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Document Title : Functional Requirements Specification of KAVACH (The Indian Railway Automatic Train Protection System)			



सत्यमेव जयते

GOVERNMENT OF INDIA
(भारत सरकार)

MINISTRY OF RAILWAYS
(रेल मंत्रालय)

**Functional Requirements Specification
of
KAVACH (The Indian Railway Automatic Train Protection System)**

SPECIFICATION No. RDSO/SPN/196/2020

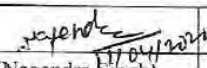
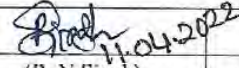
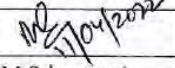
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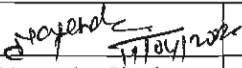
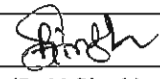
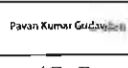
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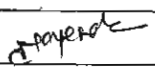
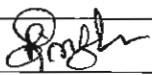
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Abstract This document covers Functional Requirements specification of KAVACH (The Indian Railway Automatic Train Protection System)		

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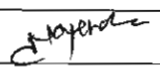
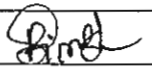
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Abbreviation	Full Form/ Description
BIU	Brake Interface Unit
DMI	Driver Machine Interface
EB	EB Emergency Brake
EI	Electronic Interlocking
EM	Emergency magnetic valve cutout cock
EMU	Electrical Multiple Unit
FS	Full Supervision Mode
FSB	Full Service Brake
GPS	Global Positioning System
GSM	Global System for Mobile Communications
IS	Isolation Mode
ISO	International Organization for Standardization
IBS	Intermediate Block Signal
IEC	International Electrotechnical Commission
LC	Level Crossing
LP-OCIP	Loco Pilot- Operation Cum and Indication Panel
LS	Limited Supervision Mode
MA	Movement Authority
NL	Non Leading Mode
NMS	Network Management System
OEM	Original Equipment Manufacturer
OS	On Sight Mode
OV	Override Mode
PT	Post Trip Mode
RDSO	Research Designs & Standards Organization
RE	Railway Electrification
RF	Radio Frequency
RFID	Radio Frequency Identification
RV	Reverse Mode
SB	Stand By Mode
SF	System Failure Mode
SH	Shunt Mode
SM-OCIP	Station Master- Operation Cum and Indication Panel
SOS	Save Our Souls -- A distress message
SPAD	Signal Passing at Danger
SR	Staff Responsible Mode
TA	Traction Active
TIN	Track Identification Number
TLM	Train Length Measurement
TR	Trip Mode
TSR	Temporary Speed Restriction

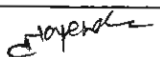
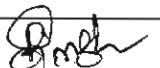
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Applicable Documents

This specification requires reference to the following documents –

S.N	Doc. No	Name of the document
1	EN 50126	Railway Applications- Specifications and demonstration of Reliability, Availability, Maintainability & Safety.
2	EN 50128	Railway Applications-Communications, Signalling and processing systems-Software for Railway Control and Protection Systems.
3	EN 50129	Railway Applications-Communications, Signalling and processing systems- Safety Related Electronics Systems for Signalling.
4	EN50159	Railway Applications-Communications, Signalling and processing systems - Safety related communication in closed and open transmission systems.
6	EN 50121 -4	Railway Applications - Electromagnetic compatibility (EMC)
7	EN50238	Railway applications – Compatibility between rolling stock and train detection systems
9	IEC 60571	Electronic Equipment Used on Rail Vehicles
10	IEC 61373	Railway Applications – Rolling stock equipment – Shock and vibration tests
11	ELRS/SPEC/SI/0015	Reliability of electronics used in rolling stock application
12	RDSO/SPN/144	Safety and reliability requirement of electronic signalling equipment.
13	IRS: S 36	Relay Interlocking systems.
14	IRS: S 23	Electrical Signalling and Interlocking Equipment
15	RDSO/SPN/192	Electronic Interlocking
16	CTC/TS—50459	Railway Applications - Communication, Signalling and Processing Systems - European Rail Traffic Management System - Driver-Machine Interface – Part 1:Ergonomic principles for the presentation of ERTMS/ETCS/GSM-R Information Part 1:Ergonomic arrangements of ERTMS/ETCS Information
17	DIN VDE 0831-200	Electric Signalling systems for Railways-Part 200: Safe Transmission Protocol according to DIN EN 50159 (VDE-0831-159)
18	Subset-026 (Chapter-05)	ERTMS/ETCS:- System Requirements Specification
19	IEC 62443	Security for industrial automation and control systems
20.	Subset of IRATP specification	Specification of temporary speed restriction (TSR) management system
21	Sub set of IRATP-NMS	Subset of Network Monitoring Specification of RDSO/SPN/196/2012

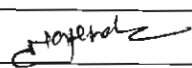
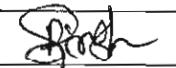
Wherever in this specification, any of the above mentioned specifications are referred, the latest version/ issue of the same is implied.

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Definitions

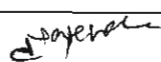
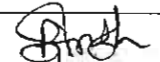
- i. **Acceptance Tests:** Tests carried out on the equipment/ system for the purpose of acceptance of the equipment/ system.
- ii. **Active Cab:** The active cab is the cab associated with an on board KAVACH, from which the traction is controlled.
- iii. **Adjustment Tag:** It is used for adjusting absolute location when two or more running lines are having different routes and converge at same stations.
- iv. **Authority to Proceed:** The written authority given to the Loco Pilot of a train, under the system of working, to enter the block section with his train.
- v. **Banking/ Coupled mode:** When, in addition to main leading loco, one or more locomotives are there in the train, other locomotives are said to be in Banking/ Coupled mode.
- vi. **Berthing Track:** This is the designated section of the track in station section on which trains normally stop e.g. Platform lines etc.
- vii. **Block Section:** The portion of the running line between two block stations on to which no running train may enter until Line Clear has been received from the block station at the other end of the block section.
- viii. **Communication Mandatory Area:** It is the area on track where continuous communication between Onboard KAVACH and Stationary KAVACH is required.
- ix. **Driving Position:** The position in the locomotive from where Loco Pilot runs the locomotive/ train, Electric locomotives, some diesel locomotives, EMU, MEMU, DEMU etc. have separate driving cabs for either direction driving and therefore have one driving position in each cab. However, most diesel locomotives have only one cab having two driving positions i.e. one for each direction driving.
- x. **Direction of movement of loco:** This is the direction of the train as per Loco cab control e.g. Forward or Reverse or Neutral.
- xi. **Dynamic Speed profile:** The speed-distance curve which a train shall follow without violating the static train speed profile till the end of movement authority. This curve depends on the braking characteristics of the train and the train length.
- xii. **End of Authority (EOA):** Location up to which the train is permitted to proceed and where target speed is zero.
- xiii. **Factory Acceptance Tests:** Tests carried out by installing some equipment in the lab to prove that the system performs in accordance with this specification & the application data.
- xiv. **First Stop Signal (FSS):** It is the first stop signal on approach to a station/ IBS/ interlocked LC gate.
- xv. **Full Supervision Movement Authority:** Permission for a train to run to a specific location within the constraints of the track infrastructure.
- xvi. **Functional Acceptance Tests:** Tests carried out by installing some equipment in the field to prove that the system performs in accordance with this specification & the

