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| Document title: Specification of Integrated Communication System for Tunnels | | | |



SPECIFICATION NO. RDSO/SPN/TC/109/2019 2023

Draft Specification
of
Integrated Communication System for Tunnels

Revision-0.0

TELECOM SECTION
SIGNAL & TELECOM DIRECTORATE
RESEARCH DESIGNS & STANDARDS ORGANISATION
LUCKNOW-226011

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| DOCUMENT DATA SHEET | |
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| Title of Document | RDSO Specification for Integrated Communication System for Tunnels |
| Author | Executive Director/ Telecom-I/RDSO |
| Approved by | Principle Executive Director/Signal & Telecom/RDSO |
| Abstract | This document specifies technical specification of Integrated Communication System for Tunnels. |

I. DOCUMENT CONTROL SHEET

| NAME | ORGANIZATION | FUNCTION | LEVEL |
|---------------------------------------------------|--------------|---------------|-----------------------------------|
| SSE/Telecom | RDSO | Member | Assist/Prepare |
| ADE/Telecom | RDSO | Member | Assist/Prepare, Check |
| Executive Director/ Telecom-I | RDSO | Member | Prepare, Review, Issue |
| Principle Executive Director/ Signal & Telecom | RDSO | - | Approve |

REVISION

| Version | Chapter/ Annexure | Revision | Effective Date/Month/Year |
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| RDSO/SPN/TC/109/2023 | All pages | Revision 1.0 | dd-mm-yyyy |

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II. Amendment History:

| S. No. | Amendment Date | Version | Reason for Amendment |
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| 1. | 30 May 2020 | RDSO/SPN/TC/109/2019 Rev. 0.0 | First Issue |
| 2. | dd-mm-yyyy | RDSO/SPN/TC/109/2023 Ver. 1.0 | First Revision. Approved by PED/S&T at Note#..... of e-file No. RDSO-TELE0LKO(SPEC)/1/2020-O/o ED/Tele-I/RDSO on date |

FINAL DRAFT CHANGES

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I. III. SUMMARY:

This document covers the technical requirements of Integrated Communication System for Tunnels on Indian Railway network of varying lengths.

H. IV. SOURCE:

1. ~~Draft~~ specification RDSO/ SPN/ TC/109/2019, Rev 0.0 have been prepared by RDSO, Lucknow as per Railway Board letter No. 2006/Tele/TC/1/Pt dated 15/07/2015.
2. Version 1.0 of the specification has been initiated based on the feedback from Railways (NFR, IRCON) and other stakeholders.

III. FOREWORD:

~~RDSO/ SPN specification is issued as draft specification. This specification is circulated to customers/ Railways and field inspection units for comments.~~

~~In the absence of IRS specification, procurement may be made as per RDSO/ SPN specification.~~

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

IV. References:

| S. No. | Document No. | Title/Document Name |
|--------|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| i. | IEC 60332-1 | Tests on electric and optical fibre cables under fire conditions - Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame |
| ii. | IEC 61034-2 | Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements |
| iii. | IEC 60754-1 | Test on gases evolved during combustion of materials from cables - Part 1: Determination of the halogen acid gas content |
| iv. | IEC 61196-4 | Coaxial communication cables – Part 4: Sectional specification for radiating cables -Coupling Loss & Attenuation Test Method |
| v. | SD:QM-333 | Standard for Environmental testing of Telecommunication equipment |
| vi. | RDSO/SPN/TC/68/2014 or latest | Specification Of Joint enclosure for Armoured optical fibre cable |
| vii. | RDSO/SPN/TC/65/2019 2021 Rev. 6.0 or latest. | Specification of IP Based Video Surveillance system |

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Note: IEC or equivalent standard shall be acceptable.

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~~RESEARCH DESIGNS & STANDARDS ORGANISATION~~
~~MINISTRY OF RAILWAYS~~
~~MANAK NAGAR, LUCKNOW~~

~~Specification of Integrated Communication System for Tunnels~~

~~RDSO Specification No. RDSO/SPN/TC/109/2019 Revision 0.0~~

1.0 SCOPE:

1.1 This specification covers technical requirement of equipments for Integrated Communication System for Tunnels on Indian Railway network of varying lengths.

1.2 These tunnels can broadly be categorized in three categories i.e. tunnels less than 500 meters per Bore, more than 500 meters to 5000 meters per Bore and tunnel more than 5000 meters length per Bore. Requirement of Integrated Communication System for above categories will be slightly different.

When a tunnel length is less than 500 meters but is one of the cluster of many tunnels, this should be considered as more than 500 meters and continued as the part of nearby tunnels of the cluster.

1.3 ~~Radio Network coverage in tunnels for VHF Simplex, LocoTrol DPWCS (Simplex), GSM-R/LTE-R (Duplex), TCAS KAVACH (Duplex) etc. Communication are to be extended as per Railway Requirement in Tunnels for communication during maintenance and constructional blocks, communication in the train in between Guard & Driver, Emergency radio communication between driver, guard, station master & Cabin, & Train Controller etc.~~

1.4 ~~The Frequency Band are allotted Frequency Band 146-163MHz for VHF Simplex communication, LocoTrol 406-407 MHz & 433-434 MHz, 876-915 MHz(Uplink) & 921-960 MHz(Downlink) for GSM-R communication and TCAS 405-512-MHz are allotted in Indian Railways. 700 MHz band are recommended to be allotted for LTE for Indian Railways. (Exact Bands and Channels authorized for use by Railways will be communicated at time of Order).~~

VHF Simplex, ~~LocoTrol~~ DPWCS, GSM-R/LTE-R, ~~TCAS~~ KAVACH communications shall be suitable to work within following frequency bands in Indian Railway network:

| | |
|-----------------------------------------------------------------------|---------------------------------------------------------|
| Very High Frequency (VHF) Simplex | 146-163MHz |
| LocoTrol Distributed Power Wireless Control System (DPWCS) | 406-407 MHz & 433-434 MHz 424 to 430 MHz |
| Global System for Mobile Communications – Railway (GSM-R) | 876-915 MHz(Uplink) 921-960 MHz(Downlink) |
| Long-Term Evolution-Railway (LTE-R) | 700 MHz band |
| TCAS KAVACH | 405-512 MHz |

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Note: Exact Bands and Channels authorized for use by Railways will be communicated at time of Order.

