accessible to the user. Normally DTWL shall be provided with flashing colour aspect and steady mode shall be operated for measurement only.
- f. Loco Pilot will activate the fog condition from HoT either by way of switch or through menu option.
- g. This warning light will be illuminated either automatically when train brakes applied in emergency or manually by the loco pilot using a cab control switch.
- h. This warning light will reset automatically when brake pipe pressure of EoT is greater than 3Kg/cm<sup>2</sup>.

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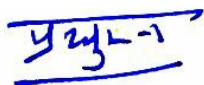
- i. This warning light will also reset by a control switch on EoT.
- j. This warning light will also reset by a command given by Loco Pilot from paired HoT either by way of a switch or menu option.
- k. When this warning light is illuminated, HVML will go in OFF condition.
- l. When this warning light is reset, HVML will illuminate automatically based on the ambient conditions.
- m. DTWL and HVML can either be in same enclosure or in different enclosures.

### 3.7 Two way Communication between HoT to EoT

- 3.7.1 To ensure interoperability requirement for EoTT device (i.e. any EoT device can be paired with HoT device of any make), communication protocols between EoT & HoT needs to be standardized. For this purpose, communication protocols between EoT & HoT shall be compliant with AAR S-9152 & TFR BBB1776 except the radio frequency used for radio communication.
- 3.7.2 Messages as per AAR S-9152 transmitted from the rear end unit to the cab unit must include the following:
- Rear unit Identification code.
  - Rear unit battery status.
  - Brake pipe pressure.
- 3.7.3 In addition, GPS & other data in 2 additional data blocks will be as per Annexure A of TFR BBB1776.
- 3.7.4 Indian Railways is operating DPWCS at frequency of 406 to 407 MHz, which is likely to be shifted to 424 to 430 MHz. It is proposed that EoTT devices shall also use same frequency spectrum allotted to Indian Railway for DPWCS. The radio shall be designed in such a way that same radio can operate in other frequency band (400 to 450 MHz) in future with minimum hardware changes.
- 3.7.5 Communication between HoT device and EoT device inside tunnels/cuttings shall be assisted using repeaters / leaky coaxial cable so as to ensure seamless transmission and reception between HoT device and EoT device. Provision of leaky coaxial cable shall be done by Indian Railways. However Specification for Leaky Co-axial cables shall be provided by the bidder along with the technical offer.
- 3.7.6 Radio equipment shall be designed to transmit power less than or equal to 10Watts and selected Radio should be listed with WPC (Wireless Planning & Coordination wing), Ministry of Communications & IT, India. Exact frequency of radio shall be given to suppliers once the same is allocated to Ministry of Railways at the time of implementation of the equipment.
- 3.7.7 It has to be a proven digital communication method that will communicate upto 2.5 kilometer range with an external antenna on the locomotive.

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- 3.7.8 Reliable communication is expected to be maintained by the equipment in all possible terrains including deep cuttings, tunnels, forests, hilly track called “Ghats” in IR terminology and densely occupied yards & station sections. IR will provide the Leaky Cables/Repeaters at required locations. Firms must specify the specific terrain conditions for which EoTT shall need Leaky Coaxial cable system. Firms must also specify standards to which such Leaky Coaxial Cable system should be designed/laid and its collateral use for other communication works pertaining to Railway applications.
- 3.7.9 Pairing between EoT device and HoT device shall be done as per AAR- S 9152.
- 3.7.10 **Manual Communication Test**  
Means shall be provided for manual initiation of an end-to-end test of the front to rear communication link with a visual/audible indication of success or failure of the test as per clause 3.8.3 of AAR S-9152.V2.1.
- 3.7.11 **Automatic Communication Test**  
The availability of front to rear communication link shall be checked automatically every 2 minutes as per clause 3.8.4 of AAR S-9152.V2.1.
- 3.7.12 **Emergency Valve Test**  
Means shall be provided to confirm availability and proper functioning of the emergency valve as part of both manual and automatic communication tests as per clause 3.8.5 of AAR S-9152.V2.1.
- 3.7.13 **Rear to front communication failures**  
Rear to front communication failures will be declared as per clause 3.8.6 of AAR S-9152.V2.1. The cab unit shall declare a rear to front communication failure on rear to front radio link failures lasting for a duration of 5 minutes or greater. Rear to front radio link failures lasting less than 5 minutes shall not be declared as rear to front communication failure. Display or indication of front to rear communication failure shall take precedence over rear to front communication failure.
- 3.7.14 **Front to rear communication failures**  
Front to rear communication failures will be declared as per clause 3.8.7 of AAR S-9152.V2.1. The cab unit shall declare a front to rear communication failure on front to rear radio link failures lasting for duration of 16 minutes 30 seconds or greater. Front to rear radio link failures lasting less than 16 minutes 30 seconds shall not be declared as front to rear communication failure. This alarm will be cleared by the next successful front to rear /rear to front confirmation cycle (automatically or manually initiated). Minimum polling of

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at least once every 2 minutes must be maintained or as often as necessary to minimize loss of front to rear communications exceeding the 16 minutes 30 seconds limit. Front to rear communication failure shall also be tested and declared during an attempted emergency activation.

### 3.7.15 **Front to Rear Message Retries**

Front to Rear Message Retries shall be handled as per clause 3.8.8 of AAR S-9152. For emergency brake application commands, the retries will continue until a status update indicates that the rear unit has received the command by setting the confirmation bit in the update. Thereafter, if the rear brake pipe pressure has not been reduced to a level below 5 psi within 4 seconds, another retry will be made and again the confirmation bit looked for. This process will repeat up to a maximum time of 2 minutes after the last emergency switch activation. If a confirmation bit has not been received within 15 seconds of the initial or 4 seconds retry emergency command, front to rear communication failure will be declared.

For manually initiated status information update requests, the cab unit will not transmit any retries automatically nor cause a communication failure indication.

### 3.7.16 **Front to rear communications**

Front to rear communications protocols and data message formats shall be as per clause 3.9 of AAR S-9152 & TFR BBB1776 except the radio frequency used for radio communication.



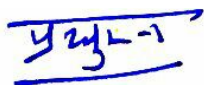
### 3.7.17 **Rear to front communications**

Rear to Front communications protocols and data message formats shall be as per clause 3.7 of AAR S-9152 & TFR BBB1776 except the radio frequency used for radio communication.