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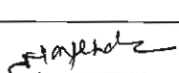
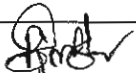
- xvii. **Interlocked LC Gate:** An LC Gate interlocked with Signals. Such gates are protected though signals provided on trackside.
- xviii. **Junction Tag :**It is used for adjusting absolute location when a station is a junction.
- xix. **KAVACH:** It is the brand name of Automatic Train Protection System developed for Indian Railways. KAVACH can be customized to the requirements of Railways.
- xx. **Last Stop Signal:** It is the last stop signal of a station/ IBS/ interlocked LC gate while leaving the station/ IBS/ interlocked LC gate.
- xxi. **Level Crossing (LC):** The intersection of road with railway track at the same level.
- xxii. **Light Engine (LE):** When the locomotive alone or consist of MU coupled locomotives runs as a train, the train is called as Light Engine.
- xxiii. **Locomotive:** The word 'locomotive' wherever used in this specification shall also mean the driving cab of EMU, MEMU, DEMU or any other self-propelled vehicle running on Indian Railways.
- xxiv. **Mid-Section:** A location on track anywhere which is between Last Stop Signal of one station to First Stop Signal of next station in the block section.
- xxv. **Movement Authority:** The distance upto which the train is permitted to travel without danger.
- xxvi. **National Values:** These values are the values of different parameters such as maximum permitted speed, speed in shunting mode, speed in OS mode, overlap distance, permitted roll away/ reverse movement distance etc. which are based on rules of train operation.
- xxvii. **'Off' aspect of a Signal:** Any aspect other than 'On' aspect of a signal.
- xxviii. **'On' aspect of a Signal:** It is the most restrictive aspect of the signal. In case of stop signal, Red (or Danger) aspect is the 'On' aspect.
- xxix. **On Sight Movement Authority:** Movement authority possessed by the Onboard KAVACH when the track ahead might be occupied by another train.
- xxx. **Overlap Distance:** The length of track in advance of a stop signal, which must be kept clear, either for clearing the stop signal next in rear or for the purpose of granting permission to approach. The overlap distance may be different for different types of signals & signalling.
- xxxi. **Point:** A turnout or point is a mechanical installation enabling railway trains to be guided from one track to another. The position of the point is said to be 'Normal' if it is set to straight track & 'Reverse' if it is set to diversion.
- xxxii. **Routine Tests:** Tests carried out on the equipment/ system by the manufacturer during production.
- xxxiii. **Schedule of Dimensions (SOD):** Indian Railways Schedule of Dimensions.
- xxxiv. **Static Speed Profile:** The Static Speed Profile (SSP) is a description of the fixed speed restrictions at a resolution of 5 Km/h for a part of track sent from trackside to train.
- xxxv. **Sectional Speed :** Permanent Speed Restriction, Temporary Speed Restriction, Turn

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out speed and maximum permissible speed of the track.

- xxxvi. **Station Section:** It is that portion of station limits which can be used for shunting even after granting Line clear to station in Rear.
- xxxvii. **Stop Signal:** A railway signal whose ON aspect is 'Red'.
- xxxviii. **Track Identification Number (TIN):** Track Identification Number is a unique number assigned to a portion of track in station section or block section.
- xxxix. **Traffic Direction:** This is the direction of the train according to the traffic movement as decided by the railway for a particular section e.g. Up or Dn (down) or up down or fast or slow. This direction is used to determine head on collision, Rear end collision, approaching or moving away from a train or station etc.
- xl. **Track Profile :** It consists of Maximum Permissible Speed, Permanent Speed Restrictions, Temporary Speed Restrictions, Gradients, Level Crossing Gates, track conditions (such as neutral section, radio hole, etc.,).
- xli. **Train Direction:** This is the direction of the train as per Loco cab control e.g. Forward or Reverse or Neutral. This direction is used for determining roll back/ forward, reverses movement etc.
- xlii. **Train Interface:** The cab inputs such as driving position, direction of throttle etc., which are used to interface Onboard KAVACH.
- xliii. **Type Tests:** Tests carried out to prove conformity with the specification. These are intended to prove the general qualities and design of the equipment/ system.

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1. Introduction

This document sets forth functional and operational requirements of KAVACH, the Indian Railway Automatic Train Protection System (formerly known as Train Collision Avoidance System).

KAVACH will be provided on sections equipped with Multi Aspect Colour Light Signalling controlled by relay or electronic interlocking and loco pilot will follow prevalent operating rules. Provision of KAVACH will be a safety aid to the loco pilot to prevent consequences arising out of Signal Passing At Danger (SPAD), to control train speed within specified limits, to indicate Movement Authority or/and display Signal Aspect in Loco pilot's cab and to further reduce the probability of train collisions in block sections and on running lines at stations through non-signalling based protections. In the event of a conflict between this specification and any other standards or specifications quoted herein, the requirements of this specification shall prevail. The operation of KAVACH shall, in no way, infringe / overrule the rules of normal train operations on the concerned Railways. The KAVACH schematic is shown in figure 1.

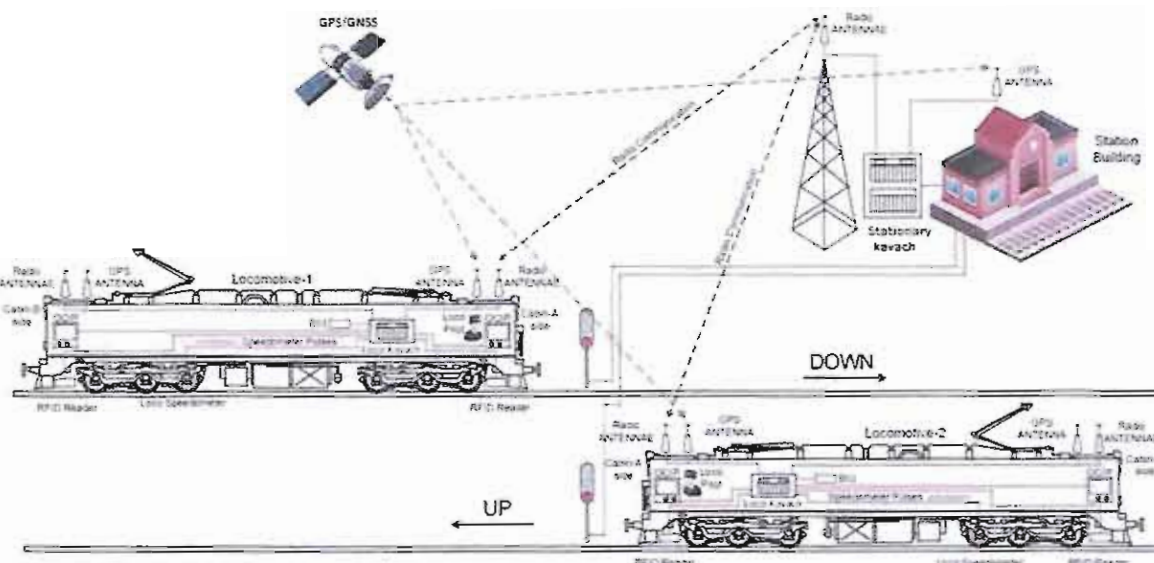
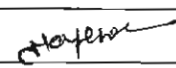


Figure 1: KAVACH SCHEMATIC

KAVACH functions shall conform to CENELEC standards EN 50126, EN 50128, EN 50129, and EN 50159 Safety Integrity Level-4 or as specified in the specifications.

All the provisions contained in RDSO's ISO procedures laid down in Document No. QO-D 8.1-11 (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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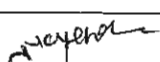
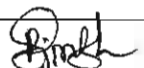
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2. Basic Functioning

- 2.1 KAVACH shall enable the train to run at maximum permissible speed safely.
- 2.2 KAVACH shall be an aid to the loco pilot which shall prevent Signal Passing At Danger (SPAD).
- 2.3 KAVACH shall be able to carry out Speed Supervision.
- 2.4 KAVACH shall be able to display Signal Aspect in Loco pilot's cab.
- 2.5 KAVACH shall be able to supervise train movement and shunting limits .
- 2.6 KAVACH is required to be functional up to a maximum train speed of 200 kmph.
- 2.7 The trains equipped with Onboard KAVACH shall be able to run in non-KAVACH territory also.
- 2.8 **Interoperability:** The interoperability requirements for the Stationary KAVACH are related to the data exchange between the Stationary KAVACH and the Onboard KAVACH , TSR interface, Direct EI interface based on OEM Proprietary protocols, adjacent Stationary KAVACH interface, RFID Tag Data, Network Monitoring System (NMS) and Key Management System.

