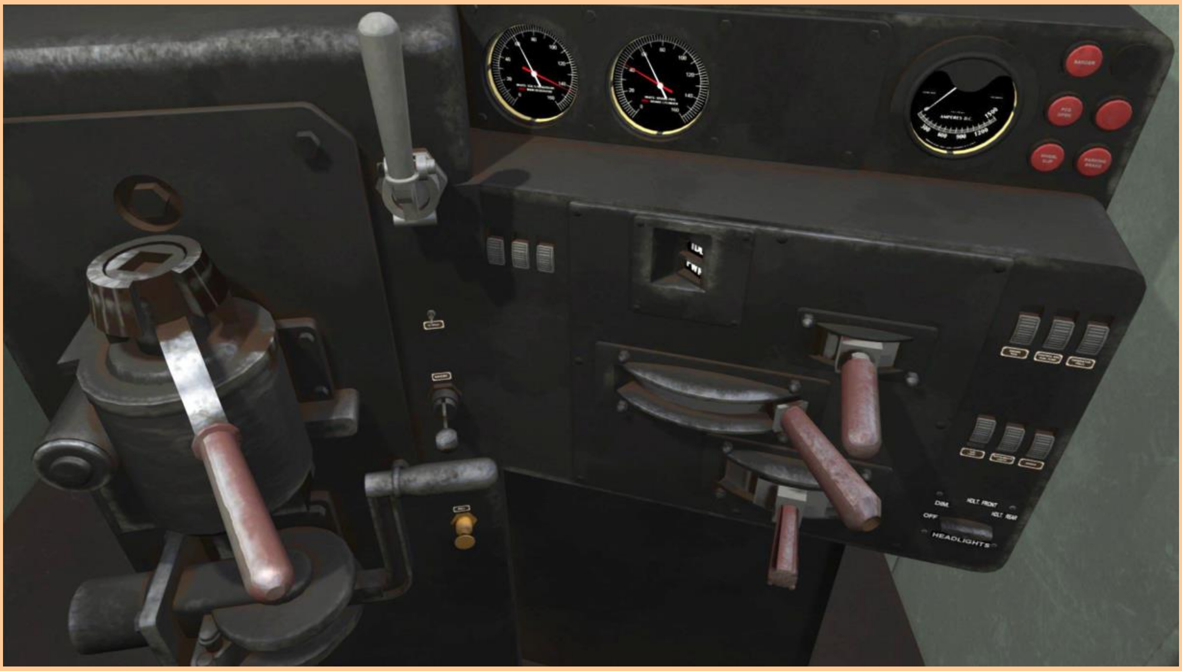
Saluda Grade:
Asheville - Spartanburg Route
developed by High Iron Simulations
Add-on route for Train Simulator Classic™



EMD GP35 and SD40-2
Diesel Locomotives
Operating Manual - Brakes
by Smokebox

Issue 1.0

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Introduction

The diesel locomotives included in the “Saluda Grade: Asheville - Spartanburg Route” DLC route package, developed by High Iron Simulations, are scripted to provide an authentic simulation of the operation and behaviour of the train and locomotive brakes.

While a variety of brake stands are simulated, the overall principles that apply are more or less standard.

This aim of this manual is to explain how to use the brakes in each particular locomotive, including any mechanical interlocking that constrains how the controls behave, and to give some insight into how brakes work in general.

Note: Immediately after loading a scenario, the locomotives will automatically apply the brakes fully to prevent the train from rolling if starting on a steep gradient. This can take around 7 seconds. It’s advisable to leave the brake handles alone during that time, so as not to interfere with the initial brake application.

