Union Pacific 4000 Class 4884-1

"Big Boy"

circa 1948-49

Developed by Smokebox

for Dovetail Games' Train Simulator™

Issue 1

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Introduction

The Union Pacific 4000 class, commonly known as the "Big Boy", is an articulated steam locomotive, meaning it has two engines, each with two cylinders and eight driving wheels. It has a four-wheel pilot truck and a four-wheel trailing truck., along with a 14-wheel "Centipede" tender.

The wheel arrangement is, in the Whyte notation, 4-8-8-4.

The model has been built, as far as possible, using Alco's original drawings for the first series of twenty locomotives, numbered 4000 to 4019 (referred to as 4884-1). Many alterations were made to the design's details, especially in the 1950s, and those can be seen on the Big Boys that are currently on display in various parts of the United States, as well as on the restored 4014 operated by Union Pacific today. Note that Big Boys were coal fired, unlike the current 4014 which has been converted to burn fuel oil. This model depicts a coal-fired Big Boy circa 1948-1949.

There are many, many printed publications, videos and internet articles covering the Union Pacific 4000 so for further information on the prototype, I recommend studying those.

32- and 64-bit TS

This model is suitable for both versions of TS2021, i.e. in 32- and 64-bit.

Expert or Simple Controls mode, HUD and Automatic Fireman

"All-in-one"

Unlike the Union Pacific FEF-3 model developed by *Smokebox*, which had separate "Advanced" and "HUD" versions, this model of the Big Boy **supports all modes of gameplay in a single, unique version**.

This means that it can be used in Expert mode as well as in Simple Controls mode, with or without the control panel at the bottom of the screen (the so-called "F4 HUD"), or using mouse and/or keyboard, in either 32- or 64-bit TS. Basically, the model is designed to allow players to run the locomotive using whatever method they prefer.

Standard TS Automatic Fireman

TS2021 has a "standard" automatic fireman but this model of the Big Boy has its own scripted "expert" automatic fireman which does a much better job and is enabled by default. It manages the exhaust injector, stoker engine and stoker jet manifold, as well as periodically blowing down the water sight glasses and water columns. It can be toggled off at any time to allow the player to fire the locomotive manually.

It is recommended to turn off TS2021's own automatic fireman via the in-game menu:

Main Menu > Settings > Gameplay > Automatic Fireman > Off

If the standard automatic fireman is left enabled, the Big Boy's specialized expert automatic fireman will still be able to do its job. However, please be aware that there are some minor side-effects because of the way Train Simulator is implemented. For example, the boiler pressure will never rise above 299.8 psi (therefore the safety valves may start to lift and feather but will never fully "pop") or go below 195 psi (65% of the maximum) regardless of how badly the locomotive is operated. This behavior is intrinsic to the standard automatic fireman.

F4 HUD

Although the F4 HUD can be used with this loco, there are a few caveats:

1. The water and coal buttons on the F4 HUD have no effect. It is recommended to enable the expert automatic fireman (click on the fireman's seat cushion or press Ctrl Shift A) or to hide the F4 HUD and fire manually.
2. If the live injector water valve has been opened (with the F4 HUD hidden), it will close again as soon as the F4 HUD is enabled. Basically, it's not possible to use the injectors manually with the F4 HUD on-screen, although the expert automatic fireman is able to continue to use the exhaust injector as needed.

High Detail (HD) and Standard Detail (SD)

There is both a "High Detail" ("**HD**") and "Standard Detail" ("**SD**") version of the model.

- **HD** has everything, including all the nuts, bolts, rivets and other small details.
- **SD** leaves out most of the nuts, bolts, rivets and other small details, including gauge lights and oil cans in the cab. Its TgPcDx file size is approximately 75% that of the HD version,

yielding an increase in frame rate. It's the version that is recommended for less capable PCs.

Recommended Settings

This is a very detailed model. While a lot depends on the amount of detail there is in the route where the locomotive is used, it's likely to need a computer that at least meets the minimum specifications for Train Simulator.

In the event that an increase in frame rates is needed, the recommendation from *Smokebox* is to reduce the amount of work that the CPU has to perform. Therefore, switch off the game's built-in ambient occlusion completely (Ctrl Shift 2), which will also allow small details in the model to be seen more easily, and reduce "View distance", "Shadow quality" and "Water Quality".

Figure 1: Recommended Graphical Settings

When a scenario is set at night or in poor weather conditions (overcast, rainy, etc.), i.e. when the sun isn't shining strongly, it is recommended to set the shadow quality to the absolute minimum (off).

Cab Layout

The diagrams below show the positions of the cab controls (as well as other controllable items such as doors and windows) and gauges.

Those controls that need only be on or off, not somewhere in-between, are operated simply by clicking on them with no need to drag from side-to-side, or up and down, with the mouse. This makes them much more comfortable and easy to use.

Many of the gauges and most of the controls move in the exterior view in the same way as they do in cab view.

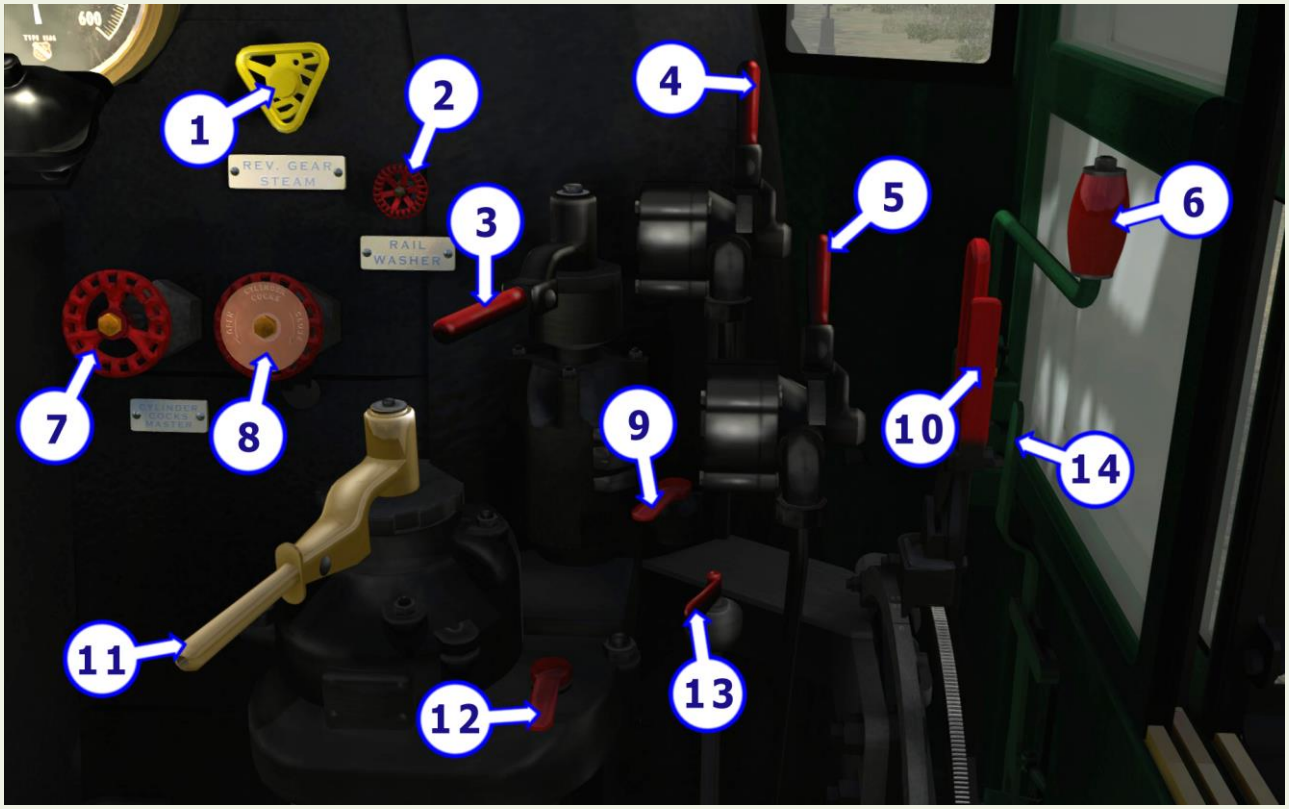


Figure 2: Cab Layout (1)

1 Reverse Gear Steam (Brake Alerts)

2 Rail Washer

3 Engine Brake

4 Smoke Stack Hood

5 Sander

6 Sludge Remover

7 Cylinder Cocks Master

8 Cylinder Cocks

9 Locomotive Emergency Brake Cylinder Pressure Control

10 Reverser

11 Train Brake

12 First Service Position Cock

13 Bell Air Valve

14 Side Vent

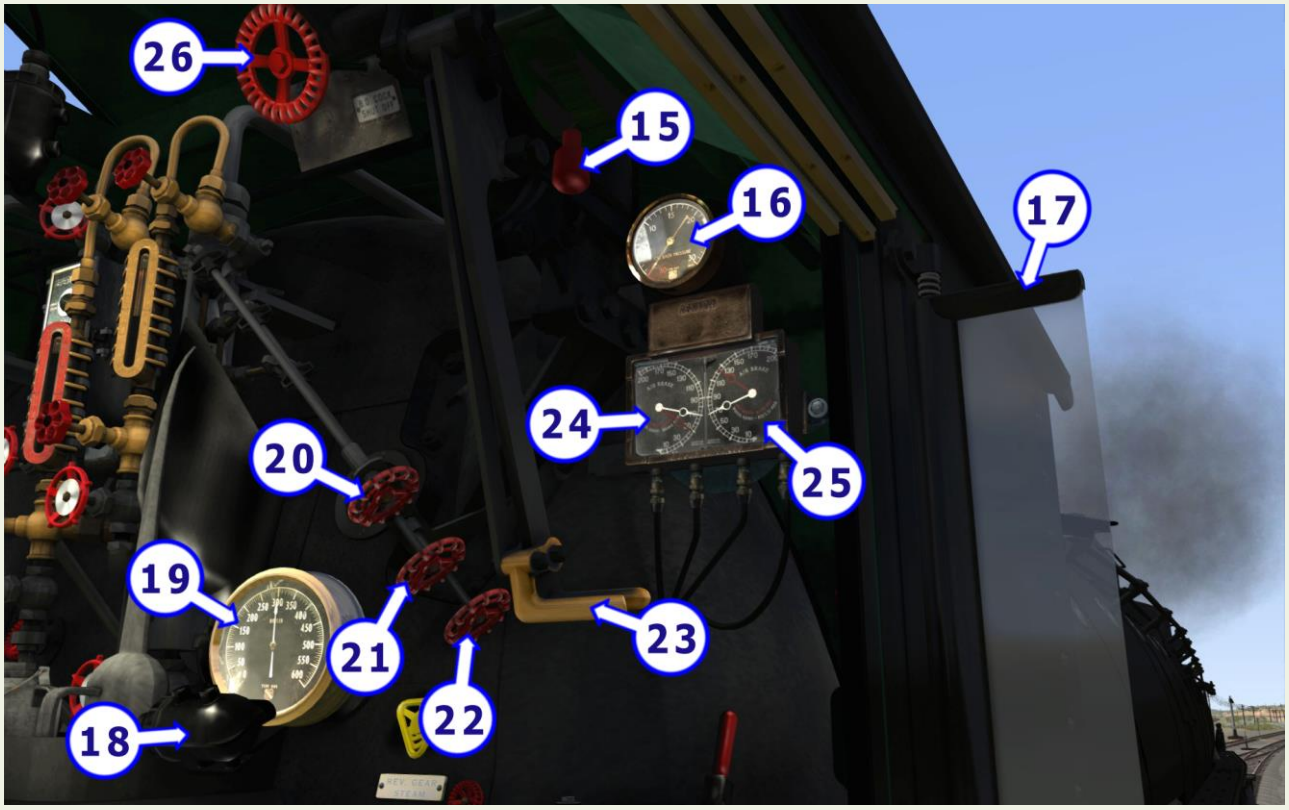


Figure 3: Cab Layout (2)

15 Headlights

16 Back Pressure Gauge

17 Windshield

18 Gauge Lights

19 Boiler Pressure Gauge

20 Water Gauge

21 Water Gauge

22 Water Gauge

23 Throttle

24 Air Brake Pressure Gauge - Brake Cylinder (Red Hand) and Brake Pipe (White Hand)

25 Air Brake Pressure Gauge - Main Reservoir (Red Hand) and Equalizing Reservoir (White Hand)

26 Blow Off Cock Shut Off

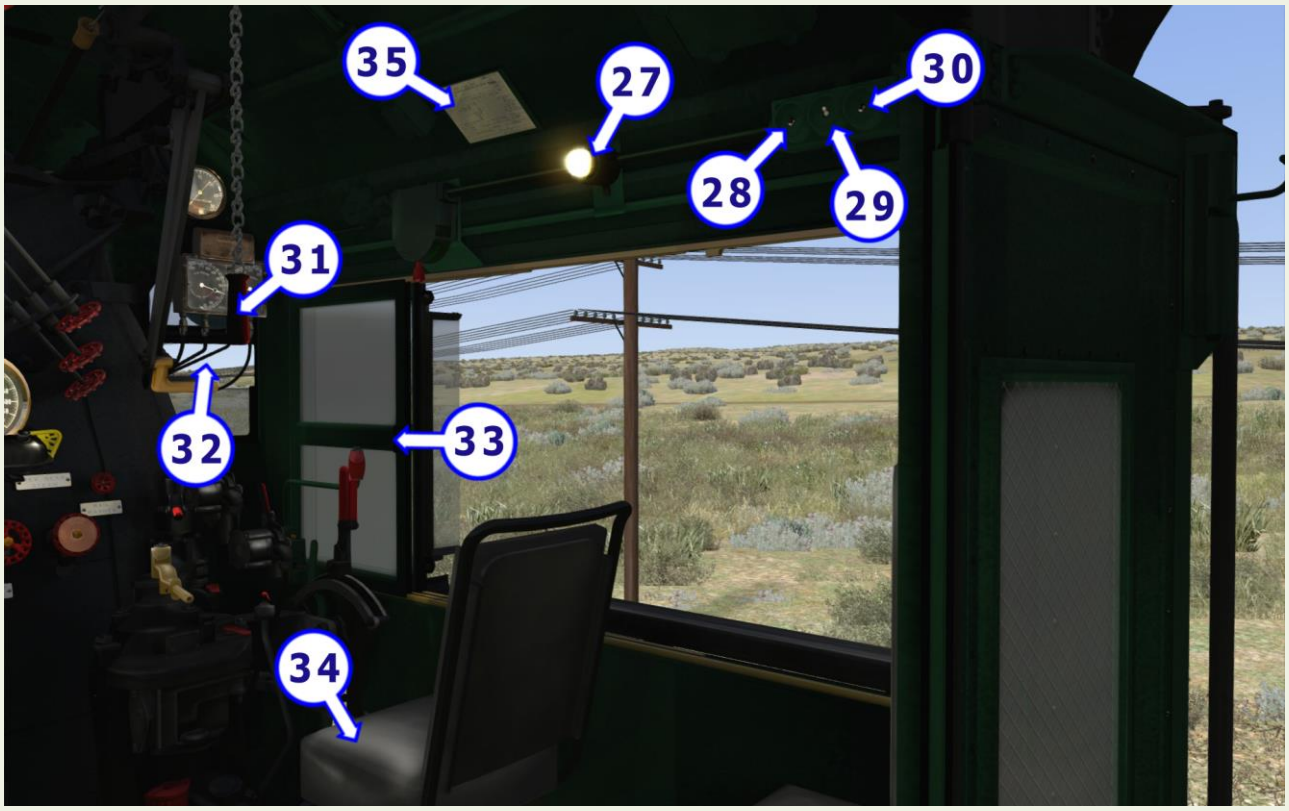


Figure 4: Cab Layout (3)