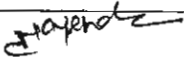
3. Operational Modes

- 3.1 This section defines the modes of the Onboard KAVACH System. The Onboard KAVACH shall be capable of supervising the following operational modes:
 - i. Stand By Mode (SB)
 - ii. Staff Responsible Mode (SR)
 - iii. Limited Supervision (LS)
 - iv. Full Supervision (FS)
 - v. Override (OVRD)
 - vi. On Sight (OS)
 - vii. Trip (TR)
 - viii. Post Trip (PT)
 - ix. Reverse (RV)
 - x. Shunt (SH)
 - xi. Non leading (NL)
 - xii. System Failure (SF)
 - xiii. Isolation (IS)

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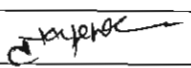
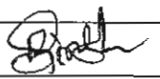
- 3.2 In case of transition, when the responsibility of the loco pilot increases due to result of such automatic transition, the KAVACH shall seek an acknowledgement from the loco pilot, whether the train is stationary or not.
- 3.3 In case the transition has to be acknowledged and the loco pilot fails to acknowledge as required, the KAVACH shall initiate a brake application. When the train is stand-still condition, in such case no brake shall be applied.
- 3.4 During the transition period between two operational states the supervision provided shall at least ensure the same protection provided by the least restrictive state.
- 3.5 The current mode shall be indicated to the loco pilot on the LP-OCIP (DMI).
- 3.6 **Annexure-A** explains about Modes, Onboard KAVACH functions during each mode and transitions between modes. This Annexure also describes how the received information is filtered and handled with respect to modes.

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4. Stand By Mode

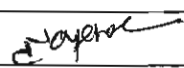
- 4.1 The Stand By mode is a default mode and cannot be selected by the loco pilot.
- 4.2 It is in the Stand By mode that the Onboard KAVACH awakes.
- 4.3 The Onboard KAVACH enters into Stand By Mode in any one of the following cases:
- (a) When the Onboard KAVACH is powered on and the Self-tests are completed successfully. §See section 19.2§
 - (b) When No CAB is occupied or EM cock is closed in SR, LS, FS, OVRD, OS, PT, RV and SH modes.
 - (c) On the exit of RV, SH, NL, SF and IS Modes.
- 4.4 In Stand By mode, the desk of the engine can be opened or closed. No interaction between KAVACH and loco pilot shall be possible as long as the desk is closed, except for isolation of the Onboard KAVACH.
- 4.5 The Onboard KAVACH unit shall perform the Standstill Supervision.
- 4.6 Radio Transmission is active if it is in KAVACH Territory.
- 4.7 The Onboard KAVACH shall display train speed and permitted speed (which in this case is Zero).
- 4.8 The Onboard KAVACH exits from Stand By mode in any one of the following cases:
- (a) If any CAB is occupied, based on New train Status and on successful self-tests it suggests SR or Shunt Mode to Loco Pilot.
 - (b) If any CAB is occupied and no new train status, it enters into the previous mode (SR, LS, FS, OVRD, OS, PT and SH).
 - (c) Transit to Non Leading mode in case Non Leading input is Active and the train is in standstill.
 - (d) Transit to Isolation mode in case Onboard KAVACH is isolated manually.
 - (e) Enters into System Failure Mode in case Onboard KAVACH is faulty.
- 4.9 The Onboard KAVACH shall display train speed and permitted speed (which in this case is zero)
- 4.10 **Responsibilities**
- 4.10.1 The Onboard KAVACH is responsible for maintaining the Loco/train at standstill.
- 4.10.2 The loco pilot cannot move the train in this mode.

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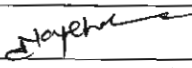
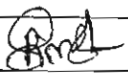
5. Staff Responsible Mode

- 5.1 The Staff Responsible mode allows the loco pilot to move the train under his or her direct responsibility in KAVACH territory/Non-KAVACH territory. SR mode can be selected manually only during start of mission §See clause 21§.
- 5.2 Loco Pilot shall acknowledge the automatic transition to Staff Responsible mode to avoid braking by KAVACH.
- 5.3 This mode is used when the system does not know the route. The Onboard KAVACH enters into this mode in any of the following cases:
- (a) Manual selection after the successful Onboard KAVACH self-tests and train configuration available and Cab is Active.
 - (b) After loss of radio communication in communication mandatory area.
 - (c) Three consecutive RFID tags missing.
 - (d) When train direction is not known.
 - (e) When KAVACH territory exit tag is read.
- 5.4 The Onboard KAVACH shall supervise against:
- (a) a ceiling speed: maximum permissible speed for loco/train.
 - (b) When both the Onboard KAVACH are functional, head-on and rear end collisions can be prevented, if TIN, direction, and absolute location information are available through Onboard direct UHF communication.
 - (c) SOS generation and emergency stop in case SOS is received if TIN, direction and absolute location information is available.
- 5.5 In case of new train formation, the Onboard KAVACH shall continue in Staff Responsible Mode till direction, On Sight movement Authority and track profile-are not available.
- 5.6 The Onboard KAVACH shall exit from SR Mode in any one of the following cases:
- (a) When No CAB is occupied or EM cock is closed (Enters Stand By Mode).
 - (b) When direction and On receipt of On Sight Movement Authority, track Profile and Valid Communication packets are available in communication mandatory area (Enters On Sight Mode).
 - (c) When Loco Pilot selects Reverse mode in standstill.
 - (d) When Loco Pilot selects Shunt mode in standstill.

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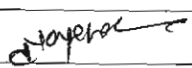
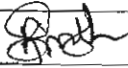
- 5.7 Since the gradient pertaining to track side is unknown to Onboard KAVACH, the supervision of the braking curves in Staff Responsible mode does not ensure that the train will stop at the given distance.
- 5.8 The Onboard KAVACH shall display train speed and permitted speed.
- 5.9 **Responsibilities:**
- 5.9.1 The Onboard KAVACH unit supervises a ceiling speed without distance limit.
- 5.9.2 The loco pilot should respect the existing line-side information (signals, speed boards etc.) in this mode.

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6. Limited Supervision Mode

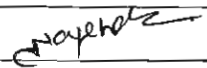
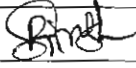
- 6.1 Limited supervision mode enables Onboard KAVACH to supervise track profile in case of communication failure.
- 6.2 Limited supervision mode cannot be selected by the loco pilot, but shall be entered from Full Supervision mode automatically when Valid Radio packets are not available (configurable) in Communication Mandatory Area and track profile is available upto 3000m (Configurable).
- 6.3 The Onboard KAVACH shall supervise train movements against a dynamic speed profile.
- 6.4 The Onboard KAVACH unit shall display the train speed. If the permitted speed is lower than the sectional speed limit and the maximum train speed, the permitted speed and the target speed shall be indicated.
- 6.5 Onboard KAVACH exits from LS Mode if any one of the condition is satisfied:
- (a) On receipt of On Sight Movement Authority and Valid Communication packets are available in communication mandatory area (Enters On Sight Mode).
 - (b) When Loco Pilot selects Reverse mode in standstill.
 - (c) When Loco Pilot selects Shunt mode in standstill.
 - (d) Enters into Staff Responsible mode for any of the following conditions:
 - (i) Track profile is not available upto 3000m (configurable).
 - (ii) When three consecutive tags are missed.
 - (iii) KAVACH Territory Exit tag is read.
 - (iv) Train traffic direction is unknown.
- 6.6 **Responsibilities**
- 6.6.1 The Onboard KAVACH is responsible for supervision of the train speed and section speed.
- 6.6.2 The loco pilot must observe the existing line-side information (signals, speed boards etc.)

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7. Full Supervision Mode

- 7.1 Full Supervision mode cannot be selected by the loco pilot, but shall be entered automatically when all the following necessary conditions are fulfilled:
- Track profile Available (Including Traffic Direction) up to 3000m or Movement Authority, whichever is less.
 - Valid Radio Packets are receiving in communication mandatory area.
 - Movement Authority is valid.
 - In case of On Sight mode, train has crossed at least one stop signal in OFF condition.
- 7.2 Track Profile and gradient are required to be available from the REAR END of the train for Full Supervision mode.
- 7.3 The Onboard KAVACH unit shall supervise train movements against a dynamic speed profile.
- 7.4 The Onboard KAVACH unit shall display the train speed, the permitted speed, Signal Aspect, the target distance and the target speed to the loco pilot.
- 7.5 Onboard KAVACH exits from Full Supervision Mode if any of the condition is satisfied:
- When train is at Standstill and Full Supervision Movement Authority is less than 200m, LP shall press 'OVRD' and 'CNFM' buttons (Enters Override mode).
 - When approaching a LSS/IBS at danger, LP shall press 'OVRD' and 'CNFM' buttons on run. Loco enters into On sight mode on receiving On Sight Movement Authority from Stationary Kavach.
 - When calling On Signal is lowered, Stationary KAVACH shall command Onboard KAVACH to On Sight mode.
 - When a train passes a stop-signal at ON or End of Authority, the Onboard KAVACH shall enter into Trip Mode.
 - When Loco Pilot selects Reverse mode in standstill.
 - When Loco Pilot selects Shunt mode in standstill.
 - Valid radio communication packets are not received and track profile available upto 3000m (Configurable) in communication mandatory area (Enters into Limited Supervision).

