Highball Sim

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STEAM LOCOMOTIVE SIMULATOR

Based on the Santa Fe & Disneyland Railroad
5/8th Narrow Gauge Railroad

OPERATING MANUAL

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by
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based on simulator version
1.0.0.2017-12

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ckhollidayplans.com

Contents

1 Installing, Updates, and Support

1.1 Installing and Running

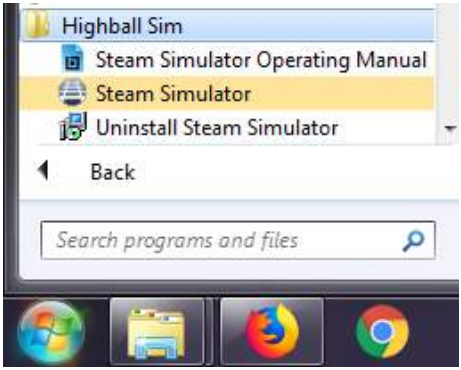
Installing the Simulator is a simple process. After you have downloaded the `.zip` package onto your computer, simply unzip it to a convenient location and run the `steamsetup.exe` executable for Windows installation, or drag the Simulator into your Application folder for macOS. For Windows, you can install the Simulator at the suggested location on your computer shown during the setup process or at a path of your choice.

To run the Simulator, on Windows, navigate to the Start Menu > Highball Sim > Steam Simulator. On macOS, simply open it from the Application folder. The Simulator will then launch and present you with the Home Menu.

1.2 Updates

Occasionally, updates to fix bugs or add features may be available. You can view the currently installed version of the Simulator by opening the About menu at Main Menu > About.

The vendor where you purchased and downloaded the Simulator program should notify you via the email address you used to purchase if there is an



The Highball Sim folder in the Start Menu containing short cuts to the Steam Simulator, the Operating Manual, and the Uninstaller.

update available. If so, simply download the new version and run the installer.

1.3 Uninstalling

To uninstall the Simulator, navigate to Windows Control Panel > Programs and Features > Uninstall a program, then select the Steam Simulator entry and select Uninstall. The Simulator, and all of its associated files and settings, will be erased.

1.4 Support

To get help with installing or using the Simulator, or if you have questions or feedback, you email me directly at `preston@ckhollidayplans.com`.

If you have any questions about the Disneyland Railroad and how they operate, you can also post your questions on the Burnsland's Disneyland Railroads Forum, the most active forum dedicated to the Disneyland Railroads.

1.5 License

2 The Simulator

The **Santa Fe & Disneyland Railroad Steam Locomotive Simulator** attempts to be a faithful digital replica of the Disneyland Railroad steam locomotives number 1 “C. K. Holliday” and number 2 “E. P. Ripley.” These two iconic 5/8 scale narrow gauge locomotives were instrumental in making Disneyland a reality, and they have been seen, photographed, and admired by countless millions of visitors. They are likely to be one the hardest working steam locomotives operating today.

We say “faithful replica” above because:

1. As reasonably as possible, the engines in the Simulator should work and function as the real engines do.
2. The program should correctly, or reasonably represent, the physics and thermodynamics that are unique to steam locomotive operations.

The Simulator’s replica of the CK Holliday as she appeared in 1955, outside the original roundhouse.

3. Ultimately, the program should be able to convey to the user what it's really like to be in the cab and at the controls of these unique machines.

The Simulator's main features include:

- Lifelike and photo-realistic 3D model of the steam locomotive CK Holliday and EP Ripley.
- Two versions of the park allow you to run the train around Disneyland circa 1955 or circa 1956, with accurate recreation of landmarks such as the Main Street Station, Frontierland Station, Rivers of America, the Mark Twain river boat, and more.
- Accurate physics and cab controls bring steam power to life. Run the locomotive as the engineer and learn how to use the throttle and Johnson Bar. Or operate the train as a fireman, where you'll have to manage water and fire using the same controls found on the real engine.
- Numerous engine equipment and fitting options, such as water alarm, pilot flags, whistle type, allow you to customize the engine to your liking based on the engine's actual fitting and equipment.
- Sound effects recorded from real steam engines. From metallic clanking of lever latches, to the continuous hissing of the atomizer and the sliding cab windows, and of course, the bell and whistle.
- Real-time day and night cycle, with accurate depiction of celestial objects depending on the time of the year.

This chapter describes how to use and interact with the Simulator along with the menus and their options. The procedure to fire up the engine is outlined on page 63, and the theory and operations of the engine starts on page 69.

The Quick Start section, below, will help you get the engine going quickly without spending the time to fire up the engine manually.

2.1 Quick Start

The Simulator always start with a cold engine, without a fire and no steam pressure in the boiler. It takes time to bring the engine from cold to operating pressure, but the Simulator offers several 'quick' options to get the engine ready.

For the first few times of running the Simulator is it *highly recommended* that you select the 'Auto inject water' and 'Auto firing' options. These options will let

the Simulator's fireman AI control the water and fire, and allow you to run the engine and learn the cab controls without being distracted with tending to the boiler. See section 2.5 (page 33) for more information about these options.

Using the Quick Setup menu

In the Simulator, press F3 to bring up the Quick Setup menu, and select one of the options presented. The option **Set ready to pull** will configure the engine with the operating pressure, a burning fire, and *most* valves in the ready-to-go position. It is *highly recommended* that this state is selected along with 'Auto firing' and 'Auto inject water' options for your first few times in the Simulator, or if you are not yet familiar with steam operations. See page 36 for more information about each state.

Directly setting up the engine's state

You can also directly configure the engine's state, such as selecting the exact boiler pressure, the air tank pressure, the lubrication state, and more. Press the F1 key to activate the Simulator's Main Menu and select the options as needed. See page 17 for more information about this menu.

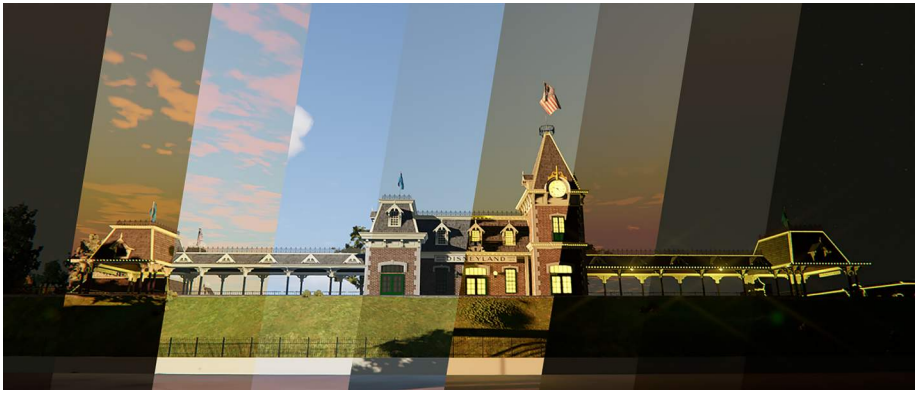
Things you should know

Throughout the development and testing of the Simulators, a number of items were found by the testers to be 'unique' to either the operation of steam, the layout/usage of the controls on these particular engines, or unique to the way the Simulator was built. These items are summarized below.

—Sim limitations

Due to the limitation of the game engine, there are a few things that had to be simplified or at all not modeled:

- Train slacks are not modeled. Your train couplers will always be taunt, even when reversing.
- Train wheel contacts with the rails are not modeled. To model the contact of every wheel with the rail would be highly computationally expensive. Instead, only the position of the center of mass of each car and engine are computed. Consequently, sometime you might see the wheels hovering outside of the rails. This doesn't mean that the car has derailed, but simply that its wheels positions aren't actually computed.



This collage shows the Main Street Station through the Simulator's day cycle from dawn to dusk. Scenery and building lighting is activated automatically at dusk for the Disneyland tracks, and manually for the ranch track via the Scenery menu (page 35).

- The entire 6-car length of train must be reasonably far away from a switch before you can operate it. *This is true even when your train is less than 6 cars!* For example, if you're pulling 3 cars, you must clear the switch for the length of 6 cars before you operate the switch!

—Hints, and other things you might not know

This section is also known as 'it's not a bug—it's a feature!' Each item is also covered in detail elsewhere within the manual.

- There is always water/condensed steam in the air compressor, cylinders, etc.: When you first start the sim, some amount of water/condensed steam accumulate inside the compressor, the cylinders, the blower line, and the atomizer line. They need to be removed before these appliances function as expected.
- The Johnson bar is really hard to move at first: When you first start the sim, the bearing lubrication start out cold. This makes the Johnson bar feel really heavy to move around. In the sim, this is simulated by making the bar move really slowly. You'll have to click and drag it a few times to get it into the corner. Once the engine is heated up from running, you'll notice that it's much easier to move.

- The train feels heavy at first: Similar to above, all of the train's bearing lubrication are assumed to be cold at first. This will make the train feel heavy. After running for a while, it should be a lot easier to get the train moving from a stop.
- The compressor can seized up: Without proper lubrication from the hydrostatic lubricator, or if there is a lot of accumulated water, the compressor can seize up and stop working.
- The battery can drain: If you're not moving enough, or if there you're not pulling a train (no generator), the battery can drain overtime. This does not affect the low water alarm.
- To simulate an in-active-service, continuously-working engine, there will also be a random amount of flue soot at each start of the sim session. Keep an eye on your stack smoke to see whether the flues need sanding or not.
- Speedometer won't work: If you're not pulling at least one car, the speedometer in the cab won't work (no speedometer dynamo).
- Steam flow is modeled: If you open the throttle a little bit, the steam will "flow" slowly into the chests and cylinders. I.e., the steam will not simply react immediately to your throttle.
- Don't forget to unlock the throttle! Otherwise the throttle will not move. You can unlock it from the main Simulator menu.
- Dead center is modeled in the sim! If you find yourself stuck, this could be why.
- Rain effect is modeled. If you find yourself playing with the weather in the sim, keep in mind that the rain does make the rails very slippery.
- The tender can run out of water and fuel.
- The injectors can overheat, and will stop injecting water. They will cool down naturally over time.
- Although unlikely, the injectors can clog from sediments. There is nothing you can do, except to use the other injector. The only way to reset the clog is to restart the sim.
- The "Light Firebox" button will light a waste in the firebox. It'll last for about 10 seconds.

- Steam won't condensed into water while the cylinders are hot. So, as expected, you don't necessarily need to open the cylinder cocks when making a brief stop.
- The brakes can get hot and become ineffective, if used excessively.
- If you want to use the electronic compressor governor, make sure to turn on the cab's electrical.
- There is a small "slack" in the fuel valve. You'll need to turn it to about 8 o'clock position before appreciable amount of fuel flows out of the atomizer (closed position is 9 o'clock looking directly down at the valve). Once passed the 8 o'clock, the valve is more sensitive!
- Try cocks will start out clogged rather than clean. You can check and clear them as part of your firing up procedure if you wish.
- You'll know when sanding the flues works when you hear sound of flowing sands. This action will only work if the blower is opened up high enough to create a sucking draft. If there isn't enough draft, clicking on the 'sand flues' button won't do anything and you won't hear the sound.
- To use the blower while the air is connected, you have to use another valve that redirect the air through the blower line. To use this valve, you exit the cab, walk to the front fireman side, and operate a small red valve near the air connection. Hint: use F8 to exit the cab, press Q to toggle walking mode, walk over to the air connection, then right click the mouse to release the mouse pointer that will allow you to operate this valve. Right clicking again will put the mouse back into free look mode.
- Air umbilical plumbing is correct per the real engine, with proper logic of upstream/downstream valves. To fire on air, the blower, the blower shutoff (on the manifold/branch), and the atomizer shutoff (on the manifold/branch) must be open to let the air flow "upstream" to the atomizer (see above).
- Applied air brakes will slowly leak (about one pound per minute) through fittings and hoses.
- The atomizer is very sensitive. You shouldn't need to be turning it very much.

And finally, here is the most important tip:

To allow yourself some throttle time, without having to worry about checking and adding water every few minutes, I recommend you select these two options:

- Auto inject water
- Auto firing
- Use low water alarm

The first option will use an AI to keep about two nuts worth of water in the glass, while the second option will hold the operating pressure for you, and the third option will let you know if the water is approaching a dangerously low level (if the AI fails to fill the boiler). Like the real water alarm, it will sound for 30 seconds before shutting off the fuel. With these options, you will still have to perform blow down to remove any sediments, and check that the tender has water and fuel.

2.2 Navigating the Simulator

You can move around in the Simulator by using a combination of your mouse and keyboard.

The first view presented to you at the start of the Simulator is the main center view. This view can also be activated by pressing F5. There are a number of view position presets that you can use to quickly move around the engine. They are:

- 1: Left out view
- 2: Left forward seat
- 3: Left seat
- 4: Center view
- 5: Right seat
- 6: Right forward seat
- 7: Right out view

The left and right 'out view' will position the camera slightly outside of the cab on either the left or the right side. This view could be useful for stopping the train at a precise point, or to carefully gauge the train's movement. The left and right seat views are the normal views seen from the fireman's and the engineer's perspectives respectively, while their 'forward' view counterparts place the camera position slightly ahead of the seat to afford a better view

The default startup view and state of the engine

outside the front windows. The 'center' view is similar to the perspective from the modern tender seat.

