OPERATING MANUAL

R300 Recreational Submersible

REDUS ENGINEERING

TABLE OF CONTENTS

I. VEHICLE CHARACTERISTICS

1. R300 SPECIFICATIONS

a. General Capabilities:

1. Operate at any depth from the surface to 300 fsw at a speed of 0-8 knots, and remain submerged for periods of up to approximately 7 hours (72 hours under emergency conditions).

2. Maneuver with thrusters like an airplane. Fly-by-wire control of pitch, roll and yaw enable underwater hydrobatics. Equipment is secured for temporary inverted orientation.

3. Hover at neutral buoyancy and/or rest on the bottom.

b. Specifications

Side and top profile views of the R300 is shown in Figures 1 and 2.

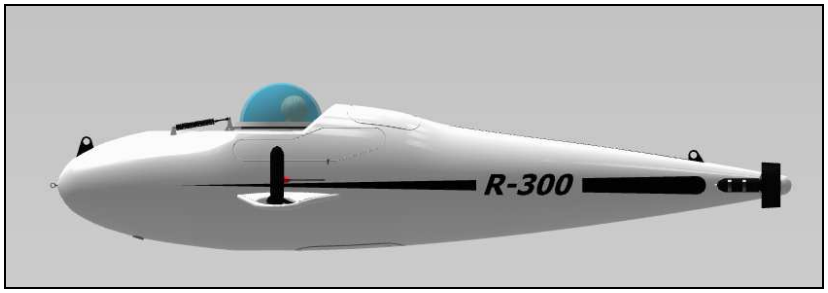


Figure 1 Side Profile View

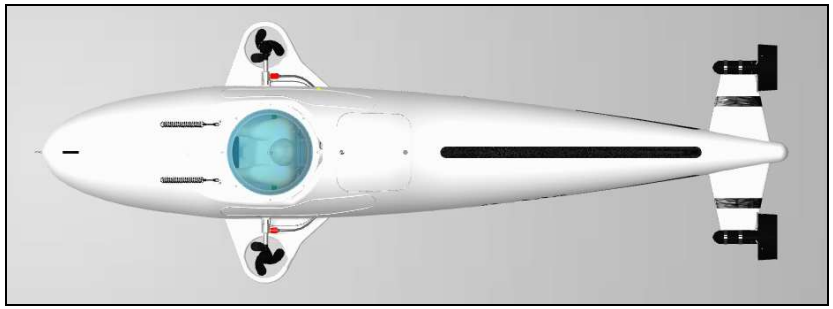


Figure 2 Top Profile View

SPECIFICATIONS	
MAIN DIMENSIONS	
Length	17.3' (5.3 m)
Beam	6'3" (1.9 m)
Height	4'1" (1.2 m)
Draft	2'7" (0.8 m)
Pressure Hull diameter	30” (76.2 cm)
Pressure Hull material	ASTM A516 Grade 70
Pressure Hull thickness	0.25” (6.35 mm)
Dry weight (excluding pilot)	4,239 lbs (1,9 kg)
Operational depth	300’ (91 m)
Payload capacity (with pilot)	260 lbs. (100 kg)
Drop weight	300 lbs (136 kg)
Hatch - ID	21.5” (54.6 cm) opening
Crew	1
PROPULSION & POWER SUPPLY	
Thrusters	Four Minn Kota 101’s
Total Power	5 kWh
Main batteries	327 Ah / 36VDC (9 batteries)
Emergency battery	100 Ah / 24VDC (2 batteries)
Battery endurance	28 hrs (normal operation)
Emergency battery endurance	72 hrs (hotel load only)
GAS SYSTEMS	
Main ballast - Soft	7.6 SCF
Primary Air	76 SCF / 207 bar
Auxiliary Air	66 SCF / 207 bar
Oxygen	78 SCF / 139 bar
Oxygen endurance	7+72 hrs
PERFORMANCE	
Normal speed	5 knots (6 mph) for 8 hrs
Max speed	8 knots (9 mph) for 4 hrs.
Range	30 miles (normal operations)

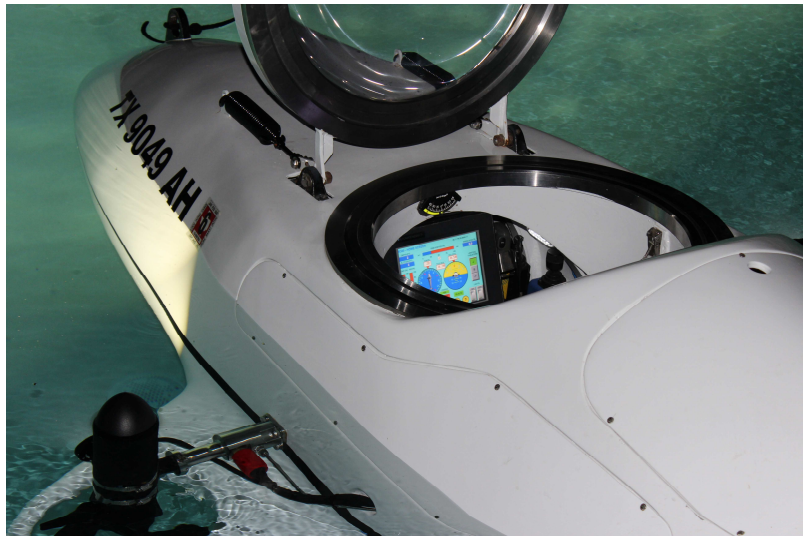
The pressure hull has been designed to conform to ABS Rules for Building and Classing Underwater Vehicles, systems and Hyperbaric Facilities[3].

The 260 lb payload listed above includes the pilot. Any remaining payload is available for user equipment during the dive. This load includes internal and external equipment, subject to some restrictions. Internal equipment must pass through 21.5" hatch opening with adequate clearance.

Normal dive duration is up to 7 hours, but this time may be reduced by excessive power usage. The primary power consumers are thrusters, and hydraulics.

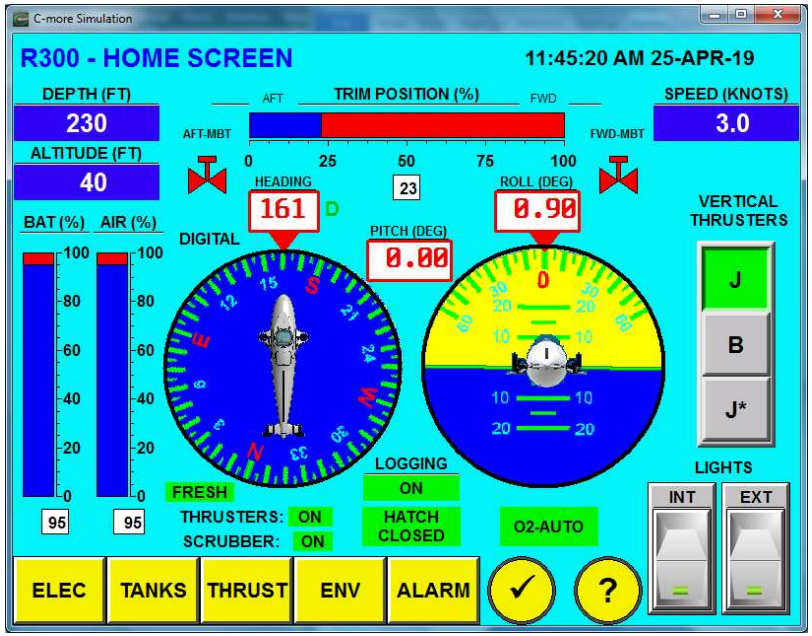
During any given dive, the percentage of time actually spent on the bottom or at desired depth depends upon the amount of time it takes to travel to and from that depth.

For more details on overall design and specifications, see the R300 Plans and Design[2].



The **HOME** screen is the main screen that will be displayed while operating the boat. This gives the operator key information to safety operate the boat including depth and altitude, battery state-of-charge (SOC), air state-of-fill (SOF), heading and speed. From this screen, the operator can navigate to other screens for more detail by using the yellow navigation buttons **ELEC**, **TANKS**, **THRUST**, **ENV**, **ALARM**,

(✓) and **(?)** as shown below. In the Controls section of the manual, a detailed description of each function on this and the other operator display screens is given.



The **get out of jail card** for the boat is the Manual Main Ballast Tank (MBT) Blow Valve on the operator's starboard side.

2. *Support Vehicle*

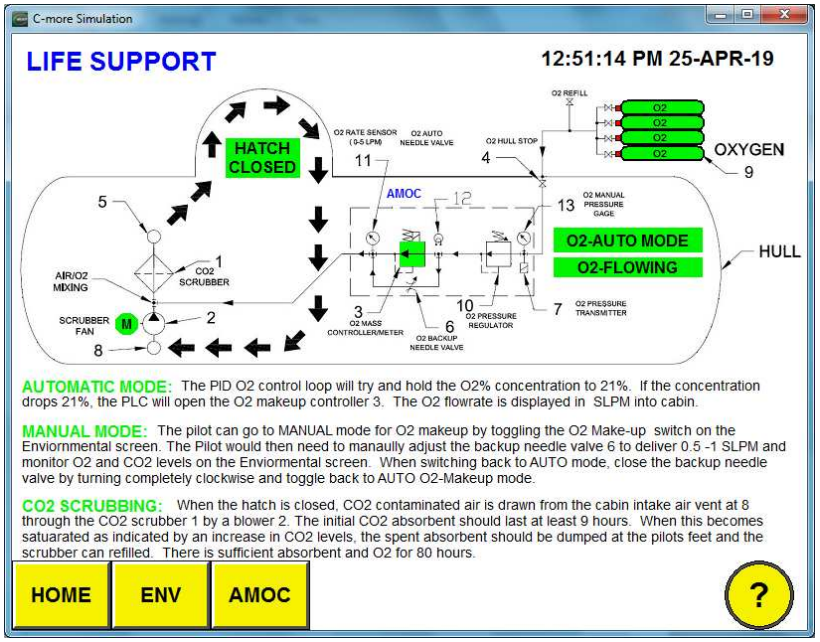
The R300 is designed to be used without a dedicated support vessel. The transport vehicle will serve as the support vehicle and base of operations. The Submersible Operations Officer (SOC) will monitor the dive from this vehicle.

II. SHIP SYSTEMS

1. Life Support

a. Overall System

When the **LIFE SUPPORT** button on the **(?)** (information screen) is pressed**,** a diagram of the overall life support system is displayed on the Human Machine Interface (HMI) as shown below. The major components are the external O_2 high pressure tanks, Air Management and Oxygen Control module (AMOC) and the scrubber. There are two modes for making up lost O_2 consumed by the pilot, automatic and manual. There functions are described on the diagram below.



b. Oxygen

High pressure oxygen is plumbed to a pressure reducing regulator coupled with an adjustable flow meter housed in the Air Management, Oxygen Control (AMOC) module located on the operator's port side. Oxygen makeup can be either automatic (default) or manual. In automatic mode, the oxygen level is held around 21%. In manual or backup mode, it is bled into the compartment at the rate of 0 to 5 SLPM using an adjustable needle valve with the nominal rate being 0.5 SLPM.

The oxygen concentration is monitored continuously and displayed on the touch screen display. The O_2 flow rate is also shown with an analog gage as O_2 (SLPM). If all electrical power is lost, then the backup oxygen dial should be adjusted so that approximately 0.5 SLPM is being introduced into the cabin. When the automatic mode is on, the backup O2 knob should be fully closed.

The O_2 pressure in the external tanks is shown on the HMI under the **TANKS** screen. A gage display of the O2 pressure is displayed in the lower left front panel of the AMOC module.

c. Carbon Dioxide Scrubber

1. Primary System

   The scrubber is a radial filter container that is packed with 3.4 lbs. of Sodasorb HP. The scrubber is mounted in front of the operatornear his knees about 4 inches off the hull for good air flow. The blower is mounted on the top of the filter and draws air in from the sides and across the radial flow filter bed. A fully packed scrubber will last 12 hours.