- 1.5 Integrated Communication System in tunnels where ever provided on Indian Railway shall be able to extend following communications in Tunnels as per Table - 1 below :

Table-1

| S. No. | Communication system Description | Tunnels less than 500 meters | Tunnels more than 500 meters to 5000 meters | Tunnels more than 5000 meters |
|--------|----------------------------------|------------------------------|---------------------------------------------|-------------------------------|
| 1. | VHF Simplex | Yes | Yes | Yes |
| 2. | LoeTrol DPWCS | Yes | Yes | Yes |
| 3. | TCAS KAVACH | Yes | Yes | Yes |
| 4. | GSM-R/LTE-R | Yes | Yes | Yes |
| 5. | PA System | No | Yes | Yes |
| 6. | Video Surveillance System | No | Yes | Yes |
| 7. | Emergency call point | Optional | Yes | Yes |

- 1.6 For Tunnels less than 500 meters per Bore are to be covered with High Gain Off-Air Channelized Repeaters feeding Dual Radiating Cable Systems. The Repeaters cover VHF Simplex, ~~LoeTrol~~ DPWCS, GSM-R/LTE-R, ~~TCAS~~ KAVACH, etc. Schematic diagram is mentioned at figure-1of specification.
- 1.7 For Tunnels more than 500 meters to less than 5000 meters per Bore, a Master/Remote Optical System is to be installed. This System consists of a VHF Simplex, ~~LoeTrol~~ DPWCS, GSM-R/LTE-R, ~~TCAS~~ KAVACH and Master Unit, feeding Optical Remote Units. These Remote Units are housed in an IP65 Case. Appropriate Antennas and Leaky Cables are to be deployed. Schematic diagram is mentioned at figure-2of specification.
- 1.8 For Tunnels more than 5,000 meters per Bore, a Redundant Master Unit as per para 1.7 may also be deployed for complete Redundancy. Schematic diagram is mentioned at figure-3of specification.

2.0 General Requirement:

- 2.1 Original Equipment Manufacturer (OEM) of Integrated Communication System for Tunnels or its authorized representative shall have service facility in India.
- 2.2 All software and firmware upgrades shall be free of cost for a period of five years or as specified by purchaser.
- 2.3 The integrated communication system shall be connected to centralized tunnel control room which shall be either at adjacent Railway station or Divisional Control HQ controlling 2 or more tunnels.
- 2.4 The Tunnel Radio System shall provide an uninterrupted radio communication inside tunnel with the headquarters and operation centers and **handheld devices of**

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adjacent station(s), handheld devices of the tunnel operator's staff, emergency staff and trains which pass the tunnel.

- 2.5 The communication of all channels in the tunnel shall be independent, simultaneous and failure-free.
- 2.6 It shall be possible to continuous coverage over the entire length of the tunnel, clear audio though out with no interference, reliable system operation under harsh tunnel environmental conditions, trunked radio channels across many bands and ease of system operation and maintenance.
- 2.7 Voice recording arrangement ~~as per RDSO/SPN/TC/38/2002 or latest~~ for all communication through the Master unit should be provided at the location of the Master unit for analysis and accountability ~~as per user requirement~~. For this purpose voice recording arrangement as per RDSO specification RDSO/SPN/TC/38/2002 or latest or any other specification as per user may be used.
- 2.8 The VHF simplex communication being the lifeline of train operation, Tunnel Radio System should be able to provide an uninterrupted radio communication between the radios located anywhere inside a tunnel (inner tunnel) and also between radios of other tunnels / master unit location (inter tunnel) of the same network.
- 2.9 All housing for equipments shall be minimum IP 65 for better protection of equipments.
- 2.10 All equipments shall be suitable for working in 25KV RE traction environment.
- 3.0 **System Description:**
- 3.1 Following systems are required to extend VHF Simplex, ~~LoeTrol~~ DPWCS, GSM-R/LTE-R, ~~TCAS KAVACH~~ (As required) communication in Tunnels as per Table - 2 below:

Table: 2

| SN | Systems | Tunnels less than 500 meters length | Tunnels more than 500 meters to 5000 meters | Tunnels more than 5000 meters length |
|----|---------------------------------------------------------------|-------------------------------------|---------------------------------------------|--------------------------------------|
| 1. | Master Unit with Power supply unit | No* | Yes | Yes |
| 2. | Fibre Junction Box | No | Yes | Yes |
| 3. | Optical Remote Unit | No | Yes | Yes |
| 4. | Off-Air Channelized Repeater | Yes | No | No |
| 5. | Leaky Cable (Two sets) | Yes | Yes | Yes |
| 6. | Antenna for system | Yes | Yes | Yes |
| 7. | Optic Fibre cable | No | Yes | Yes |
| 8. | Power supply unit for Optical Remote unit/Repeater in Tunnels | Yes | Yes | Yes |

* However, in cases where radio service signals are not available on portals of tunnel (s), Master Unit may be provided as decided by the user Railway.

