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Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

RESEARCH DESIGNS & STANDARDS ORGANISATION
MANAK NAGER, LUCKNOW - 226011



SPECIFICATION FOR
Advanced Auxiliary Warning system (AAWS)

Specification No. RDSO/SPN/213/2014
Version 1.0 (Draft)

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
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Abstract This document defines specification for - Advanced Auxiliary Warning system (AAWS)			

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
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AMENDMENTS:

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Table of Content

	Page No.
0 Foreword	6
1 Scope	6
2 General Requirements	6
3 Functional Requirements	7
4 Technical details of the onboard system	10
5 Technical details and functional interface properties of the track side system	17
6 Maintenance, Testing & Diagnostic requirements	24
7 Tests & Requirements	25
8 Quality Assurance	28
9 Packing	29
10 Information to be supplied by the Manufacturer	29
Annexure – I –to-- VI(c)	30-39
Annexure—I Outline and mounting details of BAU.	
Annexure—II Outline and mounting details of Engine Magnet	
Annexure—III Outline and mounting details of Indication Panel	
Annexure—IV Outline and mounting details of Isolating Switch Unit.	
Annexure—V Schematic sketch of IP.	
Annexure –VI (a) Placement of Track magnet- schematic sketch	
Annexure –VI (b) Placement of Track magnet- existing photo	
Annexure –VI (c) Track device installation detail	

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ABBREVIATIONS:

RDSO	RESEARCJH DESIGNS AND STANDARDS ORGANIZARION
SPN	SPECIFICATION
AAWS	ADVANCED AUXILIARY WARNING SYSTEM
IRS	INDIAN RAILWAY STANDARDS
IS	INDIAN STANDARDS
AWS	AUXILIARY WARNING SYSTEM
SPAD	SIGNAL PASSED AT DANGER
GPS	GLOBAL POSITIONING SYSTEM
GPRS	GENERAL PACKET RADIO SERVICE
PC	PERSONAL COMPUTER
IR	INDIAN RAILWAY
KMPH	KILOMETER PER HOUR
DC	DIRECT CURRENT
EMU	ELECTRIC MULTIPLE UNIT
DMU	DIESEL MULTIPLE UNIT
EBC	EMERGENCY BRAKE COUNTER
CPU	CENTRAL PROCESSING UNIT
PCB	PRINTED CIRCUIT BOARD
EM	ENGINE MAGNET
IP	INDICATION PANEL
BAU	BRAKE ACTUATING UNIT
ISU	ISOLATION UNIT
CAB	CABIN
EP	ELECTRO-PNEUMATIC
SFBB	SIGNAL FAILURE BY-PASS BUTTON
VPS	VIGILANCE PUSH BUTTON
SFBC	SIGNAL FAILURE BY-PASS COUNTER
LED	LIGHT EMITING DIODE
EBRR	EMERGENCY BRAKING REVERSE RELAY
EBNR	EMERGENCY BRAKING NORMAL RELAY
SBR	SERVICE BRAKING RELAY
BCR	BRAKE CONTROL RELAY
MCB	MINIATURE CIRCUIT BREAKER
KHz	KILO HERTZ
ATM	ADDITIONAL TRACK MAGNET
LC	LEVEL CROSSING
STR	SCHEDULE OF TECHNICAL REQUIREMENTS
MHz	MEGA HERTZ
EPROM	ERASABLE PROGRAMMABLE READ ONLY MEMORY
EMI	ELECTRO MAGNETIC INTERFERENCE
EMC	ELECTRO MAGNETIC COMPATIBILITY
IEC	INTERNATIONAL ELECTRO TECHNICAL COMMISSION
QAP	QUALITY ASSURANCE POLICY
UV	ULTRA VIOLET
VCD	VIGILENCE CONTROL DEVICE

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

0 FOREWORD:

0.1 This specification is issued under the fixed serial number RDSO/SPN/213 followed by the year of adoption as standard or in case of revision, the year of latest revision.

0.2 This specification requires reference to the following specifications:

IRS: S23 Electrical signalling and interlocking equipment.

RDSO/SPN/144 Safety and reliability requirements of electronic signalling equipment.

IS: 9000 Basic environmental testing procedures for electronics and electrical items.

IEC 60571 General requirements and tests for electronic equipments

0.3 Whenever, reference to any specification appears in this document, it shall be taken as a reference to the latest version of that specification unless the year of issue of the specification is specifically stated

1 SCOPE:

1.1 This specification covers the functional requirements of Advanced Auxiliary Warning **System (AAWS)** for carrying out following functions:

- Providing train protection functions similar to AWS system in use in Mumbai suburban section.
- Be interoperable with existing AWS system in Mumbai suburban(Interoperability is required only in communication with track magnet , on board equipment design can vary from one manufacturer to other,however it should meet the requirements mentioned in this specification) section including use of similardriver interface as existing.

2 GENERAL REQUIREMENTS:

2.1 AWS system in use in Mumbai suburban is required to be continued until an alternative is identified and implemented in both trackside and onboard systems. This necessitates provision of additional onboard systems in large number of new rakes being introduced in Mumbai suburban section. Some of the components have been identified as obsolete for the existing onboard system and hence a modern equivalent system (to be known as **Advanced Auxiliary Warning System – AAWS**) is required to be

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

designed and developed that can be used as for one to one replacement for existing onboard system of AWS system.

- 2.2 The vendors shall develop onboard systems / track side system or both systems as per this specification.

3 FUNCTIONAL REQUIREMENTS:

3.1 Introduction:

Advanced Auxiliary Warning System (AAWS) is a microprocessor/Microcontroller based control system, which continuously monitors the speed, direction of travel, distance traveled, aspect of the signal passed and the alertness of the Motorman and thus increases the safety of railway system.

- 3.2 It is a safety device preventing the unsafe situations due to the human failure. It compels the Motorman to obey the aspect of the signal and maintain the correct speed otherwise it applies brakes to decelerate the train to a stop. If it is not well acknowledge with in time AAWS decelerates the train and applies brake to stop train.

- 3.3 The AAWS System shall consist of:
- On-Board System
 - Track device

3.4 Main Functions:

3.4.1 The main functions of this system are:

- AAWS will be provided on sections equipped with Multi Aspect Colour Light Signalling and train driver will follow Line Side signals as per prevalent operating rules. Provision of AAWS will be an additional safety aid to the train driver to prevent consequences arising out of Signal Passing At Danger (SPAD) and to control train speed within specified Limits.
- Prevent to train moving faster than its allowed speed.
- Audio visual assistance to the driver about speed.
- Check vigilance/alertness of driver, while passing signals other than proceed & attention.
- Continuous monitoring of train speed including defined speed restrictions.

3.5 GPS:

- It should be possible to track the position of cab unit continuously with a tracking interval of not more than 60secs, configurable up to 1 second in steps of one second.

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

- Entire traveling distance of the cab should be tracked.
- Position data of the cab unit should be continuously sent to remote server.
- In case of track magnet failures like 1. DIP received but frequency not received. 2. Frequency received but DIP not received. 3. Invalid frequencies received. 4. Multiple frequencies received etc. The message shall be transferred to server so that same can be informed to maintenance team for necessary corrective and preventive action.
- In a fixed route GPS coordinates of track magnet has to be registered in on board system based on few trips data. Same shall be used to detect location of track magnet. In future this data can be used for diagnostic applications.
- It would be desirable to link this event logger to a GPS device and GPRS modem to automatically transmit AAWS malfunctioning data to a centralized location for identification of exact location of AAWS malfunctioning immediately. Whenever data is available with AAWS it should be transmitted to server, if GPRS coverage is not available, data should be transferred immediately when AAWS comes into coverage area.
- The accuracy of GPS device shall be as under:
 - i) Autonomous Positional accuracy shall be better than 10 meters.
 - ii) Tracking sensitivity shall be better than -150dbm.
 - iii) It shall support NMEA protocol.
 - iv) Re-acquisition sensitivity -160dbm.
 - v) Update rate shall be 4 Hz or better.

3.6

EVENT LOG:

- All the events and faults occurring in the system should be recorded.
- It should be possible to download the selected data to PC/laptop with standard interface in a user friendly manner. The connection may be wired through RS232/USB/Ethernet etc.
- All these events and fault logging data should be available in central server for IR staff review and data analysis through GPRS. Data format and protocol for data transfer to server will be developed by vendors in consultation with RDSO so that a common protocol suitable to all vendors will be framed. But

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

in all cases parameters to be displayed on server should be same by all vendors.

- Once the data is at the centralized server, analysis should be conducted via wired LAN connected to the server.
- Memory capacity of event logger in on board system shall be sufficient to keep log of minimum last 15 days train running data. The memory shall keep log on First-In-First-Out basis.
- At least, following minimum information shall be recorded in On board system with date, time stamp and current position/location details from GPS:-
 - a) Information received from trackside system
 - b) Actual speed,
 - c) Service brake intervention,
 - d) Emergency brake intervention,
 - e) Reset of push button (RESET)
 - f) Data entered, received or indicated to the driver

3.7 SETTINGS:

User should be able to configure the following parameters:

- **Wheel Diameter :**
- **Change of Direction:** Direction detection logic has to be implemented preferably through speed sensor.
- **Brake curve no. :** Brake curve signifies deceleration rate of vehicle. Worst loading conditions, permissible brake cylinder isolation and overlap distance at signal should be taken into account while deciding brake curve number for acceleration.
- **Maximum train speed :**

3.8 AAWS should work at speeds up to 200kmph, both on straight and curved tracks.

3.9 Extraneous currents or other traction currents shall not be able to give a false indication/actuation.

3.10 Care should be taken to avoid AAWS being switched ON in non-driving cab through any stray voltages.

3.11 If more than two frequencies are received, highly restrictive frequency combination should be considered for suitable action by AAWS system.

