GOVERNMENT OF INDIA

MINISTRY OF RAILWAYS

 Specification for EP Assisted Brake System for 3-Phase Locomotives Application Compatible with EP Assisted Brake System on Coaches
 Specification No. RDSO/EL/SPEC/2017/XXXX Rev. ‘0’

OCT 2017

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<th>Signature</th>
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<td>EDSE/Co-ord.</td>
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RESEARCH DESIGNS & STANDARDS ORGANISATION

MANAK NAGAR LUCKNOW 226011
## Status of Revision

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**Acronyms & Definitions:**

<table>
<thead>
<tr>
<th>Acronyms</th>
<th>Definitions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>BP</td>
<td>Brake Pipe</td>
</tr>
<tr>
<td>MR</td>
<td>Main Reservoir</td>
</tr>
<tr>
<td>FP</td>
<td>Feed Pipe</td>
</tr>
<tr>
<td>AFI</td>
<td>Air Flow Indication</td>
</tr>
<tr>
<td>MREQ</td>
<td>Main Reservoir Equalizing</td>
</tr>
<tr>
<td>BC</td>
<td>Brake Cylinder</td>
</tr>
<tr>
<td>BH</td>
<td>Brake Handle</td>
</tr>
<tr>
<td>PB</td>
<td>Parking Brake</td>
</tr>
<tr>
<td>FAD</td>
<td>Free Air Delivery</td>
</tr>
<tr>
<td>BCEQ</td>
<td>Brake Cylinder EQ</td>
</tr>
<tr>
<td>MU</td>
<td>Multiple Unit</td>
</tr>
<tr>
<td>VCD</td>
<td>Vigilance Control Device</td>
</tr>
<tr>
<td>TPWS</td>
<td>Train Protection Warning System</td>
</tr>
<tr>
<td>TCAS</td>
<td>Train Collision Avoidance System</td>
</tr>
<tr>
<td>VCU</td>
<td>Vehicle Control Unit</td>
</tr>
</tbody>
</table>
Specification for EP Assisted Brake System for 3-Phase Locomotives
Application Compatible with EP Assisted Brake System on Coaches.

1. SCOPE

This specification covers the functional requirement of EP Assisted Brake System for 3-Phase Locomotives compatible with EP Assisted Brake System provided on Coaches which are as per RDSO spec 02 ABR 02 or LHB with disc brake arrangement as per RDSO specification no. RDSO/2011/CG-04. This specification would assist in purchase, inspection, testing and acceptance requirements. This EP Assist system will be fitted on 3-phase electric locomotives required for trains having longer formation and higher speed. These locomotives can also be used for the freight trains provided with wagons having compatible EP assist brake system.

The locomotive shall be provided with EP Assisted braking system of proven design for operation of twin pipe graduated application and release application compatible with EP assisted brake system. The loco shall have control and information of the control of the coaches with compatibility of EP Assist.

2. Eligibility Criteria

2.1 The vendor or its foreign collaborator (if any) who intends to supply EP Assist System for Locomotive Control to Indian Railways, should have proven technology of EP Assist/EP System used in Locomotive/EMU/DEMU/other type of rail based rolling stock application successfully working in the world.

2.2 The vendor should have qualified and competent design personnel acquainted with the design and manufacturing technology required for EP Assist System Manufacturing.

2.3 The System should comply to UIC 541-5

2.4 The vendor or its collaborator should have manufacturing and testing facility of EP Assist Brake System

2.5 In case the credentials of a collaborator are cited, a clear specific MOU/agreement of the tenderer with the said collaborator shall be furnished.