EMD GP35 Diesel Locomotive / 26-L Brake Stand

The EMD GP35 diesel locomotive is equipped with a 26-L brake stand, as shown below:

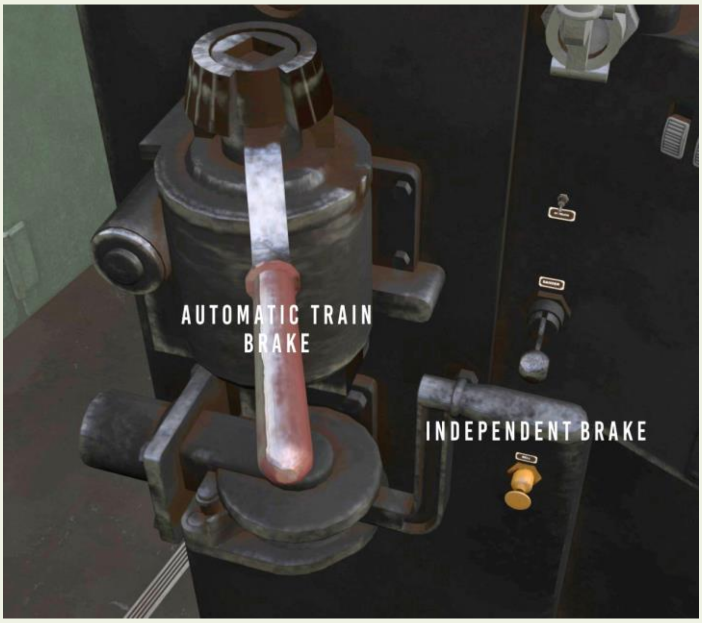
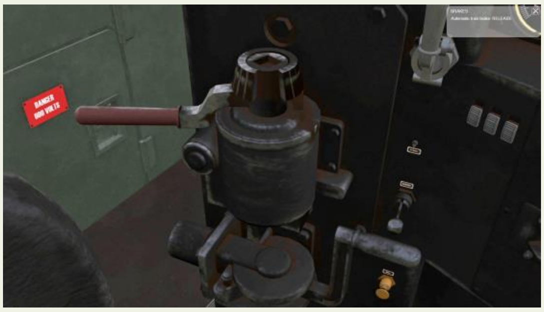


Figure 1: GP35 26-L Brake Stand

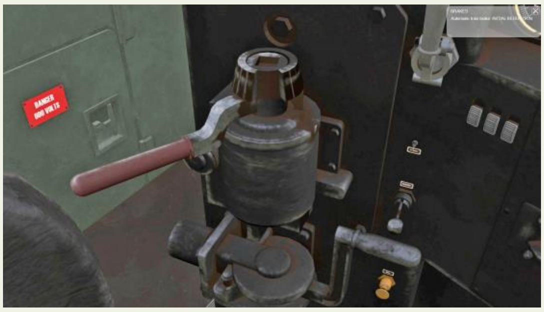
Automatic Train Brake

The automatic train brake handle operates the brakes on each of the cars in the consist. It commands brake actions by manipulating the pressure in the brake pipe that runs all the way from the locomotive to the tail end of the consist. Each car has a “triple valve” that responds to the commands (the changes in brake pipe pressure at that car, communicated via a branch pipe leading off the main brake pipe to the car’s triple valve).

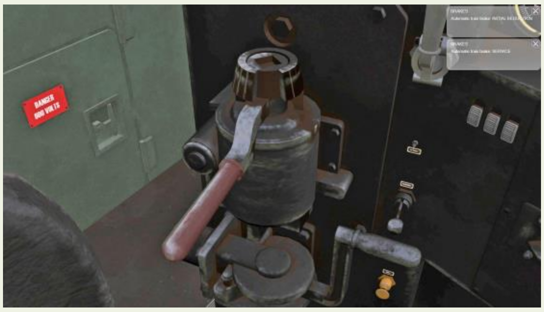
The automatic train brake has the following positions:



RELEASE raises the equalising reservoir pressure to 90 psi, with brake pipe pressure following, so that the brakes on the cars are released. Locomotive brake cylinder pressure that resulted from an automatic train brake application will also be released.



INITIAL REDUCTION lowers the equalising reservoir pressure to 84 psi. The train cars are equipped with ABD brake valves which allow the initial 6 psi reduction in brake pipe pressure to occur quickly, meaning that the corresponding brake application (15 psi brake cylinder pressure) is also relatively fast – this is called “Quick Service”.



