

## VACUUM BRAKES

### Vacuum Brakes – Lancashire and Yorkshire Railway

The Lancashire and Yorkshire Railway, chose to use vacuum brakes on all of its electric multiple units. Similar systems were used for both the Liverpool area units and the Manchester – Bury units.

These differed from normal vacuum brakes in having an exhaustor controlled by a pressure switch and additional vacuum reservoirs to speed up release. When the driver's brake handle was in the RELEASE position the exhaustors would start if the vacuum was 18 in Hg or less and cut out when it reached 22 in Hg. This system is not supported in OpenRails and a standard vacuum brake system is used.

### Vacuum Brakes – Midland Railway

The vehicles used on the Lancaster, Morecambe and Heysham route used the vacuum brake of the standard variety with two speed exhaustors.

### Vacuum Brakes – Metropolitan Railway

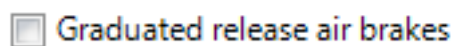
During the 1920s the Metropolitan Railway constructed a small number of motor cars fitted vacuum brakes and screw couplings for use with converted steam stock. By the end of the 1930s all had been converted to Westinghouse brake operation.

## AIR BRAKES

### Westinghouse Air Brakes

The Westinghouse air brake was the standard brake used by most railway companies for electric multiple units during the first half of the twentieth century. As fitted to electric multiple units the brake was slightly different to that used on locomotive hauled stock. In addition to the train pipe there was also a main reservoir pipe. The main reservoir pipe connected together the main reservoirs of the motor cars, but did not provide air to the auxiliary reservoirs so was not a twin pipe system in the modern sense. In OpenRails this is treated as "Air\_Single\_Pipe".

The Westinghouse brake did not offer graduated release and before driving trains with the Westinghouse brake make sure that the "Graduated release air brakes" box on the OpenRails options tab is not checked:



The positions provided on the driver's brake handle were as follows:

RELEASE – This position connected the train pipe to the main reservoir, producing a rapid rise in pressure. Leaving the handle in this position would allow the train pipe to rise above the regulation 70 psi, hence this position was used only briefly prior to departure to ensure that all triple valves were set to 'Release'. Instructions to drivers included *"the brake valve handle must never be left in the release position long enough to charge the train pipe and auxiliary reservoirs beyond the regulation pressure"*

RUNNING – This maintains the train pipe at 70 psi. The handle should always be in this position when the train is running.

LAP – This position is used to hold a particular pressure when make a brake application.

APPLY – Allows the air pressure in the train pipe to be reduced. When the pressure in the brake pipe was sufficiently reduced, this reduction could be held by moving the handle back to the lap position.

EMERGENCY – Gives the fastest possible application of the brake.

In OpenRails this type of brake valve can be represented as follows:

```
Brake_Train ( 0 1 0.01 0.50
NumNotches ( 5
Notch( 0.00 0 TrainBrakesControllerFullQuickReleaseStart ) Comment ( RELEASE )
Notch( 0.25 0 TrainBrakesControllerReleaseStart ) Comment ( RUNNING )
Notch( 0.50 0 TrainBrakesControllerHoldStart ) Comment ( LAP )
Notch( 0.75 0 TrainBrakesControllerFullServiceStart ) Comment ( APPLY )
Notch( 1.00 0 TrainBrakesControllerEmergencyStart ) ) )
```

## **Instructions for the use of the Westinghouse Brake**

### **SERVICE APPLICATION**

To apply the brake with moderate force, the handle of the brake valve must be moved beyond the LAP POSITION towards that for ORDINARY APPLICATIONS, and a reduction of pressure made of not less than 5 lbs., after which the handle must be placed in the LAP POSITION.

*(The Southern Railway instructed drivers “not to make a brake application of less than 15 pounds in the case of trains of more than 8 cars or less than 10 pounds in the case of trains of 8 cars or less.”)*

When the brakes have been put in operation, very small reductions of pressure in the train pipe will serve to gradually increase the brake power, as circumstances may require. The brakes are fully applied when a reduction of 25 lbs. has been effected in the train pipe pressure, and it would be useless to discharge any further quantity of air except for emergency applications.

### **EMERGENCY APPLICATION**

For quick stops in emergency the brake valve handle must be turned as far to the right as possible to EMERGENCY POSITION and left there.

### **STOPPING THE TRAIN**

It should be remembered that less brake force is required for stopping from a low than from a high speed, and the brakes should not be so forcibly applied as to skid the wheels, which is less effective in stopping.

After the train has been brought under control and before it comes to rest, in order to prevent the jerk which is often experienced at this moment, the brake valve handle may be put in the RELEASE

POSITION until the train comes to a stand, and then be immediately brought back to the RUNNING POSITION.

## RELEASE OF THE BRAKES

In releasing the brakes, the brake valve handle should be put momentarily into the RELEASE POSITION in order to reverse the triple valves, but brought back at once to the RUNNING POSITION in which position the pressure in the train pipe and auxiliary reservoirs will be restored to the authorised maximum through the feed valve, without any danger of creating a pressure higher than that authorised.

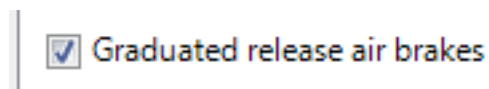
### Christensen Air Brake

As far as I have been able to ascertain, the Christensen brake worked in a similar way to the Westinghouse brake and the OpenRails model would be the same.