3. BASIC RELEVANT DATA OF LOCOMOTIVE

Basic data of WAP-7, WAG-9 and WAP-5 class of electric locomotive relevant to brake system is as under:

3.1 Capacity of compressor:
Compressor capacity (FAD) at 10 kg/cm² pressure:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>WAP7/WAG-9</th>
<th>WAP5</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>1750±10% LPM at 10.0 Kg/cm² 02 compressors</td>
<td>1750±10% LPM at 10.0 Kg/cm² 02 compressors</td>
</tr>
</tbody>
</table>

Prepared by | Checked by | Issued by
3.2 Nominal bore diameters of four major pneumatic pipes used on air brake locomotive are as under:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of pipe</th>
<th>WAP7</th>
<th>WAG9</th>
<th>WAP 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Brake pipe</td>
<td>32 mm</td>
<td>32 mm</td>
<td>32 mm</td>
</tr>
<tr>
<td>ii)</td>
<td>Feed pipe</td>
<td>32 mm</td>
<td>32 mm</td>
<td>32 mm</td>
</tr>
<tr>
<td>iii)</td>
<td>Brake cylinder equalizing pipe</td>
<td>22 mm</td>
<td>22 mm</td>
<td>22 mm</td>
</tr>
<tr>
<td>iv)</td>
<td>Main reservoir E.Q. pipe</td>
<td>25 mm</td>
<td>25 mm</td>
<td>25 mm</td>
</tr>
</tbody>
</table>

3.3 Basic data related to locomotives is as under:

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Parameters</th>
<th>WAP7</th>
<th>WAG9</th>
<th>WAP5</th>
</tr>
</thead>
<tbody>
<tr>
<td>i)</td>
<td>Max. Weight of locomotive</td>
<td>123t± 1%</td>
<td>123t± 1%</td>
<td>78t± 1%</td>
</tr>
<tr>
<td>ii)</td>
<td>No. of brake cylinders on loco</td>
<td>8</td>
<td>12</td>
<td>08</td>
</tr>
<tr>
<td>iii)</td>
<td>Bore diameter of brake cylinder</td>
<td>8&quot; UAH type</td>
<td>7&quot; TBU,</td>
<td>10&quot;</td>
</tr>
</tbody>
</table>

3.4 Length of the train is as under:
  a. Air brake passenger train = 26 coaches
  b. Air brake freight train = 58 BOXEN
  c. No. of Locomotive used = Up to 3 nos. in multiple

3.5 Relevant data of coaches and wagons are as under:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Type of Rolling stock</th>
<th>Typical Length of stock (in mm)</th>
<th>Brake pipe diameter (in mm)</th>
<th>Feed pipe diameter (in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Air brake coach</td>
<td>22297</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>2.</td>
<td>BOXN</td>
<td>10713</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>3.</td>
<td>3-Phase Locomotive</td>
<td>WAP7 20562 WAG9 20562 WAP5 18162</td>
<td>32</td>
<td>32</td>
</tr>
</tbody>
</table>

3.6 Maximum permissible speed of train:

<table>
<thead>
<tr>
<th>Type of stock</th>
<th>Speed (kmph)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>Upto 200</td>
</tr>
<tr>
<td>Freight</td>
<td>Upto 120</td>
</tr>
</tbody>
</table>

3.7 MR Service Range Pressure - 8.0 Kg/cm² to 10 Kg/cm²

3.8 Electric Power Characteristics
  Operating Voltage: 78 to 136 V dc according to EN 50155
  The electro-pneumatic or electrical devices shall be suitable for 110 volts DC on electric locomotive.
  The voltage variation on locomotive may be between 78 and 136 Volts
4.0 **Service Conditions**

The equipment shall be capable of working satisfactorily under the service conditions indicated below:

4.1 **Altitude**

Mean sea level to an altitude of 1000 meters above mean sea level.

4.2 **Temperature**

Max. Atmospheric Temp. – Under sun 60°C  
- Under shade 50°C

4.3 **Relative Humidity** = Up to 100% Saturation during rainy season.

4.4 **Reference site conditions.**

(i) Ambient Temp. Max\textsubscript{m} = 50°C, Min\textsubscript{m} = 0°C  
(ii) Humidity: 60%  
(iii) Altitude: 160m above sea level.

4.5 **Rain Fall:** Very heavy in certain areas. The locomotives will be designed to permit its running at 10 KMPH in flood water level of 102 mm above rail level.

4.6 **Atmosphere during hot weather:** Extremely dusty and desert terrain in certain areas.

4.7 **Coastal Area:** Locomotive and equipment will be designed to work in coastal areas in humid and salt laden atmosphere.

