



**GOVERNMENT OF INDIA**

**MINISTRY OF RAILWAYS**

**Specification for Computer/ Microprocessor Controlled**

**Air Brake System with Advanced Features**

**For 3-Phase Electric Locomotives**

**Specification No. RDSO/EL/SPEC/2017/0126 Rev. '0' 1**

~~FEB 2017~~  
NOV 2022

Approved By	Signature
<del>PEDSE/Co-ord.</del>	

**RESEARCH DESIGNS & STANDARDS ORGANISATION**

**MANAK NAGAR LUCKNOW 226011**

Prepared by	Checked by	Issued by
-------------	------------	-----------

## Status of Revision

S.N.	Date of Revision	Page no./Clause	Revision	Reasons for Revision
1.	-	All	0	First Issue
2	Oct' 2022	5.24, 5.26, 5.9.4, 5.9.7 5.29, 6.2.5, 8.2.3	1	Provisions of sensors and suitable communication device on Brake Panel for continuous monitoring the Brake parameters and communicate to VCU for continuously recording, Brake Blending requirement etc.

DRAFT

Prepared by	Checked by	Issued by
-------------	------------	-----------

**CONTENTS**

S.No.	CONTENTS	PAGE No.
1.0	Acronyms & Definitions:	4
2.0	Scope	5
3.0	Basic Relevant Data of Locomotives	5
4.0	Service Condition	7
5.0	Technical Requirements of Brake System	8
6.0	System Requirements	10
7.0	Literature & Drawings	22
8.0	Inspection, Testing and Approval	22
9.0	Performance Guarantee	24
10.0	Indigenization	25
11.0	Deviations	25
12.0	Training	25
13.0	Quality Assurance Plan (QAP)	26

Prepared by	Checked by	Issued by
-------------	------------	-----------

**Acronyms & Definitions:**

<b>Acronyms</b>	<b>Definitions:</b>
BP	Brake Pipe
MR	Main Reservoir
FP	Feed Pipe
AFI	Air Flow Indication
MREQ	Main Reservoir Equalising
BC	Brake Cylinder
BH	Brake Handle
PB	Parking Brake
FAD	Free Air Delivery
DBP	Direct Brake Pipe
MU	Multiple Unit
VCD	Vigilance Control Device
TPWS	Train Protection Warning System
TCAS	Train Collision Avoidance System
VCU	Vehicle Control Unit

Prepared by	Checked by	Issued by
-------------	------------	-----------

### Specification for Computer/ Micro-processor Controlled Air Brake System with Advanced Features for 3-Phase Electric Locomotives.

#### 1. SCOPE

This specification covers the functional requirement of Computer/Microprocessor Controlled air brake system for WAG9, WAP7 and WAP5 class of 3-Phase electric locomotives and this specification would assist in purchase, inspection, testing and acceptance requirements. This Computer Controlled air brake system will be fitted on WAG9, WAP7 and WAP5 class of electric locomotives and new locomotives for future development. This specification takes reference of CLW tender specification no.CLW/MS/3/001 latest Alt and CLW/MS/10/031 latest Alt.

The locomotive shall be provided with braking system of proven design for operation of twin pipe graduated release air /conventional or disc braked train. The loco shall have independent air brakes as well as parking brakes. In case of tripping of circuit breaker during regenerative braking due to any fault in the system or drop/rise in line voltage for any other reason, equivalent locomotive and / or full service train brake shall apply automatically. Service speed of the Passenger locomotive 160 kmph- upgradable to 200 kmph and test speed is 180 kmph- upgradable 225 kmph.

#### 2.0 BASIC RELEVANT DATA OF LOCOMOTIVE

Basic data of WAG9, WAP7 and WAP5 class of electric locomotive relevant to brake system is as under:

##### 2.1 Capacity of compressor:

Compressor capacity (FAD) at 10 kg/cm<sup>2</sup> pressure:

S.No.	WAG9 & WAP7	WAP5
i)	<del>1750±10%</del> 1745±5% LPM at 10.0 kg/cm <sup>2</sup> 02 compressors	<del>1750±10%</del> 1745±5% LPM at 10.0 kg/cm <sup>2</sup> 02 compressors

##### 2.2 Nominal bore diameters of four major pneumatic pipes used on air brake locomotive are as under:-

S.No.	Name of pipe	WAG9, WAP7	WAP 5
i)	Brake pipe	32 mm	32 mm
ii)	Feed pipe	32 mm	32 mm
iii)	Direct Brake pipe	22 mm	22 mm
iv)	Main reservoir E.Q. pipe	25 mm	25 mm

##### 2.3 Basic data related to locomotives is as under:

S.No.	Parameters	WAG9,	WAP7	WAP5
i)	Max. Weight of locomotive	123t± 1%	123t± 1%	78t± 1%
ii)	No. of brake cylinders on loco	12	8	8
iii)	Bore diameter of brake cylinder	7" TBU type,	8"UAH type	10"

Prepared by	Checked by	Issued by
-------------	------------	-----------

2.4 Length of the train is as under:

- a. Air brake passenger train = 26 coaches
- b. Air brake freight train = 58 BOXN
- c. No. of Locomotive used = Up to 3 nos. in multiple.

