

subROV

# Operation Manual

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Developed by



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The logo for the National Science Foundation (NSF), featuring a blue globe with a yellow sunburst pattern around it and the text "NSF National Science Foundation".	The logo for BIOS (Bermuda Institute of Ocean Sciences), featuring the word "BIOS" in blue, a stylized sunburst graphic, and the text "Bermuda Institute of Ocean Sciences" below.	The logo for the Schmidt Ocean Institute, featuring a stylized blue and yellow wave graphic and the text "SCHMIDT OCEAN INSTITUTE".

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# Table Of Contents

<b>Table Of Contents</b> .....	<b>1</b>
<b>ReadMe First: Sending Feedback</b> .....	<b>3</b>
<b>Introduction</b> .....	<b>4</b>
<b>Menu Screen</b> .....	<b>5</b>
<b>Vehicles</b> .....	<b>6</b>
Research Vessel.....	6
ROV.....	6
<b>Cameras</b> .....	<b>7</b>
External Camera.....	7
ROV Cameras.....	7
<b>Game Layout</b> .....	<b>8</b>
Main Screen.....	8
Dive Info Screen.....	9
Map Screen.....	9
SONAR Screen.....	10
Sonar Beam.....	11
Tracking Dots.....	12
ROV Info Screen.....	13
ROV Camera Screen.....	14
Main Control Panel.....	14
Right Side Panel.....	14
Cameras Control Panel.....	14
<b>Controls</b> .....	<b>15</b>
Main Menu.....	15
Dives - Overview.....	15
Cursor Movement.....	16
Camera Movement.....	16
Main View Selection.....	17
ROV Camera Selection.....	17
External View.....	18
Map View Zoom.....	19
External Focus Selection.....	19
External Focus Auto Center.....	20

Vehicle Control Selector.....	20
Research Vessel - Movement.....	20
Research Vessel - Docking and Undocking.....	21
Research Vessel - Frame and Reel Operation.....	21
Research Vessel - Releasing and Retrieving.....	22
ROV - Tether Management System (TMS).....	23
ROV - Movement.....	24
ROV - Variable Buoyancy control (VBC).....	24
ROV - Station Keeping (Hover).....	25
ROV - Dynamic Positioning (D.Pos).....	25
ROV - Lights.....	26
ROV - SONAR.....	26
ROV - Head-Up-Display (HUD).....	27
ROV - Arm.....	28
ROV - Temperature Sensor.....	28
Other Controls.....	29
Turbo Lift.....	29
Help.....	29
Quick Exit.....	31
<b>Procedures.....</b>	<b>32</b>
Measuring Hydrothermal Vents.....	32
Taking Sediment Samples.....	33
Taking Gas Samples.....	34
Measuring Reactive Oxygen Species From Corals.....	35
Downloading Data from Buoys.....	36
Tracking Creatures.....	37
<b>Quick Reference.....</b>	<b>39</b>
ROV States.....	39
Descent Procedure.....	39
Glossary.....	39
<b>Control Layouts.....</b>	<b>42</b>

## ReadMe First: Sending Feedback

To report a bug or send us feedback at any time during the game, press the **SEND FEEDBACK** button located in the Main menu or Pause menu screens. Alternatively, you can also open the feedback screen by **pressing F8** in either menu.

You can send us bug reports and suggestions, include a screenshot, or simply click on a smiley to let us know how you feel about the game.

- The reports we receive include any information you send along with a basic description of your system (processor, graphics card), and the point in the game where you sent it.
- Reports **do not** add any personal information, your email, or any information whatsoever that could be used to identify you.



We hope this tool will help you send us your feedback in the easiest way possible -right from the game-, but don't forget that you can always email us to *info "at" sqr3lab.com*, or reach us directly through our [Discord server](#).

## Introduction

Several ocean exploring organizations routinely feature livestreams of their dives, providing the general public with open access to their work. Their efforts are invaluable both as technological feats and as a means to spread awareness on the great unknown that is still the ocean.



subROV is an approachable simulator that aims to recreate these dives; it will give you hands-on experience launching a submarine ROV (Remotely Operated Vehicle), plunging it into the abyss, and exploring what's there, whilst avoiding some of the complexities associated with a true-to-life simulation.

## Menu Screen



The Menu Screen is the game's central hub. It holds the following sections:

- Dives: Here you can browse and select any of the available dives.
- Profile: Here you can check your pilot record, statistics, and dive log.
- Gallery: Here you can browse through all creatures and various objects you scan.
- Settings: Here you can modify various aspects of the game, including key and controller bindings.

The Menu Screen also holds buttons to open the Feedback Form, watch the game's credits, and exit the game.

You will arrive at the menu Screen when you start playing, right after the Title screen. You will also return to the menu after ending a dive, and you can bring a paired-down version of the menu (referred to as the Pause menu), during dives.

You can end a dive both by pressing the Exit button or the corresponding binding. There's no in-game button to open the Pause menu, though -this is done exclusively by using the binding, which by default is the **Esc** key, or the gamepad's **menu** button.

This binding is the same for exiting the dive (thus opening the Main menu), or pausing the dive, (thus opening the Pause menu). The action is determined by the state of the plastic safety cover over the Exit button: if the cover is in place, pressing the binding opens the pause menu; if it's not, and the exit button is exposed, pressing the binding triggers the exit button, ending the dive.

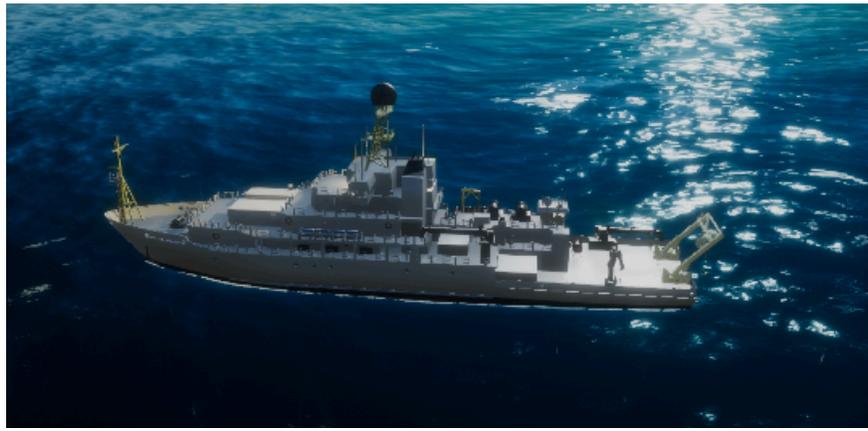
- Bringing the Pause Menu up during a dive will pause the action while it is active.
- The Pause Menu only includes sections and buttons that are appropriate to show during a dive.

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## Vehicles

### Research Vessel

The Research Vessel Comatel Explorer (also referred to in this manual as “the ship”) carries, deploys, and follows the ROV during dives. It is equipped with a multibeam sonar that reveals details of the terrain underneath it as it moves.



### ROV

The Remotely Operated Vehicle (ROV), affectionately named SuBerto, performs both observational and operational tasks underwater. It is directly connected to the Research Vessel at all times and is equipped with a sonar, a scanner, and an arm with a manipulator.

ROV SuBerto is rated to full-ocean depth and includes a Tether Management System (TMS) that ensures stability of operation regardless of the surface conditions.

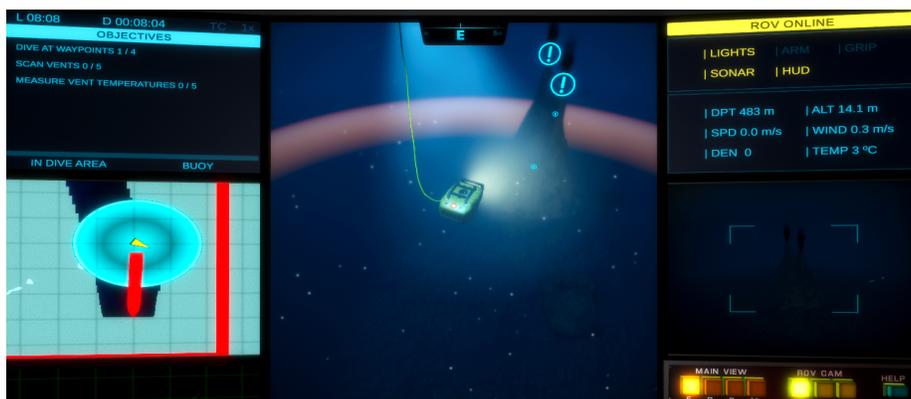


## Cameras

### External Camera

The External Camera is a “fantasy device” that has no direct counterpart in the real world; it acts as an external drone that points either at the ship or the ROV, hovering around them at all times whilst avoiding collisions with the environment.

