

Vortex Backhoe Loader Simulator Instructor Guide

1.1

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Welcome

The Vortex Backhoe Loader Training Pack is designed to help operators learn to excavate, trench, manage stockpiles, and load equipment onto trailers for transport. With practice, students can develop the coordination and digging techniques they need to master safe, efficient operations.



About this Guide

This Guide is intended for instructors of heavy equipment training programs who will supervise students as they use the simulator to learn and enhance operating skills.

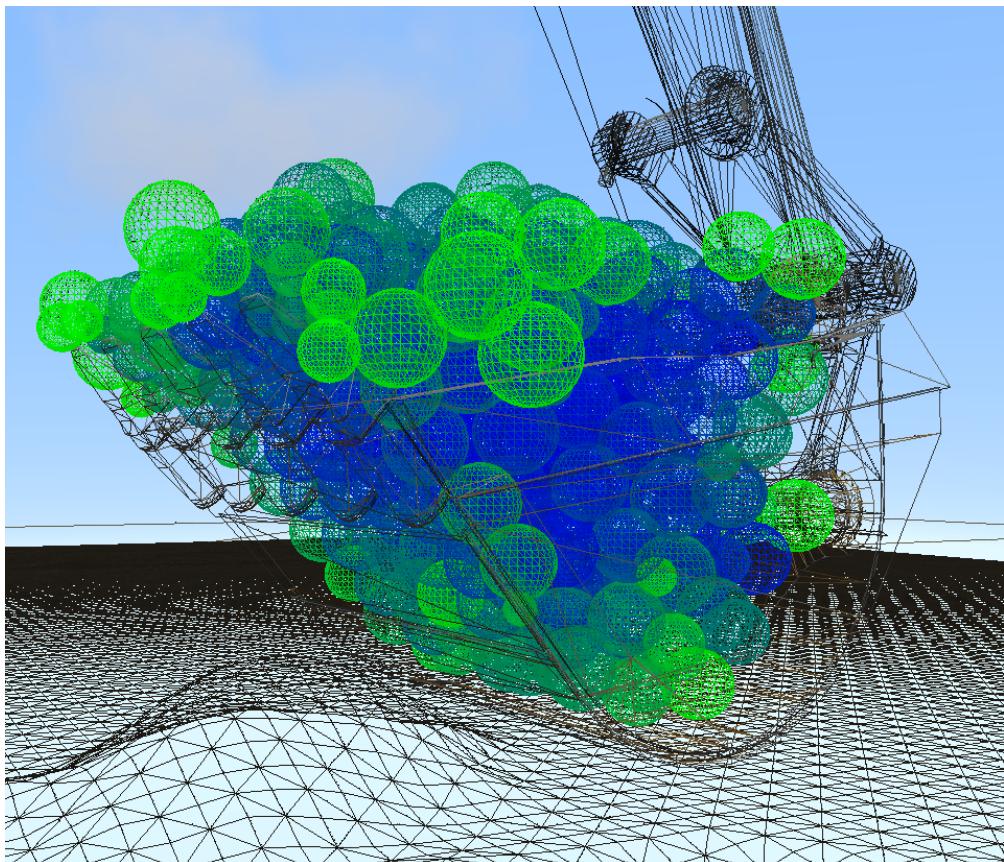
Instructors should have some experience operating construction equipment and basic knowledge of the Microsoft Windows operating system.

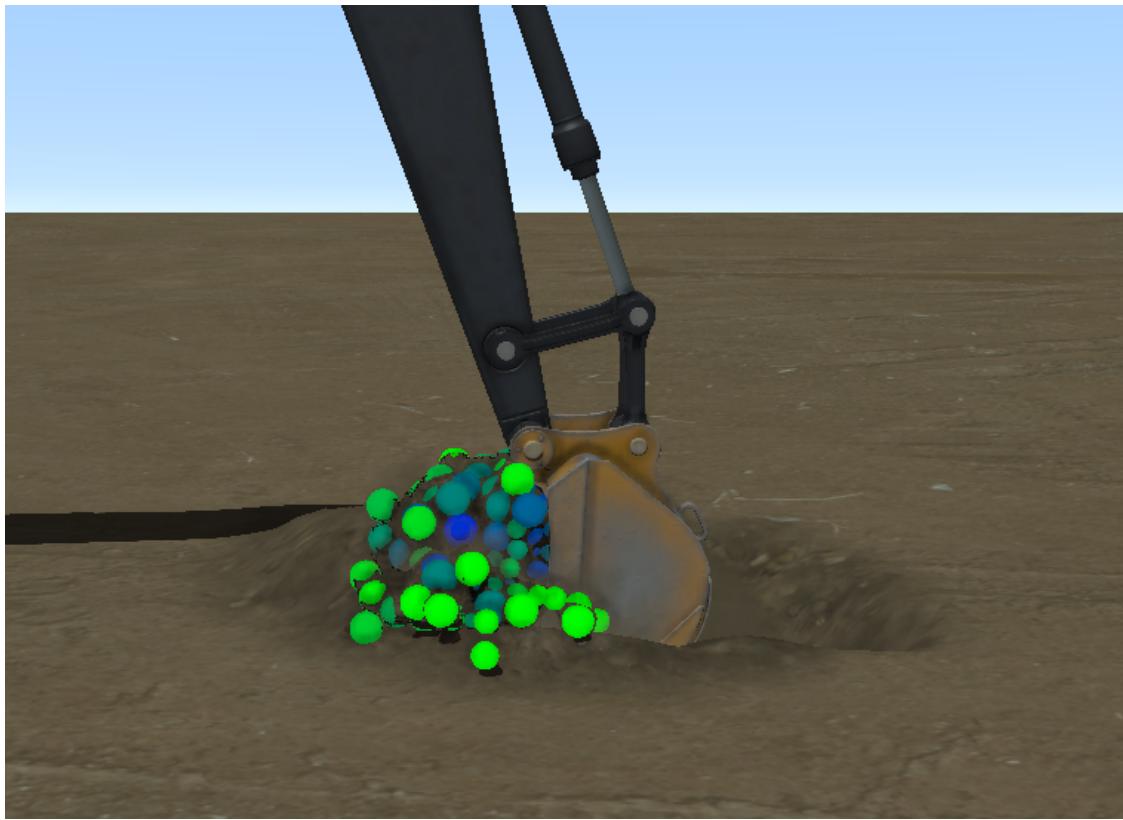
To help instructors accomplish training objectives, this Guide offers information about the following:

Section	Description
Hardware , on page 17	Describes hardware, controls, and displays you can use with this solution.
Getting Started , on page 23	Describes how to launch the simulator software application, navigate the user interface, and start a training exercise.
Managing Accounts and System Access , on page 33	Describes how to add user accounts for students and instructors, and how to add students to classes.
Conducting Training Sessions , on page 71	Activities typically involved in conducting a training session, such as assigning exercises to students, modifying weather conditions, scoring values, using hand signals, and reporting.
Backhoe Loader Training Exercises , on page 103	Detailed descriptions of training exercises and learning outcomes.

Vortex Studio

Each simulator training module is developed using the Vortex Studio platform. Vortex Studio is a modular software platform that allows for the creation of extremely realistic equipment simulation, including training, visualization, planning, and prototyping. Vortex Studio simulates articulated assemblies, contacts and constraints, realistic tracked and wheeled vehicle dynamics, precise grasping of virtual artifacts, simulating digging and dumping soil, and high-fidelity cable behavior.





For more information about Vortex Studio, see [Vortex Studio User Documentation](#).

Backhoe Loader Simulation

The simulator is designed to realistically reproduce the experience of operating a 8.3-ton backhoe loader with an 83kW engine. The simulation software relies on exact specifications and collaboration with manufacturers to make sure that the backhoe loader moves, sounds, and operates like a real backhoe loader. The simulated machine features a heavy duty buckets, rearview camera display, loader quick coupler, fork and chain attachments, and realistic HMI.



Quick Coupler Control

Operators use a simulated Quick Coupler control on the Operator Controls page to attach and detach the loader bucket and forks attachment.



Forks

The operator can detach the loader bucket and attach forks to lift pallets or pile tires.



Outriggers

The backhoe loader features extendable outriggers to stabilize the machine during trenching and lifting operations.



Mirrors

The system realistically simulates the view in each rearview mirror on the main display.



Operator Monitor

The simulator includes a realistic monitor and control page which shows the rear camera display and controls for turning on the engine, work lights, selecting a control standard, using the quick couple control, and enabling the Auto-Idle feature.



Engine Features

For training purposes, the system realistically simulates different work modes, automatic transmission, 4-wheel drive, and Auto-Idle function.

Auto-Idle Control

The Auto-Idle control reduces fuel consumption and noise by lowering the engine speed when the operator does not use hydraulic functions for 4 seconds.

Simulated Behaviors

The simulated backhoe loader is designed to let operators experience these realistic behaviors:

- Hydraulics system
- Soil digging and dumping, with realistic earth-moving
- Backhoe arm with extendable dipperstick
- Extendable outriggers
- Steering and transmission

- Deflection and instability (the backhoe loader can tip over when unstable)
- Hydraulic quick coupler, lifting, and rigging behaviors

Simulated Training Yard

The simulated training yard is designed to resemble a typical heavy equipment training area. It features realistic soil, vegetation, and training equipment. Dedicated areas of the yard let operators develop trenching skills.

Exercise	Image	Description
Basic Controls		Practice course marked with traffic cement barriers where the operator can practice driving and parking.
Loading and Unloading Trailer		Yard with different trailers to move the backhoe loader on.
Trenching		Excavation area with white lines marking trench specifications.
Truck Loading		Material pile with dump trucks.

Exercise	Image	Description
Load Handling		Yard with different lifting attachments and loads.
Skills Challenge		Pipe maze with defined targets and timers.
Sandbox		Practice yard with different areas for trenching, lifting tires, moving onto different trailers, and pushing a concrete ball through a slalom course.

Learning Program

Training exercises are designed to gradually build student skills and confidence in critical areas of competency:

- Safe operating procedures and safety violation recognition
- Swing, boom, and arm control
- How to position the backhoe loader and outriggers for stability during trenching, lifting, and travel
- Lifting and moving heavy loads
- Positioning pipes in a trench
- Loading dump trucks
- Creating a trench

Safety Features

Learning to recognize and react safely to hazardous conditions is a critical part of operator training. The following features are designed to help operators learn safe operating procedures:

Tips and Instructions

Before each exercise begins, the tips tell the operator how to complete tasks safely. Safety tips use animations to show operators best practices and give specific instructions for operating the backhoe loader safely.

Activity	Safety Guidance
Looking for hazards in the work site	Before you start to do work, look for hazards in the work site. Always operate equipment as far as possible from fire hydrants, power lines, and other persons.
Using caution near a trench	Do not move loads near the edge of the trench. The wall can collapse and cause injury to persons or equipment.
Creating a safety corridor during between the backhoe loader and a trench	When you dump material onto the spoil pile, make sure there is a safe path between the pile and the trench. Start to uncurl the bucket when it aligns with the corner of the track, at the 2 o'clock position. Obey local laws which specify the distance and width of the safety corridor.
Keeping hydraulic cylinders in good condition	To decrease maintenance and repairs, do not operate hydraulic cylinders at their limits. If the cylinders hit their limits again and again, the equipment can become worn.
Filling dump trucks	Do not touch the sides of the dump truck with the bucket. Do not move the bucket over the truck cabin.
Keeping the path of the truck clear	Make sure the path of the truck is always clear and level. When a truck drives away, clean any material that spilled.

Activity	Safety Guidance
Stabilizing the backhoe loader	Extend outriggers to stabilize the backhoe loader during excavating and lifting operations.
Advancing onto a trailer	Keep the loader bucket as low as possible when you move onto the trailer. To prevent accidents, operate the backhoe loader in a low gear while you advance onto the trailer.
Preparing for lifting operations	Before you start, review the lift plan and know where you will put each pipe. Use the Horn button to attach chains to the pipe. To prevent accidents, look for hazards in the work site. Always operate equipment as far as possible from other persons. Do not lift or move loads over workers in the work site.
Keeping a load stable	To keep the load stable and prevent unwanted movement, align the attachment point of the chain over the center of gravity of the load. Make sure that the pipe is level and the chains are vertical. If the chains are not vertical, the load will swing

Safety Violations

The system records important safety violations during each exercise. When Critical safety violations occur, the system automatically ends the exercise and assigns the operator a failing score.

Safety Violation	Description
Vehicle Flip Over	If the backhoe loader falls over for any reason, the system stops the simulation immediately and the operator fails the exercise.
Human Contact	If any part of the backhoe loader touches a person in the work site, the system stops the simulation immediately and operator earns a failing score.
Load Over Human	If the operator moves the bucket or a load over a person in the work site, the system stops the simulation immediately and the operator earns a failing score.
Contact with Power Line	If any part of the backhoe loader touches a power line, the system stops the simulation immediately and the operator earns a failing score.
Safe Parking Position	The system records how many times the operator turns off the engine without making sure equipment is level and positioning the loader on the ground. The value appears in any reports the instructor generates for the session.
Dump Truck Contact	The system records how many times the bucket or arm touch any part of the dump truck. The value appears in any reports the instructor generates for the session.
Bucket Over Cabin	The system records how many times the bucket moves over the cabin of the dump truck. The value appears in any reports the instructor generates for the session.





Hardware

All Vortex simulators feature realistic work sites and equipment simulation. Each simulator includes physical operator controls, a main display for showing the view from the operator cab, and a simulated Human Machine Interface displayed on a secondary display.

For a more immersive training experience, some simulators feature an operator seat with a motion platform and a separate touch-sensitive screen showing simulated controls.

Vortex Advantage Hardware Platforms

Vortex Advantage simulator systems feature enclosed computers which run Vortex software. Each simulator includes an operator seat with a motion platform and an LCD touch-sensitive screen which shows simulated controls and engine information.

Display Configuration

Simulator System

1-display



3-display



5-display



Vortex Edge Plus

The Vortex Edge Plus configuration uses a support that fits onto a table or desk. Attached to the support are the vertical monitor, the physical controls, and a laptop which runs simulator software and shows simulated controls.



The Vortex Edge Plus simulator can be easily transported and installed on classroom desktops or trade and job fair booths in minutes. All components, from the configurable pedals to the operator controls and workstation-class laptop, can be ergonomically positioned for optimal trainee comfort.



Vortex Edge

The Vortex Edge laptop simulator is a compact training tool that allows construction equipment operator trainers to deploy virtual equipment in classrooms, in order to demonstrate machine components, safe operator practices, and equipment behavior.



It can be transported in a single carrying case. The laptop is designed to plug into classroom displays or projectors, or operated as is, out of the box. The Vortex Edge runs on the same engineering-grade simulation that powers the larger Vortex simulators used by training schools.





Getting Started

Getting started on the simulator involves the following activities:

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Launching the Simulator Application

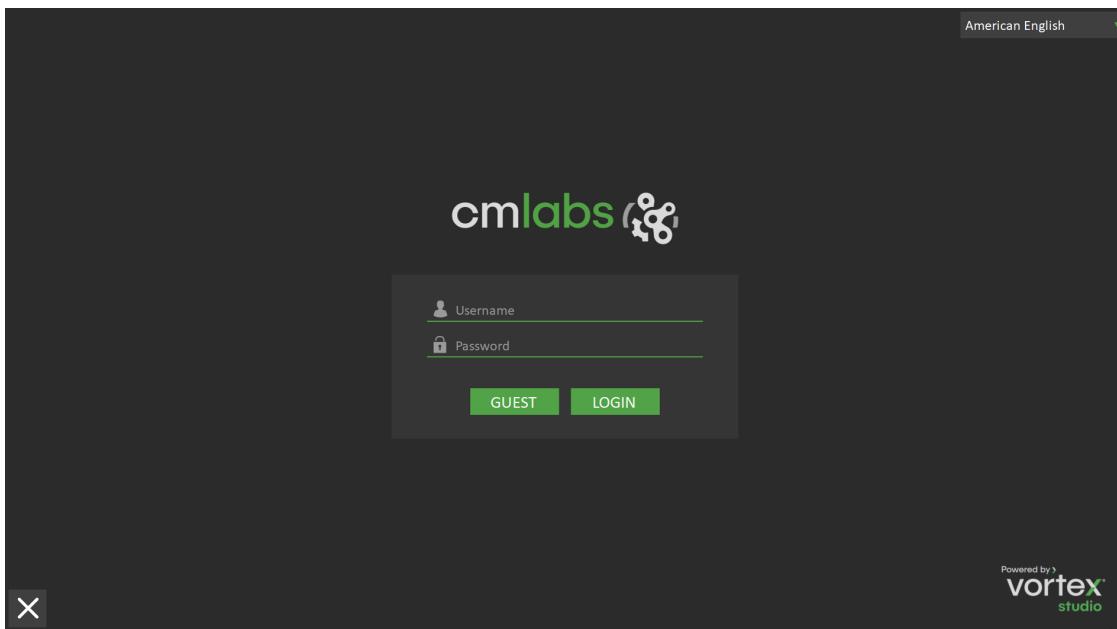
Launching the simulator application involves choosing the correct desktop icon and selecting a training module.

Depending on the training modules installed on the simulator, the desktop icons for launching the simulator software may be different:

Desktop Icon	Supported Training Modules
	Click to launch simulation software.