2. Emergency System

   In addition to the 3.4 lbs. packed in the scrubber, the R300 carries 21 lbs. of Sodasorb in three sealed containers for emergency use. The total endurance for 22 lbs. of Sodasorb is 80 hours for pilot.

d. Atmosphere Analyzers

All life support sensors are installed in the Air-Management-Oxygen - Control (AMOC) module. These include the O_2 pressure, O_2 and CO_2 concentrations, relative humidly, cabin pressure, cabin temperature and O_2 flow rate in SLPM. The purpose of the O_2 and CO_2 sensors are to measure the partial pressure of oxygen and of carbon dioxide so that the programmable logic controller (PLC) in automatic mode and the operatorin manual mode can make the adjustments necessary to maintain the O_2 and CO_2 levels within acceptable limits.

e. Thermal Protection

The submersible is subject to temperature changes. Long underwear, snowmobile type jump suits and chemical heat packs are provided to the operatorfor protection in case of long exposure. It is advisable to carry a sweat shirt or other long sleeved shirt and wear long pants.

f. Food and Water

The submersible carries 2 quarts of potable water, plus enough vacuum sealed food sticks (USCG approved life raft rations) to provide 3 days life support.

2. Pneumatic System

The pneumatic system consists of high pressure external air tanks, a high pressure internal composite tank and external high pressure O_2 tanks.

a. Air

High pressure air is stored externally aft of the hatch in a single bank of scuba tanks. This bank consists of four aluminum S19 air pony bottles with a bank capacity of 76 SCF at 3000 psig (207 bar). Air is used the blow the MBT and also for the BIBS.

In addition, there is an auxiliary air supply in the form of a 66 SCF composite air tank at 3,000 psig (207 bar). The auxiliary air supply valve is just aft of the hydraulic jack.

The high pressure air is used for buoyancy control and to pressure compensate the thrusters. Buoyancy is obtained by the use of the Main Ballast Tanks (MBT) which provides a total of 419 pounds of lift. A pressure reducing regulator reduces the pressure for the MBT to 50

psig above ambient water pressure. A relieving pressure reducing regulators supplies air to the thrusters at ambient water pressure and vents this pressure when the boat ascends.

All controls are located on the main control box.

b. Oxygen

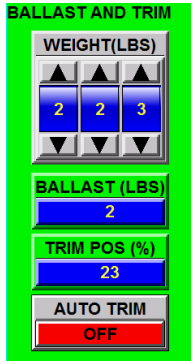
Oxygen is stored in a single external bank with tanks on the port and starboard sides. Each side consists of one medical "E" sized aluminum cylinder and one "D" sized cylinder with a bank capacity of 78 SCF at 2,000 psig (139bar). Both sides are connected together and available within the compartment. The oxygen endurance is 79 hours. This meets ABS rules[3] of 72 hours plus the normal mission period of 7 hours. Oxygen is used only for oxygen make-up to replace that which is lost due to metabolic consumption by the pilot.

3. Hydraulic Systems

Hydraulic power is provided through a 24 VDC hydraulic trim pump. This hydraulic system consist of three components, a positive displacement hydraulic pump driven off a 24 VDC motor, a one quart oil reservoir and a pressure relief valve. Hydraulic power is used to move the trim weight either forward or aft to trim the boat longitudinally.

4. Longitudinal Trim

The operator can trim the R300 longitudinally. This can be done two ways, automatically with the Trim Wizard or manually. When using the Trim Wizard the operator enters the his/her weight in the Trim Wizard found on the (✓) screen and hitting the **AUTO TRIM** button. To trim manually, press the trim buttons on the main control box which controls the longitudinal movement of 100 lbs of lead ballast located in the trim tube assembly. If the submersible is pitched upward while in a static condition, the operator presses the trim-weight-forward switch and watches an indicator on the **HOME** screen that tells him when the submersible is level. Likewise, if the submersible is pitched downward, the operator presses the trim-weight-aft switch and watches a gauge that tells him when the submersible is level. The operator then releases the button and the trim weight is locked in this position. This gives the submersible the ability to pitch upward or downward by about 10 degrees. Trimming should be done after the MBT is flooded.



5. VBS System

The Variable Ballast System (VBS) consists of adding lead ballast in a bay aft of the pilot. The Trim Wizard is used to determine the required ballast depending on the pilot's weight.

6. MBT System

The Main Ballast Tank (MBT) system is external and soft. There are two MBTs, one forward of the pressure hull and a saddle tanks wrapped around the aft part of the pressure hull. Air for blowing the MBT is supplied by four Catalina S19 scuba tanks. There is also an auxiliary air tank with a capacity of 66 SCF that can be used to blow ballast tanks. These tanks are filled to approximately of 3,000 psig and contain in total 142 scf of air. At 150 psig, these HP air

tanks will hold 7.8 scf. Therefore, the volume of air available to blow the MBT from an initial pressure of 3,000 psig down to 150 psig, is 135 scf. With the MBT volume being 6.4 ft^3, this gives the operator the ability to blow the MBT 21 times at the surface or two times at the maximum operating depth of 300 ft. See MBT Blow and Flood buttons on the control box. Press the MBT ↑ button to initiate the MBT blow on a timer. At the end of the MBT blow, operatorshould see air coming from MBT flood ports. Valves will shut off automatically. To flood the MBT automatically, hit the MBT ↓ button for one second and release. MBT valve icons shown on the home screen are green when open, red when closed.

In the event that the electrical control of the MBT fails such as with loss of all electrical power, a manual MBT valve is available. On the pilots starboard side is the MBT Air Distribution Panel (ADP). The Air Direction (AD) valve enables the operatorto selectively direct air to the forward, aft or both MBTs. This valve should normally be set on both. At the bottom of the ADP is the manual MBT blow valve. Normally this is in the closed position. At any time, this valve can be opened to force air into the MBTs as directed by the AD valve.

At the top of the ADP is the Built-In-Breathing-System (BIBS) valve. When this valve is open, Low Pressure (LP) air is available for breathing by connecting a LP second stage scuba regulator to a quick disconnect on the top of the ADP panel.

7. Electrical Systems

a. Main Battery

There are nine deep-draft, Absorbent Glass Mat (AGM) marine batteries in the main battery bank. These are set up as three banks connected in parallel with each of these three banks made up of three batteries connected in series. This bank is located within the pressure hull behind the pilot. Sealed AGM batteries were chosen primarily for safety reasons in that they can be operated at any orientation without spillage and they do not generate significant amounts of hydrogen gas during recharging. The main battery bank contains nine 12 VDC, 109 amp hour batteries giving a capacity of 327Ah.

b. Emergency Battery

Emergency battery is composed of two 100 Ah batteries connected in series. The “AUX” position of the master switch activates only the emergency battery system. In this position, the onboard Programmable Logic Controller (PLC) is powered as well as life support and communication systems. Propulsion and the hydraulic systems are offline while the master switch is in the “AUX” position.

c. Human Machine Interface (HMI)

By selecting different HMI display screens, ship systems can be viewed and interrogated. All instrumentation for the boat are interfaced with the PLC and displayed on the HMI. The HMI is designed to be rotated back underneath the pressure hull when not in use. This facilitates entering and exiting the boat.

d. DC-Power Converter

A DC to DC converter is used to convert 36 VDC from the main battery bank into 24 VDC for running all equipment except the thrusters and exterior lights.

e. Thruster Motor Controllers

Each of the thruster motor controllers works on the principle of varying the average motor voltage based on Pulse Width Modulation (PWM) technology. These controllers require a 0-5V signal from the PLC to control both the speed and direction of the thruster motor.

f. Thrusters

There are four Min-Kota 101 trolling motors that have been modified to act as pressure compensated thrusters. The aft horizontal thrusters have been fitted with Kort nozzles with a MARIN 37 series profile. These motors are brushed motors with a 36 VDC nominal operating voltage and a maximum operating current of 50 amps.

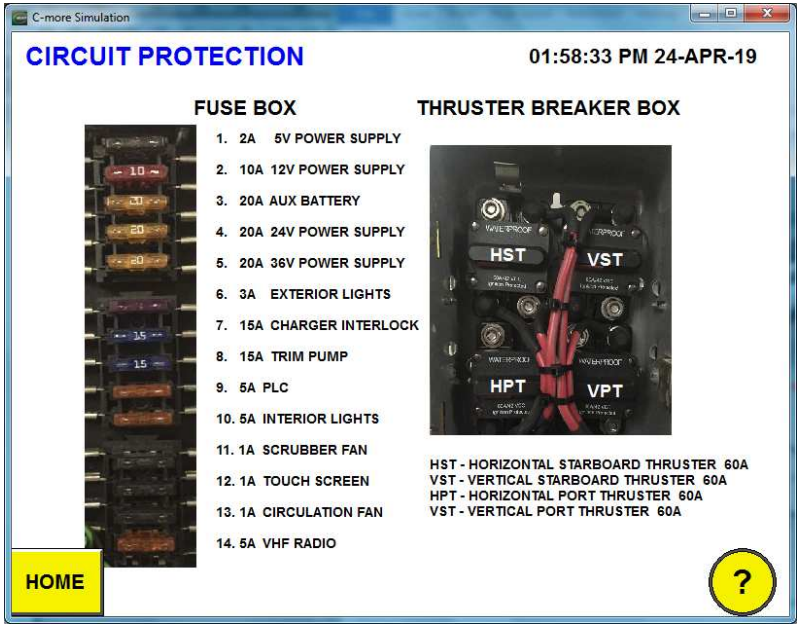
g. On Board Battery Chargers

There are two on-board battery chargers, one for the 36 VDC main battery pack and one for the 24 VDC emergency battery bank. To charge both banks, a 120 VAC plug rated for 20 AMPS can be

plugged into a 20 amp extension cord. The State of Charge (SOC) of the main battery bank is displayed while the main battery is being charged.

h. Fuse Box

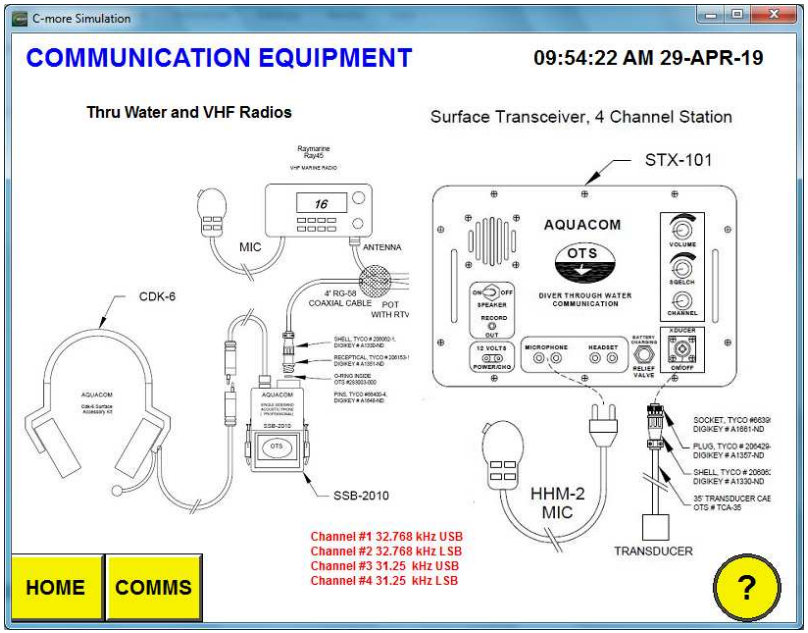
The fuse box is located on the port side of the operator seat. There are fourteen fuses with the function and maximum current of each shown below. A spare set of fuses is stored in the fuse box. In addition to these fuses, there is a circuit breaker for each of the four thrusters. These are located in a box mid ship on the starboard side just above the main batteries. If any of these breakers are tripped, they can be reset by pressing the top of the breaker.



8. Communications

The R300 is outfitted with an all channel marine VHF radio for surface communications. Also on board is an Offshore Technology Systems (OTS) underwater 2-way radio. Refer to the dive plan for the channel settings for both the VHF and OTS radios. Additional information on the communication systems is available to the by touching the **COMMS** button on the **(?)** screen. Shown below or the help screens for each button on **COMMS** screen. On the OTS system, to hear the current settings, press the PTT button on the head set three times. To change an OTS setting, press the PTT twice and then one time select an option on hearing it. Press the PTT twice to exit.

The information screen for each of these buttons is shown on the screens that follow.



C-more Simulation

AQUACOM OPERATING PROCEDURES

02:00:08 PM 24-APR-19

STEP 1: Ensure all internal settings are properly adjusted (i.e., Squelch, VOX, Side Audio, and Receive Audio)

STEP 2: Connect the Hi-Use® connector from the SSB-2010 to CDK-6 headset.

STEP 3: Confirm red LED is illuminated which indicates power is on.