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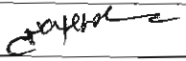
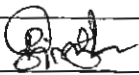
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(h) Enters into Staff Responsible mode for any of the following conditions:

- (i) Valid Radio packets are not available in communication mandatory area and track profile is not available (Including Traffic Direction) upto (3000m or Movement Authority), whichever is less.
- (ii) When three consecutive tags are missed.
- (iii) KAVACH Territory Exit tag is read.
- (iv) Train traffic direction is unknown.

7.6 Responsibilities

7.6.1 The Onboard KAVACH unit is fully responsible for the train protection.

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8. Override Mode

8.1 The Override mode enables the train to pass the signal at danger (End of Authority) when all the following conditions are satisfied:

- Train is at standstill.
- Loco pilots selects Override mode from FS, OS and PT modes.
- Movement Authority is less than 200m. (Configurable). This condition shall be relaxed when transiting from Post Trip Mode.

8.2 The Onboard KAVACH exits from Override mode when one of the following conditions is satisfied:

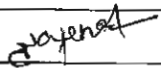
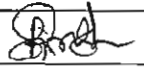
- Time out -Default: 240 s. (Loco Pilot shall cross the signal within this time out; otherwise, the extended On Sight Movement Authority will be truncated to the approaching stop signal. Loco Pilot need to select override again for moving further.
- On Sight Movement Authority extended, when Track Profile is available received and Valid radio packets are received (Enters into On Sight Mode).
- Full Supervision Movement Authority extended, when track profile is available and radio packets are received. (Enters into Full Supervision Mode)
- Enters into Staff Responsible mode for any of the following conditions:
 - Valid Radio packets are not available in communication mandatory area.
 - When three consecutive tags are missed.
 - KAVACH Territory Exit tag is read.
 - Train traffic direction is unknown.

8.3 When 'OVRD' and 'CNFM' buttons are pressed by Loco Pilot on run (if the Authority to proceed is received in advance) or at standstill (after the receipt of Authority to proceed is received), Onboard KAVACH shall display 'Override Selected' and keep informing this status to Stationary KAVACH till passing the signal foot or EOA. This feature enables passing signal at danger in the following cases without undesirable braking from KAVACH.

- Approaching LSS/IBS at ON where authority to proceed is received by Loco pilot in advance.

or

- When 'radio communication failed'.

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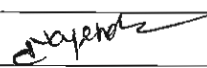
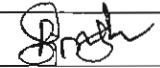
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8.4 The Onboard KAVACH shall display the train speed and the permitted speed to the loco pilot in this mode.

8.5 Responsibilities

8.5.1 The Onboard KAVACH shall supervise the train speed and permitted speed.

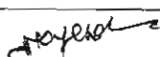
8.5.2 Loco pilot is responsible for checking the track occupancy in this mode when moving the train, because the track may be occupied.

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9. On Sight Mode

- 9.1 The On Sight mode enables the train to enter into a track section that could be already occupied by another train or obstructed by any kind of obstacle.
- 9.2 On Sight mode cannot be selected by the loco pilot, but shall be entered automatically after the permission of Stationary KAVACH.
- 9.3 The Onboard KAVACH shall supervise train movements against a dynamic speed profile.
- 9.4 The Onboard KAVACH shall display the train speed and the permitted speed to the Loco Pilot.
- 9.5 The KAVACH shall detect collisions in On Sight Mode, if KAVACH is functional in both the Onboards.
- 9.6 Onboard KAVACH shall enter into On Sight mode in the following cases:
- 9.6.1 Stationary KAVACH shall extend On Sight Movement Authority and Track Profile when Onboard KAVACH is in SR Mode
- 9.6.2 Override of Main Stop Signals other than LSS/IBS/Auto: When approaching signal is at danger, LP shall press 'OVRD' and 'CNFM' buttons within 200m (configurable) at stand still after the receipt of Authority to Proceed as per operating instructions. Loco enters into OS mode on receiving On Sight Movement Authority from Stationary KAVACH.
- 9.6.3 Override of LSS/IBS signal: When approaching a LSS/IBS at danger, LP shall press 'OVRD' and 'CNFM' buttons on run if Authority to Proceed is received in advance. Loco enters into OS mode on receiving On Sight Movement Authority from stationary Kavach.
- 9.6.4 Override of Auto signals: When approaching an Auto signal at danger, LP shall select 'OVRD' mode at standstill. Loco enters into OS mode on receiving On Sight Movement Authority from Stationary KAVACH after the train stops for one minute (Configurable) by day and two minute (Configurable) by night.
- 9.6.5 Override consecutive signals: When Consecutive signals are in danger, Onboard Kavach shall stop on approach of next danger signal (other than LSS or IBS) and LP shall select 'OVRD' mode to get the On Sight Movement Authority after the receipt of Authority to Proceed as per operating instructions.
- 9.6.6 Override of stop signal leading to multiple routes:
- (i) Loco Pilot shall select override mode only after receipt of Authority to Proceed as per operating instructions.
- (ii) Stationary KAVACH shall transmit On Sight Movement Authority for

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overridden danger signal upto next nearest (where there are multiple routes) approaching stop signal with speed restriction as specified for each signal in KAVACH table of control.

- (iii) Stationary KAVACH shall also convey 'Route not Known' information to the Onboard KAVACH.
- (iv) While approaching next stop signal, based on signal aspect, On Sight Movement Authority shall be updated.
- (v) In case, On Sight Movement Authority is not updated, when it is less than Override Selectable distance (default: 200m which is configurable), Loco Pilot shall select Override mode again.
- (vi) After passing one signal at OFF aspect, Stationary KAVACH shall send Full Supervision Movement Authority to Onboard KAVACH to enter into FS mode.

9.7 The On Sight Movement Authority shall be erased after the On Sight Movement Authority holding time (default: 120 seconds, configurable) on communication time out in communication mandatory area.

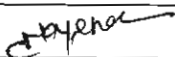
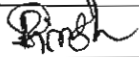
9.8 The extended On Sight Movement Authority after override shall be limited to the approaching signal foot by Stationary KAVACH, if the signal is not crossed by the train within 240 seconds (configurable).

9.9 On Sight Movement Authority shall be extended up to the foot of the stop signal (irrespective of its aspect) next to stop signal being overridden, in case of entry into override is from FS and OS modes. The next stop signal aspect, marker and description (if available) shall be linked only within 100m if no KAVACH functional loco is available between the Onboard KAVACH and the approaching stop signal.

9.10 On Sight Movement Authority shall be extended up to the foot of approaching stop signal irrespective of its aspect in case of entry into override is from PT mode. The approaching stop signal aspect, marker and description (if available) shall be linked only within 100m if no KAVACH functional loco is available between the Onboard KAVACH and the approaching stop signal.

9.11 Onboard KAVACH shall exit from On Sight mode, if one of the following condition are satisfied:-

- a) After passing the signal at 'OFF', Stationary KAVACH shall provide Full supervision Movement Authority (Enters into Full supervision mode).
- b) When a train passes a stop-signal at ON or End of Authority, the Onboard KAVACH shall enter into Trip Mode.
- c) When Loco Pilot selects Reverse mode in standstill.
- d) When Loco Pilot selects shunt mode in standstill.