SERVICE is a zone in the brake quadrant, from this position to FULL SERVICE. Within that “application zone”, the amount of brake application is directly related to the position – the farther to the right, the more the equalising reservoir pressure is reduced and thus the brake application increases. This is called “Graduated Service”. It is slower than the initial (6 psi) reduction.

FULL SERVICE is where the equalising reservoir pressure is reduced by 26 psi (from 90 to 64). To command the maximum brake cylinder pressure (65 psi) at the train cars. When the handle is moved towards the left in the application zone, the pressure does not change – brake application can only be increased, not decreased.

EMERGENCY opens the "big hole" to allow air to escape quickly from the brake pipe. The rapid depressurization is detected by the cars' triple valves, commanding them to apply the brakes quickly and fully. Equalising reservoir pressure and brake pipe pressure will drop all the way to 0 psi. Meanwhile, the brakes cannot be released.

Notes:

1. Unlike earlier brake stands, the 26-L does not have a RUNNING position. The RELEASE position charges the brake pipe, and maintains the pressure against leaks in the brake pipe, in a controlled manner and there is no danger of overcharging the brake pipe (raising its pressure higher than 90 psi).

2. Brake application and release times depend on the length of the consist (the length of the train brake line) as well as the season (outside temperature). You'll need to allow for this extra time when running a long train and anticipate your use of the brakes accordingly.

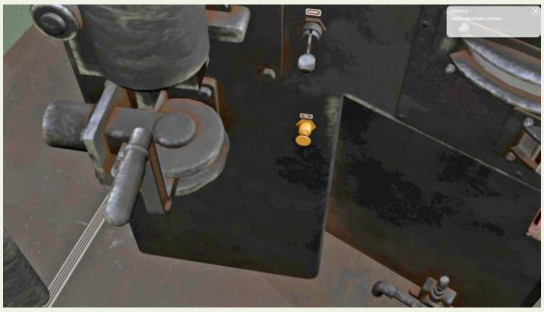
3. The automatic train brake handle has some additional scripting to simulate the tactile feel of moving the handle in and out of the detents in the brake quadrant, which helps to avoid accidentally moving the handle by more than intended.

   If the train brake handle seems to get stuck as you move it, it is because it has hit one of those detents (you'll also hear a soft "click"). When that happens, stop moving it, wait at least half a second, then continue to move the handle.

   If the handle is moved with the mouse, it's not necessary to release the mouse button. Just stop dragging the mouse to the right for at least half a second.

Independent Brake

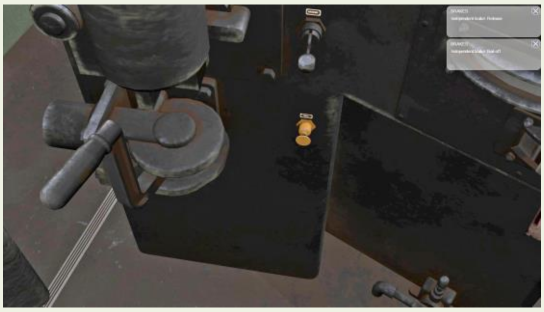
Also called the "Locomotive Brake" or (on steam locomotives) the "Engine Brake", the independent brake has the following positions:



RELEASE vents all pressure from the locomotive brake cylinders, releasing the brakes.

APPLY increases the pressure supplied to the brake cylinders directly from the main reservoir, independently of the pressure changes occurring in the brake pipe. Between APPLY and FULL APPLY the locomotive brake application is graduated, i.e. proportional to how far the handle is to the right. Moving the handle to the right increases braking, and to the left decreases braking. When the handle is stopped in the zone, the pressure is “lapped”, i.e. maintained at its current level.

FULL APPLY is where the locomotive brake cylinder pressure is raised to the maximum.