STEP 4: Depress the PTT button and talk into the microphone. You should hear your voice in the earphones. If using the system in the voice activation mode (VOX), use a vowel sound such as "AH" or say the number "FOUR" to trigger the VOX.
You should hear your voice (side audio) in the earphone (if the volume is too loud or soft, refer to the adjustment). (Note: The SSB- 2010, when first initiated, always begin in the PTT mode.)

STEP 5: Verify your transceiver is on the same channel everyone else will be using, earphone volume levels are to your liking, the VOX setting is proper (if VOX is to be used), and the squelch setting is proper for the environment and/or range you require. Refer to the adjustment procedures for assistance if necessary.

STEP 6: Turn off the squelch. Place transducer to transducerand transmit between the units. Verify that the units transmit to and receive from each other.

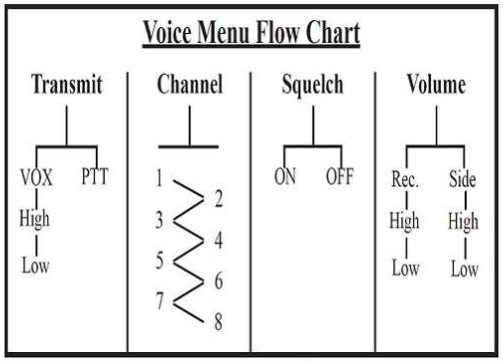
NOTE: The received sound will not be as clear in these tests as in open water. The units are factory set to start in the PTT mode, squelch off, earphone volume high, and Channel 1 for the SSB-2010.

HOME COMMS ?

C-more Simulation

VOICE MENU

01:59:34 PM 24-APR-19



VOICE-OPERATED TRANSMITTER (VOX)

VOX operation provides hands-free communications. The user simply talks for the unit to transmit automatically. The user can deactivate the VOX and use push-to-talk by simply switching to the PTT mode via the voice adjustment mode.

Hear Current Settings ==> Hit PTT 3 times
Change Settings ==> Hit PTT 2 times, then once to select, twice to exit

HOME COMMS ?

C-more Simulation

AQUACOM ADJUSTMENTS

02:00:24 PM 24-APR-19

Voice Adjustment Mode:

The SSB-2010 has a unique feature that allows you to adjust the unit electronically either out of or in the water. If you depress the PTT button twice within one second, the transceiver enters a "Voice Adjustment Mode." You will hear in your earphones a voice offering you the choices "Transmit, Channel, Squelch, Volume." This message will continue until you make a selection by pressing the PTT button once when you hear your desired option.
When completing your adjustments, you have the option to double- or triple-press the PTT button quickly. A double-click will directly exit the "Voice Adjustment Mode." Your transceiver will be in the receive mode. A triple click will tell the transceiver to play back all settings in your earphone. You can triple-click at any time if you want to know all your settings.

Push-to-Talk (PTT) Button:

The PTT button serves a dual purpose: (1) When depressed and held, the transmitter is activated. As long as you hold the PTT button, you will be transmitting. When you release the button, your transceiver will automatically return to the receive mode. If you are in the VOX mode, you can still depress the PTT to override the VOX. This feature is useful if your VOX is not adjusted properly and you have trouble activating the VOX.

Transmit Adjustment:

Access the Voice Adjustment Mode by pressing the PTT button twice within one second. You will hear in your earphone, 11 "Transmit, Channel, Squelch, Volume." Press your PTT once when you hear "Transmit." Your choices will be "VOX, PTT." Press the PTT when you hear the setting you desire.

NOTE: Your speech should be considerably slower than normal, and each word should be pronounced clearly and distinctly. Speak one word at a time instead of in flowing sentences. Do not shout, but use slightly louder than normal conversational volume.

HOME COMMS ?

C-more Simulation

OTS SSB-2010 SPECIFICATIONS

02:00:38 PM 24-APR-19

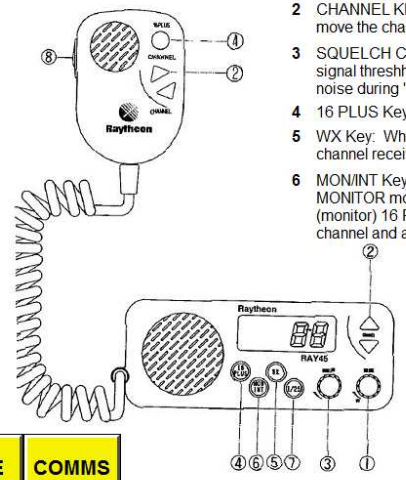
Nominal Range: Calm Sea: Greater than 1000 meters
Sea State 6: 200 meters
Acoustic Output Power: SSB-2010: 5 W PEP* (176.2 dB re 1 µPA at 1 meter)
Audio Frequency Response: 300–4000 Hz
Receiver Sensitivity: –110 dBv
Automatic Gain Control: 120 dB dynamic range
Transmitter Activation: Voice-operated transmitter (VOX) or manual activation (PTT)
Transmitter Band: SSB-2010: (1) 32.768 kHz (2) 32.768 (3) 31.250 (4) 31.250
Transducer: Piezoelectric type
Earphone: Ceramic type (standard on most FFMs)
Housing: Injection-molded, high-impact, glass-filled ABS plastic
Maximum Depth: 500 ft.
Housing Dimensions: Height: 7.60", Width: 3.55", Depth: 1.80"
Operating Temperature: 0°C to 60°C (32°F to 140°F)
Storage Temperature: –10°C to 60°C (–14°F to 140°F)
Low Battery Indication: Red LED on upper housing
Connector Type: Hi-Use®
* PEP = peak envelope power

HOME COMMS ?

C-more Simulation

RAY 45 LAYOUT

02:00:52 PM 24-APR-19



1 VOLUME Control (On/Off)

2 CHANNEL KEYS The Up and Down keys are used to move the channel selection up or down.

3 SQUELCH Control: Provides and adjustible input signal threshhold to eliminate random RF background noise during "no signal" conditions.

4 16 PLUS Key: Used to select channel 16 immediately.

5 WX Key: When pressed, puts the radio in weather channel receiving mode.

6 MON/INT Key: When pressed, puts the radio into the MONITOR mode. In this mode, the radio will scan (monitor) 16 PLUS (priorty) channel, a selected working channel and a weather channel for a weather alert tone.

7 1/25 Key: When pressed, alternatively changes the radio output power from 1 watt to 25 watt.

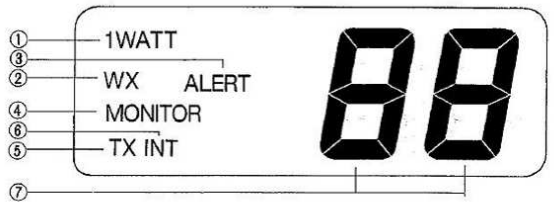
8 PTT (Push-To-Talk): When pressed, puts the radio into transmit mode and a "TX" is displayed.

HOME COMMS ?

C-more Simulation

LCD DISPLAY

02:01:11 PM 24-APR-19



1 1 WATT (High/Low Power): Will be displayed when transmitter circuits are providing 1 watt of power to the anttenna. When transmitter circuits are providing 25 watt, the 1 WATT will be extinguished.

2 WX (Weather): Will be displayed when the channel selected to be monitored is a weather channel.

3 ALERT (Weather Alert): Will blink when a weather alert tone has been detected.

4 MONITOR: Will be displayed when the MON/INT key is pressed. This indicates the radio is in Monitor mode.

5 TX(Transmit): Will be displayed when the PTT (Push-To-Talk) key is pressed.

6 INT(International/USA): Will be displayed when the international channels are programmed for use INT is not displayed when USA channels are programmed for use.

7 LCD Segments: Will displayed channel number in use.

HOME COMMS ?

C-more Simulation

RAY 45 - OPERATING PROCEDURES

02:01:25 PM 24-APR-19

STEP 1: Turning the Power On

1) Rotate the ON/OFF/VOLUME control clockwise to turn the radio on.

STEP 2: Setting the Volume

1) Rotate the SQUELCH control fully counter clockwise. Background noise will be heard.
2) Rotate the VOLUME control for the desired volume level.

STEP 3: Setting the SQUELCH

1) Rotate the SQUELCH control fully clockwise until background noise ceases.

STEP 4: Setting the Power Output

1) Simply press the "1/25" key to toggle between 1 watt output and 25 watt output.

STEP 5: Select the Channel

1) To select the disired channel, press the Up and Down channel selection keys.

STEP 6: To Transmit

1) Select the desired mode (INTor USA) by holding the MON/INT Key for more than tw seconds. Then press the PTT switch and speak into the microphone using a clear normal voice.
2) When the power is initially turned on, simply touch the PTT switch. The radio will be ready for transmission on channel 16 or a user selected priorty channel (16 PLUS).

HOME COMMS ?

C-more Simulation

VHF CHANNELS

02:01:39 PM 24-APR-19

CHANNEL 9:

The primary hailing channel. (Establish contact on this channel and move to a "working channel" as soon as possible.

CHANNEL 16:

The Emergency and Distress hailing channel only.

CHANNEL 22A:

Restricted to USCG use only. If you establish contact with the USCG on Channel 9, or 16, they may ask you to switch to Channel 22A.

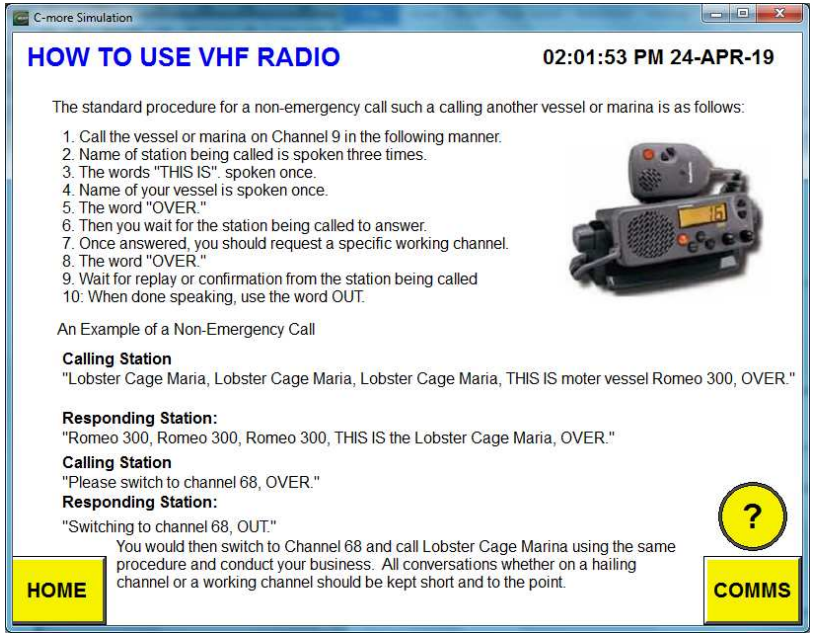
CHANNEL 13:

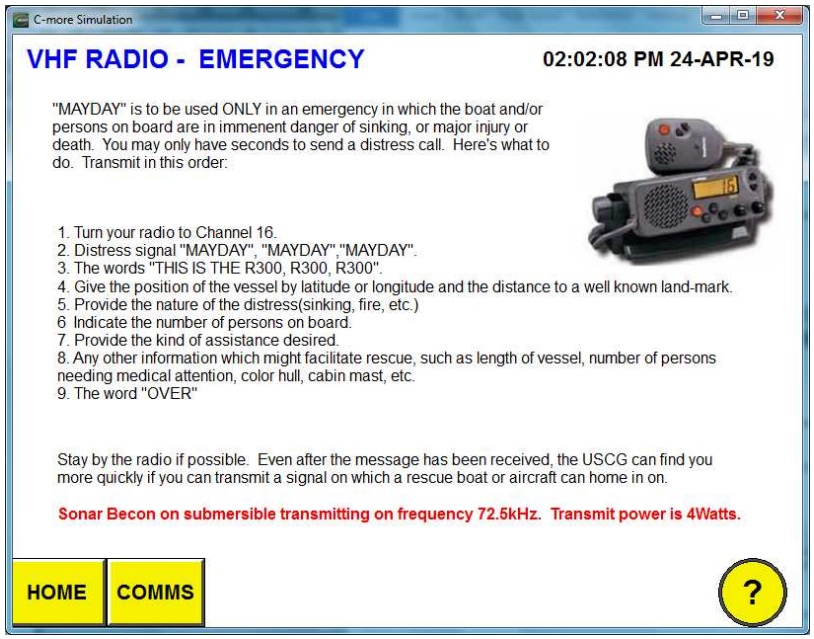
Bridge to Bridge commnication between vessels. Also used to request bridge openings.