27 Cab Light

28 Injector Light

29 Running Lights

30 Back Up Red Light

31 Whistle

32 Clear Vision Window

33 Windows

34 Expert Automatic Engineer Toggle

35 Performance Report

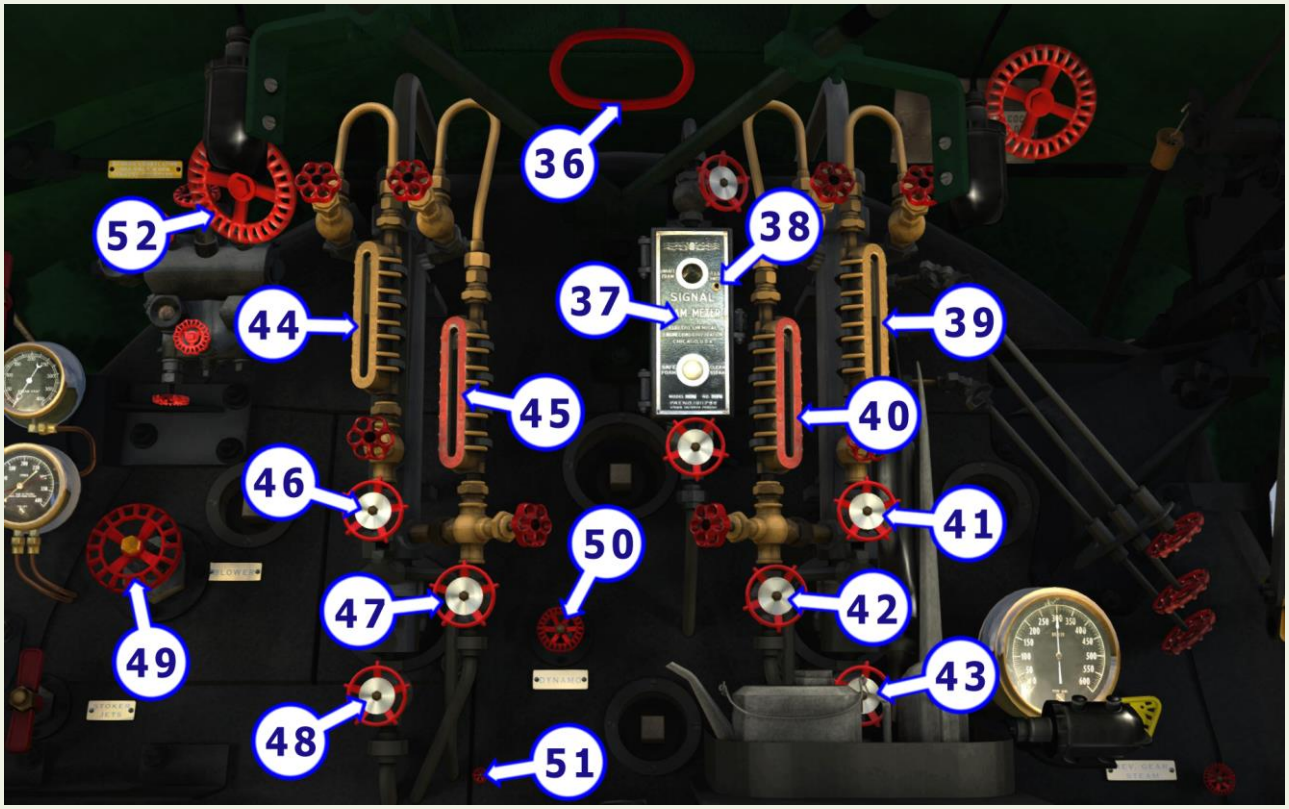


Figure 5: Cab Layout (4)

36	Roof Vent
37	Signal Foam Meter
38	Foam Meter Test
39	Water Sight Glass
40	Water Sight Glass
41	Water Sight Glass Blowdown
42	Water Sight Glass Blowdown
43	Water Column Blowdown
44	Water Sight Glass
45	Water Sight Glass
46	Water Sight Glass Blowdown
47	Water Sight Glass Blowdown
48	Water Column Blowdown
49	Blower
50	Dynamo
51	Firedoor Valve

52 Steam Heat

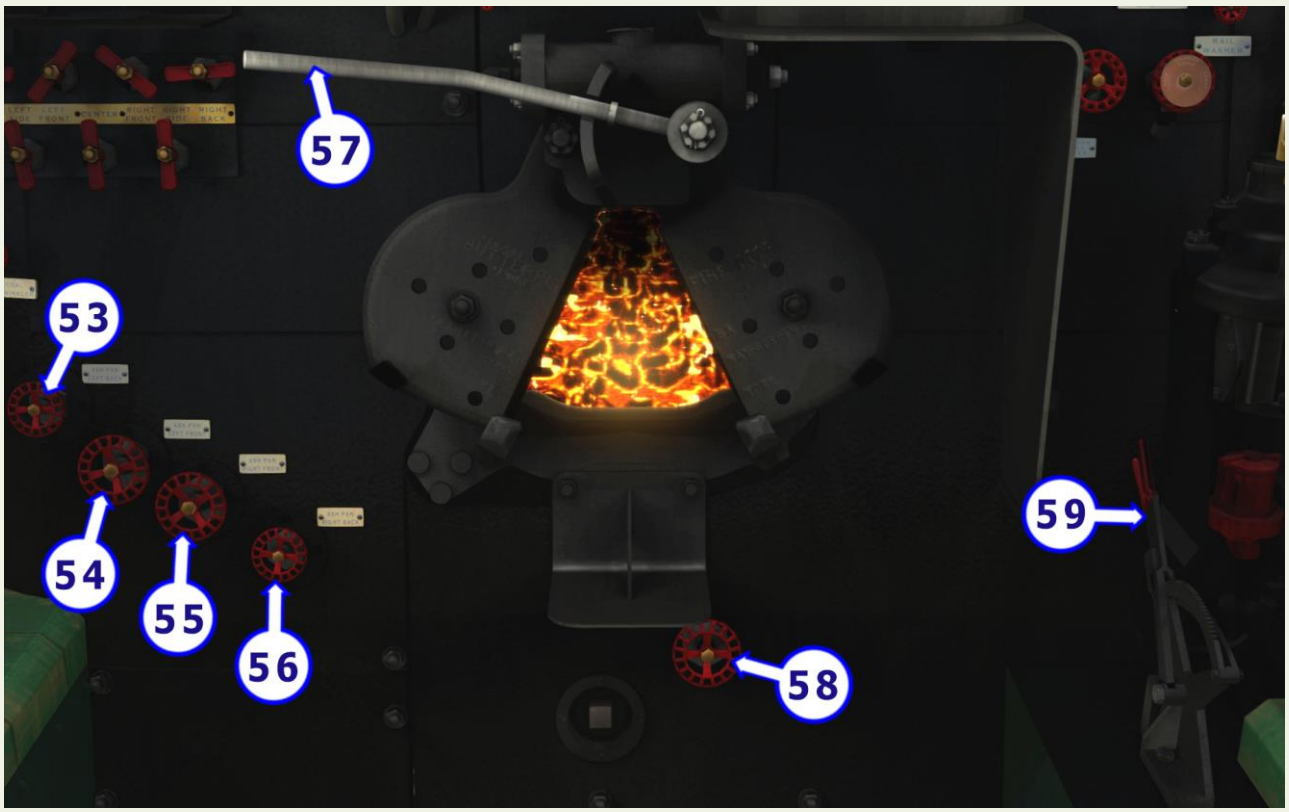


Figure 6: Cab Layout (5)

53 Ash Pan Left Back

54 Ash Pan Left Front

55 Ash Pan Right Front

56 Ash Pan Right Back

57 Fire Door

58 Ash Pan Middle

59 Live Injector Lever

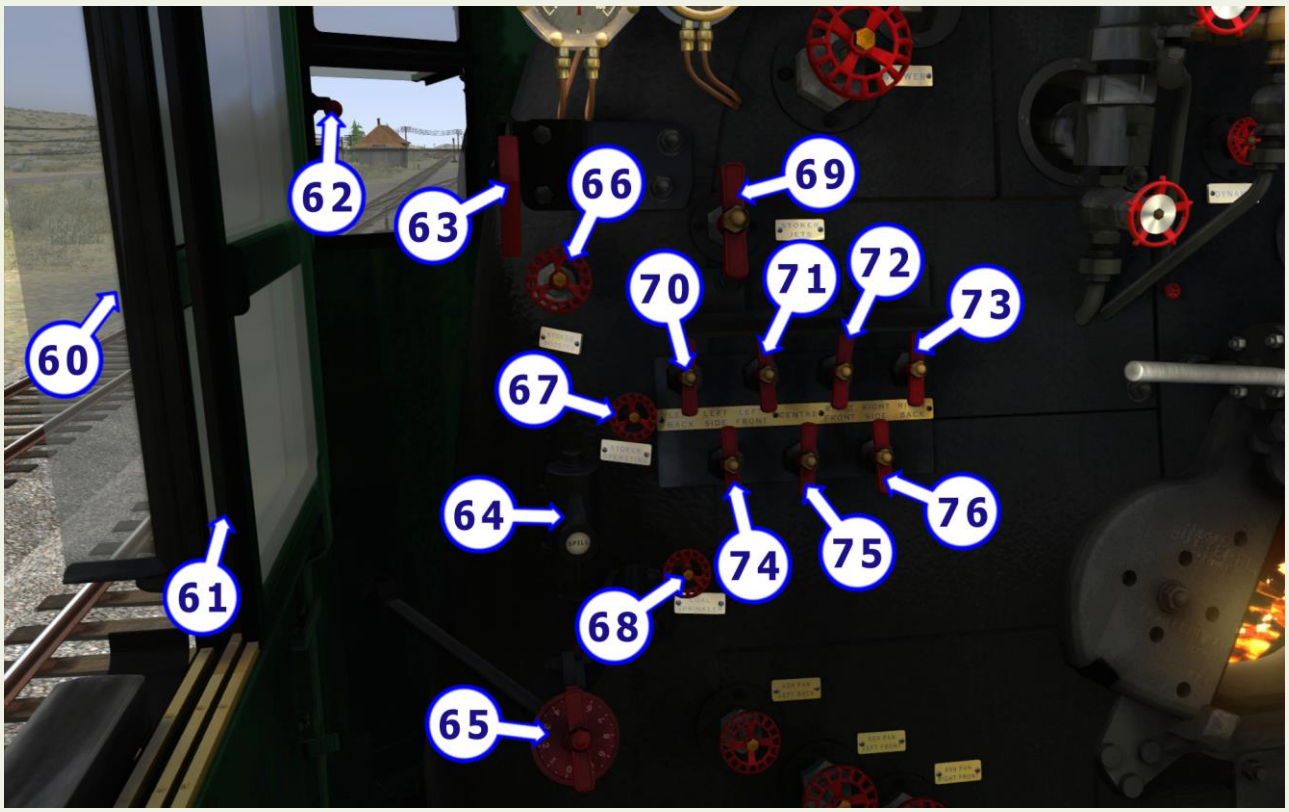


Figure 7: Cab Layout (6)

60	Windshield
61	Windows
62	Clear Vision Window
63	Exhaust Steam Injector Starting Handle
64	Exhaust Steam Injector Overflow Indicator
65	Exhaust Steam Injector Water Regulator
66	Stoker Booster
67	Stoker Operating Valve
68	Coal Sprinkler
69	Stoker Intermediate Jet Valve
70	Stoker Jet Left Back
71	Stoker Jet Left Front
72	Stoker Jet Right Front
73	Stoker Jet Right Back

74 Stoker Jet Left Side

75 Stoker Jet Center

76 Stoker Jet Right Side

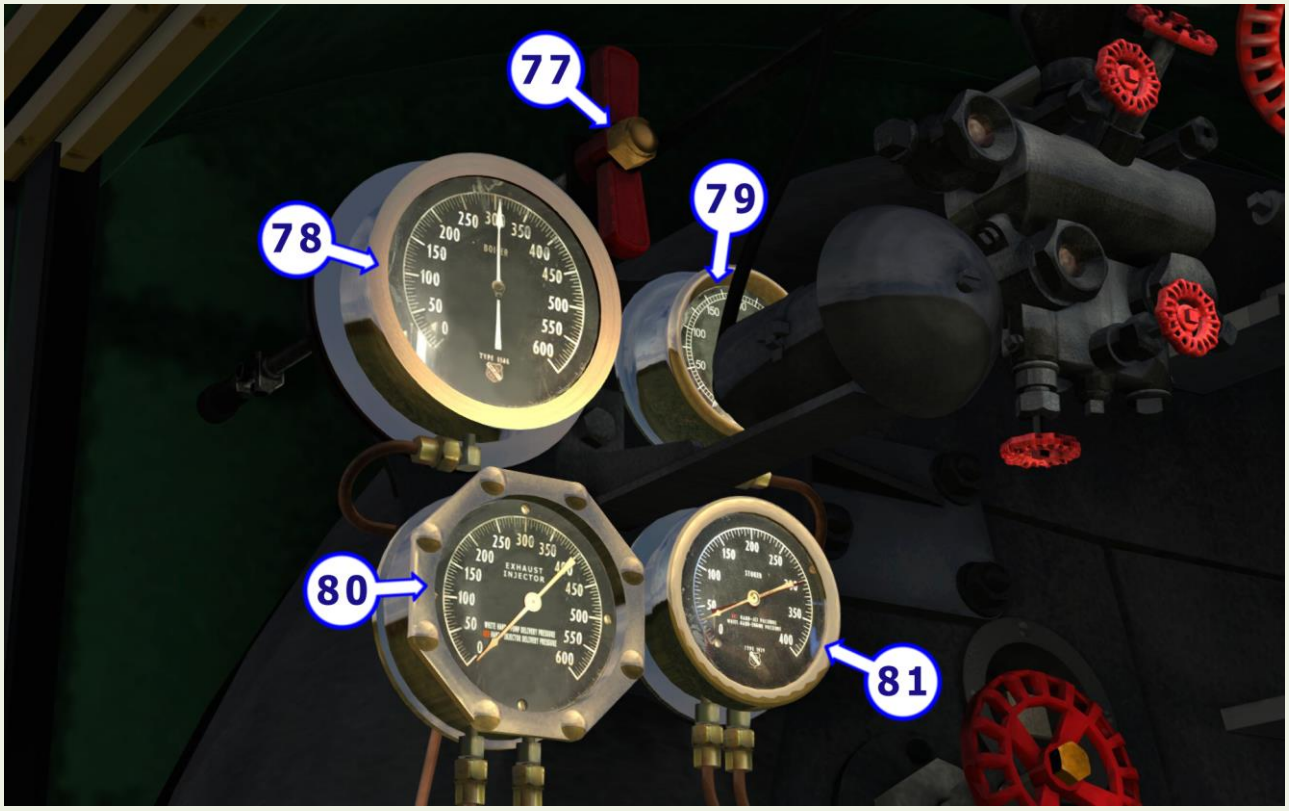


Figure 8: Cab Layout (7)