Logging On for the First Time

Before you log into the system for the first time, ensure you know the valid user name and password for your user account. Ask the person who set up your training solution for information about your account if you do not know your user name and password.



Important: Because the default password for the system administrator account is not private, we strongly recommend that you change your password the first time you log into the system.

Using the System Guest Account

Anyone can use the simulator without system reporting features for performance metrics. For example, an operator may want to test the simulator without negatively contributing to performance reports the system generates for his user account. To conduct anonymous training sessions, you can log into the system using the guest account.

Users logged into the system as guest can conduct training exercises and view performance metrics for training exercises, but have no access to the instructor

menu, student account information, or class information. When you log out of the system from the guest account, the system records no information on training exercises completed during the session.

Default System Credentials

The Vortex application is pre-configured with a default Administrator account. As part of preparing the system for other users, the Administrator can log on using the default account to create accounts for any instructors or users who will use the system.

Default User name	Default Password
admin	admin

Important: For security purposes, we strongly recommend that you change the password for the default Administrator account when you log in to the system for the first time.

For information about changing your password, see **Resetting Passwords**, on page 40.

Starting a Training Exercise

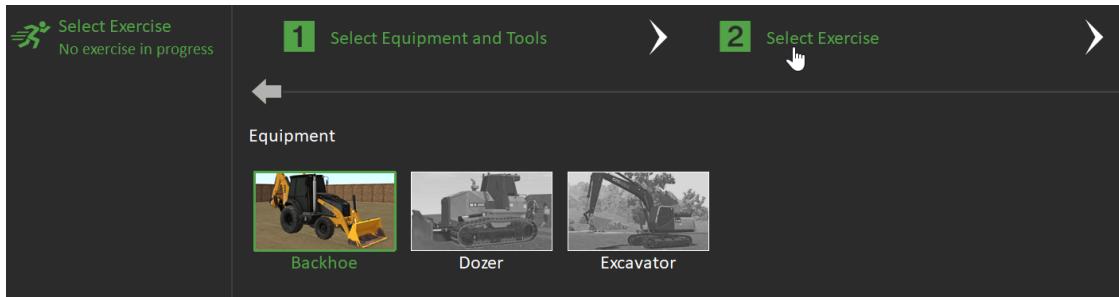
The user interface is designed to help instructors conduct training exercises and monitor performance metrics in real time. Starting a training exercise typically involves the following activities:

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Selecting an Equipment Simulation

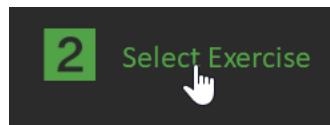
When the Vortex application launches, system shows the available equipment training modules:

Your particular training modules may differ.



Do the following:

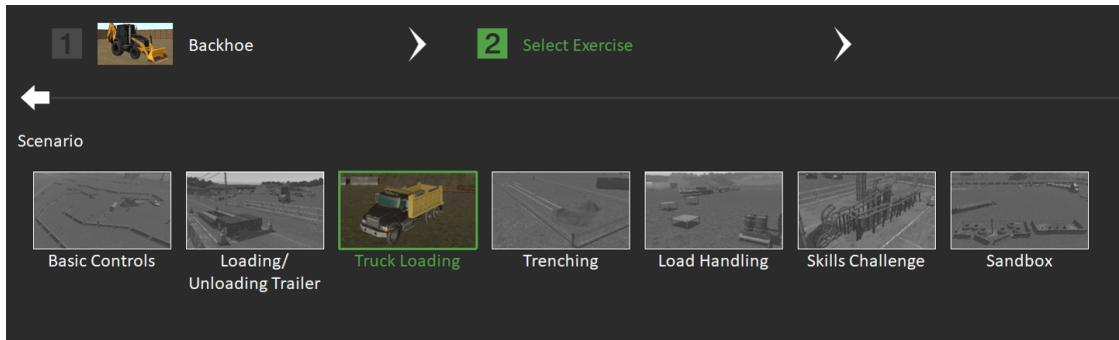
1. Click the equipment training module you want to launch. For example, click **Backhoe**.
2. Click **Select Exercise**.



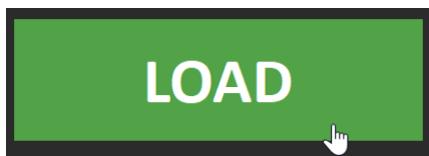
Selecting a Training Exercise

Once you select an equipment training module and click the next button, available exercises for the equipment training module appear:

Depending on the equipment training module, training exercises differ.



To select a training exercise, click the exercise you want to run and then click the **Load** button.



Once the exercise loads and is ready, press the **Horn** button on the joystick or controller to begin.

Customizing the Report Logo

By default, when you generate system reports following a training exercise, CM Labs Vortex logo is displayed in the upper left corner by default.

To use your own corporate logo, you can specify the image file the system uses for reports.

Saving a new logo image file

The image the system uses as the logo on reports is named *companyLogo* and is stored in the following directory:

```
<drive>\<cmlabs_installation_folder>\Reports
```

Example: C:\CM_Labs\Reports

The system supports only **PNG** or **SVG** image formats. Any image you use will be scaled to fit the report automatically.

To specify a new logo image file, do the following:

1. Locate the logo file you want to use for reports. The file must have a .png or .svg extension.
2. Rename the file *companyLogo.png* or *companyLogo.svg* (depending on the format of the image).

NOTE: Do not replace *comanlyLogo* with the name of your company. The literal name of the file must be *companyLogo.png* or *companyLogo.svg*.

3. Save the new logo in the CM_Labs\Reports folder.

Any reports you generate now should display the new logo image. If you do not specify a file, the system uses the CM Labs logo file saved in installation files.

If you install a new version of simulator software you will need to specify the file again.





Managing Accounts and System Access

Before beginning training activities, a system Administrator must set up the system with accounts for students and instructors, and groupings for classes.

Name	Class	Company	Active	Actions
Jerry Seinfeld	Dozer	Safer Operator Training	Active	
Susan Ross	Instructors	Yankee Construction	Active	
Jacapo Peterman	Motor Grader	J Peterman Enterprises	Active	
Ruth Cohen	Dozer	Cosmic Heavy Equipment	Active	
Administrator			Active	
Elaine Benes	Instructors, Motor Grader, Excav...	Safer Operator Training	Active	
Norbert Newman	Excavator - Beginner	Better Building Construction	Active	
Frank Costanza	Motor Grader	Better Building Construction	Active	
George Costanza	Excavator - Beginner	Yankee Construction	Active	
George Steinbrenner	Motor Grader	Yankee Construction	Active	
Cosmo Kramer	Motor Grader	Cosmic Heavy Equipment	Active	

Administrators can also customize scoring settings the system uses to evaluate students at the end of the exercise, and add a custom logo to appear in any PDF reports.

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Account Management

System administrators create accounts for any students or instructors who will use the system. For each account, the system can show records of any training exercises and whether or not the student passed or failed.

At the end of each exercise, the system can generate performance reports showing the student and instructor names.

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User Roles

The training simulator is designed to support multiple types of users. The role associated with each account reflects the responsibilities you have on the simulator.

User Role	Permissions
Administrator	Responsible for setting up the system for regular use by instructors and students. The administrator should add at least one instructor account, and can customize scoring and report settings.
Instructor	Responsible for managing students and classes. The instructor can add accounts for students and group them in classes. While operators use the simulator to complete training exercises, the instructor monitors their performance and gives feedback during training exercises. Instructors can also generate performance reports.
Student	Uses the simulator to complete training exercises and become a better operator. As the student works through each exercise, the system scores performance and records metrics for the student and instructor to review together.
Guest	Can explore exercise environments and use controls anonymously. The system does not record scores or metrics for Guest sessions.

Creating a New Account

The system identifies instructors and students in the system with unique user names. Each user must have a valid user name and password to log into the system. You can enter other identifying attributes for each user to make search more convenient.

When you create a new account, the system prompts you for the following information:

Attribute	Description	Example
User Name	A combination of letters, numbers, or both which uniquely identify the user in the system. Instructors and students must type their user names every time they log into the system.	jsmith
Full Name	The user's given name and surname. This name will be displayed throughout the user interface and on any performance reports for the user.	Jane Smith
Password	The password the user can use to access the system.	\$Chang3Me!
Type	<p>The type of user account. Choose from the following:</p> <ul style="list-style-type: none">■ Student■ Instructor■ Administrator <p>Note: Only administrators can create administrator accounts. Instructors can create other Instructor and Student accounts. cannot create new accounts in the system.</p>	Student
Company	The name of the company or organization the user account is associated with. It can be useful to sort user accounts by company.	MyCompany

Attribute	Description	Example
User ID	Any other identifying information for the user. For example, a birthday or employee ID. User ID is helpful if you know you will want to search for user accounts with a unique identifier other than User Name .	19840408

Add a New Account

Add an account for each student and instructor who will use the simulator. For each account, the system records every training session and records performance metrics which you can review in the form of reports.

NOTE: Only system Administrators and Instructors can create new accounts in the system. Choose a password that you can remember for new accounts.

Students and instructors must know their user name and password before they log on to the system.

To add a new student account, do the following:

1. On the side menu, click Instructor and then click **Students**.
The system displays a list detailing all existing user accounts.
2. On the Action menu, click **Create User**.

A window for adding a new account opens.

Name	Class	Company	Status
Gerald Seinfeld	Instructors, Dozer	Safer Operator Training	Active
Susan Ross	Dozer	Yankee Construction	Active
Jacapo Peterman			Active
Ruth Cohen			Active
Administrator			Active
Elaine Benes			Active
Norbert Newman			Active
Frank Costanza			Active
George Costanza			Active
George Steinbrenner			Active
Cosmo Kramer			Active

3. In the new account window, do the following:
 - a. In the **User Name** text box, type a unique identifier for the user. Users need to use the User Name each time they log into the system.
 - b. In the Full Name text box, type the user's full name.
 - c. In the Type drop-down list, click to select the type of account you want to create (**Student** or **Instructor**).
 - d. Do one of the following:
 - To activate the account immediately, select the **Active** check box.
 - To leave the account inactive after you create it, clear the **Active** check box.
 - e. In the **Password** box text box, type a password for the new user account.
 - f. In the **Confirm Password** text box, confirm the password.
 - g. In the **Company** text box, type the name of the company the user works for.
 - h. In the **User ID** text box, type other identifying information about the user.
 - i. Click **Create**.

The new account appears in the list of all users.

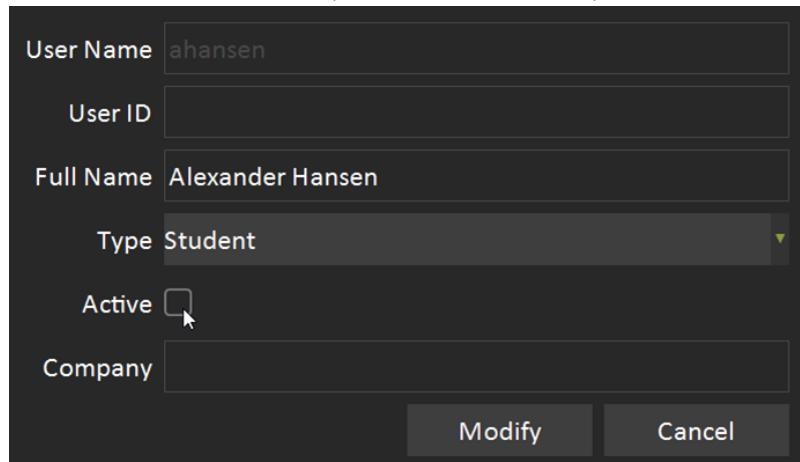
Deactivating User Accounts

By default, user accounts you create in the system are active. When a user is no longer active, you can deactivate their account to prevent them from accessing the system.

Note: To deactivate a user account, you must be logged into the system as an Administrator.

To deactivate a user account, from the instructor station, do the following:

1. On the side menu, click the **Instructor** tab and then click **Students**.
2. In the list of students, click on the user account you want to deactivate.
3. Click the **Action** menu and then click **Modify User**.
4. To disable the account, in the **Active** field, click to clear the check box.



The screenshot shows a dark-themed 'Modify User' dialog box. It contains the following fields:

- User Name: ahansen
- User ID: (empty)
- Full Name: Alexander Hansen
- Type: Student
- Active: A checkbox that is currently checked (indicated by a small square with a dot).
- Company: (empty)

At the bottom right of the dialog are two buttons: 'Modify' and 'Cancel'. A cursor arrow is positioned over the 'Active' checkbox.

5. Click **Modify**.

In the list of students, the system now shows the status of the user account as **Disabled**.

Resetting Passwords

Your role determines your privileges in the user interface. Only users with Administrator or Instructor roles can reset passwords for other user accounts. All users can reset their own passwords at any time.

User Role	Privileges
Administrator	Can create Administrator, Instructor, and Student accounts and reset passwords for all other users.
Instructor	Can create Instructor and Student accounts, and reset passwords for Instructor and Student accounts.
Student	Cannot create accounts, and can only change their own passwords.

To Reset the Password for a Different Account

Before you can reset the password for a different user, you must be logged in with a valid Administrator or Instructor account.

Note: Only Administrators can reset the password for other Administrator accounts.

From the instructor station, do the following:

1. On the side menu, click **Instructor** and then click **Students**.
2. In the list of accounts, click to select the user account you want to modify.
3. Click the **Action** menu and then click **Reset Password**.

A dialog box for resetting the password appears.

4. In the **New Password** text box, type a new password for the user account.
5. In the **Confirm New Password** text box, confirm the new password.
6. Click **OK**.

The password for the account is changed.

Change Your Password

Before changing your password, you must be logged in with a valid user account.

Note: If you do not know your password, you must contact a system Administrator or Instructor to reset it for you.

From the user interface, do the following:

1. In the upper left of the screen, click on your user name.
2. Click **Change Password**.
A dialog box appears.
3. In the **Old Password** text box, type the current password for your account.
4. In the **New Password** text box, type a new password for the user account.
5. In the **Confirm New Password** text box, confirm the new password.
6. Click **OK**.

Your password is changed.

Class Management

The system is designed as a training tool which you can use to manage multiple classes of students. The Vortex student database lets the instructor group students into classes. Once students are grouped into classes, the instructor can generate separate reports for each class.

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Creating a New Class

Setting up a new class involves creating a new class entity in the system and then adding student accounts to it.

To set up a new class, from the instructor station, do the following:

1. On the side menu, click **Instructor** and then click **Manage Class**.
2. On the **Action** menu, click **Create Class**.
3. In the **Enter new class name** text box, type a name for the class. This name identifies the class throughout the user interface. For example, type **Summer 2018**.
4. Click **Create**.

The new class name appears above the **Class** list.

5. To add a student to the class, select the student's name in the **Users** list, then click the arrow button to add it to the **Class** list for the new class.

In the **Users** list, in the row for the student, the **Classes** column now shows the new class name.

Deleting Classes

If you create a class by mistake, or would like to retire a class label, you can delete it from the **Manage Classes** page.

The screenshot shows a user interface for managing classes. On the left, there's a sidebar with icons for Michael Scott (Administrator), Exercise Running (Crawler Crane), Instructor, Students, and Manage Class. The main area has two tabs: 'Users' and 'Class'. Under 'Users', there's a table with columns: Name, Company, and Classes. The 'Classes' column contains values like '2018-Fall, 2018-Summer', '2018-Summer', etc. Under 'Class', there's another table with columns: Name, Company, and Actions. The 'Actions' column includes a 'Delete Class' button. A large green box highlights the 'Delete Class' button. To the right of the tables are two arrows: a right-pointing arrow above a left-pointing arrow, indicating a transition between the two sections.

To delete a class, from the instructor station, do the following:

1. On the side menu, click **Instructor** and then click **Manage Class**.
2. Under the **Class** section, in the **Class** filter box, click to select the class you want to delete.
3. On the **Action** menu, click **Delete Class**.
4. In the confirmation window, click **Yes**.
5. The class is deleted and the students who were previously grouped into the class you deleted still appear in the list of **Users**, but they are no longer associated with the class you deleted.

This screenshot shows the 'Manage Classes' page with the 'Class' tab active. The 'Class' filter box at the top is set to '2018-Spring'. Below it is a table with columns: User, Company, and Classes. The 'Classes' column shows '2018-Spring' for most rows. A green box highlights the '2018-Spring' entry in the 'Classes' column for the row where Ryan Howard is listed. To the right of the table is a large green box highlighting the '2018-Spring' entry. Below the table is another table under the 'Users' tab, which lists various users with their names, companies, and classes. A right-pointing arrow is to the right of the 'Users' table, and a left-pointing arrow is to its left.

Operating the Backhoe Loader

Operators and instructors use joysticks, pedals, and a steering wheel in combination with simulated switches and buttons on the Operator Controls page to control the Backhoe Loader during training exercises.

Controls support the following operating modes:

- **Backhoe**

For operations which rely on the backhoe arm for excavating or digging.
Operators can train using ISO and SAE control patterns.

- **Loader**

For loading operations with the loader bucket.

A switch on the **Operator Controls** page lets operators switch between working modes and choose a control standard for operating the backhoe arm.

Controls (Vortex Advantage and Edge Plus Simulators)	46
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Controls (Vortex Advantage and Edge Plus Simulators)

The operator uses joysticks to operate the boom, arm, loader bucket and backhoe arm bucket. Buttons on the joysticks control the horn and digging functions.