### 3.7.18 **Failure of communication in unit of time, incidences & location and unique ID or serial number of EoT device, between EoT device & HoT device must be logged for 30 days.**

### 3.7.19 **Logging of alarms and performance of both HoT device and EoT device;**

- a. The EOTT performance must be continuously monitored and logged by the EoT against time & position [GPS Coordinates] along the line, and stored in memory, so that the same is available for download at the end of the trip (through the USB port). To achieve this EoT device must make use of a GPS unit so as to track its position against real (GPS time).
- b. All communication messages received by the HoT device, as well as alarms, are to be logged versus time and GPS Coordinates. The HoT device time must be synchronized

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with that of the EoT device. Syncing of Real Time Clock (RTC) with GPS should be done at least once in 24hours. Data downloading from Master HoT through USB port.

3.7.20 Same single frequency shall be used for front to rear and rear to front communications for help in implementing repeater functionality in HoT.

3.7.21 RDSO may issue communication protocols and other technical details separately for standardization of EoTT.

### 3.8 Capturing and transmission of data by EoTT (HoT & EoT) Devices to server

#### 3.8.1 When Locomotive battery supply is available to HoT (HBA is in ON) and HoT battery is charging



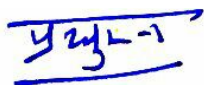
- End of Train Telemetry functions will continue as defined in various paragraphs.
- GPS data shall be captured every 05 seconds by the GPS device of HoT.
- Data transfer shall be every 60 seconds (1 minute) or less to the server.
- If due to any reason, data transfer to server is not successful, the data shall be stored in the HoT memory and will be transferred to the server at the earliest opportunity.

#### 3.8.2 When Locomotive battery supply is available to HoT (HBA is in ON) and HoT battery is not charging (charging system of HoT fails)

- End of Train Telemetry functions will continue as defined in various paragraphs.
- GPS data shall be captured every 20 minutes by the HoT device and transferred to the server.
- If due to any reason, data transfer to server is not successful, the data shall be stored in the HoT memory and will be transferred to the server at the earliest opportunity.
- For the remaining period GPS device will be in sleep mode for conserving the battery and will wake up every 20 minutes to capture and transfer GPS data. During sleep mode GPS will be active but no data transfer shall be carried out.

#### 3.8.3 When Locomotive battery supply is not available to HoT (HBA is in OFF)

- If battery supply is not available, locomotive cannot function and hence End of Train Telemetry function will also not be required. However, GPS functionality is required to trace the dead locomotive.
- GPS data shall be captured every 20 minutes by the HoT device and transferred to the server.
- If due to any reason, data transfer to server is not successful, the data shall be stored in the HoT memory and will be transferred to the server at the earliest opportunity.

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- d. For the remaining period GPS device will be in sleep mode for conserving the battery and will wake up every 20 minutes to capture and transfer GPS data. During sleep mode GPS will be active but no data transfer shall be carried out.

#### 3.8.4 When Air Turbine/Generator unit supply is available to EoT

- a. End of Train Telemetry functions will continue as defined in various paragraphs.
- b. GPS data shall be captured every 05 seconds by the GPS device of EoT.
- c. Data transfer shall be every 60 seconds (1minute) or less to the server.
- d. If due to any reason, data transfer to server is not successful, the data shall be stored in the EoT memory and will be transferred to the server at the earliest opportunity.

#### 3.8.5 When Air Turbine/Generator unit supply is not available to EoT

- a. End of Train Telemetry function will continue as defined in various paragraphs.
- b. GPS data shall be captured every 20 minutes by the EoT device and transferred to the server.
- c. If due to any reason, data transfer to server is not successful, the data shall be stored in the EoT memory and will be transferred to the server at the earliest opportunity.
- d. For the remaining period GPS device will be in sleep mode for conserving the battery and will wake up every 20 minutes to capture and transfer GPS data. During sleep mode GPS will be active but no data transfer shall be carried out.

### 3.9 Memory for the system :

3.9.1 Both EoT & HoT Device shall have the capacity to store the data for at least 30 days.

3.9.2 Vendor server shall have capacity to store the data for at least 90 days.

3.9.3 Calculations of data packet size to be provided by the vendor.



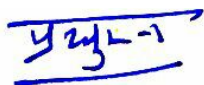
### 3.10 Web Page Functional Overview

3.10.1 The webpage layout developed by the firm will be approved by RDSO to ensure uniformity.

3.10.2 The webpage shall display the EoTT data, alarms, messages & GPS location of HoT & EoT.

### 3.11 LV Marking on EoT



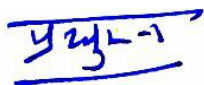
'LV' of suitable size shall be written on the EoT with retro reflective material.

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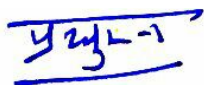
**CHAPTER - 4****ENVIRONMENTAL CONDITIONS**

- 4 The climatic and environmental conditions prevailing in India in the area of operations are the following:

A. Atmospheric temperature	<ul style="list-style-type: none"> <li>• Maximum temperature: 50 °C</li> <li>• Maximum touch temperature of metallic surface under the Sun: 75 °C and in shade: 55 °C</li> </ul> <p>Maximum temperature near electronic cards in un-energized condition of locomotive standing under direct sunlight during summer: 70 °C</p> <ul style="list-style-type: none"> <li>• Maximum temperature near electronic cards in working condition of locomotive during summer: 65 °C</li> <li>• Minimum temperature: - 10 °C</li> </ul> <p>( Also snow fall in certain areas during winter season)</p>
B. Solar radiation	1 kW/m <sup>2</sup>
C. Humidity	100% saturation during rainy season
D. Altitude:	1776 m above mean sea level
E. Rain fall:	Very heavy in certain areas.
F. Wind speed	High wind speed in certain areas, with wind pressure reaching 150 kg/m <sup>2</sup>
G. Atmospheric conditions	Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m <sup>3</sup> . In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system. The system shall be able to work at the maximum specified ambient temperature inside the locomotive without any pre-cooling requirement.
H. Coastal area	<ul style="list-style-type: none"> <li>• Humid and salt laden atmosphere with maximum pH value of 8.5,</li> <li>• Sulphate of 7 mg per liter,</li> <li>• Maximum concentration of chlorine 6 mg per liters and</li> <li>• Maximum conductivity of 130 micro siemens / cm</li> </ul>
I. Vibration & Shock	The equipment shall be designed to withstand the vibrations and shock encountered in service satisfactorily as specified in <b>Clause 2.1.4.4 of AAR S-9152 V2.1</b> . The vibration test shall be done as mounted in the actual operating condition.
J. Electro-magnetic	High degree of electromagnetic pollution is anticipated in locomotive machine room, where the equipment will be mounted. Necessary

