

TECHNICAL ADVISORY NOTE

Subject	System Improvements regarding Installation and Maintenance for KAVACH		
Document No.	RDSO-SIG0TCAS(TAN)-1-2021	Version	3.0
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1. Scope:-

These guidelines are rooted in real-world experiences from the KAVACH development project and its current execution by the Indian Railways. Following these guidelines will indeed enhance the reliability and effectiveness of the system across Zonal Railways and OEMs. Adherence to these best practices during installation and maintenance is crucial for the success and sustainability of such safety systems.

2. RFID Tags:-

2.1. Installation of RFID Tag in sleeper: -

The RFID tag enclosure shall be good quality of FRP material and fitment clamp shall be made of stainless steel of Grade 316 stainless steel is highly resistant to corrosion, particularly in harsh environments, including those with chloride exposure (like coastal areas).

Reason:

As the clamps are being used on sleepers, these are prone to different environmental conditions such as dampness, wetness, heating, UV-IR exposure, human excreta; it is proposed to use high quality metallic as well as non metallic material for fitment.

2.1 The tolerance for RFID tag placement should be within 1 meter, with a maximum deviation of 5 meters.

Reason: Error permitted before tag is declared to be missed: (Distance traveled from last tag *5%)+5m. Suppose, if two tags are placed 200m apart, then their location error can be $15-1 = 14\text{m}$ at max.

2.2 The duplicate RFID tag shall be installed minimum distance of 3 meter to 5 meter except TIN discrimination/Turn out and adjustment/Junction RFID tag. The TIN discrimination/turn out and adjustment/Junction RFID Tag shall be in same absolute location.

2.3 Placement of adjustment tag/ junction tags: -

Optimal placement of adjustment tags to maintain accurate location reporting and prevent any missed tags.

- **Adjustment/Junction Tag Placement:** The adjustment tag is to be preferably placed after the advanced starter signal. In case of typical junctions, it may be provided at centre of berthing tracks duly taking special discussion during project ISA.
- **Minimum Distance:** The distance from the advance starter to the adjustment tag / junction tags should be at least 120 meters.

2.4 Two Normal Tags may be placed before/ after the Adjustment Tag within 100 to 150 meter to take care of missing tag. If signal foot tag and signal approach tag are there before the tag, these tags to be placed before to be dispensed.Distance between the two Normal Tags:-

The maximum distance between the two normal tags shall not be more than 1000m.

Reason:

To minimize the accumulated odometric error.

2.5 Provision of Normal Tags at the Block Section limits (Yard exits):-

Normal tags with signal foot in the direction of facing of BSLB board shall be provided at the Yard Exits not protected by signals like BSLB etc.

Reason:

To protect the Kavach equipped train not to enter into block section in shunt mode.

2.6 Provision of Normal Tags (Dead stop) at the dead end and sand hump.

Provision of Dead stop tag toward the sand hump and dead end may be ensured.

2.7 Placement of Border RFID Tag

Border RFID tag shall be indicated in RFID Tag layout with absolute location of station border line. Border RFID tag indicates the maximum distance from where the departed Loco will communicate with previous Stationary SKAVACH.

- i. If the distance between last signal controlled by stationary KAVACH and first signal controlled by next stationary KAVACH is > 3 km, then Stationary KAVACH to Stationary KAVACH communication is not mandatory. The border tag can be placed in communication non mandatory area.
- ii. If the distance between last signal controlled by stationary KAVACH and first signal controlled by next stationary KAVACH is ≤ 3 km, then Stationary KAVACH to Stationary KAVACH communication is mandatory. The border tag shall be placed in signal foot tag and communication mandatory area. The border tag shall not be placed in LSS foot tag.

2.8 Provision of Normal Tags in lieu of Signal Approach Tags:-

~~Normal Tags only can be linked. Hence, to ensure linking up to the nearest location to the approaching signal, Normal Tags shall be provided in lieu of Signal Approach Tag in future installations.~~

2.9 Marking of RFID Tag number and Type at the bottom:-

All the RFID tag shall be marked at the side with tag number and tag type. The marking shall be as follows:-

RFID NO:

Type:

Location:

Reason:

To facilitate easy identification for re-installation of RFID Tags removed during PQRS works.

