GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS

Specification for
Technical Requirements for
Distributed Power Wireless Control System for
AC Tap Changer Locomotives

Specification No.  RDSO/2008/EL/SPEC/0074, Rev. ‘1’
Issued on 14/12/2011

Prepared by  Checked by  Issued by
SSE/SE&AM  ADE/SE&AM  DSE/C&S

ELECTRICAL DIRECTORATE
RESEARCH, DESIGNS & STANDARD ORGANISATION
MANAK NAGAR, LUCKNOW – 226 011
## Status of Revision

<table>
<thead>
<tr>
<th>S. N.</th>
<th>Date of Revision</th>
<th>Page No.</th>
<th>Revision</th>
<th>Reasons for Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>-</td>
<td>All</td>
<td>0</td>
<td>First Issue.</td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Prepared by

SSE/SE&AM

Checked by

ADE/SE&AM

Issued by

DSE/C&S
INDEX

<table>
<thead>
<tr>
<th>Sr No</th>
<th>Item</th>
<th>Page no</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chapter-I General</td>
<td>Page 4 to 9</td>
</tr>
<tr>
<td>2</td>
<td>Chapter-II Technical details</td>
<td>Page 10 to 13</td>
</tr>
<tr>
<td>3</td>
<td>Chapter-III Functional requirements</td>
<td>Page 14 to 21</td>
</tr>
<tr>
<td>4</td>
<td>Chapter-IV Design requirements</td>
<td>Page 22 to 24</td>
</tr>
<tr>
<td>5</td>
<td>Chapter-V Testing proving &amp; field trials</td>
<td>Page 25 to 27</td>
</tr>
<tr>
<td></td>
<td>Annexure-I Details of Type of signals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>flowing through wires of MU coupler of</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WAG7 loco</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annexure-II Brief Details of IRAB-1 brake</td>
<td></td>
</tr>
<tr>
<td></td>
<td>system (Extracts from WAG7 loco manual)</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER-I

GENERAL

1.1 OBJECT & SCOPE

1.1.1 Tap changer electric locomotives working on Indian Railways are provided with electrical wire coupler at both ends to facilitate working in multiple units (MU). There are 3 wire coupler namely B, C and D each carrying 19 core cable at both ends of loco. While working in MU consist, driver is kept only in leading locomotive and all electrical control commands (all 110 V DC signals) are transmitted to trailing locomotives through these wire couplers. Fault status & important supervision information of trailing locos is also passed through these wire coupler to leading loco for the information of driver. It is proposed to modify the existing electric locomotives by providing Distributed Power Wireless Control System (DPWCS) by using Radio Frequency (RF) technology which shall facilitate control of trailing/remote locos from leading locomotive.

1.1.2 Specification for Wireless MU coupler System for 25 kV AC tap changer locomotive was originally issued in December’2008. In this specification, control of train brakes only from lead loco was specified. After study it was found that feature of application/release of brake of remote locos in synchronism with driver initiated action for application/release of brakes in lead loco is also possible using wireless control. This feature of full control of brakes of remote locos is expected to give advantage in terms of reduced braking distance, quicker brake release thereby enabling faster acceleration and also lesser coupler forces. The specification has been re-drafted to primarily incorporate a brake interface unit for this purpose besides many other minor changes considered necessary. The name of the specification has also been changed from “Wireless MU Coupler System (WMUCS)” to more generic name “Distributed Power Wireless Control System (DPWCS)”.

1.1.3 This specification is meant for design, development, supply & commissioning of ‘Distributed Power Wireless Control System’ (also referred as DPWCS herein after) for 25 kV AC tap changer electric locomotives namely WAM4, WAG5 A/B/C/HA/HB, WAG7, WAP1 and WAP4 both for locos provided with relay based control and microprocessor based fault diagnostic control. The primary objectives of this system are

(i) To enable full control of remote locos (or consists) placed in middle and/or rear of train based on the driver initiated actions in lead loco through wireless control. On successful development and trials, the requirement of drivers in remote locos (or consist) can be reviewed.

(ii) To have smoother train operation by reducing coupler forces.

(iii) To have smaller braking distance and quick brake release for long haul
freight trains.

1.1.4 This specification covers the design, development, supply, erection, testing and commissioning of Distributed Power Wireless Control System (DPWCS) for tap changer electric locomotives namely WAM4, WAG5 A/B/C/ HA /HB, WAG7, WAP1 and WAP4 both for locos provided with relay based control and microprocessor based control and fault diagnostic system.

1.2 Definitions and meaning of terms:

For the purpose of this specification, the following definitions shall apply:

<table>
<thead>
<tr>
<th>SN</th>
<th>Term</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tenderer /Supplier/Manufacturer</td>
<td>The Firm or company who submits the offer for supply of equipment as per this specification</td>
</tr>
<tr>
<td>2</td>
<td>Contractor</td>
<td>Any Firm or Company with whom the order for supply of the equipment as per this specification shall be placed or intended to be placed</td>
</tr>
<tr>
<td>3</td>
<td>Purchaser</td>
<td>Any unit of Indian Railway</td>
</tr>
<tr>
<td>4</td>
<td>RDSO</td>
<td>Research Designs and Standards Organization, Ministry of Railway, Manak Nagar – 226011</td>
</tr>
<tr>
<td>5</td>
<td>Inspecting Officer</td>
<td>A person nominated by the purchaser to inspect the equipment on his behalf or the representative of the Inspecting Officer so nominated</td>
</tr>
<tr>
<td>6</td>
<td>MU Consist</td>
<td>2 or more locomotives (up to max 4 locos) coupled together and connected through wired couplers. This is also referred in brief as ‘consist’</td>
</tr>
<tr>
<td>7</td>
<td>Lead Locomotive</td>
<td>Locomotive attached at the head of the train. In case of MU consist at the head of train, Lead locomotive means the foremost locomotive of the MU consist.</td>
</tr>
<tr>
<td>8</td>
<td>Trail or Remote Locomotive</td>
<td>Locomotive placed at a location other than leading position in a train consist. In case of MU consist, trail or remote locomotive is the foremost loco of the MU consist</td>
</tr>
<tr>
<td>9</td>
<td>Closed Coupled Operation</td>
<td>Lead and trail locos coupled together and operating together through wireless link. This is also referred in brief as ‘Wireless consist’.</td>
</tr>
<tr>
<td>10</td>
<td>Remote Control Operation</td>
<td>Lead consist located at head of train and remote consists separated from lead consist and located inside and/or end of train. In such case, lead loco of each consist shall be equipped with DPWCS for operating through wireless link.</td>
</tr>
<tr>
<td>11</td>
<td>Synchronous Remote Control Operation</td>
<td>Simultaneous repetition &amp; execution of commands, given by lead locomotive to trail locomotive by a wireless link, such as traction, air braking, dynamic braking or any other function performed by the driver of the lead unit and duplicated in trailing units.</td>
</tr>
<tr>
<td>12</td>
<td>Electric Loco Shed</td>
<td>Facility provided on the Indian Railways for upkeep of</td>
</tr>
</tbody>
</table>
### SN | Term | Meaning
--- | --- | ---
 | electric locomotives where periodic schedule maintenance as well as unscheduled maintenance of locomotives is carried out. |  
 | Block Section | A portion of running line where only one train is allowed to operate at a time on one track. The entry and exit from the block section is controlled by appropriate signals. |  
 | Neutral section | A portion of overhead equipment (OHE) in electrified section which is dead i.e. neither charged nor earthed. Such section is provided between two portions of OHE, which are fed by different phase. There are different types of neutral section in Indian Railways, each type having different length. In all types of neutral sections, opening of 25 KV Circuit breaker of loco (called DJ hereinafter) is must. For guidance of driver caution & reminder boards are placed at 500m and 250 m ahead of neutral section followed by ‘DJ open’ board at the location where DJ should be opened. After negotiating neutral section, DJ should be closed on ‘DJ close’ board |  
 | BP | Brake pipe |  
 | FP | Feed pipe |  
 | BC | Brake Cylinder |  
 | ER | Equalizing Reservoir |  
 | AFI | Air flow indicator |  