3.12 It shall not be possible to mute the warning and automatic brake application by prior operation of the acknowledging button/lever.

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3.13 The locomotive equipment shall be workable from the DC battery supply of 110V dc nominal varying from 68V to 136V dc in case of electric locomotive and EMU stock.

3.14 The receiver on the locomotive device shall be so located and mounted that it would function correctly over the limits of transverse and vertical movements on the appropriate parts of the locomotive/EMU/DMU relative to the centre of the track. The limits are as under

Transverse	$\pm 40\text{mm}$
Vertical	$\pm 50\text{mm}$

3.15 Where the system does not tolerate sufficient air gap, the mounting of the transmitter- receiver shall be adjustable within $\pm 45\text{mm}$ minimum to cater for the status displacements.

3.16 The provisional dimensional requirement of various modules is attached in Annexure I to IV.

3.17 **Features of AAWS:**

- i) It should not be possible to switch 'ON' AAWS when train is moving.
- ii) Emergency Brake counter (EBC) increment shall take place in three cases:
 - Over speeding
 - Penalty brakes

Penalty Brakes can be because of

 1. Passing signal at higher speed than allowed in case Of caution aspect and permissive signal
 2. Not acknowledgement of caution aspect and Permissive RED signal
 - Passing absolute RED
- iii) A separate Non-resettable electromechanical counter to be provided for recording "Passing an absolute Signal at ON" so that SPAD cases can be easily identified.
- iv) Event logger should be provided as a part of engine equipment. It should be possible to select data to be downloaded from event logger in a user friendly manner.
- v) It should be possible to link this event logger to a GPS device and GPRS modem to automatically transmit AAWS malfunctioning data to a centralized location for identification of exact location of AAWS malfunctioning immediately.

4 **TECHNICAL DETAILS OF THE ONBOARD SYSTEM:**

4.1 Onboard system consists of following subsystems:

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

- Central Processing Unit (CPU) consisting of Microprocessor and PCB cards.
- Engine magnet (EM)
- Speed sensor/(RDSO approved/proven for Rolling stock)
- Indication Panel (IP)
- Brake Actuating Unit (BAU)
- Isolation Unit (ISU)
- Hooter / Buzzer

4.1.1 Central Processing Unit (CPU)

- Microprocessors/Microcontroller based control system to process and issues, various commands to interfaces like driver display and brake system etc.
- CAB display unit to display various indications in relation with passed signal aspects, speeds and to register responses by the driver.
- Brake application unit (BAU) to apply brakes (service, emergency) whenever commanded by Microprocessor/Microcontroller unit.
- Whenever emergency brakes are applied by system it can be released only by reset from the driver.
- Speed sensing unit to monitor speed of the train.
- Central processing unit has various printed circuit board cards each with specific task. The unit receives, processes all information and issues instructions for action depending on preset program.
- Depending on pulses received from central processing unit, brakes are actuated and are applied on EMU. EP brakes are applied by connecting supply to EP relays and emergency brakes are applied by disconnecting supply to magnet valves provided for the purpose.
- It shall process the information received from Engine magnet and give instruction to indication panel, hooter/Buzzer and brake actuating unit.
- When the train passes green or a double yellow signal, maximum speed of the train shall be restricted to Maximum Permissible speed of the section. When train passes yellow signal, its permitted speed should be such that it can decelerate to 38kmph within 290m distance from the foot of yellow signal. If speed while passing a yellow signal is higher than permitted speed then penalty brakes are applied. When the train passes permissive red signal or is moved under signal failure bypass condition, maximum speed is restricted to 15KMPH.
- If vehicle is moved in reverse direction emergency brakes shall be applied. (Service brakes at 2 mtrs. and Emergency brakes at 5mtrs. distance).
- In normal movement If any of the speed limits are exceeded, the system shall act in a manner as indicated

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below. However these parameters shall be configurable and can be changed as per user requirement.

- Speed \geq speed limit + 1 KMPH – Audible warning.
 - Speed \geq speed limit + 5 KMPH – Service brakes.
 - Speed \geq speed limit + 10 KMPH – Emergency brakes.
 - The brakes shall be released automatically, when speed reduces to the permissible limit.
- Brake curve is used during
 - (i) Yellow signal (to bring down train speed to 38Kmph within 290 meters)
 - (ii) During speed restrictions (to bring down train speed to restricted speed within 800 meters).
 - (iii) Following brake curve is used by AAWS:

Brake curve is obtained by plotting a Speed vs Distance graph, given the locomotive is decelerated a constant rate. Locomotive speed is taken on Y-axis, distance covered by locomotive on X-axis.

X-axis counts from 400meters to 0 (see graph below).

Brake Curve Number:

It signifies the deceleration rate of the vehicle.

There are four brake curves defined for AWS in present system.

Curve 13 uses – 0.58 m/s² deceleration rate
 Curve 14 uses – 0.69 m/s² deceleration rate
 Curve 15 uses – 0.82 m/s² deceleration rate
 Curve 16 uses – 0.95 m/s² deceleration rate
 (See graph below).

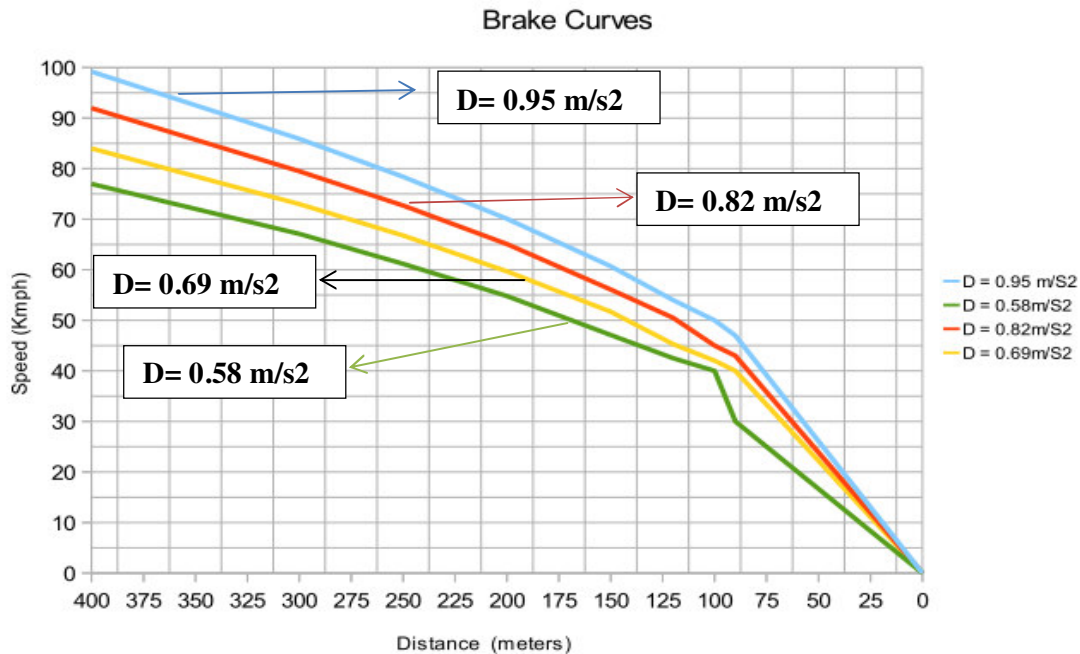
These curves are defined based on Worst loading conditions, permissible brake cylinder isolation and overlap distance at signal. Presently four curves are defined however more no. of curves can be defined based on future requirement.

Brake curve number can be selected by the user in car shed from application software (Laptop/PC).

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AAWS Brake Curve

In order to stop the train within the available braking distance (400 meters normally), AAWS will guide the motorman to control the train speed as per the brake curve. Brake curve is initiated only for YELLOW signal, RBD and Speed restrictions.

For YELLOW signal brake curve will assist the driver to drop the speed to 38Kmph within 290 meters , brake curve is released once 290 meters point is crossed however up to next signal driver cannot proceed with more than 38Kmph .

For RBD signal brake curve will assist the driver to drop the speed to 38Kmph within 120 meters ,brake curve is released once 120 meters point is crossed however upto next signal driver cannot proceed with more than 38Kmph .

For Speed restriction brake curve will assist the driver to drop the speed to restricted speed within 800 meters , brake curve is released once 800 meters point is crossed , however driver cannot go more than restricted speed until new speed restriction is received.

Note: For YELLOW > 700 meters signal, brake curve is initiated at Intermediate ATM.