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Pollution	precaution should be taken in this regard. The equipment shall be design to cater to the EMC/EMI requirements as per IEC 61000 -4-6 (latest).
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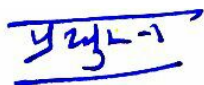
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## CHAPTER – 5

### SCOPE OF SUPPLY



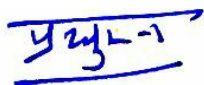
- 5.1** Scope of the specification is Supply, commissioning and installation of the EoTT device along with Antenna unit and associated wiring.
- 5.2** Installation, commissioning and maintenance (during warranty period) is in the scope of supply.
- 5.3** The following will be the scope of supply:-

SN	Items	Quantity per locomotive
I.	HoT device along with Display Units (DU) Power Supply cables, mounting brackets, etc.	01 set
II.	EoT unit along with Sense & Brake Unit (SBU), Air Turbine/Generator for SBU etc.	01 set
III.	Antennas, connectors, couplings mounting brackets, power supply, Mounting brackets, etc.	As per requirements.
IV.	Battery charging arrangement for charging EoT device while being stowed and transported on locomotive (in the event of having to run locomotive without the attached train	01 No.
V.	All necessary parts and accessories that will be required to attach the equipment to the locomotive and last vehicle of the train.	As per requirements
VI.	Any other item, hardware, software etc. as required for making the supply fully functional and operational as per this specification.	As per requirements
VII.	Cables for connecting EoTT device to loco battery	01 set
VIII.	Cables for connecting Antenna unit to EoTT device (if applicable, in case of external antenna).	01 set
IX.	Installation, Operation & Maintenance Manual	01 set
X.	Spares Catalogue in print	01 set
XI.	Above mentioned documents in s.n. (IX), (X) on software media preferably as PDF document suitably cross-linked/hyperlinked with short tutorial videos/animations.	01 set
XII.	One Track-Side / Fixed Repeater unit shall also be supplied for every five sets of EoTT equipments supplied.	01 set

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**CHAPTER - 6****INSPECTION & TESTING****6.1 INSPECTION:**

- 6.1.1** The system shall be tested generally in accordance with the IEC: 60571:2012-09 (or latest). Dry Heat test of the Electronics shall be carried out at 85° C as per IEC: 60571. All optional tests mentioned in various standards shall also be carried out. Details shall be worked out during design approval. Type tests shall be carried out by the vendor at his own responsibility and cost.
- 6.1.2** The vendor shall formulate and submit a type test protocol / plan at design approval stage for approval of RDSO before undertaking manufacturing. It shall, however, be open for RDSO to waive some of tests in case of equipment and sub-assemblies, where the vendor can establish it for the requirements of this specification that such tests have already been carried out earlier on the same equipment and where equipment has been proved in prolonged service.
- 6.1.3** Modifications found necessary as a result of the tests/trials shall be incorporated by the vendor at his own cost in the locomotives in a manner approved by the Purchaser. Drawings incorporating the modifications found necessary, as a result of tests and trials, shall be submitted to RDSO for final approval.
- 6.1.4** The vendor shall offer all the testing facilities free of charge to inspecting authority. Testing of equipment and fittings shall, as far as possible be carried out at the works of the vendors. Testing of bought out components may also be carried out at sub-vendor's premises, if so required. The vendor shall provide free of charge, such materials or fittings as may be required for testing whether at his own or his sub vendor's premises. The test for which facilities are not available may be carried out at RDSO or any other approved laboratory for which the testing charges shall be payable by the vendor.
- 6.1.5** All the equipments and the fittings required for testing shall be selected by the inspecting officer and the tests shall be carried out in his presence.
- 6.1.6** No material shall be packed or dispatched until it has been passed by the inspecting officer but the vendor's responsibility for its efficiency in every way, shall remain the same as if the work had been manufactured and tested by himself.
- 6.1.7** Should any part require alteration or any defect appear during the testing or trial, the vendor shall without any extra charges make such alteration or rectify the defects to the satisfaction of the inspecting authority.
- 6.1.8** Copies of Maker's test certificate, guarantee the performance of the equipment shall be supplied in duplicated along with the delivery of each unit.
- 6.1.9** The inspecting authority shall:-
- 6.1.9.1** Visit at any reasonable time and without previous notice, either vendor's works or his sub-vendor's works to inspect the vendors and the quality of the work at any stage.

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- 6.1.9.2** Reject any materials or fittings that does not conform to the relevant standard/ specifications or have not been manufactured in accordance with the approved practices. The rejected materials or fittings shall be marked in a distinguishable manner and shall be disposed on in such manner as the inspecting officer may direct to avoid its inadvertent use in the product order as per this specification.



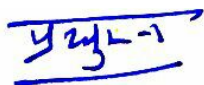
## 6.2 CATEGORIES OF TEST:

### 6.2.1 Type test:

- a. Type test as per scheme enclosed below shall have to be carried out by the firm in their premises and their results shall have to be submitted to IR along with equipment:

S. No.	Item description	Testing standard
1	HoT and EoT unit	IEC 60571,
2	Antenna assembly unit	IEC 60571
3	Radio Modem	EN 50155, EN 300 113-1
4	Operating keys	IEC 60571, TFR BBF0334 V5
5	For testing effect of working environmental conditions	AAR S-9152
6	High Visibility Marker Light (HVML), Disabled Train Warning Light (DTWL)	AAR S-9152



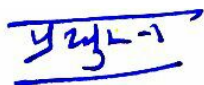
- b. After the type tests, the EoTT shall continue to work but it shall then not be deployed in service and it will not be supplied to Railways. Such type tested device may be used for demonstration and training purposes by the firm.
- c. Type test shall be carried out on equipment of the approved design. If there is any change in design or source of supply of any components/sub-components/assembly, units made to the changed design or from new source shall be treated as new item for the purpose of conducting type tests.
- d. Type tests are to be repeated in case of any major change is made. In case of minor changes, i.e. change in type, rating of component etc., special test/tests as agreed by user and vendor are to be conducted to ensure their suitability and effectiveness of the modifications.
- e. Tests will be carried out on the prototype unit as per relevant IEC specifications or mutually agreed test program. Vendor will bear the expenses of the tests.

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**6.2.2 Routine test:**

- a. Following routine tests besides other tests, as deemed fit to ensure quality, reliability and compliance of this specification shall be done by the manufacturer on all the units. Parameters measured after Burning-in test shall be recorded and enclosed with every unit:
  - i. Visual inspection of each unit as feasible through visual inspection.
  - ii. Performance Parameters and  
Low battery indication test
  - iii. Verification of marking
  - iv. Insulation test
  - v. Voltage withstand (Dielectric) test
  - vi. Reverse polarity test (For HoT only)
- b. Test record shall be properly maintained with traceability to lot/samples tested, which may be verified by inspecting officials.
- c. Manufacturer shall maintain proper accountal of LEDs, switches and all electronic components being used. The record shall include various details like source of supply, procurement invoice no. and date, quantity, incoming rejection, lot-wise consumption etc. which may be verified by inspecting officials.
- d. The tests to be carried out are given in the following table, together with the clause number of IEC 60571 ed-3 2012-09.