1.3 **CONTRACTOR’S RESPONSIBILITY:**

The contractor’s responsibility shall include following:

1.3.1 Commissioning of the equipment in service. The supplier shall depute his engineers/supervisors to CLW/Sheds/workshops for installation of the equipment on locomotive. However, cabling will be done by railways as per advice of contractor.

1.3.2 Supply of detailed commissioning instructions for proper installation of the equipment on the locomotives. Installation instruction shall be provided in acceptable form e.g. Instruction card. These instructions shall include the method of inter connection, type of cable and grade of cable, maximum resistance and whether the cable required is screened or otherwise. The supplier shall provide specification of screened cable and probable sources for the purpose of maintenance. Details of any special precaution necessary shall also be stated.

1.3.3 Provide required instrumentation and carry out detailed tests and field trials jointly with RDSO/CLW/Railways.
1.3.4 Provide special tools, instruments and test bench etc along with documentation, which may be required for maintenance.

1.3.5 Provide recommend list of spares required for satisfactory maintenance and operation of the Distributed Power Wireless Control System for a period of five years after warranty and also quote the prices for them separately.

1.3.6 Quote the cost of repair for cards /AMC for minimum period of five years.

1.3.7 **Training:** The supplier shall arrange for free of cost training of Indian Railway personnel in installation & commissioning, operation, maintenance and trouble shooting of the system supplied. Supplier will also provide detailed technical write-up to all the trainees. The syllabus for training will have to be approved by the purchaser. The venue of training will be at the place of commissioning of the system and at the destination shed.

1.3.8 **User’s manual:** The supplier shall supply sufficient copies of User’s manual in hard copy as well as soft copy. This shall include system description and operating, maintenance, calibration and troubleshooting instructions up to component level. List of spares with part number/technical specification shall also be included. Number of copies to be supplied shall be 10% of the number of equipment ordered, subject to a minimum of 5 copies per order.

1.3.9 **APPROVAL FOR DESIGN**

1.3.10 The design shall be developed based on the requirements given in this specification by using latest technology and sound engineering practices. During design approval stage, the contractor shall submit to RDSO following for examination and approval. However, contactor shall be bound to furnish any other design detail as may be required by RDSO for evaluation of the offered system.

(i) Block diagram functional description of the system offered. Description shall necessarily contain explanation as to how each of functional requirements of this specification is met with.

(ii) Design details of the hardware indicating make, technical data/ratings and governing specifications.

(iii) Flow chart description of the logic used in the software.

(iv) Coloured sectional view diagrams of the pneumatic/Electro-Pneumatic valves used along with explanation of their operating principles.

(v) Mechanical drawings of complete system and its subsystems/subassemblies with details of dimensions, mounting arrangement and weight shall be provided.

(vi) Bill of Material (BOM) clearly indicating bought out items and in-house manufactured items. Make and International governing specification of the
bought out items shall be furnished.

1.3.10.1 The Contractor shall not commence manufacture before clearance of the design by RDSO.

1.3.10.2 Approval of design means the approval of general design features. Notwithstanding the approval, the supplier will be wholly responsible for the performance of the system.

1.3.11 FIELD TRIALS:

After clearance of design & successful completion of type tests, the prototype equipments shall be subjected to field service trials for a minimum period of six months. The number of trial equipments and venue shall be as agreed between the purchaser and the supplier. The installation and commissioning of the equipments for field trials shall be carried out by the supplier. The supply and commissioning of the balance equipment against the order shall start only after successful trial and incorporating improvements measures arisen out of trial for successful performance of the equipment in the field.

Consumable materials, electrical energy for testing and commissioning of the Distributed Power Wireless Control System will be provided by the purchaser free of cost.

1.3.12 INFRINGEMENT OF PATENT RIGHTS:

Indian Railways shall not be responsible for infringement of patent rights arising due to similarity in design, manufacturing process, use of components, used in design, development and manufacturing of Distributed Power Wireless Control System and any other factors which may cause such dispute. The responsibility to settle any issue lies with the manufacturer/contractor.

1.3.13 DOCUMENTATION:

The tenderer must submit the following information with his offer in printed form and neatly compiled in a booklet form. Offer with incomplete information shall not be considered.

a) Clause by clause comments on this specification.

b) Statement of deviations to clauses of this specification indicating the reason thereof.

c) Brief block diagram functional description of the system.

d) Broad mounting dimensional drawings of the system and its subsystems/subassemblies indicating weight of each assembly.

e) Brief design details of each sub-assembly including broad ratings specifications.
f) Make and International governing specification of the bought out subsystems/sub-assembly.

g) MOU (Memorandum of understanding) with the collaborator, wherever applicable.

h) QAM (Quality assurance manual)

i) ISO 9001 certification.

j) Details of infrastructure, manufacturing and testing activities in line with guidelines issued vide RDSO spec no: ELRS/SPEC/SI/0015 “Reliability of Electronics used in Rolling Stock Application.”