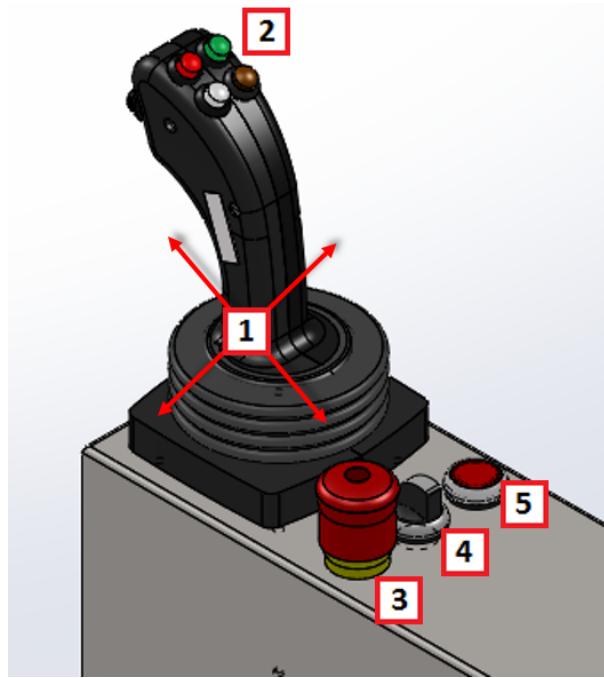
The system supports SAE and ISO control standards. Operators can use controls on the **Operator Controls** page to select a standard during each training exercise.

Joysticks (SAE)	47
Joysticks (ISO)	49
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Joysticks (SAE)

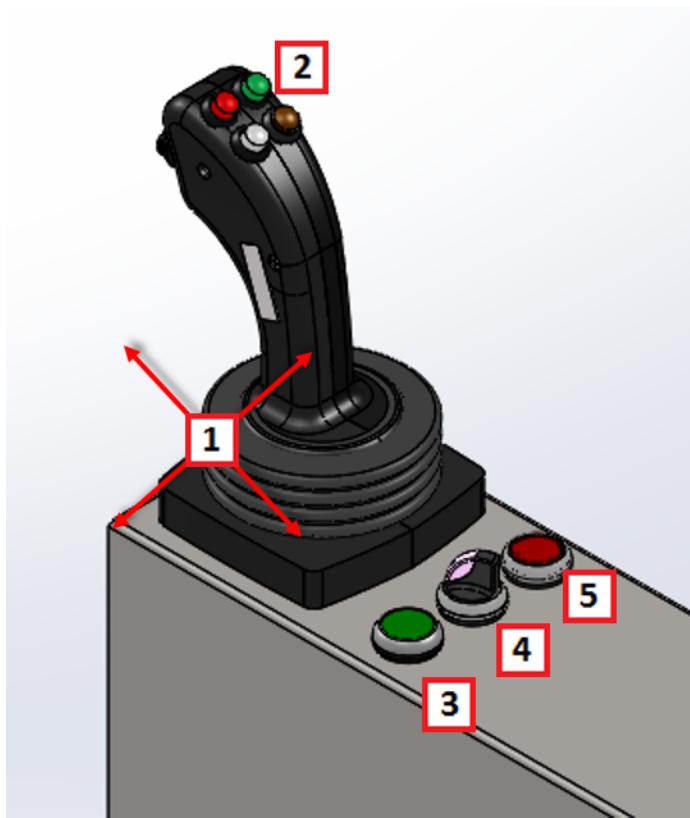
When the SAE control standard is selected, joysticks functions as follows:

Right Joystick (SAE)



Control	Loader Function	Backhoe Arm Function
1 (joystick)	<ul style="list-style-type: none">■ Move forward to boom down■ Move back to boom up■ Move left to curl■ Move right to dump/uncurl	<ul style="list-style-type: none">■ Move forward to boom down■ Move back to boom up■ Move left to swing left■ Move right to swing right
2 (joystick buttons)	<ul style="list-style-type: none">■ Red: 2nd function■ Green: MMFWD■ White: Clutch Disconnect■ Orange: Float/Return to Dig	<ul style="list-style-type: none">■ Red: Dipperstick out■ Green: Dipperstick in
3	E-Stop	
4	No function	
5	No function	

Left Joystick (SAE)

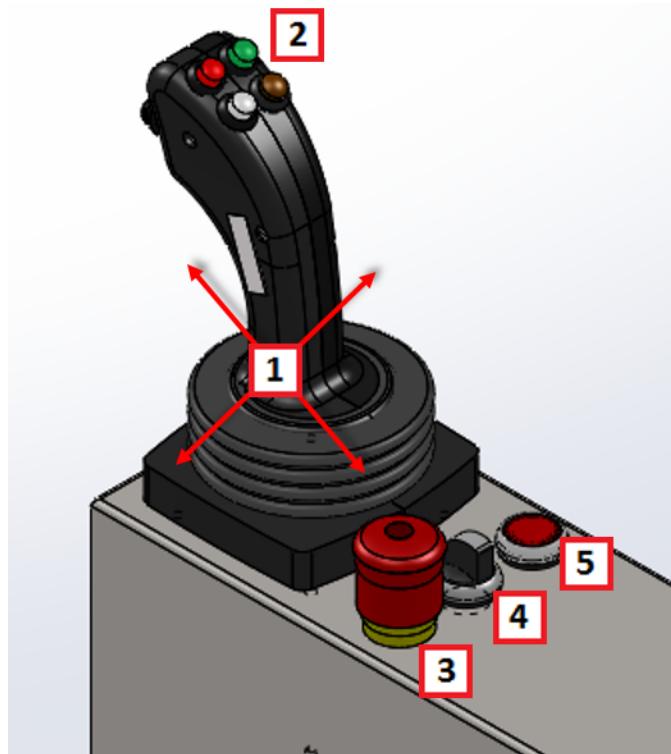


Control	Loader Function	Backhoe Function
1 (joystick)	No function	<ul style="list-style-type: none">■ Move forward to move dipperstick out■ Move back to move dipperstick in■ Move left to swing left■ Move right to swing right
2 (joystick buttons)		<ul style="list-style-type: none">■ Red: Left Outrigger Down■ Green: Right Outrigger Down■ White: Left Outrigger Up■ Orange: Right Outrigger Up■ Black: Horn
3	Start/Stop Engine	
4	Loader/Backhoe	
5	Differential Lock	

Joysticks (ISO)

When the ISO control standard is selected, the joystick functions as follows:

Right Joystick (ISO)

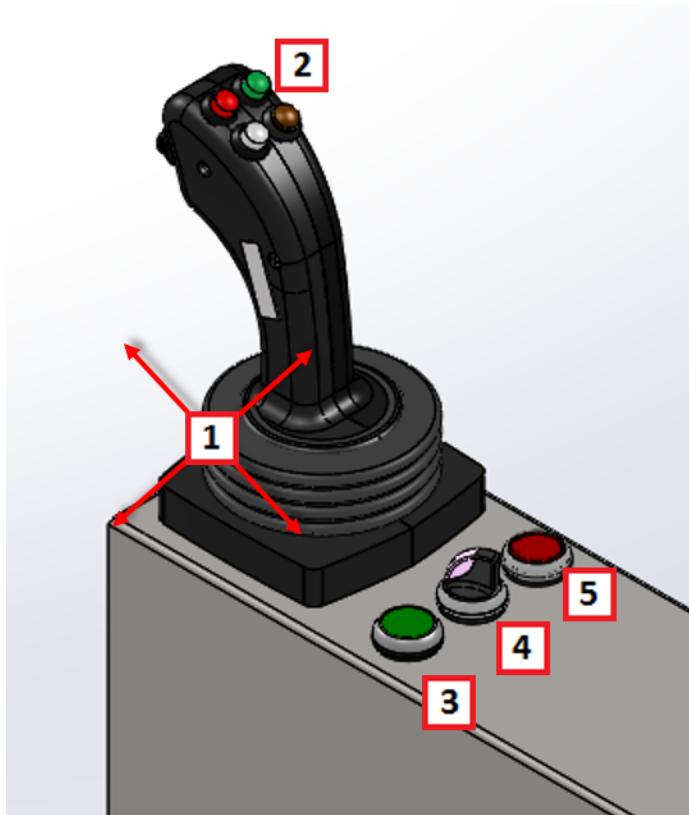


Control	Loader Function	Backhoe Arm Function
1 (joystick)	<ul style="list-style-type: none">■ Move forward to boom down■ Move back to boom up■ Move left to curl■ Move right to dump/uncurl	<ul style="list-style-type: none">■ Move forward to move dipperstick out■ Move back to move dipperstick in■ Move left to curl■ Move right to dump/uncurl
2 (joystick buttons)	<ul style="list-style-type: none">■ Red: 2nd function■ Green: MMFD■ White: Clutch Disconnect■ Orange: Float/Return to Dig	<ul style="list-style-type: none">■ Red: Dipperstick out■ Green: Dipperstick in
3	E-Stop	

Control	Loader Function	Backhoe Arm Function
4	No function	
5	No function	

Left Joystick (ISO)

When the ISO control standard is selected, the joystick functions as follows:

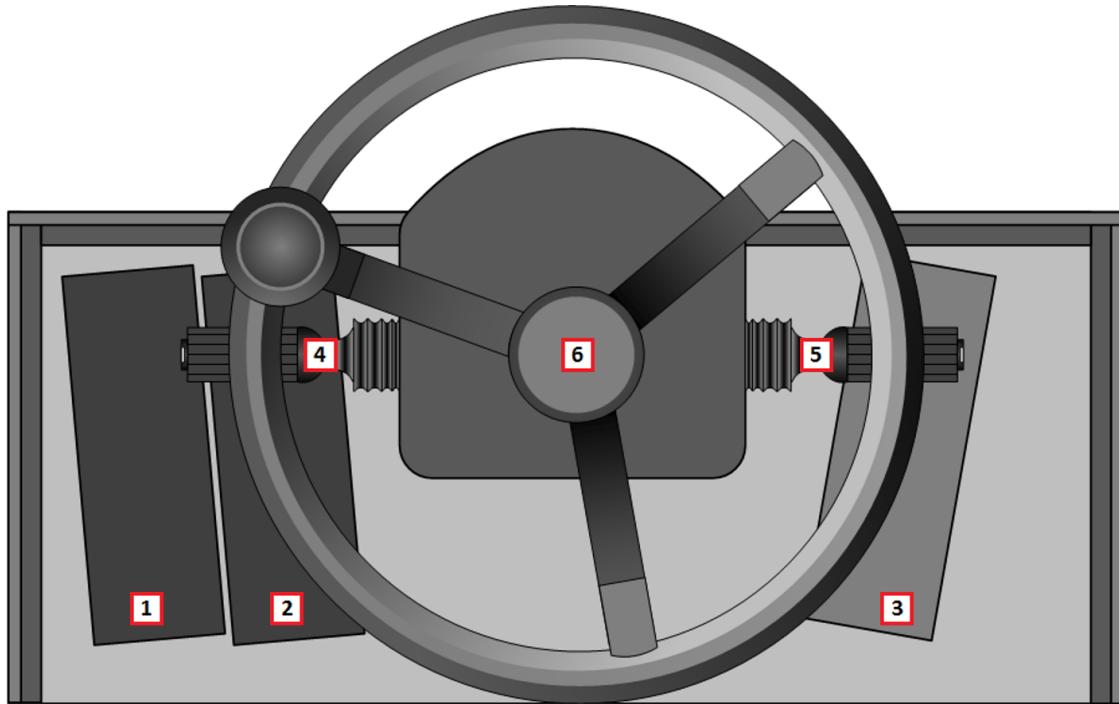


Control	Loader Function	Backhoe Arm Function
1 (joystick)	<ul style="list-style-type: none"> ■ Move forward to boom down ■ Move back to boom up ■ Move left to curl ■ Move right to dump/uncurl 	<ul style="list-style-type: none"> ■ Move forward to boom down ■ Move back to boom up ■ Move left to swing left ■ Move right to swing right

Control	Loader Function	Backhoe Arm Function
2 (joystick buttons)	<ul style="list-style-type: none"> ■ Red: Left Outrigger Down ■ Green: Right Outrigger Down ■ White: Left Outrigger Up ■ Orange: Right Outrigger Up ■ Black: Horn 	
3	Start/ Stop Engine	
4	Loader/Backhoe	
5	Differential Lock	

Steering Wheel and Foot Pedal

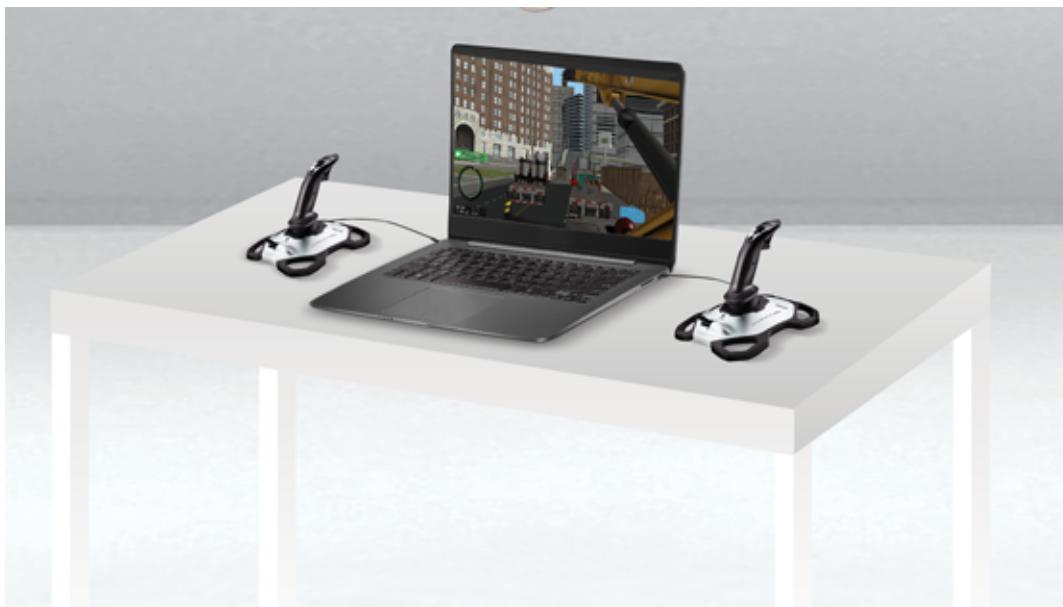
The operator uses bi-directional foot pedals to control the backhoe loader brakes and a steering wheel to steer the vehicle.



Control	Description	
1	Left Outer Pedal	Left Brake
2	Left Inner Pedal	Right Brake
3	Right Pedal	Throttle Pedal
4	Left Lever	Gear and transmission selector
5	Right Lever	Blinker (left and right)
		Press button for horn
6	Steering Wheel	Turn left or right to steer

Controls (Vortex Edge Laptop Simulator Hardware Platform)

For simulations running on the Vortex Edge Laptop Simulator, the operator uses USB joysticks or a gamepad controller to operate equipment during the exercise.