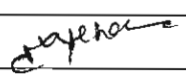
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- e) When loco pilot selects override mode in standstill.
- f) Enters into Staff Responsible mode for any of the following conditions:
 - (i) If no communication is available with Stationary KAVACH in communication mandatory area and expiry of On Sight, Movement Authority.
 - (ii) When three consecutive tags are missed.
 - (iii) KAVACH Territory Exit tag is read.
 - (iv) Train traffic direction is unknown.

9.12 Responsibilities

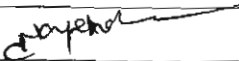
- 9.12.1 The Onboard KAVACH shall supervise the train movement against a ceiling On Sight speed specified by Stationary KAVACH
- 9.12.2 Loco pilot is responsible for checking the track occupancy in this mode when moving the train, because the track may be occupied or obstructed.

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10. Trip Mode

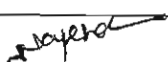
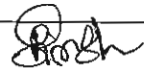
- 10.1 When a Train in Full Supervision or On Sight Mode passes a stop-signal at ON or End of Authority, the Onboard KAVACH unit shall enter into Trip Mode.
- 10.2 Application of emergency brakes and train trip are two different things. For example, exceeding the permitted speed leads to application of the emergency brakes, but as long as the train does not pass the EOA, it is not a train trip.
- 10.3 Trip can happen in any one of the following cases:
- (a) Due to Loco Pilot irresponsible operation.
 - (b) Due to malfunction of Onboard KAVACH.
 - (c) Signal flying back to danger in the approach of the train where there is no adequate braking distance.
- 10.4 The Onboard KAVACH unit shall perform the Standstill Supervision in Trip mode.
- 10.5 The Onboard KAVACH unit shall command the emergency brakes.
- 10.6 Closing the desk while being in Trip mode will not cause a mode change including standby mode but no interaction with the loco pilot shall be possible as long as the desk is closed, except isolation of the KAVACH on-board equipment.
- 10.7 The Onboard KAVACH shall display the train speed and permitted speed (which is zero in this mode).
- 10.8 On board KAVACH exits the Trip mode when the Post Trip mode is selected by Loco Pilot at Stand still.
- 10.9 **Responsibilities**
- 10.9.1 The Onboard KAVACH unit is responsible for stopping the train and for maintaining the train at standstill.
- 10.9.2 The loco pilot has to be relieved from the responsibility for train movements during the condition §10.3(a) §
- 10.9.3 During the malfunction of Onboard KAVACH, it shall be isolated and put back to service, when it is proven that it is safe for operations. §10.3(b)§
- 10.9.4 In case of §10.3(c)§, the root cause for signal flying back to danger is to be identified and mitigate as per railway procedures.

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11. Post Trip Mode

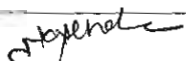
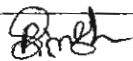
- 11.1 When the train enters trip mode, the loco pilot shall select Post Trip mode in a standstill condition to move the train.
- 11.2 On entering into post trip mode, the Onboard KAVACH unit shall release the command of the emergency brake, if the train is standstill.
- 11.3 The Onboard KAVACH shall display the train speed and permitted speed (which is zero in this mode).
- 11.4 The Onboard KAVACH shall exit from the Post Trip Mode if the following conditions are met:
- (a) When the train is in standstill, LP shall select override mode to move forward.(linking distance is to be ignored.)
 - (i) Further, on the receipt of On Sight Movement Authority with a speed limit of 15 Kmph (configurable) enters On Sight Mode.
 - (ii) When communication is not available, Onboard kavach shall continue in override Mode (Further see clause §8.2(d)(i)§Override mode).
 - (b) When the train is in standstill, LP shall select Reverse mode to move reverse.
 - (c) Enters into Staff Responsible mode for any of the following conditions:
 - (i) KAVACH Territory Exit tag is read.
 - (ii) Train traffic direction is unknown.
- 11.5 **Responsibilities**
- 11.5.1 The Onboard KAVACH is responsible for maintaining the Loco/train at standstill.
- 11.5.2 In case, the loco pilot wants to move the train forward, loco pilot shall select Override Mode after selecting the Post Trip Mode.
- 11.5.3 On receipt of Paper Authority, loco pilot shall select Reverse Mode after selecting the Post Trip Mode to back the train. When moving backwards, the train trip shall be inhibited.

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12. Non Leading Mode

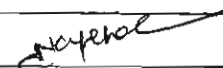
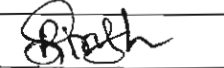
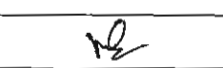
- 12.1 The Non-Leading mode is defined to manage the Onboard KAVACH of a slave engine that is either electrically coupled to the leading engine (remote controlled) or NOT electrically coupled to the leading engine (not remote controlled).
- 12.2 Non leading mode shall be selected by the Loco pilot when the train is at standstill.
- 12.3 The Onboard KAVACH shall attempt to transmit an Onboard-to-Stationary Radio Packet at a periodicity of not less than 02 minute on encountering any tag (excluding LC Gate Tag) in one of the randomly selected access time slots merely to indicate the Onboard KAVACH mode to NMS through Stationary KAVACH, when any desk is open.
- 12.4 It shall be possible to use multiple traction units/EMU/MEMUs/DEMUs without isolating the Onboard KAVACH equipment on traction unit(s) with an inoperative cab by using Non-Leading mode.
- 12.5 Information received from trackside shall not influence the traction unit(s) within operative cabs.
- 12.6 The train trip function shall be suppressed in traction unit(s) with inoperative cabs.
- 12.7 The Onboard KAVACH shall display only the train speed.
- 12.8 **Responsibilities**
- 12.8.1 The Onboard KAVACH unit shall not perform any train movement supervision in Non-Leading mode.

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13. Reverse Mode

- 13.1 The Reverse mode allows the loco pilot to change the direction of movement of the train and drive from the same cab, i.e. the train orientation remains unchanged.
- 13.2 The Onboard KAVACH unit shall supervise train movements against the following:
- (a) a ceiling speed (Reverse mode speed limit configurable, Default: 25 kmph),
 - (b) a configurable distance (Default: 500m) and
 - (c) a configurable time out (Default: 300s) for which reverse movement is allowed.
- 13.3 The Onboard KAVACH unit shall display only the train speed and the permitted speed.
- 13.4 The position reports being sent by Onboard KAVACH when in reverse mode shall refer to the location of the driving cab (as before reversing).
- 13.5 When reverse mode is not selected, reverse movement shall be detected based on Cab input and Wheel Sensor direction, the MA should increase and brakes should be applied within a distance of 2 meter (Configurable).
- 13.6 Onboard KAVACH shall ignore the RFID tag information received in Reverse mode.
- 13.7 Onboard KAVACH shall blow horn in Reverse Mode.
- 13.8 In Reverse mode, the normally allowed movement is backwards, and hence the Reverse Movement Protection avoids the train running in forward direction. If the reverser is moved out of reverse position, the Onboard KAVACH exits from the Reverse mode to Stand By Mode.
- 13.9 **Responsibilities**
- 13.9.1 The Onboard KAVACH supervises a ceiling speed in reverse direction.
- 13.9.2 The loco pilot must keep the train movement inside the distance to run as prescribed in the Authority given.

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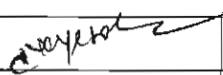
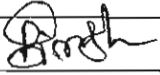
14. Shunt Mode

- 14.1 Shunt signals are not monitored by KAVACH system and hence shunt signal passing at Danger can not be supervised.
- 14.2 As Shunting allows bumping into stable loads, hence collision scenarios are not evaluated by loco or station KAVACH in this mode.
- 14.3 It shall be possible to manually select Shunt Mode only when the train is at stand still from Stand By, Staff Responsible, Limited Supervision, Full Supervision mode and On Sight mode.
- 14.4 The Onboard KAVACH unit shall perform the Train Position function.
- 14.5 The Onboard KAVACH unit shall display the train speed and the permitted speed.
- 14.6 Onboard KAVACH exits from shunt mode to Stand by mode when one of following conditions are met:

- a) No CAB is occupied or EM cock is closed.
- b) Loco Pilot presses “Shunt” and “CNFM” button in standstill.