1.4 RAILWAYS’ RESPONSIBILITY:

Railway will be responsible for followings:

1.4.1 3 Sq mm/10 sq mm single core elastomeric cables to RDSO specification No E-14/01 (Rev 2), if required, will be given by railways for installation and commissioning. Any other type of cable required shall be in scope of supply of the Distributed Power Wireless Control System.

1.4.2 Labour, consumables and electrical energy required for erection, testing & commissioning of System.

1.4.3 The wages and allowances as well as the cost of the travel to and from the place of training for railway personnel.
CHAPTER II

TECHNICAL DETAILS

2.1 SYSTEM REQUIREMENTS.

The system shall have testability built in the design to ensure the reliability and safety level required to run the loco with such electronic/wireless communication equipment. Each Unit of the ‘Distributed Power Wireless Control System’ (DPWCS) for Electric Locomotive will comprise of two Driver Interface Units (DIU), one Control & Communication Unit (CCU), one Junction Box and one Brake Interface Unit (BIU) along with other necessary interfacing devices and interconnecting cables. One set of equipment will consist of two such units.

2.2 DRIVER INTERFACE UNIT (DIU)

2.2.1 Driver Interface unit shall function as an interface between operator and system. It shall have necessary keys for this purpose and the Interface shall be user friendly. Driver interface unit shall be provided in each cab at appropriate location for convenience of operator after approval of RDSO. The driver interface unit should act as a dumb terminal simply to receive and display information from "Control & Communication Unit (CCU)" and to send keyed in information to CCU. The driver interface unit should run from 110 V dc power available in the loco. Driver Interface unit shall be back-lit LCD type to achieve good readability and it should have adjustable contrast and backlit control. The menu items, input keys/buttons and interface features and layout etc shall be provided to meet the functional requirements and shall be got approved from RDSO before manufacture.

2.2.2 Each Driver Interface unit shall be connected with CCU by means of military grade threaded circular connector for communication with CCU from both the cabs. A 3 pin military grade bayonet type circular connector shall be used for power supply. The data on display shall be updated at least once every 500 msec.

2.2.3 The DIU shall be designed to provide following provisions/functionality for display of information, providing alerts and alarms.

(i) Default screen of DIU shall continuously provide display of critical parameters and status of leading as well as remote locos which shall essentially include following.

- Healthiness of communication link
- BP, BC, MR pressure and AFI
- Status of DJ
- Traction Status- Traction/Dynamic Braking
• Notch Position

(ii) The DIU shall essentially have the following keys/buttons for quick action by driver besides having other keys/buttons for selecting various menu items, configuration of the system and for meeting the requirements of this specification

(a) Key/Button for negotiation of neutral section.

(b) Key/Button for negotiation of Panto down restriction.

(c) Emergency Key/Button for opening the DJ and lowering of pantograph of remote locos.

(iii) Default screen shall automatically resume after an idling time of max 10 seconds of display of some other screen if the driver had selected same for viewing/performing some action. A key/button shall also be provided on DIU for selecting the default screen at once.

(iv) An audio visual alert system shall exist on DIU for various abnormal situations for guidance of driver. The audio alert shall be in form of buzzer and visual alert shall be in form of contextual text display on screen. Provision for acknowledgement of audio visual alert by driver, wherever necessary, shall be provided. After acknowledgement of alert, audio buzzer shall stop sounding. The type of alerts and their contextual text shall be got approved from RDSO before commencing manufacture. However, situations where alert is required on DIU shall essentially include following.

• Communication loss/interruption

• Remote loco(s) BP charging valve cut-out

• Train parting

• Wheel slip in remote locos.

• All fault conditions which are being conveyed to driver through existing pilot lamp indications namely LSDJ, LSGR, LSB, LSCHBA, LRSRI, LSP, LSAF, LSSIT, LSBCR, LS Group, LSOL.

(v) The DIU shall be ergonomically designed to provide easy access and user friendly interface to driver. The location of various switches/keys/buttons, number of information display screens, layout of each screen, contextual text for various alerts/alarms etc shall be got approved from RDSO before commencing manufacture.

2.3 JUNCTION BOX (JB):

2.3.1 There shall be a junction box in which wires, to be interfaced from existing loco circuitry, will be terminated. It shall be located in SB of cab 2. Alternatively, the

<table>
<thead>
<tr>
<th>Prepared by</th>
<th>Checked by</th>
<th>Issued by</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSE/SE&amp;AM</td>
<td>ADE/SE&amp;AM</td>
<td>DSE/C&amp;S</td>
</tr>
</tbody>
</table>
loco wires can be directly interfaced with CCU. The connections at JB/CCU shall be through mill grade threaded circular connectors and those at loco end shall be through terminal strips in SB.

2.3.2 At present all the 57 wires of B, C & D coupl ers combined together are not used. However, in future additional functionalities can be provided through these spare wires and therefore provision shall be made in design of DPWCS for at least 10% spare relays/contactors of the quantity actually required with present design for meeting such future needs.

2.3.3 The connectors of 110 V signals and low voltage signals such as communication, pressure transducers output signals and other functions shall be separate to avoid intermixing of high and low voltage wiring from reliability view point.

2.4 CONTROL & COMMUNICATION UNIT (CCU):

2.4.1 Control & Communication Unit (CCU) shall comprise of power supply module, microprocessor module, hardware module, software module, memory module and data transmission/reception/decoding modules.

2.4.2 CCU shall be interfaced with junction box to pick up electrical control commands and shall convert same in RF signals and transmit to trailing loco(s). While in trailing loco, same unit shall be able to receive RF signal and convert them into electrical signal and pass to loco through junction box for execution of commands. Interfacing of this unit shall be through terminal strip at loco side and military grade threaded circular connector shall be used for interfacing of CCU with DIU & JB.

2.4.3 CCU shall have sufficient non volatile memory for storing log of important events, fault conditions and status of data transmission/reception. CCU shall also be provided with an RS-232, RS 485, Ethernet port and USB port to facilitate data exchange from external devices. Necessary commands for such data exchange shall be provided on DIU. The nature of events to be logged and their format shall be get approved from RDSO before commencing manufacture. The software to analyze the data log shall be in scope of supply of DPWCS.

2.4.4 Communication module shall contain radio transceiver. The radios shall have the feature of display of signal strength, diversity reception and programmable power output and frequency.