2.10 Replacement of RFID Tags after PQRS works need to be done accurately

Reason:

Wrong placement of RFID Tags may result in extension or reduction of communication mandatory zones or cause spurious EBs if they are placed on other lines.

3. Installation of stationary unit :-

3.1 **Numbering Scheme for Stationary unit: -**

The **first two digits** are allotted to each zonal railway as shown in the table below and Zonal railways may decide the **last three digits** for the stations. A proper record shall be maintained by the Zonal Railways to avoid repetition of number as station ID should be unique number.

Sl. No.	Name of the Railway Zone	Allotted code	Sl. No.	Name of the Railway Zone	Allotted code
1.	South Central Railway	00-02	11.	North Western Railway	30-32
2.	Northern Railway	03-05	12.	West Central Railway	33-35
3.	North Eastern Railway	06-08	13.	North Central Railway	36-38
4.	Northeast Frontier Railway	09-11	14.	South East Central Railway	39-41
5.	Eastern Railway	12-14	15.	East Coast Railway	42-44
6.	South Eastern Railway	15-17	16.	East Central railway	45-47
7.	Southern railway	18-20	17.	Metro Railway Kolkata	48
8.	Central railway	21-23	18.	Konkan Railway	49
9.	Western Railway	24-26	19.	RDSO, Lucknow	50
10.	South Western Railway	27-29	20.	South Cost Railway	51-53
			21.	IRISET SC	54

3.2 Kavach Wiring Diagram and configuration detail shall form part the S&T circuit diagrams issued by Zonal Headquarters and these documents shall be placed in all the relay rooms and shall be treated as part of station S&T documents. In Kavach fitted areas/new execution, any S&T modification in station /interlocked LC gate/IBs, Kavach wiring invariably taken care.

Reason:

This will ensure that Kavach circuits are also altered whenever signal alterations are carried out by the Zonal Railways.

3.3 Zonal Railways shall ensure non blanking of signal during signal aspect changing due to cascading feature.

3.4 Parallel Wiring of Relay Contacts read by Stationary unit shall be carried out.

Reason:

To minimize the failure of Movement Authority/out of correspondence of signal aspect at site and Loco OCIP, due to high contact resistance of relays, the parallel wiring of relay contacts.

3.5 **Unavailability of repeaters ECRs for inner Distant and Distant Signal of IB:-** If such IBs are available, the OFC need to be tapped at the signals and RIU can be installed or the aspects of these permissive signal can be deduced. Zonal Railways can choose either of these options.

3.6 **Train Length Measurement:** The train length measurement track circuits identified shall be such that all the trains entering into a block section pass over these track circuits. The track circuit relay input shall have connected to Stationary KAVACH and if multiple repeater is being used, then timing shall be compensated in the Stationary KAVACH configuration file.

3.7 **Wiring of SM OCIP:-** 12 Core Signalling cable shall be used for button, counter & power supply. CAT-6 armoured cables shall be used communication portion.

3.8 **Diverse Path for routing of GSM and GPS Cables:** - The cables for one set of GSM/GPS Antenna shall be routed in one path and another set shall have routed in diverse path to avoid failures due to cable cuts at a single location. **The installation shall be carried out with shortest path and drilling in roof may be permitted wherever feasible without damaging the structure with proper shielding to avoid ingress of water etc.**

3.9 **Diverse path for wiring of RIU:-** In Auto-Section, IBS, Gate, RIU shall be connected to stationary Kavach with diverse path of OFC media only in redundant manner.

3.10 All the cable entry and exit at relay room and location box near tower shall be completely sealed to avoid rodent entry.

3.11 **Rodent proof OFC patch cord** are to be provided at all stations, IBS, LC and RIU.

3.12 **Power Supply arrangement:** - The 110 Volt DC supply from IPS/Power room to Kavach rack at Interlocked Stations shall be provided with duplicated cable with suitable gauge (10 Sq. mm) so as to ensure that voltage drop in cable shall not be more than 1Volt from integrated power supply source. Each cable shall be protected with an individual isolator and fuse of suitable capacity. Existing 24 Volt internal supply may be extended to additional relay for KAVACH for better reliability and integrity.