Note that the seat view keys are centered and symmetrical about the center 4 key. That is, 1 and 7, the furthest keys from the 4, are the views furthest from the center.

Additionally, you can use the W, A, S, D keys and E, C to freely move about the cab.

Panning and Zooming

To pan around the main view, from any seat positions, press and hold your mouse's middle button and drag your mouse around the screen.

To change the zoom, press and hold the left control key on your keyboard and scroll your mouse's scroll wheel. Scroll up (towards the screen) to zoom in, and scroll down (away from the screen) to zoom out.

Outside View

You can also view the train from an exterior perspective, as well as walk around the engine. The following view modes are available:

- F6: Tender view: this view places the camera on the top of the tender.
- F7: Orbit view: this view orbits and follows the train. Pan this view by holding down the mouse right button. You can also move the orbit target up and down the train by holding down the W and S key.
- F8: Free walk view: this view allows you to freely move about the scenery by using the W, A, S, D keys and E, C. While this view is active, pressing the Q will toggle the *walk mode* on and off. The walk mode will lock the camera to an eye-level height and all movement to walking speed. Pressing X will reset the camera to the engine's current position.

2.3 Controls

This section describes how you can interact with the cab controls in the Simulator. To learn about the function and location of each control, see page 56.

All valves and levers in the cab are operated by the mouse. Two modes of interaction are offered in the Simulator:

- Push and pull (default mode): place the mouse cursor on any valve wheel, lever, or handle, then hold down the left mouse button and push or pull the mouse to manipulate the control.
- Scrolling: place the mouse cursor on any valve wheel, lever, or handle, then scroll the mouse wheel to manipulate the control.

With either method, manipulating the levers with the mouse (such as the throttle and the Johnson Bar) should be intuitive. The differences in globe wheel manipulation is outlined in the following table:

Method	Vertical globe wheel	Horizontal globe wheel
Push/pull	Pull down to open, push up to close	Pull right to open, push left to close
Scroll wheel	Scroll down to open, scroll up to close	Scroll down to open, scroll up to close

The above is true for all valve wheels except for the hydrostatic lubricator steam supply valve. Because it is mounted 'backward', it must be pushed up with the mouse to open it, and pulled down with the mouse to close.

One of the goals of the Simulator is to present how it can feel very 'analog' to work the controls in the cab. It is indeed a tiring work to turn the valve wheels and push and pull levers for a whole shift. The pushing and pulling mouse method of operating the controls is the best way to approximate this workload on a computer.

However, this method can also be 'too tiring' and bothersome, so the second method of control is offered. Using the mouse scroll wheel is a much less difficult experience but does not offer the same tactile feel of push and pull.

The Simulator starts with the push and pull method by default. To change the control method, see page 33.

The engine's bell can be operated by pulling down on the bell rope in the cab, or pressing the B key. Either action will only swing the bell once, and must be repeated to continuously ring the bell.

Special controls

A select few controls are not operated by pushing or pulling of the mouse or scroll wheel. They are:

- Ball valves: simply click on these valve handles with the right mouse button to toggle them on or off.
- Sander: right click and hold down the right mouse on the sander button to release the sand.
- Air brake quick release: right click and hold down the right mouse on the quick air release lever to activate the air brake release.

Controlling the firebox door

To unlock the firedoor, place the mouse cursor over the firebox door or the oil shelf and right click. Perform the same action to lock the fire door.

To open the firedoor, unlock the door and place the mouse cursor above the door and drag the mouse down or scroll down (if this method is active).

To close the firedoor, place the mouse cursor above the door and push the mouse up or scroll up (if this method is active).

Toggle the flashlight on/off with the F key.

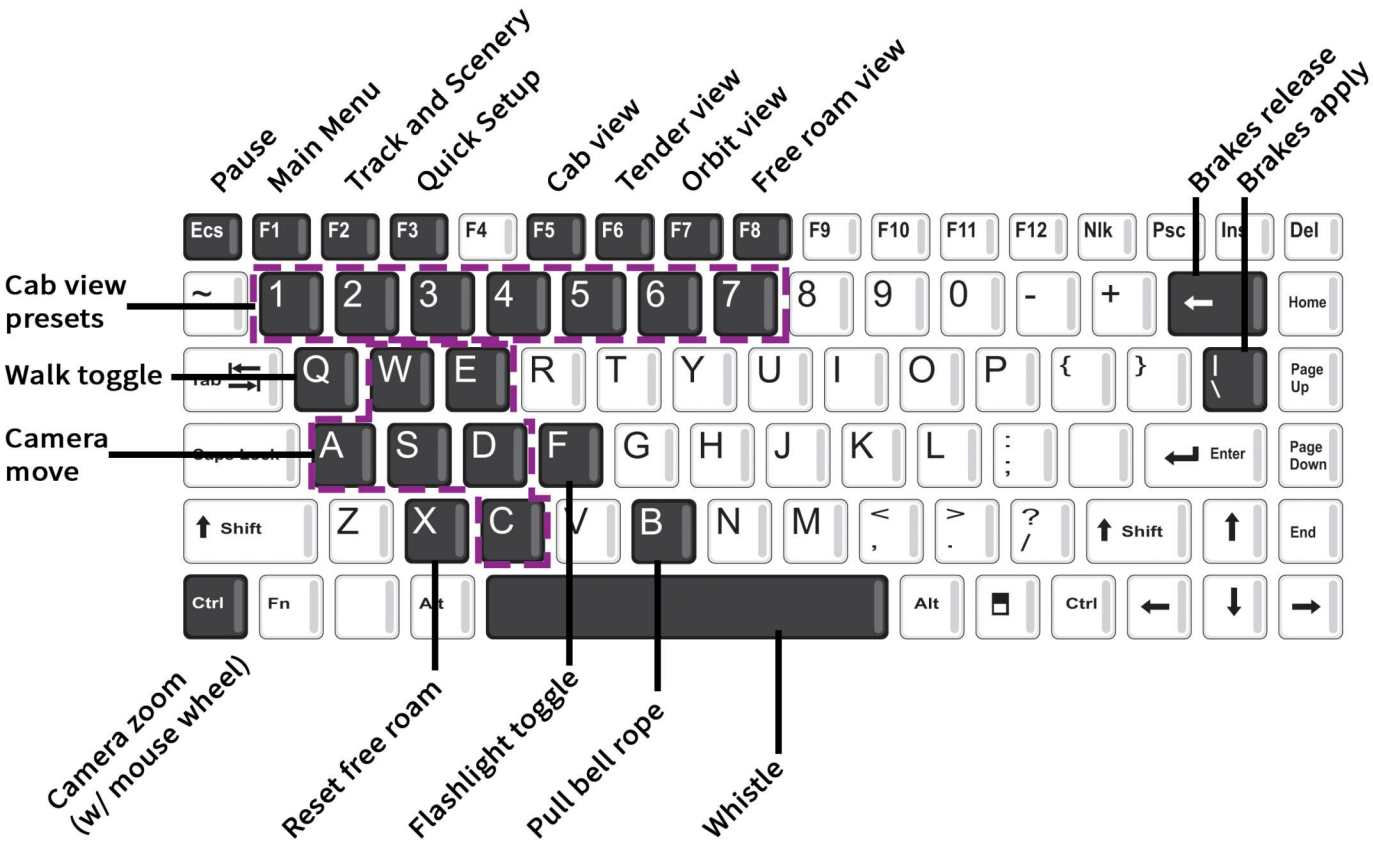
Unlocking or leaving the door unlocked when the train is in motion will result in a freely swinging door. You might have to try a few times to close the door when the train is moving.

Flashlight

A simulated handheld flashlight is available to assist with night time operation. The flashlight will naturally follow your cursor on the screen, allowing you to find the cab controls you need intuitively. Toggle the flashlight on and off by pressing the F key. The flashlight has unlimited use.

Keyboard controls

The following figure shows the controls that are available via the keyboard.


Pause
Main Menu
Track and Scenery
Quick Setup
Cab view
Tender view
Orbit view
Free roam view
Brakes release
Brakes apply
Cab view presets
Walk toggle
Camera move
Camera zoom (w/ mouse wheel)
Reset free roam
Flashlight toggle
Pull bell rope
Whistle

The Home Menu

2.4 Home Menu

The first screen that is presented after launching the Simulator is the Home Menu, which presents the option to make a track selection and make some global configurations of the program.

The left side of the screen presents the options to open the tracks selection menu, the global settings menu, and to exit the program.

Tracks Selection

This screen list the tracks and sceneries available in the Simulator. Click on one of the entry to load the desired track.

1. Tracks menu: select to open the tracks selection window. Select it again to close the window.
2. Tracks list: click to select the desired tracks and scenery

Current, three different tracks are available in the Simulator. In the future, additional tracks and scenery representing other stages of the Santa Fe & Disneyland Railroad may be added.

1. Disneyland, 1955: This scenery depicts the Disneyland park and tracks as they appeared in approximately the summer of 1955.

The Tracks Selection Menu

2. Disneyland, 1956-1957: This scenery depicts the Disneyland park and tracks as they appeared through approximately years of 1956 to 1957. It includes the Fantasyland Station and the ever-growing foliage around the park.

3. Highball Sim Ranch: This is a fictional scenery that has much longer track length with many winding curves and switches. It is styled after a typical steam railroad ranch.

Settings

This screen allows you to configure the graphic rendering settings of the Simulator. Some of these settings can have a large impact on the performance of the program. The settings are automatically saved when they are changed or selected, however, some settings may not be effective until the next program launch.

1. Settings: select to open the Graphics settings page.

2. Rendering quality: select the Simulator graphics quality. This entry selects the overall rendering quality of the Simulator. It changes the texture resolution and lighting quality. This selection can have a large impact on the Simulator's performance.

The Settings Menu

3. Screen resolution: select the fullscreen mode resolution. By default, the Simulator will try to match your computer's native screen resolution.

4. Windowed Mode: select to run the Simulator either in windowed mode or fullscreen mode.

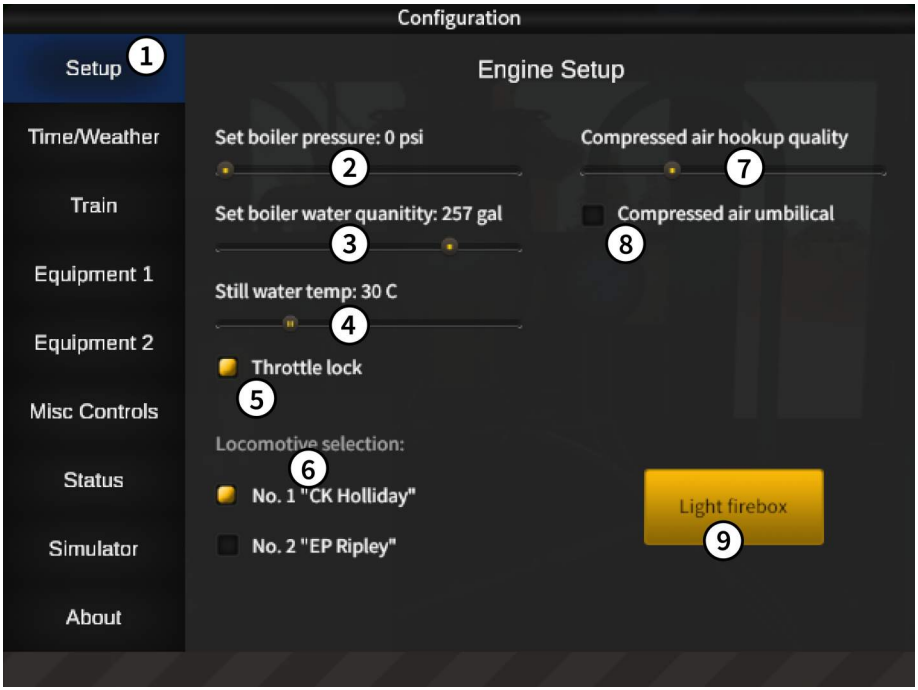
5. V-Sync: select to activate or deactivate v-sync. V-sync prevents tearing of the screen images when the Simulator is rendering more frames than the monitor refresh rate.

6. Shadow resolution: select the shadow resolution. This setting can have a moderate impact on the Simulator's performance.

7. Delete and reset all settings and sim state: selecting this option will delete all saved settings available within this menu, as well as any settings selected within the Simulator.

2.5 Main Menu

The main Simulator menu can be activated by pressing F1. This menu allows for miscellaneous controlling of the engine, setting some Simulator configuration, and setting the time and weather. The Main Menu contains different pages that are listed on the left side. Pressing F1 again will close the menu. It is possible also to drag the menu window around the screen. Click and hold on



The Engine Setup Menu

any part of the menu that is not a button, a selection, or a slider, and drag it to re-position the menu on screen.

Setup

This page allows for a 'quick setup' of the engine's state.