77 Smoke Lifter

78 Boiler Pressure Gauge

79 Steam Heat Gauge

80 Exhaust Steam Injector Dual Pressure Gauge -
Injector Delivery (red hand) and Pump Delivery (white hand)

81 Stoker Dual Pressure Gauge - Jet Pressure (red hand) and Engine Pressure (white hand)

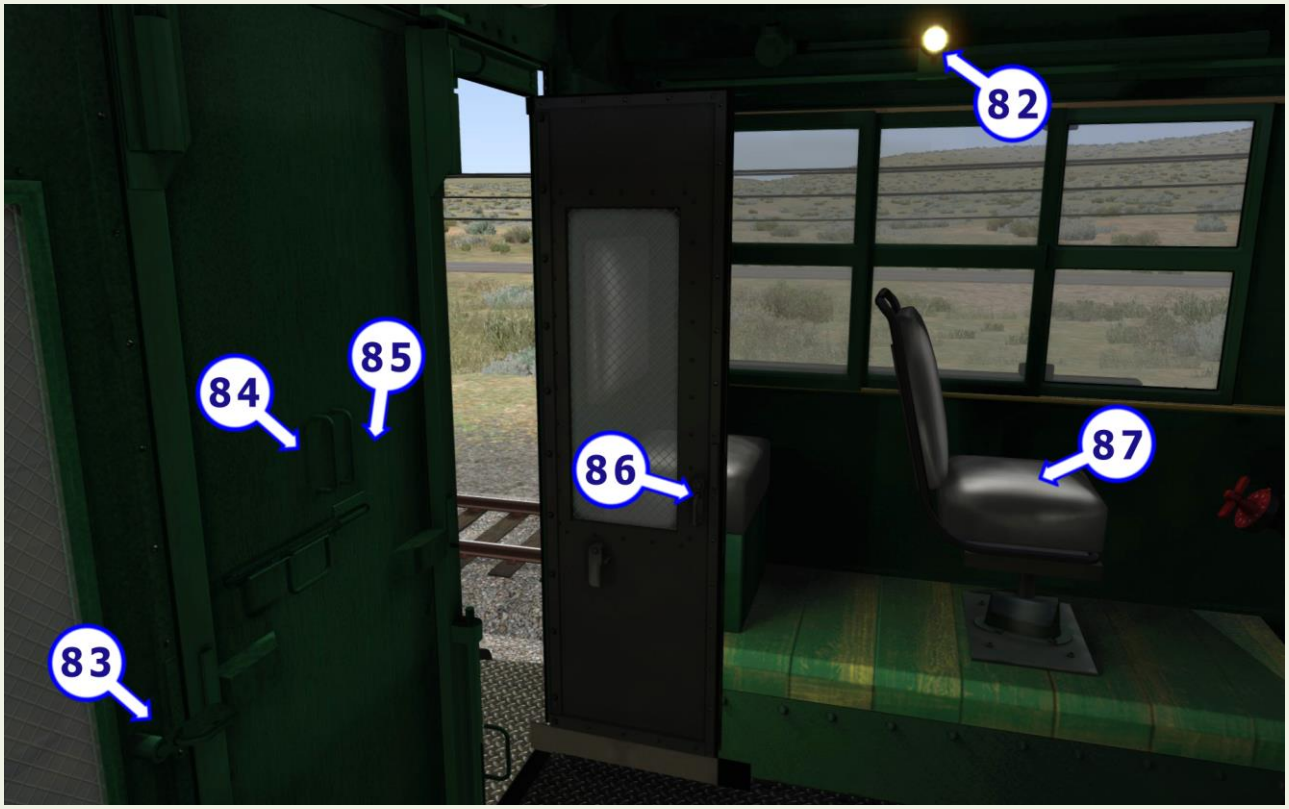


Figure 9: Cab Layout (8)

82 Cab Light

83 Door

84 Doors

85 Doors

86 Door

87 Expert Automatic Fireman Toggle

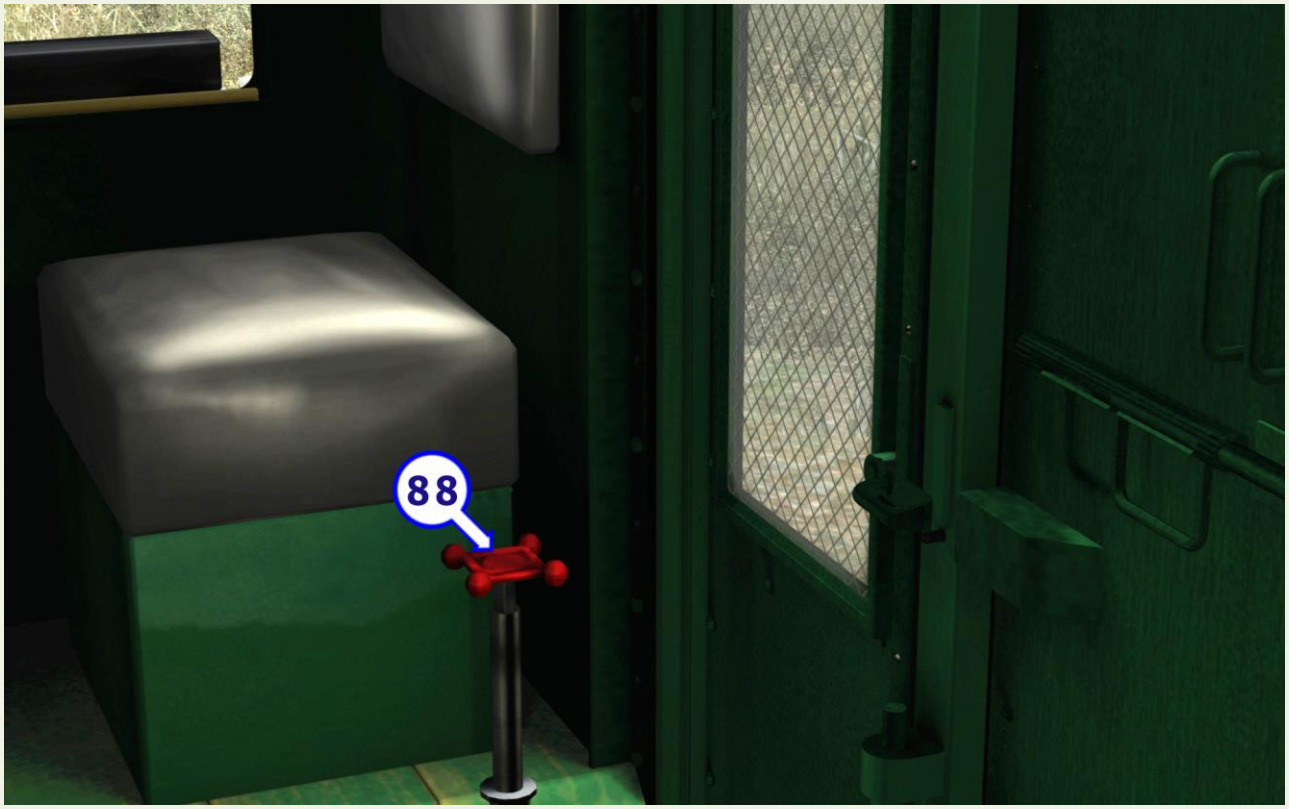


Figure 10: Cab Layout (9)

88 Live Injector Water

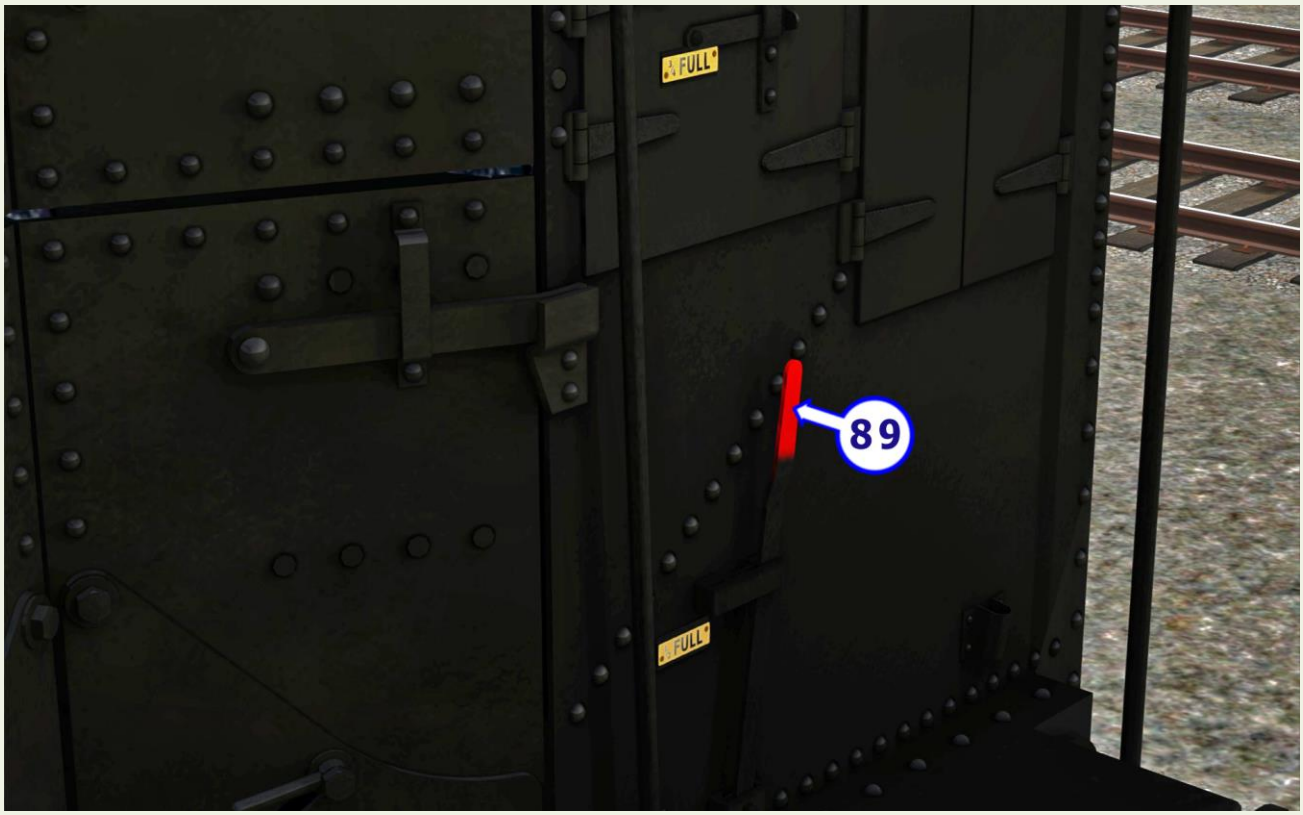


Figure 11: Cab Layout (10)

89 Stoker Reverser (*shown here in its forward position*)

Keyboard and Mouse

In the following table, when the " **Key or mouse click / drag**" column indicates "click" or "drag", it means there is no key-binding for that control and it has to be operated solely using the mouse. Most controls that do have key bindings can also be operated with the mouse.

Item	Key or mouse click / drag	Action	Remarks
Engineer's controls			
Throttle	A	Increase	The throttle controls the rate at which the steam chest (not the cylinders) is filled with steam.
	D	Decrease	
Reverser	W	Forwards	The reverser controls the cut-off, i.e. for how long steam is admitted to the cylinders on each piston stroke, as well as the direction of travel (although it is possible, in the right circumstances, to be traveling forwards with the reverser in reverse, and vice-versa).
	S	Reverse ("Hook up")	
Engine Brake	Right square bracket ( ])	Turn anti-clockwise	To perform a quick application, continue pressing "]" when the handle is all the way to the right, otherwise it will automatically spring back to the "slow application" position.
	Left square bracket ([ )	Turn clockwise	Holding down "[" (or using the mouse to drag the engine brake lever to the left continually) will bail off the pressure in the engine brake cylinders. The lever is spring-loaded, so when "[" (or the mouse) is released, the lever springs back to the "release/ running" position.
Train Air Brake	Apostrophe	Turn anti-clockwise	Six positions. From left to right: Release, Running, First Service, Lap, Apply and Emergency.
	Semicolon	Turn clockwise	
Locomotive Emergency Brake Cylinder Pressure Control	Click	In / out	If an emergency brake application occurs while this lever is in the IN position (handle pointing away from the engineer), the rate of increase of engine brake cylinder pressure is reduced, so as to reduce the likelihood of the consist running into the locomotive because of the superior braking force of the latter compared to the former.

Item	Key or mouse click / drag	Action	Remarks
First Service Position Cock	Click	In / out	While in the IN position, the brake handle detent to the right of the Running position performs the First Service function. Otherwise, in the OUT position, it acts as another Lap position (but closer to the Running position, making it ideal for performing partial release of the train brakes along the consist). First Service causes the equalizing reservoir and brake pipe pressures to drop by 6 to 8 pounds at regular service rate and continue at a reduced rate so as to obtain a reduction of 20 pounds from standard pressure (90 pounds, in freight service) in approximately 2 minutes.
Water Gauge	Click	Open / close	The three water gauge valves indicate, by means of steam or water emitting from them when open, the level of water in the boiler. They can be used to verify that the sight glasses are giving reliable indications.
Live Injector Water Valve	L	Open / close	Admits water from the tender into the live injector. Note that the F4 HUD, if it is on-screen, overrides the keyboard controls for this item.
Live Injector Lever	O	Open	When opened, allows the live injector to ram water into the top of the boiler.
	Shift O	Close	
Sander	X	Open / close	
Whistle	Spacebar	Pull handle	
	Spacebar Return	Quill the whistle	
Bell	B	On / off	
Rail Washer	Click	On / off	Aims a jet of steam behind each of the rear driving wheels of the back engine to clear sand from the top of the rails.
Cylinder Cocks Master	Ctrl C	Open / close	Steam will be expelled from the cylinder cocks only when they are open AND the regulator is not fully closed AND the master cock is open. There will be a catastrophic failure if the cylinder cocks are not used after the loco has been stationary for some time, as a result of steam condensing in the cylinders. By default, Cylinder Cocks Master is open and Cylinder Cocks is closed.
Cylinder Cocks	C	Open / close	

Item	Key or mouse click / drag	Action	Remarks
Reverse Gear Steam	Click	Open / close	In real life the yellow triangular knob controls the emergency steam supply to the power reverser (*not implemented*). In the model, this control is used to toggle on/off the display of brake-related pop-up messages.
Blow Off Cock Shut Off	Click	Open / close	Opening the blow off cock shut off allows the sludge separator in the turret just ahead of the cab to operate when the sludge remover lever is tapped.
Sludge Remover	Shift F8	Open (to close, release button)	Removes sludge from the boiler water jacket surrounding the firebox.
Defroster	Click	Open / close	The defroster uses air to clear the small windows in the front of the cab (*not implemented*).
Smoke Stack Hood	Ctrl Shift D	Open / close	The clamshell smoke hood is used in practice to protect the roofs of tunnels from the strong blast coming from the locomotive's stack.

Item	Key or mouse click / drag	Action	Remarks
Fireman's controls			
Firebox Butterfly Doors	F	Open	
	Shift F	Close	
Exhaust Injector Starting Handle	I	Pull	Pull to start the injector, push to stop it.
	Shift I	Push	
Exhaust Steam Injector Water Regulator	K	Increase	
	Shift K	Decrease	
Blower	N	Increase	Increasing the blower helps to generate steam more quickly, although it also uses steam, and to clear the smoke from inside the firebox (making it easier to check the state of the coal bed).
	Shift N	Decrease	
Smoke Lifter	Drag	Open / Close	Changes the velocity of the particles emanating from the stack.
Stoker Reverser	Click	Forward / Reverse	Forward (lever leaning outboard) to put coal in the firebox, Reverse to clear a blockage in the stoker auger.