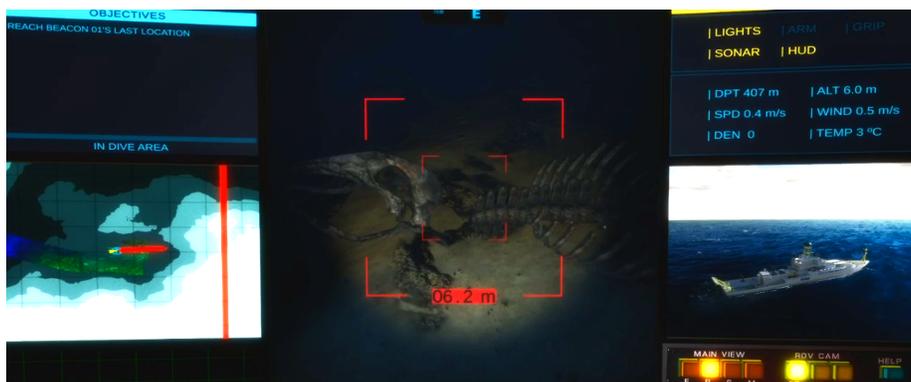
During a dive, if the external camera is pointing at the ROV (see [Focus](#) section below), it will display several “augmented” interface elements on its own screen (sonar sweep, scan icons), and others (ping radius on the Map, tracking dots on the Sonar Screen).



### ROV Cameras

These are a series of identical cameras mounted on various points in the ROV.

During a mission, the ROV cameras show a Head-Up Display (HUD) to aid you both with scanning creatures and objects of interest, and with docking operations with the TMS Cage.



## Game Layout

The Game Layout consists of a Control Panel and a series of screens and information panels.

### Main Screen



This screen shows the External Camera View by default. You can switch this view with several of the other screens, when they are active, using the **Main View** Controls.

On the top of the Main screen is a Compass, which works as follows:

- When the main screen shows the **Map** view, the the compass shows N as a fixed reference;
- When the main screen shows the **External Camera** view, the compass shows the camera's orientation;
- When the main screen shows the **sonar**, or any of the **ROV cameras'** views, the compass shows the ROV's orientation.

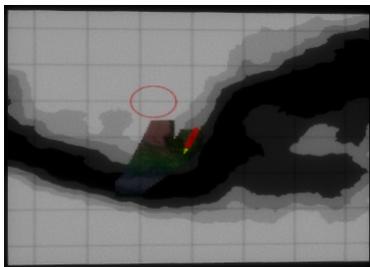
## Dive Info Screen



This screen shows the following information:

- Dive Time: Time elapsed since you started the dive.
- Local Time: Current time of the day or night.
- Turbo Lift (see [Other Controls](#)): Special function to increase speed during long ascents and descents.
- Dive Objective Tracker: A list of objectives and their statuses.
- In-Area Tracker: Tells you if you are within the dive perimeter; leaving the perimeter triggers a countdown to end the dive.
- Buoy Tracker: Tells you if you are in the vicinity of a communications buoy, and displays the progress of any ongoing communications with it.
- Target Tracker : Displays the progress of an ongoing tracking operation.

## Map Screen



This screen shows the dive map, along with an overlay representing

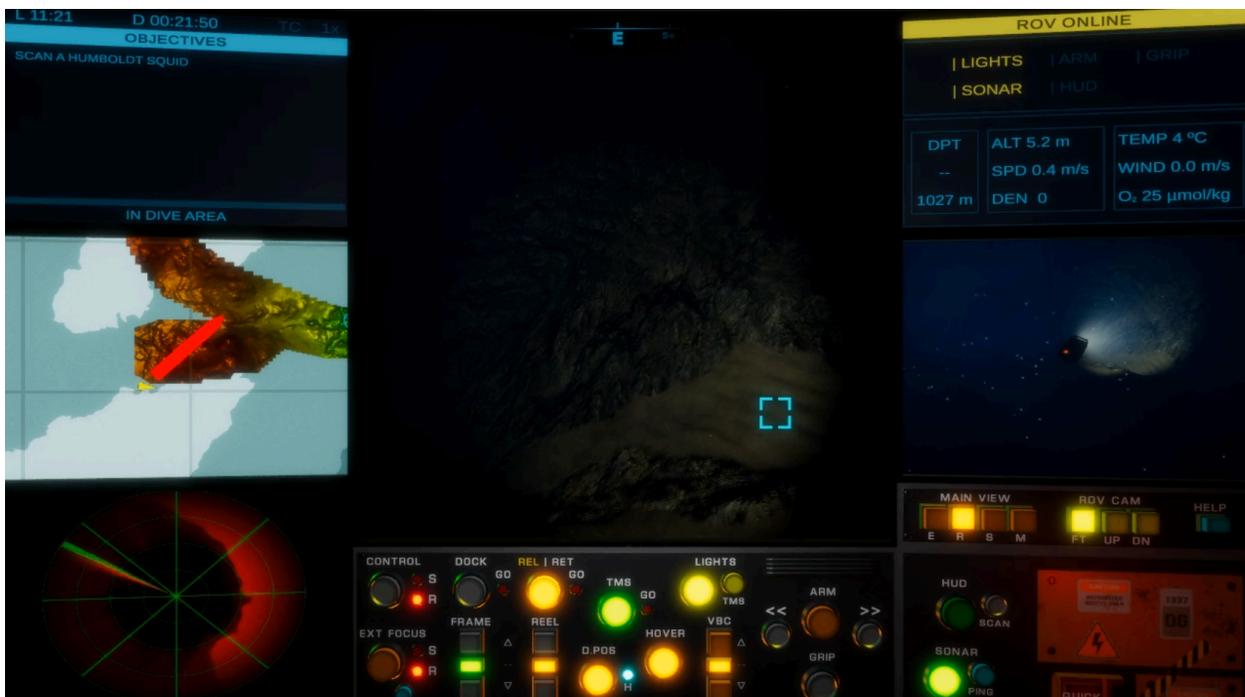
- The Research Vessel,
- The ROV,
- Dive Objectives,
- Points of interest,
- The sonar's range (when you use the **ping** function)

Most of the areas you will explore have only been mapped in low resolution. The Research Vessel is equipped with a multibeam sonar; as you move around it will update the area underneath, revealing details of the terrain and other features.

Updates to the map happen at regular intervals, representing the delay that occurs in real life as the data is processed.

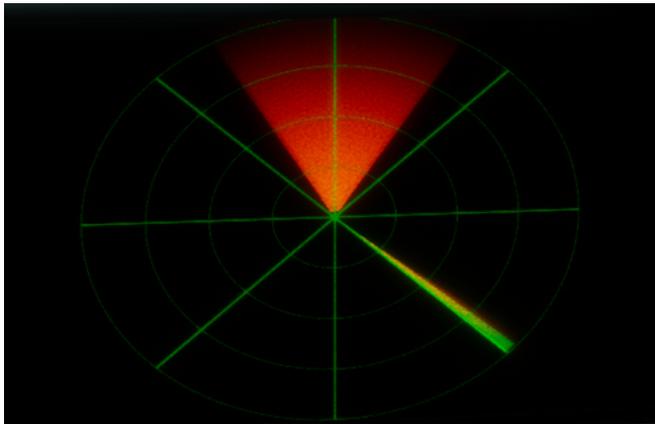
## SONAR Screen

This screen shows a slice of the features surrounding the ROV in a 20m radius, alongside Tracking Dots that represent *pinged* points of interest within that space.