BAIL OFF is reached by mouse-dragging the handle to the left of RELEASE (or press the [key, or continuously drag the loco brake slider downwards on the HUD]. It allows the engineer to release the locomotive brakes without also releasing the train brakes. This can be useful in various situations, especially when braking on a downhill gradient, as it avoids having the locomotive slow down faster than the consist it is hauling (which could otherwise cause uncomfortable “bunching” forces at the head-end of the train).

Bail Off

The automatic train brakes also affect the locomotive’s independent brakes. In other words, when you apply the automatic brakes, the locomotive’s brakes are also applied (even if the independent brake handle is not in any "application" position (to the right of the RELEASE position). Moving the independent brake handle to the RELEASE position does not release the locomotive's brakes unless the train brakes are released first.

Therefore, the bail-off position of the independent brake handle has been modeled, along with its spring-loaded action, so that you can release the locomotive brakes while the train brakes are still applied. When you drag the independent brake handle all the way to the left, holding it there against the pressure of the spring (holding down the [key or using the mouse to drag the loco brake lever to the left continually), the locomotive brake cylinder pressure drops (look at the "RED – BRAKE CYLINDER" needle of the dual brake gauge in the cab) . Meanwhile, the train brakes stay on (the "WHITE – BRAKE PIPE" needle will stay put).

Although it's still not simulated 100% (because if the train brakes are set, the locomotive, as well as the consist, is in fact still being slowed down), this implementation gives a close approximation and feel of actual bail-off.

When using the F4 HUD, you can still bail-off the independent brakes by using the mouse to click on the "Loco Brake" button and pulling the brake slider downwards. When you let go, the slider will move up and come to rest at RELEASE.

Brake Gauges

The GP35 control stand is equipped with the following gauges related to the brakes:

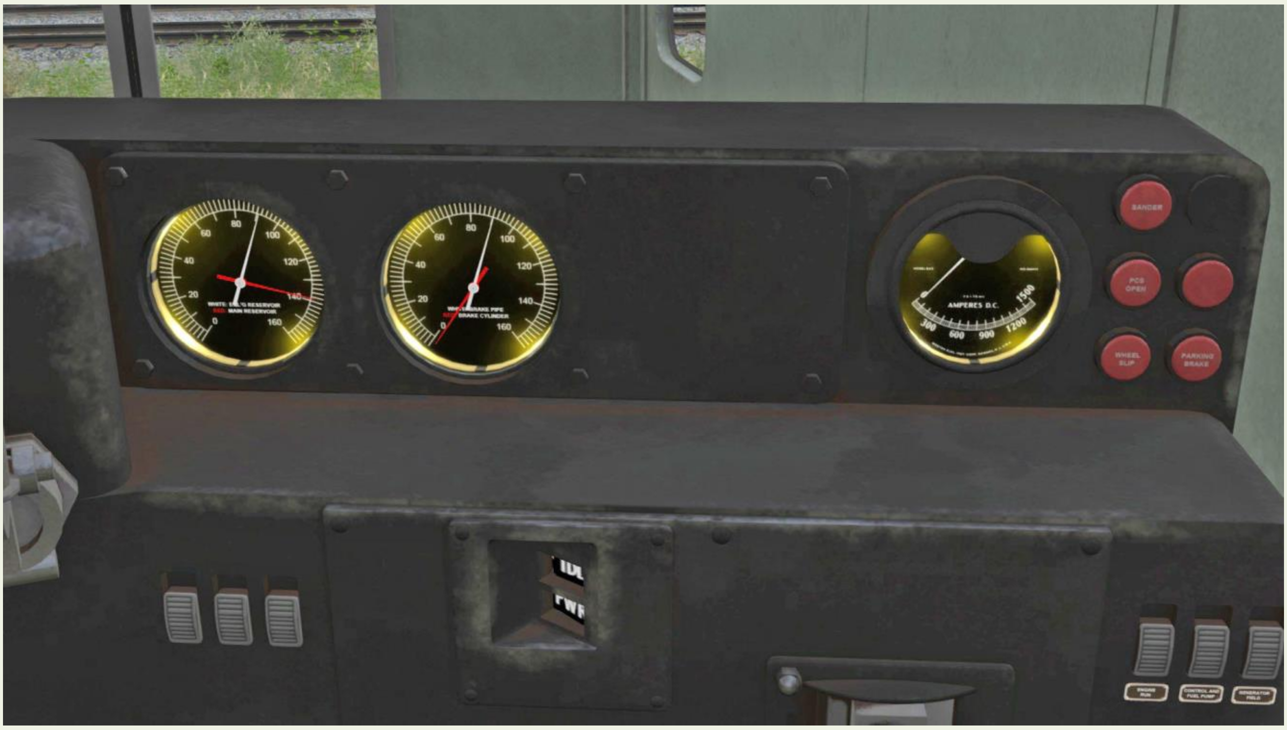


Figure 2: GP35 Brake Gauges

The purpose of each gauge needle is described below:

1. **Main Reservoir Pressure**

   The "**RED – MAIN RESERVOIR**" needle indicates the pressure in the main reservoir (MR) that stores compressed air used by the air brakes and other air-operated equipment.

   The pressure in the MR will drop when the train brakes are released, because air is taken from the MR and directed into the equalising reservoir and brake pipe. The maximum MR pressure is 140 psi. When it drops as low as 130 psi, the locomotive's air compressor kicks in until the pressure has risen to 140 psi.

2. **Equalising Reservoir Pressure**

   The "**WHITE – EQ'LG. RESERVOIR**" needle indicates the pressure in the equalising reservoir (ER). The ER is in the locomotive and its pressure is controlled directly by the brake stand. Its purpose is twofold – to determine the target pressure for the brake pipe (connected to the ER) and to absorb and reduce the fluctuations in pressure at the head-end (the end nearest the locomotive) of the brake pipe as it "sloshes" back and forth especially when large changes in pressure are commanded.

   ER pressure can be changed quickly (using the automatic train brake handle), while the actual brake pipe pressure will catch up with the ER pressure more slowly.

   In freight service (which is what is modeled here), the maximum ER pressure is 90 psi.

   The minimum ER pressure in normal operation, when the automatic train brake is applied fully, is 64 psi.

3. **Brake Cylinder Pressure**

   The "**RED – BRAKE CYLINDER**" needle indicates the pressure in the locomotive's own brake cylinders (BC).

   Note that this is not the same as the "brake cylinder pressure" observed in the F5 HUD data display. That relates to the average pressure in the train cars' brakes, not the locomotive itself. The F5 HUD data called "Loco Brake", which is given as a percentage, does relate to the pressure in the locomotive brakes.

4. **Brake Pipe Pressure**

   The "**WHITE – BRAKE PIPE**" needle indicates the pressure measured at the head-end of the train's brake pipe (BP). It will always be equal to, or heading towards, the ER pressure.

   The rate at which the BP pressure moves towards the ER pressure depends on the length of the consist and the season. The longer the consist and/or the colder the season, the more time it takes for the BP to equalise with the ER.

5. **Ammeter**

   The ammeter measures current generated in the armatures of the electric motors that power the locomotive’s axles. When the dynamic brake is engaged and the axles are turning, thus generating current in the same way as a bicycle dynamo, the ammeter needle will move into the yellow “BRAKE” zone of the dial.

Interlocking of Throttle, Reverser, Dynamic Brake and Air Brakes

1. The dynamic brake interlock feature functions during dynamic braking to release or prevent an automatic service brake application on the locomotive:

   - Any locomotive brake cylinder pressure that has been set up as a result of applying the automatic train brakes will be released as soon as the dynamic brakes are applied.

   - However, the independent brake handle can still be used to apply the engine brakes at the same time as the dynamic brakes are applied.

2. The dynamic brake lever is interlocked with the throttle and reverser levers:

   - The dynamic brake lever cannot be moved unless the reverser is in Forward or Reverse and the throttle is in Idle.

   - Neither the throttle nor the reverser can be moved unless the dynamic brake is in Off.