Reason: Duplicated cable is provided from Power supply to Kavach to have redundancy of power supply connection to equipment and to prevent failure due to rat cut or any other damage.

Cable voltage drop is restricted to 1 Volt to avoid overloading of cable & also ensure correct AWG and quality wires.

- 3.13 Reliable Power supply such as mini IPS with backup of 8 to 10 hours shall be provided at mid section, LC gates specially in Non-RE area section to avoid failure due to non-availability of power.
- 3.14 The DC-DC converters provided for stationary KAVACH unit shall have segregation of cabling and termination for power supply up to DC-DC converters shall be in N+1 configuration. It is advised that reliable DC-DC converters advised by OEMs shall be considered for better reliability.
- 3.15 It shall be ensured that the KAVACH equipment are earthed with shortest path to common earth bus bar in Relay equipment room. It shall also be ensured that front and back doors of Kavach cabinet shall be earthed using copper braid.
- 3.16 All the connectors on trackside equipment (Stationary KAVACH, RIU, Radio etc.) shall be of M-12 type connector with round shell with thread.

Reason:

This will ensure that failures on account of loose connections are avoided.

- 3.17 Standard layout of power supply connection is enclosed.

4. Communication

- 4.1 Proper Radio Survey shall be carried out before deciding up on the location and height of towers to avoid communication failure due to obstructions like buildings, terrain etc.
- 4.2 Adoption of 20m/15m tower shall be permitted at midsection interlocked LC gates/IBS to overcome the geographical limitations.
- 4.3 The mounting of all the antennae on the tower shall be at same level.
- 4.4 RF Cable length optimization in towers using Radio Box fitted at tower to reduce the dB losses in RF cable.
- 4.5 RF coaxial cable for the two Tower Radios shall be routed in the different path. The coaxial cable shall be minimum LMR-600 of Amphenol/ Heliac. As connectors are open to environment, they shall be provided with weather proof sealing. The cable harnessing shall be done at factory.
- 4.6 The Radio tower shall be provided with lightening arrester (Franklin rod) and connected to earth along with aviation lamp.
- 4.7 Cable joints shall not be permitted from tower location box to antennae. The patch cords used shall be of minimum length.

- 4.8 Weather proofing to be done at all the exposed connections and it shall be monitored on monthly basis.
- 4.9 Radio Modems shall be installed with Modified firmware (Version no. V1.4)
- 4.10 Dual OFC and dual power cable in diverse path shall be provided from Stationary Kavach unit to the location box near tower to avoid common mode failures.
- 4.11 The frequency pairs allotted for two adjacent stations shall be different. The loco time slots for the same station shall not be adjacent to each other (minimum one-time slot gap shall be kept). Also slots, P1 & P46 shall be kept as reserved. Preference shall be given to frequency pairs having wider separation. In case of any deviation, the issue shall be discussed in Project ISA, duly mitigating the hazards identified.
- 4.12 Radio Receive Signal Strength measurement to be carried out on quarterly basis to identify new shadow regions developed and facilitate attention.
- 4.13 RF Alignment to be done periodically means quarterly to avoid loss of RF packet.
- 4.14 To do safe discharge of static charges and protection against damage from nearby lightening, the coaxial shield shall be grounded in both end in onboard and similarly in stationary KAVACH, the top end and bottom end with use of 16 SQ MM copper wire shall be grounded.
- 4.15 Onboard Antenna shall be installed such as receiving both antenna shall be one side and transmitting both antenna other side on the top of the Loco.

5. Mapping Scheme of PSR, Gradient Data for Offset Problem

- 5.1. PSR/TSR and gradient data, which is the reference for speed supervision of the train is required to be provided with respect to the available kilometer stones/traction mast number.
- 5.2. Centre line of the station building shall be the reference point for the mapping scheme. The centre line shall be finalized as per the actual site condition and shall not be based on SIP or ESP.
- 5.3. All the locations of kilometer stones/traction mast number are to be mapped to the absolute locations based on the above reference point by carrying out survey using drone/Loco mounted camera.
- 5.4. Fractional distances shall be mapped to captured absolute locations during survey by using the principle of proportionality considering distance between the two adjacent kilometer stones/traction masts.