CHANNELS 68, 69, 71, 72, 78A:

"Working Channels." The only channels available to non-commercial vessels for ship-to-ship and ship-to-shore communications.

HOME COMMS ?





9. Navigation Aids

a. Depth

The R300 uses an ambient water pressure transducer interfaced with the PLC to measure water depth. The depth is displayed on top left of the **HOME** screen. As a backup, the water depth is displayed for fresh water with a bourdon pressure gage shown in the picture to the right.

b. Altitude

In addition to the depth, the altitude over bottom is also displayed on the **HOME** screen. A sonar sensor with a range of 0-175 ft sends a serial communication signal to the PLC while the boat is in the water.

c. Compass Heading, Pitch and Roll Angle

A single sensor system, packaged for submerged operations, is used to measure compass heading as well as pitch and roll of the submersible. The sensor enclosure is located in the aft exostructure outside the pressure hull so that the effect of the hull on the magnetometer can be calibrated out. As a backup, bubble style roll and pitch inclinometers are installed just below the lower hatch ring.

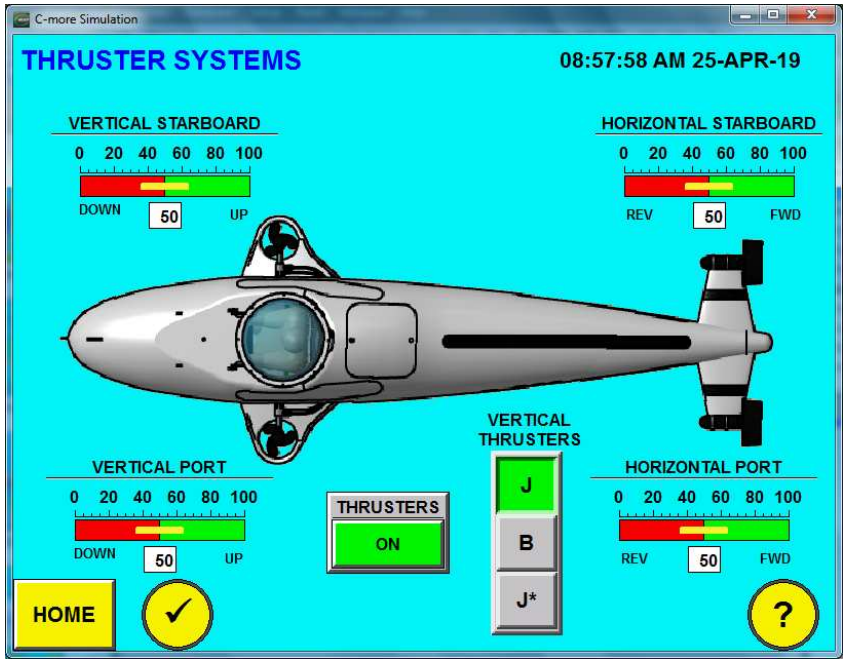
10. Lighting

Starboard and port exterior illumination is provided by four custom LED underwater lights. Each of these is a 36 VDC, 30 watt LED lamp that emits 5,000 lumens and has a maximum depth rating of 500 ft. The exterior light switch is on the bottom right of the **HOME** screen.

11. Thrusters

There are four thrusters, two in a horizontal orientation aft and two in a vertical orientation mid ship. The status of these thrusters can be obtained by touching the **THRUST** button from the **HOME** screen. Forward and reverse movement of the boat comes from the thrust of the aft horizontal thrusters. Each of these 125 lbf thrusters is equipped with a Kort nozzle to increase thrust. Forward and reverse movement is controlled by the foot control. Yaw movement of the boat is achieved by reversing the direction of these thrusters and is controlled by rotation of the operator joystick. Rotating the joystick in a clockwise direction results

in a yaw movement to the starboard side while counter-clockwise rotation rotates the boat to the port side.



Thrusters and the trim systems can be turned off to save power if the boat is stranded on the bottom by toggling the **THRUSTERS** power button at the bottom of this screen.

Each of the four thrusters is pressure compensated with air so their operation is independent of depth.

Each thruster is controlled by a dedicated motor controller. On the **THRUST** screen, the 0-100% output signals to the thrusters based on the joystick and foot control are shown for each thruster.

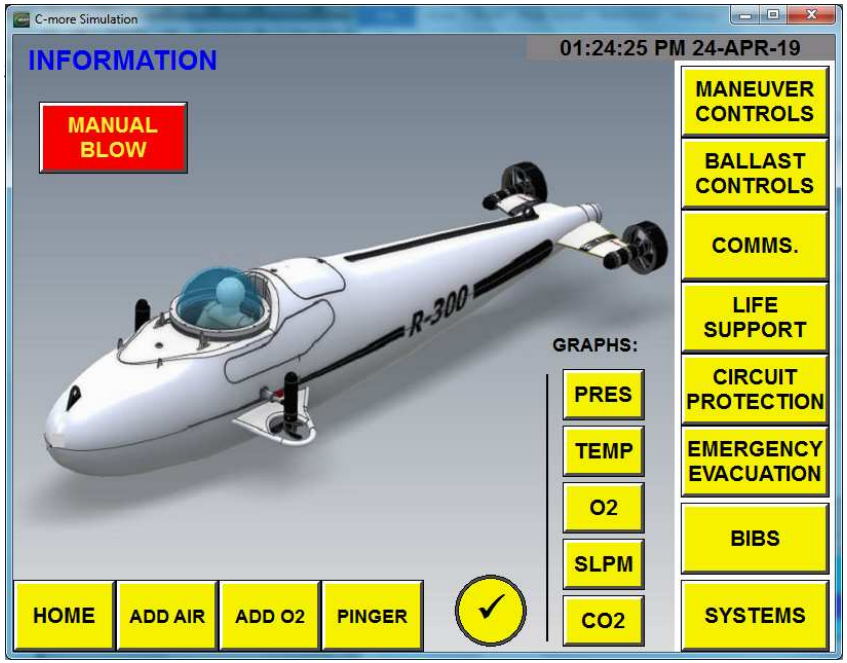
The **VERTICAL THRUSTER** selection toggles control of the vertical thrusters between 3 modes, J, B and J*. "**J**" is for joystick for full control, "**B**" for VT buttons on the main control box to control the vertical thruster with ↑ and ↓ buttons and finally the **J*** (default) mode which is joystick control but with the roll motion locked out. Touching the VT ↑ and ↓ buttons on the control box will trigger Button mode and likewise, pulling the joystick fully back while in Buttons mode will trigger full Joystick mode.

III. OPERATIONS

1. Safety

Guidelines from American Bureau of Shipping "Rule for Building and Classing and Underwater Vehicle, Systems, and Hyperbaric Facilities" were used as a basis for the R300. Key safety features include:

- The pressure hull has been designed and tested to American Bureau of Shipping requirements of 1.25 times the rated design depth of the vehicle. The test depth was 400 fsw and R300's maximum operating depth is 300 fsw, well under the test depth.
- In order to ensure that no water leaks into the pressure hull, all penetrations for wires, pneumatic lines, view ports and hatches are designed in such a way that they actually provide a tighter seal the deeper the vehicle dives and these devices are inspected prior to each dive.
- While the vehicle weighs over 2 tons in air, when submerged it can be made exactly neutral by trimming with the variable ballast system so only a very slight force is required to move it up or down. It is therefore possible to ascend or descend by using the vertical thrusters.
- If for any reason additional buoyancy is needed, the main ballast tanks can be blown at any depth.
- A lead drop weight can be released mechanically giving an additional 300 lbs. of positive buoyancy.
- The maximum dive duration is 7 hours, however, sufficient oxygen, water and supplies are provided to allow the submersible to remain submerged in an emergency situation for a period of up to 3 days.
- Emergency Procedures will be reviewed prior to each dive and are posted in the submersible handbook and also available on the HMI **(?)** screen under **EMERGENCY EVACUATION** and **MANUAL BLOW**.



2. Training Policy

Prior to the first time the operator will be allowed to dive the R300, he/she must undertake and pass a rigorous training protocol that includes demonstration of his/her ability to operate all ship systems including, ballast, longitudinal trim, life support (both automatic and manual), communications, emergency blowing of MBT at depth, emergency release of the drop-weight, and the emergency escape procedure.

Likewise, the SOC will undergo training in all ship systems with particular attention to emergency procedures and communications.

3. Submersible Operating Day

A submersible operating day is an 8 hour period (typically 0800-1600), depending on the type of mission. This is 8 consecutive hours and includes pre-dive checks, briefings, dive time, replenishment, down loading and debriefing. It may also run concurrently with undivable sea states and will not advance as the weather moderates.

The basic daily schedule will be established during the pre-mission communications.

4. Daily Dive Scheduling

Normally, two 3 hour dives per day are conducted typically starting at 0800 with surface replenishment at the end of the dive. The limiting factor is the battery which requires recharging overnight. The total dive time per day cannot exceed 8 hours. Excessive and long excursions will drain batteries fast and will result in a shorter dive. If for any reason the State of Charge (SOC) for the main batteries falls below 50%, then mandatory surfacing for recharging is required. When planning your dive, schedule 8 hours as the maximum total dive time for any operating day. This is done so that maximum battery life is achieved throughout an operating year. It is recommended that the operator meet each evening with the SOC to finalize the dive schedule and identify the names and weights of personnel and equipment to be on board the R300 the following day.

Notes:

1. Battery capacity is reduced by water temperature below 10°C (50°F) and can reduce dive time.
2. Dives covering long distances reduces battery capacity faster than dives remaining in a given area.
3. The operator constantly monitors the battery condition and can elect to shorten a dive if conditions warrant.

5. Operations Guidelines

a. Operational Limits:

The R300 submersible operates within various limits. These limits are based on safety, environmental, electro-mechanical and operational factors and were developed in order to provide the safest and most reliable submersible system in our class.

The limits listed below are not to be exceeded except in the case of a properly approved, preplanned mission or in case of an emergency to ensure the safety of personnel.

1. The Pilot-in-Command will have the authority to terminate a dive by whatever means necessary at any time that he/she feels a hazard to the submersible or him/herself exists, without regard to mission success or completion.

2. R300 will not be operated where the bottom depth exceeds 300 fsw.
3. R300 will not be operated below a depth of 300 fsw.
4. R300 will abort any attempt to operate near wreckage, debris or natural terrain features which have entanglement or entrapment potential when visibility is low, current is high, or battery voltage is low.
5. R300 will remain clear of any explosive devices which may be sighted.
6. R300 will not work or be on station beneath or near a suspended load, or a towed array.
7. R300 will not transect in blackout conditions within 50' of the bottom or towards vertical walls or high relief areas.
8. R300 will not transect in a current strong enough to prevent stopping the submersible to avoid an obstacle.

b. Limiting Conditions

The submersible and its support vehicle are a matrix of systems. Each one has its own function and operating characteristics. Every attempt is made to ensure that all systems are fully functional. Some systems, if not functional, pose no threat to operating safety. It is up to the SOC, and operator to determine what, if any, effect loss of this equipment has on the success of the dive. Other systems, particularly that for life support, main power, and communications are indispensable and must be operational any time the R300 submerges. Loss of this equipment during a dive constitutes a reason to switch to back up systems and abort the dive.

The ability of the R300 to complete her mission successfully is also affected by conditions beyond any control; high current, low visibility, surge or heavy seas, rugged topography, overhangs or the overabundance of entangling artifacts such as commercial fishing gear. Any of the above may require a modification to the dive plan based on the operator and/or the SOC assessment of the risk involved.

Weather and lake/sea condition play an important part of a successful mission. It is up to the SOC to determine that there is a reasonable fair weather window to ensure a successful launch, dive and recovery. Every situation is different, i.e., wave height, period, wind speed, height and direction of underlying swell, and weather forecast, so it is

difficult to place a predetermined limit on launch or recoveries. However, the probability of a successful launch and/or recovery is low when the wind is above 20 knots or the sea state is higher than 2 (1.5-3 foot waves).

6. Pre-Dive Briefing

Every operator is given a briefing by SOC inside the submersible prior to making his/her first dive. This briefing, which takes approximately 10 minutes, is done at the time of the individual's first dive just prior to launching. It details the location of controls, instrumentation, normal and emergency procedures. Emergency procedures are located in the cabin and are readily accessible to the pilot. This operator's manual will be aboard at all times. In addition, most of the information in this manual is available to the operator through the HMI by touching the information button **(?)** on the home screen.