4.8 **Other Conditions**

Equipment shall be capable of operating efficiently in spite of dirt, dust, mist, torrential rain, heavy sand or stone storms and presence of oil vapors and radiant heat etc. to which the rolling stock is normally exposed in service. Level of Protection should be IP-20 for Control Unit, IP65 for the Relay Boxes, Test Boxes, Junction Boxes and Indication Boxes.

5.0. **TECHNICAL REQUIREMENTS OF BRAKE SYSTEM**

5.1 **Following brake systems are presently working on 3-Phase Electric Locomotive:**

- E70 Brake System – FTIL Make
- CCB – KBIL Make

EPA is to be used on mentioned locomotives having twin pipe graduated release type of basic air brake system as per UIC 540 & 547.

5.2 The EP Assisted brake system should be generally as per UIC guidelines 541-5. Provision for continuous monitoring of the EP assisted brake system to check the
integrity of the system should be available. Any fault in the application circuit should be indicated to the driver (Red LED) to take suitable action to check the problem and isolate the system. When the EP assist fails, the green lamp for status health indication should turn ‘off’ and a red lamp should turn ‘ON’. Audio signal should also to be available to the driver to indicate EP Assist failure. Indication lamp (yellow) is to be provided to indicate bypassing of EP assist brake system.

5.3 The existing system should be able to work as conventional brake system on failure of EP assist brake system.

5.4 EP Assist brake system should be provided for new built Loco or able to retrofit on the existing 3 Phase electric loco so as to be interchangeable at system level

5.5 Analog / digital signal should be used to control the brake application and release and other features of brake system as applicable.

5.6 Suitable device(s) should be provided in locomotive to provide/ receive analog / digital signal for application and release through a wired train line circuit.

5.7 The device(s) placed in Locomotive should be used to vent the BP in coaches during application and recharge from aux. reservoir of the coach during release apart from venting or recharging of BP from the locomotive by its own brake system. However, the braking function is still carried by the UIC type Distributor Valves in each vehicle during EP assist function.

5.8 Even if there are dissimilar venting rates in the individual application device(s), BP of the train being one entity, the stabilization pressure in the BP at the end of each application should be the same throughout the train.

5.9 The system shall suit the operation requirement along with information needed for Indication and control purposes.

5.10 Multiple Unit Operation: The EP assisted system should support multiple unit operation of locomotives.
   
   • It should be possible to make multiple unit of locomotives provided with electro-pneumatic assisted brake system with other electric locomotives having other than EP assisted brake system. Such multiple unit formation may place the locomotive of any of the systems in any position of the MU consist. If the other loco is not equipped with EP Assist Brake System, it will not be possible to use EP Assist function in the coaches.
   
   • In case of parting between coupled locomotives, the brakes on the locomotive shall come on automatically. UIC type break-in-two protection should also be provided to shut down the power in all the locomotives.

5.11 EP Assisted Indicator Panel

EP Assisted indicator panel shall be provided on each control stand in front of the driver for easy identification. The EP control unit can be a separate unit, which can be placed at a convenient position in the loco to facilitate interface with the existing brake system equipment. The EP assist indicator should be
integrated with the locomotive’s existing display system as far as possible or standalone indication panel can be incorporated. The exact design is to be submitted for approval by RDSO. Its design shall conform to Fig.1 of this specification. ON/OFF of EP Assisted indicators as per Fig.1

![Indication Panel Diagram]

Fig.1: Indication Panel

5.12 Maximum working pressure is 10 kg/cm².
5.13 Normal working pressure is 5.0 kg/cm². Overcharge cycle should be inhibited during EP assist working, to initiate Overcharge from Locomotive, driver should bypass the EP Assist system.
5.14 Separate Bypass switch and indication to be provided for the driver.
5.15 It should be possible to identify the continuity from the Locomotive and if continuity is not ensured, EP Assist should not get activated.
5.16 Test Scheme for Loco with EP Assisted brake system has to be submitted.

6.0 SYSTEM REQUIREMENTS:

6.1 Control Unit
6.1.1 There should be provision for input and output of digital and analog signals from brake system and to EP Assist System.
6.1.2 There should be provision for checking the continuity of the EP Assist system from the control unit.
6.2 **Electrical Control Relay Box**

6.2.1 The Electrical Control Relay Box should be used to drive the EP Assist System of the coaches.

6.2.2 Relay for energizing and de-energizing the train line wires should have adequately designed to cater to complete train of 26 LHB coaches.