1. Setup page: select to activate the Engine Setup page.
2. Set boiler pressure: instantaneously set the boiler pressure to the specified value.
3. Set boiler water quantity: instantaneously set the water quantity inside the boiler.
4. Still water temperature: set the resting water temperature. Use this slider to simulate 'pre-heating' of the water before it enters the boiler.
5. Throttle lock: select to activate or deactivate the throttle pad lock.

6. Locomotive selection: select either the number 1 CK Holliday or the number 2 EP Ripley engine.

7. Compressed air hookup quality: adjusts the quality of the external air hookup supply. When the quality is low (slider to the left), the air supply pressure will be low and tend to fluctuate. When the quality is high (slider to the right), the air supply pressure will be high and consistent.

8. Compressed air umbilical: select to connect or disconnect the external air hookup.

9. Light waste: once click, a waste will burn in the firebox. The firebox door must be open for this control to be operational.

Time/Weather

This page allows for configuration of the time and weather inside the Simulator. The date and time selections are used to compute proper sunrise, sunset, moon phases and altitude, and other astronomical calculations to depict an accurate atmosphere within the Simulator. Some of the weather selection can also affect the characteristics of the engine. The default date at the start of every Simulator's session is the computer's current date. The default time at the start of every Simulator's session is 11:00 am, unless 'Use real time' option is selected.

1. Time/Weather page: select to activate the Time/Weather page.

2. Current sim time: shows the current time in the Simulator. The current date is shown in the sliders below.

3. Use real time: select to match the Simulator's time with the computer's time. The Set sim timer slider becomes inoperative when this option is selected.

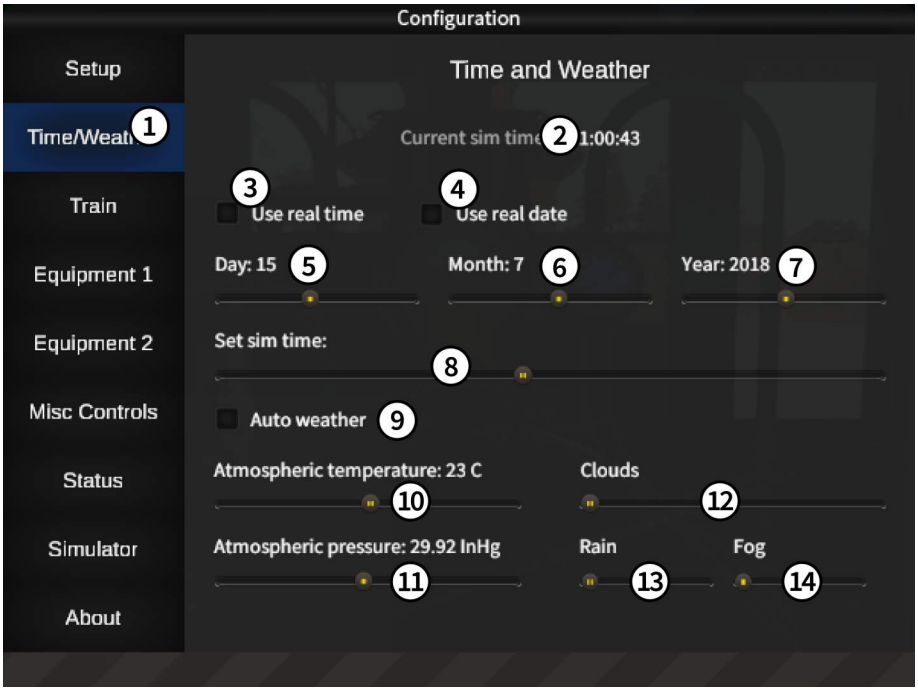
4. Use real date: select to match the Simulator's date with the computer's date. The date selection sliders become inoperative when this option is selected.

5. Day: select the Simulator's current day of the month.

6. Month: select the Simulator's current month.

7. Year: select the Simulator's current year.

8. Set sim time: select the Simulator's current time. The slider's value is displayed in the 'Current sim time' text.



Time and Weather Setup Menu

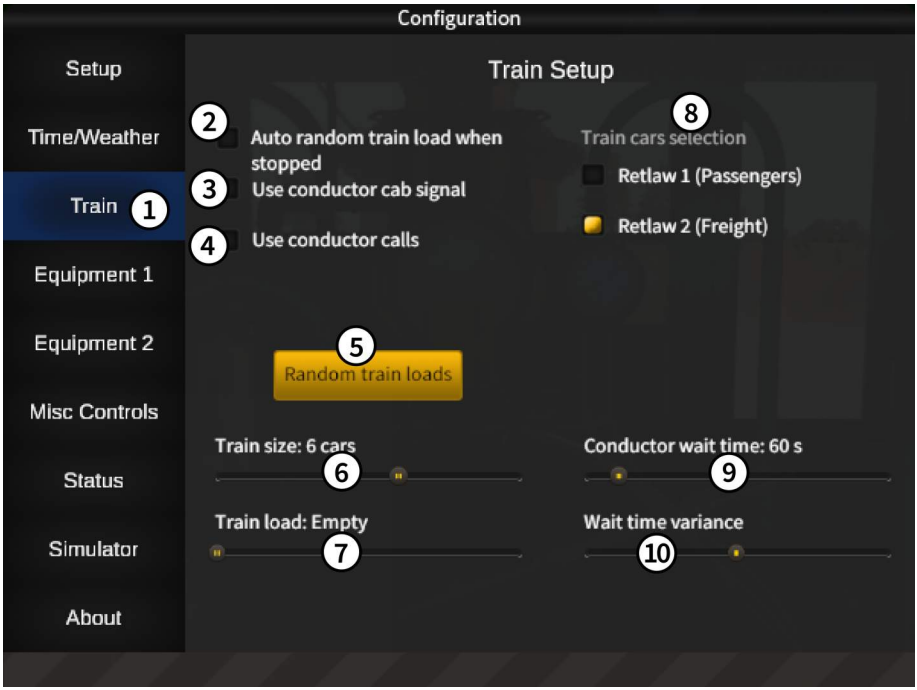
9. Auto weather: select to activate the automatic dynamic weather system. When selected, the Simulator will gradually show different weather (such as different cloud covers, rain, wind, etc.) over time.

10. Atmospheric temperature: select the Simulator's ambient temperature. This selection affects the boiler's thermodynamic calculations.

11. Atmospheric pressure: select the Simulator's barometric pressure. This selection affects the boiler's thermodynamic calculations.

12. Clouds: select the cloud cover depicted in the Simulator. The right side of the slider depicts an all clear sky, while the left side of the slider depicts a full overcast. Adjusting the slider from left to right will gradually increase the cloud cover. The cloud type and pattern is randomly select whenever the slider is being adjusted, ensuring that no selection is the same. Wind speed and direction is also randomly selected whenever the cloud slider is selected.

13. Rain: select the amount of rain (and thunder) in the Simulator. The amount of rain has a proportional effect on the rail and wheel friction.



Train Configuration Menu

When the ambient temperature in the Simulator is sufficiently low, the rain automatically becomes snow instead.

14. Fog: select the amount of ground fog in the Simulator.

Train

This page allows for configuration of the train and the virtual conductor.

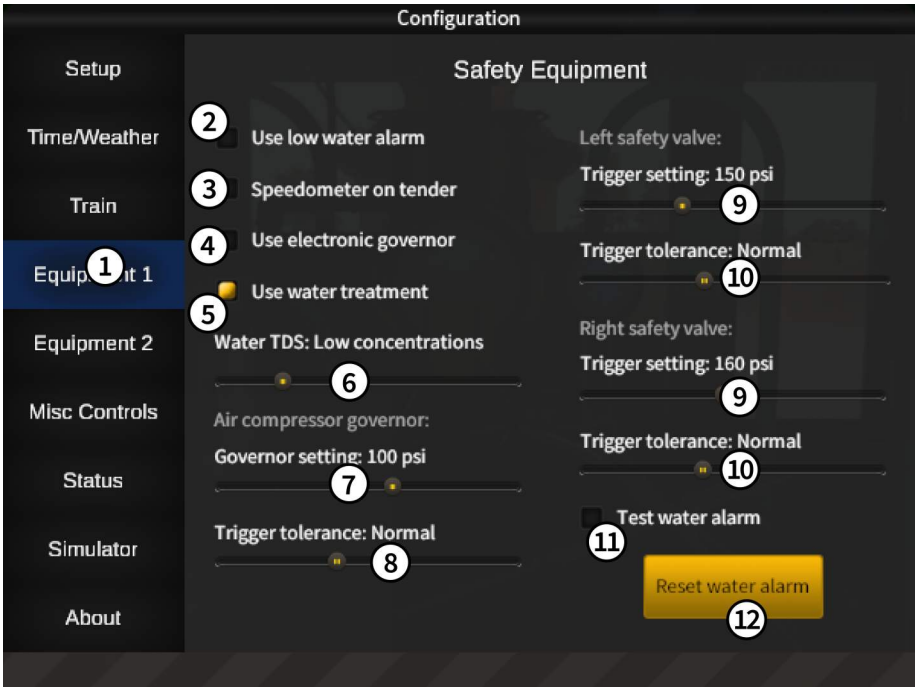
1. Train page: select to activate the Train page.
2. Auto random train load when stopped: when activated, this option will automatically select a random passenger load whenever the train is stopped.
3. Use conductor cab signal: select to activate the cab signal. When the train is stopped, after a set amount of time the conductor will ring two bells to indicate clearance to proceed forward. When this option is selected, and while the train is moving, occasionally an ‘emergency’ one bell signal to stop will be sounded.

4. Use conductor calls: when selected, and when the train has stopped for a selected amount of time, the conductor will call ‘all ‘board!’.
5. Random train loads: click to randomly select the train’s passenger loads.
6. Train size: select the number of cars in the train consist. Up to ten cars can be selected, but graphically, no more than six cars will be shown (the extra cars are treated as ‘dummy load’).
7. Train load: manually select the passengers load on the train.
8. Train cars selection: select either the Passenger car style (Retlaw 1) or the Freight car style (Retlaw 2).
9. Conductor wait time: approximate time for the conductor to wait before signaling all clear to proceed or call ‘all ‘board!’.
10. Wait time variance: select the amount of variance to the wait time. Left side of the slider is very little variance, with the wait time always adhering to the selected time, while the right side of the slider introduces large amount of variance in the selected wait time.

Safety Equipment

This page allows for configuration of the locomotive’s safety equipment.

1. Equipment 1: select to activate page one of the equipment configuration menu.
2. Use low water alarm: select to use the boiler low water alarm. When a low water level in the boiler is detected, a high-pitched alarm will sound for up to thirty seconds. If after thirty seconds the water level remains low, the alarm will shut off the fuel flow in the atomizer.
3. Speedometer on tender: when activated, the speedometer dynamo will be installed on the tender instead of on one of the car’s axle. This is useful to get a speed read out when the engine is not pulling a train consist. Otherwise, if the engine is not pulling any cars, there will be no read out on the speedometer.
4. Use electronic governor: when selected, the air compressor governor will be electronically controlled. The electronic governor is more precise than the purely spring-loaded type. Cab electrical supply is required to be on when using this option. See page 113 for more information.



Safety Equipment Configuration Menu

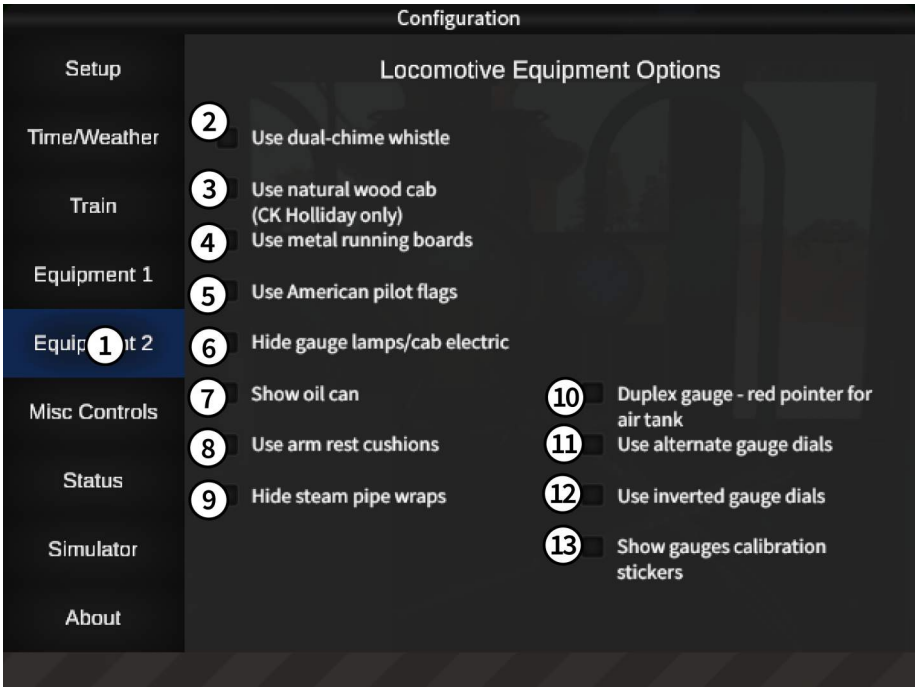
5. Use water treatment: select to use water and boiler treatment additives in the water supply. See page 76 for more information on the effects of water quality.

