



# **Vortex Excavator Simulator Instructor Guide**

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# Welcome

The Vortex Excavator Simulator lets students and experienced operators practice safe techniques for excavation, loading and dumping material, making a trench, and lifting loads. Students can become familiar with controls and practice for certification exams with no risk to equipment or personnel.



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# Intended Audience

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

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

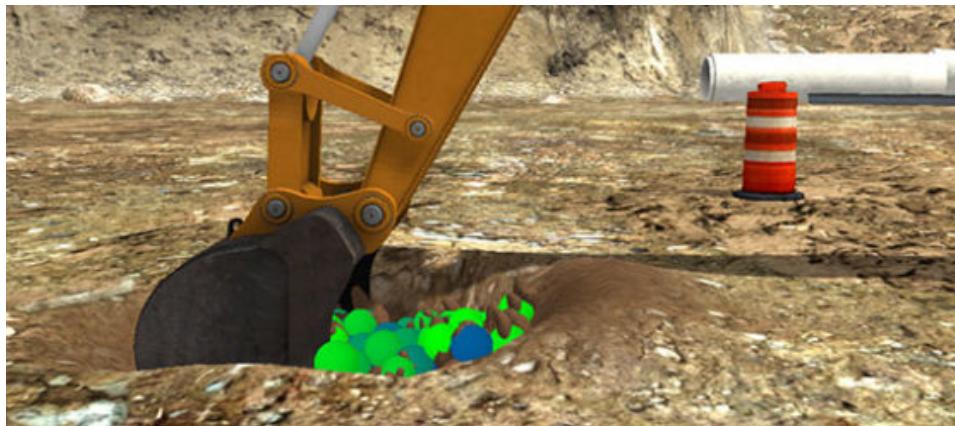
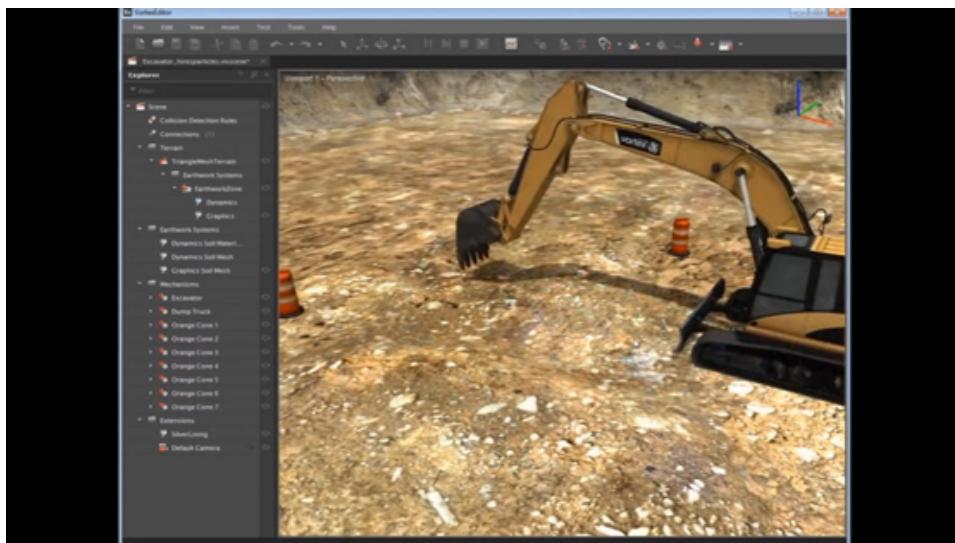
# About this Guide

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

Section	Description
<b>Hardware</b> , on page 17	Describes hardware, controls, and displays you can use with this solution.
<b>Getting Started</b> , on page 21	Describes how to launch the Vortex software application, navigate the user interface, and start a training exercise.
<b>Managing Accounts and System Access</b> , on page 31	Describes how to add user accounts for students and instructors, and how to add students to classes.
<b>Conducting Training Sessions</b> , on page 59	Activities typically involved in conducting a training session, such as assigning exercises to students, modifying weather conditions, scoring values, using hand signals, and reporting.
<b>Excavator Training Exercises</b> , on page 96	Detailed descriptions of training exercises and learning outcomes, and information for lift planning.

# Vortex Simulation Software

Each Vortex training module is developed using the Vortex Studio software platform. Vortex Studio is a modular platform that allows for the creation of extremely realistic equipment simulation, including training, visualization, planning, and prototyping. Vortex 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](#).

# Excavator Simulation

The Vortex Excavator Simulator is designed to realistically reproduce the experience of operating a 21-ton hydraulic excavator with a 119kW engine. The simulation software relies on exact specifications and collaboration with manufacturers to make sure that the excavator moves, sounds, and operates like a real hydraulic excavator. The simulated excavator features a heavy duty bucket, rearview camera display, realistic HMI, and 3D track animation.

## Parts of the Excavator

- 
- 1 Bucket
  - 2 Arm
  - 3 Boom
  - 4 Cab
  - 5 Engine compartment
  - 6 Idlers (front of tracks)
  - 7 Driving sprockets (rear of tracks)
-

## Tracks

The excavator features realistic tracks with idlers, driving sprockets, pumps, and track shoes.



## Heavy Duty Bucket

The excavator features a realistic heavy duty bucket. The bucket has the following specifications:



<b>Width</b>	1067 mm (42 in)
<b>Weight</b>	768 kg (1693 lbs)
<b>Capacity</b>	0.83 m <sup>3</sup> (1.09 cu.yd.)
<b>Dig force</b>	164.4 kN
<b>Teeth</b>	5

## 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, and enabling the Auto/Idle feature.



## Engine Features

For training purposes, the system realistically simulates different Work Modes, Power Digging, and Auto-Idle feature.

### Work Modes

To help operators learn to operate the excavator in the correct mode, the system supports multiple work modes:

- **Eco Mode**  
1700 RPM
- **Power Mode**  
1800 RPM
- **High Power Mode**  
1700 RPM

### 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.

## **Power Digging**

The Power Dig control adds power to the hydraulic system pressure for heavy digging operations. When the operator presses and holds the Power Dig button on the joystick, the system increases hydraulic power for 8 seconds. The function resets when the operator releases the button.

## **Simulated Behaviors**

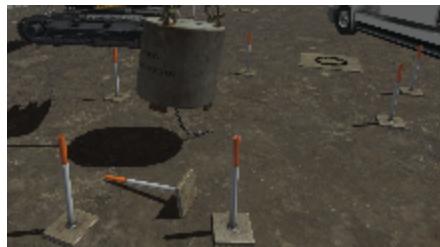
The simulated excavator is designed to let operators experience these realistic behaviors:

- Hydraulics system
- Soil digging and dumping, with realistic earth-moving
- Bucket and arm forces, trenching, and loading
- Moving forward and reverse on tracks, counter-rotating tracks.
- Deflection and instability (the excavator can tip over when unstable)
- Using chains to lift and move pipes and a test weight.
- Moving onto and off of different trailers

# Work Environment

Excavator training exercises take place in practice areas designed to resemble environments in typical suburban work sites. Operators and instructors can see shadows and light change with the time of day.

Exercise	Image	Description
Basic Controls		Practice course marked with traffic cones for the operator to practice steering with tracks.
Bench Loading		Tall bench with dump trucks that come when the operator uses the horn to signal them.
Arc Swipe		Cluttered practice area which forces the operator to move the bucket accurately in tight spaces.
Excavator Rodeo		Trade show demonstration area with scoreboard designed to encourage fun competition.

Exercise	Image	Description
Loading and Unloading		Practice yard with different kinds of trailers.
Pipe Placement		Suburban construction area with a trailer carrying pipes and trench where the operator can move pipes to.
Sandbox		Practice yard with different areas for trenching, lifting tires, moving onto and off of different trailers, and pushing a concrete ball through a slalom course.
Test Weight		Challenge course designed to help operators practice keeping a load level and at the same height as they move it through confined spaces.
Trenching		Large earthworks area with a marked area where the operator creates a trench.

# 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 excavator and tracks for stability during trenching, lifting, and travel
- Lifting and moving heavy loads
- Positioning pipes in a trench
- Loading dump trucks
- Creating a trench
- Excavating around a water pipe and manhole

# 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 give specific instructions on how to operate the excavator 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. Do not dig under the excavator.
Creating a safety corridor during between the excavator 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.
Excavating near pipes	To prevent damage, always work with a grades-person to find cross-lines before excavating.
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.

Activity	Safety Guidance
Turning the upperstructure	Because the cab is on the left side of the excavator, the boom can block your view of persons on the right side. To prevent accidents, use caution when you turn in the direction of the boom. When possible, turn the upperstructure to the left, away from the boom.
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.
Positioning the excavator safely on the bench	<p>To increase stability and digging power, do these things:</p> <ul style="list-style-type: none"> <li>■ Position the excavator perpendicular to the bench.</li> <li>■ Point the cab toward the idlers. The excavator is more stable when you excavate over the idlers or driving sprockets of the tracks.</li> </ul> <p>Important: When you excavate over the side of tracks, the excavator is less stable.</p>
Advancing onto a trailer	<p>When you move the excavator, make sure the cab points toward the idlers (refer to arrows on inside of tracks). Keep the bucket as low as possible.</p> <p>Use caution when you go over the tipping point of the machine.</p> <p>To prevent accidents, operate the excavator in a low gear while you advance onto the trailer.</p>

Activity	Safety Guidance
Moving off of a trailer	<p>To keep the machine stable while you move down the ramp, push the bucket into the ground at the bottom of the trailer.</p> <p>Move down the ramp slowly. Position the bucket on the ground to secure the excavator.</p>
Positioning the excavator for transport	<p>When the excavator is over the center of the trailer, position it for transport:</p> <ul style="list-style-type: none"> <li>■ Curl the bucket and retract the arm until it is in a stowed position.</li> <li>■ Lower the boom until it meets height requirements for transport.</li> </ul> <p><b>Important:</b> Always measure the height of the excavator on the trailer so you can refer to it later.</p>
Preparing for lifting operations	<p>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.</p>
Keeping a load stable	<p>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</p>

## 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 excavator falls over for any reason, the system stops the simulation immediately and the operator fails the exercise.
Human Contact	If any part of the excavator 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 excavator 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 bucket 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.

# Evaluation and Assessment

To help instructors monitor student progress and ability, the system records measurements for several key performance metrics.

At the end of each training session, instructors can generate reports which detail how the operator performed in these areas:

- The number of tasks the operator completed and the completion time for each task.
- How productive the operator was (quantity of mass the operator moved, cycle time, bucket capacity, spill off quantity, fuel consumption, dump trucks per hour).
- The quality of the work (the grade of trenches the operator digs, how level material is in the dump truck or spoil pile).
- How safely the operator performed tasks (collisions, shock loads, safety violations, creating a safety corridor).

For more information about ways instructors can monitor student progress, see **Monitoring Performance**, on page 69.

# Hardware

Vortex simulators are designed to facilitate instructor-led training, self-guided learning, or a combination of both.



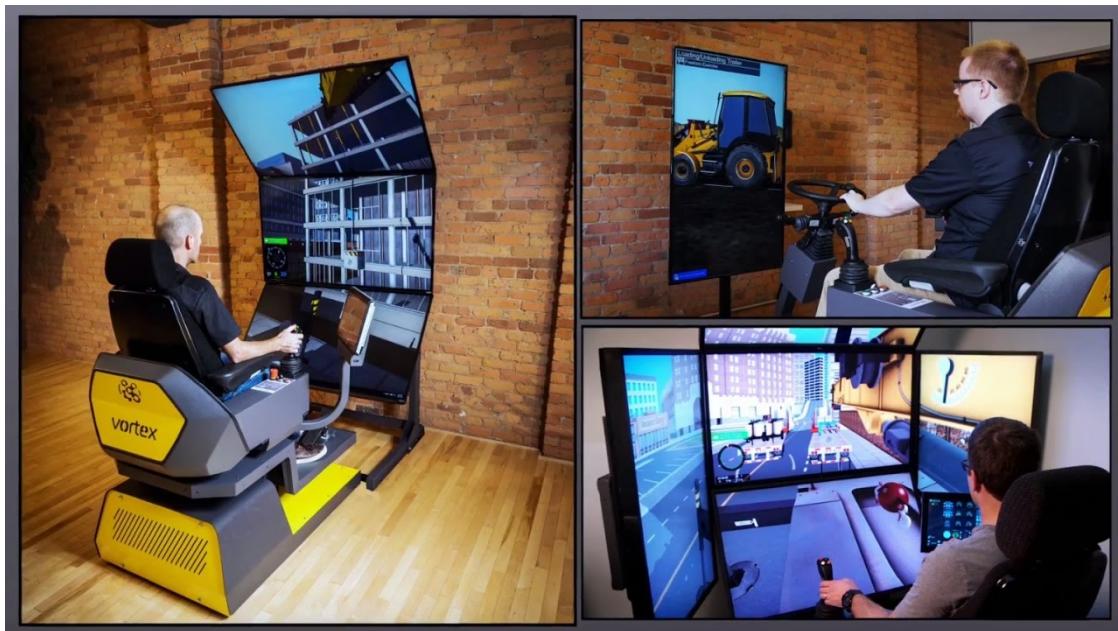
All simulators feature realistic work site and equipment simulation, physical operator controls, and training materials to enhance learning.

# Vortex Advantage

The Advantage simulator configuration can support between 1 and 5 display monitors and computers running Vortex software enclosed beneath the seat. It also includes a touch-sensitive screen for showing the machine HMI.

All controls, including joysticks and foot pedals, can be changed to support new equipment modules while the simulator is running.

To ensure operators can become accustomed to realistic movements and feedback on the ground, the Advantage simulator features a motion platform with 2 Degrees of Freedom (DOF).



# Vortex Trainer

The VxTrainer configuration uses a support that fits onto a table or desk. Attached to the support are the vertical monitor, the physical controls, and a touch-sensitive screen with simulated controls.

## VxTrainer Hardware Configuration

The VxTrainer configuration includes a single vertical monitor, touch-sensitive operator console, and physical controls.





# Getting Started

Getting started on the simulator involves the following activities:

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# Launching the Vortex Application

Launching Vortex Software 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 Vortex software may be different:

Desktop Icon	Supported Training Modules
	Click to launch Vortex simulator 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 recording 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 38.