EMD SD40-2 Diesel Locomotive / 26-L Brake Stand

The EMD SD40-2 diesel locomotive, like the GP35 described above, is equipped with a 26-L brake stand. Operation of the locomotive and train brakes is identical to the GP35, described above.

Pressure Equalization

The brake pipe pressure equalizes first at the head end of the train (that is, at the end of the brake pipe that goes into the equalizing reservoir in the locomotive), taking longer to equalize at the rear end of the train. This means that the train brakes don't apply on every car in the consist at the same time. Instead, it takes longer for them to apply the farther they are from the head end.

Even if the gauge in the cab is showing that the brake pipe pressure has equalized at the desired reduction, the full braking effect won't be felt until the reduction has reached the tail end. The time for that to happen depends on the length of the consist and the season (longer and/or colder means it takes more time) and this is something that needs to be taken into account when planning brake applications.

Note: there is no gauge in the cab that shows the brake pipe pressure at the tail end of the train, but if you look at the F5 HUD, the "Brake Cylinder Pressure" shows the average pressure in the cars' brake cylinders. Therefore, when that pressure reaches a steady value, it's an indication that the tail end brake pipe pressure has equalized.

As the brake pipe pressure reduces, the locomotive brake cylinder pressure will rise by a corresponding amount, at a ratio of 1:2.5. For example, a 10 psi reduction in head end brake pipe pressure results in a 25 psi increase in locomotive brake cylinder pressure.

The normal pressure for the fully charged brake pipe and equalizing reservoir is 90 psi (this is simulating freight service). When a reduction is made, the first 6 psi reduction in brake pressure (called an "initial reduction") triggers the "quick service" feature of the ABD brake valves on the cars in the consist. Then, instead of the brake pipe air having to travel all the way to the "small hole" in the locomotive brake stand, it vents at the cars themselves, very quickly. In that way, it's possible to get 15 psi (2.5 times 6 psi) into the cars' brake cylinders very quickly. After the initial reduction, further reductions happen at the normal rate (that is, more slowly) as the air has to travel all the way up the brake pipe to the locomotive.

Train Brake Triple Valves and Auxiliary Reservoirs

Every car in the consist is equipped with an auxiliary reservoir that holds the air used by the brakes in the car, as well as a triple valve that controls three main operations of the brakes:

- Recharging the auxiliary reservoir with air taken from a branch pipe connected to the main brake pipe (or "train line").
- Venting the air accumulated in the car's brake cylinders, so that the brake cylinder pressure falls to zero and the car's brakes release.
- Charging the car's brake cylinders with air from the auxiliary reservoir, so that the car's brakes apply.

As soon as the pressure in the branch pipe is higher than the pressure in the auxiliary reservoir, <u>by at least 1.5 psi</u>, the brake cylinders vent all the air to atmosphere, releasing the brakes, and the auxiliary reservoir begins to recharge (the pressure in the reservoir increases).

<u>There is no partial release of the brakes on each individual car</u> and the air is vented very quickly.

However, it's important to understand that the brakes don't release on all of the cars in the consist simultaneously. It takes time for the brake pipe pressure wave to travel down the brake pipe to each car. The brakes release first at the head end, closest to the locomotive, and lastly on the car at the rear end of the train. The "Brake Cylinder Pressure" in the F5 HUD is the average pressure in the brake cylinders of all cars in the consist, and that average pressure determines the actual braking effort applied to the train by the simulation.

Therefore, if you watch the F5 HUD while releasing the brakes, "Brake Cylinder Pressure" will not change until the brake pipe pressure has risen by 1.5 psi above the current average pressure in the cars' auxiliary reservoirs. Then, "Brake Cylinder Pressure" will drop fairly quickly towards 0 psi while the brake pipe pressure (shown by the gauge in the cab) continues to rise.

"Peeing Away Your Air"

To understand this, you must first understand that the brakes are applied by lowering the pressure in the train’s brake pipe (in simple terms, by letting air out of the pipe through a hole in the brake control stand) and the brakes are released by allowing compressed air into the train’s brake pipe (again, via the train brake control in the cab) until the pressure in the brake pipe is higher than in the auxiliary air brake reservoirs under each car (in main line freight service, these are normally pressurized to 90 psi).