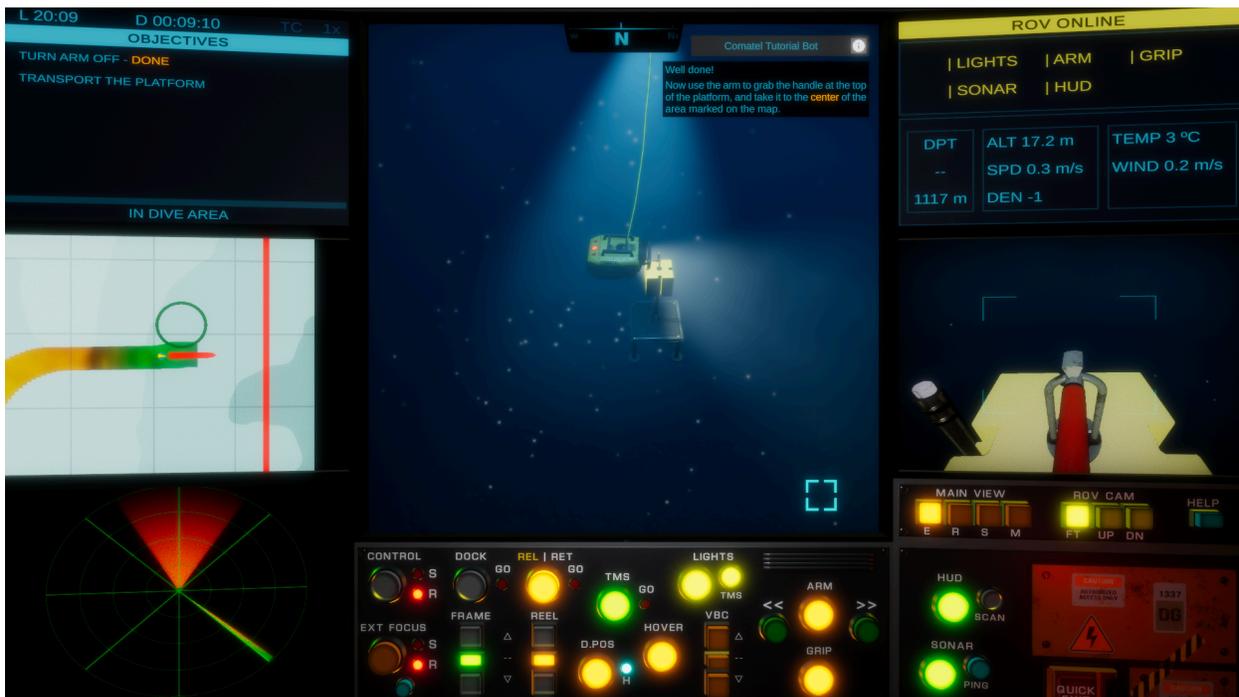
Sonar imaging doesn't depend on visibility conditions and is not skewed by perspective, which makes it useful to gauge distances, or as a navigation aid.

## Sonar Beam



Updates to the sonar screen happen over several seconds; the ROV projects an invisible rotating beam from a device located on its underside, and draws on screen the **blocked paths** of light as the beam rotates. This effectively merges both the silhouette and the “shadow” of an object in a single shape, which results in unusual contours for the untrained eye, particularly in objects with sharp angles.

To illustrate this point, consider the screenshot below where the ROV is transporting a *lander* (instruments platform), which features a cube-shaped yellow floater on top.



The cube - floater is blocking both the light and the SONAR beam in front of the ROV. This shows up as a cone in the SONAR screen, since the beam hits the edges of the cube at an angle.

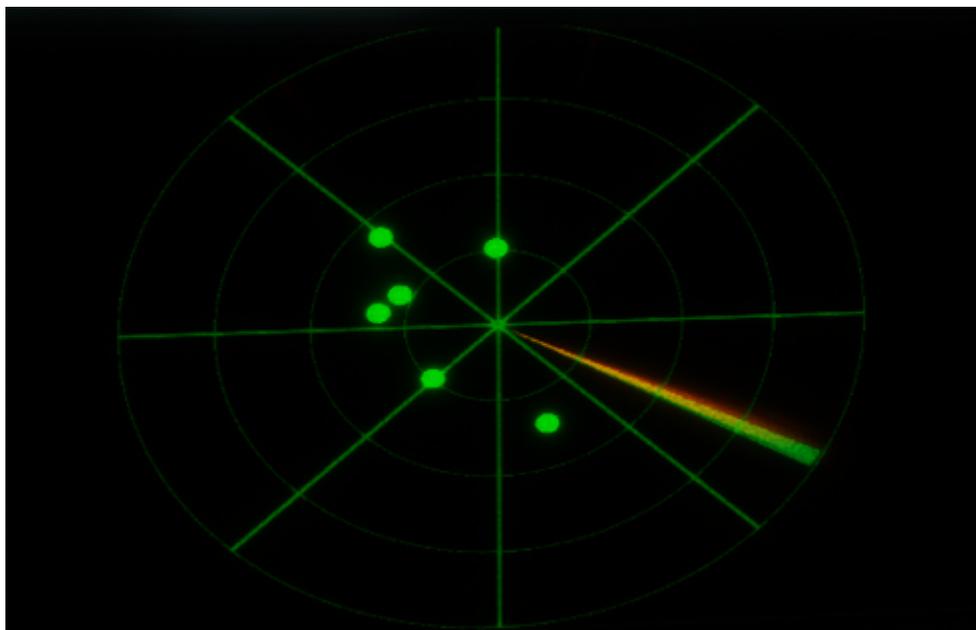
Understanding how the shapes on the SONAR screen relate to real-world objects is critical to SONAR navigation, and part of the skillset of every pilot.

The position of the *beam front* is shown on screen as a rotating line, which is useful to know what area is being redrawn at any given time. The line pulses every time it completes a full cycle; since the beam starts pointing front from the ROV, and dives in subROV always start with the ROV pointing South, the pulse marks the South and acts as a secondary compass.

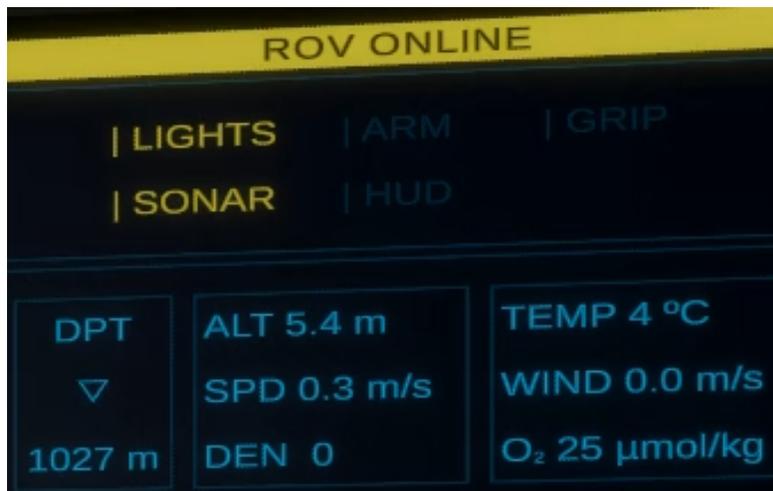
### Tracking Dots

The SONAR screen also shows Tracking Dots that represent the locations of *pinged* objects or creatures of interest (see SONAR controls section below).

- Each dot tracks the position of one such object on the horizontal plane (disregarding height), and moves taking into account both the ROV and that object's positions.
- The dots remain on screen for a limited amount of time after the respective objects have been pinged.



## ROV Info Screen



This screen shows the overall status of the ROV along with a number of useful operational parameters:

- DPT: Depth, measured from sea level,
- ALT: Altitude, or distance measured from the base of the ROV, in the direction of the seafloor, to the nearest blocking object,
- SPD: The ROV's speed, in m/s,
- DEN: A general indicator of the relative density of the ROV, expressed in steps from -4 to 4, where 0 is the point of neutral buoyancy,
- TEMP: Temperature of the seawater, in Degrees Celsius, measured directly by the ROV or by a [specialized sensor](#) in the ROV's arm,
- WIND: The water current's speed, in m/s,
- Extra parameter: this parameter is optional and custom to particular dives; in the capture above, it shows readings of dissolved Oxygen.

The DPT section features an icon in the shape of a triangle that helps see at a glance if the ROV is ascending or descending.

Depth readings depend on a passive subsystem that operates even when the ROV is not online, for as long as it is underwater; this helps the pilot discern if the ROV is ascending during the retrieval process.

## ROV Camera Screen

This screen shows the view of one of three cameras placed in the ROV (front-forward, up, and front-down). You can switch between them at any time using the **ROV Camera Controls**.

## Main Control Panel



This panel is located right under the main screen; it holds controls for most of the functions in subROV.

The switches in the Control Panel are “smart switches” with three states:

- Unlit/Grayed, when their associated function is not available,
- Lit (dim), when their associated function is available, but not active,
- Lit (bright), when their associated function is engaged.

All the switches change their state automatically depending on the overall situation; this gives you at-a-glance information of what functions are available at any given time.

## Right Side Panel



An extension to the main panel, this panel holds controls for the HUD and Sonar functions in the ROV, and for the Quick Exit button; it also has some extra space for future upgrades.

## Cameras Control Panel





This panel is located under the ROV Cameras Screen and holds controls that allow you to choose what to view on the Main Screen and which of the ROV cameras to use, in addition to sending the ROV camera feed to a secondary (physical) display, when available.

## Controls

### Main Menu

subROV uses an animated Virtual Cursor to interact with the menu, along with some extra controls to aid with navigation and interactions.