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Page 13 of 13		

4.1.2 Engine magnet (EM) - to obtain the information transmitted from track magnet.

- This subsystem interacts with existing trackside subsystem to collect information regarding signals being passed and speed limits
- Engine magnet must be compatible with existing trackside subsystem in respect of frequencies and signal strengths.
- Engine magnet shall receive energy from power supply card in central unit. It shall detect the presence of track magnet, receive and transmit signal aspect information on principles of resonance coupled oscillating circuit to central processing unit.
- Engine equipment shall have a 50 KHz oscillator which can be used as a pilot circuit for monitoring/presence of track magnet and as a source of power to track magnet. It also has a 100 KHz oscillator which acts as data circuit to be modulated by the audio oscillator inside the track magnet.
- The on-board equipment also has 100 KHz demodulator, band pass filters which takes out individual frequencies F1 to F7 present in the signal transmitted by the track magnet to the engine magnet.
- The demodulated signals are given to the central processing unit for the processing as per preset programme.

4.1.3 Speed sensor:

The **Speed sensor** is axle driven unit and informs speed and direction of vehicle to central processing unit.

4.1.4 Indication Panel: (IP)

- The indication panel shall consist of push buttons, counters and indication lamps to convey signal aspect passed to driver and permit certain operations by driver. A schematic sketch is attached at Annexure- V.

i. Signal failure bypass button (SFBB)

- This button is used only in case of failure of a signal. This permits train to pass over defective signal without application of emergency brakes. The button must be operated in stand – still condition and within 100 mtrs distance in rear of the signal.

ii. Reset push button (RESET)

- This is used for releasing emergency brakes. The push button is effective only in stand-still condition.

iii. Vigilance push button (VPS)

- This is required to be operated by driver when he passes yellow or permissive red signal. On passing these signals audible warning is heard and within 4 second, the driver must press vigilance push button,

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failing which emergency brakes are applied. If push button is kept pressed earlier than required, its action is not registered. The driver can also perform functional test by pressing the vigilance push button for 10 seconds in stand – still condition.

iv. Signal failure bypass counter (SFBC)

- No. of operations of SFBB are recorded by this counter.
- SFBC Counter should rotate half when SFBB is enabled and should rotate completely when the next signal is passed or 100 meters is completed.
- This shall be Non-resettable type electromechanical counter.

v. Emergency brake counter (EBC)

- It counts number of emergency brake applications
- EBC Counter should rotate half on (i) When emergency brake application takes place due to Penalty brake or Passing absolute RED without procedure and should rotate completely when emergency brake released by Pressing Reset push button. (ii) When emergency brake application takes place due to over speeding and should rotate completely when speed is reduced to permissible limit.
- This shall be Non-resettable type electromechanical counters.

vi. White lamp

- This lamp is normally lit steady. During Power ON white lamp flashes (1:1) twice. If there is any failure in AAWS control card white lamp will flash continuously.

vii. Blue lamp (Blue glass, White lamp)

- This lamp is lit steady when AAWS is `ON`. After the interaction with track magnet lamp extinguishes for about 5 seconds and reappears. Flashing of this lamp means fault in power supply, speed check or speed evaluation equipment.

viii. Yellow light(LED)

- This is a set of LEDs and is normally off. It lit steady if yellow Signal with inter-signal distance up to 700 mtrs is passed. After passing 290 mtrs, it starts flashing (1:1) and remains flashing upto the next signal.

On passing yellow signal with inter-signal distance more than 700 mtrs, the lamp flashes slowly (7:1) till it pass additional magnet. Before passing ADDITIONAL TRACK MAGNET (ATM) (a) If ahead signal changed to off aspect it will turn off. (b) If ahead signal continues to

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

display RED aspect it will become yellow steady and after passing 290 mtrs, it starts flashing (1:1) and remains flashing up to the next signal.

ix. Red light(LED)

- It is also a set of LEDs normally off and is lit steady if permissible red signal is passed or Emergency brakes are applied.
- The red lamp flashes if service braking takes place or if signal failure by pass button is pressed in standstill condition.

4.1.5 Brake Actuating Unit:- (BAU)

Anyone of following schemes can be used for application of service and emergency brakes.

4.1.5.1 Scheme –I: It consists of the following:-

- (i) Emergency braking reverse relay (EBRR)
 - (ii) Emergency braking normal relay (EBNR)
 - (iii) Service braking relay (SBR)
 - (iv) Brake control relay (BCR)
- The first three relays operate on 24V whereas BCR operates on 110V DC. Emergency braking reverse relay and emergency braking normal relay are normally in picked up condition where AAWS equipment is functioning and is in operation.
 - Dropping of EB(R)R results in emergency brake operation as its normally open interlock is in series with magnet valve coils, operation of EB(R) also results in operation of EP brakes as normally open interlock of EB(R)R de-energises BCR.
 - Dropping of BCR results in closing its normally closed interlock and operation of EP relays. When only service brakes are to be applied BCR is opened through SBR normally closed interlock to give EP brake application.
 - The relay designated as SBR is used for service brake application. It is normally in de-energized condition and picks up when AAWS applied service brakes. These are normally applied when speed exceeds set limit by 5 to 10 KMPH.

4.1.5.2 **Scheme –II:** This scheme consists of two contactors – one for service brake and other for Emergency brake. When AAWS wants to apply emergency brake, emergency brake contactor and service brake contactor are enabled, when AAWS wants to apply service brake, service brake contactor is enabled. The logic of scheme is given below.

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	EB Contactor	SB contactor	Supply to Master Controller	Holding RELAY	Application RELAY	FCV & EMV
Normal	0V	0V	110V	0V	0V	110V
Service Brake	0V	24V	0V	110V	110V	110V
Emergency Brake	24V	24V	0V	110V	110V	0V

4.1.5.3 In addition to above **Schemes** new design can also be developed, without affecting the actual functionalities of EMU braking.

4.1.6 Isolating Switch:

- The isolation unit shall have manually operated isolating switch and set of MCBs. It connects 110V supply to AAWS system. Provision shall also be made for counting number of isolations.
- This is meant for isolating AAWS with EMU. It consists of Isolating switch, isolation counter, LEDs in ISU to show availability of control supply, supply to magnet valves, supply to master controller and actuation of EP brakes.
- The counter indicates isolation number. The isolation switch should normally be kept on and sealed and should be operated only during emergency to switch off the AAWS unit.

4.1.7 Hooter/Buzzer

- Hooter / Buzzer – these are used for giving audible warning to drivers.

5 TECHNICAL DETAILS AND FUNCTIONAL INTERFACE PROPERTIES OF THE TRACK SIDE SYSTEM:

5.1 The track device :

- 5.1.1 The track magnet shall be a passive device and shall include necessary coils, cores, condensers and shall not require power supply. The track magnet's auxiliaries shall be properly encased in a suitable material to make it difficult to pilfer and housed in a box with terminals brought out in a covered compartment of the same housing for external connections. This housing shall be capable of being fixed on to the sleepers by bolts and nuts. The track device shall be compatible with the locomotive device.

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5.1.2 The main track magnet shall be installed between two rails at the rail height at the foot of the signal post. It is installed at a distance of 231mm from the right hand side of the inner edge of rail in the direction of the movement of train. Although it is desirable that it should maintain exactly 231 mm however it can vary ± 10 mm. Track Magnet shall be placed at least three sleepers away from the nearest rail joint if any.

5.1.3 There are two types of track magnets, namely, Variable Type and Fixed Type.

- (i) Variable Type is generally used along with the main line signals and it shall also be used as intermediate magnet in-between two main signals if the inter-signal distance is more than 700m. If it is used along with main signals, Variable type magnet has got frequencies F1 to F5 and if it is used as additional magnet, it has got frequency F1 F2 / F6.
- (ii) Fixed Type magnet need not be connected to a signal. Therefore, it does not require Opto-coupler card to control it. It is permanently set to give only two frequencies.

5.1.4 There are various Fixed types of magnets, namely-

5.1.4.1 FTMI - Having F1 F2, which is used for applying emergency brake for testing purposes when the EMU comes out of car shed.

5.1.4.2 FTM II - Mounted 'a' mts away in rear of the signal and its fixed frequency is F4F6, F5F6 and denotes that the braking distance available is less (d) from the signal in advance.
(Refer to fig below). F5-F6 track magnet is fixed in rear of second next signal.

5.1.4.3 FTM III - The last type of Fixed type magnet is permanently tuned to F3F5 to indicate that the AAWS section is over and there is no more speed restriction on passing signal at caution.

5.1.4.4 FTM IV- This is mainly for enforcing speed restrictions. It can be permanently tuned to F1F7 to F6F7 for various speed restrictions. (See Table in 5.4).

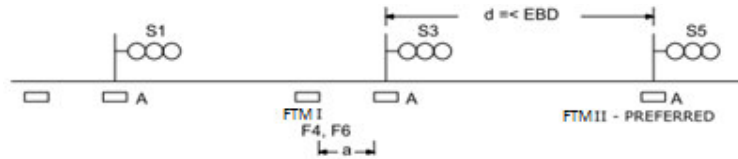
In case of speed enforcement Ack. should be given within 4 seconds otherwise brakes will be

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applied.Brake curve should be initiated and the specified speed limit should be achieved within 800meters. Yellow lamp is lit steady after the brake curve is initiated. Yellow lamp will distinguish after 800meters.