2.5 Relevant data of coaches and wagons are as under:

S.No	Type of Rolling stock	Length of stock (in mm)	Brake pipe diameter (in mm)	Feed pipe diameter (in mm)
1.	Air brake coach	22297	25	25
2.	BOXN wagon	10713	32	32
3.	3-Phase electric locomotive	WAG9 20562 WAP7 20562 WAP5 18162	32	32

2.6 Maximum permissible speed of train:

Type of stock	Air brake stock
Passenger	160 kmph
Freight	100 kmph

2.7 MR Service Range Pressure - 8.0 Kg/cm<sup>2</sup> to 10 Kg/cm<sup>2</sup>

Loco Type	Minimum Reduction		Full Service		Remarks
	BP kg/cm <sup>2</sup>	BC kg/cm <sup>2</sup>	BP kg/cm <sup>2</sup>	BC kg/cm <sup>2</sup>	
WAG-9	4.6 ± 0.1	0.40 ± 0.1	3.35 ± 0.2	2.50 ± 0.1	Leak hole palm test: 7.5 mm leak hole BP pressure should not drop by more than 0.6kg/cm <sup>2</sup>
WAP-7	4.6 ± 0.1	0.40 ± 0.1	3.35 ± 0.2	2.50 ± 0.1	
WAP-5	4.6 ± 0.1	0.75 ± 0.15	3.35 ± 0.2	5.15 ± 0.3	

2.8 CLW Specifications for Pneumatic System

S.No	Name of Item	CLW Specification
01	Specification of SS pipes (Seamless Annealed), Grade-304, Conforming to ASTM-A269	CLW/MS/3/029 Alt.7 or latest
02	Specification of Copper tubes	CLW/MS/3/030 Alt.7 or latest

Prepared by	Checked by	Issued by
-------------	------------	-----------

03	Specification for Nylon tubes	CLW/MS/3/079 Alt.4 or latest
04	Specification of Clamps	CLW/MS/3/059 Alt.5 or latest
05	Specification of Hoses (End Fittings, A108)	CLW/MS/3/033 Alt.4 or latest
06	Specification of fittings (End Fittings, A 108, Ferrule SS(Gr.316)	CLW/MS/3/053 Alt.9 or latest
07	Specification of Polypropylene strut	CLW/MS/3/52 Alt.1 or latest

2.9 Maximum down gradient: 1 in 30

2.10 Electric power characteristics:

Operating Voltage: 78 to 136 V dc according to EN 50155

Power Consumption:

BATTERY line protection switch

Max. Continuous Power consumption 175W (50-90) V, max. cont. rating 3.9A

In Rush current: 300A (pk) 200 $\mu$ s ,@87 V

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.

3.0 **Service Conditions:**

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

3.1 Altitude:

Mean sea level to an altitude of ~~4000~~ 1776 meters above mean sea level.

3.2 Temperature:

Max<sup>m</sup>. Atmospheric Temp. – Under sun 60<sup>o</sup> C  
– Under shade 50<sup>o</sup> C

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

3.4 Reference site conditions.

(i) Ambient Temp. Max<sup>m</sup>= 50<sup>o</sup>C, Min<sup>m</sup> =  $\theta$  -10<sup>o</sup> C

(ii) Humidity : 60%

(iii) Altitude: ~~460~~ 1776 m above sea level.

3.5 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.

Prepared by	Checked by	Issued by
-------------	------------	-----------

- 3.6 Atmosphere during hot weather: Extremely dusty and desert terrain in certain areas.
- 3.7 Coastal Area: Locomotive and equipment will be designed to work in coastal areas in humid and salt laden atmosphere.

3.8 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-54 for electronic enclosures.

