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Code of Practice for ECP braking

CODE OF PRACTICE

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Document Control

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Code Change Procedures

The RISSB maintains the master for this document and publishes the current version on the RISSB website.

Any changes to the content of this publication require the version number to be updated.

Changes to this publication must be approved according to the procedure for developing management system documents.

The RISSB will identify and communicate changes to this publication.

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2 Source Documents

AAR Manual of Standards and Recommended Practices

Section E-II - Electronically Controlled Braking System (revised August 2014) including the following:

S-4200: Electronically Controlled Pneumatic (ECP) Cable-Based Brake Systems - Performance Requirements

S-4210: ECP Cable-Based Brake System Cable, Connectors, and Junction Boxes - Performance Specification

S-4220: ECP Cable-Based Brake DC Power Supply - Performance Specification

S-4230: Intratrain Communication Specification for Cable-Based Freight Train Control Systems

S-4240: ECP Brake Equipment - Approval Procedure

S-4250: Performance Requirements for ITC-Controlled Cable-Based Distributed Power Systems

S-4260: ECP Brake and Wire Distributed Power Interoperability Test Procedures

S-4270: ECP Brake System Configuration Management

S-4286: Single-Car Test for Testing Electronically Controlled Pneumatic (ECP) Braking System - Design and Testing Performance Requirements

AAR Standard RP-505 Typical 26-L Type Brake Equipment Piping Diagrams for Locomotives

3 Glossary of Terms

AAR: Association of American Railroads.

Automatic Brake: A continuous Brake System for Trains that will automatically apply in the event of loss of Continuity (including Train separation).

Bogie: A structure incorporating suspension elements and fitted with wheels and axles, used to support rail vehicles at or near the ends and capable of rotation in the horizontal plane. Commonly referred to as a 'truck' in the AAR standards.

Brake Disc Pad: A Friction Element that is forced directly onto a brake disc for the purpose of braking.

Brake Pipe: The Automatic Air Brake System conduit that is installed throughout the length of a Train for delivering Brake System Energy and propagating Brake System control pressure signals.

Brake System: The braking equipment of a Vehicle or a Train.

Braking Energy: The energy to be dissipated from the Braking Surface.

Braking System Energy: The stored energy used for braking, which conventionally is compressed air.

Braking Surface: An equipment surface at which braking may be developed by friction.

Captive Unit Train Operations: Train operations where rakes of wagons do multiple return trips as a complete unit. These rakes of wagons are shunted infrequently and rarely travel outside a defined area of operation.

Car Control Device (CCD): An electronic control device that is part of the ECP brake control system, It replaces the function of the conventional pneumatic service and emergency portions during electronic braking and provides for electronically controlled Service and Emergency Applications.

Car ID Module: An electronic module that stores Vehicle-specific data such that the CCD always contains the correct characteristics, parameters and other information for the Vehicle or brake set on which it is placed.

Continuity: The continuous connection and the operability of the Brake System of a Train on all Vehicles from the front of the Train to its rear.

Control Pipe: The Locomotive Air Brake System conduit that conveys the pneumatic control signal for the Locomotive Independent Brake and for the Straight Air Brakes of connected hauled Vehicles.

Conventional Air Brake System: An Automatic Air Brake (non-ECP) configured in the manner of those generally in operation in the Pilbara (AAR style) and in Networks formerly owned by State railways.

Distributed Power: A system for control of Locomotive power distributed in a Train, which uses either a radio-based or a cable-based communication medium for the transmission of control signals between groups of locomotives.

Driver: A person with all required training, certification and competencies for driving a Train. Replaces the term "Engineer" in AAR standards.

Driving Diagnostics: Indicating system that provides information to the Driver in relation to the amount of Braking System Energy available.

Driving Supervisory System: Vehicle equipment designed to maintain safety in the event of Driver incapacitation, including vigilance control systems, operator enable (deadman) systems, on-board signaling systems and trip gear.

Dynamic (or Rheostatic or Regenerative) Brake: Braking equipment that enables a Train Driver to apply variable retardation by using traction motors to generate electrical energy that is dissipated on board or stored on board in an energy storage system or fed into the off-train supply system.