Sl. No	'd' in meters	'a' in meters
1	375 ± 12.5	15 ± 0.3
2	350 ± 12.5	17.5 ± 0.3
3	325 ± 12.5	20 ± 0.3
4	300 ± 12.5	22.5 ± 0.3
5	275 ± 12.5	25 ± 0.3
	⋮	⋮
	100 ± 12.5	42.5 ± 0.3
	75 ± 12.5	45 ± 0.3

5.2 The opto coupler card:

Normally signal aspects are denoted by (i) conventional signal lamps & (ii) LED signal lamps.

5.2.1 This part of the AAWS equipment interfaces with the signals. On the signal post, there shall be an Opto Coupler Card which monitors the output voltage on the secondary of the signal transformer (for conventional bulb) feeding the signal bulb (voltage range 10.8V to 20V AC and current 2 mA). When voltage at secondary of signal transformer is sensed less than 10.8V it will be treated as bulb is not glowing. From this, the Opto Coupler Card should sense which signal aspect (red, yellow, double yellow or green) is active at a particular instant. Similarly it shall also monitor functions like calling ON signals, 'A' markers, shunt signals and route indicators.

5.2.2 For auxiliary signals (conventional bulb) which normally works at 110V, after deciding which of the signal aspect is getting voltage, the Opto Coupler Card shall convert this information into a combination of two frequencies from F1 to F5 by giving a loop. Thus the Opto coupler shall give a loop on two circuits through the connecting cable between Opto coupler and the Track Magnet.

5.2.3 LED lamps for main signals are working at 110 V ac with a range of 82.5V to 137.5V. LED lamps for auxiliary i.e. Calling on route indicator, shut and A marker signals are working at 110 V

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

ac with a range of 88V to 132V. When voltage is sensed less than 75V, it will be treated as bulb is not glowing for both main led and auxiliary led signals.

5.2.4 Wherever the signal has to control the intermediate magnet in rear, a special type of opto coupler is to be used. In such cases three extra output terminals are brought out. This selects F6 and any one out of F1 and F2. Thus, F1F6 is selected when the signal is off and F2F6 is selected when the signal is 'ON'.

5.2.5 The auxiliary output (3 core) shall be connected by cable from opto coupler to intermediate magnet in rear.

5.2.6 Different types of Opto coupler cards are used depending upon the type of signal to which it is to be connected and also depending upon whether it has got auxiliary aspects as well. Apart from this, for the signals which have to control the intermediate and additional magnet in rear a different type of Opto coupler card is required. Regarding caution aspect, there are two types of Opto coupler cards, one having frequency combination of F1, F4 which is suitable if inter-signal distance is less than 700m and another having frequency combination F2, F4 which is suitable if inter-signal distance is more than 700m. Therefore, according to inter-signal distance between the signal and signal in advance, the type of opto coupler shall be decided.

5.2.7 It is desirable that the cards are designed in such a manner that all above functions are accommodated in less type of cards for easymaintenance.

5.3 Since AAWS is required to be interoperable with existing trackside system, following technical details are provided regarding the existing trackside system:

- Track Magnet is connected to signal through opto coupler card
- Track Magnet transmits the information of aspect of signal to onboard magnet.
- Track Magnet is passive device and includes necessary coils, cores, condensers and other auxiliaries.
- Track magnet internals are properly encased in a suitable material to make it difficult to pilfer and housed in a box with terminals brought out for external connections.
- Track Magnet housing is fixed on to the sleepers by clamps bolts and nuts. The AAWS onboard device should be compatible with the existing track device. The sketch showing details of mounting of track magnet is given in annexure vi.

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

- Track Magnet consists of two resonant coils. One circuit operates with 50 KHz and acts as a checking (Pilot) circuit. The second circuit which acts as data transmission circuit, operates with 100 KHz and is modulated with selected audio-frequencies depending on the signal aspect which is lit
- Track Magnet picks up its power supply from the engine equipment while the engine magnet passes over the track magnet.
- The following frequencies are used in the track magnet for the purpose of frequency modulating 100 KHz carrier.
 - F1 2800 Hz
 - F2 3600 Hz
 - F3 4400 Hz
 - F4 5200 Hz
 - F5 6000 Hz
 - F6 6800 Hz
 - F7 7600 Hz
 - Field tolerance - 55Hz / + 60 Hz

- ✧ When **F3F4(GREEN)OR F1F3 (DOUBLE YELLOW)** frequency is received by AAWS – Speed limit should change to maximum allowed speed, blue LED should be OFF for 5 seconds.
- ✧ When **F1F4(YELLOW)** frequency is received by AAWS – Speed limit should change to 77.5KMPH, YELLOW Lamp should be steady ON, VCD Alarm should be enabled. YELLOW lamp should flash 1:1 after 290 meters from yellow signal received, YELLOW lamp should be OFF after 800 meters from yellow signal received. While passing signal, if speed is more than 77.5KMPH emergency brakes should be applied immediately and brakes will be released only after reset is pressed and speed is zero. If while crossing signal speed is less than 77.5Kmph no brakes are applied and brake curve will be initiated.
- ✧ When **F1F5(PERMISSIBLE RED)** frequency is received by AAWS – Speed limit should change to 15KMPH, VCD Alarm should be enabled. RED lamp should be steady ON.
- ✧ When **F1F2(RED)** frequency is received by AAWS – EMERGENCY and SERVICE brakes should be applied (If SFBB is not enabled). Hooter should be enabled continuously; RED LAMP should be STEADY ON.
- ✧ When **F2F6(ATM - NO CHANGE)** frequency is received by AAWS – This signal is valid only if previous signal received is F2F4 (Y > 700meters). BRAKE curve should be effective from this point, YELLOW lamp should be lit steady, flash 1:1 after 290 meters from ATM, speed limit should be reduced to 38KMPH, YELLOW lamp should be OFF after 800 meters from ATM.

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- ✧ When **F1F3** frequency is received by AAWS – Speed limit should change to maximum allowed speed, blue LED should be OFF for 5 seconds.
- ✧ When **F1F6** frequency is received by AAWS – Speed limit should change to maximum allowed speed.
- ✧ When **F3F5** frequency is received by AAWS – Speed limit should change to maximum allowed speed.
- ✧ When **F2F4** frequency is received by AAWS – Speed limit should change to maximum allowed speed, VCD Alarm should be enabled. YELLOW lamp should flash 7:1. Speed should be reduced to 60KMPH before ATM is crossed.
- ✧ When **F1F7** frequency is received by AAWS – Speed limit should change to 60KMPH
- ✧ When **F2F7** frequency is received by AAWS – Speed limit should change to 45KMPH
- ✧ When **F3F7** frequency is received by AAWS – Speed limit should change to 30KMPH
- ✧ When **F4F7** frequency is received by AAWS – Speed limit should change to 15KMPH.
- ✧ When **F5F7** frequency is received by AAWS – Speed limit should change to 8KMPH
- ✧ When **F4F6** frequency is received by AAWS – Reduced braking distance after next signal. This signal is valid only if next signal is yellow. Speed limit is set to 58kmph if next signal is yellow. While passing the yellow signal if train speed is more than 58KMPH brakes should be applied. After crossing the signal brakes should be applied as per brake curve.
- ✧ When **F2F5** frequency is received by AAWS – LC gate out of order. Brake curve should be initiated and 15 KMPH speed limit should be achieved within 800meters. Ack. within 4 seconds is required Speed limit should change to maximum allowed speed.
- ✧ When **F2F3** frequency is received by AAWS – Signal at yellow with route indicator. When this frequency is received speed limit will change to 15/30 (or as per user Railway) KMPH and driver should acknowledge within 4 seconds.

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- ✧ When **F3F6** frequency is received by AAWS-Location of goods siding board or approach of a gate. When this frequency is received a short beep for 2 seconds will be enabled.
- ✧ When **F5F6** frequency is received –Reduced braking distance after second next signal. This signal is valid only if next signal is green and second next signal is yellow. Speed limit is set to 58kmph at second next signal. While passing the second next signal (yellow) if train speed is more than 58KMPH brakes should be applied. After crossing the second next signal (yellow) brakes should be applied as per brake curve.

5.4 A combination of these frequencies is used for conveying different signal aspects to the engine equipment are as shown below. For an information transmission, any two out of these seven frequencies shall be used. Thus, 21 information can be transmitted using this frequency coding. Their utilization is given below. If same set of frequencies is being received twice within the interval of one second then same needs to be ignored. However, in such cases where multiple frequencies are received system shall act as per most restrictive combination. Presently all combinations are not being used. Frequencies at SR.No.6, 7 and 11, 12, 14 to 21 are not used but system design must take care of all possibilities as tabulated below:

S. No	Frequency	Utilization
1.	F3 F4	Signal `OFF' (Green)
2.	F1 F4	Signal `Caution' (Yellow)
3.	F1 F5	Red Permissible (R with `A' or `C' or `SH' Red `Stop' absolute (Red)
4.	F1 F2	Red `Stop' absolute (Red)
5.	F2 F6	No change in earlier information. (Brake curve becomes effective if previous signal passed in yellow with inter signal distance more than 700 mtrs.)
6.	F1 F3	Signal attention (Yellow/Yellow)
7.	F4 F5	Signal `Attention' (Yellow) Next signal turn out.
8.	F4 F6	Reduced braking distance after next signal.
9.	F5 F6	Reduced braking distance after second next signal.
10.	F1 F6	Release of brake curve.