SN	TESTS	IEC CLAUSE NO.	TYPE TEST	ROUTINE TEST
I.	Visual Inspection	12.2.2	✓	✓
II.	Performance test	12.2.3	✓	✓
III.	Voltage variation test	12.2.3	✓	--
IV.	Cooling Test (Cold Start Test)	12.2.4	✓	--
V.	Temperature rise test (Dry heat)	12.2.5	✓	--
VI.	Temperature rise (damp heat cyclic)	12.2.6	✓	--
VII.	Supply over voltage test	12.2.7	✓	--
VIII.	Surges test	12.2.8.1	✓	--
IX.	Electrostatic discharge test (ESD)	12.2.8.2	✓	--
X.	Transient burst susceptibility test	12.2.8.3	✓	--
XI.	Radio Interference test	12.2.9	✓	--
XII.	Insulation test	12.2.10.2	✓	✓

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SN	TESTS	IEC CLAUSE NO.	TYPE TEST	ROUTINE TEST
XIII.	Voltage withstand (Dielectric) test	12.2.10.3	✓	✓
XIV.	Salt mist test	12.2.11	✓	--
XV.	Vibration and shock test	As per clause 2.1.4.4 of AAR S- 9152.V2.1	✓	--
XVI.	Water tightness test for external units like EoT/HoT , Antenna etc.	12.2.13	✓	
XVII.	Reverse polarity test (For HoT only)	--	✓	✓
XVIII.	Special tests		✓	

### 6.2.3 DETAILS OF TESTS:

#### a. VISUAL INSPECTION:



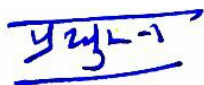
The object of visual inspection is to check that the equipment is free from defects and the equipment is as per approved drawing. Bill of materials will be submitted. The make, rating of equipment, subassemblies will be checked with the details as per approved design document. If a change is needed in make or rating of important equipment, sub-assemblies, it should be intimated and should have proper approval of RDSO. EoTT device with modified equipment, subassemblies will be given separate revision number. All the important dimensions will be measured and should be in permissible tolerance. Visual inspection is to mainly verify cable marking, cable clearance, creepage distance etc. Bill of material is also to be verified.

#### b. PERFORMANCE TEST:

Measurements shall be carried out at the ambient temperature.

The performance test shall consist of a comprehensive series of measurements of the characteristics of the equipment to check that its performance is in accordance with the functional requirements of the particular equipment concerned, including any special requirements of its individual specification, and general requirements of this standard. Performance test procedure will be submitted by the vendor for approval.

These tests are carried out to check and ensure that the performance of the equipment is in order.

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c. **VOLTAGE VARIATION TEST:**

This test shall be carried out as per clause 12.2.3 of IEC 60571. During the test, system voltage shall be as per clause 3.2.5 of chapter 3.

d. **COOLING TEST:**

This test shall be carried out as per clause 12.2.4 of IEC 60571. Bring down the temperature of the equipment to  $-10^{\circ}\text{C} \pm 2$  and keep it at the temperature for 2 hours. In this test equipment shall be in energised condition and the working of the system will be checked. Insulation test, Dielectric test at 85% voltage of the previous test and performance test will be carried out after the recovery period of 3 hrs.

e. **TEMPERATURE RISE TEST (DRY HEAT):**

This test shall be carried out as per clause 12.2.5 of IEC 60571. The temperature of the equipment will be raised to  $85^{\circ}\text{C}$  at the rate of  $1^{\circ}\text{C}$  at 1.5 minute and to be kept at that temperature for 6 hours. In this test equipment shall be in energised condition and working of the system will be checked. Insulation test, Dielectric test at 85% voltage of the previous test and performance test will be carried out after the recovery period of 3 hrs. This test can be performed without battery with similar rating of power supply as per battery parameters connected to device.

f. **TEMPERATURE RISE (DAMP HEAT):**

This test shall be carried out as per clause 12.2.6 of IEC 60571. Damp heat test shall be done keeping the equipment in de-energised condition. It is to be ensured that the RH of the oven should be between 80 to 100% during the above test. The temperature of the equipment is to be raised from ambient to  $55^{\circ}\text{C}$  in 2 hours and kept at that temperature for 6 hours. The temperature of the equipment  $55^{\circ}\text{C}$  should be brought down to ambient (recovery period) in 3 hours. The cycle is to be repeated at least two times and carry out insulation test, Dielectric test at 85% voltage of the previous test and performance test.

g. **SUPPLY OVER VOLTAGE, SURGES AND ELECTROSTATIC DISCHARGE TEST:**



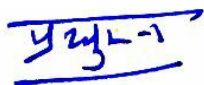
The test shall be conducted as per IEC-60571.

h. **OVER VOLTAGE TEST:**

The test shall be conducted as per clause 12.2.7 of IEC-60571.

i. **SURGE TEST:**

The test shall be conducted as per clause 12.2.8.1 of IEC-60571. The surge pulse shall be 2 kV, 1.2/50 micro Second.

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**j. ELECTROSTATIC DISCHARGE TEST:**

The test shall be conducted as per clause no. 12.2.8.2 of IEC-60571.

- |                                       |                            |
|---------------------------------------|----------------------------|
| a) Level                              | : 3 (As per IEC 61000-4-2) |
| b) Test voltage for contact discharge | : +/- 6kV                  |
| c) Test voltage for air discharge     | : +/- 8kV                  |
| d) Polarity                           | : Positive & Negative      |
| e) No. of discharge                   | : 10 at each point         |

**k. TRANSIENT BURST SUSCEPTIBILITY TEST:**

This test shall be conducted as per clause no. 12.2.8.3 of IEC-60571. The complete system in simulated condition shall be put for the test as specified in IEC.

During test the equipment shall be watched for malfunctioning or Communication between both units shall be observed for proper functioning of equipment. No degradation of the system & malfunctioning should be allowed during or after the test.

**l. RADIO INTERFERENCE TEST:**

This test shall be conducted as per clause no. 12.2.9 of IEC-60571.