2.5 BRAKE INTERFACE UNIT (BIU):

2.5.1 The system shall include a Brake Interface Unit which will interface to the existing IRAB-1 brake system of loco to provide full control of the Automatic (Train) brakes, the Independent (Loco) brakes and emergency brakes. The actions of driver in lead unit with respect to application/release of brake shall be duplicated in remote units through this interface unit. Contractor shall have to
study the existing brake system of locomotives for this purpose. The purchaser shall provide manuals of locos to contractor for this purpose.

2.5.2 The brake interface arrangement shall be such that the existing functionalities/features of IRAB-1 Brake system provided on loco remains intact.

2.5.3 The BIU may comprise of pneumatic/electro-pneumatic valves, pressure sensors/transducers, air flow measuring device, gauges etc for interfacing with loco BP/FP/BC/ER pressure pipeline. Provision and installation of such equipments along with piping etc shall be in scope of supply. The pneumatic/Electro-pneumatic valves, pressure transducers, air flow measuring devices, gauges etc used in BIU shall be of proven design for rolling stock applications.

2.5.4 The manufacturer shall furnish complete design detail of the proposed brake interface arrangement to RDSO for examination and approval before commencing manufacture.

2.6 Operating Modes:
It shall be possible from lead loco to place remote Loco(s) in the following operating modes: Necessary mode selection buttons/switches/keys shall be provided on DIU for this purpose.

(i) **ISOLATE**: In this mode system remains powered ON but wireless control functions are totally disabled.

(ii) **IDLE**: In this mode electrical functions (traction/dynamic braking) of the lead locomotive are not performed on the remote locos but air brake functions are performed.

(iii) **BRAKE**: In this mode only dynamic brake and air brake functions of the lead locomotive are performed on remote locos

(iv) **SYNCHRONOUS CONTROL**: In this mode all electrical and air brake functions of the lead locomotive are performed on remote locos in synchronism with lead loco.

(v) **INDEPENDENT CONTROL**: In this mode the electrical traction and dynamic braking functions of the remote locomotives can be independently controlled via the DIU of lead loco.

(vi) **BRAKE VALVE OUT**: In this mode, the brake valve shall be cutout and automatic brake functions of lead loco shall not be duplicated in remote locos.

2.7 Potential free contacts:
Safety devices such as VCD, ACD and TPWS may be provided in locomotives. Normally these devices shall be kept in isolated mode in remote locos. However, DPWCS shall have provision for at least 4 potential free contacts which can be used for disabling such safety devices in remote locos equipped with DPWCS.
CHAPTER III

FUNCTIONAL REQUIREMENTS

3.1 The system shall be suitable to work within UHF frequency band. The frequency identified by IR for operation of distributed wireless control system of locomotive is from 406 to 407 MHz in UHF band and thus the system shall be suitable for operation from 406 to 407 MHz. Moreover, in case IR decides to use some other frequency in UHF band, such change shall only require changing of Radio of the system.

3.2 The system shall be capable of simultaneously handling preferably up to 6 trains equipped with the DPWCS in a radius of 3 kms efficiently and without loss of communication on a single UHF channel of 25 KHz. Each such train can have up to 4 remote locos (or consist).

3.3 Indian Railway shall obtain the allocation & operating license thereof for adequate number of UHF channels or sufficient spectrum from Wireless Planning and Coordination (WPC) wing of Ministry of communication & IT, Govt of India for the use of DPWCS system on IR. However, there is possibility that the frequency of channels so allocated is different in different geographical area. Therefore the System shall have the capability of automatically switching to the available frequency channel.

3.4 In future, Indian Railway may prefer to operate the DPWCS system on GSM-R communication link. Therefore, the system shall be designed in a modular fashion for its easy upgradability to GSM-R in future. Brief details of the module to be changed/modified for such up-gradation shall be indicated by tenderers in their offer.

3.5 Performance of the system shall not be affected by other RF devices in vicinity and at the same time the system shall also not affect the working of other RF devices in the vicinity. Supplier shall mention, and give a copy thereof to RDSO, the international/national standards through which this requirement is proposed to be tested. However, RDSO after examining these standards may ask for testing through some other standards considered appropriate. It will be the responsibility of supplier to arrange such testing at his own cost. Supplier shall not commence manufacture until the testing protocol is approved by RDSO.

3.6 The system shall provide control of remote locos (up to 4 locos) of the train by signals transmitted over a (through) wireless link from lead loco, up to a distance of 1500 meters from lead locomotive. The system shall be capable of operating in continuous tunnels, JUNGLE AREA and deep cuttings without any loss of contact over wireless link through radiating antenna/external repeaters/leaky cables wherever radiating antenna/external repeaters/leaky cables infrastructure is provided. However, in critical locations in tunnels/Jungle Areas where continuity of communication cannot be ensured due to high curvatures/physical obstruction in line of sight, the system shall have necessary provisions to ensure continuous communication through radiating
antenna/external repeaters/leaky cables to be provided at such locations. The manufacturer shall assist IR in identifying such critical locations during initial trial runs and shall provide details of the radiating antenna/external repeaters/leaky cables along with procuring specification & sources for installations at such locations. The supply and installations of such radiating antenna/external repeaters/leaky cables shall not be in the scope of DPWCS.

3.7 Performance of the system shall not be affected by the overhead traction of 25 KV AC and High Voltage transmission lines in the vicinity of track.

3.8 System shall be Fool-proof so that it is not affected by similar units in other trains passing through the adjoining electrified/non-electrified track or operating on the adjacent block sections or a terminal or a cutting. The performance of the system shall also not be affected by three phase locomotive/EMUs, fitted with GTOs/IGBT control, which may be working on nearby track.

3.9 System shall not cause interference to color light signaling equipment or any other signaling installation provided on the Indian Railways.

3.10 The DPWCS equipments for lead loco and remote loco shall be identical so that any loco fitted with this system can be utilized as lead or remote loco in a train.

3.11 The existing wire couplers of the locos shall be retained and their functionality for forming wired multiple units shall not be affected by the system.

3.12 The lead loco and remote locos of a train shall have to be initially set to work as pair. During initial set up of train, DPWCS shall allow pairing of locomotives of same train only. For this purpose, continuity of BP pressure must be taken as one of the verification item besides the identity of the locos. The system shall have an inbuilt feature of checking continuity of the BP pressure. The flow chart logic of the algorithms proposed to be used for checking continuity of BP pressure shall be got approved from RDSO before commencing manufacture.