Item	Key or mouse click / drag	Action	Remarks
Stoker Operating Valve	Drag	Open / Close	
Stoker Booster	Drag	Open / Close	
Stoker Intermediate Jet Valve	Drag	Open / Close	Also referred to as the "stoker jet manifold".
Stoker Jet Left Back	Drag	Open / Close	
Stoker Jet Left Front	Drag	Open / Close	
Stoker Jet Right Front	Drag	Open / Close	
Stoker Jet Right Back	Drag	Open / Close	
Stoker Jet Left Side	Drag	Open / Close	
Stoker Jet Center	Drag	Open / Close	
Stoker Jet Right Side	Drag	Open / Close	
Coal Sprinkler	Click	Open / close	Non-functional
Ash Pan Left Back	Click	Open / close	Non-functional
Ash Pan Left Front	Click	Open / close	Non-functional
Ash Pan Right Front	Click	Open / close	Non-functional
Ash Pan Right Back	Click	Open / close	Non-functional
Ash Pan Middle	Click	On / off	Toggles the visibility of the optional smoke deflectors (technically called "Wind Wings") on each side of the smoke box. *Note: They were installed experimentally on #4019 in the late 1940s.*

Item	Key or mouse click / drag	Action	Remarks
Other controls			
Water Sight Glasses Blow-down	Click	Open / close	The water sight glasses should be "blown down" at the beginning of every run, and at least hourly after that, to prevent clogging that will cause them to give false readings. An indication of clogging is that the amount of sloshing, at speed, is greatly reduced.
Water Column Blowdown	Click	Open / close	The water columns also have to be blown down to prevent clogging.
Dynamo	Click	Open / close	The steam-driven DC generator (dynamo) supplies electricity to all the lights. So, if the generator is stopped, the lights will be extinguished.
Foam Meter Test	Click	Test	Tests the two lamps in the Signal Foam Meter.

Item	Key or mouse click / drag	Action	Remarks
Doors and windows			
Cab Window (front left)	comma	Open / close	Open by default.
Cab Window (front right)	period	Open / close	
Roof Ventilator Hatch	Ctrl T	Open / close	Open by default.
Cab Doors (left)	Shift Home	Open / close	Open by default.
Cab Doors (right)	Shift End	Open / close	Open by default.
Cab Side Door (left)	Home	Open / close	Closed by default
Cab Side Door (right)	End	Open / close	Closed by default
Cab Windshield (left)	Ctrl comma	Fold / extend	The narrow windshields attached to the cab windows can be pushed flat or extended.
Cab Windshield (right)	Ctrl period	Fold / extend	
Clear Vision Window (left)	Pg Up	Open / close	The "clear vision" (also referred to as "storm") windows afford a clearer view ahead when it's raining.
Clear Vision Window (right)	Pg Dn	Open / close	

Item	Key or mouse click / drag	Action	Remarks
Side Vent (left)	Click	Open / close	
Side Vent (right)	Click	Open / close	

Item	Key or mouse click / drag	Action	Remarks
Lights			
Classification Lights	U	Off → White → Red → Green	There is no corresponding cab control. That is because in the real loco, the light was controlled by a lever under its casing.
	Shift U	Green → Red → White → Off	
Headlight Selector Switch	H	Rear Dim → Rear Full → Off → Front Full → Front Dim	The corresponding values on the F4 HUD headlight button are as follows: 1 = Rear Dim 2 = Rear Full 3 = Off 4 = Front Full 5 = Front Dim
	Shift H	Opposite direction to H	
Shadows cast by bright lights	Ctrl Shift S	Toggle on/off	Switching off the shadows cast by the headlights (or the tail light on the tender) can give a few extra frames per second when needed. By default, shadows are on. Only bright lights, not dim, cast shadows.
Cab Lights	Minus (-)	On / off	They can be switched on/off individually by left-clicking on them with the mouse. The shadows they cast can be toggled on/off with Ctrl Shift S.

Item	Key or mouse click / drag	Action	Remarks
Gauge Lights	Equals (=)	On / off	There are several small lights to illuminate various gauges.
Injector Light	Click	On / off	The light is under the cab on the right-hand side.
Running Lights	Click	On / off	There are two running lights on each side of the locomotive, beneath the runboards.
Back Up Red Light	Click	On / off	The back up red light is at the rear of the tender, above the taillight.
Train Indicator Lamps	Ctrl Shift N	On / off	There is no switch for the train indicator lamps. In reality they would be turned on and off by disconnecting them or removing the bulbs.
Headlight Beam	Ctrl Shift H	On / off	Toggles the beam of light cast by the "Front Full" headlight. By default, the beam is off, but it's advisable to toggle it on during the hours of darkness.

Item	Key or mouse click / drag	Action	Remarks
Miscellaneous simulation control commands			
Expert Automatic Fireman	Ctrl Shift A, or click on the fireman's seat cushion	Enable / disable	This automatic fireman is specific to the Big Boy. It controls the exhaust injector, stoker engine, stoker jets, blower and the water gauge blowdowns.
Expert Automatic Engineer	E, or click on the engineer's seat cushion	Enable / disable	The automatic engineer is unique to the Big Boy. It adjusts the throttle and reverser in order to accelerate towards track speed without losing too much boiler pressure. It will try not to exceed the speed limit. However, it does not control the brakes, except to release them as soon as it is activated. Therefore, the player may have to take over manual control when in danger of speeding, such as going downhill, or to bring the train to a stop.
Performance Report	Ctrl Shift R	Show	Enables a pop-up message giving summary information on various aspects of operating the locomotive. It remains on screen for a few seconds.
Locomotive Number Selector	Shift 5	Cycle upwards	Changing the locomotive number also changes the build number and date (month) on the builder's plates. The locomotive numbers cycle through the series 4000 - 4019.
	Ctrl 5	Cycle downwards	
"Big Boy" Chalk	Ctrl Shift B	Write / Erase	"Big Boy" is written in chalk on the smoke box door.

Item	Key or mouse click / drag	Action	Remarks
Track Condition	Shift 3	Worsen	The track condition is selectable . It starts off as "dry" (practically impossible to induce wheelslip), but the slipperiness can be increased progressively through "rain", "snow" and "wet leaves" (very easy to slip). Ctrl 3 progressively decreases the slipperiness. *The track condition is initialized automatically in accordance with the weather and season at the start of each scenario.*
	Ctrl 3	Improve	
Pilot Door	Ctrl Shift P	Open / Close	The front coupler is attached to the pilot door, which rotates to reveal or hide the coupler.
Base Smoke Density	Shift 4	Decrease	Allows the base density of the stack smoke to be selected between "Dense", "Normal", "Light" and "Sparse". The default is "Normal".
	Ctrl 4	Increase	
Tender Water Tank Lids.	Shift W	Open / close	Cosmetic (visual) feature. The tender can be refilled regardless of whether the lids appear open or closed.

Cab Views and Head-Out Views

Cab Views ("1" key)

The cab is entered by pressing the "1" key. There are multiple cab camera positions. Use the left and right arrow keys to move from one position to another:

These cab views already include head-out views from which you can see the track ahead as well as operating the controls with the mouse (if you turn your virtual head a little bit towards the interior of the cab).

Head-out Views ("Shift 2" key combination)

The two "traditional" left and right head-out views place you at the rear of the cab deck looking forward. Note that, because of the way TS works, the "Shift 2" head-out views give lower frame rates than the "1" key cab views. Therefore, even though they are provided for completeness, it is recommended to avoid using the "Shift 2" views.

Expert Automatic Fireman (EAF)

The standard automatic fireman in Train Simulator™ cannot fire this model of the Big Boy correctly and so it ought to be disabled (via the game settings menu). The locomotive will still work even if the standard automatic fireman is enabled, but the operation will be less than optimal.

The model includes its own scripted "Expert Automatic Fireman" (EAF) which does a far better job of managing the fireman's controls including the stoker, exhaust injector and blower, and will also perform the periodic blow-downs of the sight glasses and water columns.

The EAF is enabled by default but can be toggled on or off at any time simply by mouse-clicking on the fireman's seat cushion or by pressing 'Ctrl Shift A' on the keyboard.

Expert Automatic Engineer (EAE)

Introduction to the Expert Automatic Engineer

This model features an "Expert Automatic Engineer" (EAE).

The EAE is scripted to do what an expert player would do in order to get maximum performance out of the locomotive.

Once every second, the EAE assesses the state of the locomotive - boiler pressure, acceleration, speed, back pressure, steam chest pressure, throttle, reverser, brake system as well as upcoming speed limit changes - and adjusts the controls to get the best performance while maintaining boiler pressure as close as it can to just below 300 psi.

The EAE is disabled by default but can be toggled on and off at any time simply by mouse-clicking on the engineer's seat cushion or by pressing 'E' on the keyboard.

The EAE can be used at the same time as the expert automatic fireman (EAF). It is also possible to enable the EAE and disable the EAF, so that the player can fire manually without needing to worry much about the engineer's tasks.

To give some idea of the power of this feature, consider this example: If the EAF and EAE are both enabled at the start of a scenario starting at Ogden yard, on the Wasatch Grade route, it's possible to run the entire way to Evanston with hardly any intervention, giving the player complete freedom to watch the train and enjoy all the different camera angles. The player would need only to turn on the headlights, blow the whistle and ring the bell, all without having to switch off the EAE, but would need to take over control near Echo to bring the train to a stop and refill the tender before

continuing on to Evanston with the EAE re-enabled, and when close to the final destination would need to take over one more time to bring the train to a halt.

Specific Actions Carried Out by the Expert Automatic Engineer

Specifically, the actions the EAE takes, depending on its assessment of the situation, are as follows:

- If the locomotive's driving wheels start to slip, the EAE will apply sand and turn on the rail washers.
- If the boiler pressure is dropping or the locomotive is getting close to the current speed limit or wheel slip is happening despite applying sand, the EAE will reduce the throttle. Otherwise the EAE will gradually open up the throttle.
- If the boiler pressure is dropping or the cylinder back pressure is getting too high, the EAE will gradually shorten the cutoff (reduce the reverser).
- If the boiler pressure is above 296 psi and not dropping, the EAE will gradually increase the cutoff (increase the reverser).
- If there is a risk that foam in the boiler might be starting to clog the water gauges, the EAE will use the sludge removers.
- When the locomotive is at a standstill, the EAE will put the reverser at full (80%) forward cutoff (80% on the F4 HUD panel, 100% on the F5 HUD display).
- If the speed is sufficiently below the current and upcoming speed limits, if any, the EAE will perform partial release of the brakes, i.e. it will move the automatic train brake back and forth between the RUNNING and FIRST SERVICE/LAP positions, eventually leaving it in RUNNING when the equalizing reservoir pressure reaches 90 psi. Otherwise it will be moved to the SERVICE position for one second followed by LAP. Further service applications will be made if necessary but without exceeding a total reduction of 26 psi in the equalizing reservoir pressure, i.e. a full service reduction.
- The engine brakes will be bailed off whenever the brake cylinder pressure exceeds 10 psi.

Immediately after the EAE takes over from the player, it will perform certain additional actions:

- If the Blow Off Cock Shut Off is closed, the EAE will open it.
- If the brakes are set, the EAE will release them by moving the automatic train bake handle to RUNNING and bailing off the engine brakes.

- The First Service Position Cock will be switched to the "OUT" position.
- If the locomotive is at a standstill, the EAE will open the cylinder cocks.

Limitations of the Expert Automatic Engineer

The EAE does not blow the whistle, ring the bell or change the setting of the headlight selector. Those are left to the player to operate.

The EAE is not endowed with complete knowledge of routes. It will attempt to anticipate changes to the speed limits and brake in time but it cannot guarantee that it will avoid speeding. Therefore, the player must still pay attention and be ready to take over manual control.

The EAE will not stop the locomotive. Instead, the player has to take over manual control to bring the train to a halt.

Firing Manually

Controls for Manual Firing

The locomotive can be fired manually by toggling off the expert automatic fireman (Ctrl Shift A, or alternatively, mouse-click on the fireman's seat cushion).

However, manually firing the Big Boy is quite complicated - there's a lot more to do than in a standard model of a steam locomotive in Train Simulator so you'll need to read this section thoroughly.

The main controls you will use as fireman to manage the boiler pressure are as follows:

- **Steam-driven automatic stoker** (a Standard Modified 'B', or "MB", model), comprising the stoker engine located inside the tender (but controlled from the cab) and the stoker jets.
- **Elesco exhaust steam injector (ESI).**
- **Nathan Type 4000 Non-Lifting Live Injector**
- **Blower**, which directs high-pressure steam up the stack so as to increase the draft and vacuum that draws heat (as well as smoke and cinders) away from the firebox, through the flues that transfer the heat to the water in the boiler.

At the start of each scenario, the automatic fireman is already enabled and everything is set for normal firing, so if the auto-fireman is subsequently switched off (for manual firing), nothing needs to be done urgently. It is just a matter of continuing to monitor the boiler pressure and water levels, and adjusting the stoker and injector as necessary.

Managing the Automatic Stoker

The stoker engine uses an auger (it looks like a very large corkscrew) to carry lumps of coal from the tender, through a conduit under the cab and up to the mouth of a trough just below the ledge that can be seen when the firebox doors are open. The MB-type stoker motor is capable of feeding up to **22,000 lbs of coal per hour** to the firebox.

The direction of the stoker auger is controlled by the **Stoker Reverser** lever at the front of the tender. When it is pointing outboard, the stoker turns forwards to deliver coal to the firebox. To reverse the direction, which is necessary to remove blockages in the auger, the lever is moved to point inboard.

Stoker jets are positioned near the firebox door opening and set up so as to use high-pressure steam to hurl the lumps of coal towards seven different areas of the firebox, in order to spread the coal evenly over the entire grate.

The rate at which the automatic stoker delivers coal to the firebox is governed by the speed of the stoker engine, which is controlled by the **Stoker Operating Valve**. Pulsations on the Engine Pressure needle of the Stoker Dual Pressure Gauge give an indication of the running speed of the stoker. The engine pressure reading on the stoker gauge should vary between **15 and 25 pounds** during normal operation.

There is an additional steam supply controlled by the **Stoker Booster** valve which increases the stoker engine power to clear exceptionally large clumps of coal. The stoker gauge's engine pressure reading will normally fluctuate a little; but if it moves up to approximate boiler pressure and remains there, it indicates that the stoker engine has stalled. This is usually caused by an obstruction lodged in the crusher zone in the tender trough. This is the only time when the Stoker Booster should be used.

The **ideal fire mass** for the firebox is set at **6,000 lbs** of coal. At this level, the fire will be at its hottest. The farther away the actual fire mass level gets from the ideal level, the poorer the rate of steam generation. This is because too much coal smothers the fire and makes it difficult for oxygen to travel through the grates, while too little coal means the grate space of the firebox is being underutilized and the locomotive's power dwindles.

Note: In real life, grates that aren't covered by coal can actually melt and the cold air traveling through open grates can damage the firebox interior. Likewise, fluctuations between too much and

not enough cause unnecessary wear and tear on the boiler and firebox. Fortunately for the player, damage to the boiler and firebox is not simulated in this model.

Even when the fire mass is at the ideal level, the steam generation will still be impaired if the coal isn't distributed evenly enough over the entire grate. The purpose of the **stoker jets** (these consist of narrow, carefully aimed jets of steam near the opening of the stoker trough and pointing towards the interior of the firebox) is to distribute the lumps of crushed coal, delivered by the stoker auger, to seven different areas of the firebox.

The seven areas of the firebox that are served by stoker jets are referred to as:

- Left Back
- Right Back
- Left Front
- Left Back
- Right Side
- Left Side
- Center

Note: "back" is nearest to the firebox door and "front" is nearest to the smoke box.

The stoker jets are near the firebox door opening, which means the front of the firebox is farthest away from the jets, then the sides and center, while the back of the firebox is nearest to the jets. Nominally, the farther a jet has to throw its portion of coal into the firebox, the more pressure it needs , so the more its corresponding valve has to be opened relative to the other jets.