## ELECTRO-PNEUMATIC BRAKES

Electro-pneumatic ( EP ) brakes began to be used on the London Underground from about 1930, were used by the LNER and LMS from 1937/8 and have been standard on British Railways electric multiple units since 1950.

All forms of electro-pneumatic brake allow graduated release, before driving trains with electro-pneumatic brakes make sure that the “Graduated release air brakes” box on the OpenRails options tab is checked:



### Electro-Pneumatic Brake – Type A

The earliest type of electro-pneumatic brake was not self lapping. Like the Westinghouse air brake the brake handle was moved to ‘EP apply’ and then returned to ‘EP Hold’.

The positions provided on the driver’s brake handle were as follows:

- I. RELEASE AND RUNNING
- II. HOLDING EP
- III. APPLY EP
- IV. LAP AIR
- V. APPLY AIR
- VI. EMERGENCY

The ‘air brake’ positions operated in the same way as the Westinghouse brake and were intended as a back up if the electro-pneumatic system failed. In normal service only the Running/Release, Holding EP and Apply EP positions would be used.

In OpenRails this type of brake can be represented as:

Brake\_Train ( 0 1 0.05 0.1  
NumNotches ( 6

```
Notch ( 0 0 TrainBrakesControllerReleaseStart ) Comment ( RUNNING )
Notch ( 0.1 0 TrainBrakesControllerEPHoldStart ) Comment ( HOLDING EP )
Notch ( 0.2 0 TrainBrakesControllerEPFullServiceStart ) Comment ( APPLY EP )
Notch ( 0.7 0 TrainBrakesControllerHoldStart ) Comment ( LAP AIR )
Notch ( 0.8 0 TrainBrakesControllerFullServiceStart ) Comment ( APPLY AIR )
Notch ( 0.9 0 TrainBrakesControllerEmergencyStart ) ) )
```

### **Electro-Pneumatic Brake – Type C**

Later electro-pneumatic brakes were self lapping. These can be represented in OpenRails as:

```
Brake_Train ( 0 1 0.05 0.15
NumNotches ( 5
Notch ( 0.0 0 TrainBrakesControllerReleaseStart )
Notch ( 0.1 1 TrainBrakesControllerEPApplyStart )
Notch ( 0.7 0 TrainBrakesControllerHoldStart )
Notch ( 0.8 0 TrainBrakesControllerFullServiceStart )
Notch ( 0.9 0 TrainBrakesControllerEmergencyStart ) ) )
```

Use of the this type of EP brake is explained in this [video clip](#).

### **3-step Electro-Pneumatic Brake**

Modern electro-pneumatic brakes no longer have a train air pipe and rely entirely upon electrical signals to operate the brakes. The ‘3-step’ brake is commonly used on British multiple units.

A three step brake can be represented in OpenRails as:

```
Brake_Train ( 0 1 0.01 0.26
NumNotches ( 5
Notch( 0.00 0 TrainBrakesControllerReleaseStart )
Notch( 0.26 0 TrainBrakesControllerEPApplyStart )
Notch( 0.55 0 TrainBrakesControllerEPApplyStart )
Notch( 0.90 0 TrainBrakesControllerEPApplyStart )
Notch( 1.00 0 TrainBrakesControllerEmergencyStart ) ) )
```

Use of the three step brake is explained in this [video clip](#).

In OpenRails it is important to use TrainBrakesControllerMinPressureReduction( 1 ) with EP brakes and stepped brakes in order to be able to select the appropriate range of brake values.

## **REGENERATIVE AND RHEOSTATIC BRAKING**

The first British electric multiple units to have ‘dynamic’ braking were the London Transport O stock and P stock trains of 1938. This equipment was removed on conversion to CO / CP stock in the 1950s. Subsequently ‘dynamic’ braking became standard on all London Underground trains since 1967. Dynamic brakes began to appear on British main line stock in the 1970s and have been standard on new trains from the 1990s onwards.

There is very little published information regarding dynamic braking on British multiple unit trains so a good deal of guess work is needed to set the OpenRails parameters for this.

In all electric multiple units dynamic braking is blended with conventional air/EP brakes. A complete braking section must be included in all OpenRails eng files for motor cars (both driving and non-driving) with dynamic brakes.

In addition to blended braking there have so far been two trains constructed where a combined dynamic brake and blended brake controller has notches for both dynamic braking and blended braking.

As built the Metadyne controlled O and P stock had the following brake controller:

- 1 RELEASE or RUNNING
- 2 HOLDING
- 3 REGENERATION 1
- 4 REGENERATION 2 and EP
- 5 REGENERATION 3 and EP (effect identical to notch 4)
- 6 LAP AIR
- 7 SERVICE AIR
- 8 EMERGENCY (AIR)

More recently the braking control on the class 390 Pendolino is as follows:

- 0 RELEASE or RUNNING
- 1 DYNAMIC BRAKE 1
- 2 DYNAMIC BRAKE 2
- 3 DYNAMIC BRAKE 3
- 4 BLENDED DYNAMIC AND AIR BRAKE
- 5 BLENDED DYNAMIC AND AIR BRAKE
- 6 BLENDED DYNAMIC AND AIR BRAKE – FULL SERVICE
- 7 EMERGENCY (AIR)

Neither of these braking systems can be modelled in OpenRails at present. With blended brake controllers all notches are blended.