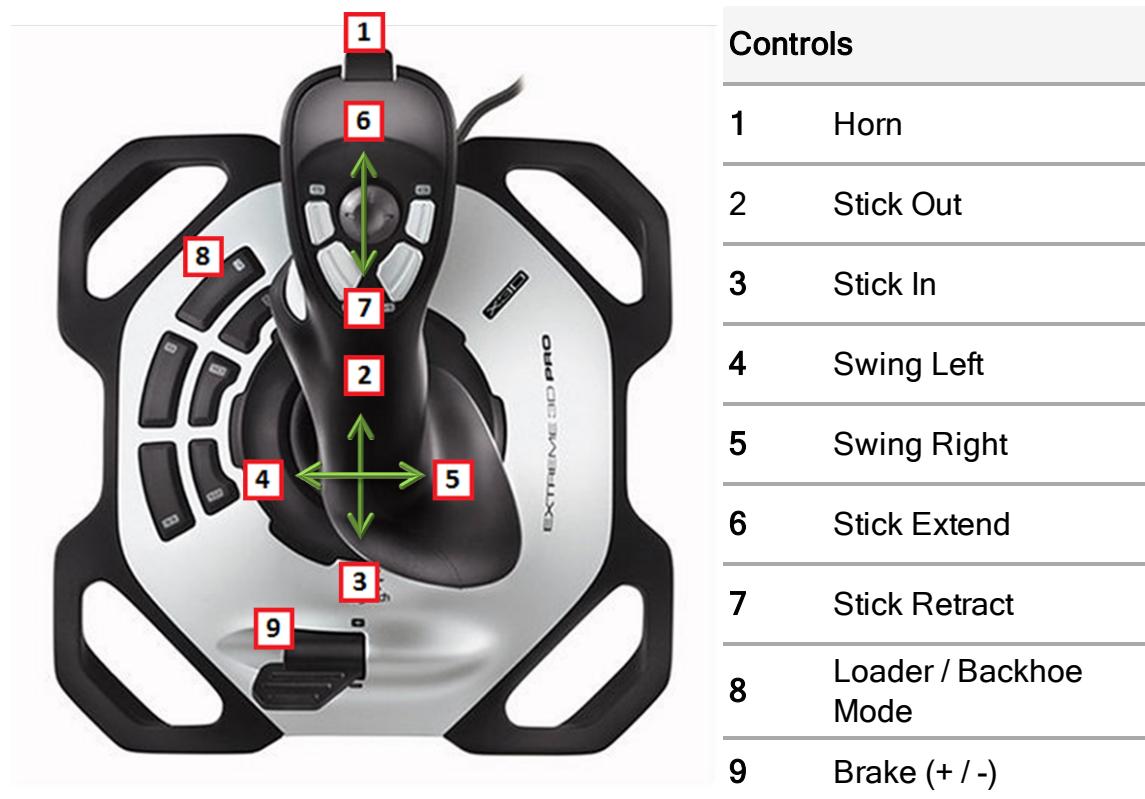
Joysticks in Backhoe Mode (SAE)	54
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Joysticks in Backhoe Mode (SAE)

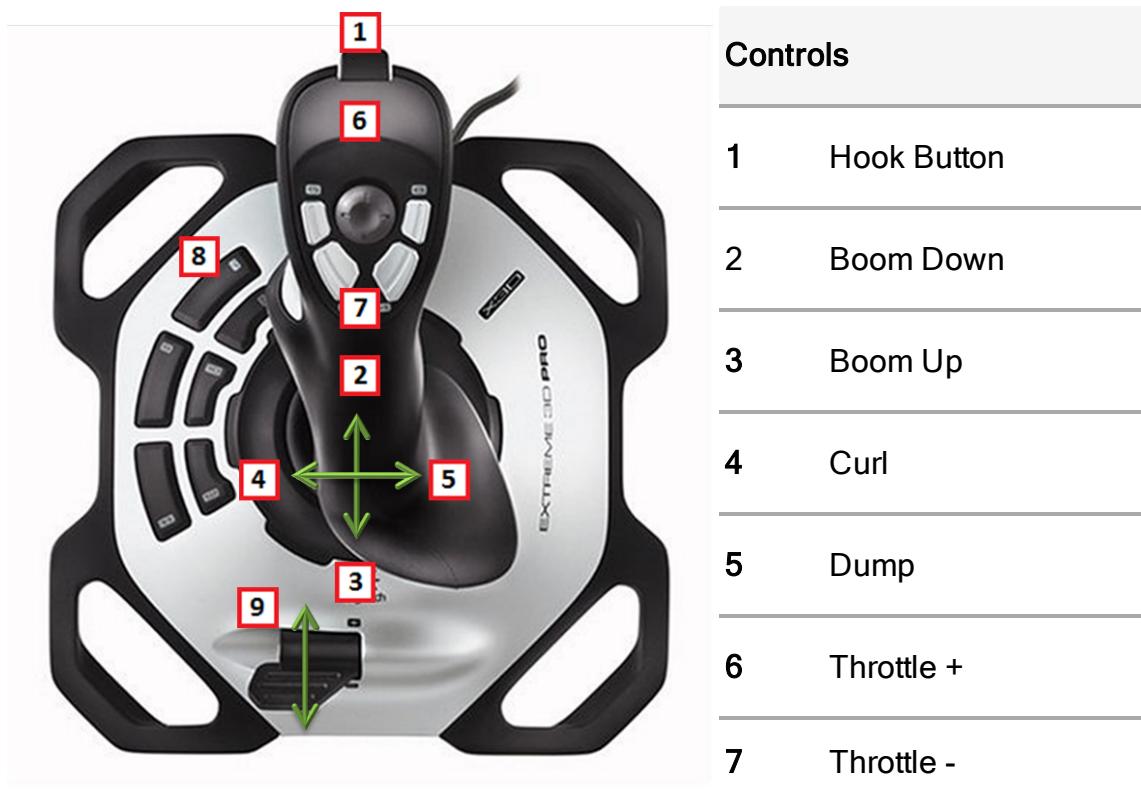
In backhoe mode, the system supports SAE and ISO control mappings. You can change the working mode (backhoe or loader) and the control mapping (SAE or ISO) from the Operator Controls page.

In SAE mode, backhoe controls function as follows.

Left Joystick Functions (Backhoe SAE)



Right Joystick Functions (Backhoe SAE)

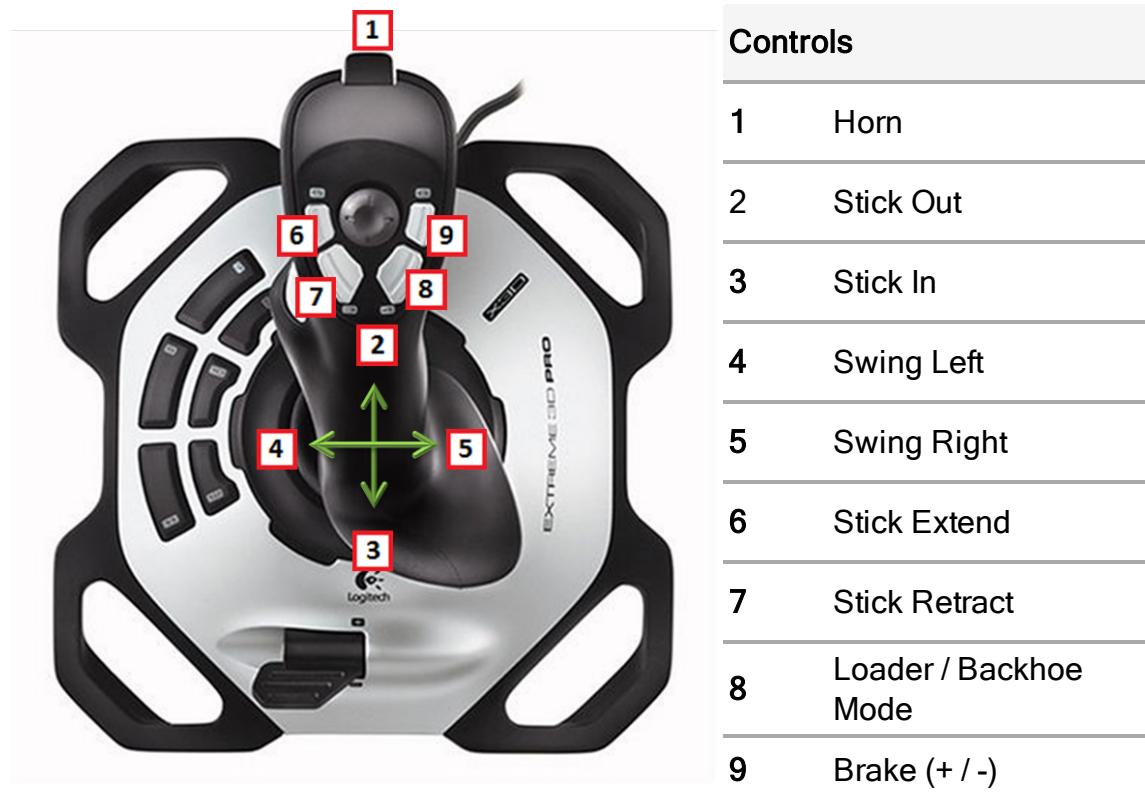


Joysticks in Backhoe Mode (ISO)

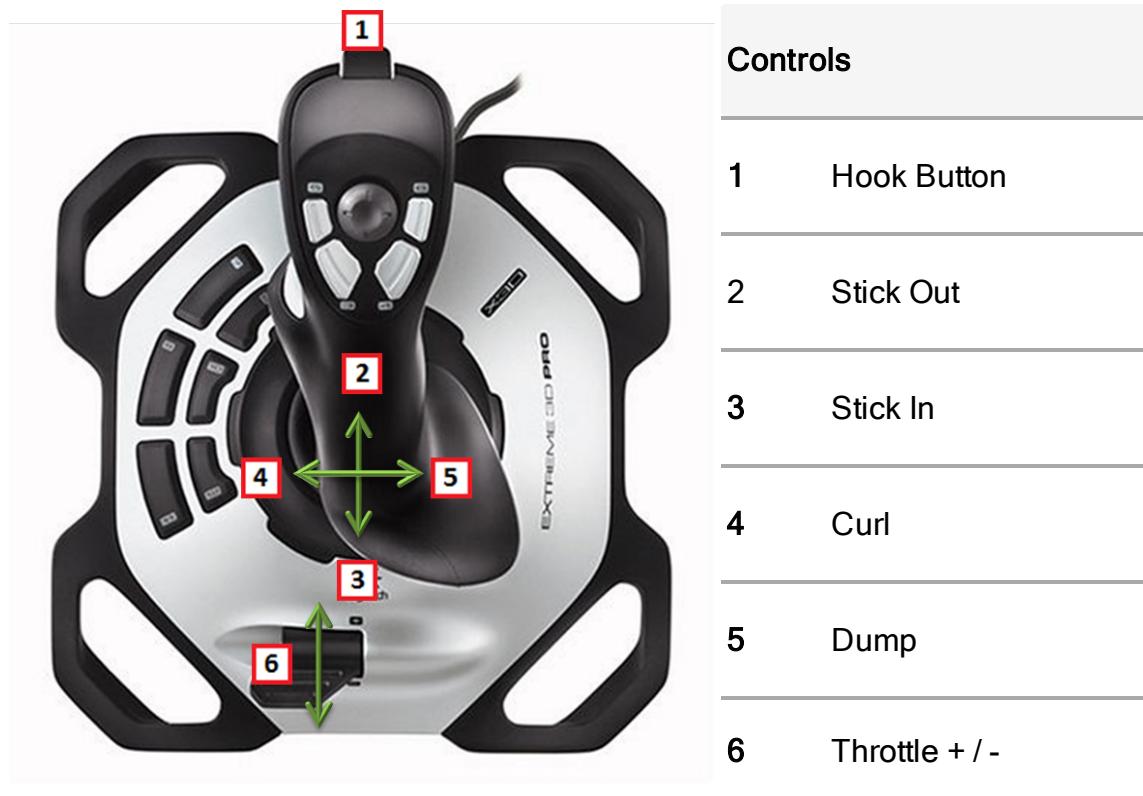
In backhoe mode, the system supports SAE and ISO control mappings. You can change the working mode (backhoe or loader) and the control mapping (SAE or ISO) from the Operator Controls page.

In ISO mode, backhoe controls function as follows.

Left Joystick (Backhoe ISO)



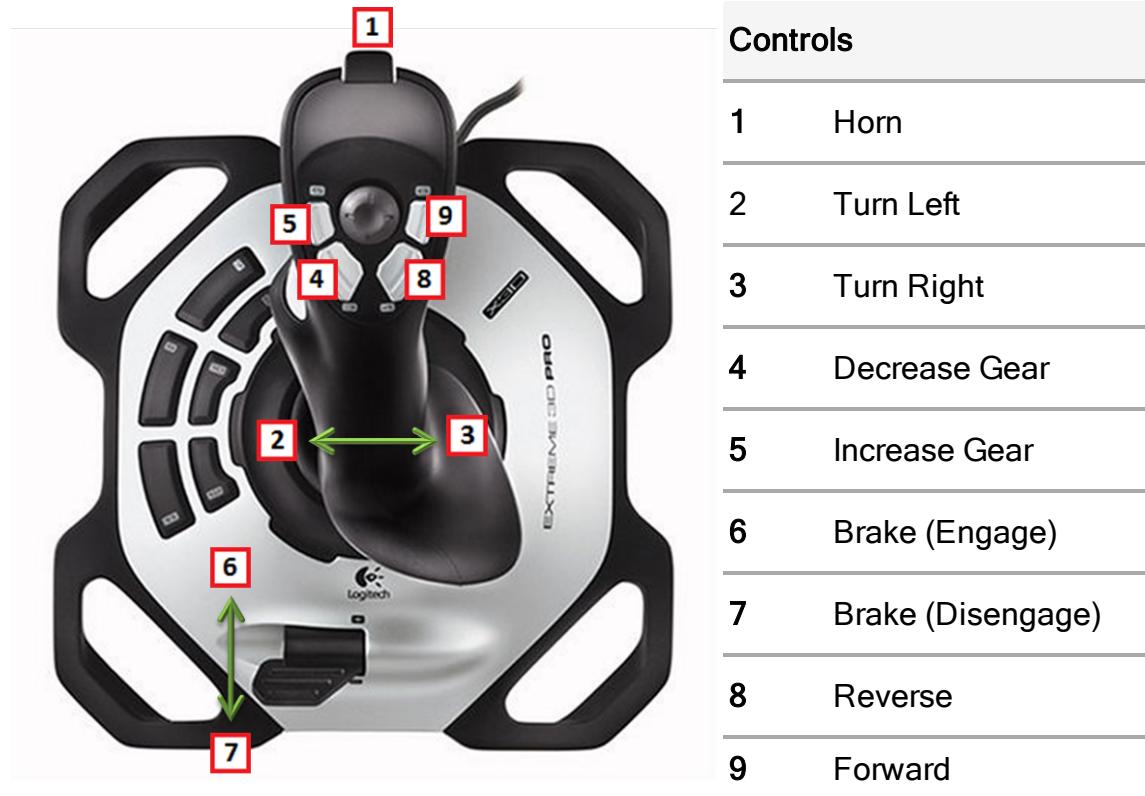
Right Joystick Functions (Backhoe ISO)



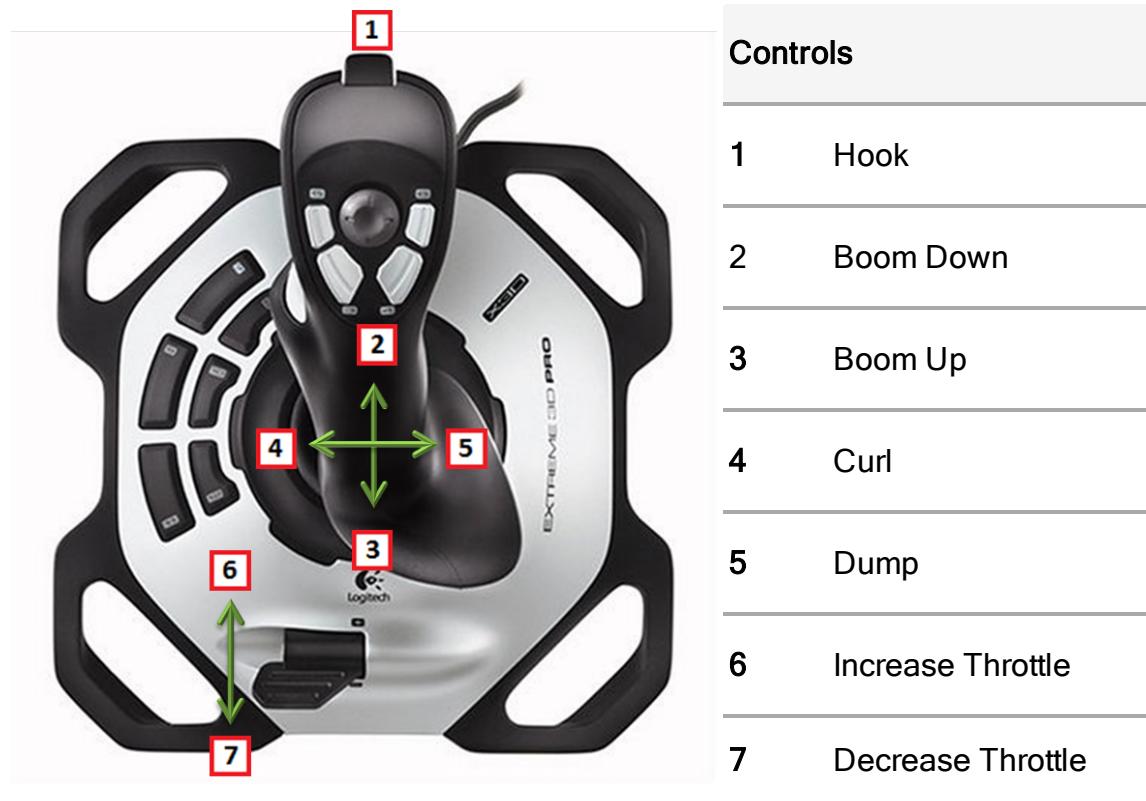
Joysticks in Loader Mode

In loader mode, joysticks function as follows:

Left Joystick Functions (Loader Mode)



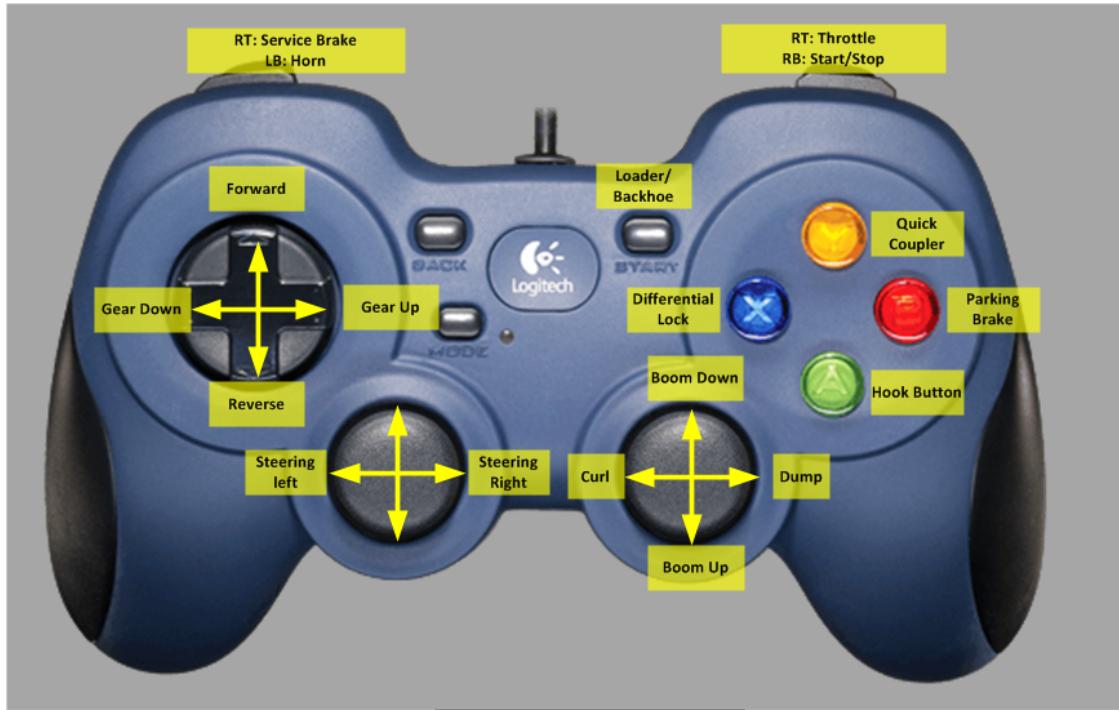
Right Joystick Functions (Loader Mode)



Gamepad Controller

You can use a gamepad controller in the following ways during the simulation:

Loader Mode



Loader Mode

Backhoe SAE Mode



Backhoe SAE Mode

Backhoe ISO Mode



Backhoe ISO Mode

Instructor Beholder Mode



Instructor Avatar Mode



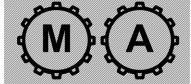
Backhoe Loader Simulated Controls and HMI

The **Operator Controls** page displays switches and buttons for selecting the operating mode and control standard, as well as for starting the engine, disengaging brakes, increasing RPM, detaching the bucket, and more.