In order for the jets to work at all, the **Stoker Intermediate Jet Valve** has to be opened to supply the manifold to which the seven individual jets are connected. For the average grade of coal, which the model assumes is carried by the tender, around **100 to 150 pounds** stoker jet manifold pressure is required to obtain proper distribution. If the boiler pressure changes, the Stoker Intermediate Jet Valve has to be adjusted to maintain the required stoker jet manifold pressure. Setting the pressure to less than 100 pounds will cause the coal to accumulate more at the back of the firebox. Likewise, if it is set higher than 150 pounds, the coal will tend to go more towards the front of the firebox.

The draft from the smoke box along with the vibration of the locomotive causes coal to "migrate" from the back of the firebox towards the front, meaning that the "back" jets may have to be opened more to compensate for this. The migration is especially noticeable when the locomotive is traveling fast and/or working hard.

If the stoker jets are not balanced correctly, coal will start to pile up unevenly in one or more areas of the firebox. Eventually, it will produce banks of coal that can be seen if the firebox doors are opened. It's important to keep an eye on the operation of the stoker jets by opening the firebox doors and looking carefully to see if banks of coal are appearing. Three examples are shown below:

Figure 12: Coal Bank, Left Back

Figure 13: Coal Bank, Left Side

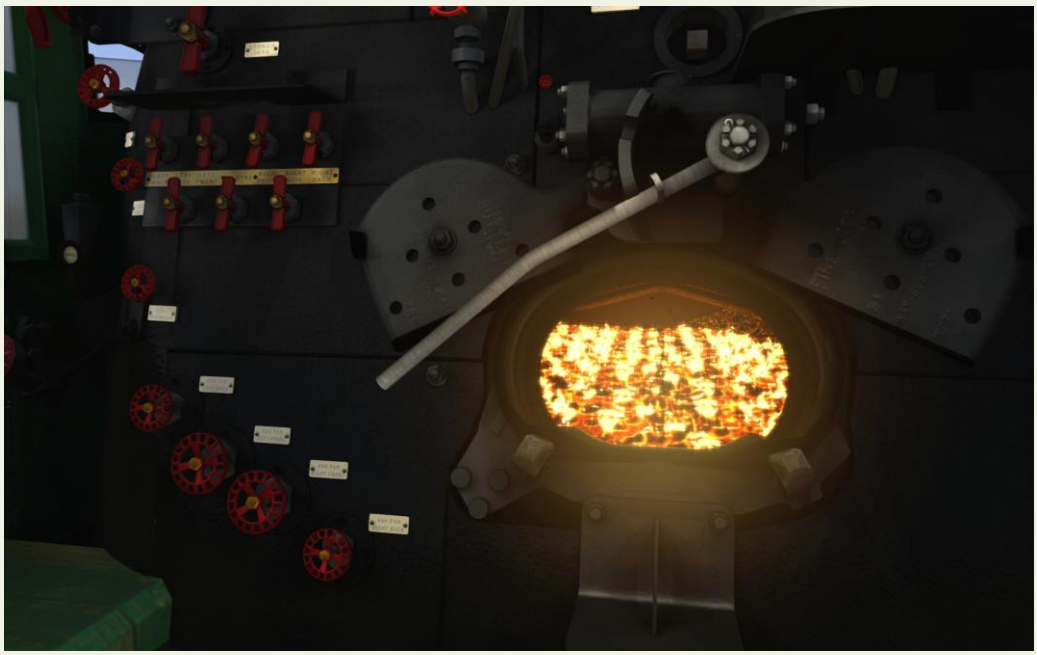


Figure 14: Coal Bank, Right Front

Note: If the smoke inside the firebox makes it difficult to see the coal banks at the front of the firebox, turn up the blower to clear the smoke.

Another way to check the state of the firebox is to bring up the Performance Report (Ctrl Shift R). It provides a lot of detail about the "unevenness" of the coal bed and how the stoker jets are currently set.

If in doubt, it's recommended to re-enable the expert automatic fireman, which does an excellent job of controlling the stoker jets and stoker engine.

Managing the Level of Water in the Boiler

There are two injectors:

- On the fireman's side, the **3 inch Elesco T.P. 400 Exhaust Steam Injector**
- On the engineer's side, the **Nathan Type 4000 Non-lifting Live Injector**

Elesco T.P. 400 Exhaust Steam Injector (ESI)

The ESI is mounted on the left-hand side of the locomotive's smoke box below the front runboard.

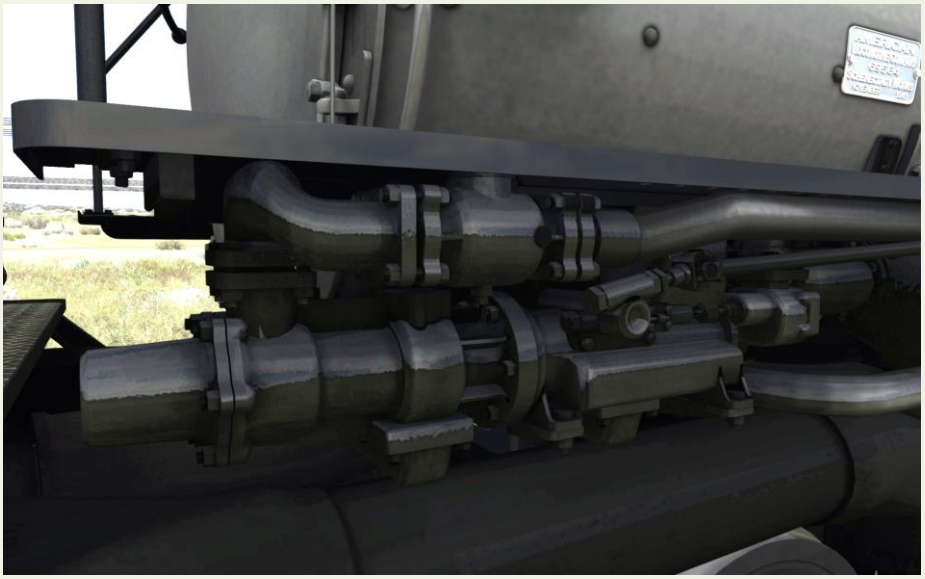


Figure 15: Elesco T.P. 400 Exhaust Steam Injector

An overflow sensor is attached to a bracket on the front of the smoke box. When the centrifugal pump under the cab is supplying the injector with cold water but the injector is not yet delivering water to the boiler, the water in the overflow chamber of the injector rises and the sensor sends an electrical signal to the Overflow Indicator in the cab.

Figure 16: ESI Overflow Sensor

The injector is started by operating the Starting Valve, located just outside the cab on the left-hand side of the boiler.

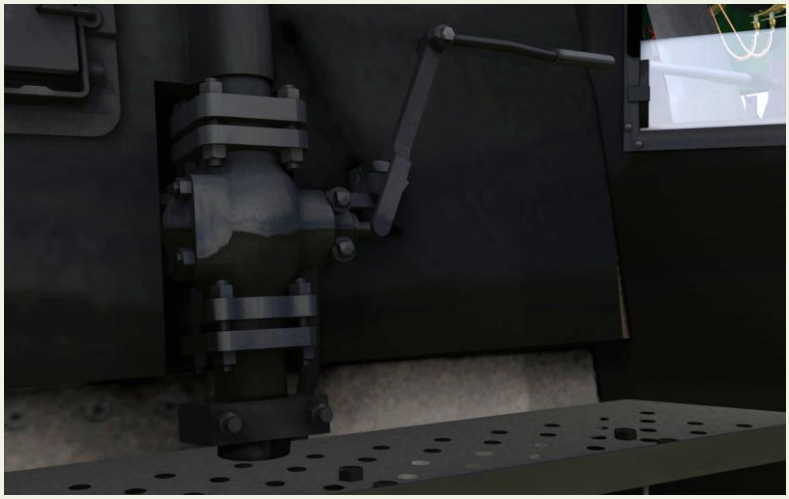


Figure 17: ESI Starting Valve

The valve is operated with the Starting Handle in the cab, pulling it backwards to start the injector and pushing it forwards to stop the injector.

As well as initiating the flow of steam and water through the injector chambers, the starting valve delivers high-pressure steam to the centrifugal pump so that it can send cold water to the injector.

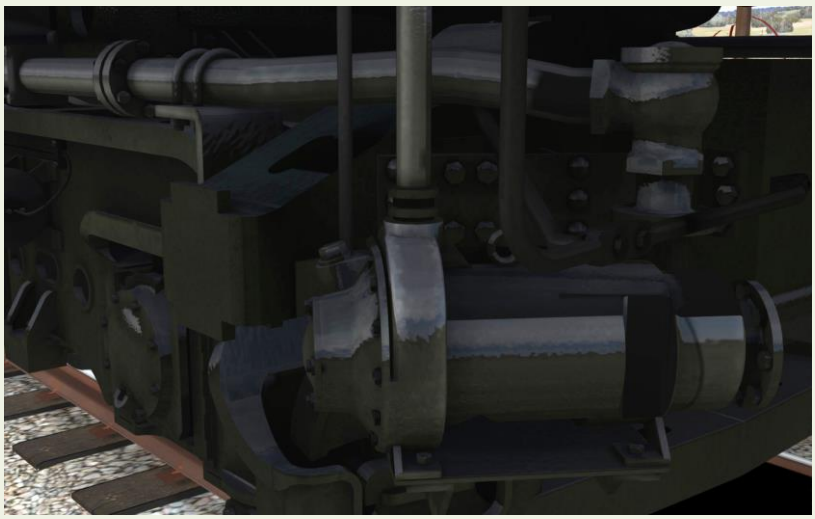


Figure 18: ESI Centrifugal Pump

The procedure to start the ESI is as follows:

1. Set the water regulator to at least 3, so that there will be enough water reaching the injector to allow the initial jet of steam to "pick up" the water from the inlet.

2. Pull the starting handle backwards about halfway and pause for a moment until the "Spill" lamp illuminates. If it hasn't lit up after about one second, push the starting handle forwards, wait a moment and try again.

3. Pull the starting handle all the way back and check that the injector dual gauge is showing the nominally expected pressures (cold water delivery and injector delivery):

Figure 19: ESI Nominal Pressures

Note: The ESI uses exhaust steam whenever there is enough of it (a minimum of about 6 psi is needed) coming from the cylinders. When the exhaust steam is insufficient, the injector switches over automatically to use live steam (from the boiler) that goes through a pressure reduction valve to lower it to 6 psi. Therefore, even though it is an exhaust steam injector, the ESI can continue to work when there is no exhaust (when the locomotive is idling).

The expert automatic fireman, if enabled, will operate the exhaust injector for you, maintaining the boiler water level at approximately 0.85 (as per the value shown in the F5 HUD).

The water regulator controls the rate at which the injector puts water into the boiler. It should be adjusted as necessary to maintain the required level of water.

The four sight glasses show how much water is in the boiler. The figure below shows what they look like when the boiler water level (as per the F5 HUD) is at 0.9 with the locomotive at a standstill on level track:

Figure 20: Water Sight Glasses

The upper sight glass should show at least a half-inch of water while the engine is climbing a grade so that the front-end flues are covered with water and not scorched.

The water level shown in the water sight glasses sloshes up and down when the locomotive is moving - the amount of sloshing increases with the speed of the engine, but decreases drastically if the sight glasses become clogged with sludge. To avoid clogging, each gauge and water column should be "blown down" by opening the corresponding blowdown valves for a short time every so often (systematically at the beginning of each journey, as a preventative measure, and once every hour thereafter).

Nathan Type 4000 Non-lifting Injector

The Nathan Type 4000 Non-lifting is a "live" injector, meaning it uses steam coming directly from the boiler to force water into the boiler. It is located beneath the cab on the right-hand side:

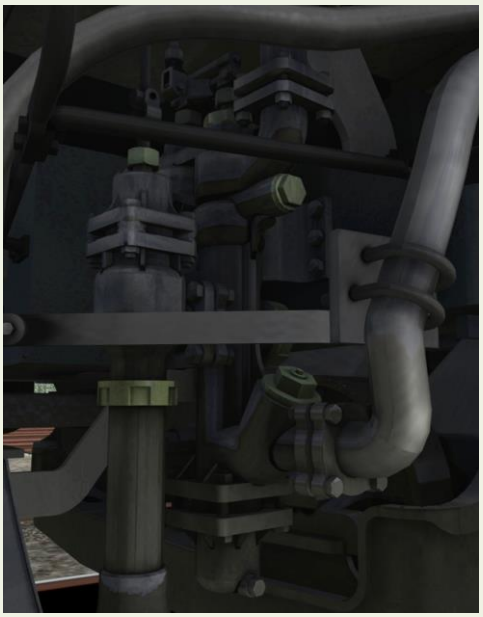


Figure 21: Nathan Type 4000 Non-lifting Injector

This injector has two controls near the engineer's cab seat:

- Just to the left of the seat, there is a notched lever to control the live steam to the injector, i.e. to activate the injector. This has a latch to seat the lever in a notch when at rest. In the model, the latch lever is squeezed automatically as soon as you start moving the injector lever and released when the injector lever stops moving - as with the reverser, it simulates the "squeeze and move" being a combined, fluid action (it avoids obliging the player to press a key unnecessarily). The purpose of the lever notches is illustrated in the following figure:

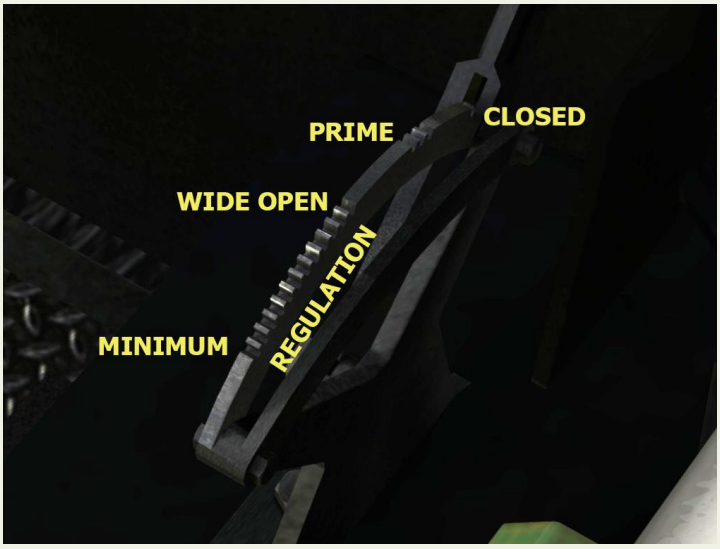


Figure 22: Nathan Type 4000 Non-lifting Injector Quadrant Notches

- Behind the engineer's seat is the control for the water to the live injector. This has to be opened to deliver water to the injector.

To operate the injector, open the water valve and move the lever to PRIME, leaving it there for at least 2 seconds, before moving the lever to the desired notch in the REGULATION arc of the quadrant. The rate of flow of the injector can be adjusted as necessary during operation.

The non-lifting injector delivers water to the boiler at a maximum rate of 216 U.S. gallons (179.9 Imperial gallons) per minute.

Power Reverser

The reverser lever in the cab operates a power reverser situated under the runboard on the right hand side of the locomotive. The power reverser is a cylinder and piston powered with compressed air from the main reservoir (a large tank in the middle of the engine frame).

The reverser lever in the cab (the "Johnson bar") has a latch mechanism to hold it in place in a notch. There is no need for you, the player, to use a separate key to release the latch. In real life, the engineer would release the latch and move the lever all in a single, fluid movement. In the simulation, it's assumed that if you move the lever, you're also squeezing the latch handle at the same time, so the animation portrays that (holding the latch lever closed while the reverser lever moves, releasing it when the lever stops). Note that there are 100 notches for the reverser (a lot more than the few notches you find on other locomotives).

Also, because the reverser is powered, and dampened by the power reverser cylinder and piston, there is no "backlash" from moving the reverser lever in the cab while the throttle is still open.