14.7 Responsibilities

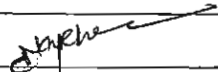
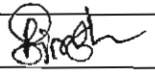
- 14.7.1 The Onboard KAVACH is responsible for the supervision of the shunting mode speed limit (Default: 15 Kmph) within shunting limits.
- 14.7.2 The loco pilot is responsible for remaining inside the shunting limits, train/engine movements and shunting operations as prescribed in Station Working Rules and General & Subsidiary Rules.

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15. System Failure Mode

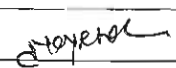
- 15.1 The Onboard KAVACH shall switch to the System Failure mode in case of a fault, which affects safety.
- 15.2 **Responsibilities**
- 15.2.1 The Onboard KAVACH is responsible for commanding the Emergency Brakes.
- 15.2.2 The loco pilot shall isolate the KAVACH system and run the train under his/her responsibility.

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16. Isolation Mode

- 16.1 In Isolation mode, the Onboard KAVACH unit shall be physically isolated from the brakes. In isolation means turning isolation switch to ISOLATE position. In addition EM cock shall be closed in case of pressure leakage.
- 16.2 There shall be a clear indication to the loco pilot that the Onboard KAVACH equipment is isolated.
- 16.3 To leave Isolation mode, procedure described in Onboard KAVACH operating manual shall be followed. This procedure shall ensure that the Onboard KAVACH unit is only put back into service when it has been proven that this is safe for operation.
- 16.4 Onboard KAVACH shall attempt to transmit an Onboard-to-Stationary RadioPacket at a periodicity of not less than 02 minute on encountering any tag (excluding LC Gate Tag) in one of the randomly selected access timeslots merely to indicate the Onboard KAVACH mode to NMS through Stationary KAVACH, when any desk is open.
- 16.5 **Responsibilities**
- 16.5.1 Isolation of the Onboard KAVACH is performed by the loco pilot under his complete responsibility.

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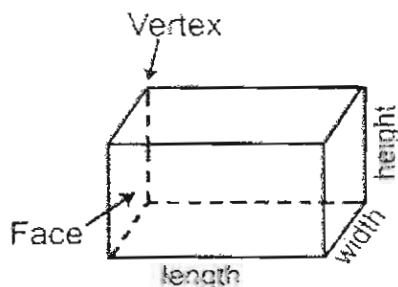
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17. Onboard KAVACH Unit Braking Parameters

- 17.1 Onboard KAVACH unit shall obtain the braking parameters from the -train configuration selected by the loco pilot at the start of mission.
- 17.2 Normal brake shall be used for ceiling speed control (wherever available).
- 17.3 Service brake shall be applied based on speed margin.
- 17.4 Emergency brake shall be applied in case of system failure, trip and exceeding the limit of EB speed margin.
- 17.5 The braking curve shall be derived such that the train shall stop within 5m of the target by application of FSB and in overlap through the application of EB.
- 17.6 Whenever traction unit has come to a standstill by Onboard KAVACH for roll away or roll back protection, brake shall be released after acknowledgment of Loco Pilot.

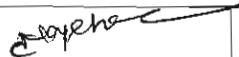
18. Onboard KAVACH Unit dimensions limits

- 18.1 The outer dimensions of Onboard KAVACH are as follows.



S.N.	Description	Dimension(LxWxH) in mm ³
(i)	ONBOARDKAVACH Unit	650x 435x 1150
(ii)	BIU Unit	610x 420x 1250
(iii)	DMI Unit	400x 200x 420
(iv)	Radio Unit	310x 230x 340
(v)	RFID Reader	560x 440x 630
(vi)	CAB Input Box	300x 150x 400
(vii)	RF Antenna	410x 180x 260
(viii)	GPS GSM Antenna	450x 250x 250
(ix)	BTM Antenna	560x 460x 140
(x)	BTM Unit	400x 500x 350

Table 1.1: Outer Dimensions of Onboard KAVACH

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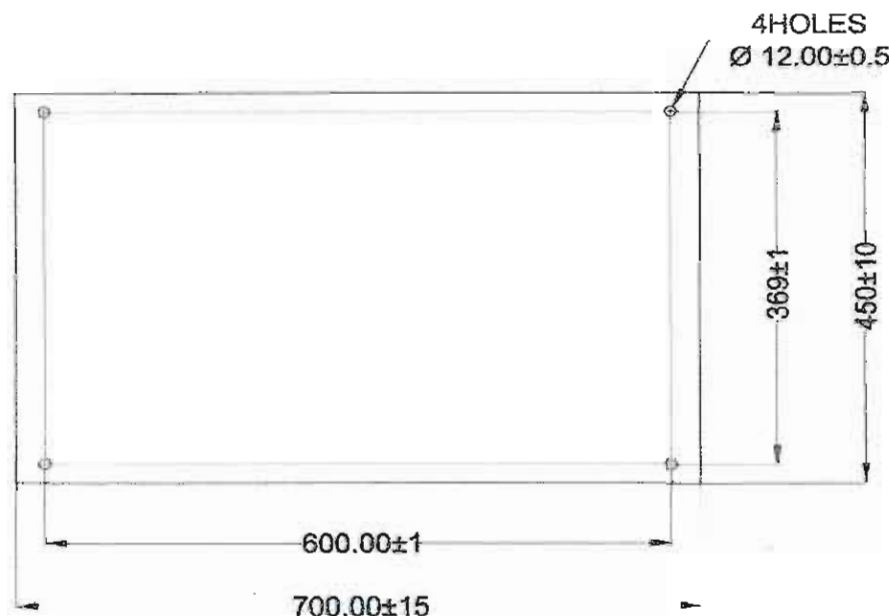


Figure -2: Onboard KAVACH mounting plate 16 mm thick

18.2 The uniform drawing for fixing arrangement (Nut/Bolt) is shown in figure 2.

19. Self Tests

19.1 Booting time of KAVACH shall be within two minutes.

19.2 Onboard KAVACH

19.2.1 The Onboard KAVACH equipment shall perform an automatic self-test when the equipment is switched ON or when train configuration changes.

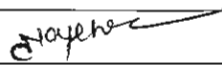
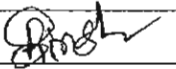
19.2.2 This self-test shall not require any action on the part of the Loco Pilot/ operator. This self-test must test all vital elements including Brake Interface Unit (BIU). Functionality of Normal Brake, Full Service Brake & Emergency Brake shall be tested (Normal Brake (NB) not applicable in EMUs) on boot-up.

19.2.3 Normal Brake (NB) self- test is not applicable in EMUs or other such vehicles.

19.2.4 The self-test shall also ensure the integrity of wiring of vital brake interface so as to prevent incidents like non-braking, not whistling due to wire-cut when the equipment is switched ON.

19.2.5 During Start of Mission, KAVACH shall prompt for "Waiting for Traction Command" till Traction Active input is received from Onboard control system. Traction active input shall indicate actual traction status. Once Traction Active (TA) input is active, KAVACH shall cut off traction and verify that traction is off. Failure of this test shall be displayed as "Traction cut-off Command fail".

19.2.6 The result of self-tests shall be indicated on LP-OCIP (DMI).

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19.3 Stationary KAVACH

19.3.1 The Stationary KAVACH equipment shall perform an automatic self-test when the equipment is switched ON and periodically, thereafter.

S. No	Self Test For	Action to be taken by system
1.	Radio	When both radios fail Vital computer will be in failure mode RF communication is stopped and the fault is logged.
2.	GPS	When both GPS modules fail Vital computer will be in failure mode RF communication is stopped and the fault is logged.
3.	GSM	No action is taken in case of failure. The fault is logged.
4.	The health of vital cards and SMOCIP	When a card fails the corresponding card is functionally deactivated and the fault is logged.

Table 3: Stationary KAVACH self tests

20. New Train Formation

20.1 A train shall be considered as a new formed train by Onboard KAVACH unit under one or more of the following conditions :

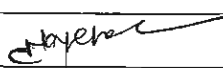
- (a) When Onboard KAVACH unit has been switched on or restarted
- (b) When Onboard KAVACH unit has come out of Non-Leading /Shunt mode/System failure mode/Isolation mode.
- (c) When driving cab/desk is changed except when Onboard KAVACH is in Shunt mode.