Electronic Equipments provided on locomotives conform to IEC:60571 and have been tested to meet the environmental requirement including that of EMI & EMC as per IEC:61000-4. The limit of radiation which the system on the locomotive can withstand are:-

- Radiated emission 10V/m (in range of 150KHz to 1GHz)
- Conducted emission 2 KV Surge.

**m. INSULATION TEST:**



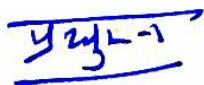
This test shall be carried out as per clause 12.2.10 of IEC-60571. Insulation resistance shall be measured with megger of 500V. The time of the meggering shall not be less than 60 Sec.

**n. Voltage Withstand Test (DIELECTRIC TEST):**

The test shall be carried out as per clause 12.2.10.3 of IEC-60571. Applied voltage shall be of sine wave, 50 or 60 Hz for one minute between the terminals that interface with locomotive short circuited and the metallic frame of the assembly box.

**o. SALT MIST TEST:**

The test is to be carried out on complete EoTT device as per clause 12.2.11 of IEC-60571. Duration of the test shall be for four hours.

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**p. VIBRATION AND SHOCK TEST**

The test is to be carried out as per clause 2.1.4.4 of AAR S-9152.V2.1.

**a) Vibration****i. Vertical & lateral:**

1Hz to 15 Hz, 0.5 g peak to peak

15Hz to 500 Hz, 5g peak to peak

**ii. Longitudinal:**

1Hz to 15 Hz, 3g peak to peak

15Hz to 500 Hz, 5g peak to peak

**b. Shock:**

10g peak for 10 ms in any axis.

After the test there shall be no resulting damage, abnormality in the operation of equipment. After completion of mechanical endurance test, vibration and shock tests, the equipment shall again be subjected to dielectric test and performance test.

**q. WATERTIGHTNESS TEST:**



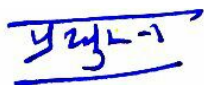
This test will be done for EoTT device as per IEC 60529.

**r. REVERSE POLARITY TEST:**

The equipment shall be tested to verify the reverse polarity protection by making the connection to reverse polarity and unit shall work normal after restoring the connection to correct polarity.

**6.2.4 SPECIAL TESTS**

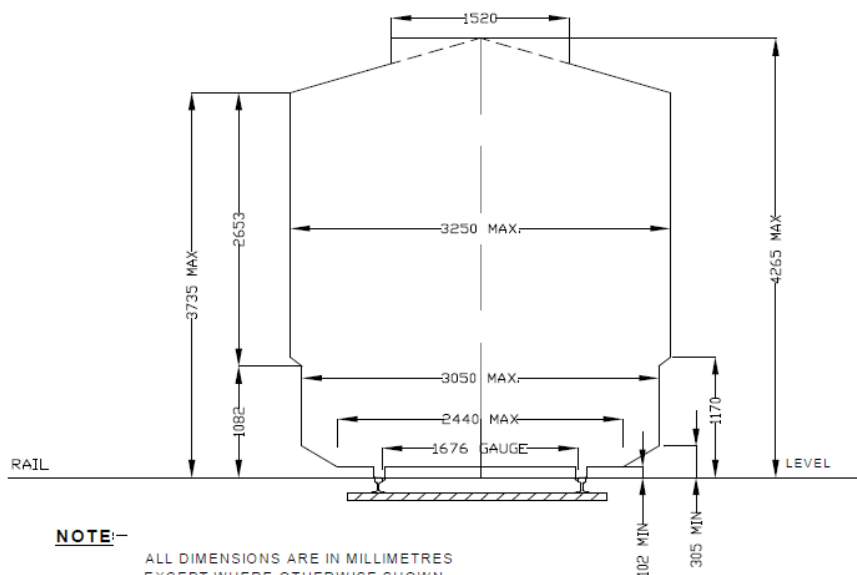
- a. Drop Test: The test lamp including the complete SBU shall withstand free drop from a height of 1.5 meters above an RCC platform on 75 mm thickness or on a steel plate 12 mm thick. For the purpose of the drop test, the complete units shall be powered up and after dropping the same twice, the units shall continue to function effectively, satisfy all parameters. Appearance of cracks on the body shall not be deemed as disqualification as long as units continue to function. The units, however, shall not disintegrate upon falling.
- b. Vendor shall submit make, grade and data sheet of all major electronic components and switches for verification during type testing of EoTT. Vendor shall also submit chemical composition and relevant IS or international specification of all metallic components used and housing of marker device.
- c. IP Protection Tests: Testing will be carried on EoT and HoT for IP 54 protection and on antennae for IP66 protection as per IEC 60529.
- d. Visibility test of HVML & DTWL.
- e. Illumination level Test for HVML & DTWL.

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**ANNEXURE- I**

Addendum &amp; Correction Slip (ACS) No. 14 to Indian Railways Schedule Of Dimensions (B.G.) 2004

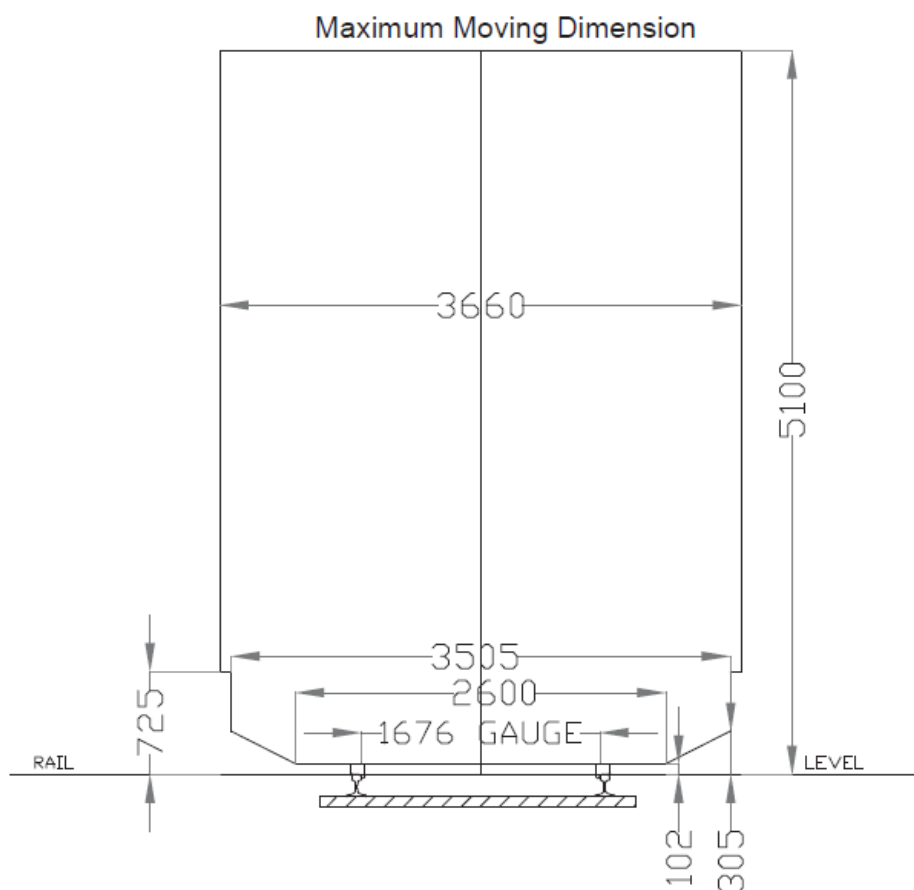
DIAGRAM No. 1D (EDO/T-2202)  
1676mm GAUGE