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3.1.1 Master Unit:

The Master Unit is used to convert signals from RF to light when fibre fed repeaters is used at the remote end of the optical link. Master Unit shall be used in more than 500 meters lengths tunnels.

Master Unit system may consist of following sub-system:

- Channelized VHF Simplex Off-Air Repeater and VHF Simplex Optical Master Unit.
- GSM-R/LTE-R Off-Air Repeater and GSM-R/LTE-R Optical Master Unit.
- Channelized ~~DPWCS-LocoTrol~~ Off-Air Repeater and ~~DPWCS LocoTrol~~ Optical Master Unit.
- Channelized ~~TCAS KAVACH~~ Off-Air Repeater and ~~TCAS KAVACH~~ Optical Master Unit.

| Item | Master Unit | | | | |
|---------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------|------------------------------------------------|-----------------|----------------|
| | VHF Band | LocoTrol DPWCS | GSM-R | LTE-R | TCAS KAVACH |
| Frequency Range(Customized) | 146-163 MHz | 406-407 MHz & 433-434 MHz 424 - 430 MHz | 907.8- 914.8 MHz/ 952.8- 959.8 MHz | 700 MHz Band | 405-512 MHz |
| Number of Channels for each service should be normally 4 or user may specify their specific requirements | Normally 4 8 or user may specify their specific requirements. | | | | |
| Channel Bandwidth | 25KHz | 25KHz | 200KHz | 10MHz | 25KHz |
| Maximum input power | DL: ≤ 10dBm | | | | |
| System Gain (Master + Remote) | Minimum 40±3dBm | | | | |
| System Gain Adjustment Range | 30dB in 1dB step | | | | |
| Passband Ripple | ≤±2.5dB | | | | |
| Uplink Noise Figure @ Max Gain | ≤5dB (1 Master Unit and 1 Remote) | | | | |
| UL output power | 33 dBm or better | | | | |
| AGC | ≥30dB | | | | |
| VSWR | <1.5 | | | | |
| Optical Input/Output Configuration | DL/UL combined | | | | |
| Number of Optical Output Ports | Min 8 | | | | |
| I/O Impedance | 50Ω | | | | |
| MTBF | 80,000 Hours | | | | |
| Temperature range | -5°C to +55°C | | | | |
| Relative Humidity | Max 95% | | | | |
| Power requirement | 230V AC 50Hz or -48V DC | | | | |
| Power consumption | ≤150W | | | | |
| Master Unit Alarm | PSU alarm, Optical Transceiver alarm | | | | |
| Mounting | Rack Mounted | | | | |
| MU-ORU Fiber Link Protocol | Digital CPRI (Common packet Radio Interface) | | | | |

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3.1.2 Fibre Junction Box:

Fibre Junction Box should be as per specification no. RDSO/SPN/TC/68/2014 or latest or any other suitable IP65 Fibre Junction Box.

3.1.3 Optical Remote Unit:

Optical Remote unit is used at the remote end to convert Optical Signal to RF Signal and then transmit it into Leaky cable in the particular area to cover the tunnel for the wireless communication. It is connected to Master Unit.

Optical Remote Units to accept for VHF Simplex, ~~LoeTrol~~ DPWCS, GSM-R/LTE-R, and ~~TCAS~~ KAVACH. The Case is an IP65 rating construction Housing. Remote unit are Monitored, Controlled and Alarmed Remotely from the Master Unit over Fibre and Remotely using an Ethernet Modem.

Optical Remote unit shall be used to provide coverage in more than 500 meters lengths tunnels. Details of Remote unit are as under:

| Item | Optical Remote Unit | | | | |
|-------------------------------------|------------------------------------------------------------------------------------------------|--------------------------------------------|-------------------------------------|-------------|----------------|
| | VHF Band | LoeTrol DPWCS | GSM-R | LTE-R | TCAS KAVACH |
| Frequency Range (Customized) | 146-163MHz | 406-407 MHz & 433-434 MHz 424 – 430 MHz | 907.8-914.8 MHz/ 952.8-959.8 MHz | 700MHz Band | 405-512 MHz |
| Passband Ripple | <±2.5dB | | | | |
| AGC | >30dB | | | | |
| Maximum input power | UL: ≤ 10dBm | | | | |
| VSWR | <1.5 | | | | |
| Alarm Detection | Optical Remote Unit: Optical Transceiver Link alarm, Door open alarm | | | | |
| Optical Input/ Output Configuration | DL/UL combined | | | | |
| RF Input/ Output Configuration | DL/UL combined DL/UL separate for Simplex Channels, Combined for Duplex Channels | | | | |
| DL output power | 33 dBm or better | | | | |
| Gain | Minimum 40±3dBm | | | | |
| I/O Impedance | 50Ω | | | | |
| IP Rating | IP65 | | | | |
| MTBF | 80,000 Hours | | | | |
| Temperature range | -5°C to +55°C | | | | |
| Relative Humidity | Max 95% | | | | |
| Power requirement | 230V AC 50Hz or -48V DC | | | | |
| Power consumption | ≤150W | | | | |
| Mounting | Wall Mounted | | | | |
| Number of ports | 4 ports (min) or as per user requirement. | | | | |
| Cooling | Provision of cooling shall be there | | | | |

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3.1.4 Off-Air Channelized Repeater:

For less than 500 meters Tunnels are to be covered with High Gain Off-Air Channelized Repeaters feeding Dual Radiating Cable Systems. The Repeaters cover VHF Simplex/~~LoeTrol~~ DPWCS, GSM-R/LTE-R, and ~~TCAS~~ KAVACH communication per Bore.