# Starting a Training Exercise

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

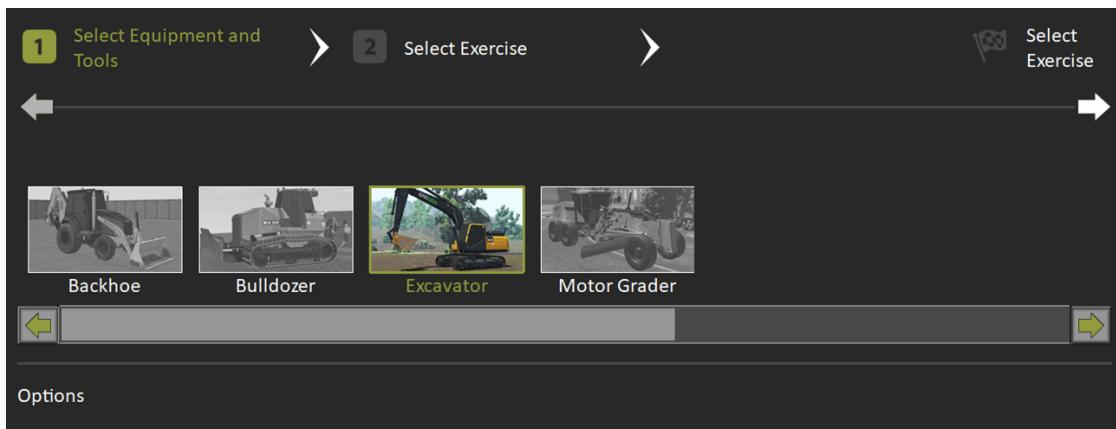
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# Selecting an Equipment Simulation

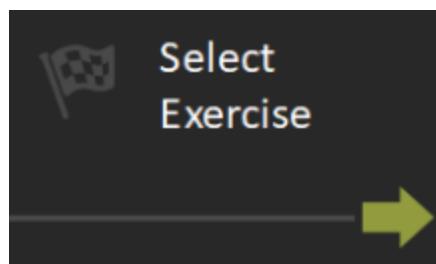
When the Vortex application launches, system shows the available equipment training modules:

*Your particular training modules may differ.*



Do the following:

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



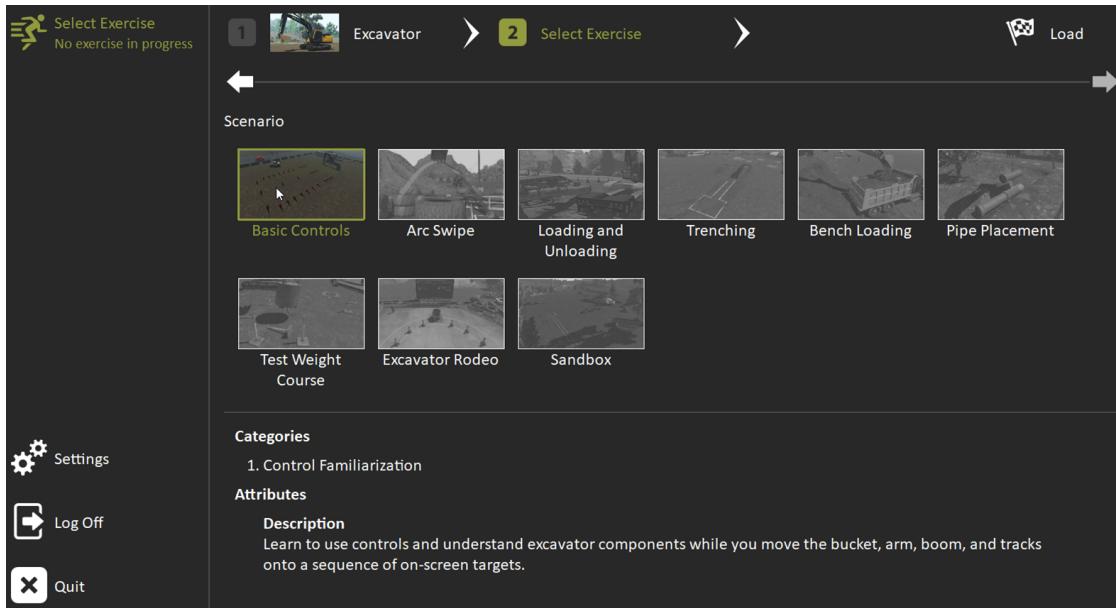
## Next Steps ...

[Selecting a Training Exercise, on page 1](#)

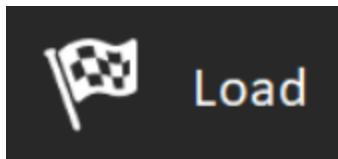
# Selecting a Training Exercise

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 **Hook** button on the joystick or controller to begin.

## Next Steps ...

[Navigating the Simulated Environment](#) , on page 1

# 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.

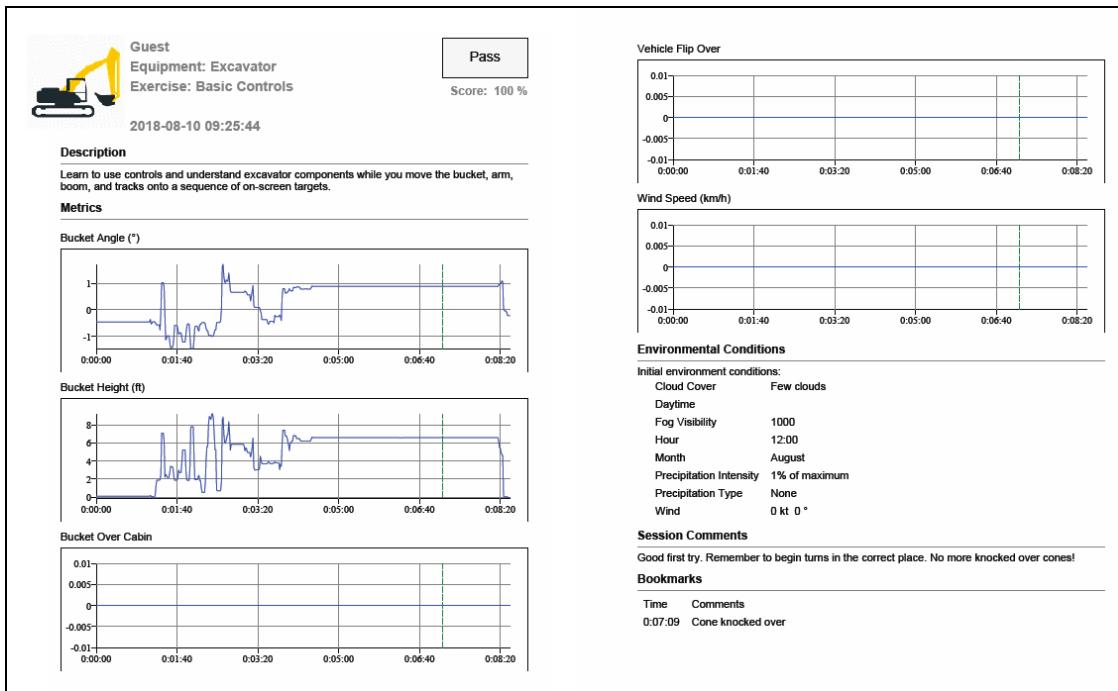
To specify a new logo image file, do the following:

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).
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 Vortex logo file saved in installation files.

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

# Sample Report with Custom Logo





# 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.

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
<b>Administrator</b>	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.
<b>Instructor</b>	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.
<b>Student</b>	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.
<b>Guest</b>	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"><li>■ Student</li><li>■ Instructor</li><li>■ Administrator</li></ul> <p><b>Note:</b> Only administrators can create administrator and instructor accounts. Students 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. <b>User ID</b> is helpful if you know you will want to search for user accounts with a unique identifier other than <b>User Name</b> .	19840408

## Add a New Account

Add an account for each student and instructor you want to train using 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 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**.
3. In the new account wizard, 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 should appear in the list of all users.

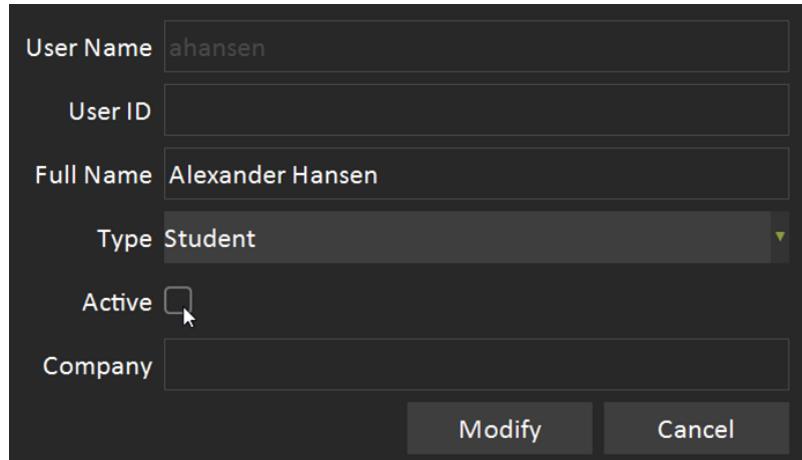
# Deactivating User Accounts

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 'Modify User' dialog box with the following fields:

- User Name: ahansen
- User ID: (empty)
- Full Name: Alexander Hansen
- Type: Student
- Active: (checkbox is unchecked)
- Company: (empty)

At the bottom are 'Modify' and 'Cancel' buttons.

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 Another Account

Before you can reset the password for another 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.

---

<b>Setting Up a New Class .....</b>	<b>42</b>
<b>Deleting Classes .....</b>	<b>43</b>

# Setting Up 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 two views of the 'Manage Classes' page. On the left, under the 'Users' section, a row for 'Michael Scott' is selected. On the right, under the 'Class' section, a row for '2018-Fall' is selected. A large green arrow points from the 'Users' section to the 'Class' section, indicating the flow of action. In the 'Actions' column of the 'Class' table, a 'Delete Class' button is highlighted with a mouse cursor.

Name	Company	Classes
Toby Flenderson	ACME Paper	2018-Fall, 2018-Summer
Stanley Hudson	ACME Paper	2018-Summer
Ryan Howard	ACME Paper	2018-Fall
Phyllis Lapin	ACME Paper	2018-Summer
Pam Beesly	ACME Paper	2018-Fall
Oscar Martinez	ACME Paper	2018-Spring
<b>Michael Scott</b>	ACME Paper	
Meredith Palmer	ACME Paper	2018-Summer
Kevin Malone	ACME Paper	2018-Fall
Kelly Kapoor	ACME Paper	2018-Summer

Name	Company	Actions
Pam Beesly	ACME Paper	<b>Delete Class</b>
Ryan Howard	ACME Paper	
Andy Bernard	ACME Paper	
Kevin Malone	ACME Paper	
Toby Flenderson	ACME Paper	

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. the students which 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.

The screenshot shows the 'Manage Classes' page. The 'Class' filter dropdown is open, showing '2018-Summer' as the selected option. A large green arrow points from the 'Users' section to the 'Class' section, indicating the flow of action. The '2018-Summer' class row is highlighted with a green background.

Name	Company	Classes
Oscar Martinez	ACME Paper	2018-Spring
Jim Halpert	ACME Paper	2018-Spring
Dwight Schrute	ACME Paper	2018-Spring
Angela Martin	ACME Paper	2018-Spring
Toby Flenderson	ACME Paper	2018-Summer
Stanley Hudson	ACME Paper	2018-Summer
Phyllis Lapin	ACME Paper	2018-Summer
Meredith Palmer	ACME Paper	2018-Summer
Kelly Kapoor	ACME Paper	2018-Summer
<b>Ryan Howard</b>	ACME Paper	
Pam Beesly	ACME Paper	
<b>Michael Scott</b>	ACME Paper	
Kevin Malone	ACME Paper	
Darryl Philbin	ACME Paper	

# Operating the Excavator

The operator uses physical and simulated controls to operate the excavator during training exercise.

To prepare operators for real equipment, foot pedals and joysticks are designed to replicate actual controls. The system Human Machine Interface (HMI) is simulated on a touch-sensitive screen near the operator seat. Instructors can see simulated controls from the instructor station on the **Operator Controls** page.

The system supports both SAE and ISO control standards. You can select a control standard from the HMI or the **Operator Controls** page.

<b>Selecting a Control Standard</b> .....	<b>45</b>
<b>Joysticks</b> .....	<b>46</b>
Joysticks (SAE) .....	47
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<b>Foot Pedals</b> .....	<b>51</b>
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# Selecting a Control Standard

To enhance training, the simulator lets instructors and operators become familiar with both ISO and SAE controls during exercise. From the **Operator Controls** page, you can select the standard you want to use during the exercise.

To select a control standard, from the **Operator Controls** page, do the following:

- To set the control standard to SAE, move the **ISO/SAE** switch up.
- To set the control standard to ISO, move the **ISO/SAE** switch down.



# Joysticks

The operator uses joysticks to operate the boom, arm, and bucket of the excavator. Buttons on the joysticks control the horn and power digging function.

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.

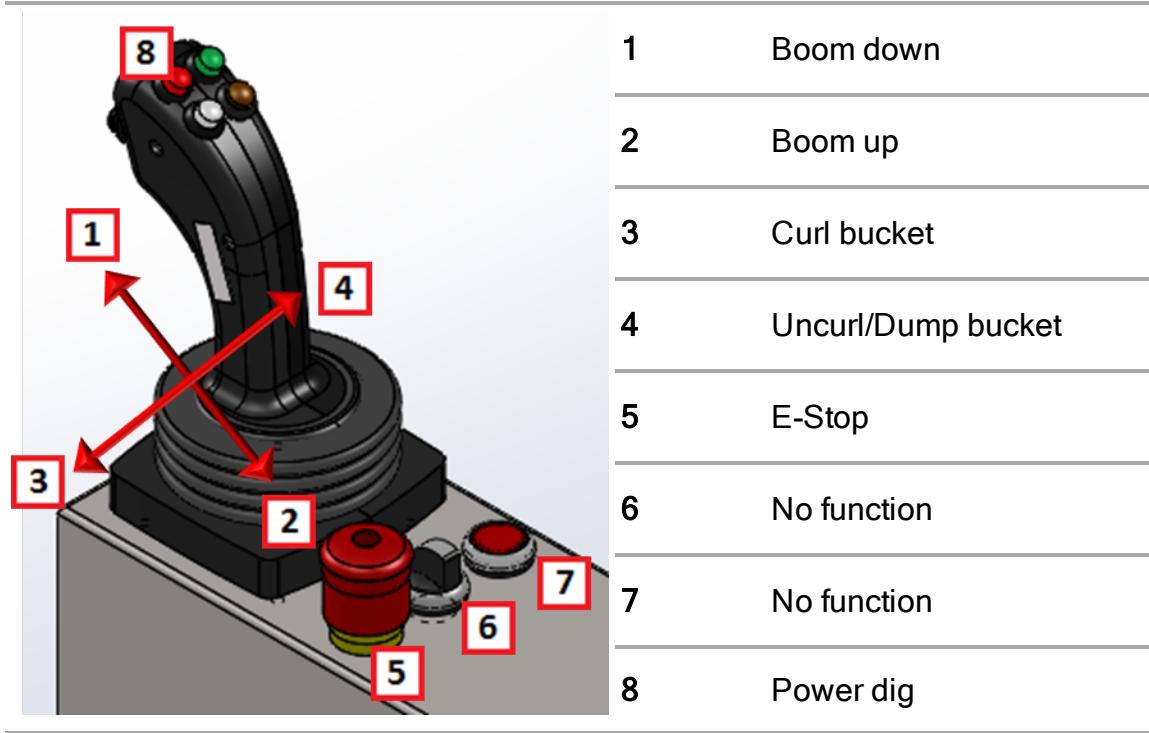
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Joysticks (SAE) .....	47
Joysticks (ISO) .....	49