6. Onboard:

- 6.1. Locos shall be installed with Modified firmware of IPICO RFID reader (Version no. V 1.c).

Reason:

This will ensure that reliability improvements of RFID reader.

- 6.2. Loco antennae shall be installed with min 3dBi antennae and LMR 400 cable. The RF cable shall be routed through the shortest possible path.

Reason:

This will ensure that RF losses on Loco front to be minimum.

- 6.3. Braking parameters are to be fine-tuned in alignment with Railways operational requirements.

Reason:

This will ensure that the braking is not reducing the operational efficiency.

- 6.4. Maintenance to be done periodically including calibrating wheel dia in period of frequency 45 days.

Reason:

This will ensure that the odometer is working properly and reduce RFID linkage error.

7. General:

- 7.1. A policy at Zonal Railway shall be issued to get the changes in SIP/Table of control/field relay interface circuit/location change of signal post /PSR/LC Gates/Gradient is reflected in Stationary KAVACH circuit.
- 7.2. It shall be ensured that Zonal Railway SIP and Table of Control shall be adhered for deducing the signal aspects and Movement Authority in **KAVACH**.
- 7.3. The Factory Acceptance Test (FAT) shall be verified by Railway official and Sample verification shall be done by minimum JAG officer during SAT (Site Acceptance Test)
- 7.4. The pre-installation and pre-commissioning checklist for concerned stationary and onboard KAVACH shall be thoroughly checked at the site at the minimum Assistant officers' level jointly with the executing OEM.
- 7.5. The modification in the application logic, KAVACH Control Table, RFID layout shall be version controlled with configuration software station wise to avoid human error.
- 7.6. The quality and integrity of the installation remains complete responsibility of the OEM. The firm must provide an OEM certificate regarding this before commissioning of any installation, any deficiency pointed out later, shall be done free of cost by OEM, this shall be confirmed by OEM before commissioning.
- 7.7. Typical drawing for fixing RFID scheme in Apron area (duly approved by track directorate) is enclosed as Annexure.
- 7.8. Continuous analysis as part of RAMS requirement for the lifecycle is to be done by OEMs and the details are to be shared to Railways and RDSO.
- 7.9. Initial and refresher training for Loco Inspectors/Pilots shall be ensured. For deployment of KAVACH Common group for Loco Operational staff,