6. Water TDS: select the water supply total dissolved solids concentrations. This select affects this boiler's thermodynamic calculations. See page 76 for more information on the effects of water quality.

7. Governor setting: select the air tank pressure target for the air compressor.

8. Trigger tolerance: select the air tank pressure's trigger 'sensitivity'. The left side is 'very sensitive': the air compressor will maintain a precise pressure in the air tank but will work more frequently, while the right side is less sensitive, but the air compressor will work less frequently.

9. Left and right trigger setting: set the trigger pressure for the left and right safety valves.



Miscellaneous Equipment Menu

10. Left and right trigger tolerance: set the trigger tolerance for the left and right safety valves.

11. Test water alarm: with the 'Use low water alarm' option activated, select this option to test the water alarm. A loud, high-pitched sound will be emitted during the test.

12. Reset water alarm: with the 'Use low water alarm' option activated, and when the fuel shut off is activated, select this button to reset (mute) the water alarm.

Other Equipment

This page allows for configuration of the locomotive's cosmetic equipment. The options presented on this page are based on what has been provided on the engines over many years.

1. Equipment 2: select to activate page two of the equipment configuration menu.

2. Use dual-chime whistle: select to use the dual-chime whistle (EP Ripley style) instead of the single-tone whistle (CK Holliday style).
3. Use natural wood cab: select to use unpainted wood cab (CK Holliday only).
4. Use metal running board: select to use the modern, raised diamond pattern metal running boards instead of wood running boards.
5. Use American pilot flags: select to use American pilot flags instead of green flags.
6. Hide gauge lamps: select to hide the cab electrical gauge lamps.
7. Show oil can: select to show the oil can on the oil shelf.
8. Use arm rest cushions: select to show the arm rest cushions on the cab window sills.
9. Hide steam pipe wraps: select to hide the protective fabric wraps around the steam pipes in the cab.
10. Duplex gauge—red pointer for air tank: select to swap the duplex gauge pointers. By default, the red pointer shows the air brakes applied pressure. When this option is selected, the red pointer will be swabbed to show the air tank reservoir pressure instead.
11. Use alternate gauge dials: when selected, gauge dials with larger numbering will be used.
12. Use inverted gauge dials: when selected, the boiler gauge dial will be white numbers on black face with a white point.
13. Show gauges calibration stickers: when selected, gauges calibration stickers will show on the face of the gauges.

Misc Locomotive Controls

This page allows for configuration and selection of miscellaneous locomotive controls.

1. Misc Controls page: select to activate the Miscellaneous Locomotive Controls page.
2. Open blower drain: select to open the blower bypass and condensate drain.

Miscellaneous Engine Controls Menu

3. Open front air tank drain: select to open the front air tank condensate drain.

4. Open air compressor exhaust and supply line drains: select to open the air compressor condensate drains.

5. Open rear air tank drain: select to open the rear air tank condensate drain.

6. Open manual blowdown: select to manually open the blowdown valve. Pneumatic pressure is not required to perform a manual blowdown.

7. Engine condition: select the engine's condition. A 'newer' engine will hold pressure and heat better, while a 'worn' engine will lose more pressure and become difficult to fire and operate.

8. Fill air tank: instantaneously fill the air tank to the selected pressure. The pressure is selected in Main Menu (F1) 〉 Equipment 1 menu.

9. Lubricate: select to refill/renew all lubricate points on the engine as well as the train car's axles.

10. Sand flues: select to add sand to the flues. This option is only valid if there is sufficient blower pressure. See page 93 for more information.

11. Check lubrication[1]: select to check the lubrication amount and condition around the engine. See below for the available reports.

12. Check journal[1]: select to check the journal and axle temperatures. See below for the available reports.

13. Check water[1]: select to check the tender water level.

14. Refill water[1]: select to refill the tender water tank.

15. Open water hatch: select to open and close the tender water hatch.

16. Check fuel[1]: select to check the tender fuel level.

17. Refill fuel[1]: select to refill the tender fuel tank.

18. Show true quantities in tender: select to display the tender water and fuel quantities in gallons.

19. Tender water quantity: after checking the tender water level, the water level readout will be displayed this in area, either as approximate volume or in gallons.

20. Tender fuel quantity: after checking the tender fuel level, the fuel level readout will be displayed this in area, either as dip stick reading or in gallons.

21. Lubrication display area: after checking the lubrication, its readout will be displayed in this area.

22. Journal display area: after checking the journal and bearings, their readout will be displayed in this area.

The following table shows the reports that are available when checking the lubrication. The text report is intended to mimic the feel of checking the lubrication points by touch and visual inspection. Each report corresponds to a state of lubrication. The engine crew is responsible for keeping the engine well oiled.

[1] The engine must be stationary for this control to function.

- Dry: the axles, journals, and lubrication reservoirs feel dry to the touch and no coat of oil can be seen.
- Dirty: the journals and lubrication reservoirs is significantly contaminated with dust, dirt, and other particles and lubrication oil does not appear to flow freely.
- Greasy: the journals and lubrication reservoirs appear to be well coated with oil and their surfaces feel slippery
- Wet: the journals and lubrication reservoirs appear to be inundated with lubrication oil.

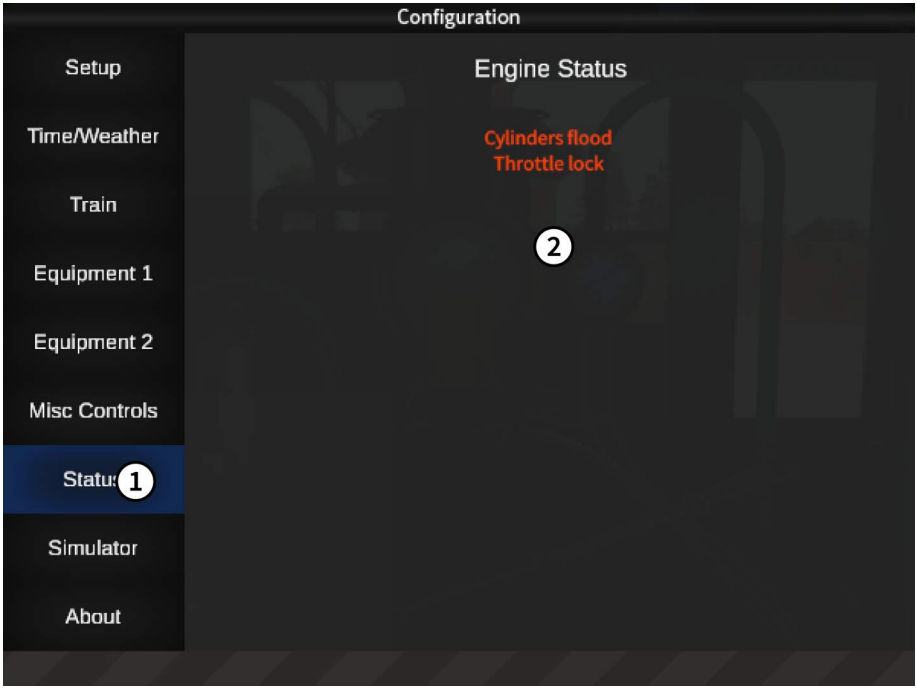
The following table shows the reports that are available when checking the journal and axle temperatures. The text report is intended to mimic feel of checking axle temperatures by placing one hand on the axle bearings. An overheating bearing (hotter than can be comfortably touched) may indicate metal-to-metal contact and lack of lubrication. See section 8.5 for more information.

- Cold: the axles and bearings feel cold to the touch (i.e., colder than ambient temperature).
- Warm: the axles and bearings feel only slightly warmer than the ambient temperature.
- Slightly hot: the axles and bearings feel hot to the touch (i.e., cannot place hand on the surface for more than five to ten seconds).
- Scalding hot: the axles and bearings feel burning hot to the touch (i.e., cannot place hand on the surface for more than a few seconds).

Status

This page displays the messages about the locomotive's state. Since running a steam locomotive is largely a tactile experience, without many instruments or status indicator lights, the Simulator provides a list of 'reports' or messages that can help you decipher the state of the engine.

1. Status page: select to activate the Engine Status page.
2. Message area: this area will display the messages about the locomotive's state. See the table below for the available reports and their definitions.

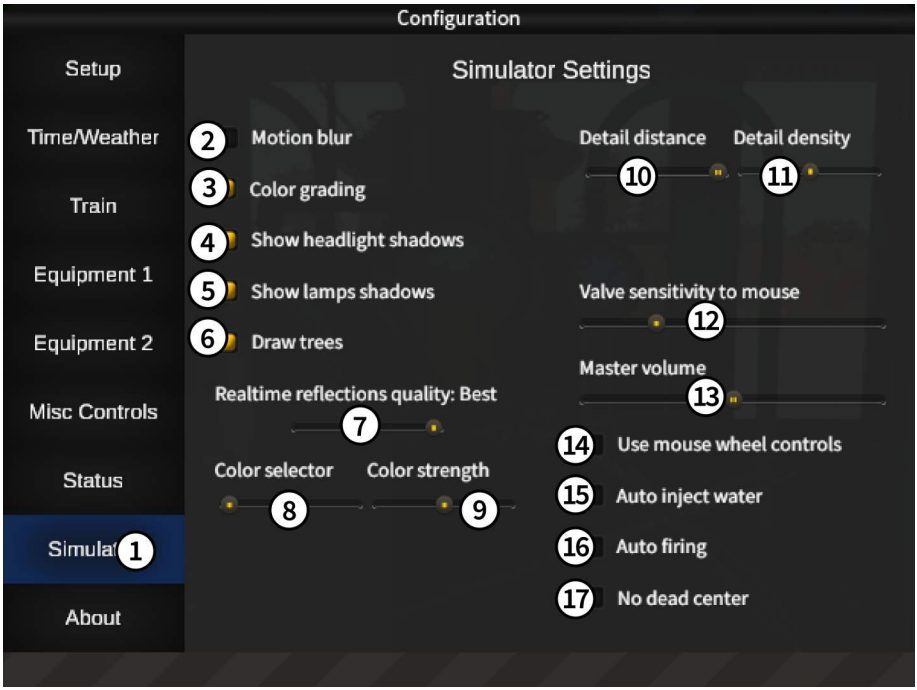


The Engine Status Page

Message	Definition
Hot brakes	The engine and train brakes are hot from excessive use. Brakes effectiveness may be reduced. See section 8.7.
Cylinders flood	The cylinders have been flooded either by carrying over or by condensate. See section 8.8.
Boiler foaming	The boiler is priming and foaming. See section 5.2.
Boiler water high	The water level in the boiler is higher than the optimal level; risks of carrying over may be increased. See section 5.1.
Boiler water low	The water level in the boiler is too low for safe operations. See section 5.1.
Soot in flues	There is a significant collection of soot in the flues. The effectiveness of the boiler heat conduction may be reduced. See section 7.2.
Low battery	The engine's electrical battery's voltage is low.
Compressor low/no lubrication	The compressor is not receiving sufficient lubrication, and risks of piston ceasing may increase. See section 8.6.
Condensate in compressor	There is significant condensated steam in the compressor. The effectiveness of the compressor may be reduced. See section 8.6.
Left (or right) safety valve open	The left (or right) safety valve has popped open. See section 6.2.
Hydrostatic lubricator metering low/no oil	The hydrostatic lubricator metering is not flowing or the metering glass is empty of oil. See section 8.6.

Message	Definition
Hydrostatic lubricator reservoir low/no oil	The hydrostatic lubricator reservoir is empty of oil. See section 8.6.
Waterglass unreliable	The waterglass is clogging and its readings may be unreliable. See section 5.1.
Water alarm	If this equipment is selected, this message indicates that the water alarm is activated. See section 5.1.
Water alarm & Water alarm fuel shutoff	If this equipment is selected, this message indicates that the fuel shutoff has been activated. See section 5.1.
Atomizer steam pressure high	The atomizer steam pressure is too high for the current oil flow. See section 7.1.
Atomizer oil pressure high	The atomizer oil pressure is too high for the current atomizer steam flow. See section 7.1.
Crown sheet heat	The crown sheet is heating up beyond the normal operating range. See section 5.1.
Left (or right) injector warm	The left (or right) injector is heating up from excessive use. Its effectiveness may be reduced. See section 5.1.
Left (or right) injector overheat	The left (or right) injector has overheated from excessive use. The injector is not effective when overheated. See section 5.1.
Left (or right) injector clogged	The left (or right) injector has clogged from sediments and is inoperative. See section 5.1.

Message	Definition
Compressed air umbilical connected & Throttle unlock not allowed	The external air hookup is currently connected to the engine. While the hookup is connected, unlocking of the throttle is not allowed to prevent the engine from accidentally moving with the compressor connected.
Throttle lock	The throttle pad lock is currently engaged. See page 18.
Auto firing active	The automatic firing is currently active. Manual fire adjustments will have no effect on the boiler pressure.