**MAXIMUM MOVING DIMENSIONS****NOTE:-**



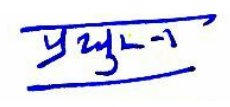
ALL DIMENSIONS ARE IN MILLIMETRES  
EXCEPT WHERE OTHERWISE SHOWN.

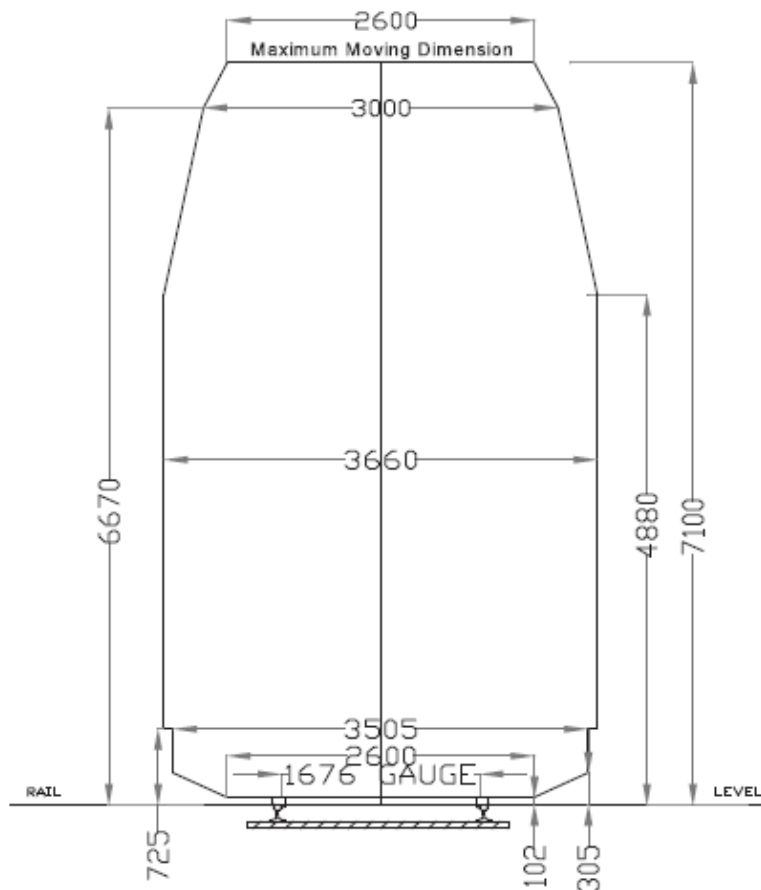
Railway Board's letter no. 2012/CEDO/SD/IRSOD/O/03, dated 18.11.2013

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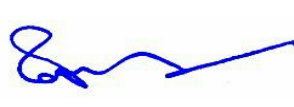
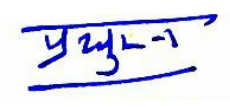
**ANNEXURE- II****DIAGRAM No. - 4**  
**1676mm GAUGE****MMD OF DFC FOR EASTERN CORRIDOR****NOTE :-**

ALL DIMENSIONS ARE IN MILIMETERES  
EXCEPT WHERE OTHERWISE SHOWN.

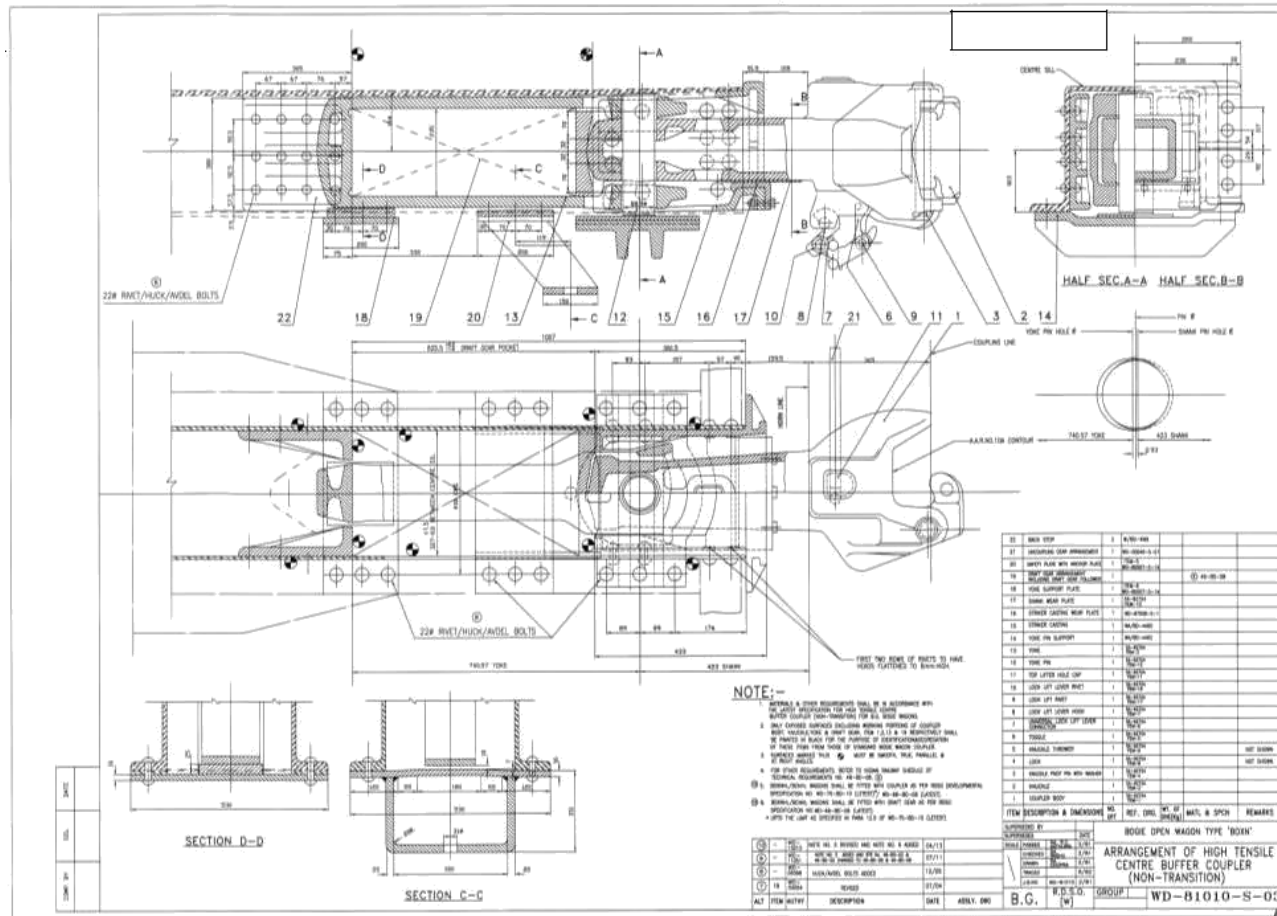
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**ANNEXURE- III****DIAGRAM No. - 8**  
**1676mm GAUGE****MMD OF DFC FOR WESTERN CORRIDOR****NOTE :-**