**4.0. TECHNICAL REQUIREMENTS OF BRAKE SYSTEM**

- 4.1 The brake system offered should be Computer/Microprocessor Controlled air brake system of proven design. It should be compatible with graduated release twin pipe air brake system in accordance with RDSO's specification 02-ABR-02. Brake system should be compatible with disc brakes also.
- 4.2 Brake panel shall be made of Aluminium alloy with not less than three plates with fittings. Manifolds should be sealed with proven, reliable and modern sealing technologies. Hydraulic test pressure of 20 bar to be conducted or Pneumatic test pressure of 12 bar. "NO LEAK" permitted nearby ports and all sides of the plate assembly in both type of tests. Testing of complete manifold shall be responsibility of OEM. Vibration testing shall be done in accordance with ~~clause class~~ 'A' category 1 of IEC-61373. The compact modular Computer/microprocessor control brake system shall comprise of electronics in multiple Electro pneumatic modules linked together through gateway or local network. Its electro-pneumatic control unit shall consist of modularised electro-pneumatic modular Line Replaceable Units (LRU)/Gateway, which shall work as intelligent units, communicate with each other through the network or gateway and control the development of all pneumatic control pressures. It should also have redundancy features with availability of back-up for having Brake pipe control for applying and release of train brakes and Locomotive brakes. The details regarding availability of this feature should be submitted along with the offer.
- 4.3 The pneumatic and electronic units shall be integrated together with Line Replaceable modular Units (LRUs) / Gateway. The interfaces shall be provided among these modular units.
- 4.4 The envelop size of the panel mounted with the equipment should be as compact as possible, and shall preferably fall within the limits of 1100 mm (L) X 800 mm (W) X 1650 mm (H). The shape and size of the panel fits well in the locomotive with ample space for maintenance. All the LRU's/Components should be preferably mounted on one side of the brake panel. The weight of the panel with equipment shall not be more than 600 Kg.
- 4.5 Even in case of failure of Computer/microprocessor controlled brake system, it should be possible to work the loco with self-power up to certain restricted speed.
- 4.6 The locomotive brake system should be provided with self-lapping type independently operated brake valve on each control unit. The brake valve should have two detente positions namely 'Release' and 'Application'

Prepared by	Checked by	Issued by
-------------	------------	-----------



- position as per UIC code. In between Release and Application position, the brake cylinder pressure built up should be in proportion to the handle movement.
- 4.7 The direction of rotation of driver's automatic and independent valves shall be anti clockwise or push to apply for the application of brakes, when placed in horizontal plane. The valve is placed on the left side of the pilot.
- 4.8 It shall be possible to apply the brakes from one cab and release it from another cab in case the pilot has to change the cab.
- 4.9 It should be possible to release locomotive brakes when the brakes of trailing stock are partially or fully applied with suitable bail off.
- 4.10 Locomotive should be provided with LCD gauges for MR+ FP, BP, AFI and BC1+ BC2 (04 nos.) in a group to provide indication to the pilot about the train pipe condition and also of the train parting while hauling air braked stock. *Details of preeusre guges shall be as per para 5.17.*
- 4.11 An emergency brake valve operational system shall be provided. During emergency application brake system should provide suitable signal to VCU for automatic shut off the locomotive traction power through Vehicle Control Unit (VCU) system.
- 4.12 It should be possible to use locomotive in multiple unit operation up to 3 locomotives in one group.
- 4.13 It should be possible to use the locomotive as banking locomotive. In case of rolling stock equipped with air brakes, the brake pipe of the rolling stock shall not be charged by the banking locomotive. It shall be possible to apply independent and emergency brake from banking locomotive.
- 4.14 Rubber components such as piston, *diaphragm*, 'O' rings etc. wherever employed in the brake system and their controls shall be entirely suitable for minimum 6 years for humid and hot environmental conditions prevailing in India.
- 4.15 Pneumatic Sanding shall be provided for all the front wheels and it shall be effective in either direction of travel. Brake system should supply air to sanding arrangement during wheel slipping.
- 4.16 It will be preferable if the sizes of pipes are limited to minimum. Sharp bends shall be avoided and where necessary standard connections shall be used.
- 4.17 The various stop-cocks and isolating valves except drain cocks installed on locomotive varios location shall be oriented in the open position to the fluid flow direction. It shall be necessary to ensure that due to weight of the handle, when operated in a vertical plane, it shall not open or close on its own under vibrations encountered in service.
- 4.18 The connecting parts necessary for piping e.g. couplings, nuts, unions, bends etc. shall be assembled by means of taper threads.
- 4.19 Adequate drainage arrangement to drain the moisture in the compressed air system shall be provided.

Prepared by	Checked by	Issued by
-------------	------------	-----------

**5.0 SYSTEM REQUIREMENTS:****5.1 Panel (Brake Rack)**

- 5.1.1 There should be a provision of Brake Controller selector switch or soft key arrangement with four positions (Normal, Trail, Banker and Test in sequence from left to right) on each control stand. Alternatively selector switch with three positions (NORM, BANKER, TEST) can be offered as separate unit to mount on each control stand.
- 5.1.2 The brake system should be capable of giving graduated application and release of brake on locomotive as well as on train for air brake system.
- 5.1.3 There are two control stands/cabs on locomotive. At a time one control stand will be used to control loco/train and brake system. Driver's brake valves are to be provided on both the control stands/cabs. Arrangement should be there to make brake valves inoperative on control stand which is not being used to control loco/train and brake system. However, it should be possible to apply emergency brakes from the control stand which is not being used.