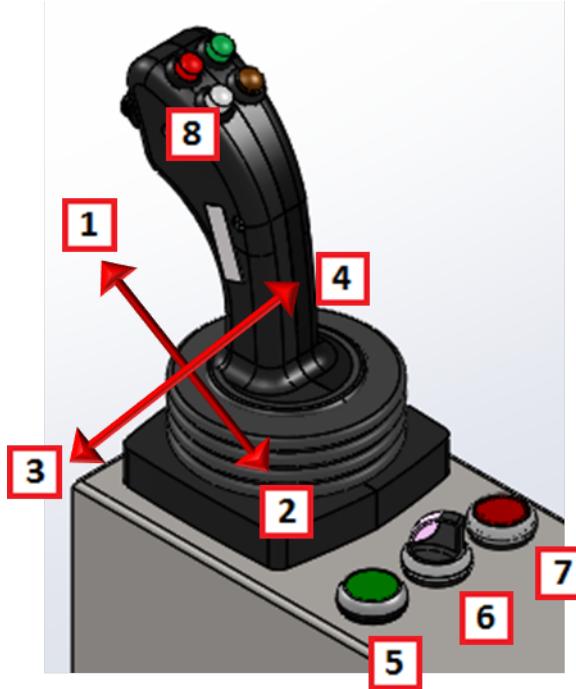
# Joysticks (SAE)

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

## Right Joystick (SAE)



## Left Joystick (SAE)

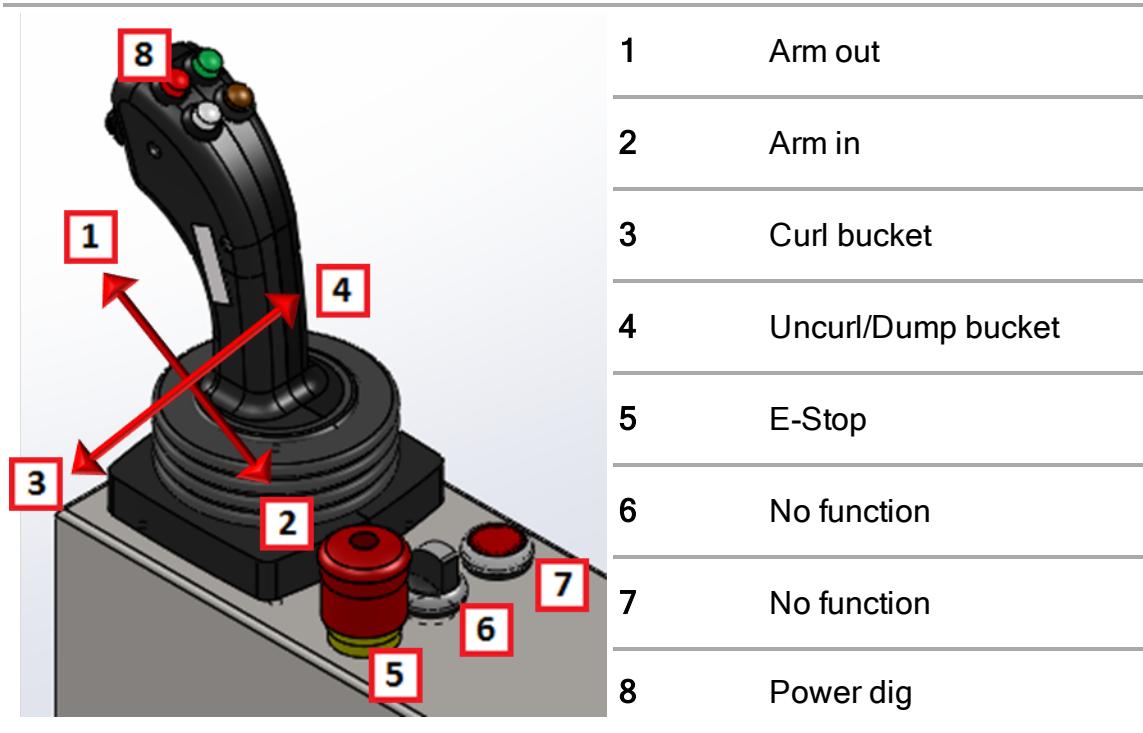


- |   |                   |
|---|-------------------|
| 1 | Arm out           |
| 2 | Arm in            |
| 3 | Swing left        |
| 4 | Swing right       |
| 5 | Start/Stop Engine |
| 6 | No function       |
| 7 | No function       |
| 8 | Horn              |

# Joysticks (ISO)

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

## Right Joystick (ISO)



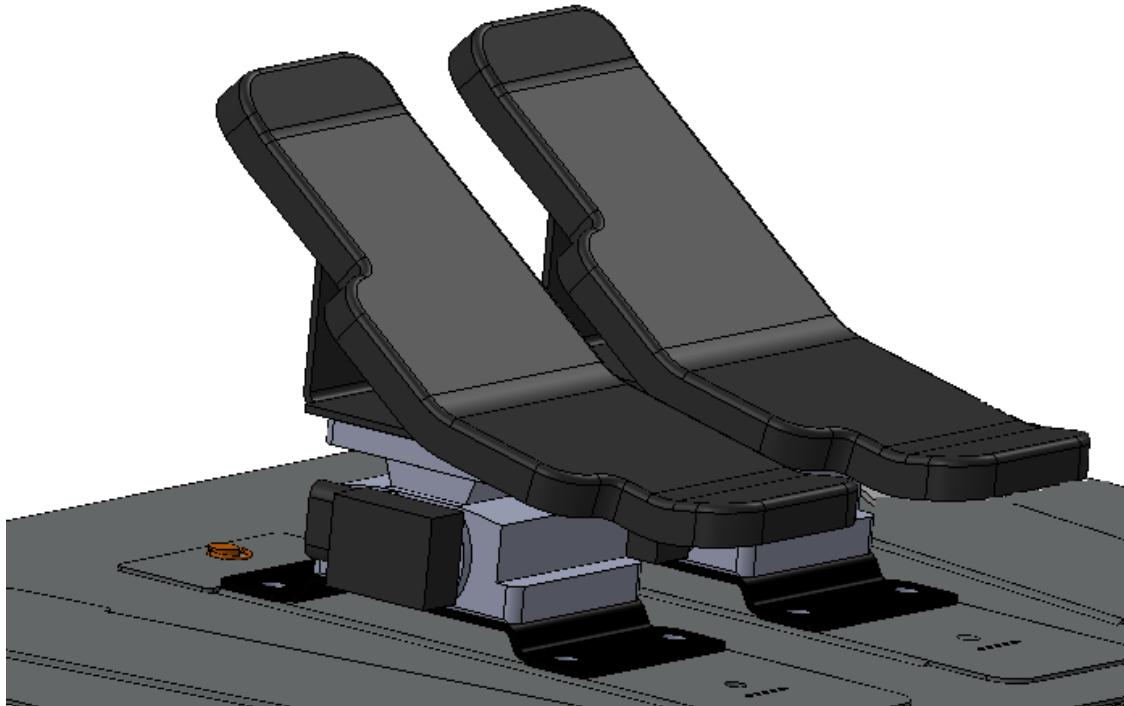
## Left Joystick (ISO)



- |   |                   |
|---|-------------------|
| 1 | Boom down         |
| 2 | Boom up           |
| 3 | Swing left        |
| 4 | Swing right       |
| 5 | Start/Stop Engine |
| 6 | No function       |
| 7 | No function       |
| 8 | Horn              |

# Foot Pedals

The operator uses bi-directional foot pedals brake and increase engine throttler.



Pedal	Function
Left	<ul style="list-style-type: none"><li>■ To move the left track forward, push pedal forward.</li><li>■ To move the left track backwards, press the pedal back.</li></ul>
Right	<ul style="list-style-type: none"><li>■ To move the left track forward, push pedal forward.</li><li>■ To move the right track backwards, push the pedal back.</li></ul>

# Simulated Excavator Controls and HMI

The **Operator Controls** page has switches and displays for the following:

- Selecting the control standard (ISO or SAE)
- Selecting the operating mode (slow or fast)
- Starting and stopping the engine.
- Changing engine RPM
- Monitoring current engine, gear, and fuel status.
- Controlling your view of the work site and operations.



# Engine Monitor and Rear Camera Display

The simulated monitor shows information about engine RPM, engine torque, fuel consumption, and the current gear and working mode. It also shows the rear camera display.



Display	Description
800 RPM	Current engine RPM
22 %	Current engine torque (% of total available)
2.9 L/h	Current rate of fuel consumption (in L/h)
Working Mode Power Mode Eco Mode High Power	Current working mode (Power Mode, Eco Mode, or High Power)
L	Shows travel speed (H for High, L for Low)

---

**A/I**

---

Shows when the Auto/Idle selector is ON.

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**PWR**

---

Shows current power mode (ECO, PWR, or H/P)

---



Rear Camera Display (shows the view from the rear of the excavator).

---

# Controls and Switches

The following controls and switches are simulated on the [Operator Controls](#) page:

Control	Description
	Engine Start and Stop Press to start and stop the engine.
	Control Mode Selector Select a control standard for the joysticks (ISO or SAE).
	Travel Gear Select the travel gear (Low or High)
	Auto/Idle Selector Select to cause the engine to automatically return to idle if the operator does not move the arm or tracks for four seconds and the current engine RPM is greater than 1200.
	Lights Select to turn on working lights.

Control	Description
	Engine Throttle Drag the control right or left to increase or decrease engine throttle (RPM)

# Operator View Controls

Operators can use controls on the HMI to change their perspective of the work site or exit the cab and walk around.



Control	Description
	Press to turn on the Grade Quality Sensor.
	Press to exit the cab and use controls to walk around the work site.
	Move the knob to tilt the point of view.
	Press to move the point of view left.
	Press to move the point of view right.
	Press to follow the primary view of excavator operations.



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.

---



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.

---

# 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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<b>Assigning an Exercise to a Student .....</b>	<b>60</b>
<b>Scoring .....</b>	<b>61</b>
<b>Changing Weather Conditions in the Environment .....</b>	<b>66</b>
<b>Monitoring Performance .....</b>	<b>69</b>
<b>Evaluating and Ending the Exercise .....</b>	<b>77</b>
<b>Understanding Reports .....</b>	<b>80</b>

# 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.

# Scoring

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.

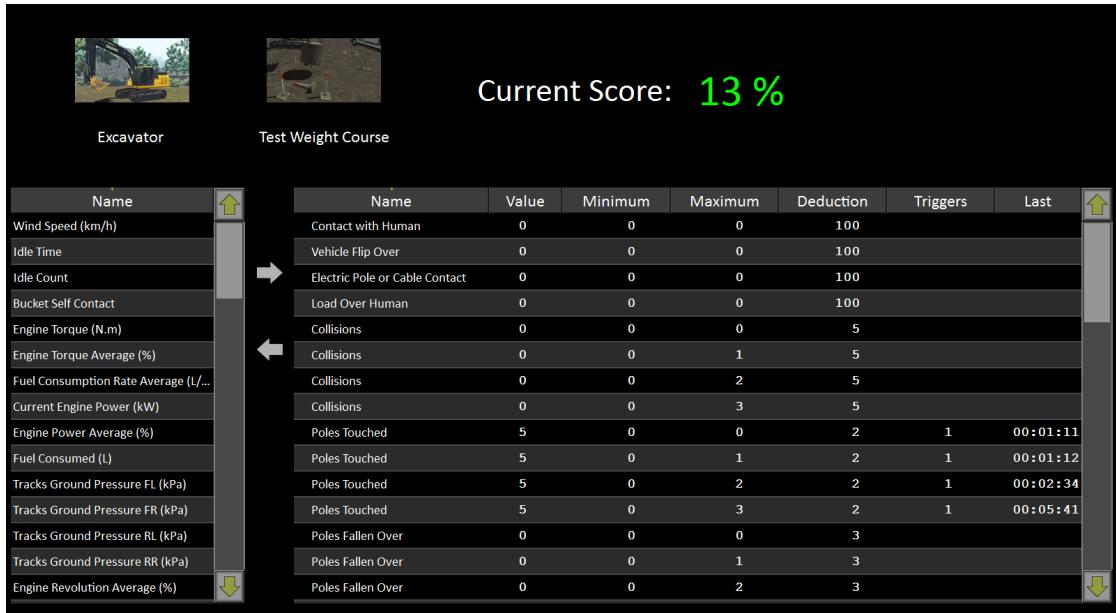
For example, for the Test Weight Course exercise, you can specify the chain on the test weight must not leave the ground more than two times during the exercise, and deduct 20% from the final score if it does.

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.

# The Scoring Page

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

## Example of a Scoring Page



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.

For each metric, the system displays the following information:

Column Head	Description
<b>Value</b>	The current system measurement for the metric.
<b>Minimum</b>	The lower limit of the threshold the system uses to assess operator performance for the metric.
<b>Maximum</b>	The upper limit of the threshold the system uses to assess operator performance for the metric.
<b>Deduction</b>	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.
<b>Triggers</b>	The number of times the value for the metric was outside the defined threshold.

Column Head	Description
Time	The time stamp of the last trigger.

# Customize Scoring Criteria

**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 and start the exercise you want to customize settings for.
3. On the side menu, click **Settings** and then click **Scoring**.

The system displays the default scoring settings for the exercise, and the current score for the exercise.

4. In the **Name** list, click the metric you want to customize settings for and then click the arrow button to move it to the list of metrics the system uses to score the exercise.
5. For each column, click to select and then enter custom values for the following:

<b>Minimum</b>	Type a minimum value for the threshold.
<b>Maximum</b>	Type a maximum value for the threshold.
<b>Deduction</b>	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 criteria immediately.