When the brakes are applied, the brake pipe (train line) pressure drops. When it falls below the pressure in the auxiliary air brake reservoirs of each car, the brakes are applied on the cars by means of pressurized air (from those auxiliary reservoirs) going into the cars’ brake cylinders. However, that in turn means that the pressure in the auxiliary reservoirs drops.

The cars´ auxiliary reservoirs are recharged with air from the brake pipe (which comes from the locomotive) when the train brake handle is in the RUNNING or RELEASE position, but it takes time, especially on a long train. If the engineer has not left the handle in RUNNING or RELEASE for sufficient time before again applying the brakes (making a “service application”), the auxiliary reservoirs might not yet have recharged to their nominal 90 psi pressure. That leads to two effects: first, the brake pipe pressure has to drop even further before it is lower than the pressure in the auxiliary reservoirs, so it takes longer for the brakes to come on, and secondly, when the brakes do come on, they do so with less force because the pressure in the brake cylinders, which comes from the auxiliary reservoirs, is lower.

The more often the engineer does this, without giving the auxiliary reservoirs a chance to recharge, the worse it gets, until eventually there is hardly enough pressure left in the reservoirs to feed the brake cylinders and apply the brakes. At that point, the engineer has “pi**ed away his air” and could have a runaway train on his hands.

Fortunately, he might still be able to stop with the emergency brakes, using air from the emergency air reservoirs under each car.

The lesson is, try to avoid applying, releasing, applying, releasing the brakes rapidly, and after releasing the brakes, leave the handle in the “running” position, to keep recharging the brake line.

Pneumatic Control System (PCS)

The locomotives are equipped with the Pneumatic Control System to detect and react to sudden drops in brake pipe pressure, which can be caused by a break in the consist while it is moving, or by putting the train brake into EMERGENCY. When that occurs, the PCS will be tripped, causing the emergency brakes to be applied and the engine power to be disconnected.

The procedure for recovering from “PCS tripped” is as follows:

1. Ensure the throttle handle is in IDLE
2. Move the automatic train brake into EMERGENCY and back to RELEASE (or RUNNING).
3. Wait for the brake pipe pressure to reach 0 psi. Only then will the brakes actually begin to release.

Wheel Slide

If power is applied and the train begins moving but the ammeter continues to show zero Amps, make sure that the locomotive brakes are released. This because the train could be picking up speed on a downhill grade after releasing the train brakes but with the locomotive brakes still applied and the wheels locked, i.e. the locomotive could be sliding!

Important Note Concerning the Data Shown in the F5 HUD

The model's scripting does a lot of fancy manipulation of the standard controls and parameters to achieve its high-fidelity simulation of the behavior of the air brakes. That leads to what might look like some strange behavior in the HUD values. This note is intended to explain why you should ignore the HUD (including the F5 HUD).

The equalizing reservoir pressure shown on the gauge in the cab is controlled entirely by the script, so you have to ignore whatever value is shown in the F5 HUD.

When the brake pipe pressure (as shown by the gauges in the cab) has reached the same level as the equalizing reservoir, the train brake value in the F5 HUD will indicate 62% - that is how the script holds the pressures equal.

When the brake pipe pressure needs to change to catch up with the equalizing reservoir pressure, the script sets the F5 HUD train brake values as needed (depending on the difference between the two pressures), applying and releasing, until the pressures are equalized.

Be aware that the "Brake Cylinder Pressure" shown in the F5 HUD is a representation of the pressure in the train brake cylinders, i.e. the average pressure in the brake cylinders in all the cars in the consist. The gauge in the cab, on the other hand, shows the pressure in the locomotive's brake cylinders.

Special Key Commands

Each of the locomotives has the following two special key commands:

Ctrl Shift 3	Toggles the tactile feel of the brake quadrant detents. Disabling it will avoid potential conflicts with the RailDriver® input device.
Ctrl Shift B	Toggles the display of brake-related pop-up messages.

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