Electronic Air Brake (EAB): A term to describe Locomotive equipment that electronically controls the Locomotive Air Brake System and can also control the Conventional Air Brakes of connected Vehicles.

Electronically Controlled Pneumatic (ECP): A term to describe electronically controlled brake equipment of a type similar to that described in the AAR S-4200 standards.

Emergency Application: An Automatic Air Brake application that is propagated faster than a Service Application and produces an equal or higher rate of retardation than Service Applications

Emulator CCD: A CCD capable of emulating a pneumatic control valve while in a conventionally braked Train. Emulator CCDs should be capable of operating for a minimum of 48 hours.

End-of-Train (EOT) Device: A device connected to the Train Line at the end of Trains fitted with ECP brakes that contains a means of communicating with the HEU, a brake pipe pressure transducer and a battery.

Electro-pneumatic (EP): Air Brake equipment incorporating principal function control by electromagnetically operated valves but not electronically controlled in the manner of ECP brakes.

Equalising Reservoir: The Automatic Air Brake reservoir on self-propelled rolling stock that stores compressed air at a reference pressure that is replicated in the Brake Pipe for control purposes.

Freight Rolling Stock: Hauled rolling stock intended for transporting goods and materials.

Friction Element: A sacrificial pad or block that is forced onto a Braking Surface to develop a braking force by friction.

Function Check: Brake checking in the field to confirm the serviceability of the Brake System of a Vehicle or Vehicles.

Handbrake: A Park Brake operated by manual effort via a wheel or lever.

Head End Unit (HEU): A control device for the Brake System mounted within the Locomotive that provides the human/machine interface for operating the ECP Brake System.

Haul Test: A test involving the hauling of stationary braked rolling stock to assess the static coefficient of friction of the Friction Elements.

Holding Brake: In an ECP Brake System, the application of a predetermined braking effort for emergency purposes or for parking or securing a Train.

Independent Brake: A non-automatic Stopping Brake applied by compressed air.

Independent Release Pipe: The Locomotive Air Brake System conduit that conveys the Bail Off signal.

Intra-train: Within a Train.

Inter-vehicle: Between Vehicles.

Locomotive: An item of self-propelled rolling stock for hauling or propelling other rolling stock.

Main Reservoir: One or more interconnected compressed air reservoirs supplied directly by one or more air compressors as a primary source of stored energy for an Air Brake System and often for additional purposes.

Main Reservoir Equalising Pipe: The Air Brake System conduit of a Locomotive or Set that conveys stored energy for Air Brakes and auxiliary equipment between coupled Locomotives or Vehicles of a Set and, where applicable, for auxiliary equipment of connected hauled Vehicles.

Minimum Service Application: A preset value programmed into the HEU that shall be set at TBC=10%.

Net Braking Ratio (NBR): The quotient of the sum of the actual braking forces (net of brake rigging frictional losses) referred as normal forces at the wheel treads of a Vehicle, and its weight.

Network: A railway system under the control of one or more Track Managers to which any prospective Operator must apply for track access.

Operational Diagnostics: The built in diagnosis of the condition of the Train that determines the sequence of vehicles and other operational conditions that may require automatic intervention by the Brake System controls.

Operator: The entity responsible by reason of ownership, control or management, for the provision, maintenance or operation of Trains, or a combination of these, or a person or body acting on its behalf.

Overbraking: Exceeding the available adhesion between wheel and rail during braking and causing wheel slide.

Overlay Brake System: A Brake System capable of operation in either a conventionally or electronically braked Train.

Park (or Parking) Brake: Braking equipment arranged to enable an individual Vehicle to be secured at rest without reliance upon the Stopping Brake.

Passenger Rolling Stock: Hauled or self-propelled rolling stock intended for the transportation of passengers or for use specifically on passenger Trains.

Powered Park Brake: A Park Brake that can be remotely applied or released by a Train Driver.

Pneumatic Backup: A system required on each vehicle to apply emergency brake cylinder pressure in the event of a vented brake pipe which also assists in propagating pneumatic signals through the brake pipe.