At start of paring process the system shall ask inputs from driver. These input shall include Driver ID, train name, loco numbers with their position(Lead,Remote-1,Remote-2 etc) and alignment (leading cab of remote locos), no of wagons/coaches in train. Once paired, the system shall only communicate with paired remote locos of the train.

3.13 System shall be capable of full control of remote locos while working in closed coupled operation as well as in remote control operation. However, while working in closed couple operation, air brake functions of remote locos through wireless control shall not be normally required as these can be achieved by connecting MR/BC equalizer pipes of close coupled locos.

3.14 System shall be safeguarded against possibility of taking over control of the lead as well as remote locos by any unauthorized person using wireless means. Tenderers shall explain in their offer as to how this requirement is met with.

3.15 The algorithm for control & indications to be used in the DPWCS system shall be deduced
by the contractor after studying the existing electrical control arrangement and braking
system of WAG7/WAG5/WAP4/WAM4 type AC tap-changer electric locomotive. For this purpose, the purchaser shall provide manuals of these locos to contractor. The algorithm of the system shall be finalized after RDSO approval. However, details of type of control signals flowing through wires of MU couplers for WAG7 loco is given in Annexure-I merely for guidance of the tenderers.

3.16 The system shall be capable of providing wireless control of any combination of relay based and Microprocessor based ac tap changer locos in a train consist. Microprocessor based locos are having “Microprocessor based control & fault diagnostic system” as per RDSO specification no ELRS/SPEC/MPC-FDS/0001 (REV-2) Aug 2005 or latest. Special attention of tenderers/manufacturers is drawn to the fact that wire numbers/ coupler pin numbers of microprocessor based locos are mostly different than those of relay based locos for same functions and therefore manufacturer shall have to make a thorough study of circuit arrangement of both type of locos in order to device the logic/algorithm for achieving wireless control in such combination of lead and remote locos. The algorithm shall be got approved from RDSO prior to manufacture.

3.17 Manufacturer must note that in existing wired MU locos, the selection of correct pantograph, and running/braking direction in trailing loco is automatically taken care of by means of cross connections & special orientation of B, C & D couplers. The DPWCS manufacturer shall have to take special precautions to ensure that command in remote locos is transferred to correct wire of loco so that selection of pantograph and running/braking direction is matching with those selected by driver in lead loco.

3.18 It shall be possible to shut down (i.e. DJ opening and Pantograph lowering) trailing locomotive(s) at any time from leading locomotive. Suitable User friendly interface shall be provided on Driver Interface unit for this purpose. Similarly it shall also be possible to energize and bring to traction the paired trailing locomotive(s) at any time with the help of simple user friendly interface at DIU. While shutting down the trailing locomotive(s), the notches should gradually come to zero before opening of DJ. Similarly, while energizing the trailing locomotive(s), the notches should progress gradually to the position corresponding to leading locomotive. While the notches in trailing locomotive(s) are progressing, the driver of leading loco may reduce the notches before coming to a stable notch position where notch position of all locomotive will be same. Gradual notch progression/regression in this context means approx 0.5 second per notch transition. After the same notch position has been reached in all locos, the paired trailing loco(s) shall follow and synchronize with the action of leading loco.

3.19 In case driver presses emergency key/button on DIU, the DPWCS shall cause opening of DJs and lowering of pantographs of all remote locos at once without following the gradual notch regression mentioned in previous clause.

3.20 In normal operation, system shall execute the same action in remote locos as are being done by driver in leading locomotive i.e. Notch progression/regression through master controller, shunting notch through MPS, forward/reverse operation

<table>
<thead>
<tr>
<th>Prepared by</th>
<th>Checked by</th>
<th>Issued by</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSE/SE&amp;AM</td>
<td>ADE/SE&amp;AM</td>
<td>DSE/C&amp;S</td>
</tr>
</tbody>
</table>
through MPJ, traction/braking mode through MP etc.

3.21 System shall also be able to execute the commands of leading loco in case of failure of MP/EEC of leading locomotive when driver works the train by manual control of notches.

3.22 The notch progression/regression in locomotives is realized through an air servo motor having EP valves which gets electrical commands from master controller. Sometime, it may happen that despite the electrical command the notch progression/regression does not take place. Therefore, the DPWCS System shall have the capability of identifying the actual notch position which shall be monitored to achieve proper synchronization of remote locos during normal course of operation as well as after communication interruptions.

3.23 **Negotiation of neutral section**: There are neutral sections (dead zone) on OHE roughly at every 30 to 40 km. There is caution board at 500 m ahead of neutral section to caution the driver of approaching neutral section, followed by reminder board at 250 m ahead of neutral section and then DJ opening board where driver must open the DJ. These boards are placed on fixed structures (normally OHE masts) alongside the track. After negotiating neutral section, driver closes the DJ at DJ closing board. In case the DJ remains closed in neutral section, it will lead to unsafe condition and therefore it is must that DJ is in open condition while negotiating neutral section. The DPWCS shall be able to meet this requirement for remote locos (or consist). The manner of handling neutral section and other requirements are as follows.

(a) While approaching neutral section, Driver opens the DJ of lead loco at ‘DJ open’ board, closes DJ at ‘DJ close’ board and then start taking notches in lead loco while during this period (period during which lead loco DJ remains open) trailing loco(s) remain energized and on notches pushing the train. After negotiation of neutral section by lead loco, when trailing loco arrives at 500 m board, its notch starts regressing and comes to zero position on reaching 250 m board, followed by opening and closing of DJ at ‘DJ open’ and ‘DJ close’ board respectively. Supplier will have to build additional software logic to achieve this functionality.

(b) System shall include a GPS device which shall be used for handling negotiation of neutral section. While approaching neutral section, lead loco driver shall press NS button on DIU thereby indicating that now system has to handle negotiation of neutral section in remote locos. After pressing NS button, when driver opens DJ, the system shall lock the GPS coordinates and remote loco(s) shall start monitor their GPS position and system shall cause reduction of notches & then opening of DJ when remote loco(s) reaches to locked GPS coordinate position. The accuracy of GPS shall be taken into account for achieving safe negotiation of NS. To cater to the situations of poor GPS signal availability, system shall have a backup provision based on speed monitoring and length of train to handle negotiation of neutral section. Suitable algorithm for calculation of train length deduced from no of wagons/coaches entered by driver and speed/time measurement etc shall have to be devised by supplier. The effect of curvatures and slack in couplings between wagons/coaches shall be also taken into account.
care of in algorithm as these factors will affect train length. System shall take input for speed from ESMON (energy cum speed monitoring system) of loco and arrangement shall be such that in case of failure of ESMON of leading loco, speed input is taken from ESMON of trailing loco(s).