The Simulator Settings Page

Simulator

This page allows for selection of miscellaneous Simulator configuration.

1. Simulator page: select to activate the Simulator options page.
2. This item not currently applicable to this version of the Simulator.
3. Color grading: select to use ‘color grading’, which recolors the screen with different selectable color tones.
4. Show headlight shadows: select to allow the headlight to cast shadows.
5. Show lamp shadows: select to allow the cab gauge lamps to cast shadows.
6. Draw trees: select to draw the scenery foliage (this option can have a large performance impact on the Simulator).
7. Real time reflections quality: this slider selects the quality of the real time reflections rendering. On the left side, the quality is minimal but with the

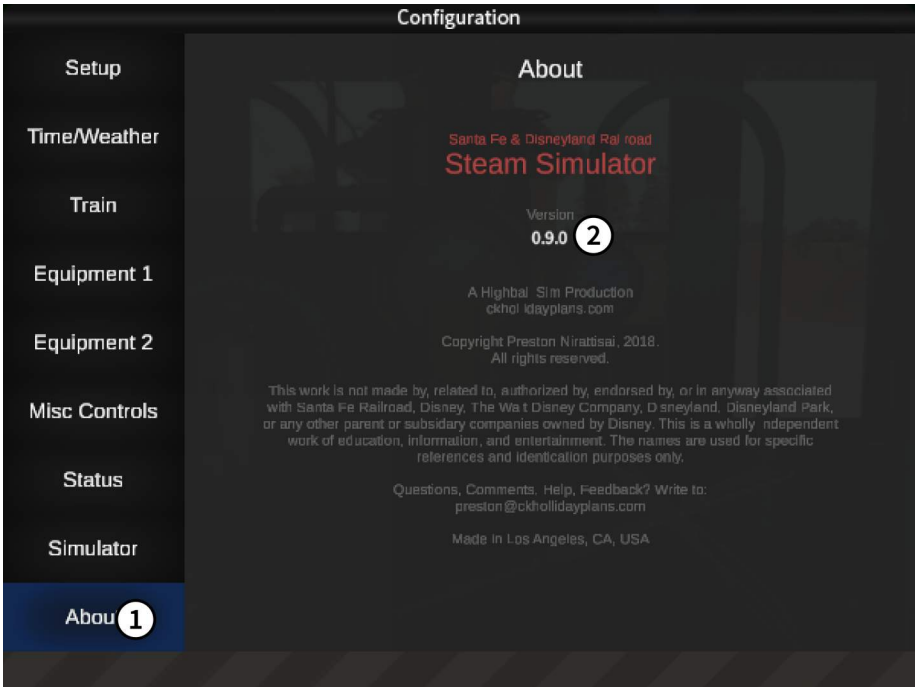
least impact on the program's performance. On the right, the quality is maximum but with the most impact on the program's performance.

8. Color selector: this slider selects the color grading tone.
9. Color strength: this slider selects the strength of the color grading tone.
10. Detail distance: select the draw/rendering distance of the grass and ground cover foliage.
11. Detail density: select the drawing density of the grass and ground cover foliage. Along with the draw distance, these options can have a large performance impact on the Simulator.
12. Valve sensitivity to mouse: this slider selects the sensitivity setting of the valve wheel response to the movement of the mouse or scrollwheel.
13. Master volume: adjusts the Simulator's sound volume.
14. Use mouse wheel controls: this option activates the mouse wheel controls in lieu of the push/pull method.
15. Auto inject water: when this option is selected, the Simulator's AI fireman will automatically inject the water whenever required. There must be sufficient steam pressure to operate the injectors, and the header valve must be opened.
16. Auto firing: when this option is selected, the Simulator's AI fireman will automatically fire the engine and hold the operating pressure. There must be at least 75 psi of steam pressure in the boiler before this option can be activated.
17. No dead center: when this option is selected, the engine will not stall in a dead center.

About

This page shows the Simulator's credit and version information.

1. About page: select to activate the About page.
2. Version: displays the current installed and running Simulator version.

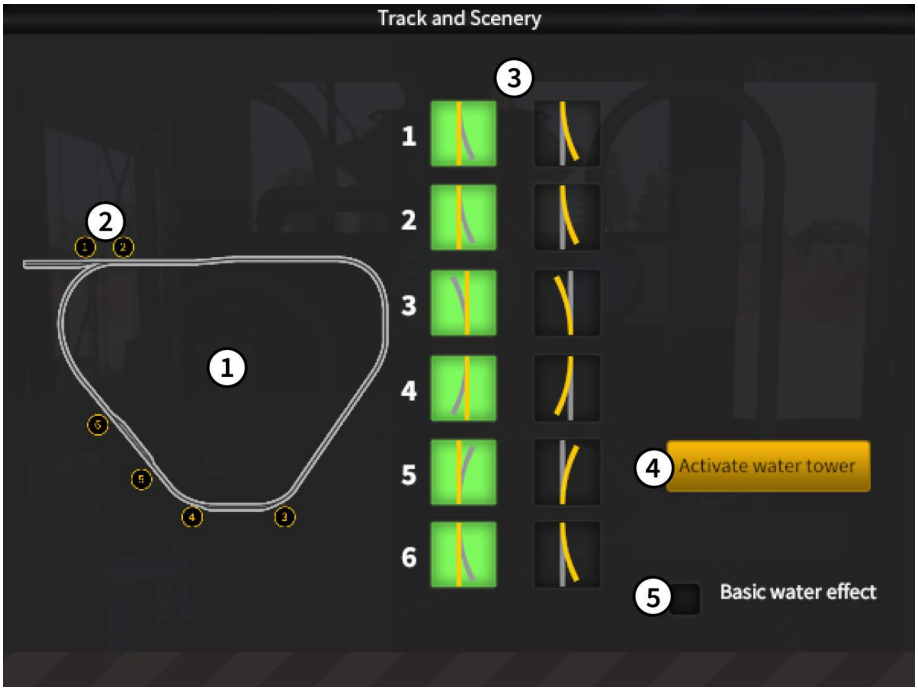


The About Dialogue

2.6 Tracks and Scenery Configuration

This menu allows you to configure the tracks and scenery, such as selecting the track turn-out switches and activating the scenery lights. The menu is activated by pressing F2, and is closed by pressing the same key again.

1. Tracks layout map: this is the layout map of the currently loaded tracks.
2. Switches: these numbers identify each switch on the layout, with the numbers corresponding to the switch selectors.
3. Tracks switches: these buttons operate the switches throughout the tracks. Green buttons indicate currently active fork of each switch.
4. Activate water tower: activate the water tower animation (this is a visual effect only. Refilling of tender water is accomplished through a separate action; see page 27).
5. Basic water effect (available with the Disneyland layout only): allow for switching between Rivers of America advanced animated water effects or



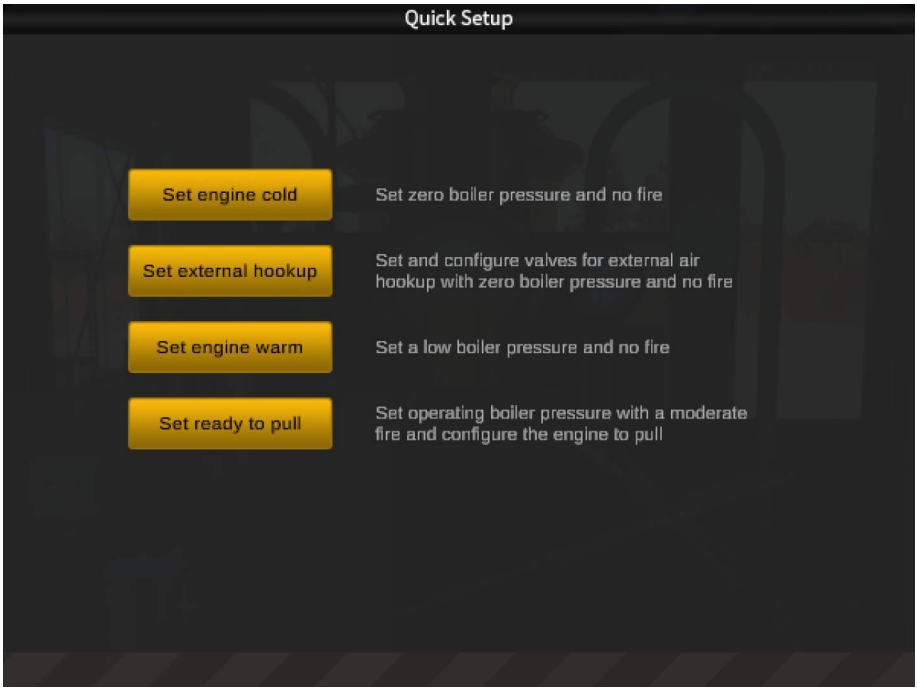
The Tracks Configuration Menu

basic static water effects. The advanced water effect includes real time reflections of the surrounding and water surface animation but can be graphically and computationally demanding on the computer. The basic water effect is a good substitution if your computer does not meet the performance specification to run the advanced water effects.

2.7 Quick Engine Setup

This menu allows you to quickly set the engine's state. The menu is activated by pressing F3, and is closed by pressing the same key again. Each option in the menu offers you with different amount of interaction with the engine to get it ready for pulling. The quickest (and most automated) option is to select Set engine ready to pull.

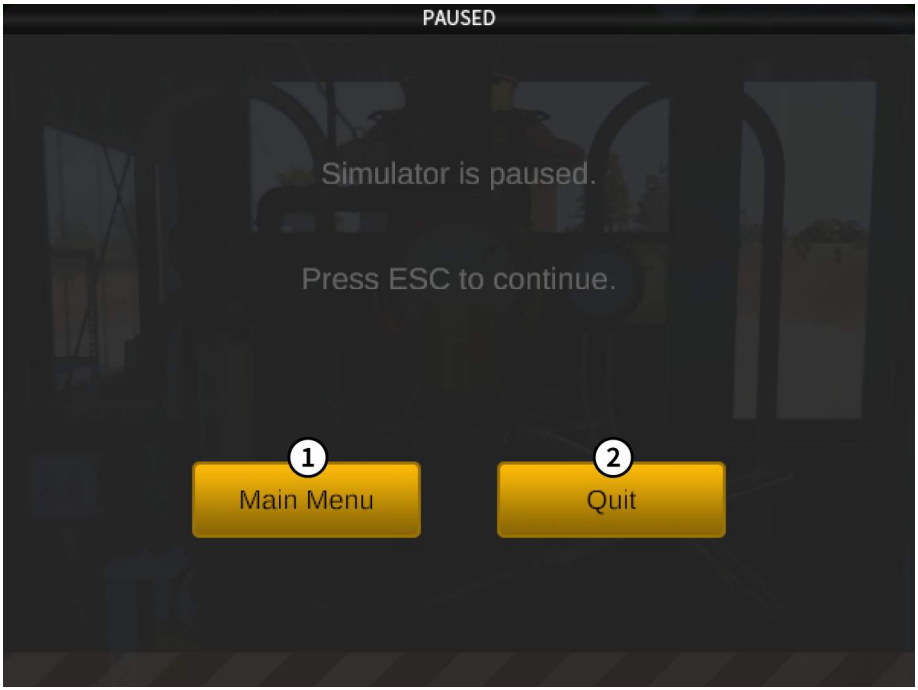
- Set engine cold: no boiler pressure and no fire. This is the Simulator's startup state. The time to ready the engine from this state is approximately 2-3 hours.



The Quick Setup Page

- Set external hookup: configure the valves for firing on external air. There is no boiler pressure and no fire. The time to ready the engine from this state is approximately 2-3 hours.
- Set engine warm: there is some 'residual' pressure in the boiler and no fire. The pressure is enough to fire the engine up to operating pressure. The time to ready the engine from this state is approximately 30 minutes.
- Set engine ready to pull: boiler pressure will be at operating pressure with a moderate fire. Air tank pressure is set, the engine is lubricated, and it is ready to pull. The hydrostatic lubricator will need to be readied (see page 114), the blowdown pneumatic supply opened, and the brakes released.

The most 'realistic' option for the DRR line when starting up at the beginning of the day is the 'Set engine warm' option, because the crew would usually find the engine with some pressure left in the boiler from the previous day.



The Pause Dialogue

2.8 Pause Menu

The Pause menu can be activated by pressing the Esc key. The menu will pause the Simulator, and present an option to return to the Home Menu, or quit the Simulator

1. Main menu: leave the current sim session and return to the Home Menu.
2. Quit: leave the current sim session and immediately exit the program.

2.9 Failure Dialogue

When the water level in the boiler is too low and the crownsheet is heated beyond its normal temperature, the Simulator will automatically pause and the following dialogue will be presented on screen.

Crownsheet overheating and melting is a serious and dangerous condition. As such, the simulation will not be allowed to continue, and the program must be reset either by quitting to the Home Menu or exiting the simulation entirely.

Derailing

Another mode of failure in the Simulator is derailing, which can occur whenever the engine travels over an open switch. When the train is derailed, no failure dialogue will be presented. The Simulator must be reset either by returning to the Home Menu or exiting the program.