**5.2 Driver's Brake Valve**

The Driver's Brake valve (Controller) shall be electronic based, and act as interface between the Brake system and the Loco Pilot (Man-Machine Interface). The communication between the driver's brake valve (Controller) and micro-processor based air brake system should be through fibre optic cable or CAN/ LAON network. Driver's brake valve (controller) shall have handles for operation of the Independent and Automatic brakes. Alternatively separate valves (Independent & Auto brake) shall be offered. The electronic brake valve or Display unit shall accommodate LCD display or suitable digital display of limited advisory and diagnostic messages (in English) to the crew. Apart from electronics, the Electronic Brake valve should contain a cam-actuated pneumatic valve, which will create a pneumatic emergency when automatic handle is brought to 'emergency' position. Each of the two driver control units of the locomotive shall be provided with Electronic Brake Valve (Controller) or separate valves (Independent, Auto brake & Display units).

**5.3 Independent Brake Valve**

The locomotive brake system should be provided with self-lapping type independently operated brake valve on each control stand. The brake valve should have two positions namely 'Release' and Full Service. In between Release and Full Service, the brake cylinder pressure built up should be in proportion to the handle movement.

**5.4 Automatic Brake Valve**

- 5.4.1 Automatic brake valve shall be self-lapping type and shall have separate 'Release' and 'Run' position as per UIC code. The 'Release' position should be spring loaded. Following detent positions ~~except release~~ should be provided on automatic brake valve:
- a) Release position - spring loaded
  - b) Run position
  - c) Minimum reduction brake application
  - d) Full service applications
  - e) Emergency application positions

Prepared by	Checked by	Issued by
-------------	------------	-----------

- 5.4.2 The required Brake Cylinder pressure corresponding to brake pipe pressure reduction in inverse proportion is given as follows.

Auto Brake Lever Position	BP Pressure (Kg/cm <sup>2</sup> )	BC (WAG-9 & WAP-7 (Kg/cm <sup>2</sup> ))	BC (WAP-5) (Kg/cm <sup>2</sup> )
Release	5.5±0.1	0.00	0.00
Run	5.0±0.1	0.00	0.00
Minimum Reduction	4.6±0.1	0.40±0.1	0.75 ± 0.15
Full Service	3.35±0.2	2.50±0.1	5.15 ± 0.30
Emergency	Less than 0.3	2.50±0.1	5.15 ± 0.30

- 5.4.3 In 'Release' position of the brake handle, an increased flow of air between the MR (Main Reservoir) air feed and brake pipe charging valve should be available to facilitate quick charging of air brake pipe. However, in 'Running position' of the automatic brake valve, the passage between MR and brake pipe charging brake unit shall be restricted for maintaining leakage in the train system. In overcharge position BP goes up to 5.5 Kg/cm<sup>2</sup> for 60 seconds
- 5.4.4 In between minimum and full service position, the brake pipe pressure built up /exhaust should be in proportion to the handle movement.
- 5.4.5 In emergency position of brake valve handle, the brake pipe shall be vented to atmosphere through a sufficiently large diameter opening in such a way that the BP pressure comes from 5.0 to less than 0.5 kg/cm<sup>2</sup> in 3-5 seconds when the locomotive is tested separately. The emergency position in driver's brake valve should be independent of normal brake control system and be available for use at all times at both the control stands/cabs irrespective of the presence of locomotive power or battery power. Whenever emergency brake application occurs, Loco traction should cut off by brake system in co-ordination with Vehicle Control Unit (VCU).
- 5.4.6 Position of Driver's Brake Valves (DBVs): Independent and automatic brake valves combined into one module shall be fitted on control stands such that movement of handle is in vertical plane with 'push to apply'. Alternatively separate valves (Independent, Auto brake & Display units) may be offered. Loco Brake Cylinder (BC) Pressure in Kg/cm<sup>2</sup> is given as follows:

LOCO TYPE	Auto Brake Valve (A9) Application	Independent/Direct Brake (SA-9) Application
-----------	-----------------------------------	---

Prepared by	Checked by	Issued by
-------------	------------	-----------

	Emergency/Full Service BC pressure) kg/cm <sup>2</sup>	Application Time (sec)	Release Time (Sec)	Full Application (BC pressure) kg/cm <sup>2</sup>	Application time (sec)	Release Time (Sec)
WAG-9	2.50±0.1	18~24	45~60	3.50±0.20	8 sec (max)	10-15
WAP-7	2.50±0.1	6~9	15~20	3.50±0.20	8 sec (max)	10-15
WAP-5	5.15±0.30	3~5	15~20	5.15±0.30	8 sec (max)	10-15
Meaning of BC Application time: BC pressure filling time upto 95% of maximum BC pressure.						
Meaning of BC release time: BC pressure reduction time from Max BC pressure to 0.4 kg/cm <sup>2</sup>						

DBP Pressure = 3.5 Kg/cm<sup>2</sup> ± 0.2

#### 5.4.7 Loco Brake WAG-9, WAP-7 & WAP-5

The different pressure and timing within the loco should be managed by the software. In particularly one software version should be able to manage two different parameter settings one for Passenger set up and one for Freight set up.

5.4.8 It should be possible to release the locomotive auto brakes by the driver even when the partial or full service application brakes on trailing stock are made.