(c) While approaching neutral section, DJ of concerned loco must open on or before (max 15 meters) ‘DJ open’ board. Similarly after negotiating neutral section, DJ of concerned loco must close only on or after (max 15 meters) ‘DJ close’ board.

(d) In case if any loco is stuck up in neutral section for any reason, DPWCS system shall provide the facility to provide traction from other loco(s) to clear the neutral section. Suitable interface shall be provided on DIU for this purpose.

(e) The system shall be fail-safe so that no violation of above conditions of negotiating neutral section takes place. The supplier is advised to study the system of speed measurement in loco and type of couplings used & their slack etc before framing algorithm so that above requirements are complied with stated accuracies.

3.24 Sometimes there are restrictions for lowering of pantograph between specified locations. This requirement shall have to be handled with the same logic as for negotiating neutral section elaborated in preceding clause with an additional function of lowering/raising of pantograph. System should be able to lower the pantograph of trailing locos (or consists) in such restriction at specified locations with same accuracies as mentioned in previous clause.

3.25 System shall be able to identify train parting and in such cases remote locos, if any, in parted rear portion of train should come to idle position. If in case of train parting, driver of lead loco applies emergency brake, this emergency condition should be sensed by remote locos where similar brake application should automatically take place to avoid collision of separated portions of the train.

3.26 System shall continuously check for the healthiness of the communication link between lead and remote locos. Check should be initiated by lead as well as remote locos so that DPWCS system of each loco (lead or remote) has the real time information of health of communication link.

3.27 Whenever there is communication failure between lead loco and remote locos for whatsoever reason, the affected remote locos shall remain in last commanded state of traction/rheostatic braking and a timer of period T shall start. If communication resumes within period T, system will perform self test, ensure identity of remote locos and then bring the affected remote locos in synchronism with lead loco. If communication is not resumed within period T, the affected remote locos shall come to idle position (zero notch position). In case the remote locos have been commanded to idle due to communication loss, the driver shall be provided with the facility, through DIU, to bring remote locos to traction and synchronize with lead loco when communication resumes. The period T shall be programmable from 10 seconds to 1 minute and its optimum value shall be worked out during trials. Moreover, if the lead loco driver makes a train brake application during communication loss period, this condition shall be sensed by
DPWCS of remote locos and system shall bring the remote locos to idle position. Alert to driver for communication failure shall be provided on DIU.

3.28 In the event of failure of leading loco for whatsoever reason, system shall provide the functionality to driver of leading loco to work the train from any combination of trailing locos and a suitable user friendly interface shall be provided in DIU for this purpose.

3.29 System shall log the events of communication failures/other failures in memory and at any point of time data of last 45 days should be available. System shall also continuously log the commands transmitted/ received/ decoded by system and at any point of time data of last 3 days should be available in memory. It should be possible to download this data through RS-232 port/USB port, RS 485 and Ethernet port. Suitable downloading commands should be provided on DIU for downloading of data. Extent and format of data elements for logging and storage of such data shall be got approved by RDSO before manufacture.

3.30 Self Test: The system shall run a self-test at power ON and thereafter continuously in real time to verify the satisfactory functioning of all system/sub-systems including Input/output. During this operation, the system shall be capable of identifying internal faults as may occur from time to time and their indication to the driver. Fault recovery capabilities and limited fault tolerance are desirable features, which shall be indicated in the offer for evaluation of the system.

3.31 Pneumatic Braking: The system shall meet the following functional requirement in respect of pneumatic braking.

(i) Train braking shall be controlled from both the lead as well as the remote locos. The actions of driver in lead loco with respect to application/release of train brakes, independent brakes & emergency brakes shall be duplicated in remote locos through wireless commands from lead loco and BIU. The status of BP/BC/FP/ER/MR pressure and Air flow of remote locos shall be displayed on DIU of lead loco and that of lead loco shall be displayed on DIU of remote locos.

(ii) During communication interruptions, if the lead loco driver makes a train brake application, the system shall seal the BP (i.e. BP charging/destruction not possible from affected remote loco) from BIU of affected remote loco. This shall be achieved by commanding concerned valve (referred as Brake valve hereinafter) of BIU to get closed. In such communication failures, train brakes shall only be controlled from lead loco. Suitable alert to driver shall be provided for such situations.

(iii) If BP charging continues despite Brake valve commanded closed in affected remote loco (this can happen due to command not getting executed properly or due to some fault in Brake valve) during communication interruption and the lead loco driver makes a brake application, this situation shall be sensed by affected remote loco by measuring air flow into the BP & BP pressure. BIU
shall have the capability to stop BP charging in such situations. For this purpose system and its BIU shall have arrangement to continuously monitor the Air flow into the BP.

3.32 **Wheel Slip**: When automatic sanding is taking place on the remote units, indication should come on DIU of the lead unit. System shall be capable of causing sanding on remote locos on request by lead loco driver. Suitable interface on DIU shall be provided for this purpose.

3.33 **Sanding**: Provision of sanding in remote locos on request by lead loco driver shall be made in the system. For this purpose, driver shall be provided with an option on DIU to enable/disable sanding synchronization on remote locos. In case this option is enabled then on pressing of the sanding foot pedal by driver in the lead loco, system shall cause operation of sanding gear on the remote unit automatically with its indication being displayed on lead unit.

3.34 The DPWCS shall also log the events of brake application (train brake, loco brake, emergency brake) by driver along with the values of BP and BC pressure. The logging shall be done in memory of DPWCS in lead as well as remote locos. The system shall log these events in all operating modes except when switched off.

3.35 **Inter-operability**: The system shall be designed to have inter-operability across DPWCS of different make to achieve flexibility in operations. After the system is successfully developed and proved during service for the intended purpose, the manufacturers shall be required to work out a common communication protocol so that DPWCS of different make can communicate with each other for achieving inter-operability before the mass scale adoption of DPWCS on IR. The system shall be designed to have inter-operability across DPWCS of same make with all versions from version 1 & above to achieve flexibility in operations.