7. Off-Loading

The R300 is designed to be transported and off-loaded much like a conventional recreational motor boat. The Gross Vehicle Weight (GVW) of the sub and trailer is 5,300 lbs. with a tongue loading of 500 lbs. A transport vehicle with the hauling capacity of at least 7,000 lbs. GVWR is recommended. Always use caution when backing your sub into a new launch and verify that the necessary depth exists to offload the sub. Recommended ramp depth at 25 ft. from water's edge is 4 ft. or greater.

To expedite off-loading, prior to arriving at the ramp, the sub should be loaded with everything that is needed for the mission. Find a quiet spot in the parking lot away from the launch lane traffic. The SOC and operator should go over the ON-BOARD and SYSTEMS checklist given in Appendix B and displayed on the **CHECKLIST** screen before traversing to the boat ramp. When you arrive at the ramp launch lane, all that is needed is to launch the sub into the water. While in the water, the PRE-DIVE checklist should be used before submerging the boat. All **CHECKLIST** items must be green before launching the boat.

Launching

1. Chock trailer and extend tongue extender.
2. Take off the trailer straps.

3. Operator climbs into sub.
4. Back the sub and trailer into the water.
5. Once the sub is floating, unhook the winch hook attached to the bow eye of the sub.
6. Slowly pulls the trailer out of the water and up the ramp.
7. Rotate the trailer jack down and jack up to make it easier to collapse the extension.
8. Chock the back of the trailer wheels and collapse extension.

Retrieving

1. Make sure aft roller guide is still in the lowered position.
2. Back the trailer into the water using tongue extender.
3. With Main Ballast Tanks completely full of air, operator maneuvers sub near the trailer.
4. Attach winch strap to the bow eye of the sub and slowly winch the sub into position over the trailer.
5. Raise the aft roller guide.
6. Slowly pull the trailer out of the water. The sub will land first in forward then aft roller guides as the trailer is pulled out of the water. Make sure wings are level.
7. Operator purges MBTs and powers down.
8. Pull the rig to a quiet spot in the parking lot away from the launch lane traffic.
9. Chock trailer wheels and collapse the tongue extender and strap R300 on trailer.
10. Close air and O_2 tanks valves, secure hatch.

7. General Information

a. Submersible Dive Plan

Successful missions do not just happen; they are planned. This is possible only if Dive Plan is developed. It should not be based on assumptions; if a piece of equipment is essential to the mission, it must be stated in the Dive Plan.

1. A complete dive profile, including day/night schedule, major gear changes, number and duration of dives, site locations, bottom conditions expected and number of revisits anticipated.

2. Equipment requirements and descriptions (dive by dive, if possible). Equipment, if provided by user or outside contractor, should be detailed by size and weight.

3. Name and phone number of operator to be contacted regarding details of the dive plans.

b Scuba Diving

Only those certified scuba divers may dive in conjunction with R300 operations.

For safety reasons, scuba diving during submersible operations is limited to less than 100'. Also, no one will dive in the R300 for at least two hours after having completed a scuba dive that is greater than 100'. A scuba dive plan should be used for all dives.

IV. CONTROLS

1. *Piloting*

a. Entering and exiting the hatch

Entering and exiting the hatch should only be attempted with the MBT fully blown and with a sea state of 1 or less. If available, support personnel should stabilize the vehicle while the operator enters or exits the boat. The operator HMI should be folded back out of the way to facilitate entry.

b. Control Box

To the starboard side of the operator seat, against the hull is the control box which contains the master power switch, trim and ballast switches as well as the three-axis joystick. The master switch has three positions, **AUX-OFF-ON**. In the "**OFF**" position, both the main and emergency batteries are disconnected from their electrical buses. In the "**ON**" position, the main batteries are connected by energizing the main contactor relay. In this position all onboard systems are available. In the "**AUX**" position, the emergency batteries are connected. In this position only life support, interior lights and the HMI/ PLC are on. Use this setting for an extended wait for rescue if main batteries are dead.

c. Submerging

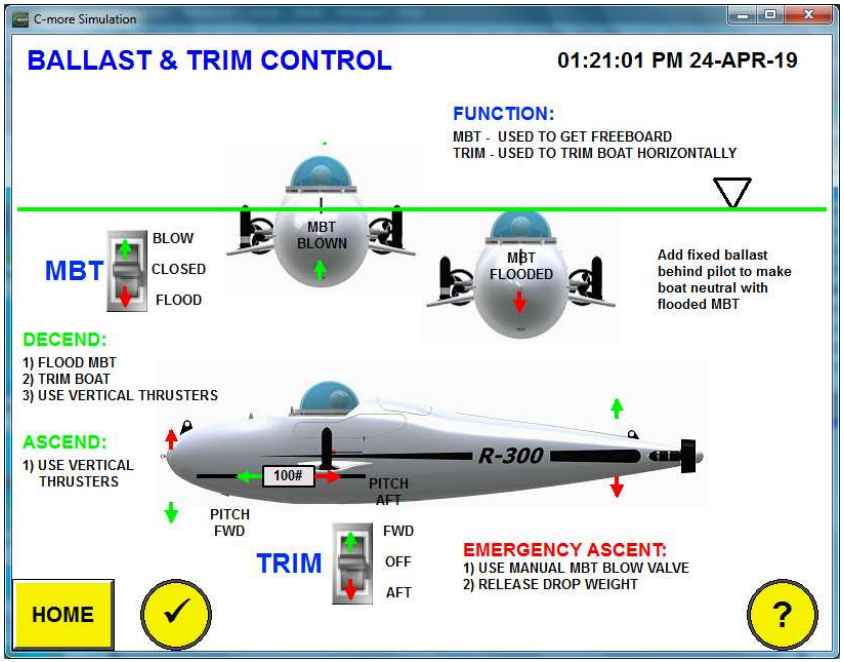
Submerging is a three-step process:

- Weigh the operator and calculate how much variable ballast (VB) is required to be added to the variable ballast container.
- Flood the MBT completely to achieve neutral buoyancy by pressing down arrow.
- Vertical thrusters as controlled by forward movement of the joystick to descend or

the down arrow under VT if in "BUTTONS" mode.

Controls for submerging are located on the control box. Note that the flood buttons for the MBT is locked out if the hatch is open.

The flood button for the MBT is shown in the diagram. When flooding the MBT, if the boat is correctly ballasted, the top of the dome is at the water's surface when the MBT is completely flooded. This will leave the sub slightly positively buoyant.



d. Surfacing

To surface the boat, use the vertical and horizontal thrusters to drive near the surface.

To gain freeboard, the MBT needs to be blown dry. To do this, press the MBT Blow button and release. Blow will continue until air starts to emerge from both the MBT flood holes. In an emergency, the MBT can be blown at depth. See Appendix A for how to use manual MBT blow valve in an emergency or view the MANUAL BLOW screen.

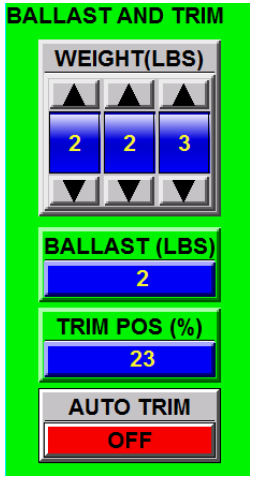
e. Depth Station Keeping

To maintain depth the boat must be neutrally buoyancy. This is achieved by first adjusting VB (adding or subtracting lead ballast) prior to diving. Then vertical thrusters are used to descend by pushing the joystick forward or to ascend by pulling the joystick backward. For a vertical decent, the vertical thrusters can be placed in BUTTONS mode and the down vertical thrusters button pressed. Each press of the up and down buttons incrementally adds or subtracts thruster speed. If the operator is concerned about stirring up the silt on bottom, the VB should be adjusted so that the boat dives slightly positive. The vertical thrusters will then direct the flow away from the bottom for depth station keeping.

f. Longitudinal Trimming

The trim weight system is controlled by the hydraulic system. Hydraulic fluid turns a reversible hydraulic motor that is connected to a lead screw which turns against a nut secured to the 100 lb. trim weight which moves the ballast within the confines of trim weight tube situated under the pilot's seat and extending to his feet. The trim system can be controlled either automatically through the Trim Wizard or manually

Trim Wizard



To use the Trim Wizard, the operator enters the his/her weight in the Trim Wizard found on the **(✓)** screen and hitting the **AUTO TRIM** button. A trim positon is then calculated and the PLC then controls the trim weight until it reaches this location then turns off.

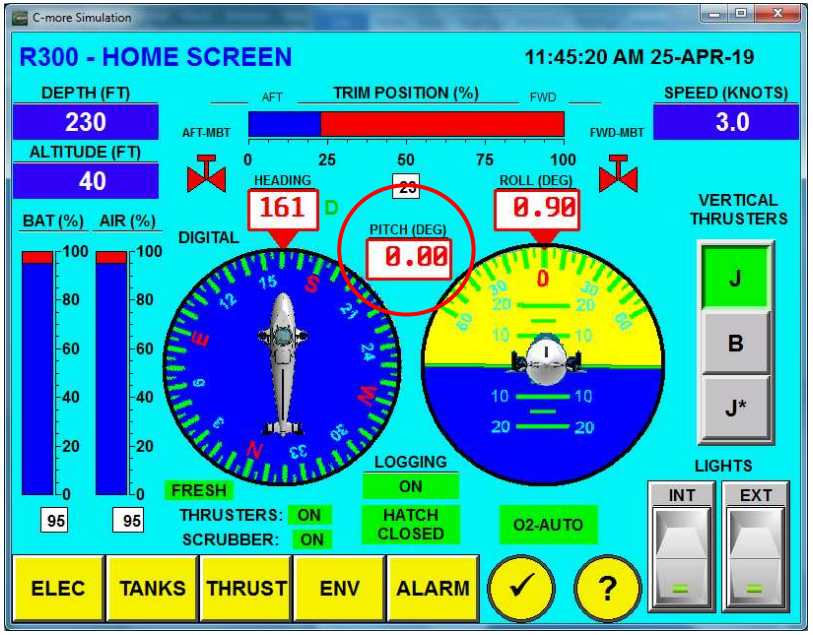
Manual Trimming

On the operator control box are forward and aft trim control buttons connected to the PLC through digital input module in the PLC. When the trim switches are not pressed, the trim weight is locked in its current position. As the operator depresses the trim weight forward switch, hydraulic fluid turns the lead screw so that the trim weight moves toward the bow of the boat. Likewise, if the operator presses the trim weight

aft switch, the trim weight moves toward the stern of the boat. Limit switches prevent the trim weight from being dead headed. The trim systems can achieve a static pitching rotation of +/- 10 degrees.

Pitch Inclination

Pitch inclination is shown on the home screen of the touch screen panel and on the pitch bubble gage on the pilot's port side just below the lower hatch ring.