| Item | Digital Off-Air Channelized Repeater | | | | |
|----------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------|----------------------------------|------------------|---------------------------|
| | VHF Band | LoeTrol DPWCS | GSM-R | LTE-R | TCAS KAVACH |
| Frequency Range(Customized) | 146-163MHz | 406-407 MHz & 433-434 MHz 424 – 430 MHz | 907.8-914.8 MHz/ 952.8-959.8 MHz | 700MHz Band | 405-512 MHz |
| Number of Channels for each service should be normally 4 or user may specify their specific requirements | 4 Channels Normally 4-8 or user may specify their specific requirements. | | | | |
| DL Power | 33 dBm or better | | | | |
| UL power output | 33 dBm or better | 33 dBm or better | 3 dBm adjustable | 3 dBm adjustable | 33 dBm or better |
| System Gain | 90±3dBm | | | | |
| Noise Figure @ Max Gain | ≤5dB | | | | |
| I/O Impedance | 50Ω | | | | |
| IP Rating | IP65 | | | | |
| MTBF | 80,000 Hours | | | | |
| Temperature range | -5°C to +55°C | | | | |
| Relative Humidity | Max 95% | | | | |
| Power requirement | 230V AC 50Hz or -48V DC | | | | |
| Power consumption | ≤130W | | | | |
| Master Unit Alarm | Power alarm | | | | |
| Mounting | Wall Mounted | | | | |

3.1.5 Leaky Cable:

3.1.5.1 For Wireless communication (VHF Simplex, ~~LoeTrol~~ DPWCS, GSM-R/LTE-R, and ~~TCAS~~ KAVACH) inside the tunnel Fire Retardant Low Smoking Zero Halogen (FRLS-0ZH) rated Leaky cable shall be provided.

Two 7/8" Leaky Cable shall runs per tunnel tube length for VHF Simplex, ~~LoeTrol~~ DPWCS, GSM-R/LTE-R, and ~~TCAS~~ KAVACH communication.

| Specifications of Leaky Cable | |
|------------------------------------------|-------------------------------|
| Construction Materials | |
| Jacket | FRLSZH Polyolefin or PE |
| Dielectric | Foam PE |
| Inner Conductor | Smooth/Corrugated copper tube |
| Jacket Color | Black |
| Outer Conductor | Copper foil |
| Dimensions | |
| Diameter Over Jacket, maximum | 27.7 mm |

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|-------------------------------------|-----------------------------------------------------|-------------------|-------------------|
| Inner Conductor OD | 9.50 mm \pm 0.2mm | | |
| Cable Weight | 0.42 kg/m \pm 0.02Kg/m | | |
| Electrical | | | |
| Operating Frequency Band | 75 – 2700 2400 MHz | | |
| Polarization | Vertical/Horizontal/Angular as per site requirement | | |
| Velocity | 89 % | | |
| Cable Impedance | 50 ohm \pm 2 ohm | | |
| DC Resistance, Inner Conductor(Max) | 1.69 ohms/km | | |
| DC Resistance, Outer Conductor(Max) | 3.5 ohms/km | | |
| Insulation Resistance(Min) | 10000 M Ω km | | |
| Jacket Spark Test Voltage (rms) | 8000 V | | |
| Peak Power | 91.0 kW | | |
| Environmental | | | |
| Operating Temperature | -30 °C to +80 °C -15 °C to +60 °C | | |
| Mechanical | | | |
| Tensile Strength(Min) | 215 kg /2100N | | |
| Fire Retardancy Test Method | IEC 60332-1 | | |
| Smoke Index Test Method | IEC 61034 | | |
| Toxicity Index Test Method | IEC 60754-1 | | |
| Standard Conditions | | | |
| Attenuation Test Method | IEC 61196-4 | | |
| Attenuation Tolerance | \pm 10% | | |
| Attenuation, Ambient Temperature | 20 °C | | |
| Coupling Loss Test Method | IEC 61196-4 | | |
| Coupling Loss Tolerance | \pm 5 dB | | |
| Electrical Performance | | | |
| Frequency | Attenuation (dB/100 m) | Coupling Loss 50% | Coupling Loss 95% |
| 150 MHz | 1.42 | 59 | 61 |
| 400 MHz | 2.55 | 61 | 65 |
| 450 MHz | 2.60 | 61 | 64 |
| 700 MHz | 3.34 | 67 | 77 |
| 900 MHz | 4.15 | 60 | 65 |

3.1.5.2 Suitable clamps as per specification of manufacturer of leaky cable shall be provided for mounting leaky cables on walls.

3.1.5.6 Antenna and its arrangement:

3.1.5.6.1 For Tunnels less than 500 meters, Antenna shall be installed at tunnel site for VHF Simplex, ~~Loe~~ ~~Tr~~ DPWCS, GSM-R/LTE-R, ~~TCAS~~ KAVACH etc.

Antenna arrangement consists of:

- RG217 (or better) Coaxial cable with proper connectors
- RF Lightning & Surge Protector
- Tower at Tunnel for fixing antenna.

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3.1.5 6.2 For Tunnels more than 500 meters, Antennas shall be installed on a Tower for VHF Simplex, ~~LoeTrel~~ DPWCS, GSM-R/LTE-R, ~~TCAS~~ KAVACH etc.

3.1.7 **Optical Fibre:**

Master Unit at Base station shall be connected to the tunnel optical remote unit through Fibre Junction Box.

Video Surveillance System and PA Systems shall be also connected though ~~same~~ **same** Optic Fibre system as per Railway requirement in para 13.2.

System shall support fibre loop redundancy as shown in fig.2 & 3. System shall support Star, cascade & Ring, mesh topologies for fibre connection.