3.36 In some locos Vigilance Control device (VCD) as per RDSO’s specification No ELRS/SPEC/VCD/0025/Rev ‘2’ of May 2004 may be fitted. The purpose of VCD is to monitor the alertness of the engine crew through a multi-resetting system which gets reset by specified normal operational activities of crew, in addition to acknowledgement of the vigilance check by pressing a push button or pedal switch provided for this purpose. Absence of the normal driving functions and the acknowledgement at specified intervals will activate vigilance control system to flash an indication which if still not acknowledged will cause audiovisual warning. If audiovisual warning is also not acknowledged, it will result in emergency brake application. The ACD shall be normally kept in isolated mode in remote locos but provision shall be made in DPWS system in form of potential free contact to disable VCD while DPWCS is in trail mode.

3.37 In some locos Train protection & warning system (TPWS) or Anti collision device (ACD) may be fitted. TPWS is an ETCS level-1 system which monitors the working of driver with respect to observance of Maximum Permissible Speed (MPS) and signal aspects and applies service or emergency brakes in case of defaulting
conditions. ACD is a GPS based system which applies service or emergency brake to avoid collision like situations. The TPWS/ACD shall be normally kept in isolated mode in remote locos but provision shall be made in DPWS system in form of potential free contact to disable VCD while DPWCS is in trail mode.

3.38 Based on the experience/system information gained during product design/development/testing/trial etc, above functional requirements may be reviewed and/or additional functional requirements may be stipulated, which may be necessary for safe and efficient operation of trains. The contractor shall be bound to modify the design within warranty period to satisfy such requirements.
Chapter-IV

DESIGN REQUIREMENTS

4.1 The design of the system shall be robust and of state-of-the-art technology. The design shall be modular up to card level for ease of maintenance and fault troubleshooting. As far as possible supplier shall design the system by using standard cards/devices which are freely available in market.

4.2 System shall draw power from loco battery. The battery supply voltage is 110V DC which may vary from 70V to 136V and is supported by the existing battery charging arrangement available in the locomotive. In locos fitted with SIV, battery charger is part of SIV as per specification No RDSO specification no ELRS/SPEC/SI/0018 (Rev 1). In locos fitted with ARNO converter, separate battery charger as per CLW specification no CLW/ES/B-11 Alt-D is provided. Supplier may refer these specifications for knowing the quality of 110 V output and its contamination. The system should be designed to work with this supply without any problem. Since memory storage are to be catered for, a battery backup as a part of the system shall also be provided.

4.3 Power supply system of DPWCS should have two power supply cards, one should be working normally and other should be hot standby. In case of failure of one card, switchover to healthy card should be automatic with an indication on DIU of failure of first card.

4.4 It will be preferable to have the entire hardware, CPU, RAM, EPROM, Input/output ports and opto-isolation etc. so optimized that the component count is kept low without sacrificing the overall system performance and reliability. As far as possible hardware shall be plug-in type. Necessary interfacing hardware and the connectors will be provided on the cabinet of the equipment.

4.5 All the cards should be suitably protected, enclosed and provided with mechanical dust proofing covers to avoid dust ingress and then mounted in a robust metallic housing so that entire assembly is capable of withstanding shocks, vibrations, electromagnetic induction and electrical surges etc. Electromagnetic compatibility of the entire system shall comply with provisions of IEC60571 and IEC 61000. The equipment should withstand surge & spikes as specified in IEC 60571.

4.6 DPWCS unit fitted on either lead or trailing locomotive shall be interchangeable. In order to have common Inventory of Radios used in transmission/reception module, the Radio modems should have minimum 2.5 MHz Bandwidth with programmable frequency within the band as per allocated frequency for use of DPWCS on IR.

4.7 Adequate provisions should be made in the design for suppression of internal transients, spikes and to withstand external transients, spikes and surges as per limits laid down in IEC-60571.
4.8 In the electronic/telecommunication equipments to be supplied to this specification, the suppliers shall use components and systems of high reliability, suitable in every way for the application on rolling stock. In this connection, supplier is well advised to refer to "Rules for Electronic Equipments used on Rail Vehicles IEC Publication 60571.

4.9 Minor deviations from the specification if any, can be mutually sorted out with RDSO during development stage if supported by justification on ground of cost and/or technical superiority.

4.10 All the components on PCBs should be wave soldered / surface mounted devices should be mounted using SMT workstation and complied with clause no. 7 of specification no. ELRS/SPEC/ SI/0015.

4.11 All ICs if mounted on the bases should be mounted on heavy duty sockets and provision should be made for tightening of the ICs on the base also complied with clause no. 6.1.3 of specification no. ELRS/SPEC/ SI/0015.

4.12 All electronic components and ICs used shall be selected after proper burn in and screening tests and shall be adequately rated to withstand the service requirements. A quality assurance scheme should be submitted by the supplier for approval of RDSO. It should be provided as per specification no. ELRS/SPEC/ SI/0015.

4.13 Military grade threaded circular connector shall be used for all external connections. Only mill grade connectors of reputed make shall be used.

4.14 System shall have real time clock for recording date & time.

4.15 Environmental conditions:

4.15.1 The equipment shall be capable of operating efficiently in spite of dust, dirt, mist, torrential rains, heavy sand or snow storms, presence of oil vapors and radiant heat etc., to which rolling stock is normally exposed in service. The equipments shall be suitable for traction application under the following environmental conditions.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheric temperature</td>
<td>Maximum</td>
</tr>
<tr>
<td></td>
<td>temperature</td>
</tr>
<tr>
<td></td>
<td>Maximum</td>
</tr>
<tr>
<td></td>
<td>temperature</td>
</tr>
<tr>
<td></td>
<td>under the</td>
</tr>
<tr>
<td></td>
<td>Sun: 75 degree Celsias and in shade: 55 degree Celsias</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td></td>
<td>temperature: -10 degree Celsius (Also snow fall in certain areas during winter season)</td>
</tr>
<tr>
<td>Humidity</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>saturation</td>
</tr>
<tr>
<td></td>
<td>during rainy</td>
</tr>
<tr>
<td>Reference conditions site</td>
<td>Ambient</td>
</tr>
<tr>
<td></td>
<td>temperature: 50 degree celsius</td>
</tr>
</tbody>
</table>

Prepared by | Checked by | Issued by |
------------|------------|-----------|
SSE/SE&AM    | ADE/SE&AM  | DSE/C&S   |
ii) Humidity: 100%

iii) Altitude: 1776 m above mean sea level

- **Rain fall**: Very heavy in certain areas.

- **Atmospheric conditions**: Extremely dusty and desert terrain in certain areas. The dust concentration in air may reach a high value of 1.6 mg/m$^3$. In many iron ore and coal mine areas, the dust concentration is very high affecting the filter and air ventilation system.