21. Start of Mission

21.1 The loco pilot may have to start mission in one of the following cases:

- (a) Once the train is swithed ON, OR
- (b) Once shunting movements are finished, OR
- (c) Once a non leading engine becomes a leading engine OR
- (d) the cab is changed in case of Dual Cab Onboard, OR
- (e) The direction of driving is changed e.g. from Short Hood to Long Hood or vice versa in case of Single Cab.

21.2 The Loco pilot shall ensure that Isolation switch is in NORMAL position, Power supply switch is in ON position and EM cock is in NORMAL position. The Driving Cab / Desk shall be activated by inserting BL key (Electric Locos) or placing Reverser handle in the forward position (in Diesel Locos).

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- 21.3 Onboard KAVACH shall have successfully passed the self-tests and shall be in Stand By mode.
- 21.4 Loco Pilot shall select a train configuration type on DMI (not applicable for train-sets etc.).
- 21.5 Onboard KAVACH will prompt the Loco Pilot to enter Staff Responsible mode or Shunt mode.
- 21.6 Onboard KAVACH shall enter into the mode selected by Loco Pilot.

22. Change in Train Formation

- 22.1 Train operations may require the change in train formation during the journey of a train. If such change does not fulfil the conditions mentioned in new train formation §See Section 20§, Loco Pilot shall change the train configuration at standstill. Subsequently, Onboard KAVACH shall conduct self-tests. On successful self-tests, Onboard KAVACH shall continue in existing mode.

23. KAVACH Territory Exit

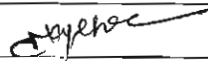
- 23.1 If KAVACH equipped train passes from KAVACH to Non- KAVACH or TPWS territory, Onboard KAVACH unit shall seek acknowledgement by the Loco Pilot. If the Loco Pilot does not acknowledge after a time period of 15 Sec (configurable) the brake shall be applied. If the Loco Pilot acknowledges subsequently, the brakes shall be released.

24. Display of Signal Aspect

- 24.1 It shall be possible to display signal aspect on LP-OCIP (DMI).
- 24.2 Signal aspect on LP-OCIP (DMI) shall be changed to aspect of approaching signal and signal description shall be made blank immediately, when Onboard KAVACH detects that it has crossed the signal on reading the signal foot tag.
- 24.3 If the signal foot tag is missed, Onboard KAVACH shall cater for +30m (Configurable) of odometry error. The blank field shall be displayed as soon as update is received from stationary KAVACH unit provided "Distance to Signal" is more than 100m or 8s time out after loco detects crossing of signal.

25. Train Length Assignment

- 25.1 Onboard KAVACH shall assume a default train length when new train is formed. §See Section 20§.
- 25.2 When the train has assumed default train length, the same shall be displayed on the LP-OCIP (DMI). Further, the value of default train length derived from train configuration parameters shall be used for the purpose of following speed restriction till the time, Onboard KAVACH acquires train length information and the same is updated in it.

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- 25.3 It shall be possible to automatically calculate train length by the Onboard KAVACH on receiving the required information from Stationary KAVACH. This feature is only applicable in case of station.
- 25.4 The train length so calculated by Onboard KAVACH shall be updated by replacing the previously stored train length if the previous train length was default train length OR If the train length calculated by Loco unit differs from the previously stored train length by more than 25m. This difference in train length shall be user programmable.
- 25.5 In case of overlapping territories, the Train Length measurement (TLM) information shall be passed to taking over station. The taking over station shall pass the train length information to the Onboard Kavach.

26. Train Location

- 26.1 The Onboard KAVACH shall determine the location of the train with the help of RFID tag data and directional type Speed sensor output.

27. Speed Calculation and Indication

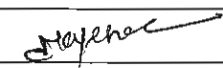
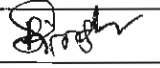
- 27.1 The Onboard KAVACH shall make speed profile/ brake curve for different situations based on movement authority, speed restriction and other information as received from Track side sub-system.
- 27.2 Current speed shall be indicated on the LP-OCIP (DMI).
- 27.3 Current speed shall be used for supervision of movement authorities and speed restrictions

28. Visual and Audio warnings on the LP-OCIP (DMI)

- 28.1 In Full Supervision mode, the Onboard KAVACH Unit shall neither generate warning for brake application nor apply the brakes as long as the current speed is less than or equal to permitted speed indicated on LP-OCIP (DMI).
- 28.2 Visual and audio warnings about expected brake intervention by Onboard KAVACH unit shall be given to the Loco pilot to enable the loco pilot to react and avoid intervention.

29. Supervision of movement authorities and speed limits

- 29.1 The Onboard KAVACH shall supervise the end of movement authority, if this information is available Onboard.
- 29.2 A train shall be supervised to its static and dynamic train speed profiles considering permanent and Temporary Speed Restrictions.
- 29.3 If the train speed exceeds the permitted speed by 2-5 Km/h (configurable), warning for over-speed would be generated.

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- 29.4 If the train speed exceeds the permitted speed by 5 kmph (configurable), the Onboard KAVACH shall execute a normal brake (where available) intervention along with warning until the actual speed is below the warning speed.
- 29.5 If the train speed exceeds the permitted speed by 8 kmph (configurable), the Onboard KAVACH shall execute a full service brake intervention along with warning until the actual speed is below the warning speed margin.
- 29.6 If the train speed exceeds the permitted speed by 10 kmph (configurable), the Onboard KAVACH shall execute an emergency brake intervention along with warning until the actual speed is below the warning speed margin.
- 29.7 The NB, FSB and EB speed margins are given in §Annexure-A§
- 29.8 In case of supervision of End of Authority or Speed Restriction of zero kmph ahead (dead stop), brakes shall be released when loco/train speed becomes zero kmph or when the loco/train speed is less than the estimated permitted speed.
- 29.9 In other cases, when target speed is non-zero, brake intervention command from KAVACH would cease once the actual speed is within 5 kmph (Configurable) of estimated permitted speed.

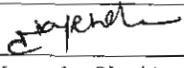
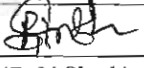
30. Prevention of Signal Passing at Danger (SPAD)

- 30.1 KAVACH system shall supervise the movement authority based on the signal aspect, point indication status and the status of berthing track circuit/axle counter for manually controlled signals.
- 30.2 KAVACH system shall supervise the movement authority based on the signal aspect and the status of track circuit/axle counter for Automatic signals.
- 30.3 A SPAD event shall be considered to have taken place when the front end of train, even in long hood operation, crosses the Movement Authority.
- 30.4 SPAD prevention is supervised by KAVACH only in FS, OS Mode.
- 30.5 When the Onboard signal is ON or blank, irrespective of the aspect of the approaching signal on the line side, Loco Pilot shall press the 'OVRD' and 'CNFM' buttons before passing the stop signal to avoid undesirable braking by KAVACH.

31. Non Signalling Based Protective Functions

31.1 Prevention of Head on & Rear end Collisions

- 31.1.1 KAVACH shall be capable of preventing Head on & Rear end collisions in Station section when both stations and locos are equipped with functional KAVACH.
- 31.1.2 KAVACH shall be capable of preventing Head on & Rear end collisions in Block section when both the locos are equipped with functional KAVACHs.
- 31.1.3 Collision prevention cannot be handled by KAVACH in the vicinity of adjustment tags and junction tag.

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31.2 **Detection of Unusual Stoppage which may cause infringement to adjacent lines in Block Section.**

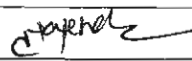
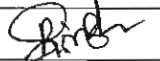
- 31.2.1 There shall be provision of automatically generating SOS from a Onboard KAVACH if it stops for a specific amount of time (Default: 15s) in both absolute block and automatic section
- 31.2.2 There shall be a provision to cancel the transmission of this message by Loco Pilot by pressing a button on the LP-OCIP (DMI) either before the generation or even after the transmission has started.
- 31.2.3 In case of unusual stopping of train in the block section (if Movement Authority is greater than 300m (configurable), Onboard KAVACH shall transmit the 'unusual stoppage' message, after a delay of 15 seconds (configurable) of stoppage of the train unless acknowledged by the Loco Pilot.
- 31.2.4 The Loco/Train approaching towards the originating location of "Unusual Stoppage" message, on getting 'Unusual Stoppage' message shall display it on the LP-OCIP (DMI with audio warning) & shall automatically apply brakes to bring the train/locomotive to standstill before reaching the originating location of Unusual Stoppage" message. After the train speed is reduced to zero kmph, train speed shall be supervised for 30kmph (configurable) till the train passes the originating location of "Unusual Stoppage" message. This defined speed need to be configured at the time of installation as application data.
- 31.2.5 If the loco pilot stops the train in block section for whatever reason, including regular stoppage, and it is not infringing on other lines, the loco pilot must acknowledge the stop to avoid an Unusual Stoppage collision message being generated (SOS).