It also displays engine status information on a simulated HMI.



HMI Indicators

Control	Description
 	Fuel level and consumption rate 20.7L/h
  100%	Torque consumption (percentage of total capacity)
  2000 RPM	Current engine RPM (graphically displayed as a percentage of total available)
	Current status indicators: <ul style="list-style-type: none"> ■ Parking Brake ■ ECO MODE ■ Auto-Idle ■ Locking Differential ■ 4-Wheel Drive ■ Working Lights ■ Quick Coupler
 12 KM/H	Current speed, displayed in metric or imperial units
	Transmission mode (Manual or Automatic)
 2F	Shows the current gear (1-2-3-4-5) and travel direction (Forward-Neutral-Reverse)

Simulated Controls

Control	Description
	<p>Start/Stop Engine</p> <p>Press to start and stop the engine.</p>
	<p>Parking Brake</p> <p>Press to engage the parking brake. Press again to release the parking brake.</p>
	<p>Eco Mode</p> <p>Press to use a different maximum engine speed depending on whether equipment is in backhoe or loader mode.</p>
	<p>Auto-Idle</p> <p>Press to make the system reduce engine speed from the current speed setting to 900 RPM when the operator stops using hydraulic functions. The system returns the engine to the current setting when the operator uses hydraulic functions again.</p>
	<p>4-Wheel Drive</p> <p>Press to engage four-wheel drive.</p>
	<p>Control Standard Selector</p> <p>Press to select a control standard for the backhoe loader:</p> <ul style="list-style-type: none"> ■ SAE ■ ISO

Control	Description
	Joystick Steering Press to turn Joystick Steering Mode on or off. When on, a green indicator light turns on.
	Floating bucket Press to cause the boom to follow the ground, applying only its own weight.
	Hazard Lights Press to cause all vehicle signal lights to turn on and flash.
	Working Lights Press to turn on working lights.
	Automatic Transmission Press to enable Automatic transmission. (By default, the transmission is Manual).
	Quick Coupler Press to retract cylinders to remove or install attachments on the Backhoe Loader. The indicator light turns on.

Control	Description
	Unit Selector
	Camera
	Exit Cabin
	Throttle Dial

Point-of-View Control

The operator can use the Point-of-View controls to offset his view in the work site and change the point-of-view in the simulated work site.



POV Control	Description
A	Automatic Camera Follow
1	A programmable view point: the operator can program this by manually using arrows to set the point of view, then pressing and holding the button.
2	Second programmable view point: the operator can program this by manually using arrows to set the point of view, then pressing and holding the button.
↻	Press to return to the center view.
Side arrow buttons	Press to shift point of view laterally in the direction of the arrow you press.
Directional pad circle (center)	Press to tilt point of view.





Conducting Training Sessions

The Vortex Instructor interface is designed to help the instructor train operators on the simulator. Conducting a training exercise typically includes the following activities:

- Launching a training exercise from the user interface and assigning it to students.
- Customizing scoring settings.
- Modifying weather conditions in the simulated environment.
- Viewing the simulation as the operator works through challenges in the exercise.
- Triggering unexpected events from the **Faults** page.
- Evaluating operator performance as reported by metrics on the **Dashboard** page and generating reports.

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Assigning an Exercise to a Student

Once an operator is seated at the simulator and ready to begin training, you can assign an exercise from the instructor station. Anyone can operate the system anonymously using the Guest account, but when you assign an exercise to an operator by name (their user account), the system records performance metrics and you can generate a detailed report with an assessment and any comments.

To assign an exercise for a specific operator to complete, from the instructor station, do the following:

1. While logged in as the Instructor, on the side menu, click **Select Exercise**.
2. Under **Equipment**, select the training module you want to launch.
3. Click **Select Exercise**.
4. Click to select the training exercise you want to assign the student.
5. Click **Select Students**.
6. In the **Users** list, double click to select the user you want to assign the training exercise to.

Note: By default, the name of the Instructor appears in the **Participants** list for each training exercise they conduct while logged in.

7. Click **Load**.

After a few moments, the exercise loads on the operator display system.

Modifying Scoring Settings

Evaluation and assessment are an important part of operator training. The system is designed to record measurements of key performance metrics and use them to evaluate operator performance at the end of each exercise. Depending on your curriculum and training objectives, the metrics and thresholds you use to assess performance may differ from the default settings.

For each training exercise, the system lets you customize the metrics the system uses to score operators. From the Scoring page for any exercise, system administrators can weight each metric and specify thresholds which the operator must not exceed.

For example, for the Trenching exercise, you can specify that the operating ratio must remain above a certain value over the duration of the exercise, and deduct percentage points from the final score if it does not.

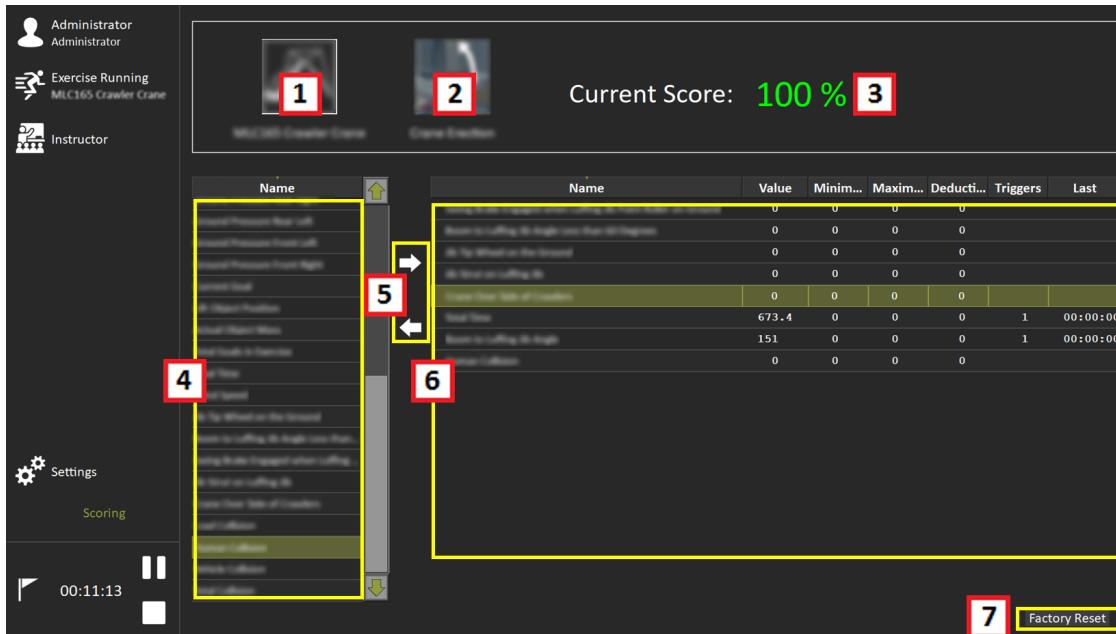
The score is displayed to the operator at the end of each training exercise. Any reports the instructor generates for the exercise also display the score. Once you customize scoring settings, the system saves your configuration for future exercises. You can revert to system settings at any time.

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The Scoring Page

The **Scoring** page shows the specific metrics and thresholds the system uses to evaluate operator performance for each exercise.

The first time you view the **Scoring** page, the system shows the default settings for each metric. Once you customize scoring thresholds for a given metric, you can revert to default settings by clicking the **Factory Reset** button in the lower right of the screen.



Feature Description	Description
1 Equipment Name	Shows the name of the equipment simulation
2 Training Exercise	Shows the name of the training exercise you started.
3 Current Score	The current score, as calculated using the scoring thresholds configured in the table below.
4 Metrics	List shows the metrics the system records measurements for during the exercise.
5 Selector Arrows	Use selector arrows to add metrics you want to add scoring thresholds for to the list of configured thresholds.

Feature Description	Description
6 List of Scoring Thresholds	<p>A table shows each scoring threshold that the system currently uses to calculate the score for the exercise. Each threshold has the following attributes:</p> <ul style="list-style-type: none"> ■ A metric ■ The current measurement in the system for the metric ■ A minimum threshold for the metric ■ A maximum threshold for the metric ■ A penalty (point deduction) the system applies when the system observes values which are outside the minimum and maximum thresholds ■ The number of times the system observed values outside the thresholds. ■ The time when the system applied the last penalty.
7 Factory Reset Button	Press to return all scoring settings to system defaults.

Scoring Rules

By default, the system records measurements for many metrics, such as Collisions, Idle Time, and Fuel Consumption. You can configure scoring rules to make the system deduct points from the operator's score whenever measurements for a metric reach a specific value.

For example, you can create a rule that makes the system deduct 10 points when the operator exceeds a time limit you define.

Adding a new rule involves the following activities:

1. You use the selector arrows to add a metric to the list of configured rules.
For example, you add a rule for the **Collisions** metric.
2. You specify when you want the system to deduct points. For example, when the system observes a collision.
3. You specify how many points the system should deduct for the rule. (For example, 10 points).

For each scoring rule, the system displays the following information:

Column Head	Description
Value	The current system measurement for the metric.
Minimum	The lower limit of the threshold the system uses to assess operator performance for the metric.
Maximum	The upper limit of the threshold the system uses to assess operator performance for the metric.
Deduction	The number of percentage points the system deducts if the value for the metric exceeds the maximum limit of the threshold or is below the minimum.
Triggers	The number of times the value for the metric was outside the defined threshold.
Time	The time stamp of the last event.

Customize Scoring Rules

NOTE: Only users logged into the system with an Administrator account can modify scoring settings.

1. Log into the system using the **Administrator** account.
2. Launch the exercise you want to customize scoring settings for.
3. Press the **Horn** or **Hook** button to start the exercise.

Note: You cannot edit scoring rules until the exercise is running.

4. On the side menu, click **Settings** and then click **Scoring**.
The system displays the default scoring rules for the exercise, and the current score for the exercise.
5. In the **Name** list, click the metric you want to create a new rule for and then click the selector arrow button to move it to the list of metrics the system uses to score the exercise.
6. For each column, click to select and then enter custom values for the following:

Minimum	Type a minimum value for the threshold.
Maximum	Type a maximum value for the threshold.
Deduction	Type the number of percentage points the system will deduct if values for the metric exceed or are below the maximum and minimum values for the threshold.

The system updates the current score to reflect the updated scoring rules immediately.

7. (Optional) Select and modify other metrics as needed.

Restore Default Scoring Settings

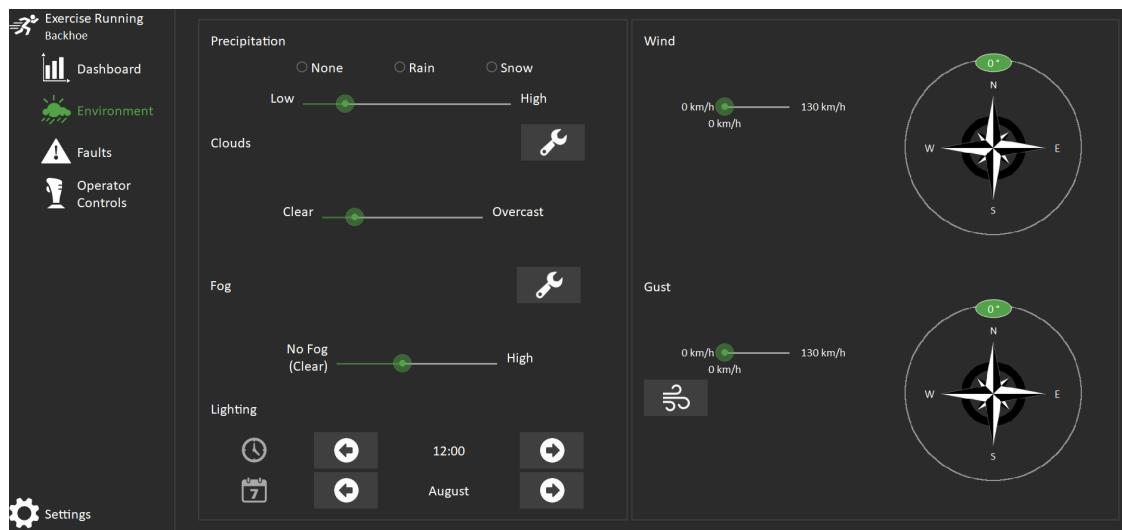
System Administrators can restore scoring settings to system defaults at any time. To reset scoring settings, do the following:

NOTE: Only users logged into the system with an Administrator account can reset Scoring settings.

1. Log into the system using the **Administrator** account.
2. Launch and start the exercise you want to reset Scoring settings for.
3. In the lower right of the screen, press the **Factory Reset** button.
Scoring values for each metric return to system defaults. The score at the top of the screen is updated at the same time.

Changing Weather Conditions in the Environment

From the **Environment** page, you can modify weather settings in the simulated environment during any training exercise.



To modify weather conditions, do the following:

1. On the side menu, **Environment**.
2. Use controls to change weather conditions in the environment. You can observe changes you make to the weather from any Instructor views of the environment.

To Increase Cloud Cover

In the **Clouds** section, do one of the following:

- To increase cloud cover in the sky, move the slider toward **Overcast**.
- To decrease cloud cover in the sky, move the slider toward **Clear**.

To Increase Fog Density

In the **Fog** section, do one of the following:

- Press the button corresponding to the fog density you want to introduce in the simulated environment.
- To adjust the fog density using a slider, press the tool button.

To Modify Wind Speed and Heading

In the **Wind** section, do any of the following:

- To increase wind speed, move the slider toward **130 km/s** (the maximum wind speed that the system supports)
- To change the wind heading, move the slider around the compass rose to the correct angle.
- To introduce a gust of wind, in the **Gust** section, use the slider and compass rose to choose a speed and heading, and then press the Gust button. The wind gust temporarily overrides wind settings.

To Make it Rain

1. In the **Precipitation** section, click **Rain**.
2. Do one of the following:
 - For heavier rain, move the slider toward **High**.
 - For lighter rain, move the slider toward **Low**.
 - To adjust rain settings using graphical buttons, press the tool button.

To Make it Snow

1. In the **Precipitation** section, click **Snow**.
2. Do one of the following:
 - For heavier snow, move the slider toward **High**.
 - For lighter snow, move the slider toward **Low**.
 - To adjust snow settings using graphical buttons, press the tool button.