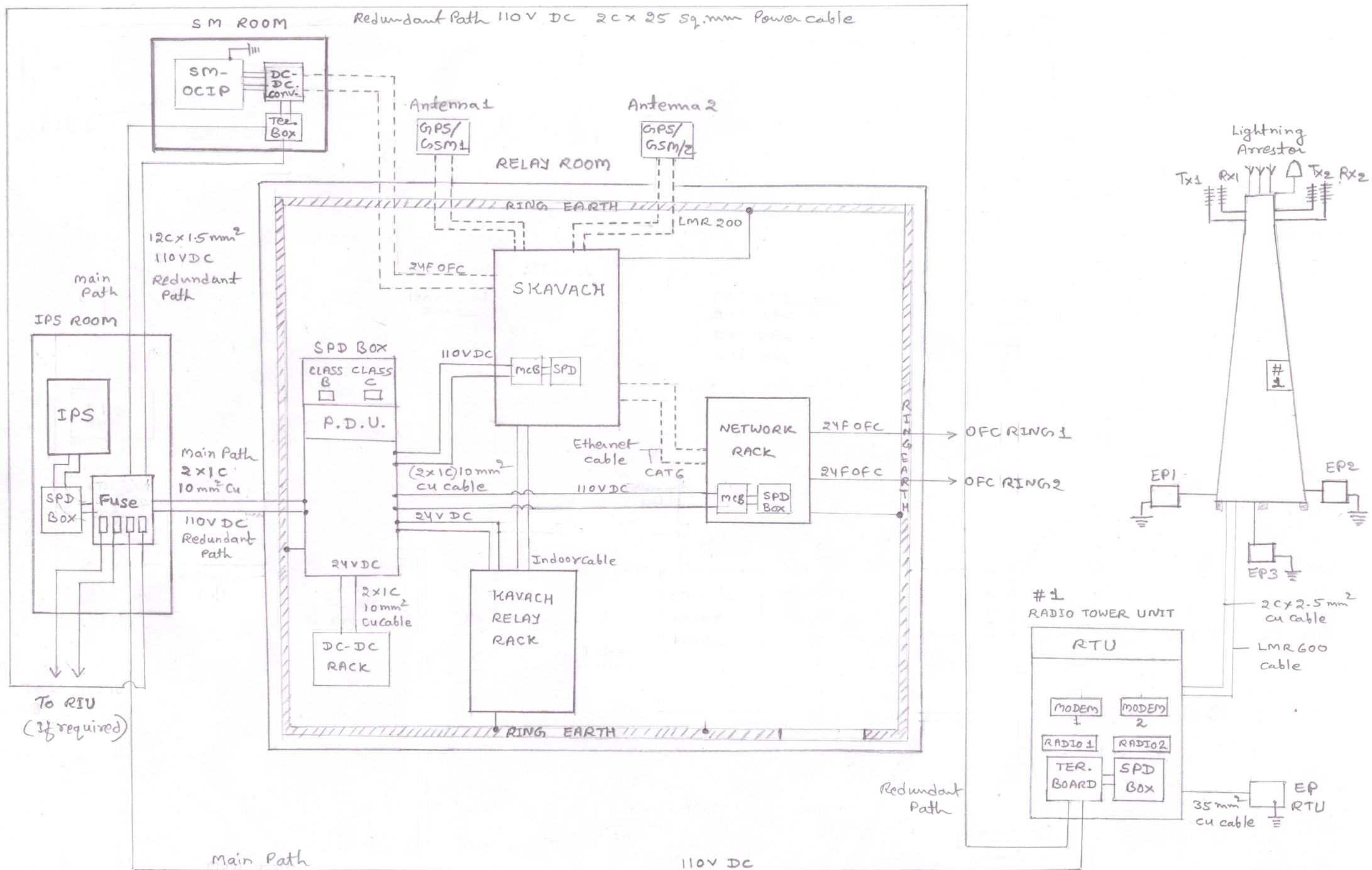
- Maintenance and Firms shall be formed to identify and discuss operational issues and arrive at solutions.
- 7.10. Equipment course shall be started by IRISSET, IREEN, IRMEE and all ZRTIs/ETTCs/STTCs/DTTCs on **KAVACH**.
- 7.11. Maintenance procedure without affecting trains or with affecting trains is to be prescribed by Zonal Railways.
- 7.12. Computerized Test report using Maintenance Simulator shall be provided to facilitate Loco Shed level testing after Periodic Maintenance of Loco. Collection of health parameters (Modules, Radio and Tags etc) are to be ensured in NMS.
- 7.13. To avoid rework, new installations shall use tag data format suitable for LTE communication.
- 7.14. Inter Stationary Kavach unit communication channel on OFC shall be provided to avoid RIU duplication and reliability enhancement.
- 7.15. Provision of KAVACH shall be included in all the estimates of S&T works in KAVACH territory.
- 7.16. Identification of stations where no Mobile coverage shall be carried out through GPS based GSM/LTE Signal Strength measurement system and accordingly SIMs of service provider shall be allocated. eSIM shall be preferred over conventional SIMs.
- 7.17. A joint procedure order at zonal level for tag handling during p-way works shall be prepared and implemented to avoid failure due to missing tags etc.

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Encl: As above

For any issues related to this TAN (Technical Advisory Note) please contact RDSO, Lucknow (Rly phone- 032-42652, DOT-0522-2465750, Email: tcasphase2@gmail.com)

For continuous update on KAVACH, please visit the intranet site:
http://10.100.2.19/01_english/signal/Final%20Compendium/19-TAN-System%20Improvements%20regarding%20Installation%20and%20Maintenance%20for%20KAVACH.pdf



Note - 1) Radio Tower Unit is placed in the tower.

2C x 25 sq. mm power cable