Real Steam Chest with Individual Valve Events

In expert mode, the throttle is not connected directly to the cylinders but instead there is a complex, scripted simulation of the way that the throttle actually fills up the steam chest (everything between the regulator ports, through which high-pressure steam enters from the boiler, and the valve admission ports, including the superheater tubes in-between). It can be thought of as a reservoir of steam that is emptied when the valve gear opens the admission ports to let steam into the cylinders to move the pistons and turn the wheels. The simulation fills this reservoir when the throttle is opened and empties it each time the admission ports are opened (and by an amount that depends on the cut-off and the speed of the pistons). It accounts for losses in pressure caused by condensation in the steam chest, the effect of "wire-drawing" when the valve pistons are moving fast, and the loss of pressure through the cylinder drain cocks when they are open.

If you watch the back pressure gauge (see below) while the pistons are reciprocating at slow speed, you should be able to see the needle moving up and down slightly as the cylinders fill and empty on each stroke. The effect is even more noticeable when the admission phase is longer (long cut-off).

Back Pressure Gauge

The Big Boy does not have a steam chest pressure gauge (even though it simulates, internally in the scripting, a "real" steam chest). Instead, it has a back pressure gauge.

Back pressure is produced by the exhaust steam that remains in the end of the cylinder towards which the piston is moving. To an experienced engineer, it gives a very good indication of how efficiently the cylinders are working, and when to reduce the cut-off ("hook up" the Johnson bar) or to increase it, and when the throttle needs to be adjusted to keep the right amount of steam pressure in the steam chest and for the admission segment of each piston stroke. Basically, if you want to maintain a certain back pressure, but see that it's falling, it means the steam chest is being emptied faster than it's being filled, so you would need to open the throttle a bit more to keep the filling and emptying balanced. Some engineers prefer to keep the throttle wide open and regulate the power using the reverser most of the time.

In addition to showing positive back pressure, the gauge has a range for negative values. These correspond to vacuum in the cylinders, which happens when there is no steam in the cylinder and the movement of the piston generates a vacuum as the volume on the "behind" half (the part of the cylinder that the piston is moving away from) increases. This happens, for example, when the steam chest is emptied (indicating that, perhaps, the throttle needs to be opened further to maintain the mass of steam in the steam chest) or the cut-off is reduced to the minimum (the Johnson bar is hooked up to neutral).

The script calculates back pressure and vacuum on each stroke of each piston - basically synchronizing them with the opening of each exhaust valve. Thus, at low speed, it's possible to see the gauge needle flickering in synch with the chuffs.

Note that the back pressure rises (quickly) only when the exhaust ports are ejecting steam. When the locomotive is at a standstill and you open the throttle, the back pressure needle will remain at zero until the first chuff occurs. A back pressure of zero doesn't mean that the steam chest is empty! If you have the brakes on and open the throttle, the steam chest can easily fill right up before the locomotive even begins to move, so when you do release the brakes, with the reverser fully forward, you are likely to get wheel slip. To avoid that, you can either open the throttle after releasing the brakes or fill the steam chest only partially (by opening the throttle for just a short time) before releasing the brakes. Remember that the "regulator" value seen on the F3/F4/F5 HUDs is actually an indication of how much steam there is in the steam chest.

Brakes

Notable Features of the Advanced Brake Simulation

The operation of the locomotive air brakes is modeled and simulated with the following features:

- When the train brakes are applied, air from the main reservoir is used to raise the pressure in the brake pipe (train line). This causes a drop in the main reservoir (MR) pressure, which starts at 130 psi. When the MR pressure falls to 120 psi, the steam-driven air compressor is switched on (in real life by a single-head governor) and you can hear it cycling (pumping) as it raises the MR pressure up to 130 psi again, then it stops.
- When the train brakes are applied (or "set"), the equalizing reservoir pressure drops, followed more slowly by the brake pipe pressure (remember that the black hand on the left-hand brake gauge shows the pressure at the *head end* of the brake pipe) . The two pressures eventually equalize. The time taken for the brake pipe and equalizing reservoir pressures to equalize depends on the length of the consist.

- “Peeing away your air”! This is a term used to describe what happens when a novice engineer applies and releases the brakes rapidly several times in succession, such as when going down a hill, causing the air in the auxiliary reservoirs under each car to become depleted (this makes it harder and harder to apply the brakes, and when they do come on, they do so with less and less force). It is simulated in this model. Try it!

- 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.

- Bailing off the engine brakes. The automatic brakes, i.e. the train brakes, also affect the engine brakes (in diesels, these are called "independent" brakes). In other words, when you apply the automatic brakes, the engine brakes are also applied (even if the engine brake handle is not in any "application" position (SLOW APPLICATION or QUICK APPLICATION). Moving the engine brake handle to the RUNNING position does not release the engine brakes unless the train brakes are released first. The only way to release the engine brakes while keeping the train brakes set is to "bail-off" " by holding the engine brake handle in the RELEASE position (against the pressure of the return spring).

- The 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 you 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.

Automatic Train Brakes

The various positions of the automatic brake handle are shown in the following figure:

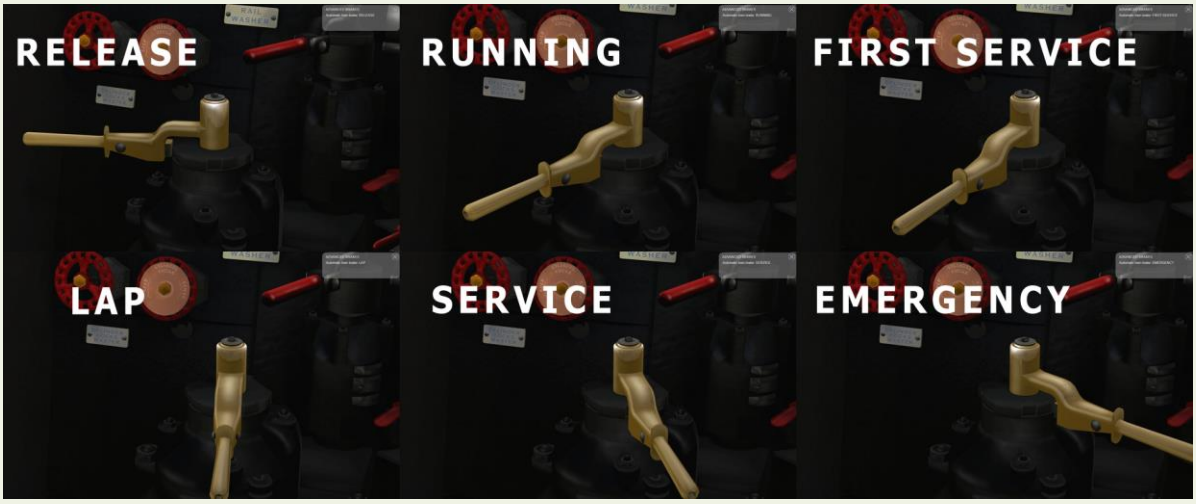


Figure 23: Automatic Train Brake Handle Positions

These positions perform as follows:

- **RELEASE**

  RELEASE connects the brake pipe directly to the main reservoir but holds the locomotive brakes, if set, applied (the brake cylinder pressure shown in the cab gauge stays steady).

  RELEASE should not be used in normal operations, because if left in this position, the brake pipe can become overcharged to more than the 90 psi setting of the feed valve. It should really be used only to recharge an empty brake pipe on a long consist and the handle would have to be moved to RUNNING before the brake pipe pressure gets close to 90 psi.

- **RUNNING**, on the other hand, releases the locomotive brakes as well as the train brakes. In this position, the equalizing reservoir and brake pipe are charged up to 90 psi. This is the normal position for recharging and releasing all brakes, and when running (in order to maintain the brake pipe at 90 psi).

- **FIRST SERVICE**. With the First Service Position Cut-out Cock (see below) set to the "In" position, FIRST SERVICE causes the equalizing reservoir and brake pipe pressures to drop by between 6 to 8 pounds at the regular service rate and then to continue dropping at a reduced rate so as to obtain a total reduction of 20 pounds , i.e. from 90 psi to 70 psi, in approximately 2 minutes. Its purpose is to assist in braking smoothly when stopping a long, heavy train.

- **LAP** stops the equalizing reservoir pressure from reducing, keeping it steady at the current pressure.

- **SERVICE** (or **APPLICATION**) reduces the pressure in the equalizing reservoir - it continues to reduce for as long as you keep the handle in this position. The drop in equalizing reservoir

pressure is followed more slowly by the brake pipe pressure as the air in the brake pipe (or "train line") vents through the "small hole" in the locomotive's brake stand. The two pressures (brake pipe and equalizing reservoir) eventually equalize but the time it takes for that to happen depends on the length of the consist.

- **EMERGENCY** gives a rapid reduction of brake pipe pressure and an emergency application of the brakes. You have to wait for the brake pipe pressure to drop to zero before being able to release the brakes.

First Service Position Cut-out Cock

To the right of the automatic train brake handle there is a small red lever called the First Service Position Cut-out Cock. It has two positions, "IN" and "OUT":

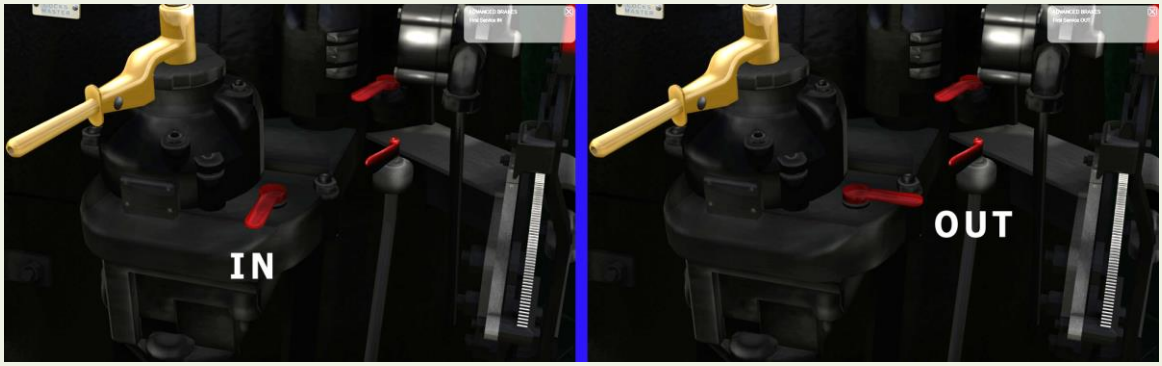


Figure 24: First Service Position Cut-out Cock

When the lever is set to "IN", the FIRST SERVICE position of the train brake handle is indeed FIRST SERVICE, but then the lever is changed to "OUT", the FIRST SERVICE brake handle position instead becomes another LAP position. This allows the engineer to perform a partial release of the train brakes. This is not to be confused with partially releasing the brakes on a railroad car (which isn't possible, because once the brakes on a car start to release, they have to release completely - there is no way to stop it). It actually means allowing the brakes along the train to release, starting with those on the cars nearest to the locomotive (the "head-end" of the train, where the brake pipe pressure rises soonest) but stopping the recharge of the brake pipe before the pressure rises enough to release the brakes on all the cars, leaving those towards the rear of the train with their brakes still on. The extra LAP position is much closer to RUNNING than is the normal LAP, which makes it easy to move the handle swiftly between RUNNING and LAP, releasing more and more of the train's brakes each time the handle is moved to RUNNING.

Engine (Independent) Brakes

The engine brake handle is behind the automatic train brake handle. It has five positions:

Figure 25: Engine Brake Handle Positions

These positions perform as follows:

- **RELEASE** releases (bails off) an automatic application of the engine brakes that occurred as a result of a brake pipe reduction following either a service or emergency application with the automatic train brake handle. This is a spring-loaded position; the handle must be held in position manually (by trying to mouse-drag it towards the left) or it will spring back to the RUNNING position.

- **RUNNING** is the normal position to carry the independent brake valve when running. It releases an independent application of the engine brakes, but not an automatic or emergency application.

- **LAP** holds the current engine brake cylinder pressure steady.

- **SLOW APPLICATION** is the normal position for applying the independent brake and for holding the brake applied when the train or engine is stopped. It produces a smooth but responsive build-up of locomotive brake cylinder pressure.

- **QUICK APPLICATION** produces a rapid increase of engine brake cylinder pressure. This is also a spring-loaded position; the handle must be held in position manually (by trying to mouse-drag it towards the right) or it will spring back to the SLOW APPLICATION position.

Locomotive Emergency Brake Cylinder Pressure Control

To the right of the engine brake handle, there is a small red lever called the " Locomotive Emergency Brake Cylinder Pressure Control" (also known as "Controlled Emergency Cock"). It has two positions, "IN" and "OUT":

Figure 26: Locomotive Emergency Brake Cylinder Pressure Control

When an emergency brake application is made with the automatic train brake, the resulting rapid drop in brake pipe pressure normally causes a correspondingly rapid increase in locomotive brake cylinder pressure. That can cause the locomotive to brake harder, and decelerate faster, than the cars it is pulling, carrying with it the risk of those cars running into the head end and derailing. To counter that possibility, the IN position results in the rate of increase of locomotive brake cylinder pressure, as the consequence of an emergency brake application, being limited to just over 1 psi per second (much slower than it otherwise would be).

The default position is IN (control), which is required for long, heavy freight consists, whereas OUT (non-control) is typically used on passenger trains, short freight trains and at all times when running light engine.

Engine Brake Bail-off

As already mentioned above, the bail-off position of the engine brake handle has been modeled, along with its spring-loaded action, so that you can release the engine (independent) brakes while the train brakes are still applied - when you push the engine 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 engine brake lever to the left continually), the engine brake cylinder pressure drops (look at the red hand on the left-hand side of the dual brake gauge in the cab) and the engine brake

pistons and shoes move, but the train brakes stay on (the white hand, denoting brake pipe pressure, on the left-hand side of the dual brake gauge 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.

Note that the opposite end of the range of travel of the engine brake handle is "quick application", used to apply the engine brakes more quickly than in the "slow application" position, but the "quick application" is also spring-loaded, so it has to be held there either by using the mouse to drag the handle to the right continuously or by holding down the right square bracket ( ]) key.

When using the F4 HUD, you can still bail-off the engine 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 about 10%.

Figure 27: Bail-off using F4 HUD Slider - Resting Position after Releasing the Mouse

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 this is something that you need to take into account when planning your 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 engine 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 engine brake cylinder pressure.

The engine brake cylinder pressure cannot rise above 65psi.

The normal pressure for the fully charged brake pipe and equalizing reservoir is 90 psi. When a reduction is made, the first 6psi reduction in brake pressure (called an "initial reduction") triggers the "quick service" feature of the 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 15psi (2.5 times 6psi) 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, by at least 1.5 psi, 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).

There is no partial release per car (brake cylinder retainers are not simulated) 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 rapidly drop to 0 psi, without stopping even if you move the handle to SERVICE, while the brake pipe pressure (shown by the gauge in the cab) continues to rise (at a rate that depends on the length of the consist).

"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 pumping 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 (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.

A good way to release the brakes smoothly (and slowly) is to put the handle in “running” rather than “release”.

Overcharged Brake Pipe

RELEASE connects the brake pipe directly to the main reservoir, circumventing the feed valve. Thus, the brake pipe pressure can continue to rise above 90 psi.

The brake pipe, in turn, recharges the auxiliary reservoirs in the cars, albeit much more slowly (this is because the auxiliary reservoirs recharge off a branch pipe, coming from the main train line, via a narrow feed groove in the triple valves which limits the rate of flow of the air into the reservoir).

If the handle is left in this position for too long, the brake pipe pressure and the auxiliary reservoirs can be charged to more than 90 psi.

When the handle is returned to RUNNING, the brake pipe gradually leaks back down to 90 psi.

