Brake equipment of a locomotive

In terms of brake equipment, the locomotive is the most complex vehicle. Indeed, a locomotive is a vehicle which missions can be very diverse (passenger or freight trains, shunting, single operation, multiple unit, double traction, hauled as a vehicle), so the brake equipment shall be able to be adapted to the different configurations.

Equipment in car body

As a locomotive is designed to haul a train and control its braking, it shall include all necessary equipment for this purpose. Moreover, it shall be braked itself, this requiring to be equipped with devices for braking control of its bogies.

Braking control

Locomotives are systematically equipped with both pipes:

- Brake Pipe (BP)
- Main Reservoir Pipe (MRP).

Both pipes are connected to pipes of hauled vehicles by means of flexible hoses linked, at each end, to a stop cock which makes it possible, during uncoupling operations, to isolate the train downstream and to vent the flexible hoses in order to avoid their uncoupling under pressure (as this could be dangerous for the agent ensuring the uncoupling operation).

It shall be noted that for most of the freight trains, only the BP is connected to hauled vehicles: the MRP remains local to the locomotive. The MRP is supplied by the Main Reservoirs (MR), which have a huge volume (500 to 1000 liters), which in turn are supplied by the air production and treatment unit (compressor and air dryer).

On the driver’s desk are available standard control devices (see page on braking control devices in driving cab): brake master controller, emergency braking mushroom type push button, ER/BP/MRP/BC manometers, neutral and overcharge switches, EP assist isolation switch, quick release push button.

Train braking control is performed by means of the BP (see page on pneumatic brake general presentation). The BP pressure variations are controlled by means of a driver’s brake valve, which is controlled from the brake master controller of the active driving cab (for locomotives with two driving cabs): the control electric design makes it possible to select the active brake master controller as a function to the active driving cab. The driver’s brake valve generally includes neutral, overcharge, quick release (high flow) and EP assist control functions.

An emergency venting device (see page on braking control devices) is connected to the safety equipment (VACMA, KVB, etc.), and makes it possible for the latter to initiate emergency braking by quick venting of the BP.

Moreover, a locomotive is equipped with the direct brake. The latter is used during shunting operations, i.e. when operated alone, without hauling any vehicle.

The direct brake makes it possible to control locomotive braking not by means of pressure variations in the BP, but by direct control of the pressure in the brake cylinders. Direct brake control is ensured by means of a dedicated master controller, which makes it possible to supply the brake cylinders from the MRP. This master controller is either of the pneumatic type, or of the electric type (in this case, it controls two magnet valves – application and release – that, in turn, control a relay valve).
The direct brake master controller can, in some cases (for SNCF locomotive in particular), be used as train braking master controller by controlling the driver’s brake valve in a pneumatic way (or controlling electrically a back-up driver’s brake valve) in case of electric failure on the latter: the commutation is realized by action on a cock, which then inhibits the direct brake function.

Finally, the driver has the possibility to control only the dynamic brake of the locomotive by means of specific positions of the traction master controller or of the brake master controller: the BP pressure is not modified, braking control being ensured in a purely electric way (even digital on recent vehicles). The friction brake of the locomotive is not solicited, no more than the train brake. This braking configuration is essentially used to keep the train speed constant on a downhill gradient without leading to damaging heating on friction brake devices.

It shall be noted that some locomotives are equipped with a release control for the locomotive only, in order to enable brake release for compressing the buffers and ease uncoupling (the train remaining braked).

**Locomotive braking**

Braking of the locomotive is generally ensured by means of:

- A dynamic brake
- A friction brake

The dynamic brake, generally of the electrodynamic regenerative or(rheostatic type, is ensured by the traction motors (see page on bogie brake equipment). It is controlled either alone (for holding braking) or blended with the friction brake (for slowing or stopping braking). Control is ensured by the electronic control units of each bogie, which control the rectifiers, inverters and choppers as a function of demands received from the concerned master controller. In some cases, the brake demand can also be transferred by means of the BP, the control electronic unit measuring permanently the BP pressure and calculating the pressure drop realized.

The friction brake is controlled:

- Either in blending with the dynamic brake, by means of an electropneumatic transducer (one for the locomotive, or one per bogie controlled by the electronic control units, and making it possible to deliver a variable pressure to the relay valves, which in turn supplies the brake cylinders in the tread brake units and disc brake units of the locomotive or the concerned bogie.
- Or alone, by means of a distributor valve (for the locomotive of per bogie), which controls the relay valve: each distributor valve is equipped with the G/P mode switchover control, so that the locomotive can haul a passenger train of a freight train.

Downstream the relay valve are installed double check valves that make it possible to supply the brake cylinders either by the direct brake of by the main braking control: the effective pressure supplied to the brake cylinders is the greatest of both pressures.

A brake auxiliary reservoir (one for the locomotive or per bogie) ensures supply of the concerned brake equipment. Isolation cocks make it possible to isolate a bogie, or the complete locomotive in case of failure.

In some cases, the parking brake is applied by a voluntary control, ensured by means of a dedicated electropneumatic device (magnet valves and valves) controlled by a push button or a switch on the driver’s desk.

All pneumatic brake devices (driver’s brake valve, direct brake, bogie brake control, reservoirs, etc.) are generally grouped in a pneumatic cabinet installed in the car body of the locomotive. Isolation and venting controls are thus directly accessible.

A wheel slide protection function is generally available: it is integrated into the electronic control units, and permanently measures the speed of the axles of the locomotive, and regulates both the dynamic (in a pure digital way) and friction brake forces, for the latter by means of dump valves (generally one per bogie).

Finally some locomotives are equipped with a magnetic track brake (see page on the bogie brake equipment): the latter is controlled by means of a specific relay valve, this being controlled by a magnet valve. The latter is activated by means of a pressure switch connected to the BP, and closing a contact when emergency braking is required. The relay valve supplies the actuators with compressed air at the adequate pressure by means of a rigid pipe and a car body to bogie flexible hose. Compressed air is generally taken into a dedicated auxiliary reservoir. An isolation cock makes it possible to isolate the magnetic track brake independently.
Bogies equipment

Most of the locomotives are braked by means of a tread brake, generally composed of one tread brake unit per wheel.

Anyway, and for reasons of thermal load on wheels and for maintenance costs reasons (reprofiling operations), more and more modern locomotives are equipped with wheel flanged brake discs. The latter are either alone, or combined with a tread brake. In this last case, the disc brake ensure the major part of brake force. Equipment generally consists of a disc per wheel, associated to a disc brake unit.

Parking brake is ensured by means of spring cylinder that is integrated to one of the tread brake units or to one of the disc brake units of each bogie, application being either fully automatic or manually controlled by the driver.

Some locomotives (such as the Re 460 of CFF) are also equipped with a magnetic track brake.