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

# Restore Default Scoring Settings

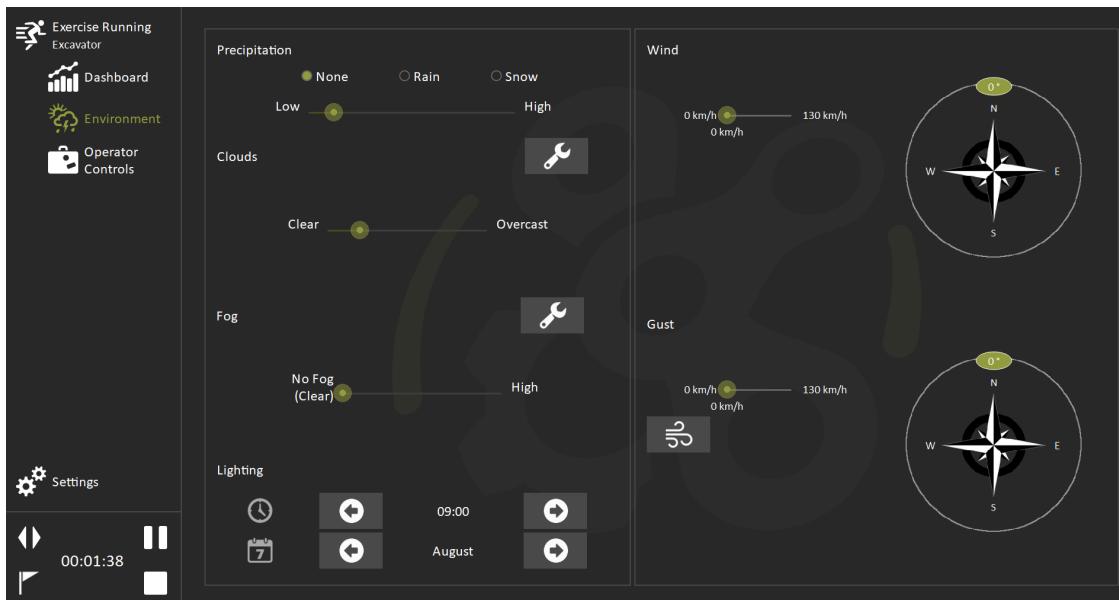
System Administrators can restore scoring settings to system defaults at any time. To reset scoring settings, do the following:

**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.

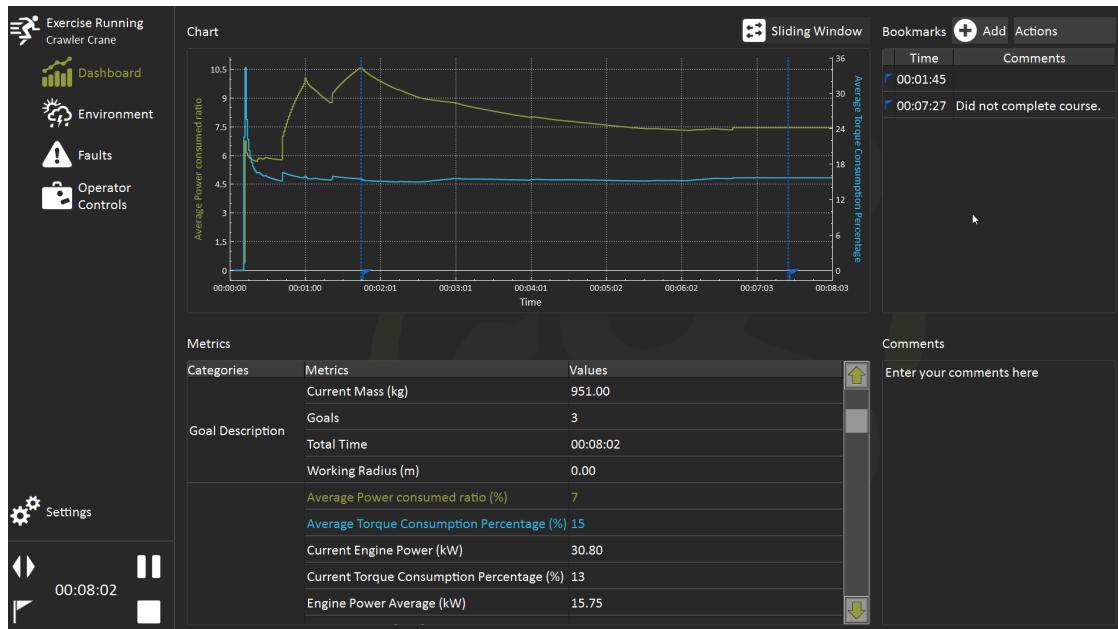
## To Adjust Lighting

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
<b>Metrics</b>	View various statistics for assessing performance during the training exercise. Click any metric to plot it over time in the <b>Chart</b> pane.
<b>Chart</b>	Plot any metrics you select in the <b>Metrics</b> 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>

# Excavator 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
Bucket Angle (°)	The current bucket angle (0° is parallel to the ground).
Bucket Capacity (kg)	The amount of material, in kg, currently in the bucket.
Bucket Efficiency (ton/L)	Calculated value which shows the amount of material moved over the amount of fuel the engine consumed in the same period of time.
Bucket Efficiency Average (ton/L)	The average bucket efficiency over the time elapsed in the exercise.
Bucket Height (m)	The distance from the lowest point of the bucket to the ground, in meters.
Bucket Over Cabin	The number of times the bucket passed over the truck cabin during the exercise.
Bucket Self Contact	The number of times the bucket touched the tracks or body of the excavator.
Collisions	The number of times the excavator collided objects in the work site.
Contact with Human	The number of times any part of the excavator touched a human avatar in the work site.
Critical Collisions	The number of collisions which the system characterized as Critical during the exercise.
Current Engine Power (kW)	The current amount of engine power consumed, in kW.
Current Score	The current score (expressed as percentage), as calculated using predefined scoring criteria for the exercise.

Metric	Description
Cycle Distance (m)	The number of times the dump truck drove on to the lower part of the bench. (Indicates that the operator did not signal the truck to stop in time.)
Cycle Distance Average (m)	The average distance the bucket traveled between the pile and the dump truck during each cycle during the exercise, in meters.
Cycle Duration (s)	The amount of time, in seconds, from when the operator fills the bucket to when the bucket is emptied.
Dump Truck Mass (kg)	The recorded mass (kg) in the dump truck when the operator signals the truck to leave.
Dump Truck Contacts with Bench	The number of times the dump truck drove on to the lower part of the bench. (Indicates that the operator did not signal the truck to stop in time.)
Dump Truck Contact	The number of times any part of the excavator touched the dump truck.
Electric Pole or Cable Contact	The number of times the equipment came into contact with an electric pole or cable during the exercise. (Critical safety violation. The exercise ends automatically.)
Engine Revolution (RPM)	The current engine RPM.
Engine Power Average (%)	The average amount of engine power consumed over the time elapsed during the exercise, in kW.
Engine Torque Average (%)	The average amount of torque consumed over the time elapsed during the exercise.
Fuel Consumed (L)	The current amount of fuel consumed, in liters.
Fuel Consumption Rate Average (L/h)	The average amount of fuel consumed per hour over the time elapsed in the exercise, in liters per hour.
Goals	The number of goals which the operator completed.

Metric	Description
Idle Count	The number of times the operator let the engine idle during the exercise.
Idle Time (s)	The total amount of time the engine was idle during the exercise.
Load Over Human	The number of times the operator let a load move over a human avatar on the ground.
Loading Average Cycle Time (s)	The average time the operator used to complete each loading cycle (from the pile to the truck) during the exercise.
Loading Cycle Time Total Duration (s)	The total time the operator spent loading material (moving it from the pile to the truck) during the exercise.
Loading Cycle Total Distance (m)	The total distance the operator traveled to complete the current loading cycle (from the pile to the truck).
Operating Ratio (%)	The total distance the operator traveled to complete the current loading cycle (from the pile to the truck).
Safe Parking Position	The total distance the operator traveled to complete the current loading cycle (from the pile to the truck).
Spill-off Quantity	The amount of material which spills from the bucket during loading cycles, in kg.
Total Excavated (kg)	The total amount of material the operator was able to excavate during the exercise, in kg.
Total Excavated Mass (kg)	The total amount of material the operator was able to excavate during the exercise, in kg.
Total Number of Cycles	The total number of loading cycles (from the pile to the truck) the operator needed to complete all the goals in the exercise.
Total Time (s)	The total time elapsed during the exercise.
Total Ground Pressure FL (kPa)	The load applied to the front of the left track.

Metric	Description
Total Ground Pressure FR (kPa)	The load applied to the front of the right track.
Total Ground Pressure RL (kPa)	The load applied to the rear of the left track.
Total Ground Pressure RR (kPa)	The load applied to the rear of the right track.
Trucks per Hour	The number of trucks per hours which the operator fills during the exercise.
Vehicle Flip Over	The number of times the operator flips the excavator over during the exercise.
Wind Speed	The current wind speed in the environment.
Penalty	( <i>Excavator Rodeo exercise only</i> ) The amount of time added to the operator's score as a penalty for dropping a ball (+ 1 minute) or knocking a cone (+ 9 seconds).
Time Score	( <i>Excavator Rodeo exercise only</i> ) The operator's current time score, including penalties.

# Graphing Performance Metrics

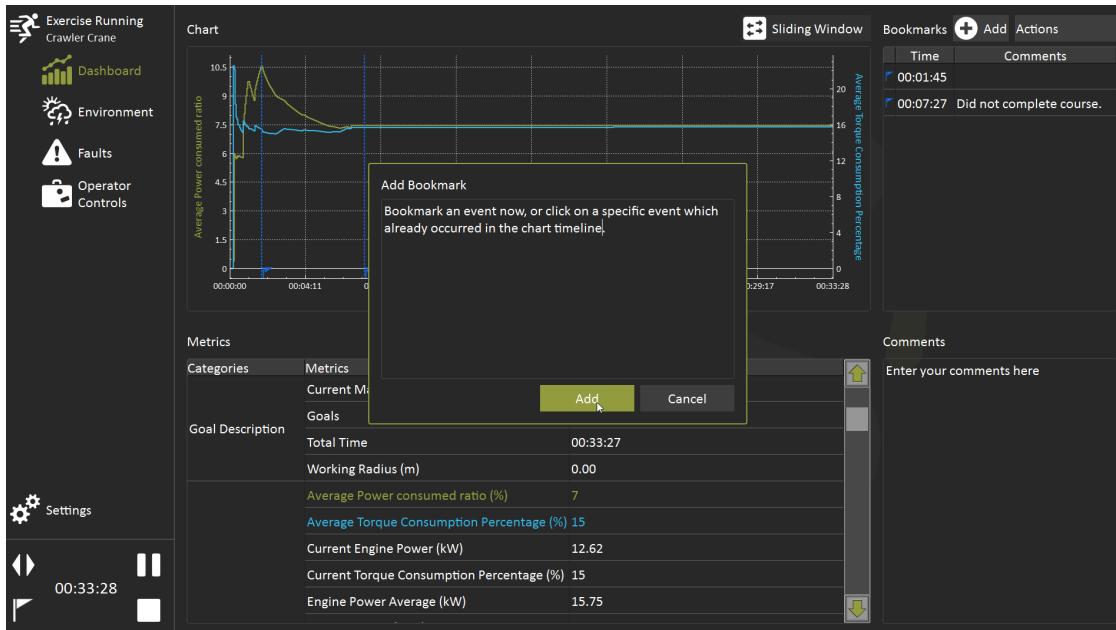
Plotting performance metrics which the system records for each a training session on a graph can offer insights into whether a student is improving certain skills through practice. You can plot up to two performance metrics over the time elapsed since the training exercise began, or the past 120 seconds,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

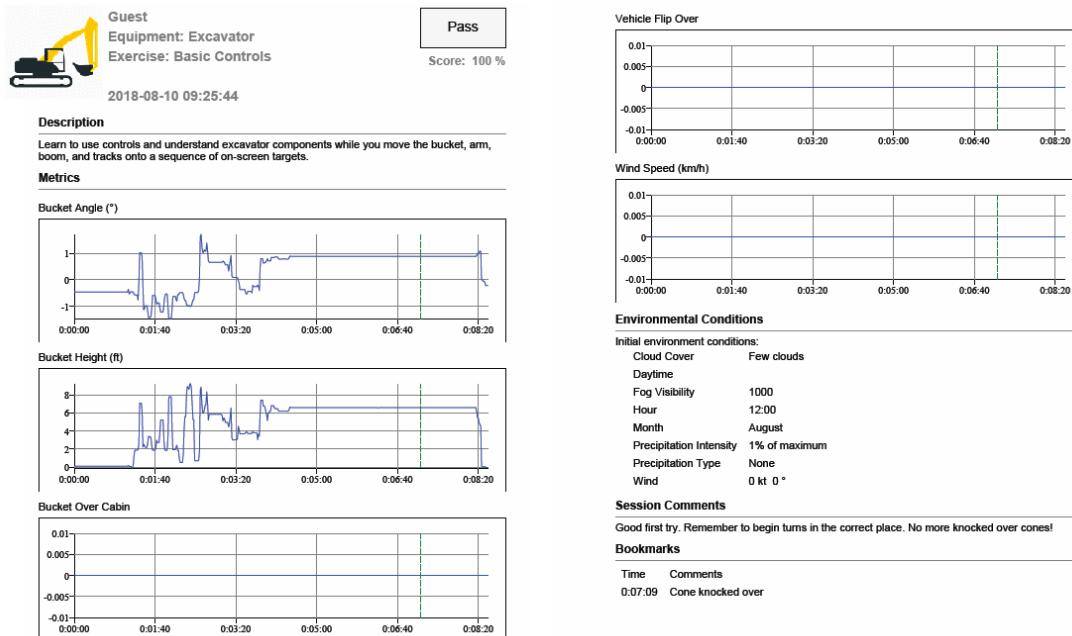
The system lets you bookmark an event which is occurring now, or an event that occurred previously in the session.

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

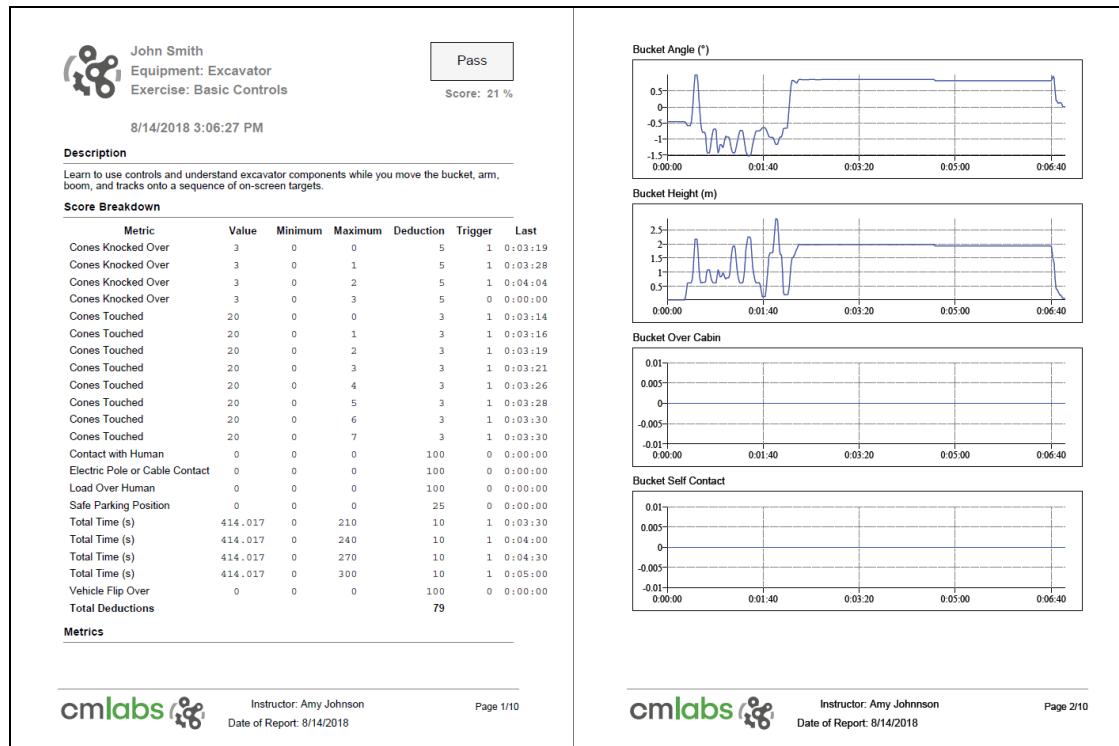
Once the operator completes the tasks in the exercise, the instructor can end the exercise from the instructor station as follows:

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, *Excavator*)
- 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: **Scoring** , on page 61