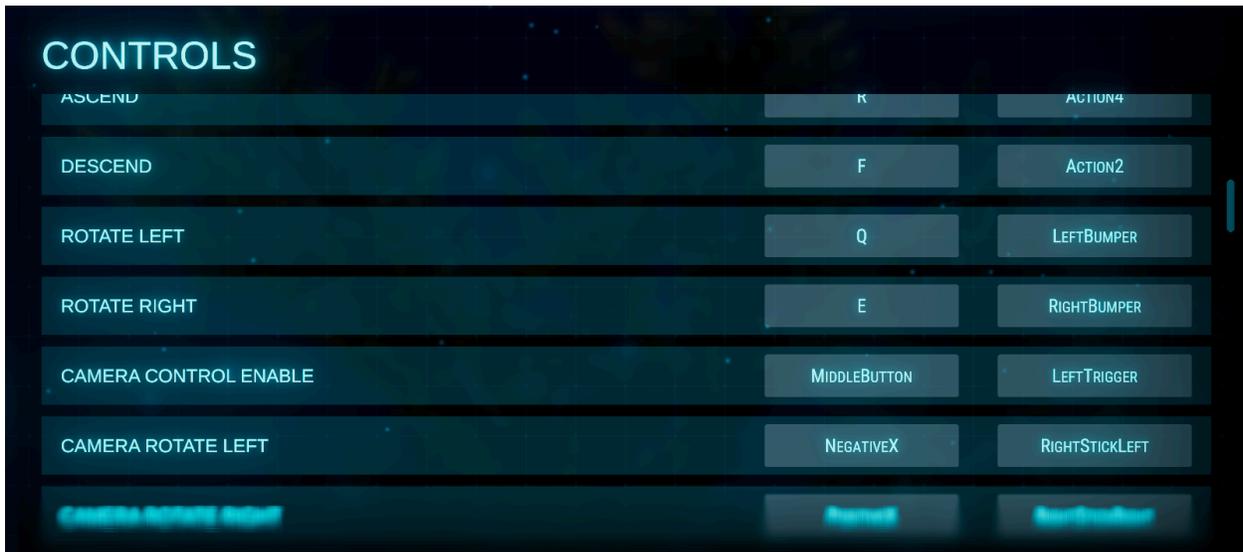
- Main menu controls are hard bound to the mouse and gamepads/joysticks. You **cannot** rebind these controls.
- The virtual cursor movement is bound to the mouse, the **right** stick in a gamepad, and the stick in a regular joystick.
- Extra interactions are bound to the gamepad's D-PAD and the regular joystick POV hat:
  - Moving up and down a list or vertical slider,
  - Moving a horizontal slider left or right.
- The cursor changes shape when hovering in and out of menu elements you can interact with.

### Dives - Overview

The operation of vehicles and devices happens through the use of switches in the game's control panel, and/or actions in your controller of choice.

- You can use the virtual cursor to press switches in the control panel;
- You can assign control panel switches to buttons in your controller;
- You can control subROV with a combination of keyboard, mouse, gamepad, and joystick;
- You can swap controllers on the fly during gameplay.

subROV has default mappings for keyboard/mouse and Xbox One gamepad. You can change the bindings to your liking in the Settings section of the game's Main Menu.



## Cursor Movement

subROV uses an animated Virtual Cursor to interact with the controls on the panel.

- The cursor movement is mapped to the mouse or one of the joysticks in your controller, the same as it is in the Main Menu. This mapping **cannot** be changed.
- In the Settings Menu you can force the cursor to only be controlled by the mouse. This gives you flexibility to control the game with a gamepad/single joystick and the mouse at the same time.
  - As this is an override to normal behavior, help prompts in the certification dives might not indicate the correct binding. We encourage you to play the certifications with a standard setup instead.
- The cursor changes shape when hovering in and out of menu elements you can interact with.



## Camera Movement

In subROV you can operate either an external camera, or one of the cameras mounted on the ROV.

- The **External Camera** gives you a third-person view of either the ROV or the Research Vessel. It always points at either vehicle and rotates horizontally around it, detecting and avoiding the terrain or other obstacles.

- The ROV Cameras give you a first-person (also called Point-Of-View, or POV) view of the surroundings of the ROV.

You can control the External Camera at all times, even if it's not assigned to the Main View, except when you are controlling an (internal) ROV camera.

To control the ROV cameras,

- Make sure that the ROV is Online,
- Select a Camera by clicking on any of the camera switches in the ROV Cam panel,
- Bring the ROV camera to the Main View by pressing the **R** switch on the Main View panel.

Camera movements are mapped by default to the same controls that move the Virtual Cursor.

- To change from moving the Virtual Cursor to moving a camera, press the **Camera Control Enable** button in your controller, and keep it pressed for as long as you want to move the camera.
  - By default, this control is bound to the middle button in a mouse, or the left trigger in a game pad.

## Main View Selection



The Main View switches allow you to display any of the available cameras and instruments in the Main Screen:

- **E** selects the External Camera (assigned by default);
- **R** selects the ROV Camera that is active in the ROV Cam panel;
- **S** selects the SONAR view;
- **M** selects the Map view.

By default the External Camera is assigned to the Main View; selecting any of the other cameras or instruments exchanges it with the External Camera.

The External Camera and Map are always available during a dive; the ROV cameras and the sonar are only available when the ROV itself is Online.

## ROV Camera Selection

The ROV Cam switches allow you to choose between three cameras mounted on the ROV:

- **FT** selects the Front Camera, located between the front lights and the arm;
- **UP** selects the Up Camera, located on top of the ROV, pointing up. This camera is very useful when docking with the TMS;
- **DN** selects the Down Camera, located under the arm, pointing down. This camera gives you best visibility of the terrain underneath, particularly when the arm is extended.

The specs and functionality of the three cameras is the same, and they are all operated in the same manner.

As with all the ROV-dependent systems, the ROV cameras are only available when the ROV itself is Online.

## External View

The **XT** button, located to the right of the ROV Camera selection buttons, allows you to send the feed from the active ROV camera to the secondary display on your system. Pressing the button sends the feed to the display, and pressing it again sends it back to the Control Panel.

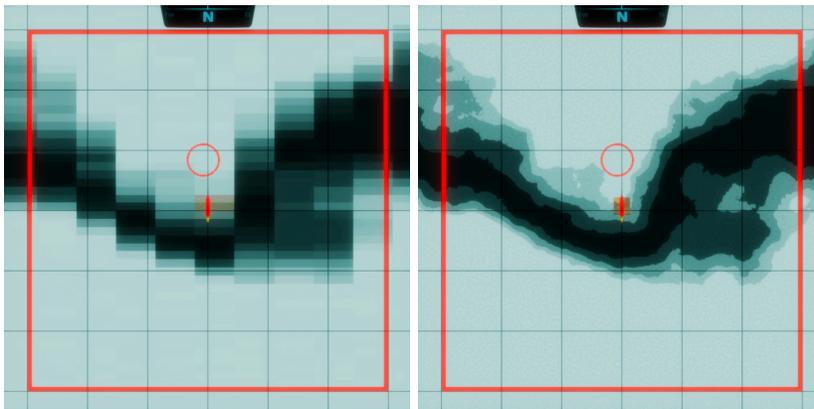


The external view is meant purely for observation -there's no HUD display, and it is not possible to rotate the camera around. If your setup features more than two displays, the feed will be sent to the display identified as secondary (2) by your system. At this time it is not possible to change its resolution independently.

## Map View Zoom

When the **Map View** is assigned to the Main Screen, you can change the view's scale freely, from a close view of the ship to a full view of the Dive Area.

- The map icons update their positions constantly while zooming. This emulates a “predictive” positioning algorithm.
- The map becomes pixelated while zooming, and recovers the normal resolution when the next image is available.



## External Focus Selection



The External Focus selector is a momentary switch that allows you to focus the External Camera either on the Research Vessel or the ROV at any time during a mission.

To avoid confusion, the Research Vessel is labeled **S** (ship), while the ROV is labeled **R**.

## External Focus Auto Center



The External Focus Auto Center Switch is located right under the Focus Selection switch. When engaged, the camera will automatically position itself behind the vehicle selected for focus whenever you're not operating it.

## Vehicle Control Selector



The Control selector is a momentary switch that allows you to select between controlling either the **Ship** or the **ROV**, gaining access to their related functions and movement.

The Control Selector becomes available only when it is safe to switch controls.

- If you are controlling the ship, it becomes available when the ROV reaches a safe operational depth after it is released.
  - Switching controls at this point enables the TMS control, which allows you to disengage the ROV from the TMS cage and move around freely.
- If you are controlling the ROV, it becomes available when it is docked with the TMS cage
  - Switching controls at this point enables the Reel controls, which allow you to bring the ROV back to the surface (or unreel it further).

## Research Vessel - Movement

- When the ROV is docked, you can move the Research Vessel forward or backward, and also rotate it.
- When the ROV is deployed you can't move the Research Vessel directly.
- If the [Dynamic Positioning](#) function is engaged, the Research vessel automatically follows the ROV.