### 5.5 Assistant Loco Pilot's Emergency Brake Valve

In addition to the emergency brake application position on automatic brake valve, two Assistant Loco Pilot's emergency brake valves ( near each control stand) shall be provided for direct venting of brake pipe pressure during emergency by the driver/assistant driver. Venting shall be through a sufficiently large diameter opening in such a way that the Brake pipe pressure comes to atmosphere level in 1 to 3 seconds when the loco is tested separately. During emergency brake application by emergency brake valve or through driver's automatic brake valve, system should go on penalty and loco traction should cut off.

Microprocessor Controlled Brake System shall have sufficient safety provisions for acknowledgment of system penalty brakes, by the driver to prevent un-intended automatic release of brakes applied as a result of various penalties as above.

### 5.6 Distributor Valve

5.6.1 A pneumatic back up brake has to be provided, so that even in case of failure of the LRUs or because of power failure etc., brake will be applied in the locomotive. The backup protection is required also to ensure graduated application and release of brake in case the loco with micro-processor based air brake system is attached dead. If the Computer/Microprocessor Controlled Air brake system is with a distributor valve, it should be only of UIC approved type. However, if the offered system is without UIC type distributor valve, the application/release timings and other features of the system should be as per relevant UIC specification.

Prepared by	Checked by	Issued by
-------------	------------	-----------

5.6.2 The distributor valve shall have changeover device, either goods or passenger mode to obtain brake application and release timings to match with the train requirements.

### 5.7 Multiple Operation

5.7.1 A maximum of 2+1 (3,Three) locomotives shall be used in multiple operation. In such cases, multiple operations with all functions of brake system should be possible for all locomotives provided with computer/micro-processor controlled air brake system.

5.7.2 In case of parting between coupled locomotives, the brakes on the locomotives shall come on automatically. UIC type break-in-two protection should also be provided to bring the Traction to zero in all the locomotives through locomotive control microprocessor. There shall be complete isolation of DBP when parting between locomotives occurs.

5.7.3 When Brake Controller mode selector switch (L/T- switch) is in 'Normal ' position, it should be possible to apply & release brakes from Brake Valve Controller. When the switch is in 'Trail' position, brake valves should be inoperative. However, in trail position, it should be possible to apply emergency brakes. In Banker mode, it should be possible to operate the independent and emergency brake.

5.7.4 In case, in leading locomotive, both control stands are wrongly set in 'Trail' position, it should not get powered. For this purpose a suitable interlock should be provided with Vehicle Control Unit (VCU).

5.7.5 Provision shall be made for utilizing the compressor capacity of trailing locomotive for releasing the train brakes or during initial charging.

### 5.8 Overcharge Feature

5.8.1 Microprocessor based air brake system shall have an overcharge feature which gets activated, whenever the brake valve handle is held in Release position.

5.8.2 Operation of overcharge feature shall increase the brake pipe pressure by 0.5 kg/cm<sup>2</sup> over the normal level of 5.0 kg/cm<sup>2</sup> (in WAG9/WAP5/WAP7 Loco). The overcharge so created by this feature, should automatically be maintained till handle is placed in Release position. The rate of drop in brake pipe pressure with the removal of such overcharge should be at uniform and slow rate so as not to cause brake application on any of the vehicles in the train. The dissipation time of BP pressure from 5.5 to 5.0kg/cm<sup>2</sup> (in WAG9/WAP5/WAP7 Loco) is as per UIC standards.

5.8.3 During assimilation or bleeding down of overcharge pressure it should be possible to apply normal brake. However, when the normal brakes are released remaining overcharge cycle should be completed.

### 5.9 Interfaces with Regenerative Brake

5.9.1 When regenerative brakes are applied, locomotive brakes should be cut off, if brakes are applied through automatic brake valve. However, in case of emergency brake application by driver's brake valve or by Assistant Driver's emergency brake valve, the regenerative brakes should 'cut-off' and locomotive brakes

Prepared by	Checked by	Issued by
-------------	------------	-----------

should be applied. Auto BC bail off by driver should remain inactive during emergency application by any means.

5.9.2 In case train is being controlled by regenerative brake on locomotive and automatic brake on the trailing stock, if the regenerative brake fails, air brakes on locomotive should be automatically applied in proportion to the position of automatic brake handle.

5.9.3 The details of equipment along with description and principle of operation should be submitted.

5.9.4 ~~Rubber components such as diaphragm and 'O' rings etc. whenever used on brake system and their controls shall be entirely suitable for humid and hot environmental conditions of India. To be deleted as repeated in Para 4.14~~

5.9.5 Over hauling of the pneumatic valves should not be required before 06/08 years.

5.9.6 In case of failure of Computer/Microprocessor Controlled based air brake system on the locomotive, there should be provision for automatic back up by pneumatic brake system. The vendor shall give necessary details.

#### 5.10 Self-Test

The Computer/Microprocessor Controlled based air brake system should have self-diagnostic and display feature. There shall also be a facility for conducting self-test, as and when desired, in which the functioning of the brake system and its interface shall be checked thoroughly. In case the system does not pass the self-test, the nature of fault shall be displayed. In case of serious fault affecting safety, the locomotive should not be allowed to move unless the fault is rectified.