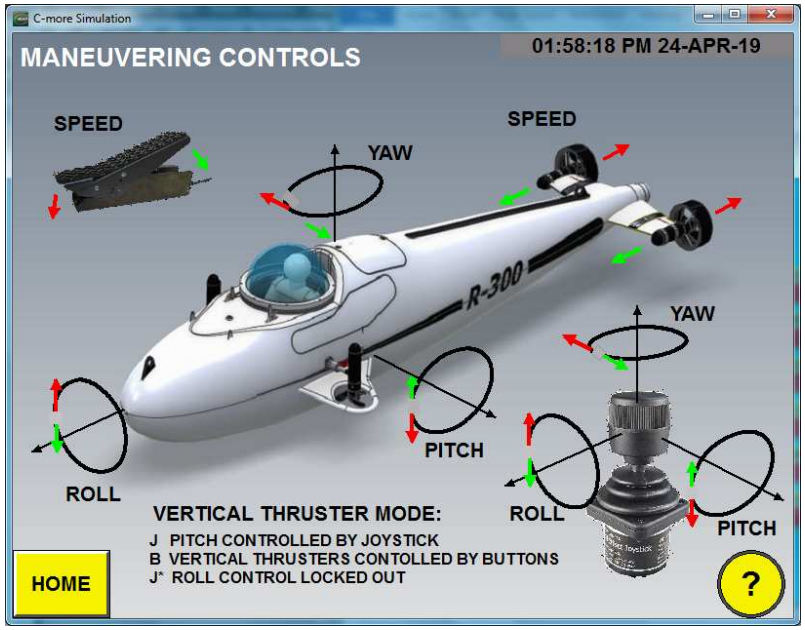


Pitch indicator on HMI **HOME** screen

Backup Pitch Inclinometer – Starboard side near hatch latch

g. Speed Control

To control the speed of the boat, a throttle foot control is used. To increase speed, rotate the foot control forward. To reverse, rotate the foot control in the opposite direction.



h. Braking

Braking on the R300 is done by reversing the horizontal thrusters by rotating the foot control backward.

i. Yaw Control

A rotation of the joystick is used for yaw control. As the operator turns the joystick in a clockwise direction, the port thruster will generate forward thrust and starboard thruster will generate a reverse thrust. This will generate the clockwise moment on the boat causing it to turn to the starboard side. Likewise, a counter-clockwise rotation of the joystick will cause the starboard thruster to generate forward thrust and port thruster to generate a reverse thrust. This will generate a counter-clockwise moment on the boat causing it to turn to the port side. This system is locked out if power is being supplied by emergency batteries or if the thrusters have been disabled.

j. Pitch Control

The operator joystick is used to control the pitch. As the operator pushes the joystick forward the submersible pitches forward. If the operator pulls back on the joystick, the boat will pitch upward. Movement is accomplished generating upward or downward thrust with the vertical thrusters.

k. Roll Control

To control the roll of the boat the operator uses the joystick with port to starboard movement. As the operator moves the joystick in the starboard direction the starboard vertical thruster will generate an upward thrust and the port vertical thruster will generate a downward thrust which will cause the boat to roll in clockwise direction. If the operator removes his/her hands from the joystick, the vertical thrusters will turn off and gravity will return the boat to a neutral position. Roll in the counter clockwise direction results from movement to the port direction of the joystick. Roll control can be locked out by hitting the J* button on the home screen.

l. Changing CO_2 Absorbent

The scrubber is used to filter CO_2 from the boat. After approximately 12 hours of use, the Sodasorb HP absorbent becomes saturated and needs to be changed. The scrubber is located between the pilot's legs. Spare Sodasorb is located in three containers behind the operator resting on the main batteries. To change out the absorbent, remove the top of the scrubber. It should not be necessary to disconnect the electrical connector to the scrubber blower. Discard the used absorbent onto the floor of the cabin and add fresh absorbent until the chamber is full. Replace the top of the scrubber and confirm that the scrubber blower is again functioning. There is enough absorbent for a total of 80 hours of life support. Secure the fresh absorbent container behind the pilot's seat. See Appendix G for specific steps to change absorbent.

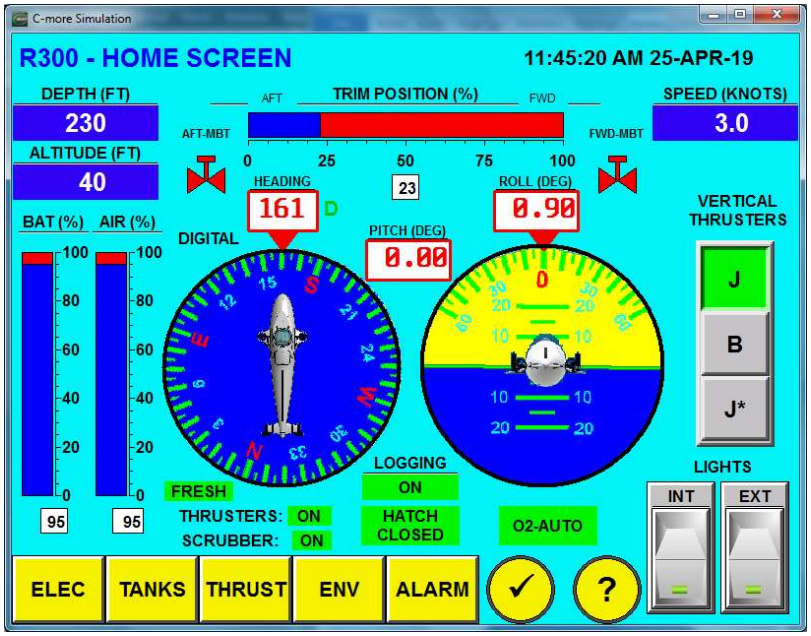
2. Touch Screen Display

a. Home Screen

A touch screen HMI is used as the interface between the operator and the programmable logic controller (PLC). It is mounted in the operator panel as seen below. This display

can be rotated out of the way to service the scrubber. Or access VHF radio.

All instrumentation displays are through the operator selectable screens. The **HOME** screen is the primary screen to be displayed during dives. The function of each item on the **HOME** screen is given below:



Screen Navigation Buttons – To navigate between screens, seven yellow navigation buttons at the bottom of the **HOME** screen are shown. The buttons bring up the following screens:

1. **ELEC** – Electrical Systems
2. **TANKS** – Ballast Tank Systems
3. **THRUST** – Thruster Systems
4. **ENV** – Environmental Systems
5. **ALARMS** – Alarms and their status
6. **(✓)** – Checklist: Onboarding, System and Pre Dive
7. **(?)** – Information/help on all boat Systems

On all other screens a **HOME** button is used to return to the home screen.

Hatch Status - A failsafe display is provided on the touch screen that clearly shows the position of the hatch cover. The display just above

the **ALARM** button changes from **HATCH OPEN** to **HATCH CLOSED** when the hatch is closed.

Depth – At the left upper top of the **HOME** display is the depth of the boat shown in blue. The depth is calculated from the measured ambient water pressure and water density. Be sure water type is set.

Altitude – Just below the Depth on the **HOME** display is the altitude of the boat shown in blue. The altitude is measured with a sonar sensor in the aft bottom of the boat. The range of the sonar is 0-175 ft.

Speed – At the upper right of the **HOME** display is the speed of the boat in knots shown in blue. The sensor for the speed is a Hall Effect paddle wheel sensor in the bottom aft of the boat.

Trim Indicator – At the upper middle of the **HOME** display is the trim inclination indicator. The trim position is given both as a percentage with 100% being fully forward and as a gauge. The trim buttons are on the main control panel and control a 100 lb. weight that can be shifted to obtain longitudinal trim. The Trim Wizard can also be used to shift the trim weight.

Main Battery SOC – The state of charge (SOC) of the main batteries is shown on the left most bar graph. The operator should surface immediately if SOC drops below 50%.

Air Pressure – The bar graph next to the Main Battery SOC graph is the HP air pressure indicator. 100% means the four external air tanks are pressurized to their maximum level. Zero means these tanks are empty or that all of the tank valves are closed. If the Aux air valve is open, then air in this tank will be combined with the four external tanks and this gage will represent percent of total air available.

Compass heading – The left most circular indicator is the heading. Compass heading is measured in degrees. Zero or 360 is due north. The numerical value of the heading is given just above this gage. When a compass declination angle is provided in the compass calibration screen, the display represents heading relative to true north. Next to the digital heading is either a "**D**" or "**A**". "**D**" when the digital compass is used and "**A**" when the analog compass is selected.

Pitch & Roll Indicator – To the right of the compass heading indicator is the pitch and roll indicator. The pitch is shown graphically in five degree increments. Positive degrees are measured for an upward pitch while negative degrees indicate a downward pitch. Pitch is also

displayed digitally. Roll angle is also shown graphically and numerically above the gage.
LOGGING – In a slot in the HMI is a SD memory card that is used to log boat systems. This switch can be used to turn on or off data logging. After the dive, the operator can download the dive data to analyze the dive.

O_2 STATUS – This is an indicator to show the oxygen is being metered automatically into the boat (Auto) or manually being controlled by using the O_2 makeup needle valve on the AMOC box on the pilot's port side by his knee. Default is AUTO oxygen makeup.

Exterior light – At the bottom right of the screen, the toggle switch titled EXT is the Exterior light switch. Pressing the switch toggles the exterior lights off and on. When on, a green indicator glows on the switch. These lights can be used with the boat submerged or completely out of the water.

Interior light – At the bottom right of the screen, to the left of the exterior light switch is the Interior light switch. Pressing the switch toggles the interior lights off and on. As with the exterior light, when on, a green indicator glows on the switch.

MBT Valves – At the top of the screen, on either side of the Trim indicator, are icons for the forward and aft MBT vent valves. When these valve icons are red, the valve is closed, when green, open.

Water Type – At the bottom of the screen, just above the yellow **TANKS** navigation button, is the water type indicator, green for **FRESH** water and blue for **SALT** water. a series of acronyms.

Thruster Status – At the bottom of the screen, just under the water type is the Thruster Status. When "**ON**" is visible, the control relay, for the thrusters, is on and conversely, if "**OFF**" is visible, the thrusters are deactivated. Use the **THRUST** navigation button to display the thruster screen where the thrusters can be deactivated.

Scrubber Status – At the bottom of the screen, just under the Thruster Status is the Scrubber Status. When "**ON**" is visible, the scrubber fan, is on and conversely, if "**OFF**" is visible, the scrubber fan is deactivated. Use the **ENV** navigation button to display the Environmental screen where the scrubber fan can be deactivated.

Date/Time – At the top of most screens is the date and time. To change this, touch the top left corner of the screen for three seconds.

b. Electrical Systems

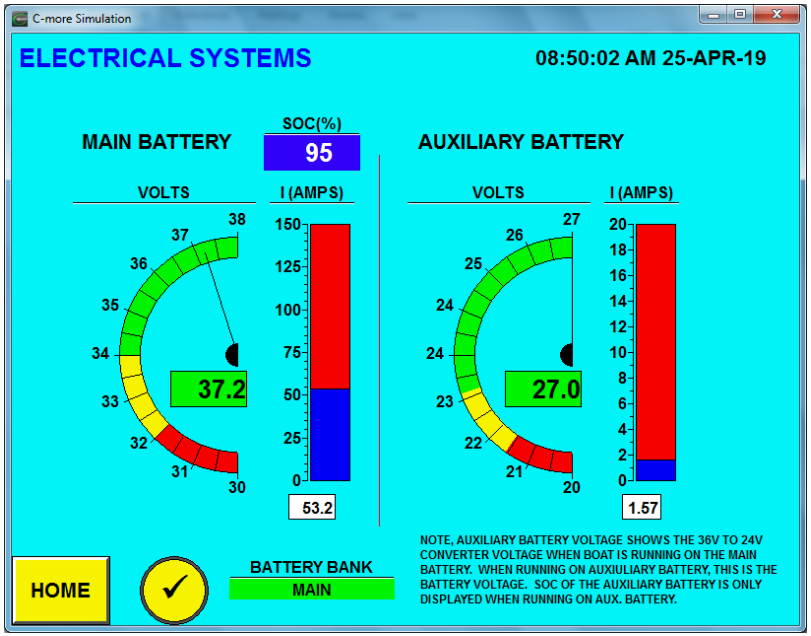
If the **ELEC** navigation button is pressed from the home screen, the Electrical Systems Screen is displayed as shown below. Items:

Main Battery Voltage – The voltage on the main battery bank is shown both on a dial meter and as a digital value. A fully charged battery voltage is greater or equal to 38 VDC. The boat should be surfaced for recharging if this voltage drops below 30 volts.

Main Battery SOC – The State-of-Charge of the main battery bank is also shown as a percentage.

Main Battery Current – The current in the main battery bank bus is shown both as a bar graph and as a digital value. The maximum current is 150 amps.

Auxiliary Battery Voltage – The voltage on the emergency auxiliary battery bank is shown both on a dial meter and as a digital value. A fully charged battery voltage is greater or equal to 27 VDC.



Auxiliary Battery Current – The current in the 24 VDC bus is shown both as a bar graph and as a digital value. The maximum current is 20 amps. 1.5 amps is the hotel load for the boat.

Home Navigation Button – Returns to the **HOME** display screen.
Checklist Button(✓) – Returns to the **CHECKLIST** display screen. This is placed on the screen so that if the operator is going through a predive checklist he can check electrical status and easily return to the checklist screen.