Regulator: A government body responsible for ensuring compliance with particular laws, acts, regulations etc., e.g. rail safety Regulator.

Service Application: A Brake application made on Driver demand, propagated at a pre-determined normal rate resulting in a normal Driver-selected rate of retardation.

Service Braking: Normal manipulation of the Brake during Train running.

Set: More than one Vehicle coupled for operation together (as for iinfrastructure mmaintenance vehicles or coal or mineral wagons).

Shall: The word "shall" indicates that a statement is mandatory for the Vehicles or Trains to which it is applicable.

Should: The word "should" indicates that a statement is a recommendation for the Vehicles or Trains to which it is applicable.

Single Car Test (SCT): Brake testing performed to confirm the correct operation of the Brake System of a Vehicle or Set of Vehicles fitted with a single set of brake control equipment.

Spring Park Brake: A Park Brake that is applied by spring force and released by compressed air or hydraulic force.

Stand Alone Brake: A Vehicle Brake System that cannot operate in a conventional pneumatically braked Train and must operate only in ECP equipped Trains.

Standard Brake Pipe Pressure: The Network specified maximum Brake Pipe Pressure to which an Automatic Air Brake is to be initially charged for normal Train operation.

Straight Air Brake: A braking system on Vehicles where the air is supplied 'straight' to the brake cylinders. For example the locomotive independent brake is a straight air brake.

State based Networks: The rail Networks formerly owned by government railways which form the bulk of the interstate and intrastate Networks in Australia.

Track Manager: The person or body responsible by reason of ownership, control or management, for the construction and maintenance of track, civil and electric traction infrastructure, or the construction, operation or maintenance of train control and communication systems, or a combination of these; or a person or body acting on its behalf.

Train Brake Commands (TBC): The level of brake application for electronically controlled Brake Systems expressed as a percentage from 0% to 100% of full Service Braking force.

Train Line: The Train Line is a two-conductor electric cable spanning the Train that carries both Train Line power (to operate all CCDs and EOT devices) and the communications network signals between the Locomotive(s) and the Vehicles on the Train.

Vehicle: A means of transportation or, specifically, an item of rolling stock (e.g. a Locomotive, a carriage or a wagon. The term wagon replaces 'car' in the AAR standards).

WDP: Wired (cable-based) Distributed Power, for control of Locomotives distributed in a Train, as per AAR Standard S-4250 Clause 3.0.

4 Purpose

This Code of Practice describes recommended practices for the configuration and operation of Trains that are fitted with Electronically Controlled Pneumatic (ECP) Brake for use in the Australian rail industry. Except as nominated, the practices described in this document are typically mandatory for all Trains.

The recommendations are also intended to underpin the interoperability and interchangeability of Locomotives and wagons provided by lessors and other Operators. A further purpose is to cover the requirements of the emergency recovery of Trains or procedures where additional rolling stock has been leased by the Operator.

5 Scope

This Code of Practice is applicable to locomotive hauled Trains that are equipped with ECP brakes and that are to operate in a Network. Passenger Trains that operate in dedicated consists and Trains operated on light rail, cane railways and monorail networks are not covered.

The practices described are recommended but not mandatory for Captive Unit Train operations or for operations where rolling stock operators, Vehicles or Locomotives do not interchange across functional boundaries.

The primary focus of this Code of Practice does not include the use of Distributed Power in Captive Unit Train operations typical for large mining companies. The use of this equipment is discussed in this document, but the content of this Code has no mandatory rulings in relation to this technology when operated on a private Network.

6 Brake System basic requirements

6.1 Stopping Distance Performance

Braking performance including stopping distance performance of a Train shall be compatible with the performance requirements of the Network in which the Train is to operate. The Brake System shall have the capacity to absorb and dissipate the Braking Energy input without damage or a reduction in braking performance below the required Network stopping distance requirements.

Network Access Providers may specify the maximum stopping distances for various classes of Train or Set and Operators shall observe such requirements.