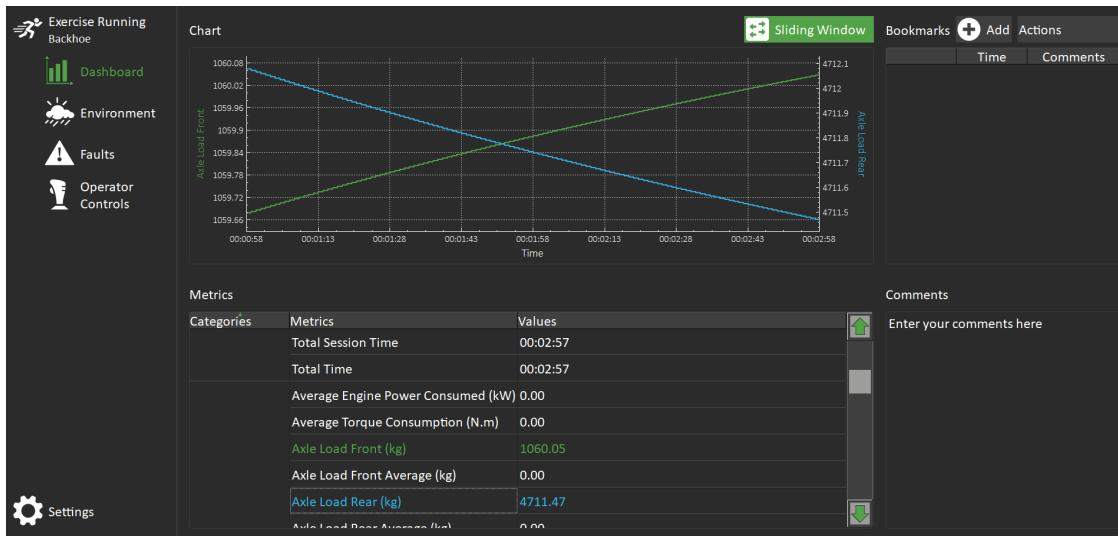
To Adjust Lighting

In the **Lighting** section, do one of the following:

- To adjust light in the simulated environment for the time of day, in the row for time use the arrow buttons to set the time.
- To adjust light in the simulated environment for the time of year, in the row for month, use the arrow buttons to set the month.

Monitoring Performance

Once a training exercise is running, the instructor console automatically displays the **Dashboard** page. From the **Dashboard** page, the instructor can monitor and assess operator performance in real-time using the charts and metrics. The instructor can also bookmark specific moments during the training exercise to give specific written feedback.



The **Dashboard** page shows multiple panes for monitoring performance and offering timely, relevant feedback.

Dashboard Pane	Description
Metrics	View various statistics for assessing performance during the training exercise. Click any metric to plot it over time in the Chart pane.
Chart	Plot any metrics you select in the Metrics pane over time. You can select up to two metrics for the system to plot on the Y-axis (The X-axis represents time). Press a metric in the list to select or deselect it.

Dashboard Pane	Description
Bookmarks	<p><i>Only available when logged into the system.</i></p> <p>Bookmark any specific time in the exercise and comment for later review. By default, the system inserts bookmarks anytime the instructor triggers a fault.</p>
Comments	<p><i>Only available when logged into the system.</i></p> <p>Type general comments for the operator to review here.</p>

Backhoe Loader Performance Metrics

During each training exercise, the system records measurements for performance metrics which the instructor can use to assess operator progress. Depending on the exercise, the system may offer different metrics.

Metric	Description
Average Engine Power Consumed	The average percentage of engine power consumed over the duration of the exercise.
Average Torque Consumed	The average torque consumed over the duration of the exercise.
Axle Load Front (kg)	The load, in kg, applied to the front axle, in real time.
Axle Load Front Average (kg)	The average amount of load, in kg, applied to the front axle during the exercise.
Axle Load Rear (kg)	The load, in kg, applied to the rear tandem axle, in real time.
Axle Load Rear Average (kg)	The average load, in kg, applied to the rear tandem axle during the exercise.
Brake Pedal Position Average Left(%)	The average position of the left foot pedal over the duration of the exercise, expressed as a percentage.
Brake Pedal Position Average Right (%)	The average position of the right foot pedal over the duration of the exercise, expressed as a percentage.
Bucket Angle (°)	The current bucket angle, as measured from a position parallel with the ground (0°).
Bucket Capacity (%)	How full the bucket is, in real time, expressed as a percentage.
Bucket Capacity Average (%)	The average bucket capacity over the duration of the exercise, expressed as a percentage.
Bucket Efficiency (ton/L)	Ratio of the quantity of material the operator moved during the exercise over the amount of fuel consumed during the exercise (Tons/L).
Bucket Efficiency (ton/hr)	Ratio of the quantity of material the operator moved during the exercise over the amount of time elapsed during the exercise (Tons/hr).

Metric	Description
Bucket Height (m)	The current height of the bucket, as measured from the ground to the lowest point of the bucket, in meters.
Bucket over Cabin	The number of times the operator moved either bucket over the cabin of the dump truck.
Bucket Self Contact	The number of times either bucket touched the body of the backhoe loader.
Collisions	The number of times the backhoe loader or a load collided with another object in the environment.
Concrete Balls Fallen on the Ground	The number of concrete balls which fell or were knocked on the ground during the exercise.
Concrete Balls Scored at Checkpoint 1	The number of concrete balls which the operator guided to the first checkpoint in the pipe maze.
Concrete Balls Scored at Checkpoint 2	The number of concrete balls which the operator guided to the second checkpoint in the pipe maze.
Cones Knocked Over	The number of cones the operator knocked over during the exercise.
Cones Touched	The number of cones the backhoe loader or load touched during the exercise.
Contact with Human	1 if the operator let the backhoe loader or load contact a human avatar in the work site. (The exercise ends automatically when this occurs.)
Current Engine Power Consumed	The current percentage of engine power consumed over the duration of the exercise.
Current Torque Consumed	The current torque consumed over the duration of the exercise.
Cycle Distance Average (m)	The total distance the operator traveled to complete the current loading cycle (from the pile to the truck).
Cycle Distance (m)	The total distance the operator traveled to complete the current loading cycle (from the pile to the truck).

Metric	Description
Cycle Distance Average (m)	The average distance the operator used to complete each loading cycle (from the pile to the truck) during the exercise.
Cycle Duration	The total time the operator spent loading material (moving it from the pile to the truck) during the exercise.
Cycle Duration Average	The average time the operator used to complete each loading cycle (from the pile to the truck) during the exercise.
Dump truck Contact	The number of times either bucket hit the dump truck or bin.
Electric Pole or Cable Contact	1 if the operator let the backhoe loader touch an electrical pole or cable. The exercise automatically ends when this occurs.
Engine Revolution Average (%)	The average RPM over the duration of the exercise, expressed as a percentage of total capacity.
Engine Revolution RPM (%)	The current RPM, expressed as a percentage of total capacity.
Fuel Consumption Rate (L/h)	The current rate at which the backhoe loader consumes fuel, in liters per hour (L/h).
Gear Time 1st	The amount of time the vehicle spent in forward 1st gear during the exercise.
Gear Time 1st Reverse	The amount of time the vehicle spent in reverse 1st gear during the exercise.
Gear Time 2nd	The amount of time the vehicle spent in forward 2nd gear during the exercise.
Gear Time 2nd Reverse	The amount of time the vehicle spent in reverse 2nd gear during the exercise.
Goals	The number of goals the operator completed, out of all the goals to be completed in the exercise.
Idle Count	The number of times the operator let the engine idle during the exercise.

Metric	Description
Idle Time	The total amount of time the engine was idle during the exercise.
Left Outrigger Load Average (kg)	The average load on the left outrigger over the duration of the exercise, in kg.
Left Outrigger Load Current (kg)	The current load on the left outrigger, in kg.
Load Over Human	1 if the operator moved a load over a human avatar in the work site. The exercise automatically ends when this occurs.
Maximum Shock-Load (Bucket Chain)	The maximum load applied to the backhoe bucket chain due to rough handling during the exercise, in kg.
Maximum Shock-Load (Loader Chain)	The maximum load applied to the loader bucket chain due to rough handling during the exercise, in kg.
Operating Ratio (%)	Ratio between the time operated and the idle time, expressed as a percentage. With no idle time, the operating ratio is 100%.
Right Outrigger Load Average (kg)	The average load on the right outrigger over the duration of the exercise, in kg.
Right Outrigger Load Current (kg)	The current load on the right outrigger, in kg.
Safe Parking Position	1 if the operator turned off the engine while the bucket was not touching the ground or the backhoe loader was not level (over 3 degrees). The system automatically ends the exercise when this occurs.
Shock Load	The maximum load applied on the rigging up to this point in the exercise, due to rough handling, in kg.
Spill off Quantity (kg)	The amount of concrete which the operator lets spill off the bucket due to careless handling.
Throttle Pedal Position (%)	The position of the operator throttle pedal in real time, expressed as a percentage.

Metric	Description
Throttle Pedal Position Average (%)	The average pedal position (expressed as a percentage) over the time elapsed during the exercise.
Time Remaining	The amount of time which remains for the operator to complete the task.
Total Time	The total time elapsed during the exercise.
Trucks per Hour	The number of trucks per hour the operator filled with material during the exercise.
Vehicle Flip Over	1 if the backhoe loader tipped over during the exercise. The system automatically ends the exercise when this occurs.
Wheel Slip Count	The number of times the wheels slipped during the exercise.
Wheel Slip Time	The total amount of time wheels spent slipping (spinning) during the exercise.
Wind Speed	The current wind speed in the environment.

Graphing Performance Metrics

Plotting performance metrics which the system records for each a training session on a graph can offer insights into whether a student is improving certain skills through practice. You can plot up to two performance metrics over the time elapsed since the training exercise began, or the past 120 seconds, on a graph in the **Chart** pane of the **Dashboard** page.

To view a graph of a performance metric over time during a training exercise, on the **Dashboard** page of the instructor console, do the following:

1. In the **Metrics** section, click the metric you want to plot. For example, click **Engine Power Consumed**.

The **Chart** pane displays a graph of the **Engine Power Consumed** metric over the time elapsed since the training exercise began appears.

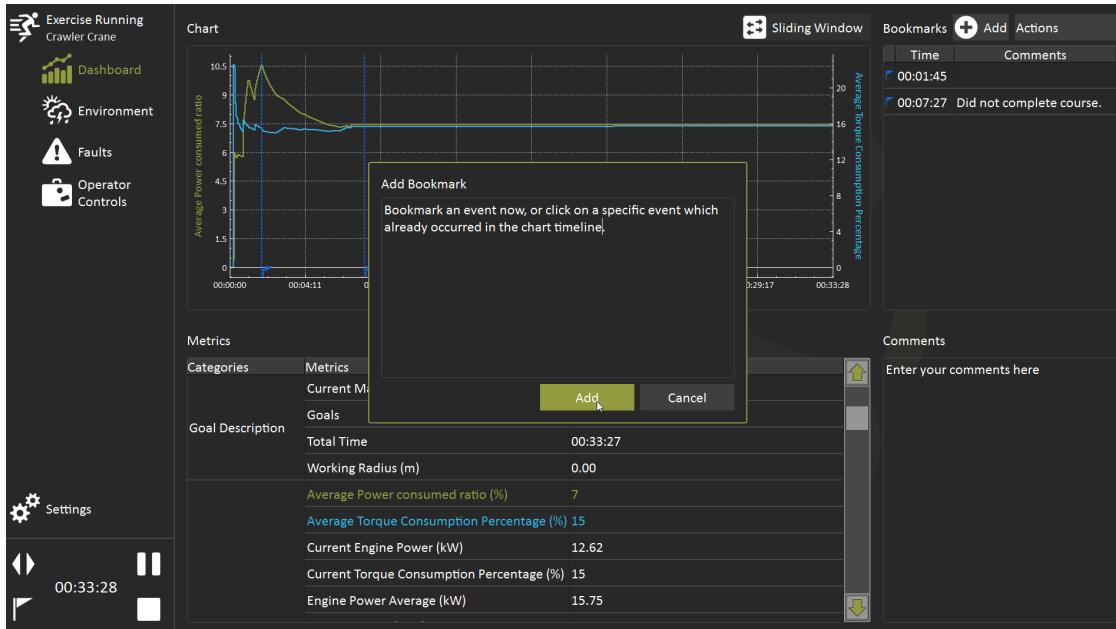
2. To plot another metric over time in the same graph, click the metric you want to view. For example, click **Idle Time**.

The **Chart** pane displays a graph of the **Idle Time** metric over the time elapsed since the training exercise began appears.

3. To plot the metrics over the past 120 seconds, click the **Sliding Window** button.

Bookmarking Events for Review

As you observe the operator completing exercises, there may be events for which you want to provide targeted, timely feedback. You can *bookmark*, or flag timestamps in the training exercise to review with the operator and provide commentary.



For example, if you notice the operator ignore a pedestrian in the work area but don't want to stop the exercise to discuss the event, you can bookmark the event on the **Bookmarks** pane, add a comment, and review the incident with the operator at the end session.

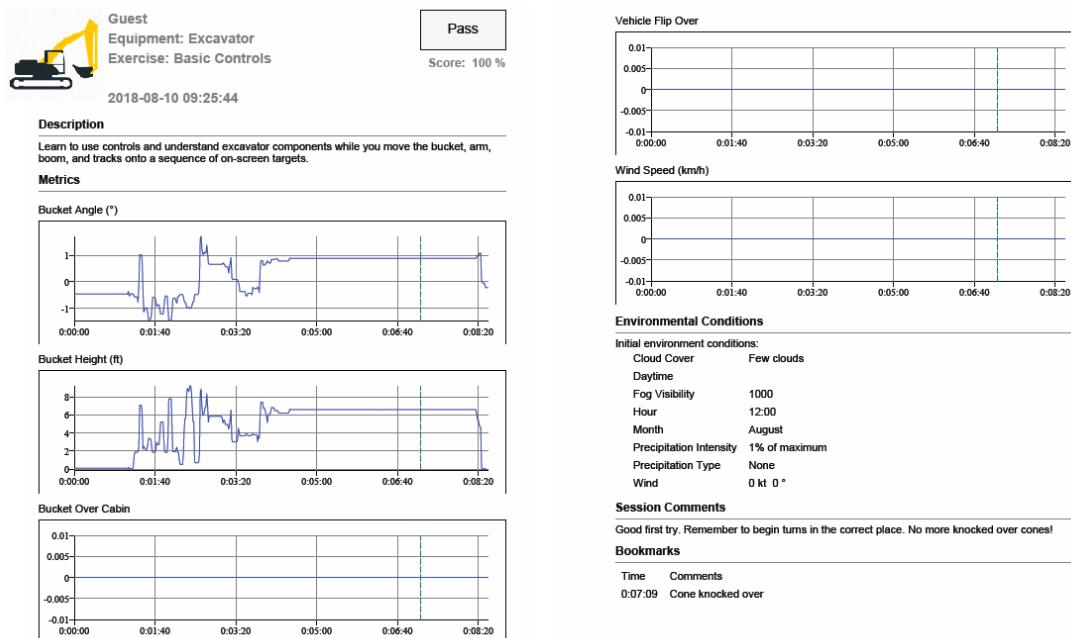
The system lets you bookmark an event which is occurring now, or an event that occurred previously in the session.

All bookmarks and comments appear in the reports you generate for this training session.

Evaluating and Ending the Exercise

Once the student completes all the tasks in an exercise, you can end the session and evaluate operator performance. You can also generate a performance report for the session.

Sample Report



Any time you end a training exercise, the system prompts you to evaluate the student. You can choose from the following options:

Option	Description
Pass	Any reports that the system generates for this exercise will show that the operator passed this exercise.
Fail	Any reports the system generates about this exercise will show that the operator did not pass this exercise.

Option	Description
Don't record	The system will not store any performance metrics for this training exercise, and no record of it will appear under the list of exercises the operator completed. This is useful if something outside the operator's control prevents him from completing the exercise.

To End an Exercise and Evaluate the Session

Once the operator completes the tasks in the exercise, the instructor can end the exercise from the instructor station as follows:

1. In the lower left of the application, click the **Stop** button .
2. In the window that appears, do one of the following:
 - To indicate that the operator successfully completed the exercise, click **Pass**.
 - To indicate that the operator did not successfully complete the exercise, click **Fail**.
 - To discard the session and leave the record of it in the system, click **Don't Record**.
3. In the **Comments** text box, type any feedback you would like the operator to review. The feedback will appear in any reports that you generate for the session.
4. (Optional) To generate a performance report for this session, on the **Action** menu, click **Generate exercise report**.
The system generates a PDF report detailing performance statistics for the exercise.
5. (Optional) To return to the exercise after generating the report, click the **Back** button.
6. To end the exercise, click **Stop**. The exercise closes.

Understanding Reports

The reports that you generate at the end of an exercise typically show the following information:

- The name of the user who completed the exercise
- The equipment simulation (for example, *Backhoe Loader*)
- The name of the training exercise
- The date and time of the exercise
- Pass/Fail mark
- A description of the main objectives of the exercise
- The score, as determined by system scoring rules
- A summary of how the system calculated the score
- Graphs for each metric the system recorded measurements for during the exercise
- Any instructor comments
- Any events which the instructor marked during the exercise
- A summary of environmental settings during the exercise



For information about configuring the scoring rules the system uses to evaluate operator performance during exercises, see [The Scoring Page](#), on page 74.

Scoring and Metrics Summaries

The system shows graphs for each metric the system records measurements for during the exercise. Graphs show time elapsed during the exercise on the x-axis and recorded values for an individual metric on the y-axis. When there are system scoring thresholds configured for a metric, the system shows a dashed line to indicate when operators exceed the threshold.

Example: Basic Controls Scoring and Metrics Report

Reports which the instructor generates at the end of the exercise include graphs for the following key performance metrics.

In the following example, the operator earned a score of 100%.