3.1.8 **Power Supply unit for Master Unit:**

For Integrated Communication System in Tunnel, power supply unit with 12 Hrs. battery backup (230VAC 50Hz or -48 VDC) for Master Unit should be provided by supplier. For installing of system Railway shall ensure that 230V AC, 50Hz is available at the location of the Master Unit at base station site.

3.1.9 **Power Supply unit for Optical Remote unit/Repeater in Tunnels:**

For Integrated Communication System in Tunnel, power supply unit with 12 Hrs. battery backup (230VAC 50Hz or -48 VDC) for Optical Remote unit/Repeater in Tunnels should be provided by supplier. For installing of system Railway shall ensure that 230V AC, 50Hz is available at the entrance of Tunnel.

3.1.10 **Earthing:**

3.1.10.1 Proper earthing arrangement shall be provided for telecom equipment's ($\leq 1\Omega$) in tunnels by providing an earth grid at both ends of the tunnel and running copper (metallic) earth bus bar across the tunnel and grounding it at regular intervals inside tunnels by providing ring earth of four electrodes in maintenance niche.

3.1.10.2 Earthing of cable armour and trays at regular intervals to be ensured as per standard practice of RE area to ensure the safety of working staff. However earthing should be provided at least at every ORU location.

3.1.11 **Emergency call point:**

Industrial grade SIP based emergency call point phones for public/staff which will be connected to Railway network shall be available in tunnel as per user requirement.

4.0 **PA system:**

A Public address system shall be provided to inform/warn maintenance and service staff and give instructions to people in abnormal conditions during incident. Therefore ~~loudspeakers~~ **Industrial grade IP Speakers** shall be installed ~~every 100 m~~ in the tunnel as per user requirement. ~~Purchaser should list out the items required to be installed in tunnels as per RDSO specification no. RDSO/SPN/TC/78-63/2008-2006 Rev. 0.0 1.0 or latest.~~

5.0 **IP Based Video Surveillance System:**

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IP based Video Surveillance System shall be provided inside tunnels to ensure that there are no blank spots over the tunnels. All the camera feed will be transferred to Tunnel Control Center/Divisional Control Room for viewing, recording and monitoring of tunnels through cameras. Purchaser should list out the items required to be installed in tunnels as per RDSO specification no. RDSO/SPN/TC/65/~~2019~~ 2021 Rev. ~~5.0~~ 6.0 or latest. **However, Railways may add specific latest parameters to suite tunnel environment.**

6.0 Test Requirement:

6.1 Condition of Tests:

- 6.1.1 Unless otherwise specified all tests shall be carried out at ambient atmospheric conditions.
- 6.1.2 Inspection and testing shall be carried out to the effect that all requirements of this specification are complied with.
- 6.1.3 Inspection shall be carried out for one complete system of Integrated communication system for tunnel.

6.2 TYPE TEST:

- 6.2.1 For type test, one complete system shall be subjected to following tests as applicable.
- a) Visual Inspection (Clause 7.1)
 - b) Performance test(Clause 7.2)
 - c) Climatic and environmental requirements (Clause 7.2.2)
 - d) Endurance test(Clause 7.3)
- 6.2.2 Any other tests shall be carried out as considered necessary be the inspection authority

6.3 ACCEPTANCE TESTS:

- 6.3.1 The following shall constitute the acceptance tests which shall be carried out by the inspecting authority for the purpose of acceptance on randomly selected 20% of items offered from the lot (minimum 1 each type of item) offered for inspection by the supplier:
- a) Visual inspection of complete system (Clause 7.1)
 - b) Performance test (Clause 7.2)
 - c) Endurance Test(Clause 7.3)
- 6.3.2 Any other tests shall be carried out as considered necessary by the inspecting authority.

6.4 Routine tests:

- 6.4.1 The following shall comprise the routine tests and shall be conducted by manufacturer on every equipment and the test results will be submitted to the inspection authority before inspection.
- a) Visual Inspection of complete system (Clause 7.1)

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b) Performance test (Clause 7.2)

7.0 Test Procedure:

The test procedure shall be based on the system design. The methodologies to be adopted for various tests shall be decided taking into account the system design/configuration.

7.1 **VISUAL INSPECTION:** Each equipment of the system shall be visually inspected to ensure compliance with the requirement of clause 3, 4, 5 & 10.1 of this specification.

7.2 PERFORMANCE TEST:

7.2.1 The equipment shall comply with the requirements as specified in clauses 2, & 3, 4, 5, 8, 10.1.

7.2.2 CLIMATIC AND ENVIRONMENTAL REQUIREMENTS:

7.2.2.1 Climatic and environmental test shall be carried out on following equipments:

- (i) Master unit
- (ii) Power supply unit
- (iii) Optical Remote Unit
- (iv) Off-Air Channelized Repeater
- (v) PA system
- (vi) Emergency call points

7.2.2.2 The above equipment shall meet the following climatic and environmental requirements:

| SN | TEST | REFERENCE |
|----|---------------------------------------|-------------------------------------------------|
| 1. | Cold test | Category B2 of QM-333 TEC 14016:2010 |
| 2. | Dry heat test | -- do -- |
| 3. | Damp heat test (Cyclic) | -- do -- |
| 4. | Rapid temperature cycling test | -- do -- |
| 5. | Damp heat test (Steady state storage) | -- do -- |
| 6. | Vibration test | -- do -- |

Note: A test certificate and test report shall be furnished by the supplier for the above tests. The test agency shall be an accredited agency as per RDSO norms and details of accreditation shall be submitted by the firm to Purchaser.