6.2 Automatic Response

In the event of Train separation, the Brake System of a Train shall detect the separation and respond by interrupting traction power and applying an emergency application of the ECP Train Brake. An emergency application of the Pneumatic Backup brake shall also occur.

6.3 Intra-train compatibility

The Brake System on each of the Vehicles making up the Train shall be compatible with the braking instructions from the Driver and with any other systems that may request brake applications.

Where ECP brake equipment from more than one brake manufacturer is operated on the Train, all braking equipment shall be compatible. The Interoperability Test Procedures for these Trains shall be consistent with the relevant scope of AAR Standard S-4260.

All Locomotives in an ECP Train shall be fitted with two Brake Pipe vent valves, one at each end, as shown in AAR Recommended Practice RP-505 to ensure the propagation of the Pneumatic Backup emergency signal in the Brake Pipe.

6.4 Inter-vehicle compatibility

The Brake System shall be designed to allow the brakes of a Vehicle or Train to be released and applied from an attached Locomotive or other driven Vehicle.

For loaded Trains, any commanded brake percentage shall result in a consistent response on individual Vehicles so that each Vehicle achieves the same deceleration rate as the train when on level tangent track thereby minimising intra-train longitudinal forces.

For empty Trains, the commanded full service brake percentage shall result in a consistent response so that each Vehicle achieves the same deceleration rate as the train when on level tangent track thereby minimising intra-train longitudinal forces.

Empty/Load devices (where fitted) with a progressive rise in brake cylinder pressure across the full range of commanded brake percentage are preferred to limiting types which increase brake cylinder pressure as for a loaded Vehicle up to the empty limit pressure.

The braking level delivered should be consistent with the requirements for the adjustment of brake cylinder pressure to Train Brake Command percentage in AAR Standard S-4200.

Vehicle reservoirs shall be charged from the Brake Pipe via a 1.6mm choke when operating on State based Networks. Private Networks should follow the reservoir charging requirements of AAR S-4200.

6.5 Driving Diagnostics

The features and functions of the cab screen display shall comply with the requirements of the current version of AAR Standard S-4200 which requires the following features.

1. A means of indicating the amount of Brake System Energy available to the Driver. The usual means is by the incorporation of instruments registering Main Reservoir pressure, Brake Pipe pressure and Brake Pipe air flow.
2. A means of warning the Driver when there is insufficient Brake System Energy available.
3. A defined system for detecting and responding to various component and system faults.
4. The Fault Response and Recovery Functions should prioritise faults into a hierarchy of fault severity that results in recovery responses that range from an immediate emergency brake application to logging a minor fault for display on system diagnostic screens.

6.6 Operational Diagnostics

These features are described in the current version of AAR Standard S-4200 and the ECP Brake System should incorporate:

1. A means for Brake System initialisation to evaluate Train conditions.
2. A means to establish the identity of all network devices in the Train communications network.
3. A means for in-service diagnostic and fault detection and periodic query of operating status.
4. The ability to sequence the Train to determine relative position and orientation of each Vehicle in the Train.

6.7 Crosstalk

Crosstalk is the unwanted coupling of ECP communications between two adjacent Trains and has been experienced across Networks once the density of ECP train operations increases.

The mitigation for crosstalk has been to update the communication protocols so that each Train has unique network addresses for HEUs, CCDs, PSCs and EOTs.

All ECP installations shall have their software updated to provide for unique network addresses.

7 Automatic Brake Control System

7.1 General

Every Train in operation shall be equipped with an Automatic Brake that has Continuity and provides consistent, repeatable brake performance during Train running.

Every ECP equipped Train shall have electrical Continuity supporting an Automatic Brake function and a Pneumatic Back-up brake which has pneumatic Continuity.

The ECP Train Brake System provides continuous communications along the Train that will automatically apply the Train brakes in the event of loss of Continuity (including Train or Set separation).

The Train Line is a two-conductor electric cable spanning the Train that carries both power (to operate all CCDs and EOT devices) and communications network signals between the Locomotive(s) and the Vehicles using a common and established communications protocol.

The Train Line shall be continuous from the hauling Locomotive(s) to the rear of Train and a compatible EOT device shall be fitted at the rear of Train to ensure integrity of the networked signal.