# 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 1: 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:

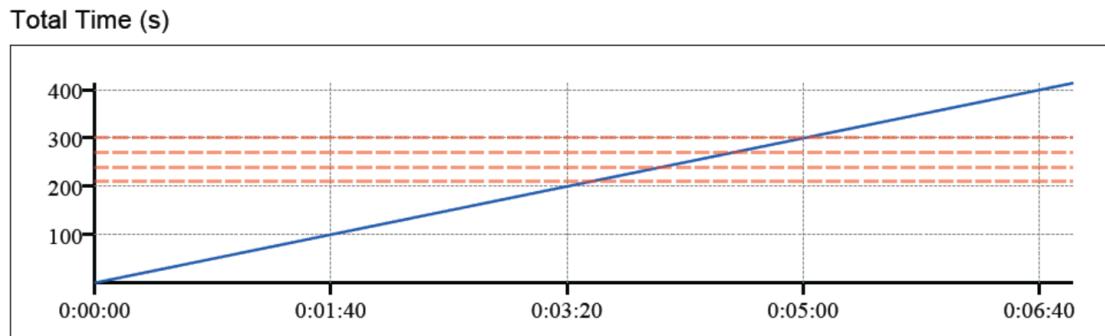
**Score Breakdown**

Metric	Value	Minimum	Maximum	Deduction	Trigger	Last
Cones Knocked Over	3	0	0	5	1	0:03:19
Cones Knocked Over	3	0	1	5	1	0:03:28
Cones Knocked Over	3	0	2	5	1	0:04:04
Cones Knocked Over	3	0	3	5	0	0:00:00
Cones Touched	20	0	0	3	1	0:03:14
Cones Touched	20	0	1	3	1	0:03:16
Cones Touched	20	0	2	3	1	0:03:19
Cones Touched	20	0	3	3	1	0:03:21
Cones Touched	20	0	4	3	1	0:03:26
Cones Touched	20	0	5	3	1	0:03:28
Cones Touched	20	0	6	3	1	0:03:30
Cones Touched	20	0	7	3	1	0:03:30
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	25	0	0:00:00
Total Time (s)	414.017	0	210	10	1	0:03:30
Total Time (s)	414.017	0	240	10	1	0:04:00
Total Time (s)	414.017	0	270	10	1	0:04:30
Total Time (s)	414.017	0	300	10	1	0:05:00
Vehicle Flip Over	0	0	0	100	0	0:00:00
<b>Total Deductions</b>				<b>79</b>		

## 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.



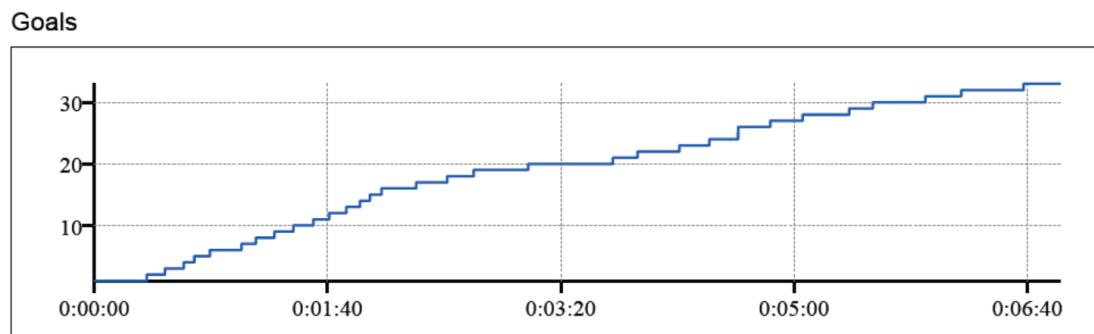
Dashed lines show the values where the system deducts points according to configured scoring rules. In this example, the system deducts 10 points when the operator exceeds 210 seconds, 240 seconds, 270 seconds, and 300 seconds.

## 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.

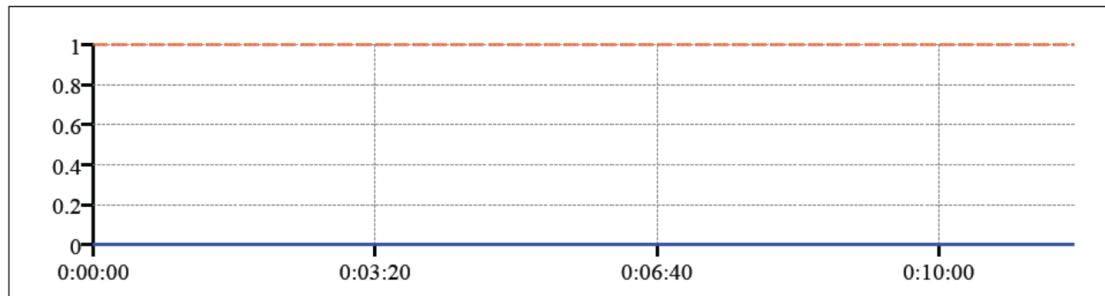


## Bucket Self Contact

The number of times the bucket touched the tracks or body of the excavator.

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

Bucket Self Contact



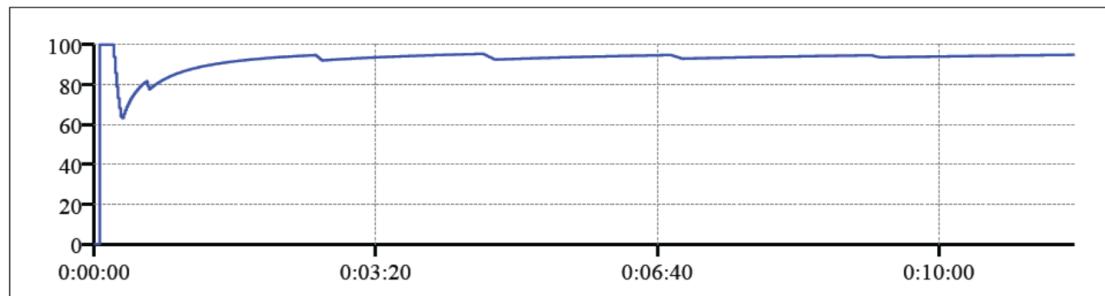
The dashed line shows the value where the system deducts points according to configured scoring rules. In this example, the system would deduct points if the bucket touched the excavator or tracks one time.

### 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 (%)

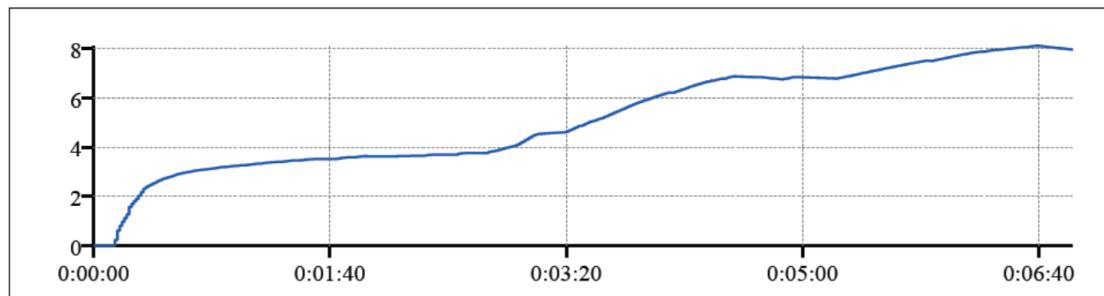


### Fuel Consumption Average

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)

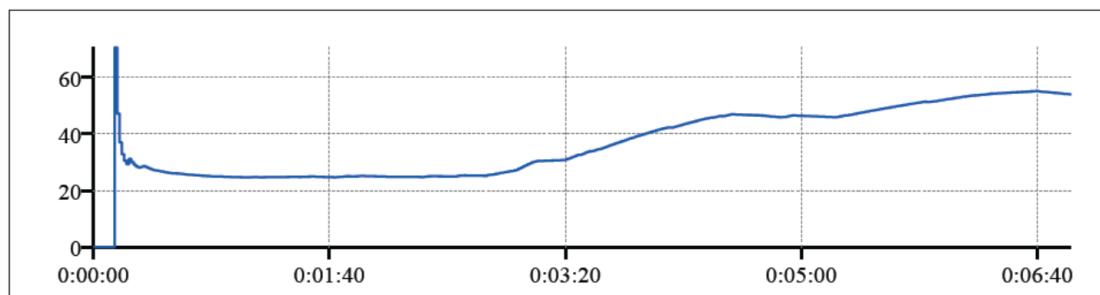


### Engine Torque Average

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 excavator through the slalom course.

Engine Torque Average (%)



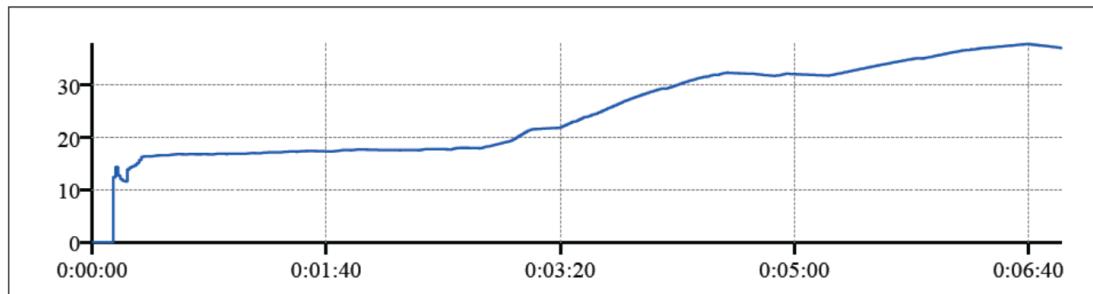
### Engine Power Average

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 poser 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 excavator through the slalom course.

Engine Power Average (%)

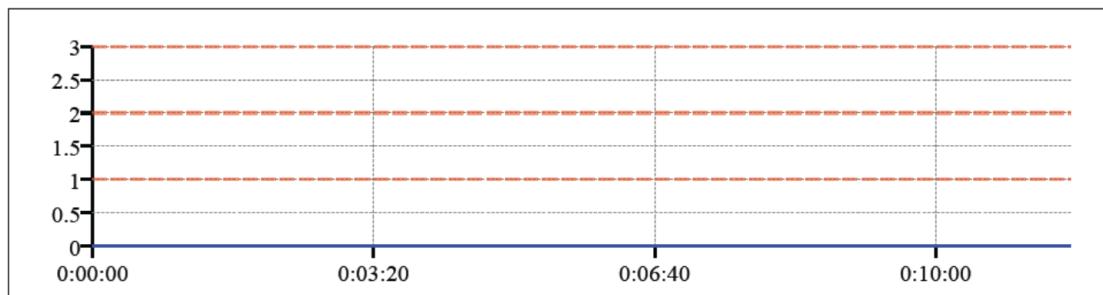


## Collisions

The number of times the excavator contacted objects in the work site.

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

Collisions



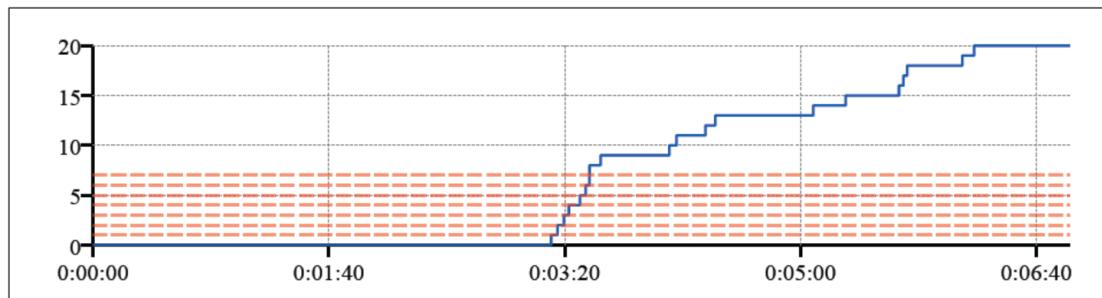
The dashed lines show the values where the system deducts points according to configured scoring rules. In this example, the system deducts points each time the excavator collides with an object.

## Cones Touched

The number of cones the excavator touched during the exercise.

The graph shows that for the duration of the exercise (x-axis), the excavator touched 20 cones (y-axis).

**Cones Touched**



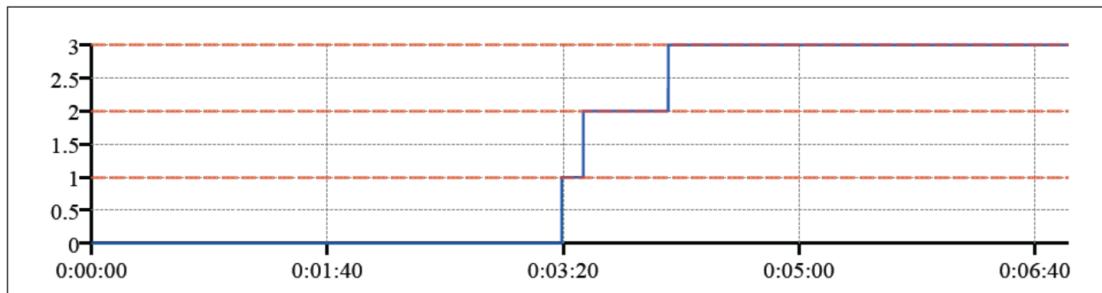
The dashed lines show the values where the system deducts points according to configured scoring rules. In this example, the system deducts points each time the excavator touches a cone (up to seven times).

### Cones Knocked Over

The number of cones the excavator touched during the exercise.

The graph shows that for the duration of the exercise (x-axis), the excavator 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 excavator knocks over a cone.

## Example 2: Bench Loading Scoring and Metrics Report

A scoring summary at the end of the exercise shows values for the metrics which the system used to evaluate operator performance during the exercise.

Bench Loading	
🏁 Scenario Results	
Total Time	00:11:36
Goals	20
Operating Ratio	94 %
Fuel Consumed (L)	2.20
Dumptruck Contact	0
Trucks per Hour	140
Bucket Capacity Total	103066.86 kg
Bucket Efficiency Average (ton/hr)	522.84
Bucket Efficiency Average (ton/L)	48.17
Spill off Quantity	1600.81 kg
Total Number of Cycles	8
Loading Cycle Time Total Duration	00:00:36
Loading Average Cycle Time	00:00:04
Loading Cycle Total Distance	0.69 m
Cycle Distance Average	0.09 m
Total Excavated	0.00 kg
Total Excavated Mass	103066.86 kg
Dump Truck Contacts with Bench	3
Dump Truck 1 Mass	12670.17 kg
Dump Truck 2 Mass	12282.46 kg
Dump Truck 3 Mass	12654.68 kg
Dump Truck 4 Mass	12951.33 kg
Dump Truck 5 Mass	13285.97 kg

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

### Score Breakdown

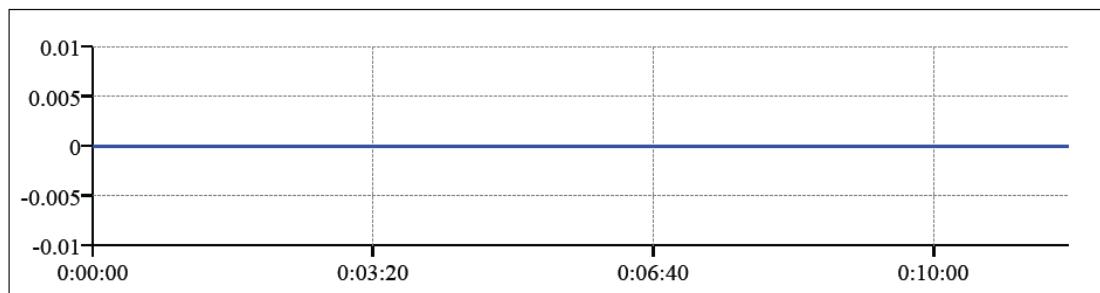
Metric	Value	Minimum	Maximum	Deduction	Trigger	Last
Bucket Over Cabin	0	0	0	100	0	0:00:00
Bucket Self Contact	0	0	0	10	0	0:00:00
Bucket Self Contact	0	0	1	10	0	0:00:00
Collisions	0	0	0	5	0	0:00:00
Collisions	0	0	1	5	0	0:00:00
Collisions	0	0	2	5	0	0:00:00
Collisions	0	0	3	5	0	0:00:00
Contact with Human	0	0	0	100	0	0:00:00
Dump Truck Contacts with Bench	3	0	0	5	1	0:03:56
Dumptruck Contact	0	0	0	10	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	25	0	0:00:00
Total Time (s)	696.017	0	1200	10	0	0:00:00
Total Time (s)	696.017	0	1500	10	0	0:00:00
Total Time (s)	696.017	0	1800	10	0	0:00:00
Total Time (s)	696.017	0	2100	10	0	0:00:00
Vehicle Flip Over	0	0	0	100	0	0:00:00
<b>Total Deductions</b>				<b>5</b>		

### Bucket Over Cabin

The number of times the bucket passed over the truck cabin during the exercise.