Score Breakdown

Metric	Value	Minimum	Maximum	Deduction	Trigger	Last
Collisions	0	0	0	5	0	0:00:00
Collisions	0	0	1	5	0	0:00:00
Collisions	0	0	2	5	0	0:00:00
Collisions	0	0	3	5	0	0:00:00
Cones Knocked Over	0	0	0	3	0	0:00:00
Cones Knocked Over	0	0	1	3	0	0:00:00
Cones Knocked Over	0	0	2	3	0	0:00:00
Cones Knocked Over	0	0	3	3	0	0:00:00
Cones Touched	0	0	0	2	0	0:00:00
Cones Touched	0	0	1	2	0	0:00:00
Cones Touched	0	0	2	2	0	0:00:00
Cones Touched	0	0	3	2	0	0:00:00
Contact with Human	0	0	0	100	0	0:00:00
Electric Pole or Cable Contact	0	0	0	100	0	0:00:00
Load Over Human	0	0	0	100	0	0:00:00
Safe Parking Position	0	0	0	10	0	0:00:00
Total Time (s)	9.450	0	480	5	0	0:00:00
Total Time (s)	9.450	0	540	5	0	0:00:00
Total Time (s)	9.450	0	600	5	0	0:00:00
Total Time (s)	9.450	0	660	5	0	0:00:00
Vehicle Flip Over	0	0	0	100	0	0:00:00
Total Deductions				0		

Metric Graph Examples

The report also shows graphs for the metrics the system measures values for over the duration of the exercise. Where scoring thresholds are configured for a metric, they appear as orange dashed lines in the report.

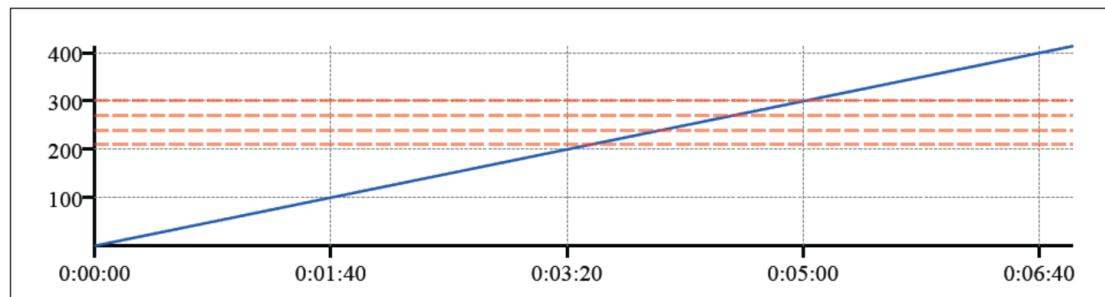
The following are examples of graphs reports show for an exercise:

Total Time

The number of seconds elapsed from the beginning of the exercise until the end of the exercise.

For example, the graph below shows seconds increase from 0 at the beginning of the exercise until 6 minutes and 50 seconds, when the exercise ends.

Total Time (s)



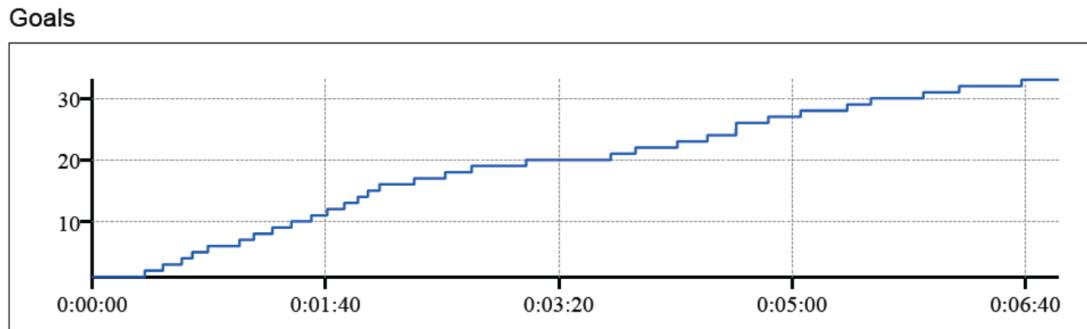
Dashed lines show the values where the system deducts points according to configured scoring rules. In this example, the system deducts 10 points when the operator exceeds 210 seconds, 240 seconds, 270 seconds, and 300 seconds.

Goals

The number of goals which the operator completed.

The graph shows that over the duration of the exercise (the x-axis), the operator completed more than 30 goals (y-axis).

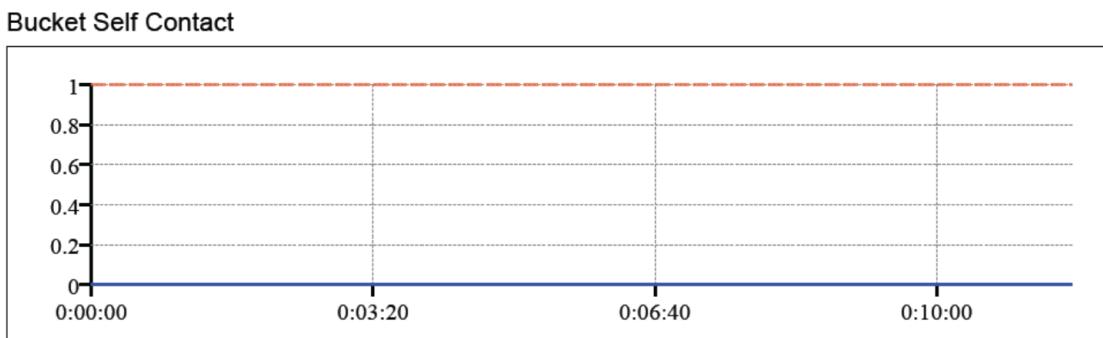
Where the value on the y-axis remains flat, the operator was in between goals.



Bucket Self Contact

The number of times the bucket touched the wheels or body of the backhoe loader.

The graph shows that over the duration of the exercise (the x-axis), the operator did not let the bucket touch the wheels or body of the backhoe loader (blue line shows a value of 0 on the y-axis for the duration of the exercise).



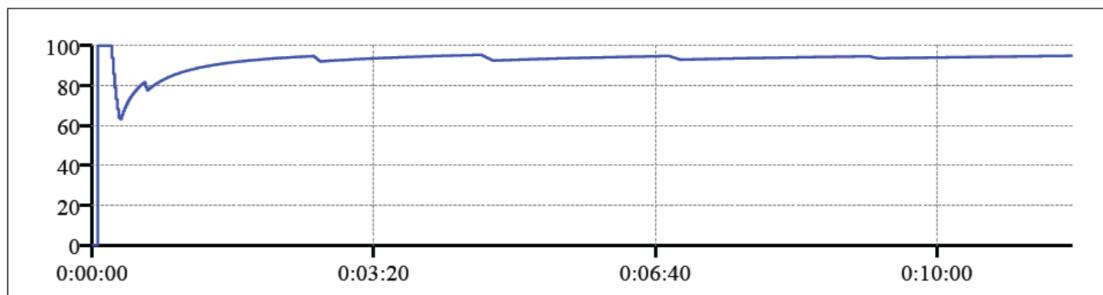
The dashed line shows the value where the system deducts points according to configured scoring rules. In this example, the system would deduct points if the bucket touched the backhoe loader or wheels one time.

Operating Ratio

Ratio of the time the operator spent working over the time equipment was idle (not traveling or moving the arm or bucket).

The graph shows that during the beginning of the exercise, the operator was inactive (planning, observing). Between goals, the amount of idle time increased for a short time while the operator prepared for the next goal. Where the y-axis value is 100%, there is 0 idle time.

Operating Ratio (%)

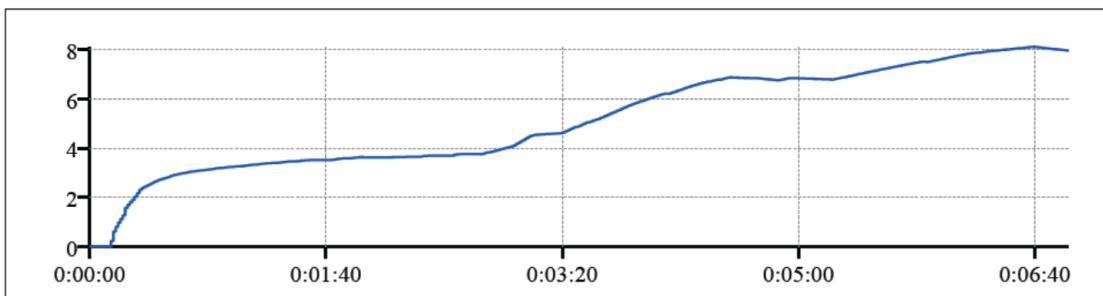


Fuel Consumption Average

The average amount of fuel consumed per hour over the time elapsed in the exercise, in liters per hour.

The graph shows that over the duration of the exercise (x-axis), fuel consumption average increased and reached a maximum value of 8 liters per hour near the end of the exercise (y-axis).

Fuel Consumption Rate Average (L/h)

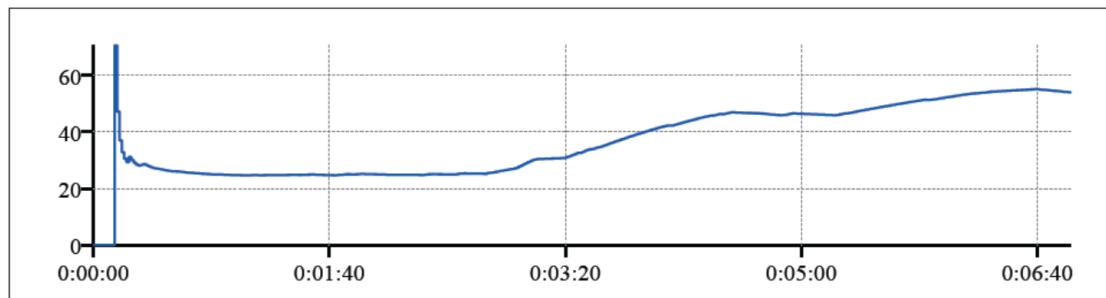


Engine Torque Average

The average percentage of torque consumed over the duration of the exercise, expressed as a percentage of total capacity.

The graph below shows that over the duration of the exercise (x-axis), the average torque consumed increased quickly when the operator started the engine (y-axis). The operator used less torque to complete bucket and arm movement goals. Engine Torque Average increased when the operator moved the backhoe loader through the slalom course.

Engine Torque Average (%)

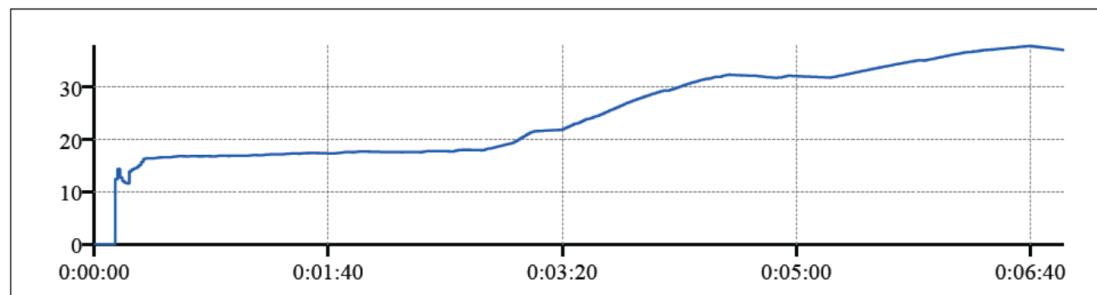


Engine Power Average

The average position of the operator pedal over the duration of the exercise, expressed as a percentage of total capacity.

The graph below shows that over the duration of the exercise (x-axis), the average engine power increased when the operator started the engine (y-axis). The operator used less power to complete bucket and arm movement goals. Engine Power Average increased when the operator moved the backhoe loader through the slalom course.

Engine Power Average (%)

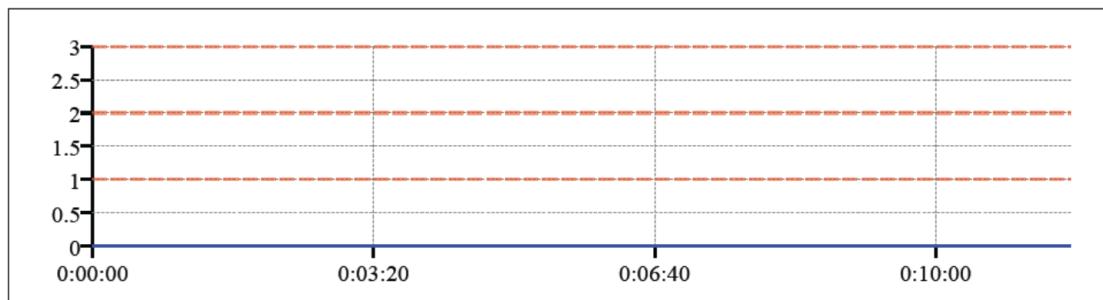


Collisions

The number of times the backhoe loader contacted objects in the work site.

The graph shows that for the duration of the exercise (x-axis), the backhoe loader did not touch any objects (blue line shows a value of 0 on the y-axis for the duration of the exercise).

Collisions



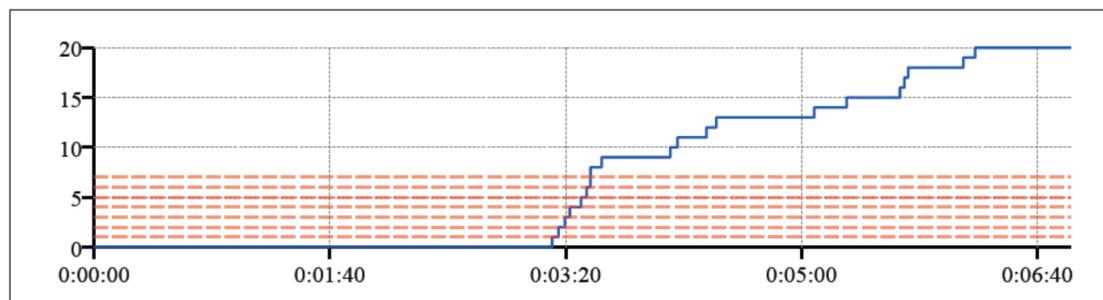
The dashed lines show the values where the system deducts points according to configured scoring rules. In this example, the system deducts points each time the backhoe loader collides with an object.

Cones Touched

The number of cones the backhoe loader touched during the exercise.

This graph shows that for the duration of the exercise (x-axis), the backhoe loader touched 20 cones (y-axis).

Cones Touched



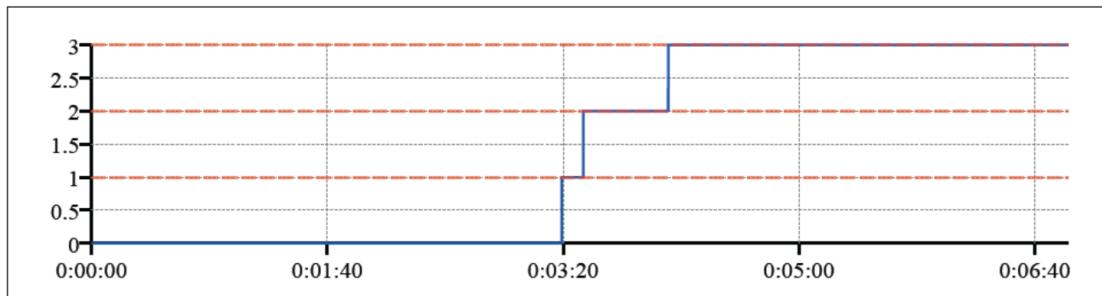
The dashed lines show the values where the system deducts points according to configured scoring rules. In this example, the system deducts points each time the backhoe loader touches a cone (up to seven times).

Cones Knocked Over

The number of cones the backhoe loader touched during the exercise.

The graph shows that for the duration of the exercise (x-axis), the backhoe loader knocked over 3 cones (y-axis).

Cones Knocked Over

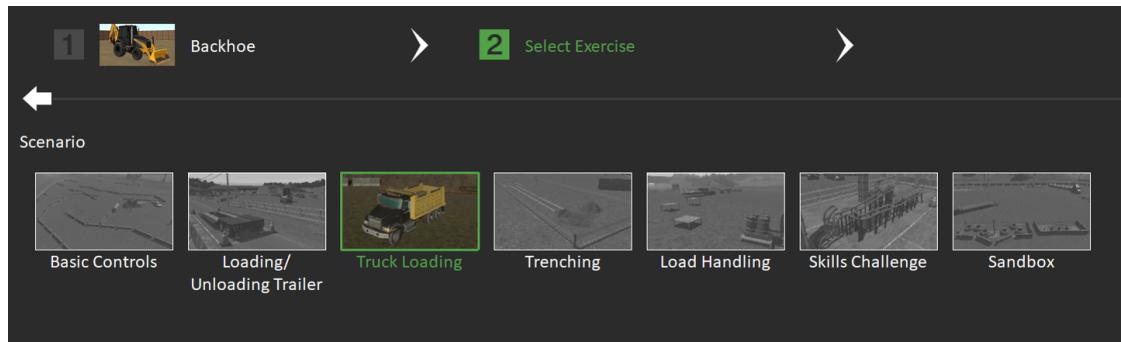


The dashed lines show the values where the system deducts points according to configured scoring rules. In this example, the system deducts points each time the backhoe loader knocks over a cone.



Backhoe Loader Training Exercises

Backhoe Loader training exercises are designed to help instructors demonstrate major Backhoe Loader components and functions, in addition to using basic controls for completing everyday tasks.