The Automatic Brake control system shall provide for graduated application of the Automatic Brake and direct release when a Train has Vehicles not equipped with ECP brake.

The Automatic Brake control system used on Vehicles fitted with ECP brakes shall provide for graduated application and graduated release of the Automatic Brake when coupled in a train completely made up of compatible ECP equipped Vehicles.

On new locomotives: The same locomotive brake control handle shall be used for both Pneumatic and ECP brake applications. This shall not reduce any of the functional requirements of AAR S-4200 or this code of practice for the application and release of ECP brake applications.

When retrofitting ECP to existing locomotives: Converting an existing locomotive fitted with only pneumatic brake controls, it shall be permissible to provide a separate ECP brake control device for the Driver to operate the Automatic Brake.

7.2 Brake System and Control

The installation of an ECP Brake System on a Locomotive or Train should be in conformance with the current requirements of the AAR Manual of Standards and Recommended Practices, Section E-II and this Code of Practice.

Where appropriate, ECP electrical installations shall comply with AS 3000 and ECP cable selection shall comply with AS 3008. Where appropriate, approval and testing of ECP electrical installations shall comply with AS 3100. Compliance with internationally recognised electrical standards shall be permissible in lieu of Australian standards.

An End-of-Train Device is required on all Trains to allow initialisation and ensure the Continuity from the front to the rear of the Train. A trailing locomotive may function as an EOT device.

7.3 Inter-train compatibility of braking systems for Trains

7.3.1 Vehicles carrying out multiple trips on a Network

Communications Protocol for all Trains that are fitted with an ECP Brake System may comply with the current version of AAR Standard S-4230.

Where a communications protocol other than one fully compatible with S-4230 is used, the entire train will use compatible versions of the alternate protocol and a single communications adapter shall be used to communicate with locomotives equipped to S-4230.

Where rolling stock owned by more than one operator is present on an ECP equipped Train, all Operators shall be able to demonstrate that the ECP systems used on their rolling stock are fully functional with the other ECP system equipment present in the Train before the train enters the Network.

Compatibility shall be demonstrated by prior testing to the current standards (i.e. industry, RISSB or AAR S-4260 as relevant) when the Vehicles are tested during commissioning using train testing procedures provided by the brake equipment manufacturer/s prior to entering service. Such demonstration includes the Operator maintaining records of the knowledge and control of software functionality for all software and hardware versions fitted to an Operator's vehicles by the ECP brake equipment suppliers whether the Vehicles be owned or leased.

The Trains shall be tested to validate brake system performance in the largest train configurations that are to be operated.

Compatibility testing for ECP and WDP operations shall include the following tests listed in sections 3 and of AAR S-4260:

3.0 ECP Operation

- 3.1 ECP Setup
  - 3.1.1 ECP System Operating Modes
- 3.2 RUN Mode Operation
  - 3.2.1 ECP Initialization
  - 3.2.2 Train Sequencing
  - 3.2.3 Brake Control
  - 3.2.4 Train Empty/Load Command
  - 3.2.5 Individual CCD Empty/Load Command
  - 3.2.6 Trainline Power Control
- 3.3 SWITCH Mode Operation
  - 3.3.1 Train Empty/Load Command—SWITCH Mode
- 3.4 END ECP Operation
  - 3.4.1 Cutout/END ECP
  - 3.4.2 Individual CCD CUT-OUT and CUT-IN Commands
  - 3.4.3 CCD Isolated Critical Loss CUT-OUT
- 3.5 Fault Response and Recovery
  - 3.5.1 Loss of EOT Beacon—RUN Mode
  - 3.5.2 Low Brake Pipe Pressure (BPP)
  - 3.5.3 System Critical Loss
  - 3.5.4 Reduced Percentage of Operative Brakes
  - 3.5.5 Low Trainline Voltage
  - 3.5.6 High Trainline Voltage
  - 3.5.7 EOT Low Battery Charge—RUN Mode
  - 3.5.8 HEU Receives CCD Incorrect BCP Exception
  - 3.5.9 Multiple Lead HEUs in Network
- 3.6 ECP System Diagnostic Tests
- 3.7 Locomotive ECP Equipment as the EOT