## Research Vessel - Docking and Undocking

Docking is an automatic procedure that latches the ROV to the Research Vessel, leaving it in a condition where it is safe to move to another location. Undocking the ROV unlatches it from the Research Vessel, readying it to be taken into the water. To dock or undock the ROV, it must be resting on the Research Vessel's platform.



Both Dock and Undock operations share a switch labeled **DOCK**, and an indicator labeled **GO**.

- When the ROV is ready to be docked or undocked, the GO indicator lights up. The Dock Switch also lights up.
- Pressing the Dock switch when it is ready starts the Dock or Undock procedure, as appropriate.
- When the ROV is docked, the Dock switch lights up with a bright color. If it is undocked and ready to dock, it will have a dim color. Otherwise the switch stays unlit.

There is also a set of lights in the frame that indicate whether the ROV is docked or undocked:

- When the ROV is docked, the set of lights on the frame takes a red, unlit color.
- When the ROV is undocked, the set of lights on the frame turn green. This also signals that the frame is now online.

## Research Vessel - Frame and Reel Operation



The Frame and Reel controls are two sets of three switches that operate in a similar fashion: the upper and lower switches trigger movement in one direction, and the central switch stops it if necessary.

After undocking the ROV you will usually operate these controls at the same time, reeling the umbilical cable while rotating the frame out to raise the ROV from the platform and move it over

the water. After this point you typically won't move the frame, though it will remain in operation for as long as the ROV is out of the water.

As with all the other switches, the switches in both sets of controls change color automatically depending on whether they are or not available.

## Research Vessel - Releasing and Retrieving

Releasing is an automatic procedure that turns the ROV On and brings its systems online, readying it for full deployment. Retrieving the ROV marks the point at which it is turned OFF, in preparation to bring it back on board. To release or retrieve the ROV, it must be underwater, close to the Research Vessel.



Both Release and Retrieve Operations share a switch labeled **REL | RET**, and an indicator labeled **GO**.

- When the ROV reaches the depth at which it is ready to be released or retrieved, the GO indicator lights up.
- Pressing the REL | RET switch when it is ready brings the ROV online or offline as appropriate.
- Since the ROV is always either released or retrieved, the REL | RET switch is always lit up and bright. To better signal the current state, it shines green when the ROV is retrieved, and orange when it is released.
- The switch label also lights up either the REL or RET text according to the ROV's condition.

Note: Since the ROV is directly connected to the Research Vessel at this stage, it will oscillate following the motion of the waves. Depending on the oscillation, the "GO" indicator might sometimes turn ON and OFF as the ROV enters and leaves the "safe" release/retrieve depth. This is normal, and you can either wait until it turns ON to engage the switch, or use the reel controls and add or take a bit of extra umbilical to compensate for these movements.

In the real world, all systems related to Releasing and Retrieving an ROV are grouped under the acronym LARS (Launch and Retrieval System).

## ROV - Tether Management System (TMS)

For as long as the ROV is connected to the ship, it will inherit its motions as it is dragged by the umbilical. There are two mechanisms that help avoid this issue, namely the Heave Compensation System, which automatically adds or removes slack from the umbilical, and the TMS, which decouples the ROV from the ship by releasing a tether cable contained in a **Cage**.

subROV uses a TMS with a dedicated **Cage**, a cylindrical-shaped container which you can see on top of SuBerto (the ROV) when it is docked. The cage is latched to SuBerto by default, and they behave as a single body until the ROV is underwater, released, and control is passed to it.



The TMS control is a single switch, labeled **TMS**, with an indicator light labeled **GO** next to it. Like the Dock and Undock switch, you use it both to latch or unlatch the ROV to and from the Cage.

- When the TMS is ready to be activated, the GO indicator lights up.
- Pressing the TMS button when it is ready and the ROV is latched decouples it from the cage, activating all its movement and buoyancy-related controls.
  - At this point, the ROV “is in TMS”.
  - When in TMS, two important aids, Hover and Dynamic Positioning, become available.
- Pressing the TMS button when it is ready and the ROV is unlatched couples it back from the TMS, also bringing the Control switch back online.

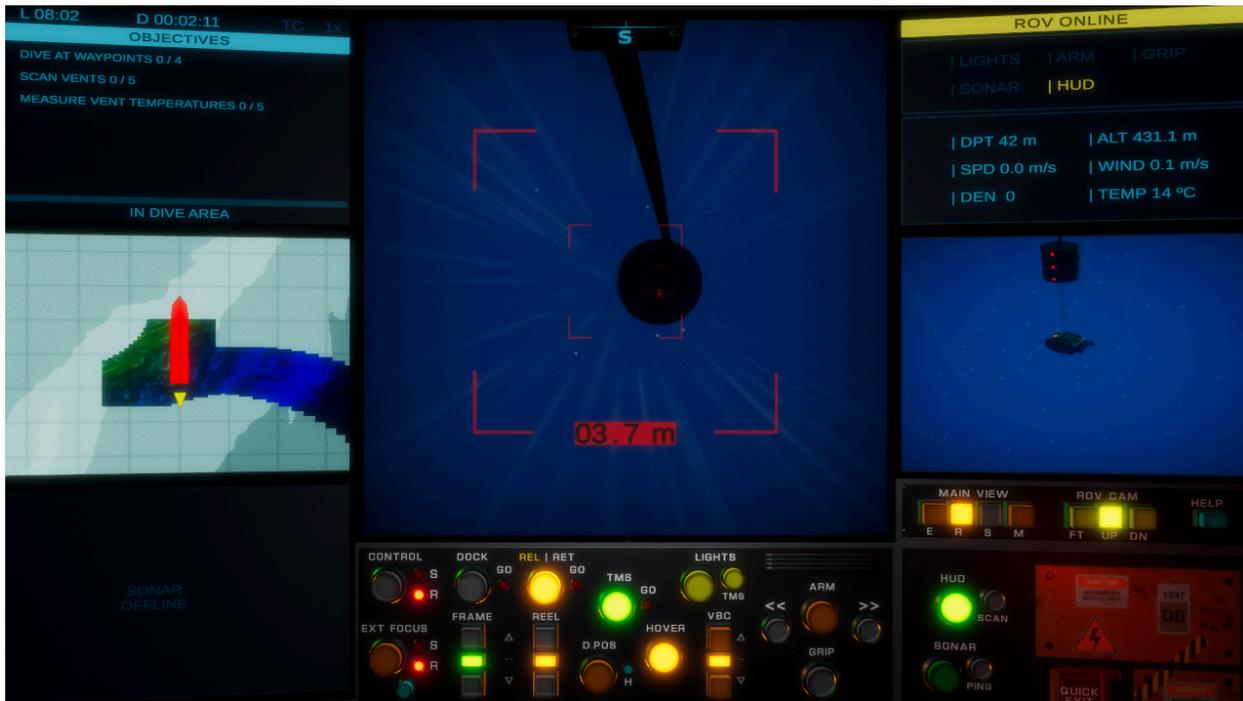
When the ROV is in TMS, it is not subject anymore to the fluctuations of the ship on the surface. It is still tethered to the Cage, but the length of this segment of cable is controlled automatically, so you can move it freely (up to the tether’s length).

To latch the ROV back to the Cage after it’s been moving around, you have to bring it back up to the Cage, to the point where they both touch. The cage is coupled to the ship and will move up and down constantly, so this maneuver takes a bit of practice.

Best Practices:

- Use HOVER to keep the ROV steady as you approach the TMS.
- Disconnect Dynamic Positioning if it was engaged to keep the TMS in place.
- Select the ROV UP camera.
- Connect the HUD. This will show two frames:

- The big frame stays aligned with the TMS.
- The small frame moves with the camera view.
- Move the ROV and the camera until both frames are aligned with the TMS.
- Ascend until the TMS is straight over the ROV, then click the TMS button. The ROV will first realign itself with the cage, then latch to it.



## ROV - Movement

To move the ROV it must be in TMS, unlatched from the Cage.

- You can move the ROV back and forth, left or right, up and down, and rotate it (yaw).

Note that there are no roll or pitch controls - the ROV always stays parallel to the horizontal plane.

## ROV - Variable Buoyancy control (VBC)

ROV SuBerto comes equipped with a system that allows it to change its buoyancy by expanding or releasing compressed air.



The Buoyancy control is a set of three switches, labeled **VBC**, that becomes available when the ROV is fully deployed and free to move, in TMS; the upper switch increases buoyancy, the lower switch decreases it, and the central switch returns the ROV to neutral buoyancy.

- The buoyancy system works in steps, or charges; you have a range of four steps in each direction.

The buoyancy system is silent and passive; it allows you to descend or ascend in a controlled manner, without needing to keep any movement key pressed.