- **Coastal area**: Humid and salt laden atmosphere with maximum pH value of 8.5, Sulphate of 7 mg per liter, maximum concentration of chlorine 6 mg per liters and maximum conductivity of 130 micro siemens/cm.

- **Wind speed**: High wind speed in certain areas, with wind pressure reaching 150 kg/m$^2$.

### 4.15.1.1 Vibration & Shock:

The System shall be designed to withstand the vibrations and shock encountered in service satisfactorily as specified in IEC 61373 and IECs as applicable to other equipments.

### 4.15.1.2 Electromagnetic and Radio Frequency Interference Pollution

High degree of electromagnetic pollution is anticipated in locomotive machine room, where the equipment will be mounted. Necessary precaution should be taken in this regard. The supplier may test the actual level of EMI in locomotive and design the system accordingly. Railways shall provide all necessary assistance for such measurement. The system shall be interference free and same should be tested as per IEC 60571 and IEC 61000 for Electro Magnetic Compatibility.
CHAPTER - V

TESTING, PROVING AND FIELD TRIALS

5.1 CATEGORIES OF TEST

Following are the type of tests to be carried out on the equipment to be supplied against this specification.

5.1.1 TYPE TESTS

5.1.1.1 Type tests shall be carried out on equipment of the approved design. If there is any change in the design or source of supply of any components/sub-assembly/assembly, units made to the changed design or from new source shall be treated as new item for the purpose of conducting type tests.

5.1.1.2 Type tests are to be repeated in case of any major change is made. In case of minor changes, i.e. Change in type, rating of component etc special test/tests as agreed by user and manufacturer are to be conducted to ensure their suitability and effectiveness of the modifications.

5.1.1.3 The type tests shall be repeated once in five years by RDSO and such tests are termed as 'consistency type tests'.

5.1.2 ROUTINE TESTS

Routine tests shall be carried out on every equipment of each order.

5.1.3 ACCEPTANCE TESTS

Acceptance Test shall be carried out on 10% of batch quantity subject to minimum of 4 numbers.

5.2 TEST DETAILS:

The tests to be carried out on complete unit are given in the following table. Type and routine test schemes shall be prepared in accordance with the relevant specifications and furnished to RDSO for approval. Type test will be conducted on the basis of the approved type test scheme in the presence of RDSO/Railway representative. However, any additional test, if felt necessary may also be conducted at the time of type test. Manufacturer will bear the expenses of the tests.
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>TESTS</th>
<th>Relevant Spec</th>
<th>To be carried out as</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Spec Clause No</td>
<td>Type test Routine test Acceptance test</td>
</tr>
<tr>
<td>1.</td>
<td>Visual Inspection</td>
<td>EC 60571 10.2.1</td>
<td>✓ ✓ ✓</td>
</tr>
<tr>
<td>2.</td>
<td>Performance test</td>
<td>EC 60571 10.2.2</td>
<td>✓ ✓ ✓</td>
</tr>
<tr>
<td>3.</td>
<td>Cooling Test</td>
<td>IEC 60571 10.2.3</td>
<td>✓</td>
</tr>
<tr>
<td>4.</td>
<td>Dry heat test</td>
<td>IEC 60571 10.2.4</td>
<td>✓</td>
</tr>
<tr>
<td>5.</td>
<td>Damp heat test</td>
<td>IEC 60571 10.2.5</td>
<td>✓</td>
</tr>
<tr>
<td>6.</td>
<td>Supply over voltage, Surges and electrostatic discharge test</td>
<td>IEC 60571 10.2.6</td>
<td>✓</td>
</tr>
<tr>
<td>7.</td>
<td>Transient burst susceptibility test</td>
<td>IEC 60571 10.2.7</td>
<td>✓</td>
</tr>
<tr>
<td>8.</td>
<td>Radio interference test</td>
<td>IEC 60571 &amp; IEC 61000 10.2.8</td>
<td>✓</td>
</tr>
<tr>
<td>9.</td>
<td>Insulation test</td>
<td>IEC 60571 10.2.9</td>
<td>✓ ✓ ✓</td>
</tr>
<tr>
<td>10.</td>
<td>Salt mist test</td>
<td>IEC 60571 10.2.10</td>
<td>✓</td>
</tr>
<tr>
<td>11.</td>
<td>Vibration and shock test</td>
<td>IEC 61373 -</td>
<td>✓</td>
</tr>
<tr>
<td>12.</td>
<td>Water tightness test*</td>
<td>IEC 60571 10.2.12</td>
<td>✓</td>
</tr>
<tr>
<td>13.</td>
<td>RDSO spec no ELRS/SPEC/SI/0015 of Oct 2001 for specification for reliability of electronics used in rolling stock</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>14.</td>
<td>Functional tests</td>
<td>As per clause no 5.3</td>
<td>✓ **</td>
</tr>
</tbody>
</table>

* To be carried out on Antenna only.

** After prototype approval, the manufacturer shall submit functional test scheme to be considered during acceptance test to RDSO for approval. Tests as per approved functional test scheme shall be carried out during Acceptance test.

5.3 FUNCTIONAL TESTS

Functional tests shall be carried out at the works of the manufacturer and/or during trial fitment of equipment on locomotives. The purpose of these tests is to assess the functioning of the equipment, as per the functional requirements indicated in Chapter-III of this specification, before the equipment is cleared for field service trial. For this purpose, the contractor shall work out and propose the detailed testing methodology and same shall be finalized after approval of RDSO.
5.4 TESTS AND MONITORING DURING FIELD TRIALS

5.4.1 System shall be subjected to extensive field trials for a period of at least six months after fitment on locomotives. During field trials operation of the system shall be checked for all functional requirements mentioned in Chapter III of this specification which shall necessarily include following checks:

a) Performance of the system in long curved tunnels.
b) Performance of the system in Ghat section with heavy cuttings.
c) Performance of the system when two DPWCS operated trains passes each other. In this test it will be checked whether system in remote loco in one train responds to commands of lead loco of another train.
d) Time delay in response of system on remote loco to a command from lead loco.
e) Feedback of each response by system on remote loco to system of leading loco. This test will have to be carried out for every single command.
f) Performance of the system for negotiating neutral section and restrictions of lowering of pantographs.

5.4.2 As the system is expected to give smoother train operation and reduction of coupler forces, RDSO may also arrange coupler force trials at railway's cost to verify this aspect.

5.4.3 RDSO may prescribe additional tests/trials based on the experience of product, development/trials for proving the intended performance of the product.

-----------X-X-X-----------