However, if the auxiliary reservoirs are also charged at more than 90 psi, that leakage is detected by the cars' triple valves as a reduction, which produces an unintended brake application. The train brakes are, therefore, applied (partially) but the brake pipe is still at its nominal maximum of 90 psi, with the automatic brake handle already in RUNNING, so the brakes cannot be released (brakes are released by raising the pressure in the brake pipe, but in RUNNING, the brake pipe pressure cannot be increased above 90 psi). You can still bail off the engine brakes, but the train brakes are stuck on!

In this condition, if you move the automatic brake handle to RELEASE, the train brakes can be released, but as soon as you move it back to RUNNING, they apply again.

The method for recovering from an overcharged brake pipe is as follows:

- Make an emergency application of the train brakes (move the handle to EMERGENCY)
- Wait for the brake pipe pressure to fall to 0 psi
- Move the handle to RUNNING in order to recharge the equalizing reservoir and brake pipe to 90 psi.

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 things such as the real steam chest, the air

brakes, throttle, etc. 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 "regulator" value that you see in the HUDs is not actually the physical position of the throttle lever in the cab. It's a measure of the amount of steam in the steam chest. The "steam chest" is everything between the throttle valve, basically the dry pipe, and the cylinder admission ports.

Even if you have the throttle only slightly open, the steam chest can eventually fill up (especially if the reverser is in neutral and the cylinder cocks closed, so very little steam is being used up), in which case you see the "regulator" value on the HUDs go up to 100%. If you close the throttle completely, the steam in the steam chest will condense and the "regulator" value will start to fall gradually (meaning less steam in the steam chest).

When you see the "regulator" value going up and down, it's actually the live steam from the boiler filling up and emptying the steam chest on each stroke of each piston as the admission and exhaust ports of the cylinder valves open and close.

The values and names for the brake position that you see in the HUDs are not the position of the physical brake handles either. They actually give you a peek into what the simulation is doing "under the hood" to achieve the extremely realistic behavior of the air brakes, including the way that on a long consist the equalizing reservoir pressure changes more rapidly than the brake pipe pressure (which has to "catch up" because of the speed of propagation of the pressure wave along the brake pipe). The engine (independent) brake also manipulates the standard control values to be able to simulate bail-off. That's why, if you've put it at 0% (bail-off) and let go, it rises back up to 10% - that's the spring-loaded action that returns the handle to the RUNNING position.

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 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 engine brake cylinders.

Steam-driven Cross Compressors

The two cross compressors at the front of the locomotive (slightly hidden behind the smoke deflectors) recharge the main air reservoir when the pressure falls below 125psi, to keep the main air reservoir pressure at 130 psi.

Compressed air is used up when various equipment is operated:

- Train and engine brakes
- Power Reverser
- Sanders
- Cylinder cocks
- Bell
- Sludge removers

The compressors will work only when the Air Pump valve is open.

When the compressors are running, a plume of white exhaust steam can be seen coming from the exhaust pipe between the two smoke stacks.

Blow-off (Sludge Separation)

Situated approximately in the middle of the steam turret, just forward of the top of the cab, there is the Wilson sludge remover that separates water from steam, by a swirling action in a chamber above the boiler. This can be activated by opening the blow off shut-off cock in the cab (above the backhead) and tapping the "sludge remover" lever in the cab. Pull it down (by clicking on it and holding down the left mouse button). Doing so will expel the sludge out of the spreader located under the cab on the engineer's side and create a plume of steam from the separator.

To see the effect from outside, perform the operation in the cab but without releasing the mouse button until you are in the outside view. When you are back in the cab, click on the sludge remover lever again to release it.

Signal Foam Meter

High up in the center of the backhead there is a Signal Foam Meter. This device reacts to the amount of foam detected on the surface of the water in the boiler. Two lamps in the meter signal the detection of a "safe" level and an "unsafe" level.

Figure 28: Signal Foam Meter

If the "safe" lamp illuminates, the system will automatically activate the sludge separator for 30 seconds, to reduce the amount of foam.

If the foam is being produced so fast that it can't be blown off quickly enough, it could continue to rise, eventually causing the "unsafe" lamp to illuminate. At that point, the engineer should use the manual sludge remover and take other steps to reduce the amount of foam, such as slowing down. (the sloshing of water in the boiler that occurs at faster speeds can lead to more foam). Lowering the level of water in the boiler will also help to avoid the foam reaching the unsafe level.

The meter has a toggle switch for testing that the two lamps are in working order.

Impaired Operation

The Advanced version simulates several ways in which things can go wrong:

- Damage to the cylinders when they aren't properly drained of condensation
- Clogging of the sight gauges, because of frothing and impurities in the water, which cause them to give false readings
- Damage resulting from the mechanical stresses of overspeeding (including wheelslip at high revolutions)
- Problems caused by overfilling the boiler

All of these are in addition to the "standard" failures such as running out of water, dousing the fire, derailments ...

Cylinder Damage

When the locomotive is left standing for some time, with the cylinder cocks closed, condensation builds up in them. Water, unlike steam, cannot be compressed, so if the water is left in the cylinders when the pistons start to move, it can reach a point where the pistons are pushing up against the water. If they keep on pushing, something has to give, and it's usually the cylinder caps, or sometimes it can be worse and result in damage to the pistons and rods. To prevent that from happening, the cylinder cocks should be opened before the locomotive starts to move, so that on each piston stroke, water will be expelled from the drain cocks beneath the cylinders. After a few revolutions, the cylinder cocks can be closed - doing so means that steam pressure isn't lost through the drain cocks and it also helps to preserve the lubrication in the cylinders.

Clogging of the Water Sight Gauges and Water Columns

Once every second there is a random chance of clogging in the sight gauges or water column (each one is handled separately, so one or more could be clogged while the remainder are still working fine).

When a sight gauge is clogged, there are two visible symptoms:

- The amplitude of the sloshing that occurs at speed is greatly reduced - in other words, the level will still go up and down, but not by as much as it normally does.
- The average level indicated by the sight gauge won't change. You'll notice it if you compare the level shown on the two lower sight gauges (one facing the fireman, the other facing the engineer).

You can also use the three water gauge cocks that protrude at a downward angle from the right-hand side of the water column, starting at the top. If the water level in the column is below the gauge cock, it will make a hissing sound when you open it, otherwise you'll hear the sound of trickling water.

To clear the clogging, you have to open the corresponding blowdown valve at the very bottom of the sight gauge or column, and close it after all the water has drained away - it takes just a few seconds. In fact, as the probability of clogging increases if the sight glass or water column has not been blown down, that procedure should be followed systematically at the beginning of each journey, as a preventative measure, and once every hour thereafter.

Also note that the chance of clogging increases considerably if the boiler is kept nearly full (more than 0.9 on the F5 HUD) because of foam spilling over from the boiler, but that too can be reduced by using the sludge remover levers to do a "blow off" regularly (once every 15 minutes).

Overspeeding

When the rotational speed of the driving wheels exceeds the equivalent of 80 MPH (note that this can happen during extreme wheelslip, even if the actual speed of the locomotive is very low), damage starts to accrue in the motion and valve gear. Eventually, there will be a catastrophic failure (which will end the scenario).

Overfilling the Boiler

Care has to be taken to avoid overfilling the boiler - keep watch on the sight glasses, and especially the upper, middle one. If water starts to appear in the middle sight glass, it's a sign that the boiler is overfilling.

When the boiler is too full, two things happen. First, when the level is at around 1.23 (the value you would see on the F5 HUD), water spills over into the front end throttle valve and the throttle gets stuck. You won't be able to move it again until the water level drops below 1.00. If the water level continues to rise and reaches 1.25, water from the boiler enters the cylinders - game over!

Stoker Blockages

Once every second, while the stoker is operating, there is a random chance of a blockage in the auger that carries lumps of coal from the tender to the stoker table inside in the firebox. When this happens, a warning message will appear, the stoker engine pressure will rise continuously until it reaches boiler pressure, where it will stay, and the stoker will fall silent.

To remove the blockage, follow the procedure outlined below:

1. Turn off the steam supply to the stoker (close the "Stoker Operating" and "Stoker Booster" valves).
2. Put the stoker in reverse (click on the Stoker Reverser lever at the front of the tender so that it points inboard, i.e. towards the middle of the tender).
3. Slowly open the Stoker Operating Valve.
4. Close the Stoker Operating Valve.
5. Put the stoker in forward again (click on the Stoker Reverser lever so that it points outboard).
6. Open the Stoker Operating valve as much as needed.

Auto-numbering

In addition to the locomotive number, the model also features auto-numbering on the train consist boards mounted on the smoke box. These accept digits from 0..9 as well as "X" and "-".

The auto-numbering code that you enter into the locomotive when creating a scenario is composed of 10 characters, as illustrated with the following examples:

Example 1:

#X40144014

#X40144014 Ignored (could be used for something in a future update)

#X40144014 Train code is set to "X4014"

#X40144014 Locomotive number is set to "4014"

Example 2:

#--27-4000

#--27-4000 Train code is set to "--27-"

#--27-4000 Locomotive number is set to "4000"

Note: Regardless of how the auto-numbering has been initialized (in the Scenario Editor), the locomotive number (and the corresponding builder's plate) can be changed at any time by pressing Shift 5 or Ctrl 5 repeatedly until the desired number appears on the locomotive and tender.

Genuine Wheel Slip

The model features extremely realistic wheelslip physics using a method pioneered way back in 2013 by Smokebox.

The motion of the two articulated sets of eight driving wheels and all of the connected rods, cranks, links and valve gear, even the linkage to the mechanical lubricators, are governed by LUA scripting (the forwards backwards motion of the locomotive, as well as the rotation of the trailing and tender wheels is still controlled through the core code). This allows the model to exhibit true wheelslip behavior in different track conditions that can be selected (via key presses) by the player. When the locomotive loses traction, you will see the driving wheels slip. Wheel skid has been omitted because with its relatively small driving wheels it is very difficult to cause the Big Boy to skid.

The LUA scripting contains some quite complicated calculations for wheel inertia, momentum and adhesion, taking account of the locomotive's instantaneous tractive effort, the weight on the driving wheels (allowing for the current mass of water in the boiler), sanding and the coefficient of friction between the driver tires and the rails (or brake shoes, if applied).

The friction can be changed "on the fly" through a keystroke combination, even to the extremely slippery condition of "leaves on the track" (leaves produce a resinous black goo so slippery that not even sanding will help).

It's possible to induce wheelslip even when running "light engine" (in fact, the weight of the consist pulled by the locomotive is not a direct factor in determining wheelslip - it only affects how much power is needed to overcome the inertia of the consist and get it rolling) and, furthermore, the power reverser can be used to slow down the engine, and then when traction is lost, the wheels will spin in the opposite sense to the direction of travel of the locomotive.

Once wheelslip occurs, if it's not corrected promptly, the wheels will continue to spin faster and faster until "something bad happens" to your locomotive.

Example: If you close the throttle and put the reverser into the opposite direction, then open the throttle again, the driving wheels will slow down (losing their rotational momentum as the pistons act like brakes) and eventually rotate in the opposite direction (back-pedaling).

Note: when the reverser is put into reverse, the radius rod will be lifted into the reverse position even though the locomotive is still going forwards, and if the reverser is put into forward, the radius rod will be dropped into the forward position even though the locomotive is still going backwards.

Note: When wheelslip occurs, the engine script sets the core code reverser control to zero, in order to prevent the locomotive from accelerating (the core code, which controls the backwards/forwards movement of the entire locomotive, doesn't know that the drivers are slipping). As soon as the wheels regain traction, the control returns to where it was before the wheelslip. This may be observed if the F5 HUD is on screen. It does not affect the position of the visible reverser in the cab.

Animations

The Big Boy has a huge number (hundreds, quite literally) of animated parts and **nearly one hundred separate animation sequences**!

- The entire **valve gear and running gear** is animated.
- The animation of the Walschaert's valve gear extends to the links to the **mechanical lubricators** situated near the cylinders - watch the little red handles rotate a bit each time the ratchets on the front of the lubricators are yanked down by the combination levers when the loco is moving.
- The **reversing gear**, from the lever in the cab, through all the linkage, the Alco power reverser cylinder, down the reversing rod to the tumbler shaft and lifting links, and including the movement of the radius bar, valve piston, combination lever and union link. Basically, when you move the Johnson bar, practically everything connected to it that moves in the real loco will move in the model.
- The rods running along the outside of the boiler, connecting the throttle lever in the cab to the **front-end throttle assembly** on the side of the smokebox are animated.
- The **brake rigging and brake pistons** are animated on the engine's driving wheels and also on the trailing truck, as well as on all fourteen wheels of the enormous "Centipede" tender, including its own front articulated truck.
- All **cab doors**, **side windows**, **front storm windows**, **side and roof vents** can be opened and even the **side windshields** (attached to the cab windows) can be pushed flat or extended.

- On the tender, the **water filler lids** on the top deck can be opened.
- The **cab controls** and **gauges** are animated in both the cab view and the external model, so when you look into the cab from outside, you can see the controls and gauge needles moving just as they do in the internal cab view.

Lights

Headlights, Taillights, Classification, Marker, Cab and Gauge Lights

The locomotive has a headlight with two intensities, dim and bright, which can be selected using the keyboard or the control in the cab. When bright is selected, the headlight beam illuminates well ahead of the loco.

The tender also has a headlight that can be set to dim or bright.

The locomotive also has two 3-colour classification lights. These have to be switched on with the keyboard command (U or shift U). The colors and their meanings are explained below:

- **White** - an “extra” unscheduled, i.e. not in the timetable, train;
- **Red** - the loco is at the rear of the train; (note: being pedantic, red is actually a "marker" light instead of a "classification" light)
- **Green** - the train is part of a timetabled service that has been split into several consists, or sections, and another section is following behind it.

The cab has two main lights, one on each side, and several gauge lights that focus light on specific parts of the cab. There is also a deck light outside the cab, above the doors.

Note that the lights will not illuminate if the steam-driven electric DC generator (dynamo) is not running and producing 32V. The dynamo is on by default.

Shadows

The two main cab lights and the bright headlight beam can be toggled between casting shadows or not.

By default, the shadows are OFF. Switching shadows ON will probably decrease your frames per second (the impact will depend, obviously, on your particular system), but on a reasonably powerful system, the effect of the shadows is (in my opinion) well worth the cost.

Headlight Beam

The headlight beam, which illuminates the ground and other objects, can be toggled on and off. By default it is off, which eliminates the unsightly effect of the headlight beam illuminating objects on sunny days. However, the player can toggle the beam on at any time, which is especially useful at night. The beam is also toggled on automatically when the locomotive is in a tunnel.

Sanding

The model has been scripted to simulate a limited amount of sand in each sandbox (sand dome), enough for about 2 hours of continuous operation.

The locomotive is also equipped with rail washers, operated by a valve in the cab. They direct jets of live steam directly behind the rear driving wheels to clear away sand (after the driving wheels have already gone over it) so that it doesn't cause unwanted friction and wear on the wheels of the trailing truck, tender and consist. When they are operating, a cloud of steam appears at the nozzles of the rail washers. However, they have no actual effect in the simulation, being a purely cosmetic (visual and audible) feature.

Particle Effects

The action of the cylinder cocks steam emitters is scripted to take account of there being two cylinder cocks per cylinder, one for the forward stroke and another for the backward stroke. The script controls the steam emission, alternating between the forward and rear cylinder cocks, synchronized exactly with the piston strokes.

The engine has a double smoke stack, and there are several particle emitters in each stack. Both stacks are synchronized to the exhaust chuffs of the two articulated engines. The color of the smoke from the stacks gives a visual indication of how the locomotive is being fired.

The dynamo shows exhaust steam when running.