#### 5.11 Self-Diagnostic Feature

Microprocessor Controlled air brake system should have self-diagnostic & display feature. The display of fault should be such that it can be easily viewed by the crew, and will not require any opening of cover etc. It should also include fault diagnosis and display (Transparent protected window should be provided on brake system so that fault code is easily visible to the loco pilot). It should have real time diagnostics which can identify component failures, apply the train brake automatically if safety is compromised and provide trouble shooting information for facilitating repair/replacement. It should be possible to monitor as well as conduct on-board trouble shooting using computer/ laptop on fully charged and operational brake system on the locomotive. In case of proven system, an exception can be made with the approval of RDSO. The vendor will provide complete detail along with additional feature, if any.

5.12 There should be a provision of appropriate battery backup system or other arrangement so that time and date does not change in case of power failure or power off situation.

5.13 There should be an arrangement for electrical isolation of brake system, for carrying out any welding activity in the locomotive to safe guard against spike voltages. All the interface connector with VCU should be removable before carrying out any welding work on the locomotive.

Prepared by	Checked by	Issued by
-------------	------------	-----------



**5.14 Brake System Pressure and Brake Application/Release Timings.**

The brake system should be capable to maintain following pressure and brake release / application timings. Where timings are not given UIC standard timings can be taken to design brake system.

**5.15 Pressure specification.**

Pressure	Values
Main Reservoir pressure	8-10 kg/cm <sup>2</sup>
Brake Pipe pressure	5.0 <sub>-</sub> 0.1 kg/cm <sup>2</sup>
Feed pipe pressure	6.0 <sub>-</sub> 0.1 kg/cm <sup>2</sup>

**5.16 Standard Timings**

Application and release timings with automatic brake valve, shall be as per para 5.4.6 and BC timings to be recorded from handle movment.

**5.17 Pressure Gauges**

The following gauges shall be supplied as per following CLW drawings:

The gauges should be self-illuminated with L.E.D with flush mounting. All the pneumatic gauges shall be calibrated in 0.1 Kg/cm<sup>2</sup> pressure and least count should be 0.1 Kg/cm<sup>2</sup>. Following gauges are available in the driver cab to indicate air pressure level in various parts of the system.

- a) Main Reservoir MR pressure gauge.
- b) Feed Pipe FP pressure gauge.
- c) Brake Pipe BP pressure gauge.
- d) Airflow indicator gauge(digital indicator)
- e) Brake Cylinder BC pressure gauge
- f) Any other gauge which is required as per the system offered.

If the above gauges are not within the scope of supply of the vendor of Computer Controlled air brake system. It is the responsibility of the vendor of Computer Controlled air brake system to provide suitable pneumatic signals for the above gauges as per existing locomotive air piping diagram. Digital display in Analogue form for all the above mentioned pressures may be offered as an optional item.

**5.18 Air Flow Indicator/ Sensor**

5.18.1 Locomotive is provided with air flow indicating device (indicator gauge) to show air flow to the brake pipe.

5.18.2 It should indicate conditions of train-parting and Guard brake valve operation/Passenger Alarm chain pulling. The computer/ microprocessor controlled air brake system has to provide a pneumatic signal to the air flow sensor. It is the responsibility of the vendor of Computer/ microprocessor Controlled air brake system to provide suitable pneumatic signals for the above flow indicator as per existing locomotive air piping diagram.

Prepared by	Checked by	Issued by
-------------	------------	-----------

**5.19 Banking Operation**

- 5.19.1 The brake system shall have necessary provision for using these locomotives as banking locomotives
- 5.19.2 When locomotive is used for banking operation it should not be possible to apply/ release the train brakes from banking locomotive. It shall be possible to apply independent and emergency brake in banking locomotive.

**5.20 Dead Engine Feature**

While hauling a dead locomotive as a trailing locomotive (MU pipe connected), provision shall be made for application and release of brakes on this locomotive from the leading locomotive.

While hauling a dead locomotive as a piped vehicle (MU pipe not connected), provision shall be made for application and release of brakes with the help of distributor valve on this locomotive.

**5.21 Loss of Power Feature & OHE Failure**

When voltage supply feed to Computer/Microprocessor Controlled air brake system getting disrupted and in case of OHE power failure, there should be facility to apply brakes on train and locomotive through distributor valve or other LRUs/Gateway and for train through Brake Pipe pressure drop to emergency.

**5.22 Bail off Feature (Quick Release)**

Release of an Automatic locomotive brake while retaining the train brake cylinder pressure shall be possible by operating the bail off ring on the independent valve handle. Alternately bail off shall be possible through foot pedal operation. Auto BC (Brake cylinder pressure created through auto brake valve) bail off by driver should remain inactive during emergency application by any means.