ALL DIMENSIONS ARE IN MILLIMETERES  
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## ANNEXURE - IV



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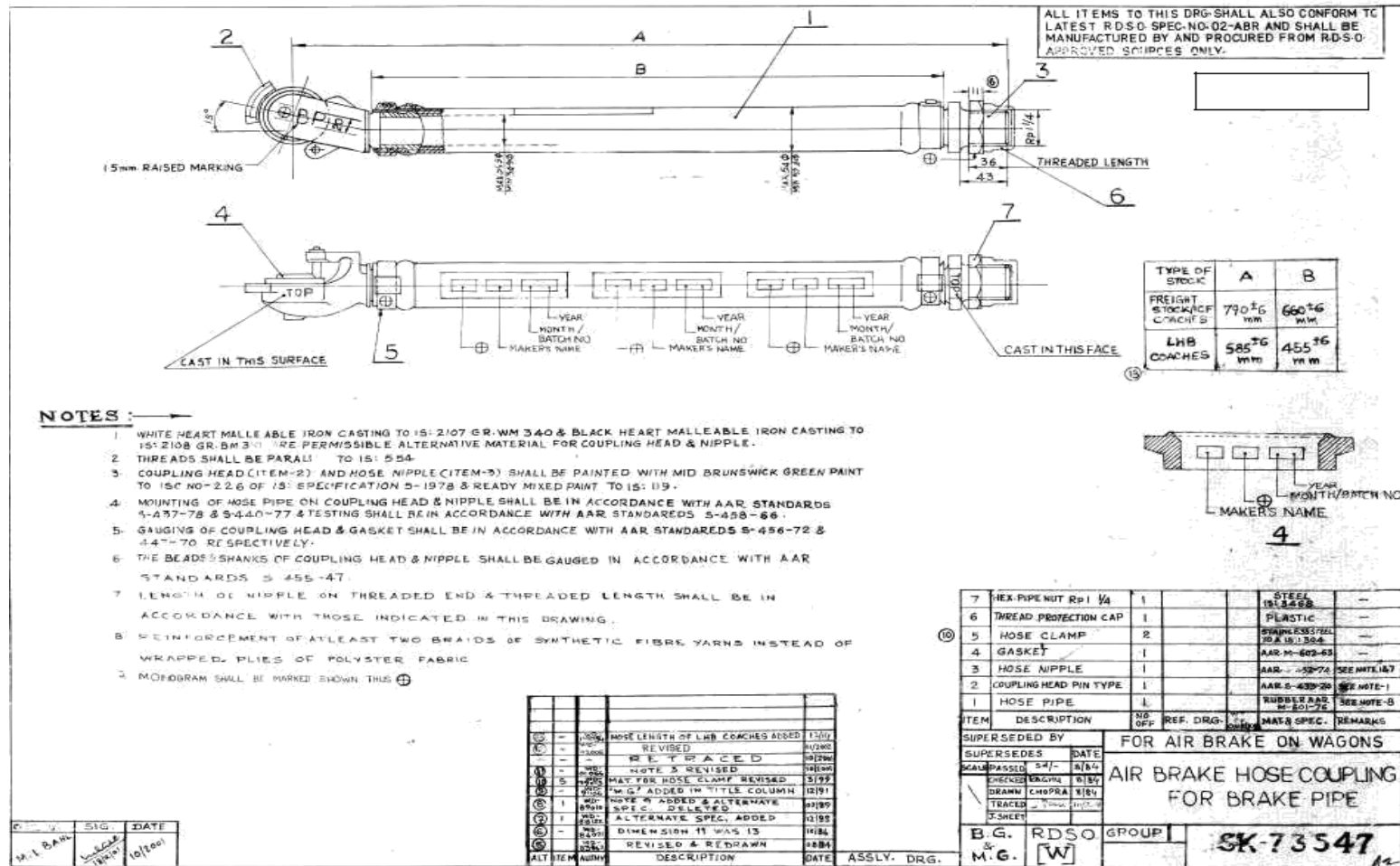
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## ANNEXURE - V