The Wilson sludge separator in the dome just ahead of the cab gives off a plume of steam when blowing off.

There are five safety pop valves, set to lift at different pressures. Two are muffled and one is un-muffled. At 299 psi, the boiler's maximum operational pressure, the first muffled safety valve will be showing some faint wisps of steam.

The sludge spreader below the cab on the right-hand side gives off a jet of steam when the sludge remover handle in the cab is pressed down.

The Nathan 4000 exhaust injector's centrifugal cold water pump, below the cab on the left-hand side, gives off wisps of steam when it is running.

The whistle, when blown, gives off steam - faintly in spring, summer and autumn/fall, but much more in winter.

The sanders show particles of sand coming out of the nozzles near the driver tires.

Big Boy used as AI

When used as an AI, on its own (not as a helper with a player-driven loco), the Big Boy will exhibit the following features:

- It will blow appropriate whistle codes when starting and stopping.
- It will put the headlight on full as soon as it starts to move and turn it off when it stops.

What to do to after Entering the Cab for the First Time

By default, the expert automatic fireman is enabled, doors and windows are open, and items such as the cylinder cocks master valve, dynamo, etc. are already prepared. Therefore, there is much less to do than in the FEF-3 (which has quite an elaborate procedure to follow before the locomotive is ready for the off).

Nevertheless, before setting off down the track there are still a few things to do:

1. If desired, change the locomotive number (Shift 5 or Ctrl 5) .
2. Select the color of the classification lights, as appropriate (press U or Shift-U as many times as needed).
3. Switch on the headlights (dim or bright, as appropriate).

4. Open the cylinder cocks.
5. Crack open the regulator slightly – you should now see steam coming out of the cylinder cocks (this helps to warm the cylinders and to expel any water that might have condensed in them while the locomotive was stationary).
6. Turn on the bell, if required, by opening the air valve.
7. Push the Johnson bar (the reverser) forwards.
8. Blow the whistle (two blasts).
9. Release the independent brake (turn it all the way to the left) - this will bail-off the engine brakes while the train brakes remain set.
10. Once the locomotive has started moving, move the train brake to the RUNNING position.
11. Open the regulator further to gather speed, but slack off (or reduce the cut-off) if you hear the wheels slipping.
12. Close the cylinder cocks after about twenty seconds.
13. As the back pressure rises, pull the Johnson bar a bit closer to you (this is like changing gear in a car before you redline the revs, to be able to go faster), to reduce the back pressure to close to zero.
14. If the back pressure goes negative, indicating a vacuum in the cylinders because the steam chest is empty and the pistons are moving, open the throttle a bit further in order to give the steam chest and the cylinders more steam (the back pressure will go to zero and then positive again).
15. Turn off the sanders (unless you still need sand because of conditions).
16. Once out of the station area, turn off the bell.

Quick Drive

The Big Boy is compatible with Quick Drive scenarios.

Pre-built Consists

The following pre-built consists, with variations for HD, SD, clean and dirty versions of the locomotive, are available to use in Quick Drive:

- Light Engine
- 1,258 sh. tn. (50 empty boxcars)
- 2,487 sh. tn. (100 empty boxcars)
- 2,911 sh. tn. (70 loaded PFE reefers)
- 3,244 sh. tn. (57 loaded boxcars)
- 4,449 sh. tn. (83 freight cars)
- Doubleheader + 4,551 sh. tn. (105 boxcars) *Requires high-end PC
- 6,096 sh. tn. (132 freight cars) *Requires high-end PC

Some of the QD consist tonnages have been chosen to match closely the maximum tonnages permitted between particular destinations on the Wasatch Grade and Sherman Hill routes, as per a 1948 Union Pacific schedule, as described below:

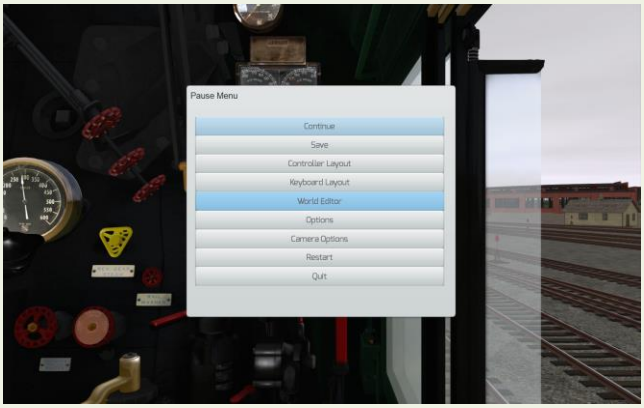
- 3,250 sh. tn. out of Cheyenne via Buford
- 6,100 sh. tn. westbound from Evanston
- 4,450 sh. tn. EB from Ogden.

Note: the locomotive and tender, in working order (fully laden), add a further 599 sh. tn. to the consist mass.

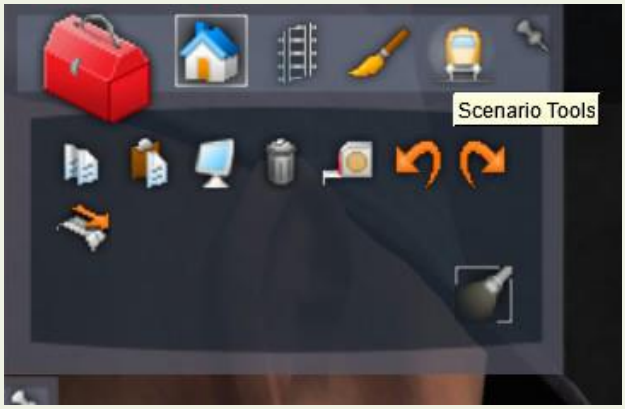
How to Change the Quick Drive Consist Type to Freight

Quick Drive scenarios set the consist type to "Special" by default. On routes that have different speed limits depending on the consist type, this means that when the consist is actually meant to be freight, the wrong speed limits will be applied. There is an easy way to work around this problem, which is to make one simple edit to the Quick Drive scenario. Here's how:

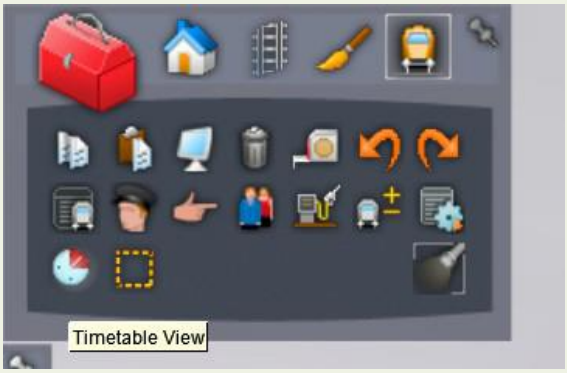
1. Immediately after starting the Quick Drive scenario, hit the "Esc" key.
2. Select the World Editor.



3. Select the Scenario Tools.



4. Select "Yes" to continue editing the scenario.
5. Select the Timetable View.



6. Click on the first line, which contains the driver symbol and start time.

7. Change the Service Class to the appropriate value select from the menu.

8. Close the Timetable View.

9. Click on the yellow "Drive" triangle and select "Yes" to save the changes.

10. Hit "Esc" and select "Quit" in order to return to the "Drive" menu. It's important to follow this step instead of playing the scenario directly (which otherwise can provoke errors).

11. At the Quick Drive page, select "Replay".

Save and Resume

Considerable effort has been put into trying to ensure that save and resume (for scenarios) works flawlessly. However, after resuming, it may take a few seconds for the smoke effects to settle down to the way they appeared at the time of the save.

It is inadvisable to save and resume while ascending a steep grade with a heavy consist. This is because the momentum that the train had at the time of the save can be lost immediately, causing the train to slow down and possibly stall, where it would have continued on up the hill without any fuss if the scenario hadn't been interrupted by the save/resume. This is a random occurrence. If it does happen, the advice is to exit the scenario, return to the main menu and from there, re-select and resume the scenario. Usually it works well the second time, with the momentum correctly restored.

Career Scenarios

The package includes three Career scenarios for the ***Wasatch Grade*** route (developed by *Milepost Simulations* and available on Steam as a separate DLC).

Title	Description	Start Location	**Destination**	**Duration (minutes)**
Big Boy Max Tonnage EB, Part 1	Big Boy #4004 is preparing to take a heavy freight, the maximum permitted tonnage of 4,450 short tons, on the long haul eastbound up the Wasatch Grade to Evanston.	Ogden	Echo	136
Big Boy Max Tonnage EB, Part 2	Big Boy #4004 is preparing to take a heavy freight, the maximum permitted tonnage of 4,450 short tons, on the long haul eastbound up the Wasatch Grade to Evanston.	Echo	Evanston	125

Title	Description	Start Location	Destination	Duration (minutes)
Big Boy Max Tonnage WB, Part 1	Big Boy #4002 is ready to take a maximum tonnage consist (6,100 sh.tn., 112 boxcars) from Evanston to Riverdale. Part 1 takes you to Wahsatch Depot.	Evanston	Wahsatch	30
Big Boy Max Tonnage WB, Part 2	While resting in the long siding at Wahsatch, set the retainers before continuing down the steep grade to Castle Rock.	Wahsatch	Castle Rock	40

There are HD (suitable for high-end computers) and SD (more suited to less capable computers) versions of each scenario.

All of these career scenarios are rated as difficult, but the actual difficulty will depend on the use of the Expert Automatic crewmen. If the EAF and EAE are activated for practically the entire journey from start location to destination, the scenarios will be somewhat easier to complete, although in some cases it may result in a less than perfect score. The ultimate challenge is to complete them without any help from the "automatics".

Livery Variations

Three variations of the Big Boy livery are included and each is available in SD or HD models:

Variation	Asset Names	Image
Clean	[UP4000] Big Boy [HD Clean] [UP4000] Big Boy [SD Clean]	
Dirty	[UP4000] Big Boy [HD Dirty] [UP4000] Big Boy [SD Dirty]	
Silver Trim	[UP4000] Big Boy [HD Silver Trim] [UP4000] Big Boy [SD Silver Trim]	

Rolling Stock

The following items of rolling stock, in empty (mt) or loaded (ld) variations, are included with the Big Boy:

Type	Asset Names	Image
40' Boxcars	[UP4000] Boxcar 40ft [Brown, mt] [UP4000] Boxcar 40ft [Brown, ld]	
	[UP4000] Boxcar 40ft [Gray mt] [UP4000] Boxcar 40ft [Gray ld]	
	[UP4000] Boxcar 40ft [UP-1 mt] [UP4000] Boxcar 40ft [UP-1 ld]	

Type	Asset Names	Image
	[UP4000] Boxcar 40ft [UP-2 mt] [UP4000] Boxcar 40ft [UP-2 ld]	
	[UP4000] Boxcar Wooden [Brown mt] [UP4000] Boxcar Wooden [Brown ld]	
	[UP4000] Boxcar Wooden [Red mt] [UP4000] Boxcar Wooden [Red ld]	

Type	Asset Names	Image
Cabooses	[UP4000] Caboose CA-4 [brown]	
	[UP4000] Caboose CA-4 [yellow]	
Flatcars	[UP4000] Flatcar [Cable]	

Type	Asset Names	Image
	[UP4000] Flatcar [Covered Load]	
	[UP4000] Flatcar [Crates]	
	[UP4000] Flatcar [mt]	

Type	Asset Names	Image
	[UP4000] Flatcar [mt stanchions]	
	[UP4000] Flatcar [Logs]	
	[UP4000] Flatcar [Pipes]	

Type	Asset Names	Image
	[UP4000] Flatcar [Rails]	
	[UP4000] Flatcar [Ties]	
	[UP4000] Flatcar [Timber]	

Type	Asset Names	Image
70t Hopper	[UP4000] Hopper 70t [Coal mt] [UP4000] Hopper 70t [Coal ld]	
10,000 gallon tankcar	[UP4000] Tankcar 10000 gal OTLX [mt] [UP4000] Tankcar 10000 gal OTLX [ld]	
PFE Reefer	[UP4000] PFE Reefer R-40-10 [mt] [UP4000] PFE Reefer R-40-10 [wx, mt] [UP4000] PFE Reefer R-40-10 [ld] [UP4000] PFE Reefer R-40-10 [wx, ld]	

Type	Asset Names	Image
	[UP4000] PFE Reefer R-40-10 [alt, mt] [UP4000] PFE Reefer R-40-10 [alt, wx, mt] [UP4000] PFE Reefer R-40-10 [alt, ld] [UP4000] PFE Reefer R-40-10 [alt, wx, ld]	
	[UP4000] PFE Reefer R-40-28 [mt] [UP4000] PFE Reefer R-40-28 [wx, mt] [UP4000] PFE Reefer R-40-28 [ld] [UP4000] PFE Reefer R-40-28 [wx, ld]	

"wx" indicates a dirty/weathered version.

Troubleshooting

Black Steam and Water

In extreme circumstances (such as when running the HD version with 100+ cars on a route that is densely populated with assets) an internal error can be triggered that manifests itself as all particle emissions turning completely black because of TS failing to load the associated shaders correctly.

If this happens, quit the scenario and return to the main menu - that will allow the internal state that provoked the error to be reset. Usually everything works correctly after starting the scenario again via the Drive menu. However, if the fault occurs again, consider lowering the graphics settings for scenery detail, shadows, etc. and/or using the SD, instead of HD, version.

Strange Values such as "1.$" in the F5 HUD

If a scenario is played directly after editing it in the Scenario Editor (accessed via the World Editor after clicking on the "Scenario Tools" button), it can sometimes provoke an internal error that corrupts the simulation data. The most obvious symptom is when nonsensical values such as 1.$ appear in the F5 HUD data.

If this fault occurs, proceed as described above for the "Black Steam and Water" fault.

Sounds Vanish in Outside Camera Views

This can happen immediately after resuming a scenario. It can often be solved by pressing '1' to gin to cab view and then returning to the outside view. In some cases, panning the "helicopter" camera view around the locomotive brings the sounds back. If the sounds are still missing, proceed as described above for the "Black Steam and Water" fault.

Locomotive Ran Out of Water

If this occurs soon after switching off the Expert Automatic Engineer, with the Expert Automatic Fireman enabled, try again but this time ensure that the game's default automatic fireman is switched off in the game settings menu.

Train Simulator Crashes in 32-bit Mode

This has occurred in testing but was resolved either by switching to 64-bit mode or, in the case of Quick Drive scenarios, by checking the "Player train only" box so that no AI trains were spawned into the scenario. The Big Boy itself is perfectly capable of running in 32-bit mode.

Tools used to Build the Model

- **3DCrafter Pro version 9.3** to create the model geometry and animations.
- **Adobe Photoshop** to produce the source textures.
- The **Asset Editor** provided with Train Simulator.
- **Audacity** to create the sounds*.
- **HxD** (freeware hex editor) to edit the cab view exported geometry, changing the material name of the window textures to enable rain effects. The geometry file is too large to be compiled by the serz.exe application.

* A few sounds, such as switch and button clicks, were made using samples from http://www.freesound.org, distributed under a Creative Commons Attribution License (http://creativecommons.org/licenses/by/3.0/legalcode).

Special Thanks

This model of the Union Pacific Big Boy couldn't have been made without the help of many friends and supporters who, through various forms of social media, have given me advice, ideas, technical explanations, reference photos and data and, above all, feedback and encouragement throughout the entire process of building the Big Boy. My sincere thanks go to all of you.

Extra special thanks to:

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- The Union Pacific Historical Society for their superb database of original engineering drawings of the Big Boy.
- Everyone at Dovetail Games who supported the testing and release of this Big Boy.
- My son, David, for giving moral support, showing interest, critiquing and for having some good ideas that found their way into the model.

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Perth and Kinross, Scotland,

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