**5.23 Compatibility with Distributed Power System**

- a) Purchaser has an option to install distributed power system on the locomotive in future. The computer/microprocessor controlled air brake system shall be compatible with Distributed Power System
- b) **Compatibility for EP-Assist System:** WAG9/WAP7/WAP5 locomotives which are fitted with computer/micro-processor controlled brake system shall have possibility to add EP assist in future for brake pipe control. In pneumatic brake systems using the Brake Pipe (BP) the brake signal is transmitted pneumatically. Requirements for the EP assist brake are to be incorporated as per UIC541-5OR in the existing computer/micro-processor controlled brake system.

**5.24 Interface with Locomotive Microprocessor/Control Electronics (VCU) and other warning systems:**

- 5.24.1 WAG9/WAP7/WAP5 Locomotives are fitted with computer/microprocessor controlled brake systems conforming to RDSO specification no. RDSO/EL/SPEC/2017/0126 (Latest revision) shall be interfaced with warning systems meant to provide protection by preventing trains to pass signal at Danger (RED),

Prepared by	Checked by	Issued by
-------------	------------	-----------



excessive speed over turnouts/ speed restrictions and to avoid situation in which more than one trains are on the same track to cause collision, in case operation are not able to control so. It also provides assistance to Loco Pilots by means of real-time display of signal aspects in Loco Pilots cab. It is the responsibility of the successful tenderer of Computer / Micro-processor controlled brake system to interface with KAVACH (TCAS)/TPWS/ACD and other warning systems from the locomotive microprocessor control system (VCU). The general interface requirements between the TCAS and other warnings systems will be as given below:

- Normal Braking (NB) application/release,
- Emergency Braking (EB) application,
- Full Service (FS) application/release
- Light Locomotive (LL) indication

Based on the real pressure feedback through pressure switched/Pressure transducers already in place and feedback can be extended to TCAS/TPWS/ACD from computer /microprocessor control brake system to VCU for BP, BC/DBP etc. in case of power breakdown. The control of locomotive brake application/release interfacing with any warning system shall be through Vehicle Control Unit (VCU) only.

**5.24.2** It is the responsibility of the successful tenderer of Microprocessor Controlled air brake system to kept provision for interface with locomotive microprocessor/Control Electronics (VCU) using RS485/Ethernet input/output electrical and communication serial interface, to facilitate interface using common protocol of Brake system – VCU communication for different make of VCU's, so that the brake system parameters i.e. A9/Electronic brake valve control pressure/ER, Brake Pipe (BP), Feed pipe (FP), Air flow & Brake Cylinder (BC) pressures, EBV Handle Positions etc. data should be continuous recorded with the VCU & shall be downloaded to facilitate post-accident investigations.

**5.24.3** Computer/Microprocessor Controlled based air Brake System should be capable of responding to Brake blending requirements to be controlled by VCU.

## **5.25 Interfacing with Piping and Wiring**

Interfacing with Piping and Wiring of the locomotive shall be responsibility of the vendor of Microprocessor Controlled air brake system.

Major overhauling of locomotives would be done in 9/12 years. However, Computer/Microprocessor Controlled air brake system should be capable of working for nine years without major overhauling.

## **5.26 Data/Fault Logging, Diagnostics, and Display**

The system shall have built in data logging, diagnostics and trouble shooting, including indication of fault status, analysis of the fault data and provision of necessary information to drivers/maintenance crew. For analysis of fault, the data (essential information for fault analysis) corresponding to the time of occurrence of faults as well as a few seconds before and after the event fault should be logged along with real times and date. The fault, with resolution of 1 second data pack of 8 snap shots (five prior to faults and 3 post faults) with 1 second mapping may be recorded in fault archive. This function may be executed by the air brake system either by itself or through Loco micro-processor control electronics (VCU) system by necessary exchange of fault data. This snap shot fault data shall remain active as long as fault log is active. It should

Prepared by	Checked by	Issued by
-------------	------------	-----------

be possible to retrieve all such data. All the logged faults must be chronologically recorded with real date and time of the occurrence of fault and should be immediately displayed. The fault detection and diagnostics should be of comprehensive nature to include all possible faults, including wiring/connector faults. The fault messaging text shall include the displayed message, fault code, description, real time and date and troubleshooting advice (wherever applicable). It should be possible to recall all details of active fault log. Till the fault(s) details are downloaded, the same shall be considered active fault log.

### 5.27 Download of Data

Suitable provision for downloading the data from the locomotive to a computer should be provided. The system should have arrangement for downloading of fault data pack and information pack through common USB port or a serial port so that data can be downloaded in a pen drives also either directly or through a Portable test Unit or laptop.

### 5.28 Software Change and Up gradation

Any software change as necessitated or felt during use must be proposed, mooted, tested and validated within 180/120 days. If this software change necessitates hardware change, it should be possible to do the same in situ. There should be provision for up gradation of software at different Brake cylinder pressures settings for freight/ goods locomotives with the assistance of Manufacturers. For this purpose a suitable simulator should be available by tenderer or its collaborator. There should be a provision in the brake panel for carrying out modification /setting of Auto Brake Cylinder pressure from 1.0 Kg/cm<sup>2</sup> to 2.5 Kg/cm<sup>2</sup> with minimum interval of 0.2 Kg/cm<sup>2</sup> by the OEM, as per the requirements by zonal Railways.