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11.	F3 F5	End of AAWS section.
12.	F2 F5	L.C gate out of order.
13.	F2 F4	Signal at caution `Yellow' with inter signal distance more than 700 m.
14.	F2 F3	Signal at Yellow with route indicator (Turnout ahead 30 KMPH for future use)
15.	F3 F6	Location of goods siding board or approach of a gate.
16.	F1 F7	Restricted speed section 60 KMPH.
17.	F2 F7	Restricted speed section 45 KMPH.
18.	F3 F7	Restricted speed section 30 KMPH.
19.	F4 F7	Restricted speed section 15 KMPH.
20.	F5 F7	Restricted speed section 8 KMPH.
21.	F6 F7	End of restricted speed section.

6 MAINTENANCE, TESTING AND DIAGNOSTIC REQUIREMENTS:

- 6.1 To ensure that the above safety criteria is maintained, the system shall have diagnostic checks carried out at frequent intervals, monitoring a condition giving appropriate indications and alarms.
- 6.2 The system shall be provided with indications indicating various failures.
- 6.3 A trouble-shooting chart should be provided indicating the action required to be taken for repair of the equipment corresponding to each error indication.
- 6.4 Audiovisual alarm shall be provided in case of failure. The audio alarm should stop when acknowledged but the visual alarm should continue till the fault is rectified.
- 6.5 Necessary provision shall be made in the hardware and software for modular expansion of the equipment.
- 6.6 The dimensions given in specification for various parts of AAWS are to be maintained for uniformity. However if expansion is needed this can be changed based on merit of the requirement.

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7 TESTS AND REQUIREMENTS:

7.1 Conditions of tests

Unless otherwise specified all the tests shall be carried out at ambient atmospheric conditions.

7.2 For inspection of material, relevant clauses of IRS: S 23 and RDSO/SPN/144 shall apply.

7.2.1 Test Equipment

Test equipments should be provided as per STR for Electronic Signaling equipment.

7.3 Type Tests

The following tests shall constitute type tests for onboard and trackside equipments:

- Visual inspection as per Clause 7.6
- Insulation Resistance tests as per Clause 7.7
- Card-level functional tests on all the cards
- System-level functional tests
- Environmental/climatic tests as per Clause 7.9.1
- Applied high voltage test as per clause 7.8.
- Immunity to Interference/EMI/EMC/Surge/Transients as clause 7.9.2
- The system shall be compatible & interoperable with the existing AWS system as per Clause 7.10.

7.3.1 Only one pair of equipment shall be tested for this purpose. The equipment shall successfully pass all the type tests for proving conformity with this specification. If the equipment fails in any of the type tests, the purchaser or his nominee at his discretion, may call for another equipment/card(s) of the same type and subject it to all tests or to the test(s) in which failure occurred. No failure shall be permitted in the repeat test(s).

7.4 Acceptance Tests

The following shall comprise acceptance tests for onboard and track side equipment:

- Visual inspection as per Clause 7.6
- Insulation Resistance tests as per Clause 7.7
- Module level functional tests on each type
- System-level functional tests

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7.5 Routine Tests

The following shall comprise the routine tests and shall be conducted by manufacturer on every equipment and the test results shall be submitted to the inspection authority before inspection.

- Visual inspection as per Clause 7.6
- Insulation Resistance tests as per Clause 7.7
- Module level functional test on all the cards
- System-level functional tests
- Environmental stress screening test for PCB & sub- systems as per relevant clause of RDSO/SPN/144

7.6 Visual Inspection

The equipment shall be visually inspected to ensure compliance with the requirement of Clauses of this specification. The visual inspection will broadly include –

- System Level Checking:**
 - Constructional details
 - Dimensional check
 - General workmanship
 - Configuration
- Card Level Checking**
 - PCB laminate thickness
 - General track layout
 - Quality of soldering and component mounting
 - Conformal coating & shielding
 - Legend printing
 - Green masking
- Module Level Checking**
 - Mechanical polarization
 - General shielding arrangement of individual cards
 - Indications and displays
 - Mounting and clamping of connectors
 - Proper housing of cards

7.7 Insulation Resistance Test

Insulation Resistance test shall be carried out as per relevant clause of RDSO/SPN/144.

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7.8 Applied High Voltage Test

Applied High Voltage Test shall be carried out as per relevant clause of RDSO/SPN/144.

7.9 Environmental requirements

7.9.1 AAWS equipment of onboard and tracksideshall withstand the following environmental tests as per the specifications mentioned against each.

S.No.	Test Type	Equipment condition	Severity	Specification
1.	Dry heat test (Operation)	Operating	For functional trials: Temp. $70 \pm 2^{\circ}\text{C}$ Duration: 16 hrs.	IS: 9000 Pt.III Section: V
	Dry heat test (Storage)	Non-operating	Temp. $75 \pm 2^{\circ}\text{C}$ Duration: 16 hrs.	
2.	Cold Test (Operation)	Operating	Temp. $-10 \pm 2^{\circ}\text{C}$, Duration: 2 hrs.	IS: 9000, Pt. II
3.	Rapid variation temperature test	Operating	-10 to $70 \pm 2^{\circ}\text{C}$, Duration: 3 hrs. Rate of change: 1°C per minute. No. of cycle: 03	IS: 9000 Pt. XIV Section: II
4.	Damp heat test (storage)	Non-operating	RH 95 ± 2 , -3% @ $40 \pm 2^{\circ}\text{C}$ Duration = 4 days	IS: 9000 Pt. IV
5.	Damp heat test (Cyclic)	Operating	RH 95% @ 40°C Duration: $12 + 12 = 24$ hrs cyclic No. of cycles = 6	IS: 9000 Pt. V Section-II
6.	Bump Test (Package)	Non-operating	40g peak, 1000bumps Duration: 6 milliseconds No. of axes: 03	IS: 9000 Pt. VII Section II
7.	Mechanical shock On Board	Power off Condition	50 Hzs vibration for 2 minutes with maximum acceleration of 30m/s^2 (amplitude $a=0.3\text{mm}$)	IS: 9000 Pt. VII Section-I
8.	Vibration test On Board	Operating	10Hz to 55 Hz Acceleration A: 0.35mm or 5g 20 sweep cycles on 3 axes	IS: 9001 Pt. XIII
	Track Side	Operating	5 Hz to 35 Hz Acceleration A: 2g 20 sweep cycles on 3 axes	

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S.No.	Test Type	Equipment condition	Severity	Specification
9.	Salt Mist test	Non-operating	2 Hrs + 22 Hrs, 35(+/-)3°C, RH: 93+2, -3% No. of cycles: 03	IS: 9000 Pt. XI
10.	Dust test	Operating (1 hour only)	As per IS: 9000 Pt. XII	IS: 9000 Pt. XII

7.9.2 Immunity to Interference/EMI/EMC/Surge/Transients etc.:

The above test shall be carried out as per relevant clause of IEC 60571

7.9.3 The track magnet shall be compliant to IP 67.

7.10 Interoperability and compatibility test:

It shall be done through field trials by observing performance of the system with track magnet of one make and onboard of other make and vice versa.

8 QUALITY ASSURANCE:

- 8.1 All materials shall be of the best quality and the workmanship shall be of the highest class as per QAP standards laid down by RDSO.
- 8.2 The equipment shall be manufactured as per quality assurance procedure laid down so as to meet the requirement of the specification.
- 8.3 Amongst other requirements of the specification, validation and system of monitoring of QA procedure shall form a part of type approval. The necessary Plant, Machinery and Test Instruments as given below shall be available with the manufacturer.

8.3.1 Plant & Machinery:

Test equipments should be provided as per STR for Electronic equipment and should include the following:

- i) Wave soldering station
- ii) Burn in chamber
- iii) Dry heat and Humidity chambers
- iv) Cold chamber
- v) PCB assembling jig
- vi) Anti-static assembly
- vii) EPROM/Micro-controller Programmer
- viii) UV Eraser
- ix) Microprocessor/Microcontroller development system
- x) Computer aided design system

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Prepared By: JE/Signal	Checked By: DD/Signal	Issued By: DirectorSignal-6	Page 28 of 28

ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

8.3.2 Test Instruments:

All test instruments as per Clause 7.2.1 shall be available with the manufacturer.

8.3.3 Along with the prototype sample for type test, the manufacturer shall submit the Quality Assurance Manual, Operation, Maintenance & Fault Repairing Manuals.

9 PACKING:

As per the relevant clause of RDSO/SPN/144.

10 INFORMATION TO BE SUPPLIED BY THE MANUFACTURER:

10.1 Documentation as per relevant clause of RDSO/SPN/144.

10.2 The manufacturer should supply the following information:

- a) Design approach for the system;
- b) Functions achieved in hardware & software;
- c) Mode of interaction between hardware & software;
- d) Salient features through which safety has been achieved e.g. use of a watchdog timer, automatic shutdown etc.