### ROV - Station Keeping (Hover)

Once the ROV is unlatched from the TMS cage, it can be easily dragged by submarine winds, making it difficult to navigate or perform any activity requiring steadiness.



The Hover control is a single switch, labeled **Hover**, that becomes available when the ROV is in TMS. Once engaged, it compensates automatically for any currents present, keeping the ROV in place.

- While hovering you can still move the ROV around, but its maximum speed is greatly reduced.

The Hover system is very useful when operating underwater devices with the arm, or when you need to navigate against the current. In some cases, though, it might be easier and faster to study the currents and use them to your advantage.

### ROV - Dynamic Positioning (D.Pos)

The ROV is free to move around once it is unlatched from the TMS Cage, but by default its range is limited by the length of the last segment of tether.



The Dynamic Positioning control includes a switch, labeled **D.POS**, with an indicator labeled **H** (height) next to it. It becomes available as soon as the ROV is in TMS; when engaged, the Research Vessel follows the ROV at close distance, giving it total freedom of movement.

- When the ROV reaches a safe depth away from the TMS Cage, the H indicator lights up and the Research Vessel starts automatically reeling and unreeling the main segment of tether to match the ROV's vertical movement.

## ROV - Lights



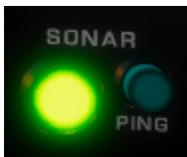
Both the ROV and TMS Cage are equipped with a set of front lights, controlled each by its own switch.

- The ROV light becomes available as soon as the ROV is released.
- The TMS Cage light becomes available when the ROV is in TMS. This light always points at the ROV, following it as it moves.

## ROV - SONAR

ROV SuBerto is equipped with both a passive and an active sonar.

- The passive SONAR is always connected and linked to the general sound system; it registers any sounds occurring underwater as received by the camera displayed in the Main View.



The Active SONAR controls are a set of two switches that become available when the ROV is Online:

- The main switch turns the Sonar View ON and OFF;
- The **PING** switch triggers a pulse that quickly expands from the ROV in every direction, highlighting the contours of the terrain, creatures, and objects in range.
  - The Ping switch becomes available only when the Focus of the External Camera is set to ROV (see below).
  - After you trigger the pulse, the pulse's range is represented by a shaded circle in the Map View.
  - If the pulse reaches a creature or object of interest,
    - An icon will appear over the creature or object in the External Camera View. It will disappear after a few seconds to avoid cluttering the view.
    - A Tracking Dot will appear in the SONAR View. The dot will also disappear after a few seconds, in sync with the External Camera icon.
    - A brief sound will play. This sound is played at the orientation of the creature or object with relation to the camera in the Main View.
  - If the pulse reaches a creature or object of **special interest**, an icon will also appear revealing its position in the Map View. These icons remain visible while the creature or object is in range until it is scanned, allowing you to track it.
- Once a pulse is triggered, it cannot be retriggered until it finishes its current sweep.

The **PING** function, as displayed in subROV, has no counterpart in the real world. For that reason, it is coupled to the external camera view and is only available when the external camera is focused on the ROV (see External Camera View section above).

## ROV - Head-Up-Display (HUD)

The Head-Up-Display is an overlay that shows a reticle in any of the ROV Camera Views, along with useful information about any creatures or points of interest it is pointing at.



The HUD controls are a set of two switches:

- The main switch becomes available when the ROV is online, and turns the HUD ON and OFF.
- The **SCAN** switch becomes available when the camera is centered on a creature or point of interest that is in range and hasn't yet been scanned.

- To scan a creature or point of interest, press the SCAN switch. An indicator will show up on screen representing the scanning progress;
- You must keep the creature or point of interest centered in the camera view for as long as scanning is in progress.

When the ROV's Up Camera is selected, the HUD's reticle will stay fixed in place regardless of the camera's panning. This makes the reticle a reference to orient the camera when returning the ROV to the TMS Cage.

## ROV - Arm

ROV SuBerto is equipped with an extensible arm and a pressure-sensitive grip.



The Arm controls are a set of four switches:

- The main switch, labeled **ARM**, becomes available when the ROV is Online.
  - Pressing this switch once extends or retracts the arm.
  - After pressing the switch, the arm will extend or retract fully, unless it finds an obstacle mid-way.
  - Retracting the arm automatically opens the grip.
- The rotation switches, labeled << **and** >>, become available when the arm is extended.
  - The arm rotates continuously while a rotation switch is pressed.
- The **GRIP** switch becomes available when the arm is extended.
  - Pressing this switch once opens or closes the grip.
  - After pressing the switch, the grip opens or closes fully, unless it finds an object mid-way. This mechanism operates individually for each of the extensible sides of the grip, making it possible to grab objects even when the grip is not centered.

## ROV - Temperature Sensor

ROV SuBerto is equipped with a temperature sensor located on the **end of its arm**. The sensor takes measurements every second and is able to detect temperature changes that differ from the baseline temperature at a given depth, and signal them in the ROV status screen.

- When the arm detects an abnormal rise in temperature (close to a source of heat), the TEMP text changes color, reaching a bright red at the maximum detected temperature.

## Other Controls

### Turbo Lift



Descent and ascent to and from the seafloor can take hours depending on the ROV model and seafloor depth. Turbo Lift is a *fantasy feature* that allows you to speed up descents and ascents considerably.

The Turbo Lift (TL) marker is located in the right upper corner of the Dive Info Screen.

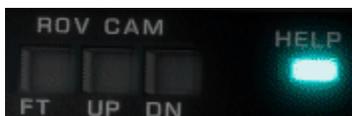
Turbo Lift automatically lights up when the feature is available (descending or ascending, with the External Camera focusing on the ROV, between 50 m depth and 50 m altitude). Once it is available, you can increase the ascent/descent speed up to eight times in three increments, each represented by an additional triangle. You can change speed back and forth at your convenience.

Turbo Lift is meant to be used only to ease descent or ascent, so only a very limited set of actions are allowed while it's engaged (e.g. moving the camera or turning the ROV's light ON/OFF).

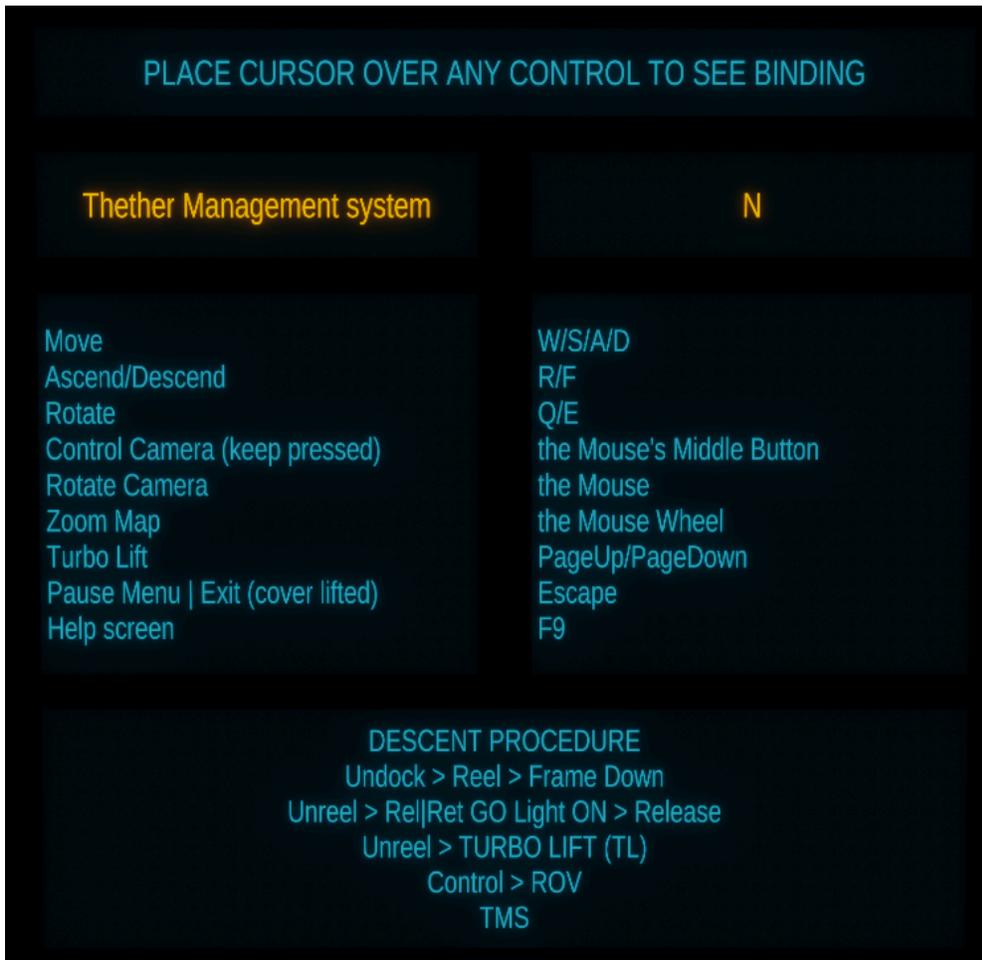
After it is engaged, Turbo Lift will stop automatically when the ROV reaches the upper or lower depth thresholds, or if you use (most of) the controls.