6.3 **Indication Panel**

6.3.1 Indication panel should be mounted in a suitable place in driver’s desk with proper visual and easy access.

6.3.2 Indication should have the indications as per figure 1 of clause 4.10. Supplier should submit the design along with the offer.

6.3.3 Bypass option should be provided on the Indication Panel.

6.4 **Connection Cable Between Vehicles and Laid through vehicle**

6.4.1 Connection Cable between vehicles shall meet the criteria as below. This cable not intended for installation inside vehicle.

6.4.2 The cable comprises of the following elements (as per Fig.2)

- 4 conductors of 10 mm² cross section, designated 1 to 4
- 2 conductors of 6 mm² cross section, designated A and B
- 1 conductor of 2.5 mm² cross section, designated D
- 1 screened sheathed pair of two twisted conductors with minimum cross section of 2.5 mm², designated X & Y for a data bus conforming to the provisions of UIC leaflet 556.

6.4.3 Wiring in the vehicle laid underframe should follow clause 5.4.2 and control cables inside the vehicle shall have a minimum cross section of 1.5 mm² copper.

![Fig. 2: EP Cable](image)

6.5 **Connectors and Sockets**

6.5.1 Connectors and Sockets used in the vehicle shall conform to UIC 541-5. (as per Fig.3 & 4)
6.6 EP Test Box

6.6.1 EP Test Box is provided on the both side of the vehicle to check for the continuity by pressing the push button while brake signal is generated by the locomotive.
6.6.2 The continuity is ensured by the status of the indicator turning ON.

6.7 Junction Box

6.7.1 Suitable Junction boxes to be provide along the Loco to receive or deliver brake commands signals and other associated signals for the proper functioning of the EP Assist System in a Train.

6.7.2 Boxes should be with IP65 protection and mounted suitably on the vehicle.

**Any other equipment which are required for proper operation of EP Assist system of Locomotive should be provided by the supplier.

6.8 Scope of Supply

The Scope of supply includes the followings, including the fittings and connectors required for integration of the system with locomotive and its various existing system.

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Description</th>
<th>Qty. / Loco</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control Unit</td>
<td>1 No</td>
</tr>
<tr>
<td>2</td>
<td>Electrical Control Relay Box</td>
<td>1 No</td>
</tr>
<tr>
<td>3</td>
<td>Indication Panel</td>
<td>2 Nos</td>
</tr>
<tr>
<td>4</td>
<td>Cables – 9 Core and 11 Core as per UIC</td>
<td>1 Set</td>
</tr>
<tr>
<td>5</td>
<td>Sockets and Plugs</td>
<td>2 Sets</td>
</tr>
<tr>
<td>6</td>
<td>Test Box with PCB</td>
<td>1 No</td>
</tr>
<tr>
<td>7</td>
<td>Test Box without PCB</td>
<td>1 No</td>
</tr>
<tr>
<td>8</td>
<td>Junction Box</td>
<td>1 No</td>
</tr>
<tr>
<td>9</td>
<td>Other Equipment (if any)</td>
<td>1 Set</td>
</tr>
</tbody>
</table>

The above scope is for to only EP Assist System for the Locomotive as a whole. The System is not interchangeable at component level with other manufacturers. Driver interface and other accessories of EP Assist system should be.

7.0 LITERATURE AND DRAWINGS

7.1 The tenderer shall submit brake schematic diagram along with description of the complete system with the offer. Pamphlets covering schematic diagram, installation drawing of complete system shall be submitted along with the offer for proper appreciation of the system offered by the vendor.

7.2 The supplier shall submit testing procedure for EP Assisted brake system as a whole.

7.3 After the system is finalized, the tenderer shall submit copies of the instructional, maintenance and test specifications

8.0 Inspection, Testing and Approval

During the developmental stage, for proper control & monitoring, Railways will be the controlling agency. The supplier shall submit it offer of equipment to
Railways along with all the details of equipment as per Clause 6. The firm will be inspected to check capacity and capability as per information submitted according to specification of RDSO. Manufacturer will be in constant touch with Railways for design review and prototype development. If found suitable product will be taken up further for prototype inspection.