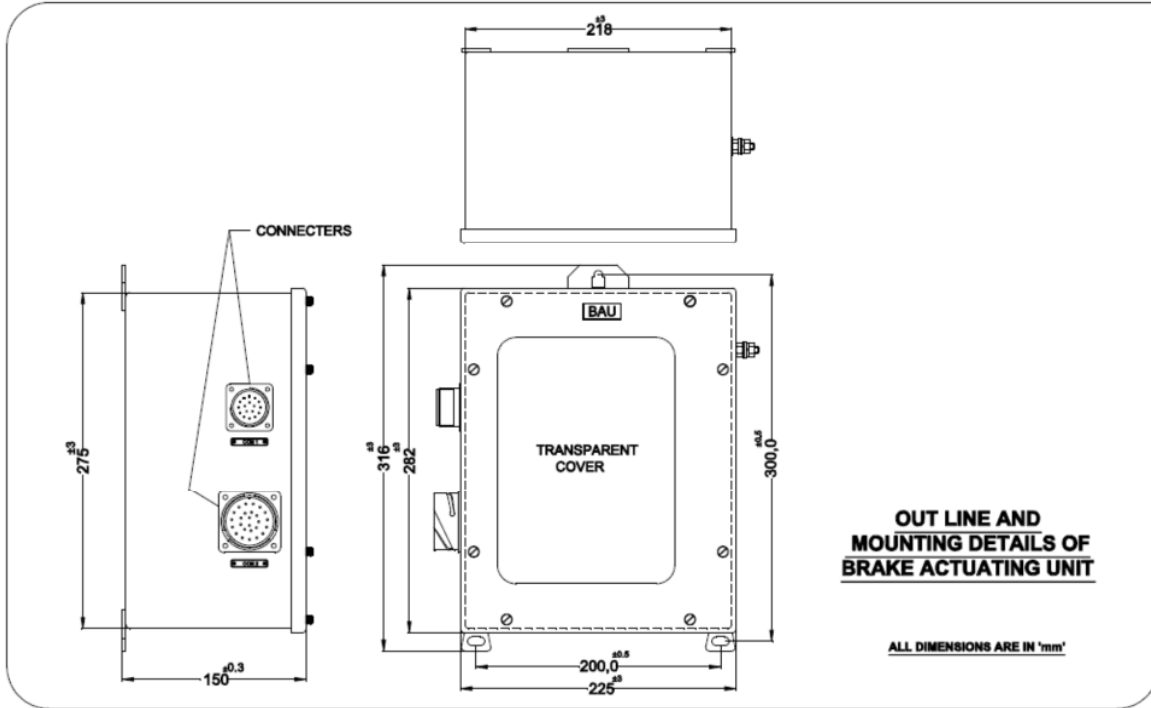
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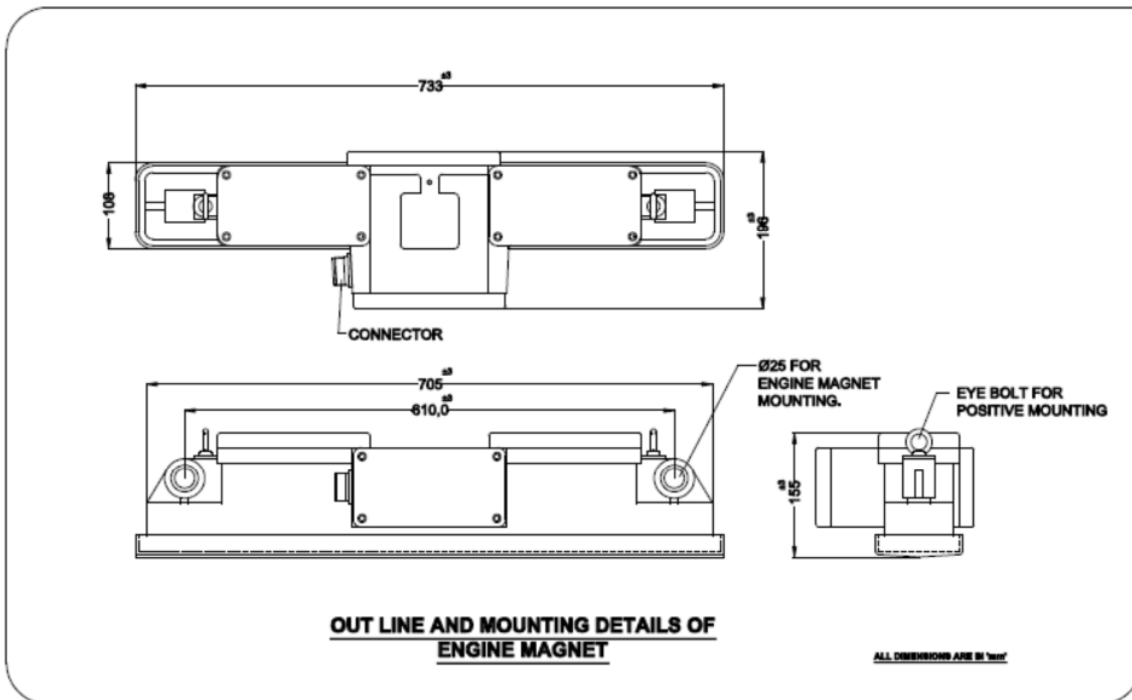
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Annexure-I