The graph shows that over the duration of the exercise (the x-axis), the operator did not move the bucket over the cabin of the dump truck (blue line shows a value of 0 on the y-axis for the duration of the exercise).

Bucket Over Cabin

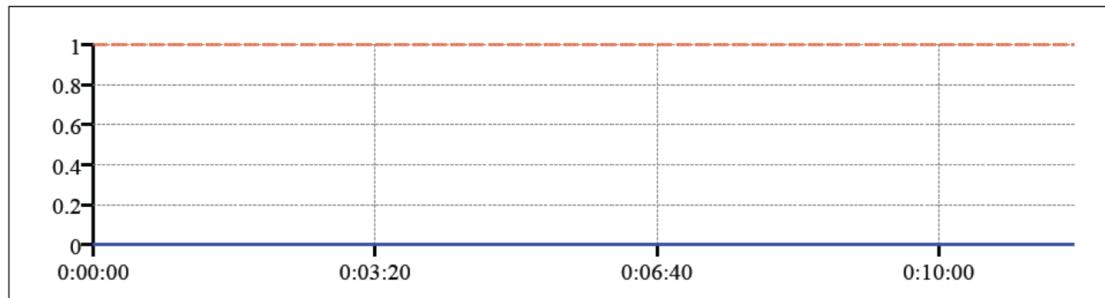


## Bucket Self Contact

The number of times the bucket touched the tracks or body of the excavator.

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

Bucket Self Contact

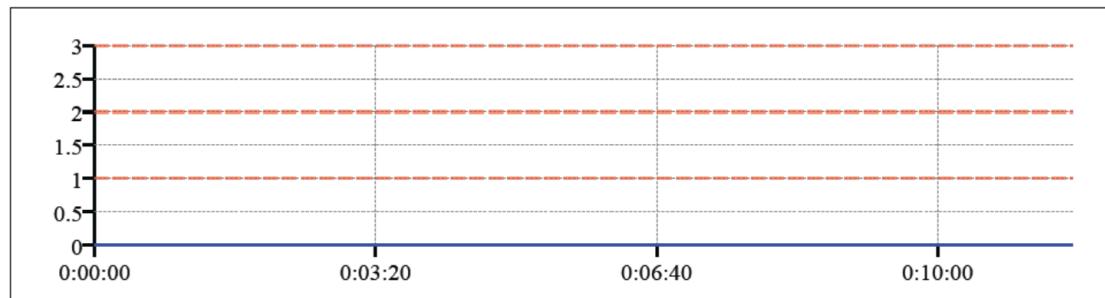


The dashed line shows the value where the system deducts points according to configured scoring rules. In this example, the system would deduct points if the bucket touched the excavator or tracks one time.

## Collisions

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

Collisions



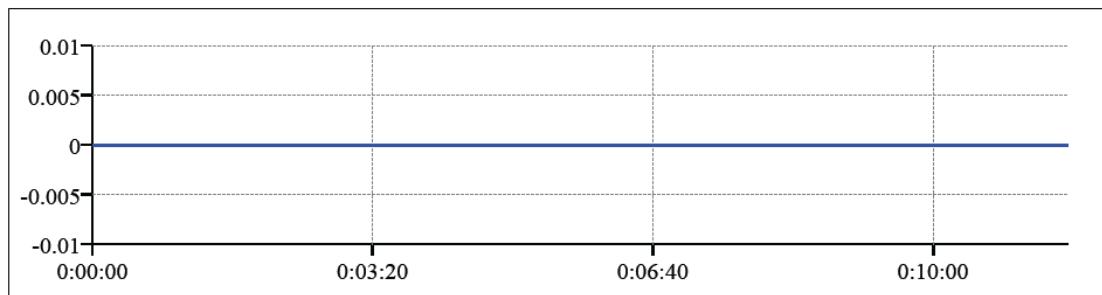
The dashed lines show the values where the system deducts points according to configured scoring rules. In this example, the system deducts points each time the excavator collides with an object.

## Contact with Human

The number of times any part of the excavator touched a human avatar in the work site. (The exercise ends immediately when the excavator touches a human avatar.)

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

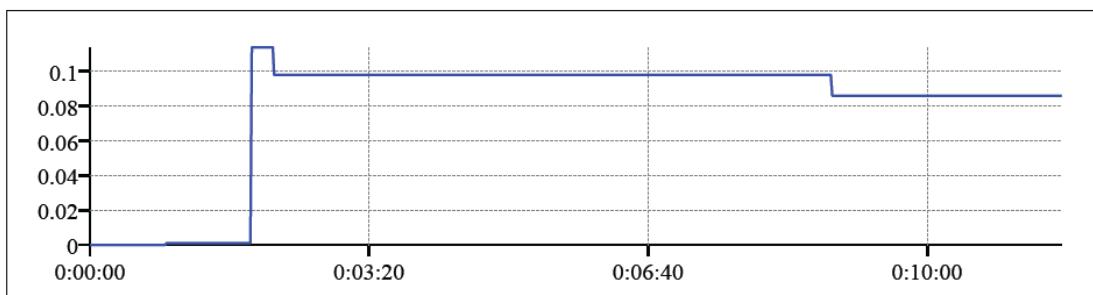
Contact with Human



## Cycle Distance Average

The average distance the bucket traveled between the pile and the dump truck during each cycle during the exercise, in meters.

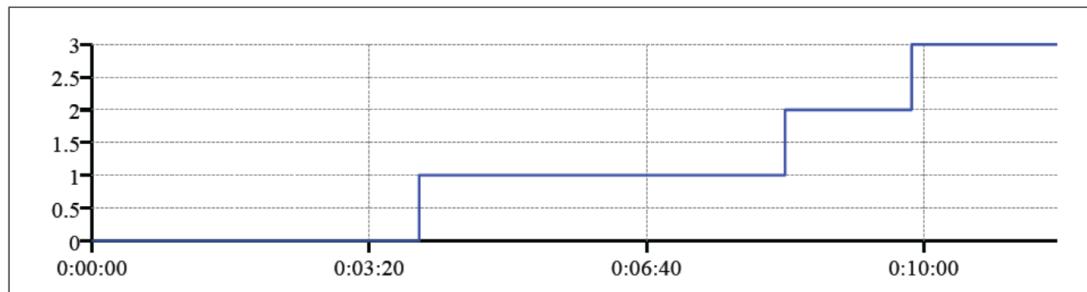
Cycle Distance Average (m)



## Dump Truck Contact with Bench

The number of times the dump truck drove on to the lower part of the bench.  
(Indicates that the operator did not signal the truck to stop in time.)

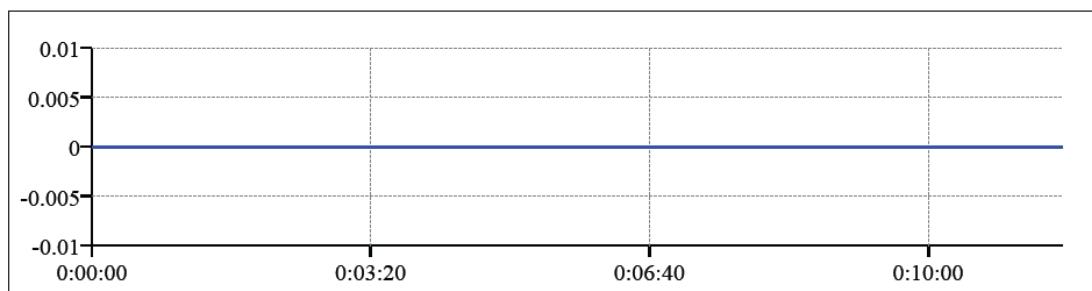
Dump Truck Contacts with Bench



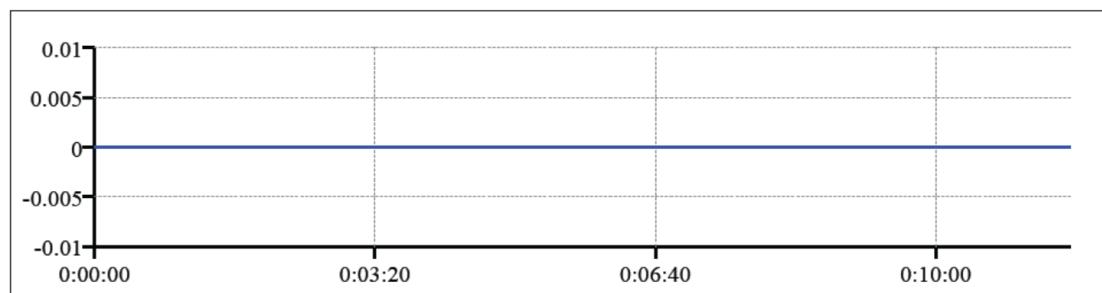
## Dump Truck Contact

The number of times the equipment came into contact with an electric pole or cable during the exercise.

Dumptruck Contact



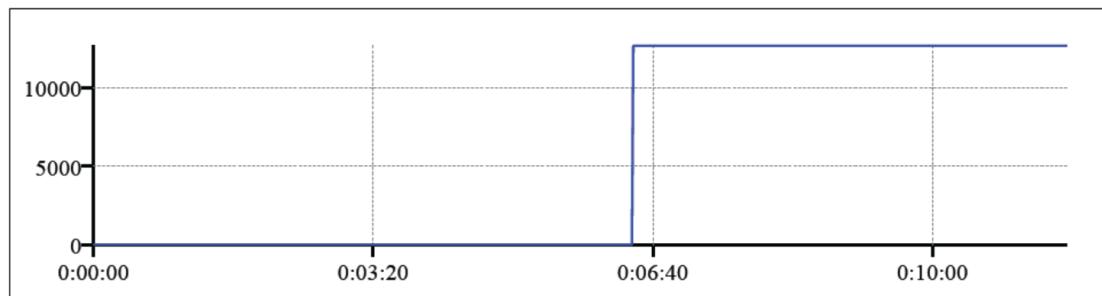
## Electric Pole or Cable Contact



## Dump Truck Mass

The recorded mass (kg) in the dump truck when the operator signals the truck to leave.

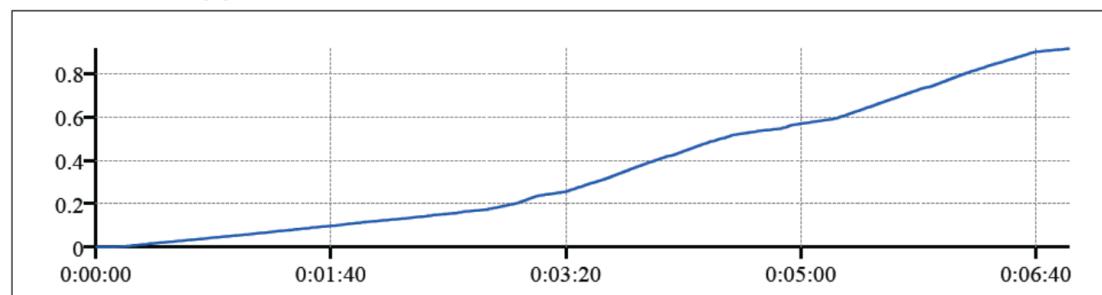
Dump Truck 3 Mass (kg)



## Fuel Consumed

The current amount of fuel consumed, in liters.

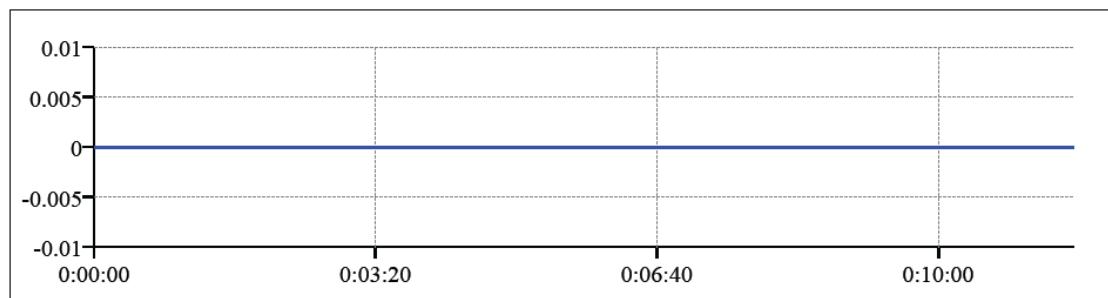
Fuel Consumed (L)



## Load Over Human

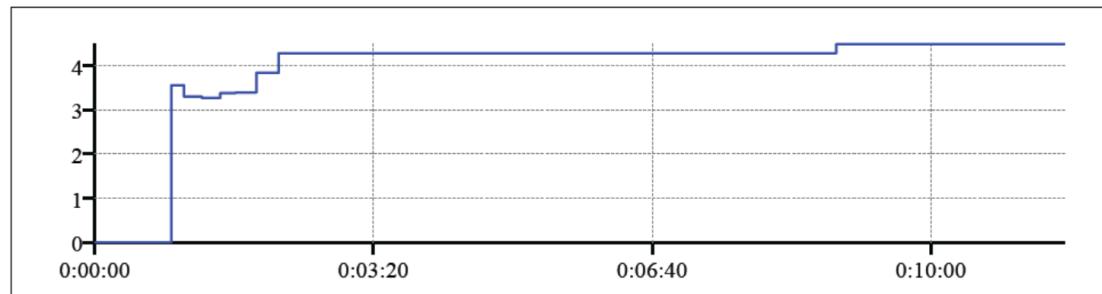
The number of times the operator let a load move over a human avatar on the ground.