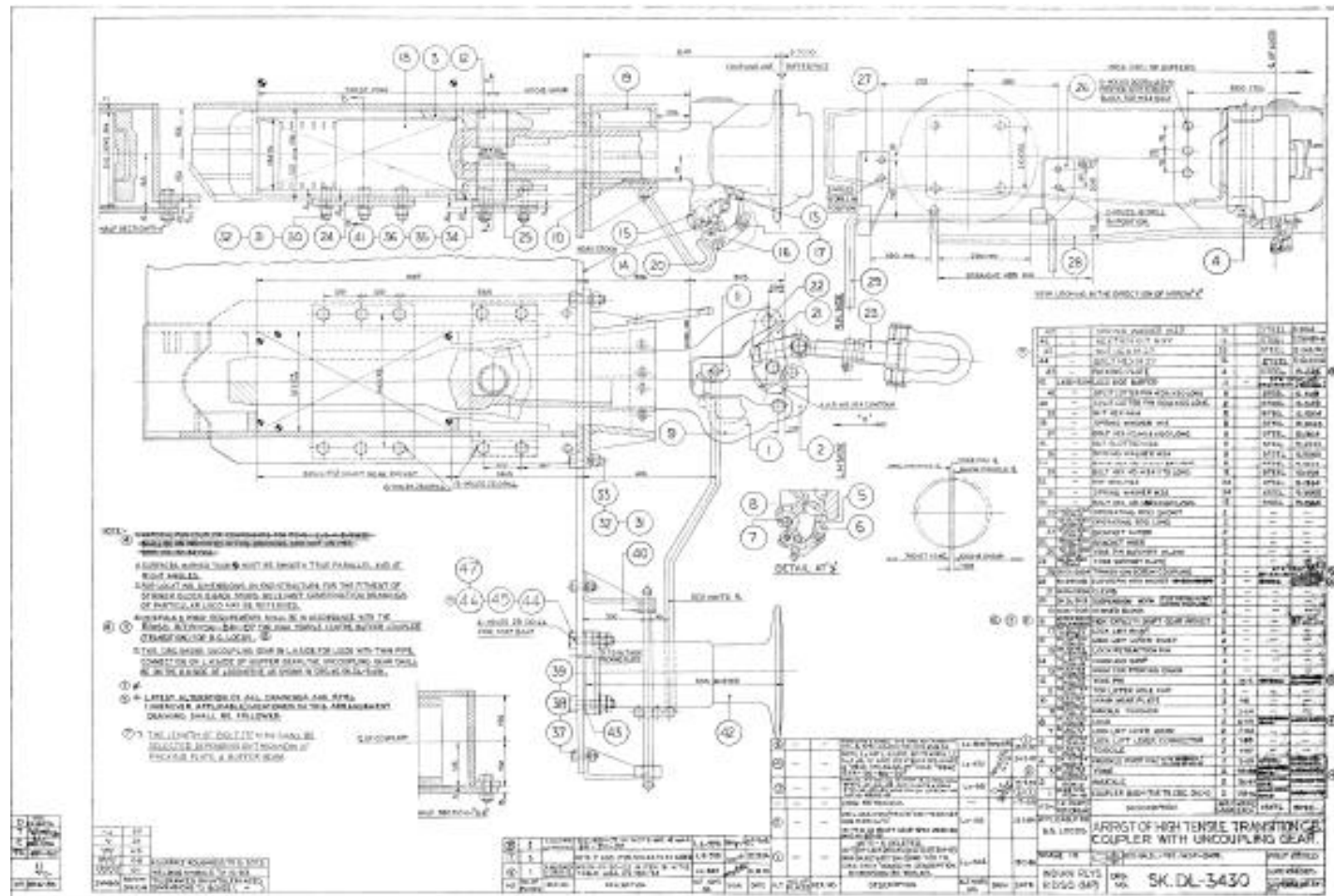
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## ANNEXURE – VI



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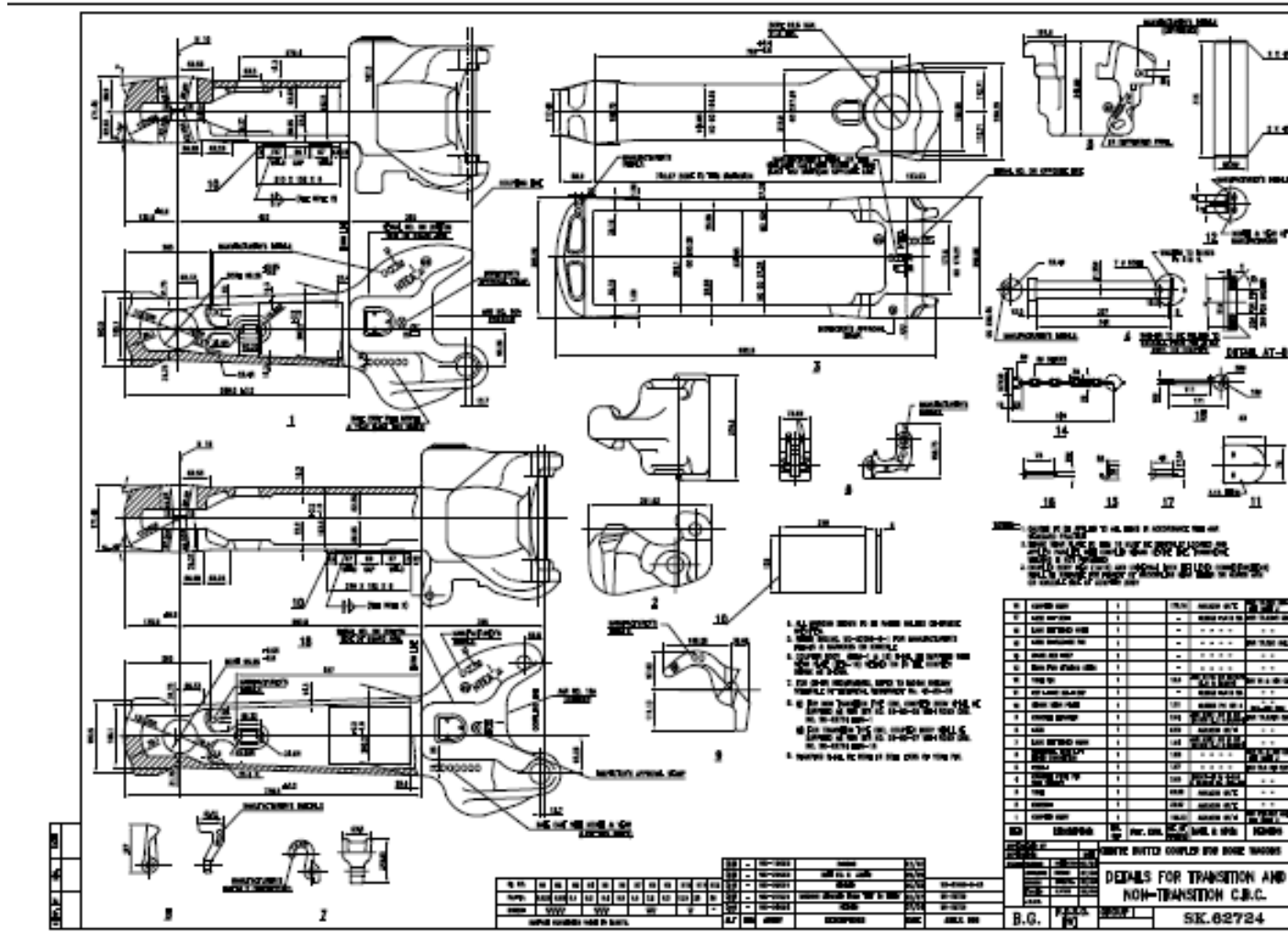
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