4.0 WDP Mode

- 4.8.7 Throttle Step Miscompare
- 4.8.9 Brake Valve Mode Miscompare
- 4.8.10 Critical WDP System Failure
- 4.8.11 WDP Unit Status Invalid
- 4.8.14 Wheel Slip
- 4.8.15 Dynamic Brake Warning
- 4.8.16 Unit Alarm Bell
- 4.8.17 Manual Sanding

Operators should be prepared to demonstrate that the Brake Pipe settings and Vehicle brake characteristics conform to the requirements described in Section 7.4 below for trains on the State based Networks.

Where Vehicles with an Overlay Brake System are operated in a Train, Operators should be prepared to demonstrate that Service Brake applications of the electronic brake on a wagon do not actuate the pneumatic brakes on this or adjacent wagons by causing a localised drop in Brake Pipe Pressure, and that any resultant risk of dragging brakes is managed.

For Vehicles fitted with an Emulator CCD, Operators should be prepared to demonstrate that the communications protocols and functionality of the Vehicles are compatible with the other equipment used in Trains when operated on a Network.

7.3.2 Vehicles carrying out a single transit of a Network

Where a Vehicle does not conform to the standard communication protocol under the conditions described above, and is required to transit once over a Network, the Operator should demonstrate that either:

1. ECP brake settings, software and hardware control are in place that establish that the systems used are fully compatible with other ECP traffic operating on the Network; or
2. Sufficient safety control is in place to ensure the Train can transit the Network without safety or reliability issues and that appropriate first response and Train rescue preparations have been put in place.

7.4 Inter-train compatibility and intra-train compatibility

Where Locomotives, Vehicles or Vehicle types are changed on a Train, or Vehicles are changed between Trains, the application of standard settings or operating rules reduces delays or faults in traffic. The items below have been identified as components or settings that affect compatibility:

1. Brake Pipe pressure of 500 kPa (+3 kPa, -10 kPa) for operation on the State based Networks. On isolated Networks the Brake Pipe pressure used in AAR S-4200 and S-401 is used.

2. Locomotives should be configured such that Adjustment of the brake pipe pressure shall only be available through maintenance screens. The driver shall not have access to adjust the brake pipe pressure under normal operating conditions.
3. Maximum brake cylinder pressure for full service is nominally 350kPa on the State based Networks which, for the typical configuration of Australian freight wagons, is the fully equalised brake cylinder pressure for 500kPa Brake Pipe Pressure.
4. Minimum service Brake Cylinder pressure shall be 10.0% of full service in response to a TBC of 10%. Full service provides 100% brake cylinder pressure of 350 kPa for a 500 kPa Brake Pipe Pressure on State based Networks. Therefore, for a minimum brake application 10% is equal to 35 kPa brake cylinder pressure. The equipment supplier shall be able to adjust the minimum service Brake Cylinder pressure on a Vehicle through the CCD using static data. Design of the brake system must ensure a minimum service brake application shall be sufficient for the brake blocks to come in full contact with the wheels.
5. Vehicle brake cylinder fill and exhaust rates - as per AAR Standard S-4200 for operation as an ECP train. When operating in emulation mode the brake cylinder fill and exhaust times should match the wagons forming the majority of the Train.
6. Emergency application - The propagation rate shall be as per AAR S-4200 and AAR S-401 and emergency brake cylinder pressure shall be 15-20% higher than the full service pressure.
7. The loaded Net Brake Ratio (NBR) shall be between 11% and 14% at the full service pressure of 350 kPa for vehicles on the State based Networks. Isolated Networks use the full service pressure in AAR S-401.
8. The empty Net Brake Ratio (NBR) shall not be greater than 28% at the tare full service pressure for vehicles on the State based Networks.
9. Load Compensation operation - Load sensing is automatic on State based Networks and may be Driver initiated on private Networks but neither system can operate effectively on the same Train. Different manufacturers apply the variable pressures using different sets of criteria and standardisation of technology could provide some benefit. Load compensation that is proportional to Vehicle mass from tare to gross when increasing and decreasing is preferred.
10. The ECP braking levels on State based Networks shall always be set to loaded and shall not provide for adjustment of braking levels to Vehicle loading via the HEU. Isolated Networks may use the HEU to set empty and loaded status in the Train.