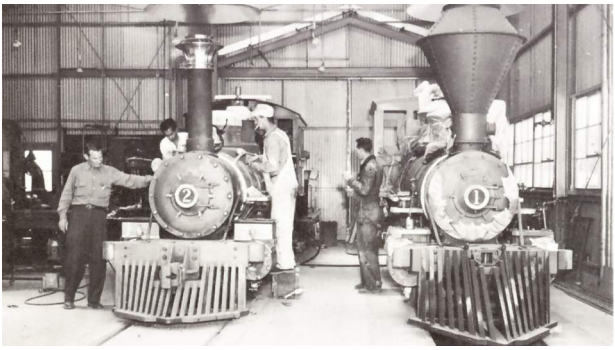
3 The Locomotives

3.1 History

The CK Holliday and the EP Ripley were the first two locomotives built and operated at the Disneyland Park for Walt Disney's Santa Fe & Disneyland Railroad. Designed by railroad draftsman Ed Lingenfelter, under the supervision of a railroad veteran, Earl Vilmer, the first drawings were penned in late 1954, with the construction of both engines taking place along side each other in Burbank, California.

Walt Disney based the look of the engine on his one-eighth scale live steamer Lilly Belle, which is itself a scaled replica of the Central Pacific Railroad CP173. The engine was meant to evoke the look of an American 4-4-0 locomotive popular in the mid to late 1800s. For the Holliday, typical of the American 4-4-0 design is the large 'balloon' smokestack, brightly colored paint, and brass trims; in fact, this type of engine is what most people associate with the images of the American West. The Ripley based her style on a later period of around 1890s, in which the oil-burning American locomotives had straight smokestack.

The engine number 1 is named after Cyrus K. Holliday, the founder and first president of the Atchison, Topeka and Santa Fe Railway. Engine number 2 is named after Edward P. Ripley or E. P. Ripley, the fourteenth president of the Atchison, Topeka and Santa Fe Railway.



The CK Holliday and the EP Ripley completing their construction in the original roundhouse. Photo by Earl Vilmer. S. DeGaetano collection.

The major components of the engines were manufactured by subcontractors. Of note are the engine's frames, which were cut from a single piece of steel. Dixon Boiler Works constructed the boiler, and Wilmington Iron Works casted and machined the wheels. Other parts were made by Disney's crew using wood patterns.

The two engines were finished construction in summer of 1955. After being steam tested at the studio, they began their first run around the park at Disney's Fourth of July party while the park was still under construction. Thus, the Santa Fe & Disneyland Railroad became the first operational attraction at Disneyland. Shortly after the party, Walt Disney was at the throttle of the EP Ripley at the park's opening day, July 17, 1955, before giving the famous 'Welcome' dedication speech on Main Street.

For more history on the engine, its operation, and information on the Disneyland Railroad, one can reference Steve DeGaetano's *Welcome Aboard the Disneyland Railroad!* (Steam Passages Publications, 2004, www.steampassages.com).

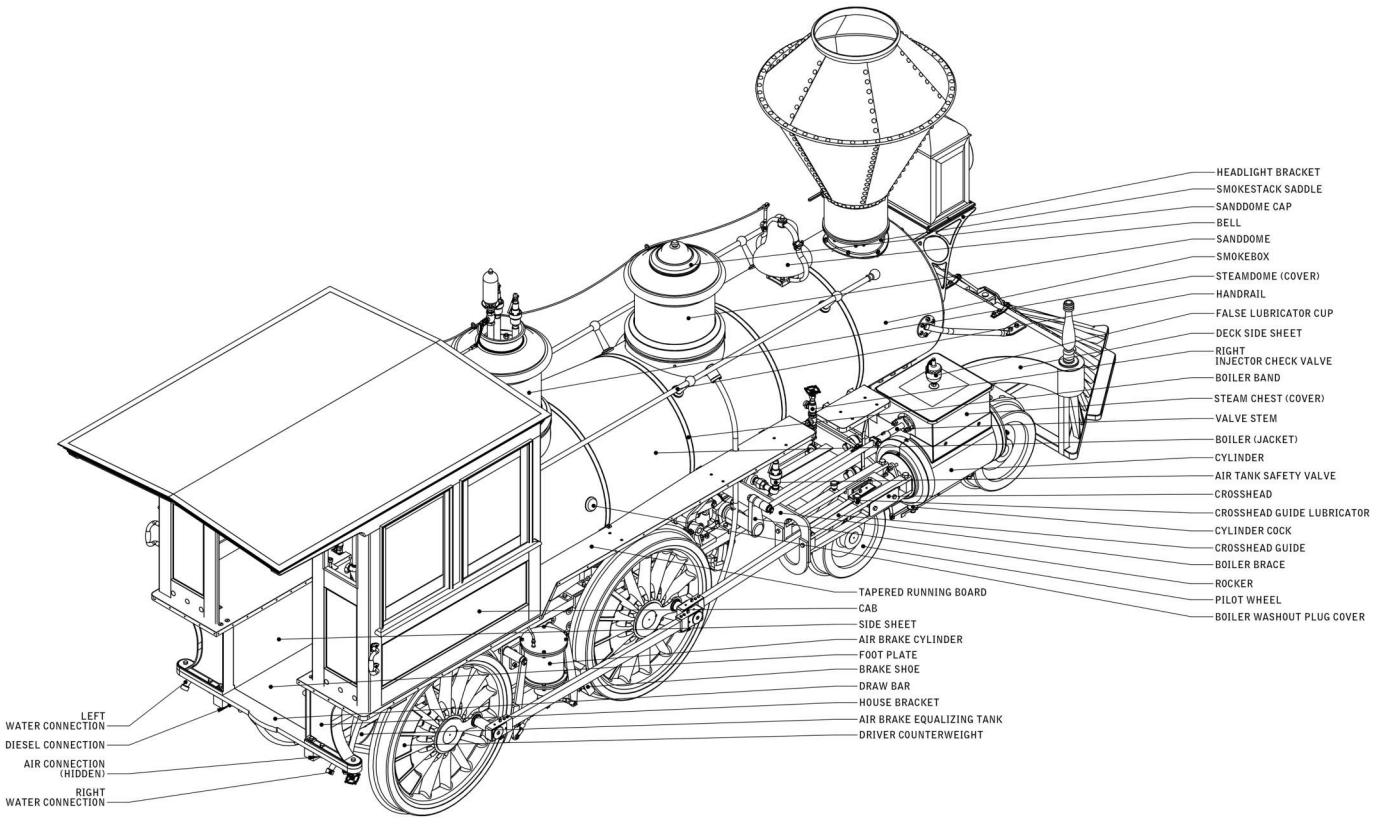
Engines Statistics

Note: being of the same construction, both engines share the same vital statistics.

Builder	Walt Disney's WDI
Architect	Ed Lingenfelter, Earl Vilmer
Completion	June, 1955
Boiler Diameter	33.5"
Cylinder	10" X 15"
Operating Pressure	125 psi
Driver Diameter	36"
Weight	23,200 lb
Tractive Effort	4,427 lb

3.2 Engine Components

The following sections desribe the engine components and cab controls for the CK Holliday, but they are also applicable to the EP Ripley.


HEADLIGHT BRACKET
SMOKESTACK SADDLE
SANDDOME CAP
BELL
SANDDOME
SMOKEBOX
STEAMDOME (COVER)
HANDRAIL
FALSE LUBRICATOR CUP
DECK SIDE SHEET
RIGHT INJECTOR CHECK VALVE
BOILER BAND
STEAM CHEST (COVER)
VALVE STEM
BOILER (JACKET)
CYLINDER
AIR TANK SAFETY VALVE
CROSSHEAD
CROSSHEAD GUIDE LUBRICATOR
CYLINDER COCK
CROSSHEAD GUIDE
BOILER BRACE
ROCKER
PILOT WHEEL
BOILER WASHOUT PLUG COVER
TAPERED RUNNING BOARD
CAB
SIDE SHEET
AIR BRAKE CYLINDER
FOOT PLATE
BRAKE SHOE
DRAW BAR
HOUSE BRACKET
AIR BRAKE EQUALIZING TANK
DRIVER COUNTERWEIGHT
LEFT WATER CONNECTION
DIESEL CONNECTION
AIR CONNECTION (HIDDEN)
RIGHT WATER CONNECTION

able. The compressed air operates the atomizer and the blower. With sufficient water in the boiler, fuel in the tender, and the atomizer and blower operating on compressed air hookup, the crew can fire the engine and bring the boiler pressure up. The compressed air is then unhooked and the rest of the startup process is accomplished with the engine's internal steam.

Crosshead—The crosshead moves in a straight-line motion to transfer the force and motion from the piston to the **main rod** and the drivers. The CK Hollidays uses a four-guide type, meaning that the crosshead is guided by four rails, to keep the crosshead's motion linear while the main rods move in an oblique fashion.

The crosshead is made of cast iron, with wearing surfaces that come in contact with the steel guide rails, called gibs, made of brass.

Crown Sheet—The crown sheet is the metal sheet at the top of the firebox. It must always be submerged under the boiler water or the heat in the firebox may melt the sheet, resulting in catastrophic boiler explosion.

Under normal operation, there are about three to four inches of water covering the crown sheet. There are several safeties to ensure that the water level does not drop below the safe level, including the try-cocks, the water sight glass, and recently, an electronic low water level alarm.

Cylinders—The cylinders, one on each side of the engine, house the steam piston. The cylinders are measured by their diameters and stroke. The CK Holliday's cylinders are 10" X 15".

Cylinder Cocks—Each cylinder is provided with two cylinder cocks mounted at the bottom. Their purpose is to allow condensed steam (water) to escape the cylinder. If water is allowed to collect in the cylinder, the cylinder caps are liable to be blown off by the motion of the piston, as water is less compressible than air.

The cylinder cocks are operated by a lever on the engineer's side of the cab through a system of links and shafts. The cocks are opened by the engineer when the engine is stationary, and closed when in motion.

Driver—The thirty-six inches diameter drivers were casted from wooden pattern, and each driver is composed of a hub and tire. The tires are casted slightly smaller (approximately 0.08" diameter) than the hub. To fit the tires, they are heated over open flame until they expand, then slipped onto the hub and allowed to cool and contracted onto the hub.

The drivers are locked to their respective axles by rectangular keys.

Dry Pipe—The dry pipe conveys the steam from the steamdome to the steam chests. A valve is fitted at one end of the dry pipe and opens to admit steam into the pipe when the throttle in the cab is pulled.

Mechanical Lubricator—The cylinders and pistons receive their lubrication through the mechanical lubricator, located on the left, forward side of the engine. It is operated by the valve stem's oscillatory motion, and with each stroke, the lubricator sends a small amount of lubrication into the steam chest. The thick lubricant reacts with the hot steam in the steam chest and coats the parts that come in contact with the steam.

Piston—The ten inches diameter piston in each cylinder is acted on by the steam pressure from the boiler to move the drivers via the crosshead and main rod. At the nominal operating pressure of 125 pound per square inch, the piston experiences about 9800 pounds of pressure.

Richardson Relief Valve—The Richardson Relief Valve is installed in the front of each steam chest. Its purpose is to admit clean air from the outside, thereby preventing a vacuum from being formed in the steam chests and cylinders when the engine is in motion without a flowing steam supply from the throttle. Without the relief valve, the cylinders are liable to draw air through the saddle's exhaust, along with the diesel fumes and dust.

Rockers—The rockers, one on each side of the engine, are the intermediate motion link between the link gear and the valve stem. They have their own lubrication cups mounted on top of their arresting brackets.

Running Boards, Split and Tapered—Typical to the period, the engine has running boards that taper in front of the cab, and a small, split section forward of the boiler.

The modern engine currently wears a straight type running board, which is somewhat anachronistic to the engine's period.

Saddle (Casting)—The saddle is a boiler support point forward of the engine. It has steam and exhaust passages casting inside. On the CK Holliday, the two cylinder castings are bolted onto the saddle and the frames on either side.

Safety Valves—The boiler uses two safety valves mounted at the top of the steam dome. In the event of over-pressure in the boiler, these valves will 'pop' open and the escaping steam produces a loud, unmistakable hiss, indicating to the crew that the boiler has reached an over-pressure state. Usually, the valves are set to open when the boiler pressure reaches 150 and 155 pounds per square inch respectively, well below the boiler's ultimate pressure capacity.

The over-pressure condition is remedied by opening the injectors to feed cold water into the boiler, resulting in reduction of pressure in the boiler.

A safety valve is also fitted on the engine's air tank.

Sanddome—Dry sand is often used to help the locomotive's drivers gain traction to the tracks, especially when the engine is pulling a heavy load coming

Air Brake Handle—The air brake handle controls the applied air brake pressure.

Air Brake Release Valve—The air brake release valve is an alternative method to release the applied pressure from the air brake.

Air Brake Stand—The air brake stand houses the air brake control.

Air Compressor Steam Supply—This line supplies steam to the air compressor.

Air Compressor Steam Valve—This valve governs the steam supply to the air compressor.

Air Line from Air Tank—This air supplies the air from the air tank to the air brake.