8.1 Prototype Inspection:

8.1.1 The prototype inspection including stage inspection will be carried out by representative of Electrical Directorate of RDSO, Manak Nagar, Lucknow 226011 at the manufacturer’s premises. In general the inspection will be carried out according to UIC/RDSO specifications. Detailed type tests inspection scheme will be submitted by the vendor along with their offer. The test scheme should include testing of complete system as well as testing of individual brake valve/equipment. The test scheme should indicate stage inspection and final inspection on test bench as well as on locomotive. Vendor should get prior approval of test scheme from RDSO before actually conducting prototype inspection.

8.1.2 There should be proper test equipment/test racks at manufacturer work's premises to conduct such tests. The vendor shall provide, without extra charges material, tools and any other assistance which the purchaser may consider necessary for any test, examination and dimensional checking.

8.1.3 The vendor shall, on demand make available manufacturing related drawings and specifications to the inspecting authority at the time of inspection. Vendor will also submit the test results of the test conducted by them.

8.1.4 During prototype inspection manufacturer certificates of components/valves/equipment which have been purchased from outside shall be produced as a proof of quality assurance.

8.1.5 Electronic equipment used in the system shall be tested in accordance with IEC-60571- 2012. These tests as per relevant clause of IEC-60571 shall be carried out for prototype only. A certificate from recognized testing laboratory should be considered satisfactory for this purpose. The tests required to be conducted are given below:

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Nature of Test</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Visual Inspection</td>
<td>As per clause 12.2.1 of IEC 60571</td>
</tr>
<tr>
<td>2.</td>
<td>Performance Test</td>
<td>As per clause 12.2.2 of IEC 60571</td>
</tr>
<tr>
<td>3.</td>
<td>Reversal of Polarity</td>
<td>This is a design feature as per clause 7.2.6 of IEC 60571. The effectiveness of Reversal Polarity protection is tested over a period of not less than 1 minute within the specified voltage range. After this test the system shall be connected correctly and the performance checked. No degradation permitted.</td>
</tr>
<tr>
<td>4.</td>
<td>Supply Over voltage</td>
<td>As per clause 5.2 of IEC 60571</td>
</tr>
</tbody>
</table>
5. Temperature variation
   1 Cooling test
   2 Temperature rise test (with enclosure)
   As per clause 12.2.3, 12.2.4 & 12.2.4 of IEC 60571

6. Insulation test
   As per clause 12.2.10.2 of IEC 60571

7. High voltage test (Flash test)
   This is done on the complete unit. The insulation between all terminals coupled tightened and earthed, shall withstand for one minute, 1000 V r.m.s, 50 Hz supply applied in such a manner as to avoid any ac voltage provided. During the test the maximum leakage current shall be measured which shall not exceed 0.005A.

8. Voltage Withstand Test
   As per clause 12.2.10.3 of IEC 60571 is to be done.

9. Surge test
   As per clause 12.2.8.1 IEC 60571.

10. Vibration & shock tests (with enclosure)
    As per clause 12.2.12 of IEC 60571, Category 1 Class A

11. Radio Frequency Test
    As per clause 12.2.9 of IEC 60571.

12. Water tightness Test
    As per clause 12.2.13 of IEC 60571 (For Applicable Equipment)

8.2 Inspection of fitment of the EP Assist system on locomotive.

8.2.1 The installation of first system on electric locomotive shall be the responsibility of the vendor. Assistance with regard to labor and other facility which are available in the production unit/work shop/diesel shed of Indian Railways would however, be provided to the vendor during prototype installation. Vendor will provide all necessary guidance and technology including any special tooling or wiring etc. required for satisfactory installation of the system on the locomotive.

8.2.2 The fitment aspect of the system will be checked on the locomotive by the representative of Electrical Directorate, RDSO, Manak Nagar, Lucknow and purchaser in presence of the vendor. It is the responsibility of the vendor of Computer Controlled air brake system to interface with locomotive microprocessor control system. The inspection on locomotive will be carried out
generally in accordance with vendor’s test plan which shall be approved by RDSO prior to testing.

8.2.3 After successful prototype development and testing, development order will be placed. The performance of the brake system in field will be monitored for at least two years. On satisfactory performance in field, the vendor will be placed in approved list.