5.29 Change in performance, functionality and deviation(s) from scope, if any, of the proposed system shall be brought out clearly.

### 6.0 Additional Requirements of Brake System

In addition to the basic technical requirements given in Para 3, 4 & 5 with sub-paras, following additional features should also be incorporated in the Computer Controlled air brake system being offered:

#### 6.1 Multi-Resetting Vigilance Control Device

The Vigilance Control Device (VCD) feature is provided to enhance the safety of locomotive operation by ensuring alertness of the crew all the time. The system shall be of multi-resetting type i.e. acknowledgement of the system is not only by means of pressing reset push button but by the other normal driving activities (i.e. throttle handling, dynamic brake application, operation of sanders or application of brakes), of the driver during the train operation. This reduces the strain on the driver, as he is not required to press the reset push button always when operating other controls of the locomotive.

#### 6.2 Automatic Switching 'ON' of Flasher Light

6.2.1 Suitable signals to be made available to VCU by brake system for automatic switching 'ON' of as following:

Prepared by	Checked by	Issued by
-------------	------------	-----------

- 6.2.2 Flasher lights have been provided with on both the sides of electric locomotives to give indication of abnormal condition to driver of the train coming from other direction.
- 6.2.3 The flasher light will glow automatically in the direction of train movement in the following emergency / abnormal situations on the train.
- Parting of a train
  - Emergency brake application by ALP Emergency Valve
  - If Emergency stop push button is pressed
- 6.2.4 The flasher light would not glow automatically in the following condition
- Brake application and release by driver
  - Alarm Chain Pulling
- 6.2.5 In above conditions, the flasher should glow automatically and should not switch OFF due to brake application by the driver. Flasher light should continue to glow till such time above conditions remain on train or the driver switches it OFF manually by a separate reset switch to be provided by loco control system. ~~vendor of brake system~~. However the system should be such if power ON/OFF switch is in OFF position, even then flasher light should again glow automatically if above conditions reappear on train.

## 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 tenderer shall submit testing procedure, specification etc. brake system as a whole. The tenderer shall also indicate the maintenance facilities required for proper upkeep of the equipment. Offer should also include requirements of spares along with cost of each item for a period of 6 years. The cost of spares will also be given in the offer.
- 7.3 After the system is finalized, the tenderer shall submit copies of the instructional, maintenance and test specifications at the rate of one copy per two locomotive covering the following:
- Manuals 03 copies incorporating in detail the general description of the Brake System complete and individual valves/equipment along with operating features.
  - Assembly and disassembly instructions.
  - Trouble shooting instructions
  - Testing procedure / specification of whole brake system.
  - Overhauling kits of Valves
  - Overall dimensions and mounting details of individual items.
  - Particulars of cable entry points, if any.
  - Weight of various assemblies.
  - Lubrication chart, if any (equivalent indigenous lubricant may be indicated).

Prepared by	Checked by	Issued by
-------------	------------	-----------

## 8.0 Inspection, Testing and Approval

During the developmental stage, for proper control & monitoring, Railways will be the Controlling Agency. The supplier shall submit its offer of equipment to Railways along with all the details of equipment as per clause 7. 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 Railways at the manufacturer's premises. In general the inspection will be carried out according to IEC 60571/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 Railways 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 or equivalent international standard. These tests as per relevant clause of IEC-60571 shall be carried out for prototype only. A certificate (original) from NABL accredited testing laboratory shall be considered satisfactory for this purpose, if tested in India.
- 8.1.6 Vibration testing shall be done in accordance with clause 'A' category 1 of IEC-61373.

### 8.2 Inspection of fitment of the brake 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.

Prepared by	Checked by	Issued by
-------------	------------	-----------

8.2.2 The fitment aspect of the system will be checked on the locomotive by the representative of Railways 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 Railways 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 before according the prototype approval.~~  
To be deleted as Amendment-01 issued vide letter no. EL/3.2.19/3-Phase dated 21.04.2022.

### 8.3 Routine Inspection

Routine inspection as per Railways 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 further 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

Prepared by	Checked by	Issued by
-------------	------------	-----------

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 / Railways 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.

## 13.0 Quality Assurance Plan (QAP)

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

### 13.2 Revision of QAP

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

#### Note:

Prepared by	Checked by	Issued by
-------------	------------	-----------

Page 23 of 23	Issued on : <del>Feb 2017</del> Dec' 2022	Specification No. RDSO/2017/EL/SPEC/0126 Rev. '0'1
---------------	--	--

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 items 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 for as possible.

\*\*\*\*\*

DRAFT

Prepared by	Checked by	Issued by
-------------	------------	-----------