Air Pressure Duplex Gauge—The duplex gauge shows the current air tank pressure and the air brake applied pressure in pounds per square inch.

Air Valve to Blowdown Valve—This valve controls the compressed air to operate the blowdown valve.

Atomizer Line—This line supplies steam to the atomizer.

Atomizer Steam Valve—This valve controls the steam supply to the atomizer.

Atomizer Valve—This valve controls the steam supply to the atomizer.

Bell Rope—The fireman operates the bell rope. Pulling on the rope swings the bell mounted forward of the sand dome. The bell is sounded when the train is entering a station, transversing within the yard, and crossing a grade.

Blowdown (Operating) Valve—This valve operates the boiler blowdown valve.

Blower Line—This line supplies steam to the blower.

Blower Steam Valve—This valve governs the steam supply to the blower.

Blower Valve—This valve controls the steam supply to the blower.

Boiler—The boiler stores the water, steam, and the firebox used to create the steam.

Boiler Build Plate—This plate contains the boiler build information.

Boiler Pressure Gauge—This gauge shows the current boiler pressure in pounds per square inch.

Boiler Pressure Gauge Shutoff—This valve controls the steam to the boiler pressure gauge.

Boiler Washout Plug—The plug covers the boiler washout access hole.

Cylinder Cock Lever—This lever controls the cylinder cock drains.

4 Steps to Fire Up The C.K. Holliday Simulator From "Cold" to Operation

By Steve DeGaetano

The C.K. Holliday simulator ("sim") is one of the most accurate steam locomotive simulators ever created. Being modeled on a narrow gauge 4-4-0 American-type locomotive, its controls are simpler and easier to understand than what one would find on a large locomotive, and therefore it is an ideal teaching locomotive. However, for the uninitiated, the controls and their functions might at first seem puzzling. This guide has been prepared to assist you in "starting" the sim. It was written with the assistance of Steve DeGaetano, a qualified steam locomotive fireman on the New Hope Valley Railway in Bonsal, North Carolina, which operates its own oil-fired steam locomotive.

The procedures outlined below are typical for an oil-fired locomotive. By following these steps, and learning the controls in the process, you should develop a deeper understanding and knowledge of what is required to fire and operate a typical steam locomotive. While reading this "quick start" guide, please refer to the C.K. Holliday backhead diagram with callouts to the various controls.

Okay, let's start the sim, and get her fired up!

1. Make sure the Main Header Valve is closed (we don't want to fill the boiler with compressed air, which we will be using before we have the necessary steam pressure).

2. Open the two water glass globe valves—the one at the base of the curved pipe going to the glass, and the one right under the glass. We need to make sure we have water in the boiler.

3. Open the main blower and atomizer valves on top of the header.

4. On the Main Menu (F1), hook up the umbilical air. This external compressed air source will operate our atomizer and blower before we have any steam. When we have a few pounds of pressure on the gauge, we can "switch over" to steam.

5. When the engine is firing on compressed air hook up, we'll need to "reconfigure" the valves to redirect the air supply to the atomizer. See section 7.4 on how to do this, or use the Quick Setup (see page 36).

6. While on the Main Menu, make sure we have the blower condensate line opened.

7. Slightly open the blower and atomizer control valves located just to the right of the water glass. An eighth to quarter-turn each should be sufficient. We want to clear the firebox of any accumulated volatile gases that could explode in our faces when we try to light the fire. You should now hear a faint "hiss". That's the compressed air being blown through the atomizer. If you don't hear anything while opening the atomizer, and the air compressor is hooked up, then the valves are not properly configured to redirect the compressed air to the atomizer. See section 7.4 on how to do this.

8. Go to the Main Menu and close the blower condensate valve.

9. Lift the latch on the fire door, and open the door as far as possible.

10. Go to the Main Menu, and light a piece of waste. This will be automatically thrown into the firebox. You have about ten seconds before it burns out and you need to light another one.

11. While the waste is burning, open the fuel valve to about 8 o' clock position (9 o' clock is closed, and 6 o' clock is fully open). You should get a puff of smoke and be able to see that the fire is lit. A small "spot fire" is all you need, but you can put a little heavier fire in if you wish.

12. Make adjustments to the atomizer until there's no visible soot or smoke coming out of the smoke stack, there's no excessive rapid flickering of the fire, and there's no "pounding" sound from the fire box. See section 7.2 for an example of a proper fire.

13. Close the fire door and latch it. Now, we need to wait while pressure builds. You can use this time to BS with the rest of the crew, but oiling around and checking the rest of the engine might be a better use of your time. You can do some of these things on the Main Menu.

14. Keep your eye on the pressure gauge. Its movement is almost imperceptible. When you get to about 20 pounds, we can switch over to steam. We do this by closing the Atomizer and Blower valves. I like to leave a puddle of burning fuel on the fire pan—this will make it easier to light off with steam.

15. Go to F1 and disconnect the umbilical air.

16. Open up the Main Header Valve. This is now admitting steam to all the accessories, including the blower and atomizer.

17. Re-open the blower, then the atomizer, from the control valves next to the water glass. There may be some condensate in the atomizer which will be spit out. When it's only steam, open up the Fuel Valve again. If we've done everything correctly, we should get a fire back. Open the door and make sure. If not, light a piece of waste and throw it in.

18. Adjust your fire accordingly. If you want a bigger fire, open the atomizer more, then open the Fuel Valve (making a smaller fire, do this in reverse; i.e., close the fuel valve a little, then turn off the atomizer a bit). Again, in real time, it may take an hour or two to get up to operating pressure. Keep an eye on the pressure gauge.

19. You may notice the water in the sight glass is going up: No, water isn't being added; it's expanding as it is heated. We are using so little steam you won't have to add water for a while.

20. When we get to about 75 pounds, you can probably check the injectors. The injector works by opening the water valve (on the fireman's side, the two valves to the furthest left. The water valve is the lower one). Once the water valve is opened, open the steam valve. If the injector is working, two things should happen: The water in the glass will go up, and the pressure on the gauge will go down. If you're satisfied that it's functioning, you can turn it off by turning off the steam valve FIRST. When that's closed, you can close the water valve. Double check that the try-cocks are functioning as well.

21. Blow out the water glass, to make sure it isn't giving a false reading. Close both the globe valves connected to the glass—the one on the curved pipe and the one below the glass. Now, open the yellow ball valve drain, also under the glass. Open the globe valve below the glass—this is the "water side" valve. Blow it out completely, and then close the globe valve. Go to the upper glove valve, and open that one—blow it out completely. Then close it.

22. Close the yellow drain valve. Now open up both globe valves again. Water should reappear in the glass. Open and close the yellow drain valve and see if the water "bounces" back up in the glass.

23. When we get to about 125 psi on the gauge, you can start the locomotive's air compressor. Go to F1 and make sure the compressor drains are

opened. We don't want to "vapor lock" it. Also, the compressor can be damaged if you start it with water in the system.

24. The compressor also needs lubrication. The Disney engines use hydrostatic lubricators. This is the brass device just to the left of the steam gauge. To operate it, open the two small red valves: one at the top and one behind it. At the bottom of the cylinder body, there's a small square nut: open that to the left. The glass closer to you in the cab is the reservoir, and the glass further from you (closer to the compressor) is the metering. Basically, the oil in the reservoir glass flows into the metering glass, and the steam picks up the oil from there.

25. If one of the glasses is empty of oil, or if the valves aren't opened, the compressor will still run for a while but will eventually slow way down or seize completely. The oil in the glasses is also a bit hard to read due to the stains inside the glass, since the oil is so thick. You'll have to move in pretty close to see the levels.

26. Go ahead and open the main compressor valve—that's the valve at the very top of the header, centered right over the steam gauge. You should hear it thumping.

27. After a while, go ahead to the Main Menu and close the compressor drains. If we have some air pressure, you can open the air tanks and blow out any condensate from here as well.

28. When we get to 150 psi, with maybe two nuts of water in the glass, we are ready to go! Look at the brake gauge—it has two needles: One shows the pressure of air in the air tanks (black), and the other shows any pressure applied to the brake cylinder (red). There may be pressure showing with both needles, meaning the brakes are applied.

29. You can try and function at both fireman and engineer positions, but this can be tricky. To make it easier, you may want to go to the Main Menu and select the "Automatic Water Feed" option, so you can concentrate on running the engine.

30. If you want to be the fireman too, remember that you need to increase your firing rate to match the engineer's motions—when he pulls out the throttle, he's using steam which you will need to replace with a bigger fire; when he closes the throttle and stops, you will need to mirror him accordingly by lowering your fire) and add water as necessary (understanding this will also take your pressure down). It can be VERY challenging.

31. While on the Main Menu, "unlock" the throttle. Now the fun really starts!

32. Open the cylinder cocks with the lever on the very far right on the engineer's side. We want to blow out any condensate that could damage the cylinder heads (since water doesn't compress).

33. Put the Johnson bar "in the corner" (all the way forward).

34. Release the brakes completely. This can be done two ways: You can either push the brass brake lever all the way forward, and let the air bleed off, or you can release it more quickly by pressing on the release lever right next to the main brake lever. Look at the brake gauge to confirm you have released all the air (Black arrow should be on the zero peg).

35. Blow the whistle two short blasts.

36. Grab the throttle latch, release it, and pull back on the throttle. Don't worry if you don't start moving right away—the steam takes some time to go through the dry pipe and into the cylinders. After a few seconds, you can slowly pull the throttle back a little more. Keep repeating the "pull back a bit, wait a bit" routine, and you should eventually hear the "Chuffs" as the wheels start turning, and the scenery starts moving past. If you suddenly hear a rapid fire of "chuff chuff chuff", and the engine sway violently, you've pulled the throttle back either too far or too quickly. Immediately close the throttle completely, and try to open the throttle again slowly.

37. After a few chuffs, you can close the cylinder cocks. As we speed up, you can open the throttle a little bit more to accelerate faster, then "hook up" the valve gear by pulling the Johnson Bar back a little—but not all the way to center—that will just put you in "neutral."

38. When you are ready to stop, close the throttle. Pull back on the brass brake lever, and watch the brake gauge. You only need about 10 to 20 psi to stop the train.

39. Center the Johnson Bar. You can blow the whistle once to let the crew know we've stopped moving and won't move again until signaled.

Okay! If you have followed the above instructions, you should have a good understanding of the basic locomotive controls, and how to use them. You will need to practice with everything to become proficient. So, just have fun learning about all the little nuances in the program. Be sure to check out all the functions on the Main Menu as well. And above all, enjoy "operating" a Disneyland Railroad train, in the sim's immersive virtual reality environment.

5 Water Management (Fireman)

The *fireman* is generally responsible for maintaining the water, steam, and fire on the engine. The fireman must operate the engine efficiently to minimize wasteful fuel and water loss, and the fireman must pay attention to the water quantity *and* quality to keep a plentiful supply of usable steam in the boiler.

Water is used to make steam. This is accomplished by heating the water in the boiler, and through heating, some of the water is converted into steam. As the water mass is used and leaves the boiler, replacement water is normally brought into the boiler via one or both of the injectors in the cab. A supply of replacing water is stored in the tender, along with the fuel. For safety reasons, the boiler must contain a certain minimum amount of water at all times.

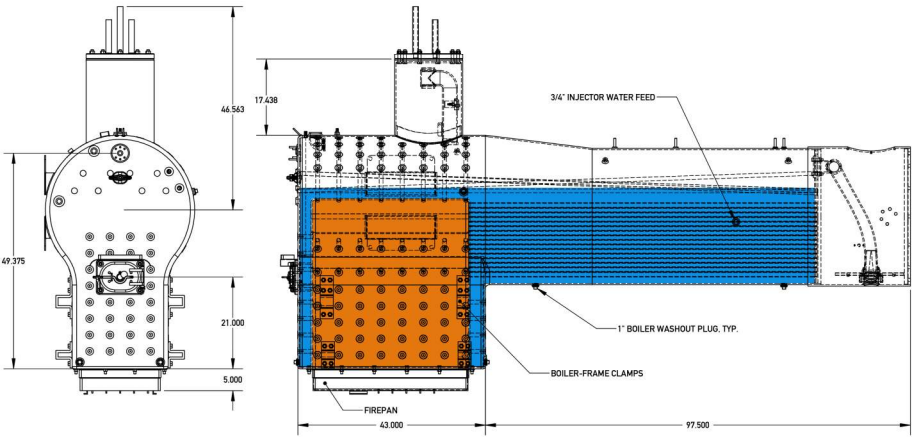
5.1 Water quantity

The fireman is responsible for maintaining a safe quantity of water in the boiler. A low water level in the boiler is a grave situation and can result in catastrophic damages to the engine and the surrounding property, and injury or death of the crew.

The engine's firebox is suspended in the boiler by a series of stay-bolts. A gap of about three inches surrounds the sides of the firebox, with the top of the firebox opened to the steam dome. This gap is filled with water, and the top is also covered by some amount of water, so that in a normal operation the firebox is completely surrounded by water.