It is important to note ascents and descents are far from routine, as chance encounters with rare creatures are always a possibility. Turbo Lift won't stop if one such creature shows up nearby; it is up to you to focus on speed or observation.

### Help



The Help button is located to the right of the ROV camera controls. Pressing this button brings up the Help Screen to the Main View.



The Help Screen is divided in several sections:

- Individual binding help: when you hover the virtual cursor over a switch, this panel shows you brief information on the switch, and the current controller's binding to it (if there's any defined).
  - If you have set the mouse to control the cursor exclusively, place the cursor on the switch, then click a button on the controller to get help for that controller.
- General control bindings: this is a list of controls that are **not** related to the panel, such as movement or camera control. The list is contextual to the controller you are currently using.
- Descent procedure: a reminder of the steps you need to take to deploy the ROV.

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## Quick Exit



The Quick Exit is a switch that exits the current mission when pressed. It is located in the side panel, and is protected by a transparent plastic cover.

- The quick Exit switch becomes available when the plastic cover is up.
- Pressing the switch immediately ends the dive. It is a shortcut equivalent to leaving the dive area.

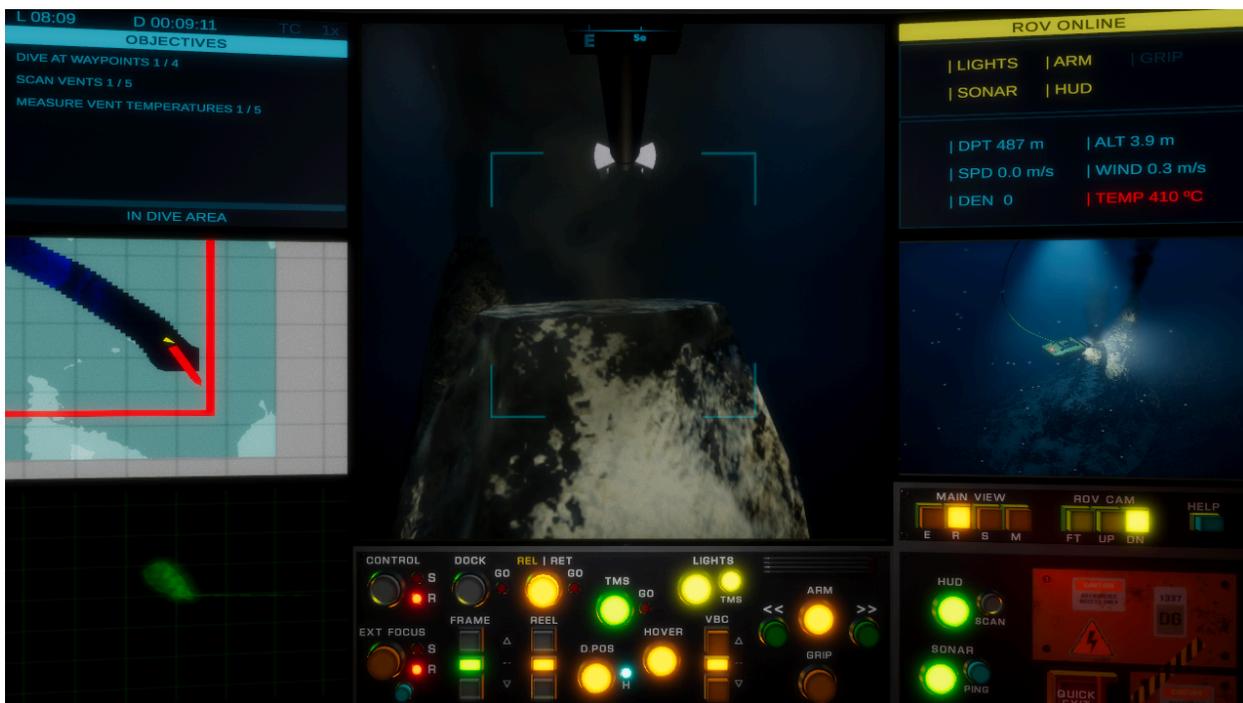
## Procedures

### Measuring Hydrothermal Vents

To measure the temperature of a hydrothermal vent you should aim to move the sensor (located at the end of the arm) as close as possible to a point slightly over the origin of the smoke plume.

Best practices:

- Extend the arm.
- Use HOVER to keep the ROV steady as you approach the vent.
- Select The ROV Down Camera, and point it to the tip of the arm. This will give you an optimal view of the plume's origin as you approach it with the arm.



Even though some of these vents are extremely hot, the temperature around the origin of the plume decreases extremely fast; it is normal to start detecting temperature changes **only** when in very close proximity to the origin.

## Taking Sediment Samples

You can take sediment samples from any sandy areas in the seafloor using a corer -a hollow translucent cylinder fitted with a handle so it can be pushed into the sediment.

To take a sample, you need to

- Retrieve a corer from its canister in the Experiments Platform.
- Take the corer to the area you want to take the sample from.
- Gently push down the corer into the sand.
- Gently move back up and check that there is **any** amount of sediment in the corer. If you see any sediment, the sample is valid.
- Replace the corer back in a canister in the Experiments Platform. This will trigger a signal to the ROV that the sample has been taken correctly.



Best practices:

- Use D.Pos to stabilize the ROV during the procedure.
- Select The ROV Down Camera, and point it to the tip of the arm. This will give you a better view of the corer.
- Choose a flat, sandy area, far from obstacles.
- Use the buoyancy controls to descend at a constant rate.
- Sometimes the corer won't enter with the right angle and might refuse to go down

- Sometimes the corer won't retain the sediment and come back empty.

## Taking Gas Samples

You can take samples from gas seeps using the Gas/Liquid sampler. The Sampler is a modular tool that consists of several identical units (three, in the current configuration), connected to a common funnel. Each unit consists of a bottle connected to a valve system, which is operated with a handle that rotates into three positions: closed (handle's arrow points up or down), open (arrow points right), or purge (arrow points left). A light placed next to the handle lights up with different colors according to the status of the bottle.



To take a sample, you need to

- Retrieve the Gas Sampler from its dock in the Experiments Platform.
- Place the Sampler right over the gas seep.
- Using the arm, rotate the handle a quarter of a turn clockwise into the **open** position, and wait until it fills up.
  - A blinking **blue** light indicates that the bottle is filling up.
    - If you remove the Sampler from the gas seep, the status light stays blue, indicating that the bottle is partially filled.
  - Once the bottle is full, the status light turns **green**.
- Using the arm, rotate the handle a quarter of a turn in either direction to one of the **closed** positions.

If you happen to sample more than one source on the same bottle, the status light will turn **red** to indicate that the bottle's contents are mixed. Mixed samples are invalid, and should be discarded.

To discard a sample,

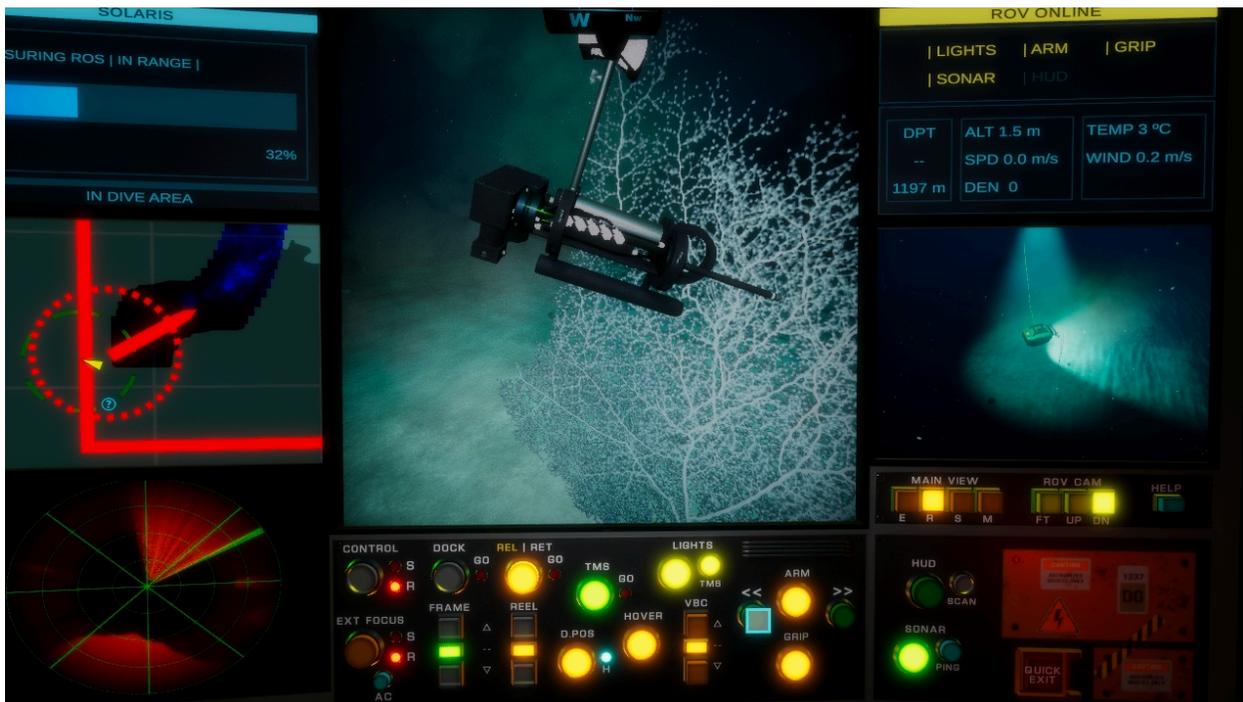
- Using the arm, rotate its unit's related valve into the purge position.
  - You will see a small column of bubbles emerging from the side of the bottle.
  - When the bottle is purged, the status light turns off.

