1) System overview

The S7 and S8 trains comprise block trains, of 7 and 8 cars respectively. All cars are motor cars. The brake system on both types of train is the same.

Braking modes

The braking system on S Stock gives the driver 3 modes of brake:

- Emergency Brake - high rate friction brake – 1.4 m/s/s nominal deceleration on level track
- Service brake - A graduated brake for normal operation blending dynamic and friction brakes for maximum efficiency and passenger comfort – 0.2 to 1.15 m/s/s nominal deceleration range
- Parking brake - Spring applied brakes to secure the train when powered down. Capable of holding fully laden train on 1 in 30 gradient

2) Braking Methods

There are 3 main types of braking on the S Stock, they are:

- Spring Applied Parking Brake (SAPB)
- Friction Braking
- Dynamic Braking (Rheostatic & Regenerative)

Spring Applied Parking Brake (SAPB)

- The SAPBs function is to stop the train rolling away under its own weight when the air has drained off.
- Held off by the main line pressure (which maintains the air brake system pressure)
- Automatically starts to apply once the main line pressure falls below 5 bar
- Automatically starts to release as the main line pressure rises above zero.

Friction Braking

- The friction brake is the prime brake system on S Stock
- The friction brake is pneumatic and fed from the main line compressed air system
- There is one brake actuator per wheel
- The brake actuator applies a composite brake block to the tread of the wheel
- During service braking, the dynamic brake is given priority, so as to maximise energy recovery and minimize the use of the friction brake
- In emergency braking, the friction brake is the only brake used.

Dynamic Braking

- The dynamic brake only operates during service braking
- The dynamic brake has priority over the friction brake; if the dynamic brake is not working or needs to be supplemented, then the friction brake will be applied

- The traction motors are used to generate electricity hence producing a braking effort which slows the train down
- The electricity is either
  - Returned to the 3rd/4th rail through the shoegear (Regeneration)
  - Dissipated in the brake resistor on each car (Rheostatic)
- The dynamic brake is controlled by the propulsion system
- The brake system dictates whether the dynamic brake is required and if so, how much effort is to be provided

Regenerative Braking

- Uses the trains motors as generators
- Returns energy to 3rd/4th rail via the shoegear for other trains to use
- Regeneration is the preferred braking method because it has environmental and cost benefits
  - Regenerates at up to 890V and up to 4500 A
- Only available if there is a train in the same dc section taking power
- Normally does most of the braking (only works above 10kph)
- Inhibited during emergency braking
- Reverts to rheostatic braking should there be no train taking power in the dc section

Rheostatic Braking

- Uses the train's motors as generators
- Reduces wear of brake blocks
- Dissipates the energy produced as heat in the brake resistor
  - The fan forces cool air over the resistor elements
- Supplements the friction brake.
- Used when regeneration is not available
- Only used above 10kph
- Inhibited during emergency braking.

Brake Blending

- The train uses a combination of friction and dynamic braking in each stop
- Brake blending is used to ensure a smooth transition between friction and dynamic braking
  - Controls combination of friction and dynamic braking
  - Dynamic braking is ineffective at low speeds and the blending function smoothly introduces friction braking to compensate until braking is completely friction as the train comes to a stand

  - At high speed or loads, brake blending adds some friction brake to supplement the dynamic brake
    1. When the dynamic brake has reached its power limit.

Load Adjustment

- The air suspension system is used to indicate the load being carried by each bogie.
- This information is used by the brake system to adjust the brake effort, in accordance with the passenger load, so as to maintain the braking performance (deceleration) as the load varies in service operation.

WSP function

- During braking, the Wheel Slide Protection (WSP) system within each gateway & smart valve is constantly monitoring the wheel rotations.
- The WSP system compares each axle rotation with the others on that car and also with the other cars.
- If one axle is turning faster or slower than any others the gateway & smart valve will adjust the braking on that axle accordingly to bring it back into line with the others.

Sanding function

- During braking, the sanding system will be triggered by the brake control if the train is experiencing adverse adhesion conditions.
- The adhesion between the wheel and rail is the means by which the braking force (applied to the wheel treads) is passed to the track in order to decelerate the train.
- Such conditions are detected by the occurrence of WSP at a number of wheelsets simultaneously on the leading portion of the train.
- When triggered, the sander will cause sand to be dispensed at that wheelset in order to improve the adhesion.

3) Braking System Components

The key components that make up the friction braking system are:

- Traction Brake controller (TBC)
- Dual Pulse Width Modulation (PWM) Encoder unit
- EP 2002 Smart valve
- EP 2002 Brake Gateway valve
- Brake supply reservoir
- Brake Actuators

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