8 Brake System Couplings between Vehicles

Continuity of the ECP Brake of a Train shall be achieved by means of Train Line couplings between Vehicles.

Where the coupling used is not able to physically couple to the AAR Standard S-4210 coupling, adapter cables may be used. Train Line couplings should be compatible within a Train of ECP equipped rolling stock.

The connectors shall be designed to connect securely but part without damage in the event of Train separation.

Brake System couplings between Vehicles shall be arranged to avoid damage to or kinking of flexible hoses or cables from movement or from falling objects.

Locomotives for use on the State based Networks shall be fitted with Brake System couplings or cables that are compatible with those of all other rolling stock in use on that Network, either directly or by use of an adapter coupling.

9 In-service Static Brake Test for Trains with ECP brakes

A Static Brake Test shall be conducted prior to the departure of an ECP braked Train from its point of origin, just as for conventionally braked Trains. An in-service Static Brake Test conducted on a Train shall establish whether its Brake System will function and perform as specified when placed in service.

The Driver can verify the number and sequence of Vehicles on the Train and the status of their CCDs. Refer AAR Standard S-4200 for the procedure to sequence Train and the procedure for seeing the status of ECP equipment in the train.

Set Up and Initialisation of the ECP system is to be carried out prior to entering RUN mode. Refer 4.2.3 of AAR Standard S-4200 for the procedure for registering network devices and Train conditions.

An End-of-Train Device is required on all Trains to allow initialisation and ensure Train and Brake Pipe Continuity.

A Static Brake Type Test shall be carried out for each new Train configuration with the full number of Locomotives proposed for the configuration and a representative number of wagons.

10 Static Brake Test of Vehicles fitted with ECP brakes

A Static Brake Test should be carried out for a Vehicle passing through a maintenance location where work has been carried out on the Vehicle Brake System. The purpose of the Static Brake Test is to verify the Vehicle Brake System is operating correctly.

The work that has been carried out to the Vehicle could range from replacing an air hose coupling or tightening a pipe union to replacing the main Car Control Device of the Vehicle ECP system. A further issue that may be encountered in Australian mineral Train applications is that the wagon being worked on may be one Vehicle in a set of up to four rigidly coupled wagons.

Staff conducting automated single car testing shall have a suitable level of electrical safety training and understanding of the electrical aspects of the ECP system before conducting tests.

There are two levels of Static Brake Test that can be used to verify Vehicle performance:

1. A single car test in accordance with AAR Standard S-4286 shall be used to test the brakes on a single wagon after repairs have been carried out to the brake control system on that wagon. If a standard AAR ECP single car test device is used the brake pipe length of the vehicle set shall be reduced to that of the Vehicle on which the CCD is

located unless the operating software of the tester has been calibrated for the full vehicle length. The minimum sequence of tests shall be equivalent to those in section 3 of AAR S-4286 and special tests may be conducted equivalent to section 4 or AAR S4286. The SCT device shall be calibrated annually equivalent to section 5 of AAR S-4286.

2. A Multi Vehicle tester or Unit Train Maintenance (UTM) Tester should be used to test 'packs' of between 2 and 4 cars after the Vehicles have passed through workshops or after minor brake related repairs have been carried out. The UTM Tester shall have different testing software in which HEU communication is sent out to the number of CCDs present in the set of Vehicles being tested.

The multi Vehicle tester comprises an ECP single car brake tester that has been set up to test multiple Vehicles with shared equipment. For this test, the focus is on testing ECP brake functionality as distinct from the full ECP Control Device Test that would be used if ECP control equipment had been replaced or if a specific ECP functional fault was being investigated.

10 Ending ECP Operation

When ending ECP operation, the Driver shall end ECP operation and change to conventional pneumatic brake control.