7.2.2.3 Test certificate and reports for items i.e. Leaky cable, Fiber Junction box etc. shall be submitted by supplier.

7.3 ENDURANCE TEST:

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- 7.3.1 During type test, endurance test shall be conducted on complete system for continuous operation which shall be 168 Hrs at ambient room temperature without giving any deterioration.
- 7.3.2 During acceptance test, endurance test shall be conducted on complete system for continuous operation which shall be 48 hrs at ambient room temperature without giving any deterioration.
- 8.0 **QUALITY ASSURANCE:**
- 8.1 All materials & workmanship shall be of good quality.
- 8.2 Since the quality of the equipment bears a direct relationship to the manufacturing process and the environment under which it is manufactured, the manufacturer shall ensure Quality Assurance Program of adequate standard.
- 8.3 Validation and system of monitoring of QA procedure shall form a part of type approval. The necessary Plant, Machinery and Test instruments as mentioned in Schedule of Technical Requirements (STR) shall be available with the manufacturer.
- 9.0 **REJECTION:**
- 9.1 Any of the materials which do not comply with the requirements of this specification may be rejected.
- 10.0 **MARKING & PACKING:**
- 10.1 The following information shall be clearly marked at a suitable place on each equipment:
- Name and address of the manufacturer.
 - Year of the manufacturer.
 - Serial number of equipment.
 - Specification Number
 - Schematic diagram of the equipment at suitable place.
- 10.2 The equipment and its sub assemblies shall be packed in suitable boxes and the empty spaces shall be filled with suitable filling material. The equipment shall be finally packed in a wooden/suitable case of sufficient strength so that it can withstand bumps and jerks encountered in a road/rail journey.
- 11.0 **TRAINING:**
- 11.1 Onsite training shall be provided to the Railway staff which shall include complete assembly of the system through the use of various modules, integration of hardware with software and complete operation of the system.
- 11.2 Sets of training manual in two hard copies and two soft copies containing details of technical specifications, installation and commissioning, trouble shooting & maintenance schedule etc. shall be supplied along with the equipment.

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12.0 DOCUMENTATION:

12.1 The following documents should be supplied along with the system:

12.1.1 Mechanical drawings of each sub system/ rack.

12.1.2 Installation and maintenance manual incorporating trouble shooting exercises, printed cards patterns, software etc.

12.1.3 Operating and troubleshooting manual including maintenance schedule.

12.1.4 Pre-commissioning check list.

12.1.5 Detailed installation and commissioning document including site topology diagram.

13.0 Following Details are required for Integrated Communication System for Tunnel:

13.1 Supply, Installation, Testing and Commissioning of following item by the supplier for Tunnel communication:

| SN | Item | Cl. No. | Nos. | Condition of requirement |
|-----|----------------------------------------------------------------|----------------|------------------------------------------------------------------------------------------------------------------|----------------------------|
| 1. | Master Unit | 3.1.1 | As per site requirement | Tunnel length > 500 meters |
| 2. | Fibre Junction Box | 3.1.2 | As per site requirement | Tunnel length > 500 meters |
| 3. | Optical Remote unit | 3.1.3 | 01 No. at every interval of 500 meters length As per site requirement. | Tunnel length > 500 meters |
| 4. | Off-Air Channelized Repeater | 3.1.4 | 01 No. Repeater | Tunnel length < 500 meters |
| 5. | 7/8" Leaky cable | 3.1.5 | One both side of Tunnel | all type of tunnels |
| 6. | Antenna for each system | 3.1.6 | For VHF Simplex, LoCoTrol DPWCS, GSM-R, LTE-R, TCAS KAVACH etc. as per Railway Requirement | all type of tunnels |
| 7. | OFC Cable | 3.1.7 | Fibre Junction box to length of tunnel | Tunnel length >500 meters |
| 8. | Power supply unit for Master Unit | 3.1.8 | As per site requirement | Tunnel length >500 meters |
| 9. | Power supply unit for Optical remote units in Tunnels & Cables | 3.1.9 | As per site requirement | Tunnel length >500 meters |
| 10. | Power supply unit for Repeaters in Tunnels | 3.1.9 | 01 no. for per Repeaters | Tunnel length <500 meters |
| 11. | 7/8" & 1/2" RF Feeder Cable with proper connectors | 3.1.5, 3.1.5.1 | as per requirement | all type of tunnels |
| 12. | Leaky Cable accessories kit, connectors & installation kit for | -- | as per requirement | all type of tunnels |