Training Objectives

Each exercise gives operators the information and practice the need to take away specific learning outcomes:

Exercise	Training Objectives
Basic Controls , on the facing page	Operators become familiar with loader bucket, backhoe arm and bucket movements, outriggers, and travel
Loading and Unloading Trailer , on page 109	Operators learn to move the backhoe loader onto a trailer and put it in a safe position for transport.
Trenching , on page 113	Operators learn to create a trench with exact specifications
Truck Loading , on page 117	Operators move material into dump trucks using the loader bucket or the backhoe bucket.
Load Handling , on page 121	Operators use the quick coupler function to attach forks and move different loads in the practice yard.
Skills Challenge , on page 125	Operators demonstrate acquired skills in a fun competitive environment while the guide concrete balls through a pipe maze.
Sandbox , on page 128	Operators improve skills independently in a free-form practice area which includes a trenching area, slalom course, fork-lifting activity, and tires for piling.

Basic Controls

The Basic Controls exercise is designed to familiarize operators with loader bucket, backhoe arm and bucket movements, outriggers, and travel.

To complete the exercise, operators follow onscreen instructions to place the loader and backhoe buckets on successive targets. Then, the operator follows instructions to practice driving straight and over speed bumps. The operator must perform a three-point turn, drive in reverse, and put the Backhoe Loader in a tripod position before ending the exercise.



Learning Outcomes

This exercise is designed to teach operators to:

- Perform basic Backhoe Loader functions, using joysticks to control the loader bucket, backhoe arm and bucket, and travel.
- Extend outriggers to stabilize the machine.
- Position the Backhoe Loader for travel.
- Steer over even and uneven terrain.
- Perform a three-point turn.
- Position the backhoe in a tripod position.
- Use the backhoe arm to reposition the equipment.

Exercise Workflow

The exercise is designed to teach the operator skills in the following order:

1. Loader and Backhoe Arm Positioning

The operator uses controls to place the loader and backhoe buckets on successive targets. Each target requires the operator to use controls in specific ways, for example to extend or retract the backhoe arm or boom and curl the bucket simultaneously.

2. Driving Straight

The operator drives straight down the road in the work site. The system instructs the operator to keep the bucket fully curled and low (300 mm from the ground), with a lower center of gravity, to maximize machine stability and the field of vision.

The operator drives over a series of speed bumps on the road. The system instructs the operator to put the transmission in 2nd or 3rd gear when anticipating an obstacle for more control and stability.

3. Slalom

The operator performs a series of tight turns to navigate through a slalom course. The system instructs the operator to use the directional brake to make tighter turns (decrease the turning radius).

4. Perform a 3-Point Turn and Return

The operator follows on-screen instructions to perform a 3-point turn before traveling back over the road course to the start point.

5. Tripod Set-Up

The operator must put the Backhoe Loader in a tripod position. The system instructs the operator to do the following:

- a. Lower the loader bucket on to the ground until the front tires clear the ground.
- b. Extend both outriggers at the same time until the rear wheels clear the

ground.

- c. Adjust equipment so that the left and right axle are level.

Loading and Unloading Trailer

Operators learn to move the backhoe loader onto different trailers and put it in a safe position for transport. On-screen targets and tips help operators learn the correct procedure for moving onto and off of the following types of trailers:

- Detached lowboy trailer
- Dropdeck trailer



Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Put the backhoe loader in a secure position for transport on each trailer.	<p>The operator must put the backhoe loader in a secure position for transport on each trailer.</p> <p>On-screen tips tell the operator to:</p> <ul style="list-style-type: none">■ Curl the bucket and retract the arm fully.■ Lower the boom and loader bucket until no part is higher than the cabin.
Follow safe operating procedure to move onto and park the backhoe loader on a detached lowboy trailer.	On-screen tips explain how to drive onto the trailer.
Follow safe operating procedure to move onto and park the backhoe loader on a dropdeck trailer.	On-screen tips explain how to drive onto the drop-deck trailer.

Exercise Workflow

To start the exercise, press and hold the **Horn** button.

1. Move Onto the Detached Lowboy Trailer

- a. Align the wheels and loader bucket with the ramp.
- b. Advance onto the ramp slowly. Stop when wheels are fully over the ramp.
To prevent accidents, operate the vehicle in a low gear.
- c. To make the backhoe loader more stable, curl and lower the loader bucket.
- d. When the vehicle is over the center of the trailer, secure it for travel:
 - i. Curl the backhoe bucket and retract the arm fully.
 - ii. Lower the boom until no part is higher than the cabin.

2. Move off of the Detached Lowboy Trailer

- a. Raise the boom, arm, and outriggers until you have a satisfactory view and the machine is stable.
- b. Keep the machine stable while you move down the ramp. Move down the ramp slowly. Stop when the wheels are fully off of the ramp.
- c. To safely park, position the loader bucket on the ground.

3. Move onto the Dropdeck Trailer

- a. Align the wheels and loader bucket with the ramp.
- b. Advance onto the ramp slowly. Stop when wheels are fully over the ramp.
To prevent accidents, operate the vehicle in a low gear.
- c. To make the backhoe loader more stable, curl and lower the loader bucket.
- d. When the vehicle is over the center of the trailer, secure it for travel:
 - i. Curl the backhoe bucket and retract the arm fully.
 - ii. Lower the boom until no part is higher than the cabin.

4. Move off of the Dropdeck Trailer

- a. Raise the boom, arm, and outriggers until you have a satisfactory view and the machine is stable.
- b. Keep the machine stable while you move down the ramp. Move down the ramp slowly. Stop when the wheels are fully off of the ramp.
- c. To safely park, position the loader bucket on the ground.

Once the operator completes all tasks, the system shows a success message and the exercise ends.

Trenching

This exercise is designed to help operators learn to create a trench with exact specifications.



Operators excavate a narrow trench area (marked with white chalk lines) with the following specifications:

Depth	1.2 m (4 ft)
Width	1 bucket width (.61 m, or 2.0 ft)
Length	20 m (65.61 ft)
Square at the end of the trench	3.0 m (9.8 ft) long x 3.0 m (9.8 ft) wide

The completed trench must be straight and level, with a safety corridor between the trench and the pile.

An on-screen display (Grade Quality Sensor) shows the quality of the trench and gives operators immediate feedback about where the trench is too shallow or too deep as they work.

At the end of the exercise, a score shows the quality of the completed trench.

Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Select the correct location to set up.	Before the operator starts, on-screen tips tell the operator to look for hazards, personnel, fire hydrants, and power lines. The trench area is marked with a white line.
Satisfactorily excavate layers of material	The operator must move forward and position the backhoe, arm, and bucket correctly to remove layers of material. The operator must make sure equipment is stable. To give operators information about the quality of the trench while they work, a display shows the current depth of the trench and how level it is.
Remove material in shallow layers, maintaining the correct bucket angle and a consistent grade.	The system measures the time from when operators fill the bucket with material to when they release it onto the pile. A display shows the average time each cycle takes to encourage operators to become faster.
Maximize bucket volume for each loading cycle.	Instructors can turn on a Grade Quality Sensor feature which uses colors to indicate current grade quality on the display. The Grade Quality Sensor shows operators where the trench is too deep (red), too shallow (blue), or the correct depth (green). Operators can observe the impact of the bucket angle on the grade quality and the bucket capacity.
	The system displays how full the bucket is in real-time. The bucket capacity measurements should exceed 100% per cycle.

Goal	Methodology
Release material evenly on the side of the trench and create a safety corridor.	On-screen tips instruct the operator to keep the work area clean and create a safety trench.
Use shadows to gauge depth and identify reference points to delineate the perimeter of the work area, visually assessing ground elevation for highs and lows.	On-screen tips instruct the operator to use shadows to gauge depth and assess hazards before beginning work.

Exercise Workflow

When the exercise starts, the backhoe loader is parked in front of the trenching area.

To start the task, press the Horn button and follow on-screen instructions to complete these activities:

1. Set Up

Move forward and position the bucket to start removing material in the correct place.

2. Make the Trench

Use the bucket and arm at the same time to remove thin layers of material and dump it in the correct place on the side.

Clean material that spills from the bucket and leave a path for a safety corridor.

To see the quality of the trench, look at the Grade Quality Sensor display. Correct your work when necessary.

3. Park

When the trench and square area are complete, move the backhoe loader to the on-screen target and stop the engine.

When the operator completes all tasks, the exercise ends and the system shows a success message.

Truck Loading

The operator moves material into a sequence of dump trucks using the loader bucket or the backhoe bucket. The operator must use the horn to signal each dump truck to stop in the correct position and make sure the backhoe loader is stable during each operation.



Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Estimate equipment limits and ground conditions.	
Set the backhoe loader in a position that increases stability and decreases the distance that the bucket must move during operation.	On-screen tips tell the operator how to set the backhoe in the best position.
Use correct method to fill the bucket.	A display shows how full the bucket is at all times. Using the correct method, the operator fills the bucket until it is 100% full each time.
Use the correct method to dump material in the truck.	The HUD shows the current level of material in the dump truck. On-screen tips tell the operator to use the arm to release material into the truck equally, from back to front.
Empty the bucket lightly and carefully.	The system records each collision between the bucket and the body of the dump truck.
Use the correct method to move material.	The system records the quantity of material the operator spills during the exercise.
To prevent spilled material, align the bucket over the center of the dump truck.	An on-screen warning tells the operator not to move the bucket over the cabin.
Use horn to signal truck driver.	The operator uses the horn to signal trucks to come. Once a dump truck is full, the operator uses the horn to signal the truck to go.
Complete each operation with smooth, continuous movements.	The operator must fill multiple dump trucks within the specified time period. The system records measurements to calculate efficiency while you work.

Goal	Methodology
Signal the truck to stop in the best position.	<p>On-screen tips tell the operator where the best place for the truck is.</p> <p>The system metrics that calculate efficiency show better values when operators stop the truck in the correct place.</p>
Keep the truck path clean and level at all times.	<p>On-screen tips tell the operator to keep the path clean. The system records the quantity of spilled material.</p>

Exercise Workflow

When the exercise starts, the backhoe loader is in front of a pile of material, waiting for a dump truck to come.

To start the exercise, press the **Horn** button and do the following:

1. Fill the Bucket

Fill the bucket until it is a minimum of 80% full.

2. Position the Backhoe Loader

When the bucket is 80% full or more, a dump truck image appears. Position the bucket in the place where you want the dump truck to move towards.

3. Signal the Dump Truck

To signal the dump truck to drive toward the position you indicated, push the Horn button one time. When the truck is in the correct position, push the Horn button again to signal the truck to stop.

4. Release Material into the Dump Truck

Carefully release material into the dump truck so that material is as level as possible.

Do not let the bucket touch the sides of the dump truck.

5. Go back to the Pile

Go back to the pile and fill the bucket again. Continue to move material to the dump truck until it is full.

6. Signal the Truck to Go

Push the Horn to signal the truck to go. Another truck arrives. Do the steps again until you fill 5 trucks.

When the operator completes all tasks, the exercise ends and the system shows a success message.

Load Handling

In this exercise, the operator uses the quick coupler function to attach forks and move different loads in the practice yard. To complete the exercise, the operator must satisfactorily complete the following:

- Unload pallets from a trailer and position them at different heights on steel racks.
- Use forks to move a long steel pipe to a target destination.
- Lift concrete pipes from a trailer and move them to the side of a trench.
- Use chains attached to the bucket to stack concrete blocks.
- Use chains attached to the backhoe bucket to move pipes into the trench.



Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Use quick coupler to attach and detach each tool	The operator must align equipment with each attachment and verify that each tool is securely attached.
Correctly align forks with pallets	On-screen tips instruct the operator to align forks correctly with each pallet before lifting.
Control pendulum swing of each load	On-screen tips instruct the operator to: <ul style="list-style-type: none">■ Make sure attachment point correctly aligned over the center-of-mass of each object.■ Move slowly for more control. The motion platform lets the operator feel when the backhoe loader is unstable.
Use each attachment safely near personnel in the work site	On-screen tips instruct the operator to: <ul style="list-style-type: none">■ Verify that each attachment is secure before lifting or moving.■ Always look for hazards and personnel. The system ends the exercise automatically when the load or equipment touch a person.

Exercise Workflow

When the exercise starts, the backhoe loader is in a practice yard. In front of the operator is a loader bucket target.

To start the exercise, push and hold the **Horn** button and complete the following activities:

1. Attach Forks

- a. Drive to the on-screen bucket target and position the loader bucket on the target.
- b. Disconnect the bucket using the control on the HMI and reverse to remove the loader bucket from the equipment.
- c. Drive to the loader forks and use the quick coupler control to attach them to the backhoe loader.

2. Move Steel Barrel Pallets

- a. With the forks attached, drive to the flatbed trailer.
- b. Move each pallet of steel barrels to targets on the yellow steel tables.

3. Move Steel Pipe

- a. With the forks still attached, drive to the steel pipe.
- b. Lift and move the steel pipe to the empty pipe cradles and lower the pipe onto the target.

4. Move Concrete Pipes

- a. Drive to the concrete pipes on the trailer.
- b. Lift and move each concrete pipe to the empty cradles and lower them on to the targets around the trench.

5. Remove Forks and Attach Bucket

- a. Drive to the forks target on the ground and position the forks on the target.
- b. Use the control on the HMI to detach the forks and reverse to remove the attachment.

- c. Drive to the loader bucket and use the control on the HMI to attach it to the backhoe loader.

6. Stack Concrete Blocks

- a. Drive to the concrete blocks.
- b. Use the chain on the loader bucket to lift and move each block to targets until you make a wall.

7. Position Concrete Pipes in Trench

- a. Reverse toward the target between concrete pipes.
- b. Lower outriggers until the backhoe loader is stable.
- c. Use the chain attached to the backhoe bucket to lift each concrete pipe and position them on targets in the trench.

8. Parking Position

- a. Return to the parking position.
- b. Lower the loader bucket to the target on the ground.

When the operator completes all tasks, the exercise ends and the system shows a success message.

Skills Challenge

This exercise is designed to challenge students and operators in a fun and competitive environment.



To complete the exercise, the operator uses the backhoe bucket to move 5 concrete balls through a pipe maze as quickly as possible. An on-screen timer begins to count down from 2 minutes when the operator starts the exercise.

Each time the operator successfully moves a ball into the target, the system increases the available time.

When the operator knocks a pipe off the rails, the system deducts seconds from the available time.

Learning Outcomes

This exercise is designed to teach operators these skills:

This exercise is designed to teach operators to:

- Demonstrate precise control of the bucket and steering, delicately moving the ball through the course.
- Use complex repetitive motions to get the ball through the slalom course.

Goal	Methodology
Use the backhoe bucket to push and control movement of concrete balls	The system records anytime the balls leave the rails of the pipe maze.
Safely operate equipment in a confined area surrounded by obstacles	The backhoe loader is surrounded by obstacles and system records any collisions.
Use multiple functions at the same time to perform complex motions	To complete the challenge quickly, the operator must operate the backhoe arm and bucket with expertise and accuracy.
Move the backhoe bucket accurately and quickly	

Exercise Workflow

When the exercise starts, the backhoe loader is in front of a pipe maze.

1. To begin the exercise, press the **Horn** button.
2. Extend outriggers until the backhoe loader is stable.
3. Use the backhoe bucket to move the each concrete ball through the maze to each checkpoints.
4. Repeat until all balls are through the maze.

The exercise ends once the operator moves all balls through the maze.

Sandbox

Students improve skills independently in a free-form practice area which includes an embedded pipe, manhole, slalom course, and tires for piling. They can also practice moving the backhoe loader on and off of different trailers.

There are no specific goals for operators to accomplish in this exercise. Instructors can direct students to complete activities according to training needs.



Learning Outcomes

This exercise is designed to help operators learn these skills:

Goal	Methodology
Correctly excavate a trench.	<p>Operators do the following things to create a trench:</p> <ul style="list-style-type: none">■ Use outriggers and the loader bucket to stabilize the backhoe loader.■ Safely remove layers of material from the trench.■ Use the backhoe bucket to reposition equipment.■ Keep the safety corridor clear of material and debris.
Use the bucket to lightly lift and pile tires.	Operators use the bucket to lift tires and pile them on top on one another.
Attach forks to move barrel pallets	Operators detach the loader bucket and attach the forks attachment to move barrel pallets from yellow platforms.
Use the bucket to move an object with control and accuracy.	Operators use the bucket to move a concrete ball through a short slalom course.
Move the backhoe loader onto and off of different trailers	<p>The practice area includes these trailers:</p> <ul style="list-style-type: none">■ Detached lowboy■ Attached lowboy■ Flatbed■ Dropdeck

Exercise Workflow

When the exercise starts, the backhoe loader is in the center of a training yard with different areas for each challenge.

To start the exercise, press and hold the **Horn** button and follow on-screen instructions to complete the following:

1. Trailers

Move the backhoe loader onto and off of any of these trailers:

- Detached lowboy
- Attached lowboy
- Flatbed
- Dropdeck

2. Concrete Ball Challenge

Use the backhoe bucket to move a concrete ball through a slalom course from one target to another.

3. Tires

Lift tires and put them on top of another.

4. Trench Excavation

Use the backhoe bucket to excavate a trench.

5. Move Barrel Pallets

Detach the loader bucket and attach forks to move barrel pallets from yellow platforms.

After the operator completes all tasks, the exercise ends and the system shows a success message.