31.3 **Protection of Roll Back**

- 31.3.1 On board unit shall be capable of detecting Roll Back (Direction of Throttle and train/loco movement are opposite) of the train through train interface.
- 31.3.2 The roll back intervention shall be indicated on the LP-OCIP (DMI).
- 31.3.3 When the traction unit has come to a standstill and acknowledged by Loco Pilot, Onboard KAVACH unit shall release the brakes.
- 31.3.4 It shall ensure standstill protection when the train speed is zero and reverser is detected at neutral in the SR, LS, FS, OS, OVRD, PT and SH mode

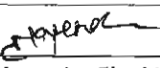
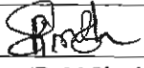
31.4 **Manual SOS generation/ Cancellation**

- 31.4.1 There shall be provision of manually generating and cancelling SOS from both Stationary and Onboard KAVACH.
- 31.4.2 Onboard as well as Stationary KAVACH shall have provision of sending SOS message by pressing SOS and Common buttons together.

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- 31.4.3 These SOS and Common buttons shall be so positioned on SM-OCIP/ LP-OCIP (DMI) that these could not be pressed inadvertently.
- 31.4.4 Onboard as well as Stationary KAVACH unit shall have provision to cancel the Manual SOS message by pressing 'Common' and 'ACK/Cancel' buttons together.
- 31.4.5 When the SOS and Common buttons are pressed simultaneously in Onboard KAVACH, the Onboard KAVACH of all the approaching trains/locos within 3000m of location of SOS originating source as well as self-train (if SOS is generated by Onboard KAVACH) and approaching towards location of SOS originating source, It shall apply brakes immediately to bring the train/locomotive to standstill. After the train speed is reduced to zero kmph, train speed shall be supervised for 30kmph (configurable) till the train passes the originating Location of "SOS" message.
- 31.4.6 When the SOS and Common buttons are pressed simultaneously in Stationary KAVACH, the Onboard KAVACH of all the trains/Locos within 3000m of location of SOS originating source shall apply brakes immediately to bring the train/locomotive to standstill. After the train speed is reduced to zero kmph, Loco Pilot shall acknowledge releasing the SOS. Loco Pilot shall further handle the train based on the information received from Station Master.
- 31.4.7 The normal speed shall be restored only if any one of the following condition is satisfied:-
- SOS message is cancelled by the source.
 - Train is moved away to more than 1500m (Configurable) from the source Onboard KAVACH.
 - SOS message reception is not received from the source for more than 3 minutes (Configurable).
- 31.4.8 SOS sending as well as receiving KAVACH equipment shall log sending & receiving of SOS messages. In addition, the information shall be sent to Network Monitoring System by Onboard KAVACH through Commercial GSM/LTE and Stationary KAVACHs either through Ethernet or Commercial GSM/LTE.
- 31.5 **Onboard Specific SOS**
- 31.5.1 In case of unusual movement of Onboard KAVACH, Stationary KAVACH shall generate Onboard Specific SOS. The Onboard KAVACH shall then bring Loco/train to Standstill. Afterwards, the speed can be relaxed to 30 Kmph (default) configurable or mode specific speed limit whichever is lower, until the Onboard Specific SOS is released by Stationary KAVACH. The SOS time out and SOS Cancel distance shall be as defined in configurable parameters in Annexure-A.
- 31.5.2 MA shall be made 0 (zero) for Onboard specific SOS except for rear end collision prevention.
- 31.5.3 In case of rear end collision prevention, MA shall be reduced by train length of front loco and rear end collision margin distance.

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32. Auto whistling on approach of Level Crossing Gate

- 32.1 KAVACH shall have provision of optional auto whistling to alert the road users of approaching train.
- 32.2 It shall be possible to cancel the auto-whistling by pressing Ack/Cancel button alone.

33. Configurable Parameters

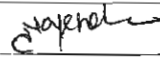
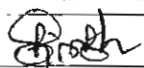
- 33.1 KAVACH shall have provision for entering configurable parameters to facilitate time-outs, linking distances and speed limits as per the requirements of Railways. These are known as National Values.
- 33.2 The Onboard KAVACH configurable parameters are shown in Table A.5 of Annexure- A.
- 33.3 The Stationary KAVACH configurable parameters are shown in Table A.7 of Annexure-A.
- 33.4 After any modification, relocation, new provision of signals etc. to be updated in KAVACH system.

34. Test benches

- 34.1 Stationary KAVACH test bench shall be provided at important locations as per the choice of purchaser railway to test the modules of Stationary KAVACH.
- 34.2 Provision should be there for Loco Shed Test Bench for testing Onboard KAVACH while leaving the loco shed to ensure the functioning of Onboard KAVACH components such as brake interface unit, RFID Reading and communication capability. Purchaser Railway would decide the finer requirements and location for installing Loco Shed Test Bench.

35. Other Requirements

- 35.1 Kavach LP interface shall be uniform in all respects irrespective of OEM.
- 35.2 In case of more than one situations/ scenarios existing at the same time, the Onboard KAVACH shall take action as per the most restrictive situation/ scenario.
- 35.3 Once a situation is detected by Onboard KAVACH based on the information received by it, which warrants application of brake & further update of information is not available, the action for brake application shall be initiated or continued if already initiated as per the brake curve at the time receipt of last information. Further update of brake curve shall be done only after start of receipt of further information.
- 35.4 Time reference for the entire KAVACH network shall be synchronized. Logging shall be done for every two seconds.
- 35.5 Onboard KAVACH shall intimate critical message such as "Single RFID Tag missing in Set", "Transition to LS or SR Mode" to NMS which in turn shall send SMS alert to the Maintenance Staff.

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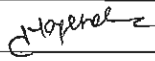
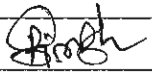
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- 35.6 During Non Interlocking, Stationary KAVACH shall be switched OFF. Collisions are to be detected through Onboard to Onboard communication, if tags are properly installed.
- 35.7 KAVACH shall enable Temporary Single Line working on Double Line.
- 35.8 The data shall be recorded at three levels.
- Detailed Data logging need to be retained for minimum 72 hours.
 - Maintenance data, which will help in maintaining the KAVACH, must be stored for minimum 15 days.
 - The record of critical events needs to be maintained for minimum 90 days.

36. Failures and Fall-Back Procedures

36.1 Radio Communication Failure

- 36.1.1 Radio communication unit shall have hot standby. In the event of radio communication failure beyond time-out :
- The Onboard KAVACH shall transit from Full Supervision or On Sight mode to Limited Supervision mode, in case track profile information is available and shall seek acknowledgement from the Loco Pilot.
 - If the track profile information is also not available during Radio Communication Failure, Onboard KAVACH shall transit from Full Supervision or On Sight mode to Staff Responsible mode.
 - If the loco pilot fails to acknowledge the transition of mode within stipulated period (Default: 15s), Onboard KAVACH shall apply service brakes.
 - In case of Radio Communication Failure, the Movement Authority shall not be displayed on LP-OCIP (DMI).
- 36.1.2 If the last packet received from Stationary KAVACH is more than 6 seconds older, the signal aspect and signal description shall be made blank. However, the Onboard KAVACH shall continue to function in Full Supervision mode and shall supervise the Movement Authority received in latest packet, till communication time out.
- #### 36.2 Onboard KAVACH Equipment Failure
- 36.2.1 If there are failures of the Onboard KAVACH which compromise the safety of train supervision, the Onboard KAVACH shall switch to System Failure mode.

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