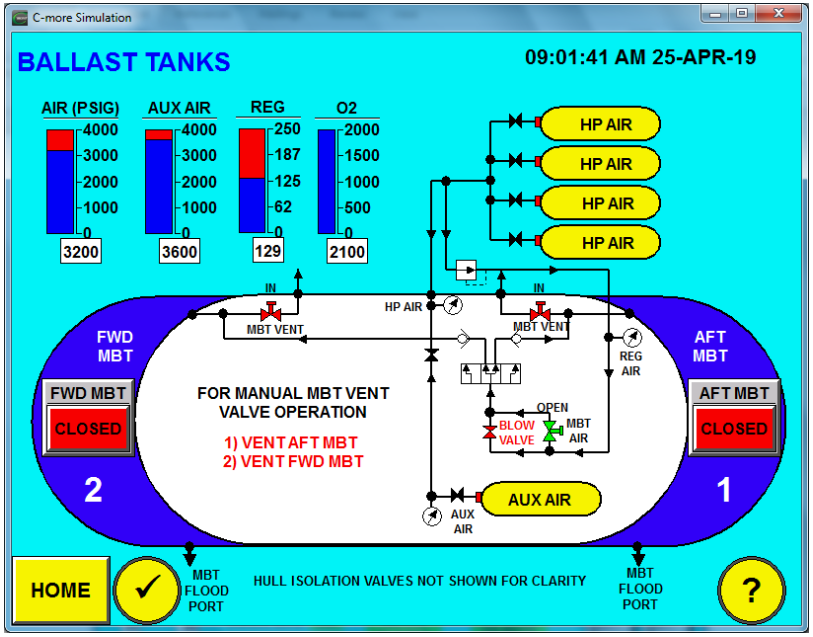
c. Ballast Tanks

If the **TANKS** navigation button is pressed from the **HOME** screen, the Ballast Tanks Systems screen is displayed as shown below. Buttons shown on the tanks can be used to open MBT vent valves if the hatch is closed.

The function of each item on this is given below:

AIR-PSIG – The air pressure indicator displays the gage pressure of the external HP air tank. The scale is 0 to 4,000 psig. The maximum air pressure is 3,200 psig.

AUX-PSIG – The auxiliary air pressure indicator displays the gage pressure of the internal composite auxiliary HP air tank. The scale is 0 to 4,000 psig. The maximum air pressure is 3,600 psig. Note that if the auxiliary air valve is open, then both the auxiliary and main HP air tanks are connected and both Air and Aux air valves will read the same value.

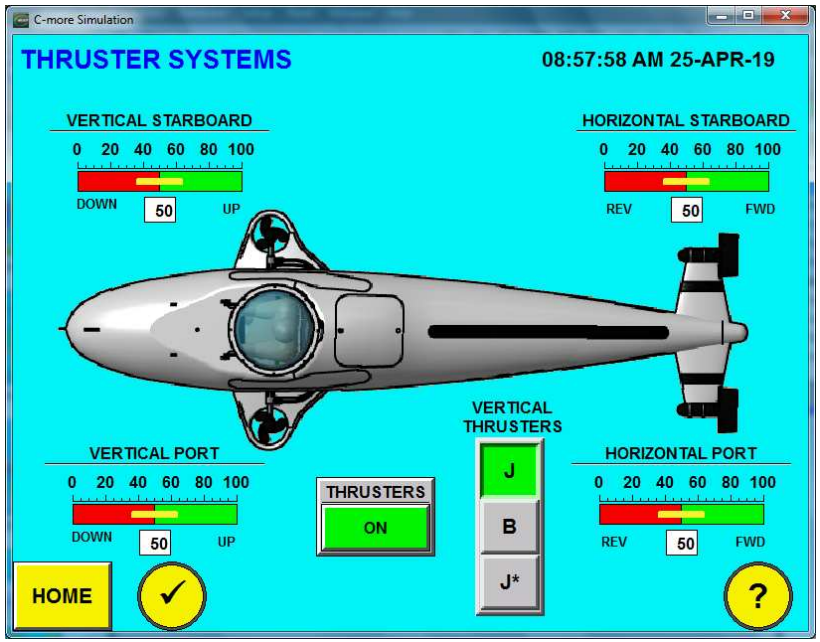


REG-PSIG – The regulated or LP air pressure indicator displays the gage pressure of the LP side of the first stage scuba regulator. Note that this pressure floats approximately 50 psi above the ambient water pressure. The scale is 0 to 250 psig.

CONTROL VALVES – Each of the ballast control valves is shown in either red for closed or green for open. The valve on the diagram labeled Blow Valve is the manual emergency blow valve. At any depth, if this valve is opened, LP air is directed to either the forward, aft of both main ballast tanks depending on the setting of main ballast air distribution valve. The default setting for this valve is for both tanks.

d. THRUSTER Screen

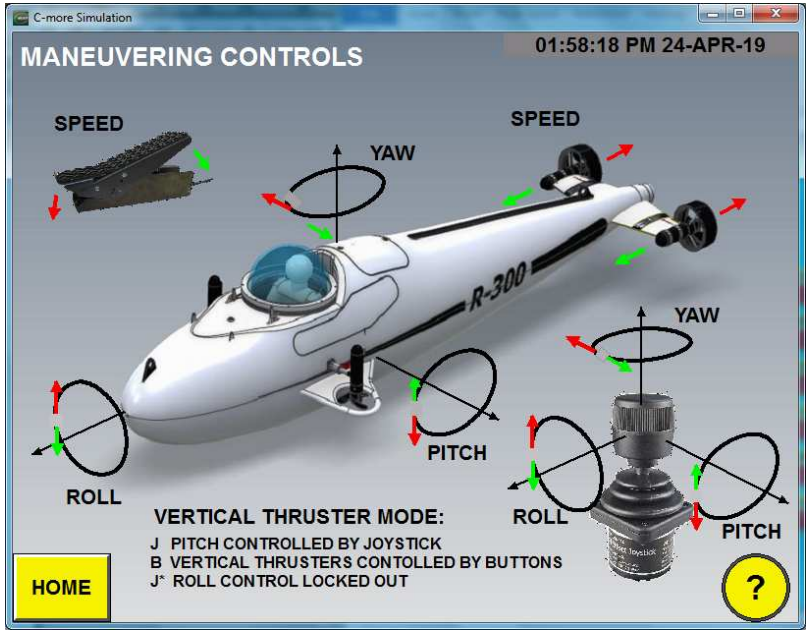
To display the thruster screen, hit the **THRUST** button on the **HOME** screen. Four thrusters, two aft mounted horizontally and two near the boat CG mounted vertically are used to maneuver the boat. Shown on this screen is the 0-100% signal being sent to each thruster shown as bar graph. The yellow band on each bar graph is a dead band in which the thruster is off. A 50% signal to any of the thrusters indicates the thruster is off and the joystick and foot control are centralized. 100% is full speed in one direction while 0% is full speed in the opposite directions. At the bottom of the screen is an on/off button to lock out the thrusters to save power in the event the operator is stranded on the bottom and waiting rescue.



e. Maneuvering Controls

The controls to maneuver the boat are shown below.

When the boat is either surfaced or submerged, pushing forward on the foot control activates the aft horizontal thrusters to control the boat forward speed. By rocking backward on the foot control the boat is reversed or slowed down. The operator 3-axis joystick is used to control the boat yaw, pitch and roll movements as indicated on the diagram.



f. Environmental System Screen

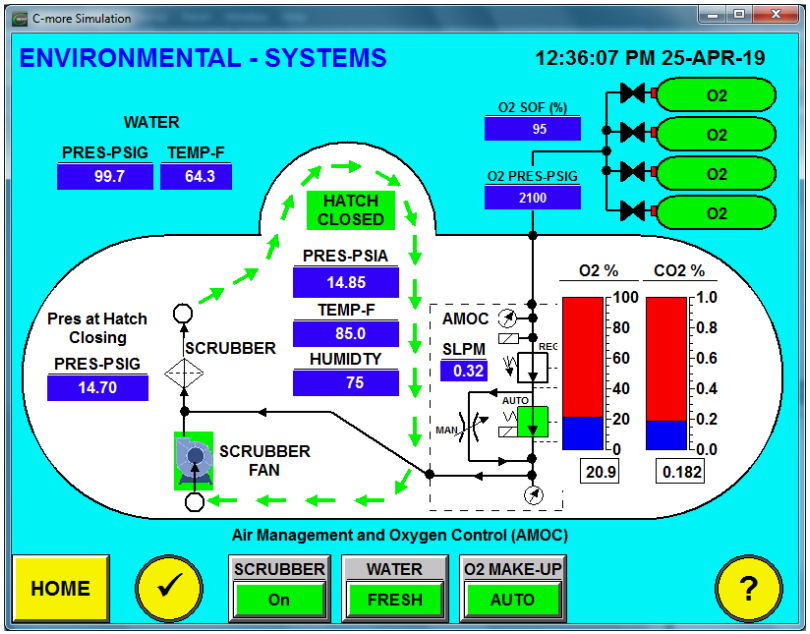
If the **ENV** navigation button is pressed from the **HOME** screen, the Environmental Systems screen is displayed as shown below.

The purpose of the screen is to show the both the external and internal environments of the boat. The function of each is given below:

WATER PRES – This shows the water pressure measured in psig.

WATER TEMP – This shows the water temperature in degrees F^o.

The PLC will not let the boat MBT be flooded if the hatch is open.



HATCH STATUS – This shows if the hatch is open or closed.

CABIN PRES – This shows the cabin absolute pressure measured in psia. Typically is around 14.7 psia for atmospheric air in low altitudes.

CABIN TEMP – This shows the cabin temperature measured in degrees F^o.

HUMIDTY – This shows the cabin relative humidity (RH). Zero indicates the air is completely dry and 100% indicates the air is completely saturated with water vapor.

WATER TYPE SWITCH – This is a switch that toggles between SALT water and FRESH water. This is used to select the correct water density to calculate the water depth from ambient water pressure. The default is fresh water.

SCRUBBER SWITCH – This button activates the scrubber blower. Green indicates that blower is on (default) and red off.

O_2 MAKE-UP SWITCH – This button is used to select either Automatic (default) or Manual O_2 make-up. In the automatic mode, oxygen is blead into the boat if the O_2 percent drops below 20%. If Manual is selected the automatic O_2 makeup system is disabled and the

operator controls the amount of O_2 added to the cabin by adjusting the manual O_2 valve on the AMOC box on the pilot's port side.

O_2 (SLPM) – This is gage that displays the oxygen flow rate in SLPM being supplied to the cabin when in the automatic life support mode.

O_2 % – This shows the mole percent of oxygen in the cabin. Normal air contains 20.95 mole % of oxygen.

CO_2 % – This shows mole percent of carbon dioxide in the cabin. 0.04% (400 ppm) is in normal air.

PRES @ CLOSE – This shows the cabin absolute pressure measured in psia the last time the cabin hatch was closed.

O_2 SOF – This shows the State-Of-Fill (SOF) of the oxygen tanks as a percent. There is enough oxygen for the normal mission time plus 72 hours.

O_2 PRESSURE– This shows the pressure in psig of oxygen in the external tanks.

g. AMOC Screen

While in the **LIFE SUPPORT** screen, if the **AMOC** navigation button is pressed the **A**ir **M**anagement **O**xygen **C**ontrol (**AMOC**) screen is displayed as shown below.

The purpose of the screen is to show the status of the life support sensors in the AMOC module.

O2 MAKE-UP – This indicator shows if the Automatic (default) or Manual O2 make-up mode is active.

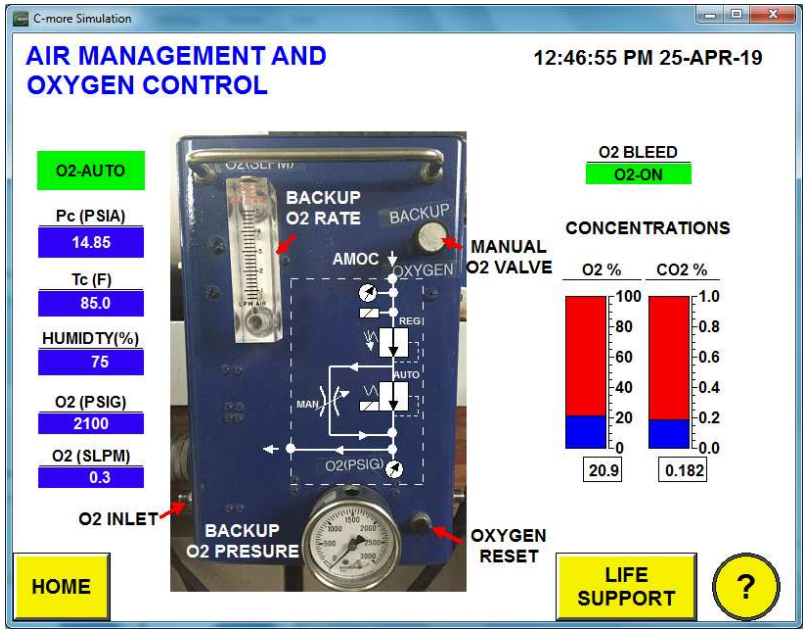
Pc – This is the cabin pressure in psia.