Best practices:

- Use D.Pos to stabilize the ROV while operating the valves.
- The arm's grip fits in the valves' sockets, but you can rotate them even if it's outside.
- Close the valve right after filling up a bottle.
- If you mix the contents of a bottle with a second source, you can purge and refill the bottle right on the spot.

## Measuring Reactive Oxygen Species From Corals

You can measure the ROS levels in corals using SOLARIS (see Glossary for reference). SOLARIS is a tool that consists of a “wand”, an Analysis mid-section, and a Reagent and pump section (the “backpack”). Seawater collected from the wand is mixed with reagents, and the results analyzed on the spot.





To take a measurement, you need to

- Retrieve SOLARIS from its “dock” (a milk crate) in the Experiments Platform.
- Place the tip of the wand as close as possible to the coral.
  - Measuring starts automatically once the unit is close enough to the specimen.
- Keep the wand close to the coral while measuring proceeds.

If during the measuring process the wand gets too far from the specimen, the process is interrupted, and the measurement is discarded.

IMPORTANT - if a measurement fails, to take a new measurement you’ll have to move back the unity a bit, then bring the wand back close to the specimen.

Best practices:

- Use D.Pos to stabilize the ROV while operating SOLARIS.
- Grab SOLARIS facing sideways so you can see better where the tip of the wand is.
- When SOLARIS is close to the specimen, sometimes it’s easier to make fine adjustments rotating the arm than moving the ROV.

## Downloading Data from Buoys

You can download data on Points of Interest or dive parameters straight from data buoys found in the Dive Area.

The location of data buoys is not known in advance. When the ship gets sufficiently close to a data buoy,

- A circle is drawn on the map representing the detection perimeter of the buoy;
- An icon is drawn on the map, showing the location of the buoy;
- A notification that a Buoy is in range is displayed on the Dive Info screen;
- A circle is drawn over the ship on the map, representing the download range of the ship.



To download data, you have to bring the ship close to the buoy, until it is within the ship’s download range; Then you’ll have to keep the buoy within range while the data is transferred. The Transfer progress is displayed on the Dive Info Screen.

After a successful data transfer,

- If the data transferred was a dive parameter, the corresponding element in the ROV Info Screen will become active, showing the data readings when appropriate.
- If the data transferred was a Point of Interest, a circle showing its approximate location will show up on the Map Screen -you might have to zoom all the way out to find it.

### Tracking Creatures

Tracking creatures is a procedure in development, and at the moment it is fine-tuned to work on Humboldt Squid in the Cocos Ridge Dive. For that reason, it has been designed as a semi automatic procedure that shoots a (harmless) tag at the squid the moment it is successfully scanned; in turn, the tag starts sending tracking data immediately after it lands on the squid.

Once tracking starts,

- A Tracking Progress Bar is shown on the Dive Info Screen;
- A Distance Gauge is shown on the external camera, if it is focused on the ROV.
- A sound is heard as the data is being transferred.

The Distance Gauge is a visual aid that connects the ROV to the squid being tracked and shows the distance between them as a color relative to the optimal tracking distance -as the distance increases, the color turns red. In this way you can quickly locate the squid and make sure you are within appropriate range from it.



To track a squid, it is required that it stay within range for a set period of time once tracking starts. If the squid moves out of range, tracking is interrupted and the process resets itself.

- If tracking fails, it will resume automatically if the squid comes back close to the ROV. This applies to **any** squid that has been scanned.
- Only one squid can be tracked at any given time.

Best Practices:

- Even though the tag is both harmless and painless (and safely degrades over time, leaving no residue), squids are sensitive creatures and will move away once tracking starts. Make sure to prepare accordingly.
- Pay attention to the tracking sound; you can estimate if you are getting out of range by the amount of static noise in the signal.

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## Quick Reference

### ROV States

Retrieved - The ROV is Offline, with all its systems disconnected

- Docked - ROV is on the Research Vessel's platform, latched to the Research Vessel.
- Undocked - ROV is unlatched from the platform and connected to the Research Vessel by the umbilical cable.

Released - The ROV is Online. Some or all of its systems are available

- Not in TMS - ROV is latched to the TMS Cage. Systems not dependent on movement are available.
- In TMS - ROV is unlatched from the TMS Cage. All systems are available.

### Descent Procedure

1. Undock > Reel > Frame Out
2. Unreel approx. 12m > Release
3. Unreel (**engage Turbo Lift if available**)
4. Control > ROV
5. TMS (Hover, D. Pos)

### Glossary

ROV: Remotely Operated Vehicle, connected to a host ship via a series of cables. ROVs come in all sizes and form factors, and sometimes are given proper names. subROV's ROV is named SuBerto, and it is an observation class ROV with light-work capabilities.

R/V: Research Vessel. We don't use this acronym in subROV to avoid confusions with ROV. The Research vessel in subROV is the Comatel Explorer; Comatel is a fictional agency funding the Explorer's operations.

A-Frame: The superstructure used to move the ROV out to the sea or back to the R/V. It is named simply Frame in the Control Panel.

LARS: Launch And Retrieval System, a series of mechanisms involved in releasing and retrieving the ROV.



Heave Compensation System: A mechanism that adds or removes slack from the umbilical to counteract the vertical motion of the ship. subROV doesn't use this system at the moment.

TMS: Tether Management System, a device used to decouple the ROV from the host ship's motions while remaining connected.

Cage: The container of the TMS. In subROV it has a cylindrical shape.

Umbilical: Cable that connects the TMS to the Research Vessel.

Tether: Cable that connects the TMS to the ROV.

VBC: Variable Buoyancy Control, a system used to make the ROV more or less buoyant for free and silent ascent and descent.

D.Pos: Dynamic Positioning, a system that keeps both the ship and the TMS in close range of the ROV as it moves around.

SOLARIS: Submersible Oceanic ChemiLuminescent Analyzer of Reactive Intermediate Species, an instrument that measures ROS (see below) in situ, without touching or altering the subject in any way. It does so by sampling seawater in the immediate proximity of the specimen, mixing it with a series of chemical reagents, and detecting their reactions' with ROS with a specialized photocell. The unit consists of two parts, the analyzer section, and the reagent container. In subROV, the analyzer section is almost identical to the real counterpart; the reagent section has been miniaturized and attached to the back of the analyzer to make the whole unit portable.

SONAR: Sound Navigation and Ranging, a system to listen to and map the surroundings of the ROV. Active sonars release distinct sounds, or Pings, and analyze the way in which those sounds interact with objects on their path to image the surroundings; passive sonars listen to and analyze sound sources in those surroundings.

HUD: Head-Up Display, a system that overlays essential information on the pilots' view so that they don't get distracted by looking at gauges elsewhere.

ROS: Reactive Oxygen Species (e.g. superoxygen), a byproduct of biological processes involving oxygen. As they are toxic, and in most cases, undesired, organisms seek to neutralize them. Stressors of various kinds compromise the organisms' ability to neutralize superoxides, thus making it possible to assess the condition of individuals by measuring the ROS they release at a given time against a baseline. Since any stressors could alter the measurements, a tool that allows scientists to measure without interfering, such as SOLARIS, is very advantageous compared to methods that require bringing the subject to a laboratory.



RTM: Read The Manual, a piece of advice that is always good to follow.

# Control Layouts