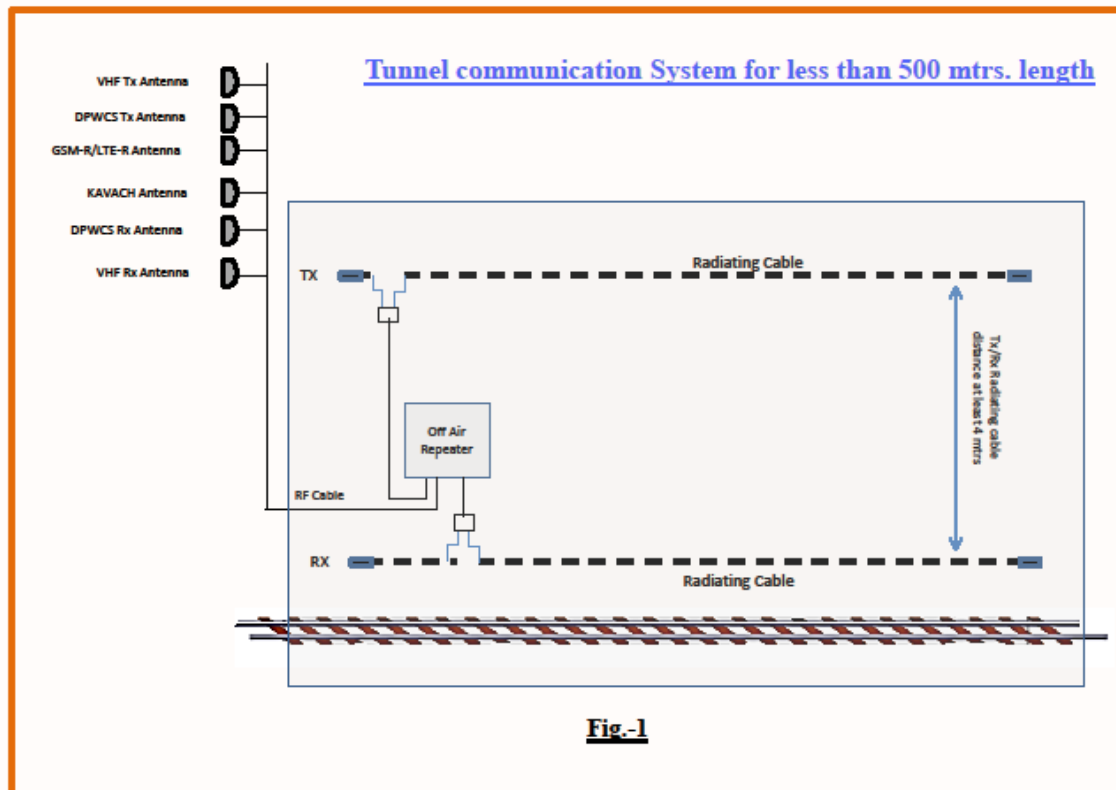
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|-----|-----------------------------------------------------------------------------------------|---------|--------------------------------|----------------------------|
| | Leaky cables | | | |
| 13. | Cross band couplers, Dividers, Directional Couplers, RF terminations and RF accessories | -- | as per requirement | all type of tunnels |
| 14. | RF cable with proper connector | 3.1.5.1 | length as per site requirement | all type of tunnels |
| 15. | Tower at Tunnel for fixing antenna | 3.1.5.1 | 01 no. | Tunnel length < 500 meters |
| 16. | RF Lightning & surge protector for Tower at Tunnel | 3.1.5.1 | 01 no. each | Tunnel length < 500 meters |
| 17. | Video Surveillance System | 5.0 | as per requirement purchaser | Tunnel length > 500 mtr. |
| 18. | PA System | 4.0 | as per requirement purchaser | Tunnel length > 500 mtr. |
| 19. | Emergency call point | 3.1.11 | As per requirement purchaser | Tunnel length > 500 mtr. |
| 20. | Voice Recording arrangement | 2.7 | As per requirement purchaser | all type of tunnels |

13.2 Details to be furnished by Purchaser:

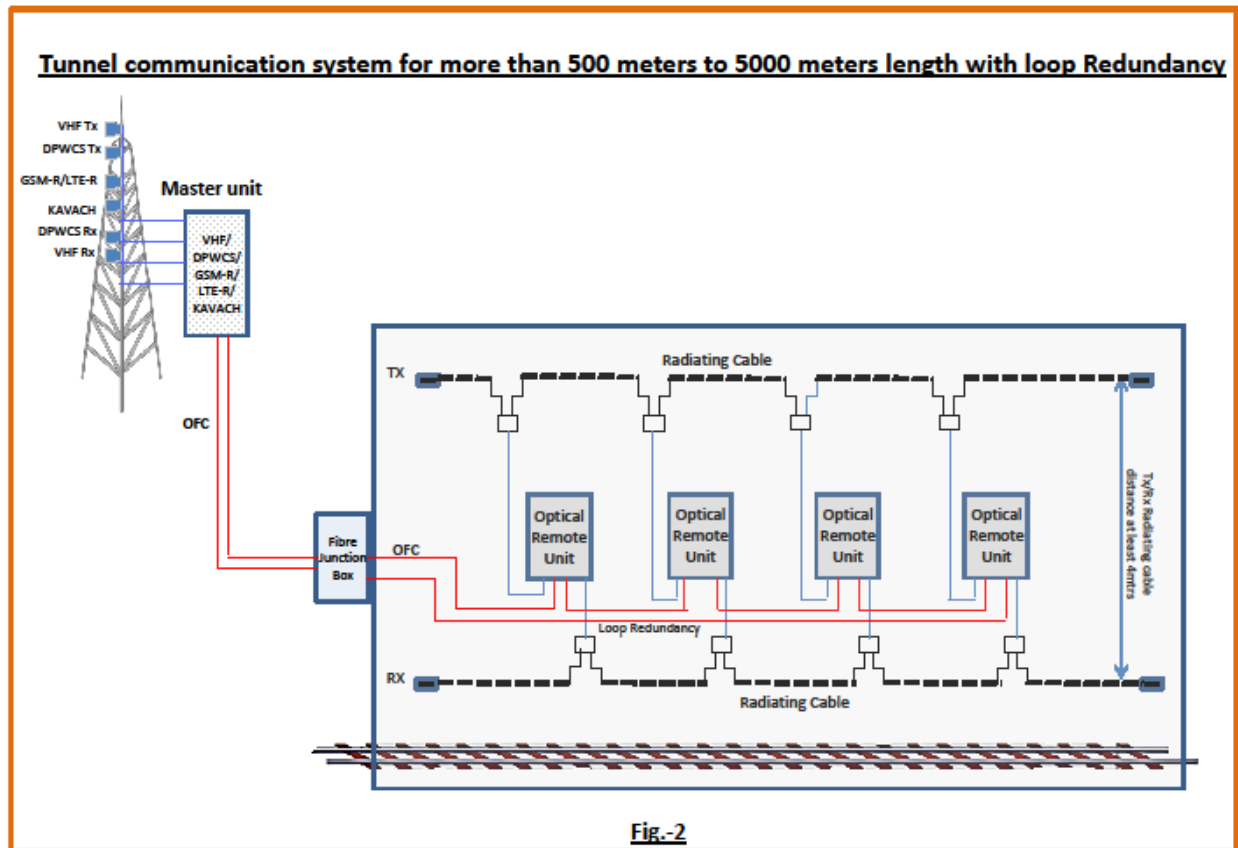
| SN | Details |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. | Length of tunnel |
| 2. | Number of Tunnel Bores |
| 3. | Type of communications to be extended (VHF, LoeTrol DPWCS, GSM-R/LTE-R, TCAS KAVACH etc.). |
| 4. | Number of Channels for each service (VHF, LoeTrol DPWCS, GSM-R/LTE-R, TCAS KAVACH etc.) should be specified. |
| 5. | Single mode OFC connectivity for Master Unit (from base station site to Fibre junction box) and for Video Surveillance System & PA System at the entrance of tunnel to be provided by purchaser. |
| 6. | 230V AC, 50Hz at the entrance of Tunnel and the location of Master Unit at base station site. |
| 7. | List out the item and quantity required to be installed in tunnels for Video Surveillance System as per RDSO specification no. RDSO/SPN/TC/65/2019 2021 Rev. 5.0 6.0 or latest. |
| 8. | List out the item and quantity required to be installed in tunnels for PA System as per RDSO specification no. RDSO/SPN/TC/78 63/2008 2006 Rev. 0.0 1.0 or latest. user requirement. |
| 9. | Size of Tower at Tunnel for fixing antenna. |
| 10. | Exact Bands and Channels authorized for use by Railways for VHF/ LoeTrol DPWCS/GSM-R/LTE-R/ TCAS KAVACH. |
| 11. | Number of Earthing arrangement required ($\leq 1\Omega$) (Earthing arrangement should normally be provided at every 500 meters Optical Remote unit inside of Tunnel) |