Annexure-II

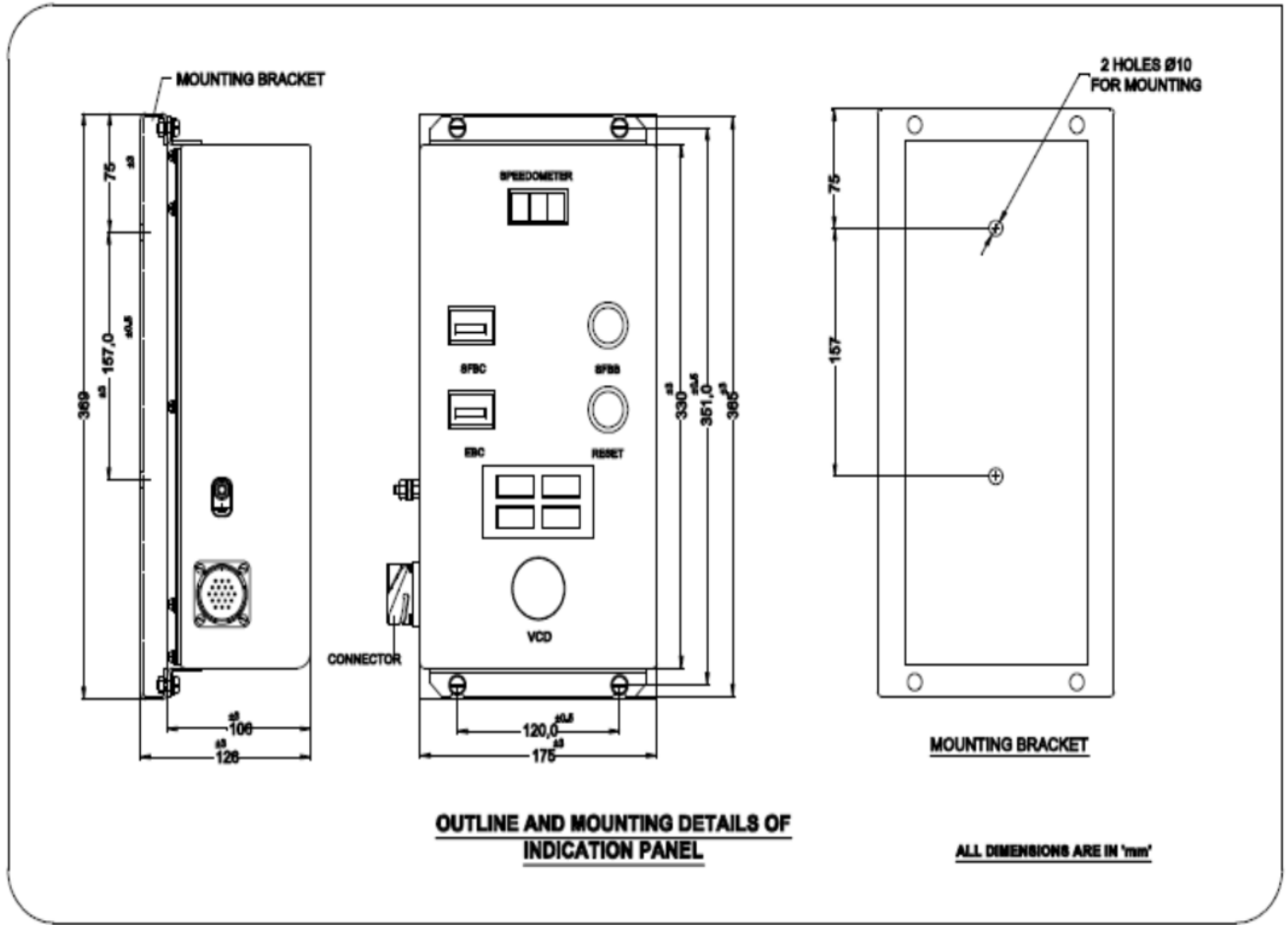


Annexure-III

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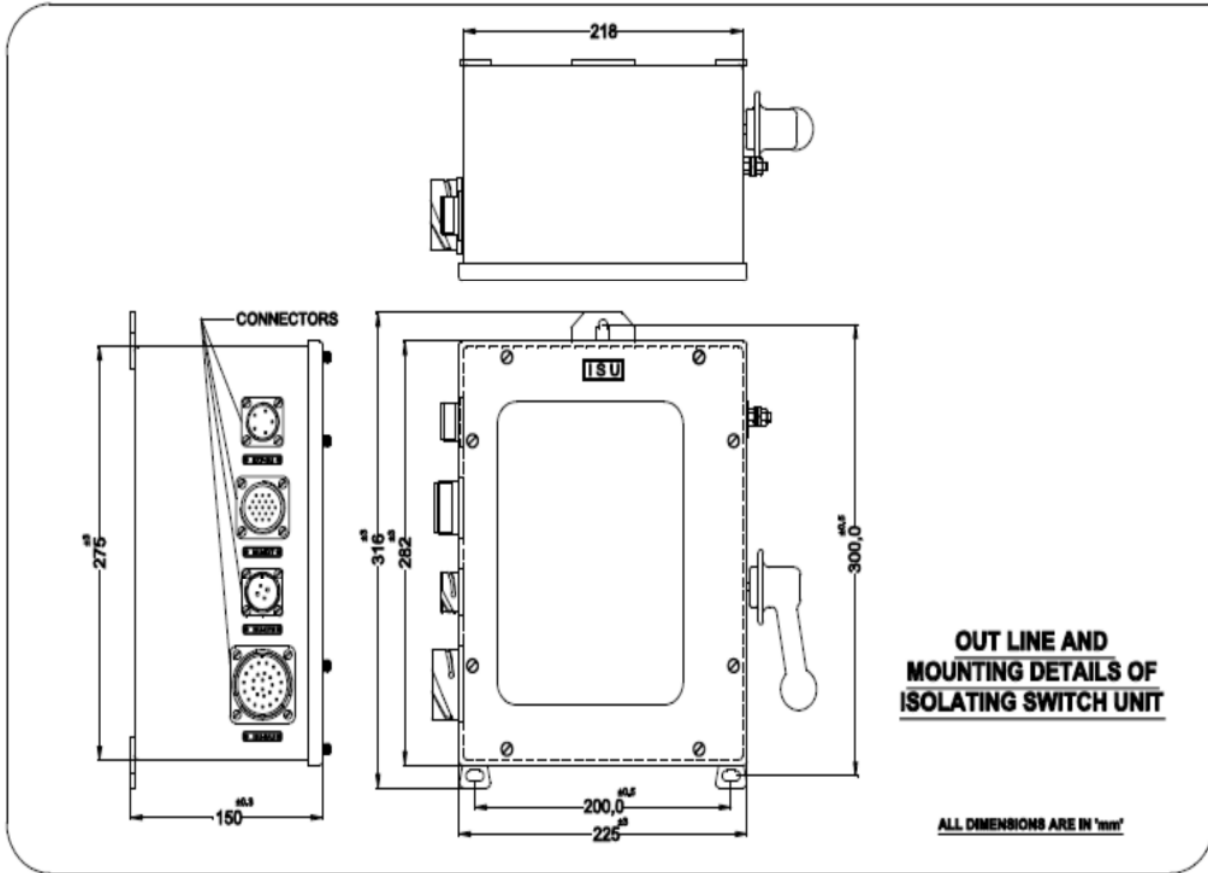


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Annexure-IV



ISU should contain:

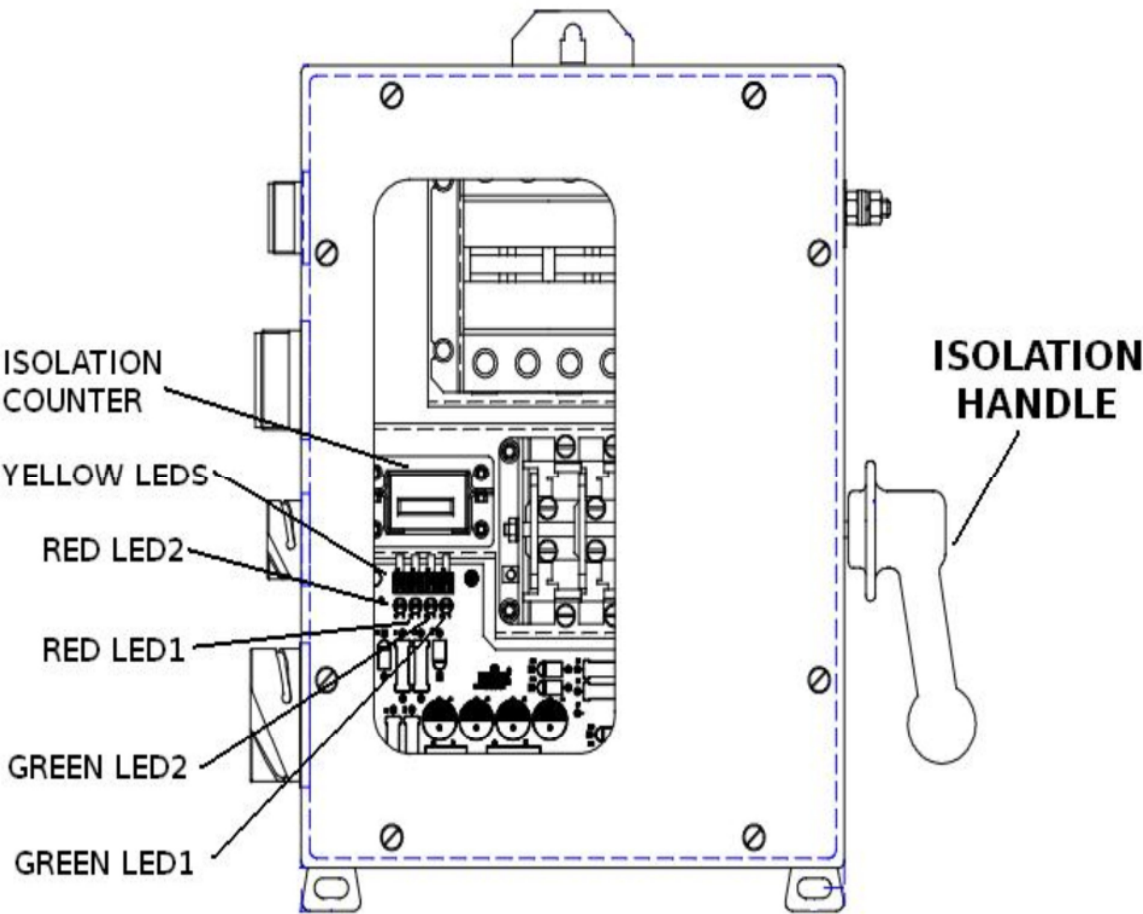
1. Isolating handle – When this handle is operated, AAWS should get isolated from EMU; total power to the system should be switched OFF.
2. Isolation counters to count the number of isolations. Every time the system is isolated this counter is incremented.
3. Yellow LEDs(4 Numbers) to show availability of 110V DC
4. Green LED1 to show availability of supply to magnet valve
5. Green LED2 to show availability of supply to master controller.
6. RED LED1 to show availability of supply to Application relay
7. RED LED2 to show availability of supply to holding relay

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Reason: IREPS-CRIS
Location: New Delhi

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ISOLATING UNIT



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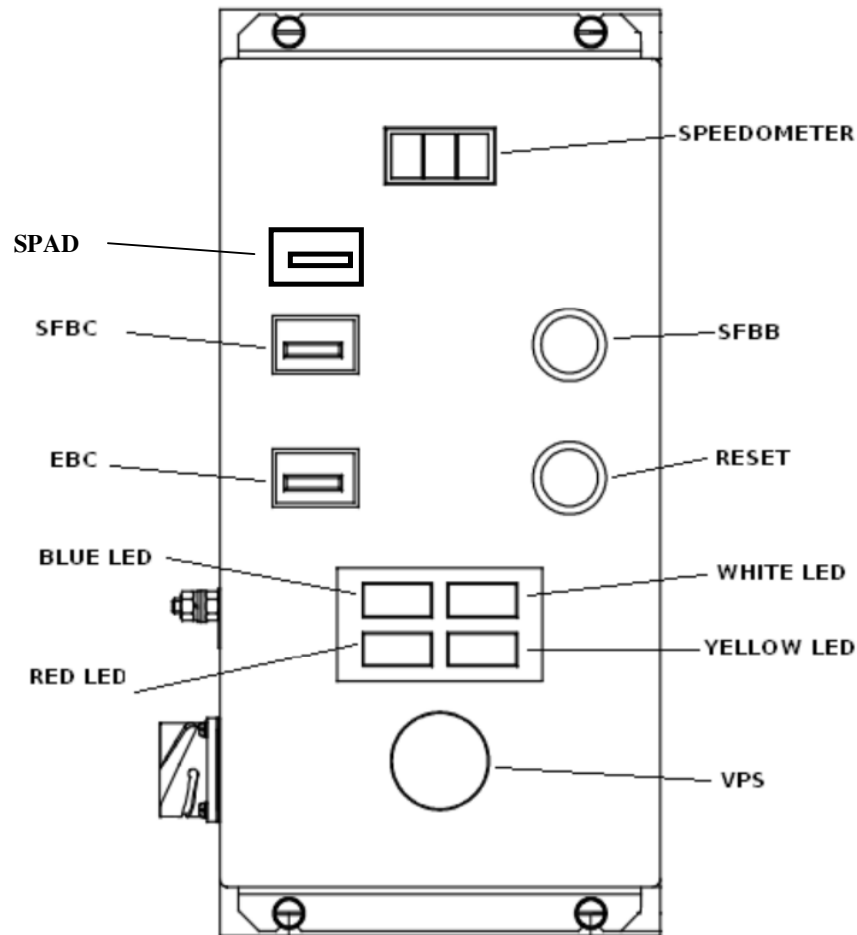
Annexure-V

Indication Panel (IP):

The indication panel should contain the following:-

1. Signal failure bypass button (SFBB)
2. Reset push button (RESET)
3. Vigilance push button (VPS)
4. Signal failure bypass counter (SFBC)
5. Emergency brake counter (EBC)
6. SPAD Counter
7. White lamp
8. Blue lamp
9. Yellow lamp
10. Red Lamp
11. Speedometer

INDICATION PANEL



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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

Signal failure bypass button (SFBB):

This button should be used only in case of failure of a signal. SFBB permits train to pass over defective signal (absolute red signal) without application of emergency brakes. It must be operated in stand – still condition and within 100 meters distance in rear of the signal.