Load Over Human



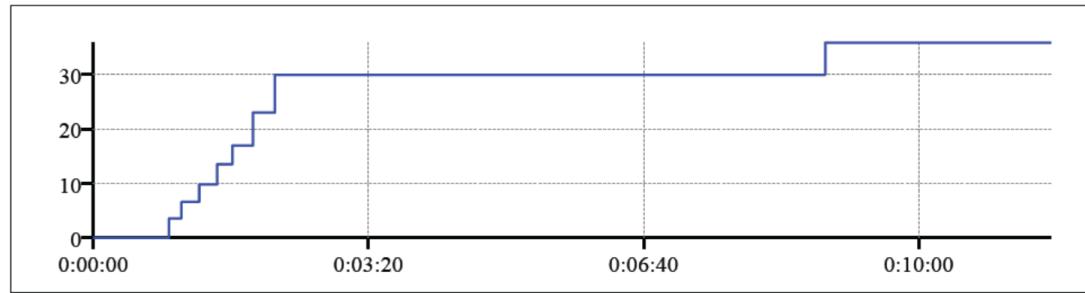
The average time the operator used to complete each loading cycle (from the pile to the truck) during the exercise.

Loading Average Cycle Time (s)



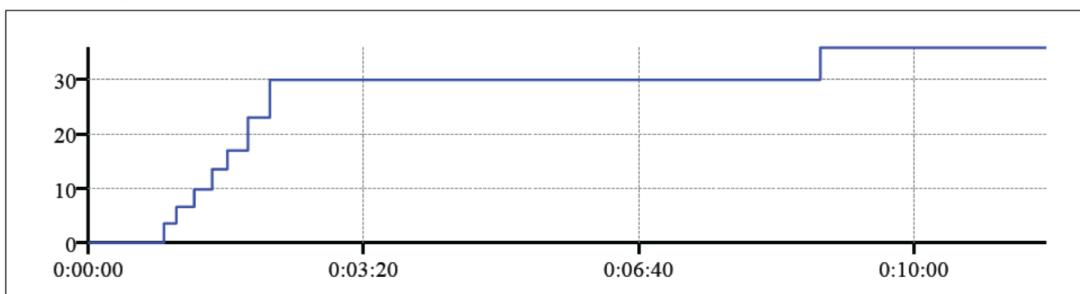
The total time the operator spent loading material (moving it from the pile to the truck) during the exercise.

Loading Cycle Time Total Duration (s)



The total distance the operator traveled to complete the current loading cycle (from the pile to the truck).

Loading Cycle Time Total Duration (s)



# **Excavator Training Exercises**

Excavator training exercises are designed to help instructors demonstrate main excavator components and functions, as well as use basic control techniques to perform everyday operations.

Operators can choose from the following exercises:

<b>Basic Controls</b> .....	97
<b>Arc Swipe</b> .....	101
<b>Loading and Unloading Trailer</b> .....	104
<b>Trenching</b> .....	109
<b>Bench Loading</b> .....	112
<b>Pipe Placement</b> .....	116
<b>Test Weight</b> .....	121
<b>Excavator Rodeo</b> .....	125
<b>Sandbox</b> .....	128

# Basic Controls

Operators learn to use controls in different combinations to move the parts of the arm and drive through a slalom course on tracks. Each goal is more difficult than the last. At the end of the exercise, the operator must lower the bucket to secure the excavator in a parked position.



# Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
<ul style="list-style-type: none"><li>■ Distinguish controls and excavator functions.</li><li>■ Position the bucket accurately.</li><li>■ Move the bucket along the best path between targets.</li></ul>	<p>Operators must use Arm, Boom, Bucket, and Swing controls to position the bucket on a sequence of targets.</p> <p>The system scores operators on their ability to move the bucket along the optimal path to each target, without overcompensating or over-correcting.</p> <p>An on-screen status display is updated each time the operator completes a goal.</p>
Accurately steer and travel on tracks	<p>Operators must use pedals to drive across a course which is lined by cones.</p> <p>Traveling to each target requires the operator to use forward and backward pedals in various combinations to steer.</p>
Show knowledge of the spatial relationship between the excavator, targets, and objects in the work site.	<p>The system realistically simulates equipment and the work site under different lighting and weather conditions.</p> <p>On-screen tips tell the operator to look at shadows to estimate the distance between the bucket and the ground.</p>

Goal	Methodology
<p>Make sure the excavator and bucket are always a safe distance from objects, personnel, and utilities.</p>	<p>The system warns operators to look for objects and persons in the work site before they start tasks.</p> <p>On-screen tips tell operators to use caution when they rotate the upperstructure clockwise and to rotate counterclockwise when possible.</p> <p>Operators use mirrors and back-up cameras when they reverse the excavator or rotate the upperstructure.</p> <p>Reports show all collisions between the excavator and objects in the work site.</p>
<p>Demonstrate understanding of equipment components and limitations.</p>	<p>To complete the exercise, operators must use controls accurately to move the arm and bucket to the correct positions.</p> <p>On-screen tips warn operators not to hit the limits of the hydraulic cylinders, and to use smooth, continuous movements to keep cylinders in good condition.</p>

## Exercise Workflow

When the exercise starts, the excavator is parked a few meters away from a course which is marked by cones.

To complete the exercise, the operator does these things.

1. To start the exercise, press and hold the Horn button.
2. Follow on-screen instruction to complete these activities:

Task	Description
Bucket targets	Use controls to position the bucket on targets.
Driving position	Position the bucket on a target to prepare for travel.

Task	Description
Move forward	<ul style="list-style-type: none"> <li>a. Use foot pedals to move forward on the path.</li> <li>b. Steer the excavator through the course, following on-screen arrows.</li> <li>c. Stop the excavator on the target at the end of the course.</li> </ul>
Rotate upperstructure	Follow on-screen targets to rotate the upperstructure of the cab.
Move in reverse	<ul style="list-style-type: none"> <li>a. Use foot pedals to move in reverse through the path.</li> <li>b. Steer the excavator in reverse through the course, following on-screen arrows.</li> <li>c. Stop the excavator on the target at the start of the course.</li> </ul>
Parked position	Position the bucket on the ground to secure the excavator.

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

# Arc Swipe

Operators use the bucket to trace on-screen arcs which become more difficult as the exercise continues. To trace each arc, the operator must control the bucket, arm, and boom at the same time. When operators move away from the on-screen arcs, a timer encourages the operator to return to the arc or start the exercise again.



# Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Control the boom, arm, and bucket at the same time to accurately trace arcs.	To satisfactorily follow the path of on-screen arcs, operators must make smooth, continuous movements using multiple controls at the same time. Arcs become more difficult as the exercise continues.
Show understanding of the relationship between component dimensions and joint angles of the excavator arm.	When operators move away from the on-screen arcs, a timer encourages the operator to return to the arc or start the exercise again.
Transition between movements smoothly.	To complete the exercise, operators perform basic movements and complex movements to simulate grazing the ground and pouring material.
Move the bucket with accuracy, without hitting any of the obstacles around the excavator.	Objects around the excavator force the operator to use caution and move the bucket accurately. The system records all collisions.
Safely turn the upperstructure clockwise	For some goals, the operator must rotate the upperstructure clockwise and be careful to not hit objects in the work area.

# Exercise Workflow

When the exercise begins, the excavator is in the center of a work site, surrounded by obstacles.

To successfully complete the exercise, the operator does these things.

1. To begin the exercise, press and hold the Horn button.
2. Following on screen instructions, complete these arc motions:

Task	Description
<b>Basic Movements</b>	<p>Follow on-screen indicators to trace these arcs:</p> <ul style="list-style-type: none"><li>■ Horizontal (turn)</li><li>■ Horizontal (extend arm)</li><li>■ Vertical (back and down)</li></ul>
<b>Combination Movements</b>	<p>Follow on-screen indicators to trace these arcs:</p> <ul style="list-style-type: none"><li>■ Over the bin</li><li>■ In front of the truck</li></ul>
<b>Complex Movements</b>	<p>Follow on-screen indicators to trace these arcs:</p> <ul style="list-style-type: none"><li>■ From the ground to the center of the pile of tires</li><li>■ From the center of the pile of tires to the ground</li><li>■ From back to front, close to the ground, in a grading motion</li><li>■ Over the gravel box, in a motion which simulates moving excavated material into the box</li><li>■ From back to front over the bed of the gravel box, to simulate pouring material into the box</li><li>■ Return to start</li></ul>

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

# Loading and Unloading Trailer

Operators learn to move the excavator 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
	To move on and off of each trailer, operators must be able to: <ul style="list-style-type: none"><li>■ Identify the front and rear of the tracks (the idlers and driving sprockets).</li><li>■ Use pedals to move forward and reverse when the cabin points in the direction of idlers and driving sprockets.</li><li>■ Counter-rotate tracks to move the excavator into a different position while on the trailer.</li></ul>
Move tracks accurately	The operator must put the excavator in a secure position for transport on each trailer. On-screen tips tell the operator to: <ul style="list-style-type: none"><li>■ Curl the bucket and retract the arm fully.</li><li>■ Lower the boom until no part is higher than the cabin of the excavator.</li></ul>
Put the excavator in a secure position for transport on each trailer.	On-screen tips explain how to drive onto the trailer.
Follow safe operating procedure to move onto and park the excavator on a detached lowboy trailer.	On-screen tips explain how to drive onto the drop-deck trailer.
Follow safe operating procedure to move onto and park the excavator on a dropdeck trailer.	

## Exercise Workflow

To complete the exercise, the operator does these things:

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

### Detached Lowboy Trailer

To move onto the detached lowboy trailer:

1. Make sure the cabin points toward the idlers and the arm is perpendicular to the ground.
2. Align the tracks with the ramp and make sure the excavator is parallel with the trailer.
3. Advance onto the ramp slowly. Stop when tracks are fully over the ramp.  
To prevent accidents, operate the excavator in a low gear.
4. To make the excavator more stable, curl and lower the bucket until the flat side is level with the ground.  
Use caution when the tracks tip over the ramp.
5. When the excavator is over the center of the trailer, secure it for travel:
  - a. Curl the bucket and retract the arm fully.
  - b. Lower the boom until no part is higher than the cabin of the excavator.

To move off of the detached lowboy trailer:

1. Raise the boom and arm until you have a satisfactory view and the machine is stable.
2. Rotate the upperstructure until the cabin points toward the driving sprockets.
3. To keep the machine stable while you move down the ramp, push the bucket into the ground at the bottom of the trailer.  
Move down the ramp slowly. Stop when the tracks are fully off of the ramp.
4. To safely park excavator, position the flat side of the bucket on the ground.

## **Dropdeck Trailer**

To move onto the dropdeck trailer:

1. Align the tracks with the ramp and make sure that the excavator is parallel with the trailer.
2. Advance onto the ramp slowly. Stop when tracks are fully over the ramp.  
To prevent accidents, operate the excavator in a low gear.
3. To make the excavator more stable, curl and lower the bucket until the flat side is level with the ground.  
Use caution when the tracks tip over the ramp.
4. When the excavator is over the center of the trailer, secure it for travel:
  - a. Curl the bucket and retract the arm fully.
  - b. Lower the boom until no part is higher than the cabin of the excavator.

To move off of the dropdeck trailer:

1. Raise the boom and arm until you have a satisfactory view and the machine is stable.
2. Rotate the upperstructure until the cabin points toward the driving sprockets.
3. To keep the machine stable while you move down the ramp, push the bucket into the ground at the bottom of the trailer.  
Move down the ramp slowly. Stop when the tracks are fully off of the ramp.
4. To safely park excavator, position the flat side of the bucket on the ground.
  1. Lower the bucket to stabilize the excavator.
  2. Counter-rotate the tracks until they are perpendicular over the center of the trailer.
  3. Turn the upperstructure until the cabin points toward the idlers.
  4. Lower the boom and set the flat side of the bucket level on the ground.
  5. Move the arm in and move the tracks forward at the same time until two-thirds of the tracks hang over the edge of the trailer.
  6. Move the tracks forward until they touch the ground and support the weight of the excavator (the rear tracks should still be on the trailer).
  7. Slowly rotate the upperstructure until the cabin points toward the driving sprocket.

8. Move the tracks forward and move the arm in at the same time until the excavator moves off of the trailer.

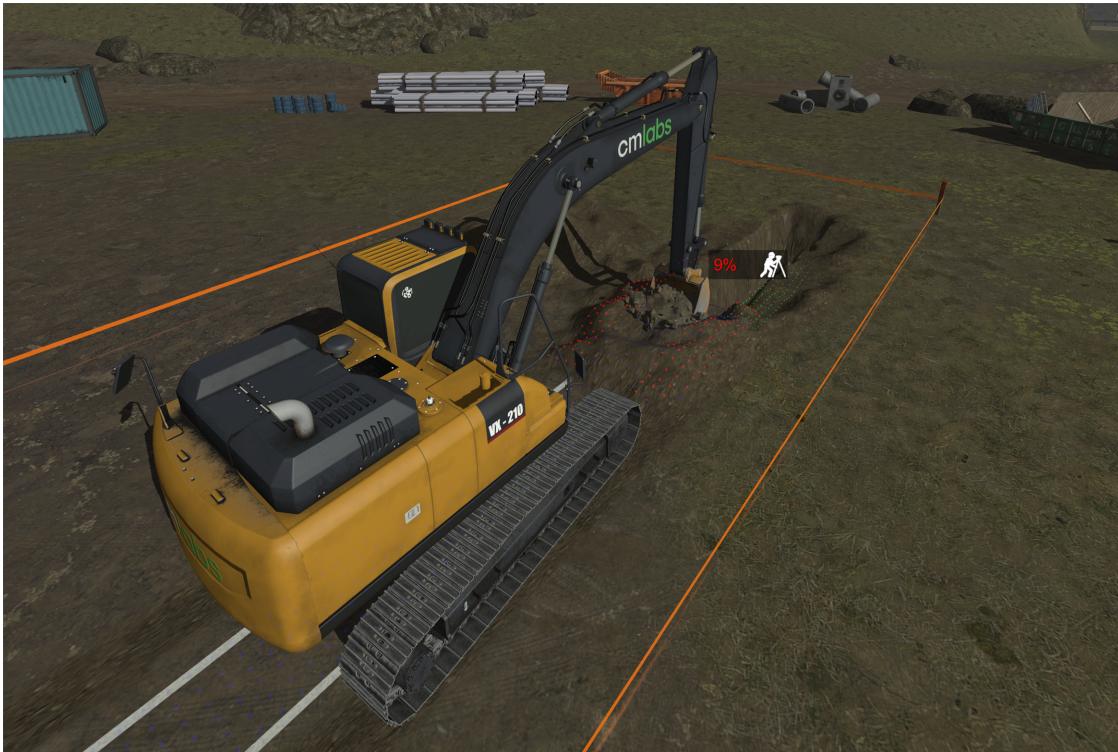
Once the operator completes all tasks, the system shows a success message and the exercise ends.

# Trenching

Operators excavate a trench area with these specifications:

Depth	1.2 m (4.0 ft)
Width	1 bucket-wide
Square at the end of the trench	3.0 m (9.8 ft) long x 3-buckets wide

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



An on-screen display 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 bucket correctly to remove layers of material.
Remove material in shallow layers, maintaining the correct bucket angle and a consistent grade throughout the entire excavation.	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. 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
Excavate on the idler side, unloading material evenly on the side of the trench and creating a safety corridor.	On-screen tips instruct the operator to keep the work area clean and excavate on the idler side. The system automatically detects when operators deposit material on both sides of the 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 excavator is parked in front of the trenching area.