This surrounding water is necessary to absorb the high heat from the firebox. The firebox is constructed out of steel, and under normal operation, it is heated *beyond* the melting point of steel. If the boiler water level falls low, the top of the firebox, called the crownsheet, becomes exposed and is liable to melt. If the crownsheet melts, the internal boiler pressure will cause the firebox to implode. The boiler contents will then expand suddenly into the atmosphere, and the sudden release of steam and water becomes like an explosion, causing damage to surrounding property and personnel.

Too much water in the boiler can also be problematic. As the water level reaches the steam dome, and when the steam is drawn from the dome, some of the water at the top will travel with the steam and inundate the cylinders and the appliances. A flooded cylinder, due to the incompressibility of water, restricts



The boiler layout for the CK Holliday and EP Ripley is shown with the firebox space colored in orange, and the water space in blue. The white space above the water level is the steam space. The top interface between the firebox and the water space is the crownsheet.

the movement of the pistons. The pistons may seize up, or at worst, the pressure applied to the piston can force the water to blow the cylinder caps and buckle the driving rods, and may injure the crew and nearby personnel.

Too much water in the boiler also makes steam generation difficult, as more water mass is required to be heated, causing more time and fuel to be spent to heat the water. Similarly, this makes the boiler less responsive to heating changes, so the fireman will need to further anticipate the steam needs and changes.

A safe water level should be maintained at all times. The water level should be about one-half nut to two nuts in the water glass. The fireman should anticipate the need of the water ahead of time so that the water never falls below a safe level. The amount of water converted to steam is proportional to the heat applied. For example, when starting a heavy train, a lot of steam will be expended, requiring water to be converted to replace the used steam. Therefore, the fireman should put a slightly larger amount of water in the boiler before the train starts moving.

The primary method of monitoring the water level in the boiler is with the water sight glass (see page 73). A recently added safety device is the low water alarm. This solar panel powered alarm will emit a loud, high pitched tone when the water level is approximately below the water glass. If the alarm is sounded continuously for 30 seconds, the alarm solenoid control will automat-

ically shut off the fuel valve, extinguishing the fire. Only the train crew lead (manager) may reset this alarm, ensuring that the management is aware of any automatic shutoffs that occur. You can simulate this equipment by selecting the appropriate option in the `Safety Equipment` menu.

Adding water to the boiler

The primary method of adding water to the boiler is by using the steam powered injectors. The injector uses steam from the manifold to draw the water from the tender, combines the steam and water in a chamber, and then forces this mixture back into the boiler. The boiler thus receives new water as well as the steam (now condensed into water) it spent from the injection. The injection point is slightly forward of the sand dome, so that the relatively colder water does not cause uneven cooling of the firebox.

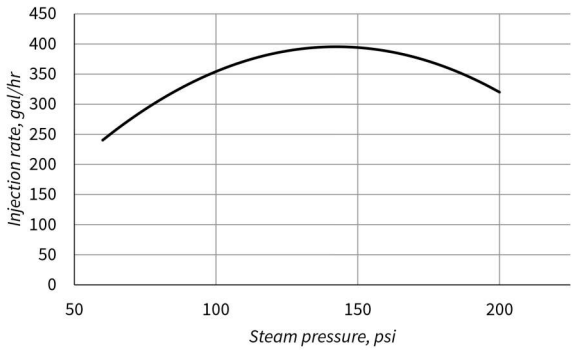
Operating pressure	Injection rate
60 psi	238 gal/hr (4 gal/min)
100 psi	367 gal/hr (6 gal/min)
120 psi	390 gal/hr (6.5 gal/min)
140 psi	400 gal/hr (6.7 gal/min)

The injector is advantageous over the mechanical pump because it has no moving parts, and the cold water from the tender is mixed with the steam to near boiling before it enters the boiler, making it easier to maintain the boiler pressure when adding the water. However, the injectors can still fail to perform in two ways:

- Overheating. Because an injector operates by mixing the steam in a chamber inside, the injector will heat up by some amount. Normally, it would have a cool down period whenever it is not use. But if an injector is operated frequently or continuously without a cool down period, it will heat up to a point at which water will no longer mix with the steam in the chamber, and thus no water will be injected into the boiler. It's also possible for an injector to inadvertently heat up if the steam valve leaks or is not tightly closed.
- Clogging. It is possible for the water supply piping or the injector's cone to be clogged with sediment or debris, thus blocking the water's delivery into the boiler. A water filter in the tender is used to minimize debris from entering the injectors.

Additionally, the injectors may fail to operate due to:[1]

[1] These items are not simulated.



Water injector rate vs. operating steam pressure.

- Injector cones being out of alignment.
- Air leaks causing cavitation in the water piping.

Two injectors are provided: one on each side of the cab. To operate the injector, fully open the water feed valve, and then open the injector steam valve. The manifold must have steam available to power the injectors. The average rate of water injected is 6.5 gallons per minute (389 gallons per hour),[2] and varies with the amount of steam pressure available. The injector operates between 60 and 200 psi.

With the steam and water valves opened to the injector, watch the water glass carefully for the rising water column. When the water rises to the required level, turn off the valves in the reversed order. Be sure that the water valve is closed tightly to minimize water leaking out of the tender, and that the steam valve is closed tightly to minimize steam loss and overheating the injector.

If, after thirty seconds or so, very little or no water column rise is observed, either the injector is faulty, the water glass is clogged, or the water supply is obstructed. Check if the injector is warm or overheated,[3] and if so, use the other injector, then verify that the water can be added to the boiler normally. If the injector is not warm or overheated, then either the injector is clogged or

[2] Each time the simulator starts, each injector's maximum rate is slightly randomized to simulate the differing equipment condition the crew might find from day-to-day operation. The variation is very subtle, but nonetheless considered, so you might find injectors with different 'personalities' each time.

[3] Of course, it's not possible to feel whether the injector is warm or hot in the sim. Check the Engine Status page for any messages about the injectors.

6 Steam and Pressure Management

Once water is heated and converted to steam, the steam must be carefully managed to limit unnecessary losses. Excessive steam loss requires additional water to replace it, and more fuel and time to heat the water, causing the engine to become more expensive to operate.

Steam pressure is generated by heating the water in a closed boiler. The internal pressure of a closed vessel is generally approximated by the Ideal Gas Law:

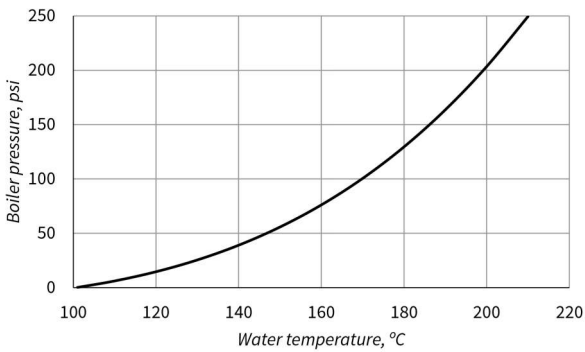
$$Pv = nRT$$

in which P is pressure, v is the volume of the vessel, n is the amount of steam (in moles), R is the ideal gas constant (approximately 8.314), and T is the absolute temperature (in kelvin) of the steam.

With a closed vessel where the volume is constant, and the amount of water is assumed to be constant, pressure is *directly proportional* to temperature.

Note that, at the engine's normal operating pressure, the water is heated *beyond* its 'normal' boiling point. The water temperature in the boiler can be as high as 180 °C, and this is possible due to the pressure in the boiler.

Steam in the boiler is simply water particles with energy added from a transfer of energy, called heating. Adding heat to the water excites the molecules, giving



A closed vessel's internal pressure varies with the temperature; if pressure loss occurs, the temperature also decreases.

7 Firing and Fire Management

Fire is a combustion process involving a fuel,[1] and an oxidizing material. These two materials, when combined in an exothermic chemical reaction, produce heat, carbon dioxide, nitrogen, and water. The heat is used for increasing the boiler energy for the purpose of making steam. The fuel material is diesel grade number 2 (No. 2-D)[2] stored in the tender, and the oxidizing agent is the atmospheric air.

$$\text{Fuel} + \text{Air} \rightarrow \text{(via combustion) Heat}$$

or

$$(C + H) + (O_2 + N_2) \rightarrow \text{(via combustion) } CO_2 + N_2 + H_2O$$

The combustion process takes place in the firebox, located at the rear end of the boiler. It occupies approximately 1,300 cubic inches (9 cubic feet) of space. Heat generated by the firebox is carried through the boiler by 74 1 inch flues, along with the fuel's exhaust. The flues also allow air to flow through the firebox, creating a draft for better combustion. A small louver at the bottom of the firebox also serves this purpose.

A poorly maintained fire can cause excessive steam loss, waste of fuel, excessive generation of smoke, and degradation of the boiler's capacity to store heat. The fire size needed depends on the scenario. These are the typical scenarios during operation, and the corresponding fires that are needed:

Scenario	Fire
Stationary engine	Small fire
Pulling out from stationary	Moderate fire
Coasting	Small to moderate fire
Short or scheduled stop	Moderate fire

[1] The No. 2-D fuel is also artificially colored red with Solvent Red 26 azo dye, required by the Internal Revenue Service to identify tax-exempt fuel intended for heating uses and by off-road vehicles.

[2] Disneyland Railroad switched from burning diesel #2 to biodiesel in 2007. The two types of fuel provide similar performance, and the Park saves money by producing its own fuel (the biodiesel is partially recycled from used cooking oil collected from kitchens throughout the Park).

stationary, and to shut it off when the engine is moving. Some fireman may prefer to use the blower while injecting water into the boiler to help combat the loss of boiler temperature, instead of adding more fuel to the fire.

Additionally, the blower, with an addition of fine-grained sand, can be used to clear the flues from carbon buildup and soot, using the following procedure:

1. Open the firedoor.
2. Fully open the blower valve; this will help to create a vacuum effect in the smokebox.
3. Add a handful of sand into the firebox. The vacuum in the smokebox will draw the sand through the flues, taking along with it any soot buildup.
4. Turn the blower down or off as necessary, and close the firedoor.

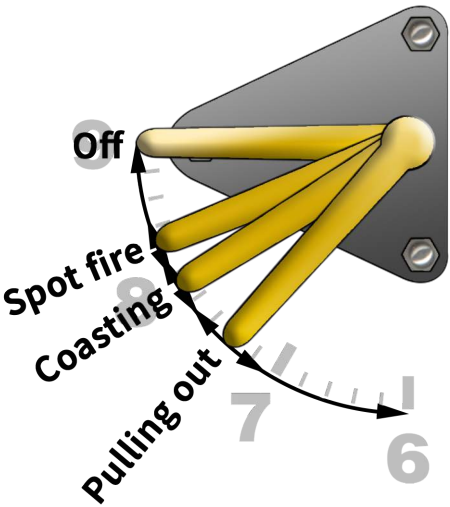
Using the fuel valve

The fuel valve[4] controls the rate of diesel fuel being added into the atomizer and the firebox. The fuel line is plumbed from the underside of the fuel tank in the tender, and flows via gravity into the atomizer, and therefore does not require any artificial or external power to operate. The rate of flow is controlled by the fuel valve, which is linked directly to a ball valve fitted on the fuel line, just beneath the cab's floor plate.

Because the fuel valve is actually a ball valve (instead of a globe valve found on nearly all other cab devices), the range of the valve's motion is limited to only 90 degrees between fully closed and fully opened. The fireman should only make small incremental adjustments to the valve, because a small movement translates to a large change in the fuel flow. The valve is fully closed when the handle is perpendicular to the running board, and fully open when turned parallel.

When the engine is stationary, only a 'spot fire' is required to maintain the boiler's pressure, or when building a pressure from a warm or cold engine. This is a low level fire with a corresponding low amount of fuel flow. When the steam is most needed, such as when pulling out of a stop of coming up a grade, the fuel flow needs to increase to keep up with the steam demand. As the engine speeds up, the steam demand decreases and the natural draft feeding the fire increases, so the fuel flow can be decreased from the pulling out position.

[4] Disneyland Railroad crew calls the fuel valve the 'fuelstick'.



A top down view of the fuel valve with standard placement of the handle for typical firing situations. Zones may overlap and actual placement will depend on actual condition and fireman's experience. The clock dial between 6 and 9 o'clock is provided for positioning reference. Note the relatively small amount of movement required between all positions, and that rarely does the valve need to travel beyond the 7 o'clock position.

With practice, the fireman will come to recognize the best position for the fuel valve. Once the optimal position is set, no further adjustments to the fuel valve are required under most situations. Constantly making large changes to the fuel valve is indicative of inexperienced firing.

When increasing the fuel rate, the fuel valve should *trail* the atomizer steam: open the atomizer valve first, then open the fuel valve.

When decreasing the fuel rate, the actions should be performed in reverse.

Not fully closing the fuel valve can cause small drips of fuel to enter the firebox. These drips will pool and the fuel fume will inundate the firebox. When heat is added (such as with a lit waste), the collected fumes and vapors can explode, causing not only a surprise to the fireman, but potentially an injury as well. It is a good practice to check that the fuel valve is fully closed at the end of its use, and to open the blower for a few minutes at the next lighting to remove any fumes trapped in the firebox.