SFBB is valid only upto 100 meters, if no signal is received within 100 meters SFBB is disabled automatically.

Signal failure by pass counter (SFBC):

It should count the number of operation of SFBB. On pressing SFBB, SFBC should rotate half and on passing the signal (Track magnet) or 100meters distance the rotation should be completed.

Reset:

This should be used for releasing emergency brakes. The push button should be effective only in stand-still condition.

The resetting button/lever shall be located in such a manner that it shall not be possible for the driver to operate the same while the train is in motion and it may be accessible from the ground within easy reach of the driver.

Emergency brake counters (EBC)

It should count the number of penalty or emergency brakes applied. EBC should rotate half when emergency brakes are applied and rotate completely when reset push button is pressed.

If emergency brake is applied due to loco over speeding then the counter rotates half when brake is applied and rotates completely when brakes are released.

SPAD Counter:

It should count the number of emergency brakes applied due to SPAD. SPAD Counter should rotate half when emergency brakes are applied due to SPAD and rotate completely when reset push button is pressed.

Vigilance push button (VPS):

VPS button needs to be operated by driver when the train passes yellow, permissive red, speed restriction signal. On passing these signals an audible warning should be generated (continuous beep), driver must acknowledge this alarm by press vigilance push button within 4 seconds, failing to do so should result in emergency brake application. If push button is kept pressed earlier than required, its action should not be registered.

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ISO 9001:2008	Document no. RDSO SPN 213/2014	Version1.0	Date Effective: 19.11.2014
Document Title : Specification for Advanced Auxiliary Warning System (AAWS)			

Blue indication lamp:

This lamp should be lit steady when AAWS is `ON`. On passing any track magnet the lamp should extinguish for about 5 seconds. This lamp should start flashing if there is any fault in power supply, speed check or speed evaluation equipment.

White indication lamp:

This lamp should normally be lit steady. After power on it should flash twice and becomes steady. If there is a fault in control card this lamp should flash continuous.

Yellow indication lamp:

This is a set of LEDs and should be normally off. It should be lit steady if yellow signal is passed. After passing 290 meters it should flash (1:1) and remain flashing upto 800 meters distance. Also on passing yellow signal with inter-signal distance more than 700 metersthelamp should flash (7:1) till it passes additional magnet.

Red indication lamp:

It is also a set of LEDs normally off and should lit steady if either permissible red signal is passed or emergency brake is applied. The red lamp should flash if service brake is applied or if signal failure by pass button is pressed in standstill condition.

Speedometer:

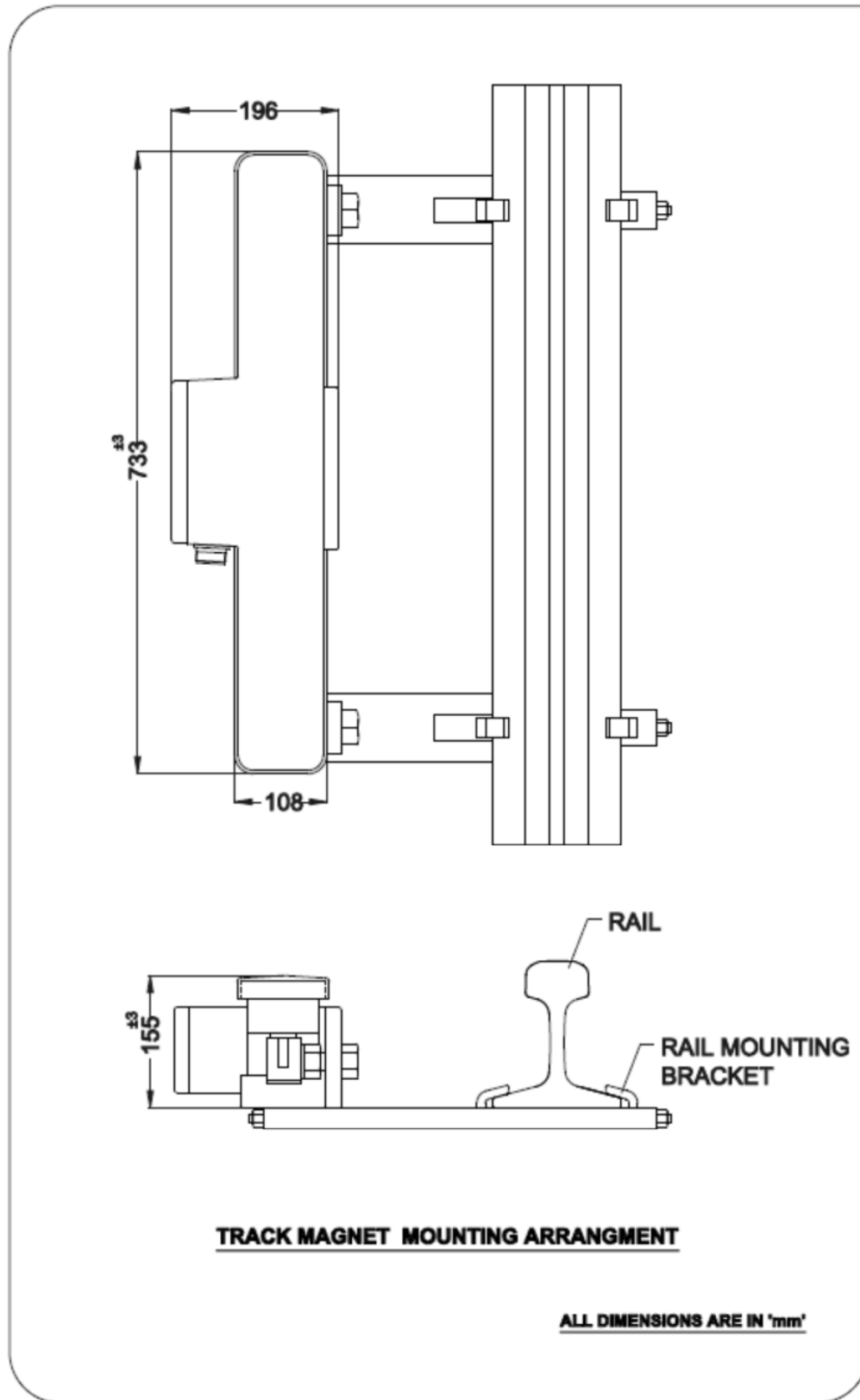
It is a three digit seven segment display that displays the current speed of the train (in KMPH)

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Annexure-VI (a)



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Annexure VI (b)



Placement of TrackMagnet

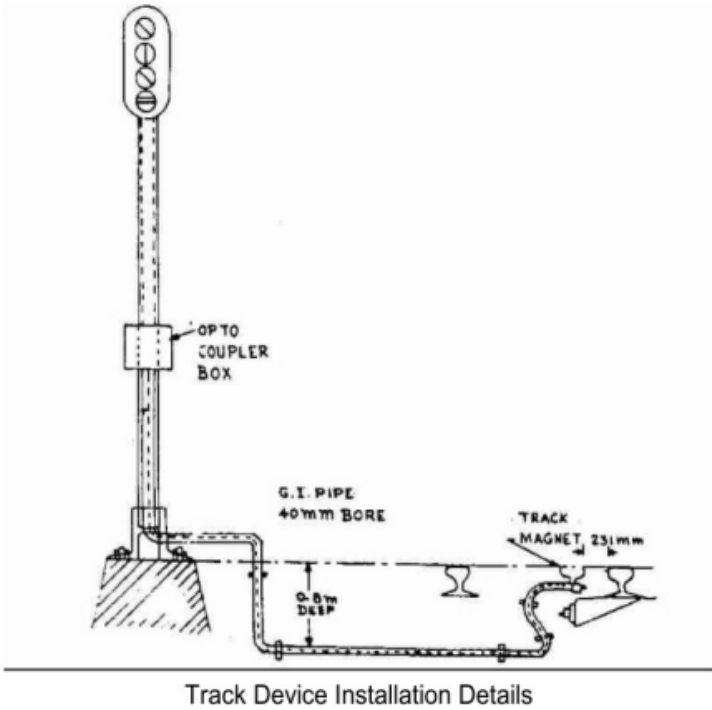
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Annexure VI(c)

TM details :



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