When the Driver enters the End ECP command, all CCDs in the Train will cut out, stop responding to ECP brake commands and release the Vehicle brakes. The only Train brake that remains operational is the CCD pneumatic back up brake which will commence release of the Train brakes if the Brake Pipe is charged to higher than the brake cylinder pressure and apply only if the Brake Pipe is vented.

Where the Train or rake of wagons is to be stowed, the handbrakes must be applied or other procedures followed to secure the Train in accordance with Rail Operator's instructions.

When selecting ECP cut-out the ECP system shall require the driver to confirm such an operation by acknowledging a confirmation message, the confirmation message shall state:

1. That confirmation of this action will cut-out ECP
2. That such an action will result in a pneumatic emergency application
3. That such an action will result in loss of service brakes on ECP wagons, unless these Vehicles are converted to Emulation mode.

These three items may be incorporated into one confirmation message.

In order to prevent inadvertent confirmation of the cut-out of ECP, the confirmation message(s) shall be acknowledged through a different selection key than that used to select cut-out from the setup menu. This is to prevent accidental double-tapping of the same selection key.

Prior to initiating cut-out of the ECP braking system, the system shall ensure that the following actions have taken place:

a. The driver has placed the service brake handle into the full service position, and
b. EOT device brake pipe pressure shall reach a full service level.

When these requirements are fulfilled, the ECP braking system shall initiate the requested end ECP operation. Prior to finalising cut-out of ECP, the ECP system shall initiate a pneumatic emergency application throughout the train.

11 Emergency Feature

Both Locomotives and Vehicles shall be fitted with Air Brake equipment that responds to and propagates a rapid drop in Brake Pipe Pressure occurring at any location in the Train.

This is usually achieved by locally venting the Brake Pipe, ensuring a drop in Brake Pipe Pressure at an emergency rate and resulting in removal of traction and dynamic braking and an emergency brake application. This rapid reduction in Brake Pipe Pressure and removal of tractive power can assist the identification of a loss of Train Brake Pipe Continuity.

The rapid reduction in Brake Pipe Pressure can also improve the retardation rate of distributed power Trains in the event of a failure in the control logic using either an ECP Train Line or radio based Locomotive distributed power.

This function can be provided on hauled vehicles by the arrangement of emergency portions and vent valves in the AAR Manual of Standards and Recommended Practices Section E Brakes and Brake Equipment Valves, Specification S-401 as referenced by AAR S-4200.

Locomotives hauling ECP Trains and hauling non-ECP Trains fitted with AAR emergency portions shall be fitted with two Brake Pipe vent valves as shown in AAR Recommended Practice RP-505 to ensure the propagation of the Pneumatic Backup emergency signal.

12 Distributed Power

The Scope of this Code of Practice includes recommended practices for configuring and operating of Trains fitted with both ECP brake and distributed Locomotive power capability. The control system for Distributed Power uses the allocated bandwidth on the ECP Train Line. The brake control and WDP systems shall be capable of simultaneous operation without degrading the operation and response of either system.

Performance Requirements for all Trains that operate on the State based Networks and are fitted with an ECP Brake System and WDP shall comply with the current version of AAR Standard S-4250. The Interoperability Test Procedures for these Trains should comply with AAR Standard S-4260.

Performance Requirements for all Trains that operate on isolated Networks and are fitted with an ECP Brake System and WDP should comply with the current version of AAR Standard S-4250. The Interoperability Test Procedures for these Trains should comply with AAR Standard S-4260.

A End of Vehicle connection locations

Locations for standard gauge wagons on State based Networks are to be nominally in accordance with section 9 of AAR MRSP standard S-4210 as relevant to the wagon structure and the requirements of the Rail Infrastructure Manager.

Locations for narrow gauge State based Networks are to be in accordance with section 9 of the requirements from AAR MRSP standard S-4210 as relevant to the wagon structure and the requirements of the Rail Infrastructure Manager.

Locations for private Networks are to be in accordance with section 9 of the requirements from AAR MRSP standard S-4210 as relevant to the wagon structure and the requirements of the Rail Infrastructure Manager.

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