1. To start the task, press the Horn button.
2. Start the excavator.
3. Follow on-screen instructions to complete these activities:

Task	Description
Set up	Move forward and position the bucket to start removing material in the correct place.
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.
Park	When the trench and square area are complete, move the excavator 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.

# Bench Loading

The operator moves material from a bench into a sequence of dump trucks. The operator must use the horn to signal each dump truck to stop in the correct position.



# Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Estimate equipment limits and ground conditions.	On-screen tips tell the operator how to set the excavator in the best position.
Set the excavator in a position that increases stability and decreases the distance that the arm must move during operation.	On-screen tips tell the operator to do the following things to increase stability and digging power: <ul style="list-style-type: none"><li>■ Set the excavator perpendicular to the bench, facing idler wheels.</li><li>■ Operate the arm and bucket over the tracks of the excavator.</li></ul> If the excavator falls over, the exercise ends automatically.
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.
Balance the load in the dump truck with axle weight restrictions.	The system shows current mass of material in the dump truck at all times.

Goal	Methodology
Use horn to signal truck driver.	<p>The operator uses the horn to signal trucks to come.</p> <p>The operator moves the bucket to signal where the truck driver must stop.</p> <p>Once a dump truck is full, the operator uses the horn to signal the truck to go.</p>
Complete each operation with smooth, continuous movements.	<p>The operator must fill multiple dump trucks within the specified time period.</p> <p>The system records measurements to calculate efficiency while you work.</p>
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>
Prevent the truck from driving on the bench or into the pile.	<p>The operator must use the horn to signal the truck to stop in a safe position.</p> <p>The system records the number of times the truck drives on the bench or in the pile.</p>

## Exercise Workflow

When the exercise starts, the excavator is on the top of the bench, waiting for a dump truck to come.

To complete the exercise, the operator must do these things.

1. To start the exercise, push and hold the Horn button.
2. Do the procedure that follows:

Task	Description
Fill the bucket	Fill the bucket until it is a minimum of 80% full.
Signal the dump truck	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. 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.
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.
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.
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.

# Pipe Placement

Operators use chains to lift a catch basin and pipes from a trailer and carefully move them to specified locations in a trench.

The chains are attached to the back of the bucket. To simulate the work personnel do to attach the chains to each load, the operator presses the Horn button when the chains are near the load. Visual aids appear to signal the operator when the chains are in the correct position.

When the pipes are in the trench, the operator must correctly align the spigot and bell sections of each pipe.



# Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Accurately estimate the weight of the load and calculate the capacity of the current attachment and rigging.	Training materials supplied with the simulator include a load chart and lift planning information.
Use load charts to find the rated Safe Working Load of the machine with the current attachment and rigging.	On-screen tips tell the operator to review lifting procedures and plan.
Use controls to smoothly operate equipment during lifting operations.	To prevent collisions and minimize pendulum, the operator must skillfully use controls to handle the load and complete each task.
Use the excavator to lift and move objects (pipes) from the flatbed trailer.	To complete the exercise, the operator must lift and safely move 8 pipes and 1 catch basin from a trailer to the correct location in the trench.
Monitor the center-of-gravity of the excavator when you lift the load over the side of the excavator.	The operator can feel strain when the excavator lifts a heavy load and observe deflection in arm. The view from the upperstructure tilts.  If the excavator tips over because it is unstable, the exercise ends immediately.  Operators can also observe measurements for track pressure on the ground during the exercise.
Monitor the pendulum of the load while you move it to the trench.	To minimize pendulum and unwanted movement, on-screen tell the operator to: <ul style="list-style-type: none"><li>■ Keep the rigging attachment point over the center-of-gravity of the load at all times.</li><li>■ Make sure the load is level before lifting to minimize pendulum.</li></ul>

Goal	Methodology
Keep loads low and near the ground. Carry the load up an incline with the heavy end of the pipe raised.	<p>The system records measurements for the following performance metrics:</p> <ul style="list-style-type: none"> <li>■ Shock load</li> <li>■ Collisions with the truck and ground.</li> </ul>
Operate the excavator safely near power lines.	On-screen tips tell the operator to look for hazards in the work site and operate the excavator as far as possible from workers on the site.
Correctly position pipes in the trench and align the spigot and bell sections of each pipe.	On-screen targets show the operator where to position the catch basin and each pipe.

## Exercise Workflow

When the exercise begins, the excavator is on a work site near a trailer. The pipes and catch basin wait on the trailer.

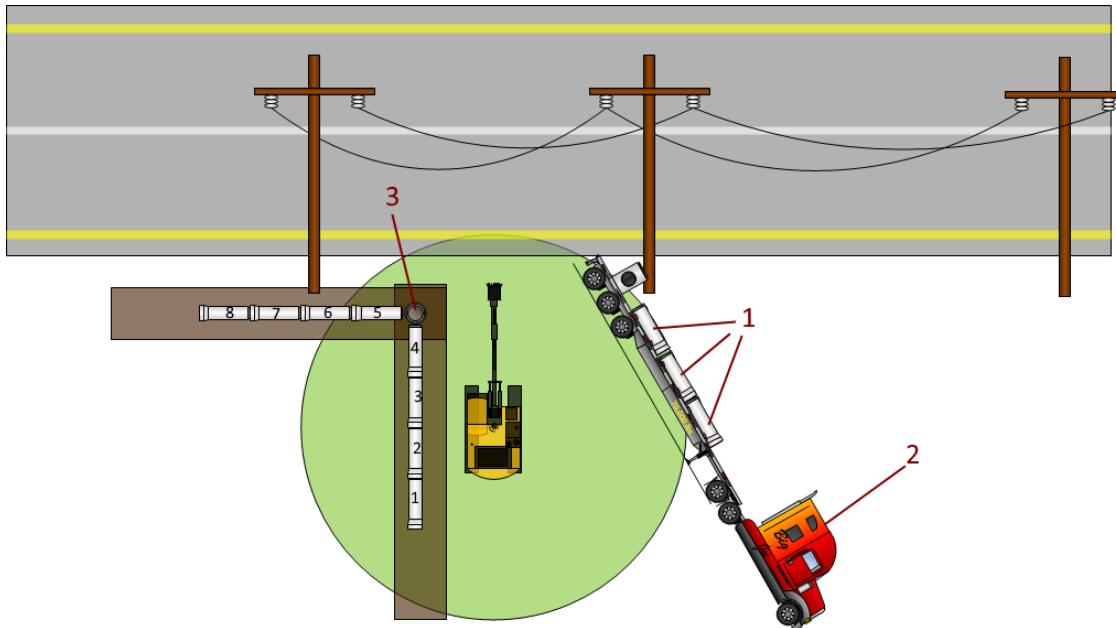
To successfully complete the exercise, the operator does these things.

1. To begin the exercise, press and hold the Horn button.
2. Following on screen instructions, complete these tasks:

Task	Description
1st pipe	Lift the first pipe and move it to the target position. Make sure the pipe is correctly oriented in the trench, with the bell side on the left and the spigot side on the right.
2nd pipe	Lift the second pipe and move it to the target position in the trench. Adjust the position until the pipe automatically connects with the spigot side of the previous pipe.
3rd pipe	Lift the third pipe and move it to the target position in the trench. Adjust the position until the pipe automatically connects with the spigot side of the previous pipe.
4th pipe	Lift the fourth pipe and move it to the target position in the trench. Adjust the position until the pipe automatically connects with the spigot side of the previous pipe.
Catch basin	Lift the catch basin and move it to the target position in the trench. Adjust the position until the bell section automatically connects with the spigot side of the pipe.
5th pipe	Lift the fifth pipe and move it to the target position in the trench. Adjust the position until the pipe automatically connects with the bell section of the catch basin.
6th pipe	Lift the sixth pipe and move it to the target position in the trench. Adjust the position until the pipe automatically connects with the bell section of the previous pipe.
7th pipe	Lift the seventh pipe and move it to the target position in the trench. Adjust the position until the pipe automatically connects with the bell section of the previous pipe.
8th pipe	Lift the eighth pipe and move it to the target position in the trench. Adjust the position until the pipe automatically connects with the bell section of the previous pipe.

Task	Description
Parking position	Use the tracks to move the excavator to the target destination.
Lower bucket	Lower the bucket and make sure the excavator is in a safe position.

When the operator completes all tasks, the layout of the pipes should appear as follows:



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

# Test Weight

Operators lift a test weight and move it through an obstacle course. The path that the test weight must move through is marked with poles. The operator must not let the test weight touch the poles.

The operator must keep the test weight suspended at the same height while it moves through the test course. The system deducts points from the score if the weight touches the ground or the chains lift off of the ground.

Movements become more complex as the exercise continues.



# Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Keep the load at the same height while it travels through the course.	The system penalizes the operator for letting the test weight touch the ground, or lifting the chains off the ground.
Use swing, boom, and stick controls at the same time with skill.	To move the test weight through the challenge course without collisions, the operator must control all parts of the arm with skill.
Move the load through confined spaces.	The operator must move the test weight through narrow paths with objects on all sides.
Keep the lift point directly over the load at all times to control pendulum swing.	The system records how many times and how long the load swings in uncontrolled pendulum.
Complete the course in a short period of time without interruption.	A display shows how long the operator takes to complete the course.
Show competence under pressure and in variable weather conditions.	Instructors can change wind and lighting settings to make the exercise more challenging. The operator should try to get the best score possible.

## Exercise Workflow

When the exercise starts, the excavator is in front of the test weight. A chain is attached to the end of the arm.

To complete the exercise, the operator does these things.

1. To start tasks, press and hold the Horn button.
2. Following on-screen instructions, complete these activities:

Task	Description
Attach the weight	Curl the bucket and lower the chain until it touches the attachment point of the weight. When hooking spheres change from yellow to green, press the Hook button to attach the chain.
Lift the weight	Raise the boom until the test weight aligns with the target.
Swing right	Use swing controls to move the weight to the next target.
Move weight forward and right	Use boom and arm controls to move the weight forward and right at the same time to the next target.
Swing right	Use swing controls to move the weight through the path marked with poles until you reach the next target.
Navigate the weight up and right	Use swing, boom, and arm controls to move around the barrels and fence until you get to the next target.
Move the weight up and right	Use swing and arm controls to move the weight to the next target.
Rotate and move the excavator	Keep the weight stable and at the correct height while you rotate and move the excavator to the target position.
Move weight around fences to next target	Use swing, arm, and boom controls to move the weight to the target on the plywood platform.
Move weight around fences to next target	Use swing, arm, and boom controls to move the weight to the target on the plywood platform.

Task	Description
<b>Move weight around fences to next target</b>	Use swing, arm, and boom controls to move the weight to the target at the end of the line of fences.
<b>Move weight around tires and barrels</b>	Move forward and swing to move the load diagonally. Stabilize the weight on plywood circle before moving.
<b>Move the weight up, forward and left</b>	Use boom, arm, and swing controls to move the weight up and diagonally to the left.
<b>Rotate and move excavator</b>	Keep the weight stable and at the same height while you move and rotate excavator to the next target.
<b>End</b>	

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

# Excavator Rodeo

This exercise is designed to reproduce a challenge which typically occurs at trade shows. Operators use the excavator bucket to collect basketballs from the tops of construction cones and then drop them into a barrel as quickly as possible.



# Learning Outcomes

This exercise is designed to teach operators these skills:

Goal	Methodology
Develop strategies to manage competitive situations.	The exercise is designed to encourage competition between operators. To earn the best score, operators must show skills and manage time carefully.
Control the bucket with skill and accuracy to lightly collect and dump balls in the barrel.	To earn the best score, operators must drop as few balls and cones as possible. If the bucket touches a ball with too much force, the ball falls and the system shows a penalty.
Perform complex and repetitive movements under pressure.	To move as many balls as possible, the operator must perform a sequence of careful movements with the arm and bucket again and again.
Look at shadows to estimate the distance between the bucket and the barrel.	Operators must look at shadows to estimate how near the bucket teeth are to each ball.

# Exercise Workflow

The exercise is designed to support two competition modes:

- **Classic Mode**

Operators try to earn the best score by moving six balls to the barrel within two minutes. The system deducts points if the operator knocks over a cone, and subtracts 5 seconds from the available time if the operator drops a ball.

<b>Available time</b>	2 minutes
<b>Number of balls</b>	6
<b>When the operator puts a ball in the barrel...</b>	The system adds a point to the score
<b>When the operator drops a ball...</b>	The system subtracts 5 seconds from the available time.
<b>When the operator drops a cone ...</b>	The system subtracts a point from the score.

To earn the best score, the operator moves all six balls into the barrel as quickly as possible without knocking any cones.

- **Endurance Mode**

Operators try to earn the best score by moving as many balls as possible for as long as possible. The system adds more available time when operators put a ball in the barrel.

<b>Available time</b>	2 minutes
<b>Number of balls</b>	No limit
<b>When the operator puts a ball in the barrel...</b>	The system adds 10 seconds to the available time.
<b>When the operator drops a ball...</b>	The system subtracts 5 seconds from the available time.
<b>When the operator knocks over a cone</b>	The system subtracts 5 seconds from the available time.

When the exercise begins, the excavator is in the center of the competition area.

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

# Sandbox

In this exercise, there is no special order in which operators must complete tasks. Operators can practice specific skills alone, or instructors can refer to training needs to select tasks for each operator.

The practice yard includes different practice areas where operators can:

- Excavate an embedded pipe.
- Excavate around a manhole.
- Use the bucket to move a concrete ball through a slalom course.
- Use the bucket to pile tires.
- Move the excavator onto and off of different trailers.



# Learning Outcomes

This exercise is designed to help operators learn these skills:

Goal	Methodology
Use the correct method to remove material from around embedded objects. Release the material in the correct location.	Operators carefully remove material from around a manhole and an embedded pipe. On-screen tips tell the operator the correct method for removing material from around each object.
Use caution near cross lines.	Operators carefully remove material to expose an embedded pipe. On-screen tips tell operators how to remove the material safely and recommend that they always use a gradesman to find cross lines.
Use the bucket to carry boxes correctly.	A trench box and gravel box are in the practice area for the operator to lift and move.
Use the bucket to lightly lift and pile tires.	Operators use the bucket to lift tires and pile them on top on one another.
Use the bucket to move a an object with control and accuracy.	Operators use the bucket to move a concrete ball through a short slalom course.
Move the excavator onto and off of different trailers	The practice area includes these trailers: <ul style="list-style-type: none"><li>■ Detached lowboy</li><li>■ Attached lowboy</li><li>■ Flatbed</li><li>■ Dropdeck</li></ul>

## Exercise Workflow

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

To complete the exercise, the operator does these things.

1. To start the exercise, press and hold the Horn button.
2. Following on-screen instructions, complete these activities in any order:

Task	Description
Trailers	<p>Move the excavator onto and off of any of these trailers:</p> <ul style="list-style-type: none"><li>■ Detached lowboy</li><li>■ Attached lowboy</li><li>■ Flatbed</li><li>■ Dropdeck</li></ul>
Concrete Ball Challenge	<p>Use the excavator bucket to move a concrete ball through a slalom course from one target to another.</p>
Tires	<p>Use the excavator bucket to lift tires and put them on top of another.</p>
Pipe Excavation	<p>Remove shallow layers of material to get to a pipe.</p>
Manhole Excavation	<p>Excavate around a manhole.</p>