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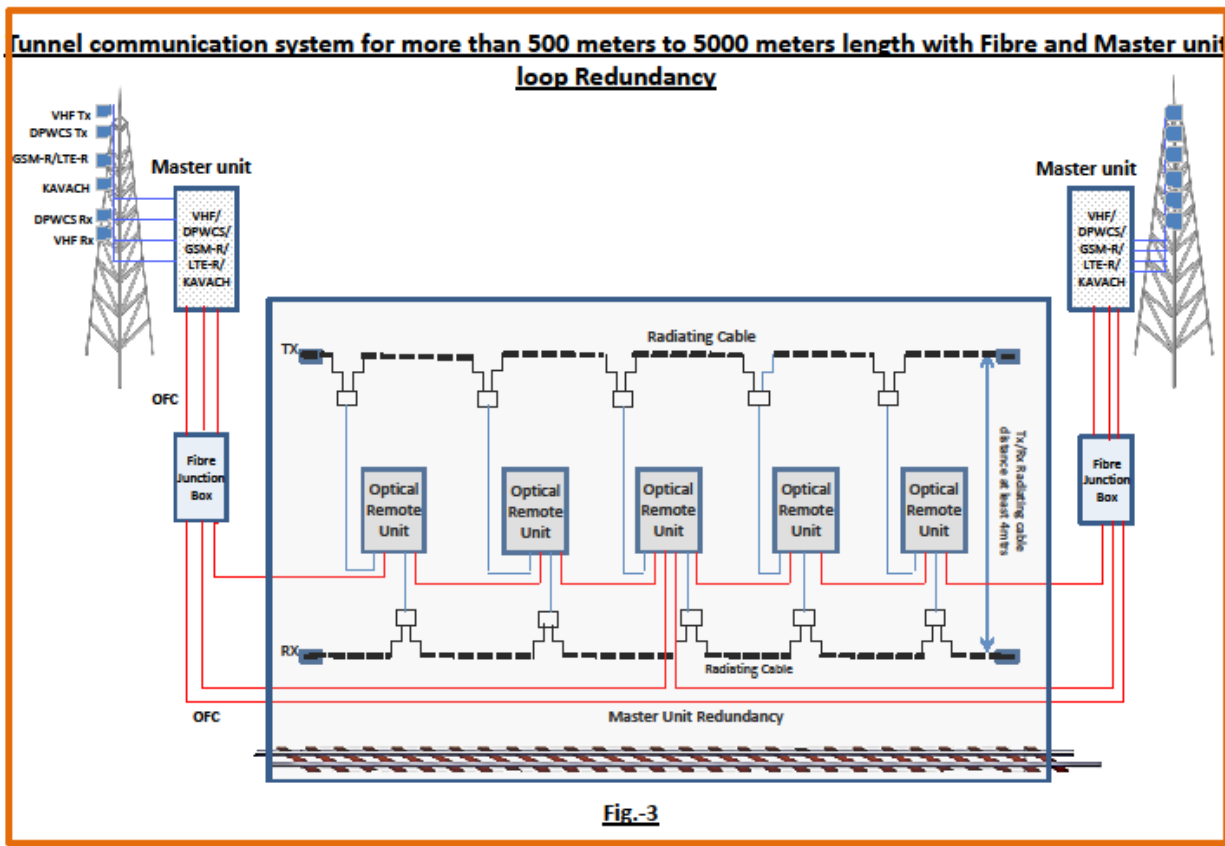
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