8.3 Routine Inspection

Routine inspection as per RDSO approved Plan of the equipment shall be carried out by the purchaser or his nominee. The supplier shall provide, without extra charges, for material, equipment, tools and any other assistance, which the purchaser or his nominee may consider necessary for any test and examination. The supplier shall make available manufacturing drawings and material specifications of the components to the inspecting authority at the time of inspection.

Supplier will offer brake system for inspection after complete checking by them. The test results of every brake system will be submitted to the inspecting authority. Inspecting authority shall carry out all tests necessary to prove that the equipment fulfils the technical requirements, covered in this specification.

9.0 Performance Guarantee.

9.1 The equipment supplied by the vendor shall guarantee the equipment against design and manufacturing defects for a period of 02 (two) years from the date of commissioning. Notwithstanding anything that may be specified in this specification, the final responsibility for suitability of the design shall lie with the vendor who shall undertake to carry out all modifications and alterations to the equipment supplied by them for satisfactory functioning in accordance with this specification as may be necessary during guarantee period. Such modification shall be carried out on all units by the vendor free of cost. The component/material which fails during guarantee period must be replaced by the manufacturer/supplier free of cost. The replaced components shall be under guarantee for a period of 02 (two) years from the date of their fitment.

9.2 Marking

Each Assembly/subassembly/Individual component shall have clear readable marking on its body. The marking shall be as following

a) Manufacturer’s name or trademark if any.
b) Month and year of manufacture.
c) Part No./Drg. No./Type No.
d) Batch No. if any.
e) Important technical data, such as rating, if any.
9.3 Packing & Delivery

All the equipment will be properly packed to avoid any damage during transit and storage.

10.0 Indigenization

In case the offered system is being manufactured in country other than India, vendor shall arrange for manufacture of equipment in India by transferring the technology to a suitable organization in India. The vendor will give stage wise details of indigenization program including:

a) Design calculations, material specifications.
b) Detailed manufacturing drawing, with tolerances, surface finish, jigs and fixtures and special tools and machines required for manufacturing equipment.
c) Manufacturing process sheets including detailed instructions on special techniques wherever applicable.
d) Detailed specifications for inspection & testing.
e) Other technical clarifications and supplementary instructions, if any, which may be required for manufacture of the equipment.

11.0 Deviations

11.1 The vendor shall submit clause wise comments from the specification and shall indicate the deviations, if any with the reasons thereof.

11.2 Any deviation from the standards laid down in this specification, with a view to improve the performance of the equipment shall be given with details. Supporting documents for such suggestion shall also be given with the offer.

12.0 Training

12.1 Sufficient number of technicians / engineers /officers shall be trained in consultations with the purchaser / RDSO so that adequate staff is available in the field for maintenance. This training shall be at the vendor works and electric sheds for a suitable period and shall cover maintenance and testing, brake system and design, quality control and trouble shooting.

12.2 Adequate numbers of maintenance manual covering schedule maintenance, maintenance practices, testing, maintenance tools, spare etc and wall charts showing pictorial view of components along with part numbers will be given. These maintenance manuals and wall charts are meant for wider circulation for Railways and fresh copies will be given with each order even if there are no changes in the design. The maintenance manual should mention the list of components with their average life, list of tools & machinery required and maintenance procedures for ensuring proper maintenance of the system.
13.0 Quality Assurance Plan (QAP)

13.1 The firm will give a quality assurance program (QAP) for approval to RDSO.

13.2 Revision of QAP

QAP is required to be revised with approval of RDSO as per Guidelines for preparing the QAP.

Note:
1. In case exact equivalent is not offered, functional equivalent must be offered. The total no. of items comprising the microprocessor controlled air brake system may be more or less than the existing system provided that the existing locations for mounting of one no. Brake rack and two nos brake controllers are followed.
2. Dimension of the offered items should not exceed the dimensions of the corresponding items of existing system. In case any dimensions of offered item exceed the corresponding dimension of existing item, vendor must ensure the sufficient space is available on the locomotive and submit details along with the offer.
3. Mounting arrangements, piping and wiring connection etc. should be interchangeable with existing system as far as possible.