Tc – This is the cabin temperature in ^{o}F
HUMIDTY – This shows the cabin relative humidity (RH). Zero indicates the air is completely dry and 100% indicates the air is completely saturated with water vapor.

O_2 PRESSURE– This shows the pressure in psig of oxygen in the external tanks.

O_2 (SLPM) – This gage displays the oxygen flow rate in SLPM being supplied to the cabin when in the automatic life support mode.

O_2 BLEED – This indicator is red with the O_2 make-up valve is closed and green when Oxygen is flowing into the cabin.



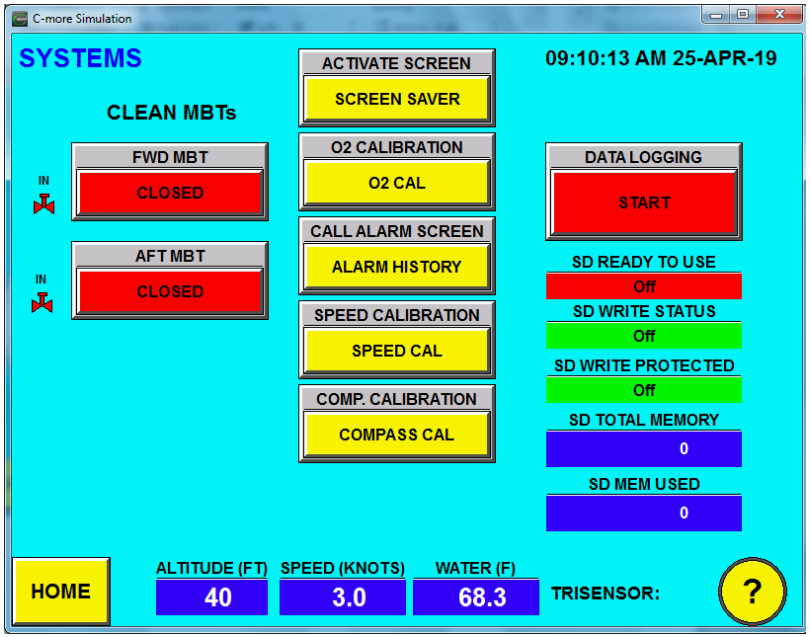
O_2 % – This shows mole percent of oxygen in the cabin. Normal air contains 20.95 mole % of oxygen.

CO_2 % – This shows mole percent of carbon dioxide in the cabin.

Note that this is an informational screen to show the AMOC system. The **ENV** screen is the primary screen to display environmental status during dives.

h. Systems

If the **SYS** navigation button is pressed from the home screen, the **(?)** screen is displayed as shown below.



The function of each item on this is given below:

FWD MBT – This button is used to open the forward MBT flood valve to permit cleaning of the forward MBT when the boat is on land. **Caution**, this button is not deactivated when the hatch is open. Under no circumstances should this button be hit while the boat is in operation as it could flood the boat through the hatch. The valve icon next to the button will be green when the valve is open and red when closed.

AFT MBT – This button is used to open the aft MBT flood valve to permit cleaning of the aft MBT when the boat is on land. **Caution**, this button is not deactivated when the hatch is open. Under no circumstances should this button be hit while the boat is in operation as it could flood the boat through the hatch. The valve icon next to the button will be green when the valve is open and red when closed.

SCREEN SAVER – The button turns off the display screen. Hitting any key restores the screen.

O_2 CAL – This button takes you to calibration screen for the oxygen sensor.

ALARM HISTORY– This button lets you look at a history of alarms since the last time the boat was powered up.

SPEED CALIBRATION – This button opens the speed calibration screen for the speed paddle wheel sensor.

COMPASS CALIBRATION – This button opens the compass calibration screen for selection which sensor package is used for compass as well and roll and pitch sensors.

DATA LOGGIN SWITCH – This switch either enables or disables data logging. If a SD card has not been installed in the HMI unit, then an error will occur when data logging is enabled.

SD READY TO USE – This is a status indicator if the data logging SD memory card is installed and ready to be used to record data.

SD WRITE STATUS – This is a status indicator data is being written to the data logging SD memory card.

SD WRITE PROTECTED – This is a status indicator if the data logging SD memory card can accept data or if it is write protected.

SD MEM USED – This is a numeric field that shows the amount of data in bytes used on the SD memory card.

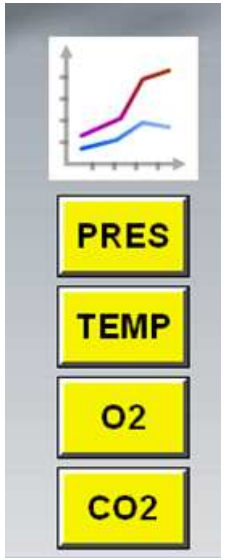
TRISENSOR – This is raw data coming from the DST800 Airmar Trisensor. If the values are updating, the Trisensor is operating correctly. If sounders is working correctly, if you place your ear on the sensor on the bottom of the boat below the aft lifting lug, then you will hear clicking.

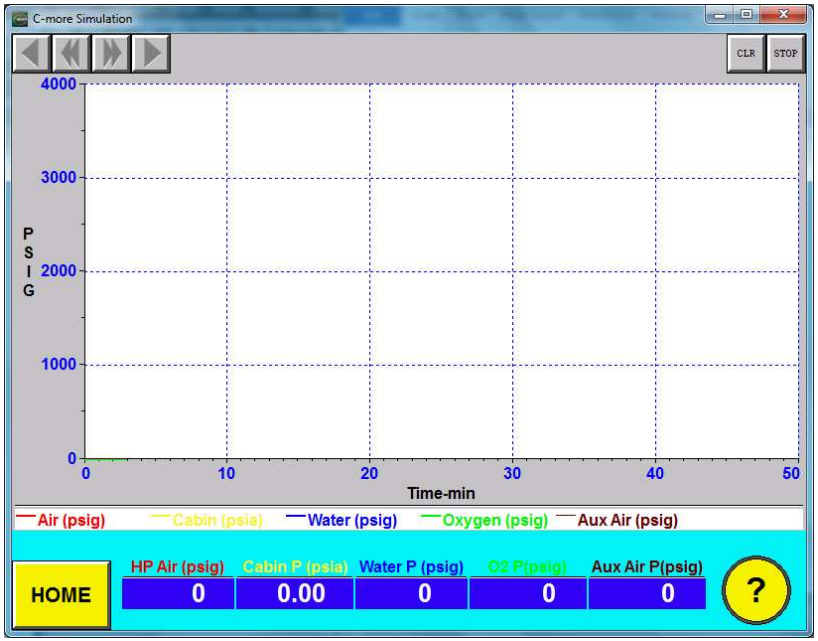
Home Navigation Button – Returns to the **HOME** display screen.
Information/help Button **(?)** – Returns to the **INFORMATION** display screen.

h. Charts

If the **PRES** CHART navigation button is pressed from the **(?)** screen, Pressure Charting screen is displayed as shown below. Likewise **TEMP**, **O2** and **CO2** concentrations plots are available by pressing the appropriate button for the desired chart.

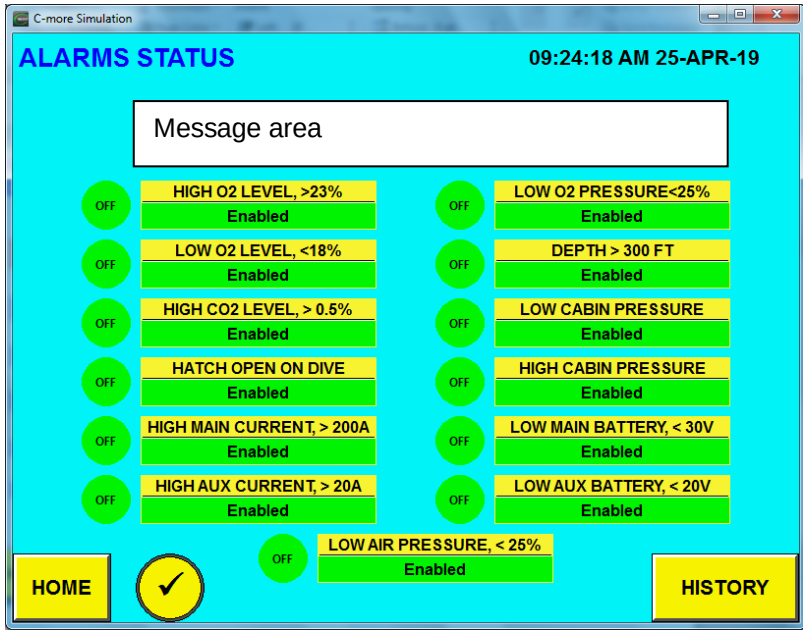
Pressing the **HOME** navigation button returns the user to the Home screen while pressing **(?)** returns user to the information screen. For each of these charts, controls on the screen enable the user to page forward and back as well as clear and stop the chart. All of the data on these charts are logged on the SD memory card.





I. Alarms Database

There are a number of alarms that will activate with both an audible sound and message across the bottom of the screen regardless of which screen is displayed. On the Alarms screen, at the top of the screen are recommended actions to taken. On the left of each alarm is an indicator that shows if the alarm is on or off. Each of these alarms can be disabled by touching the alarm description.



If an audible alarm is on, a red button will indicate which alarm(s) is set. To deactivate an alarm, press the button and the indicator should go green. Causes for the alarm and possible solutions are shown across the top of the screen.

HOME Navigation Button – Returns to the Home display screen.

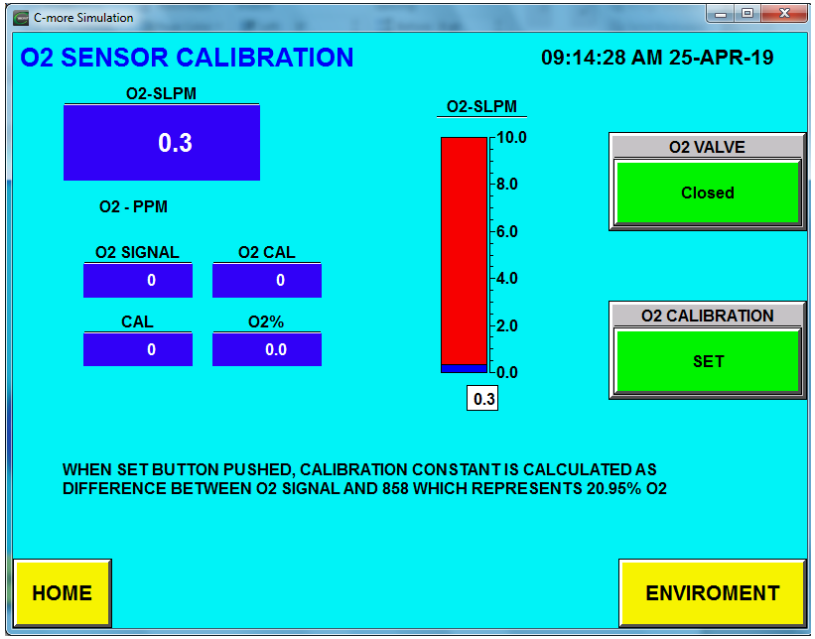
HISTORY Navigation Button – Returns to the Alarm history display screen.

I. O2 Calibration Screen

From **SYS** screen, if the **O_2 CAL** button is pressed, the following screen is displayed. The purpose of the screen is to calibrate Oxygen sensor. From this screen the O_2 control valve can be opened:

O_2-SLPM – This display shows the current oxygen flow rate in SLPM. During automatic life support mode, when the PLC detects that the oxygen level and uses a PID control loop to hold this at 21%.

SET – When this button is pushed, a calibration constant is calculated as the difference between the O_2 sensor reading and 20.95%, the normal concentration of O_2 in the air. This is used to calibrate the sensor back to 20.95%.



O_2 VALVE – When this button is pushed, the O_2 controller is opened and directed to flow at 4 SPLM. This is used to test the function of the controller.

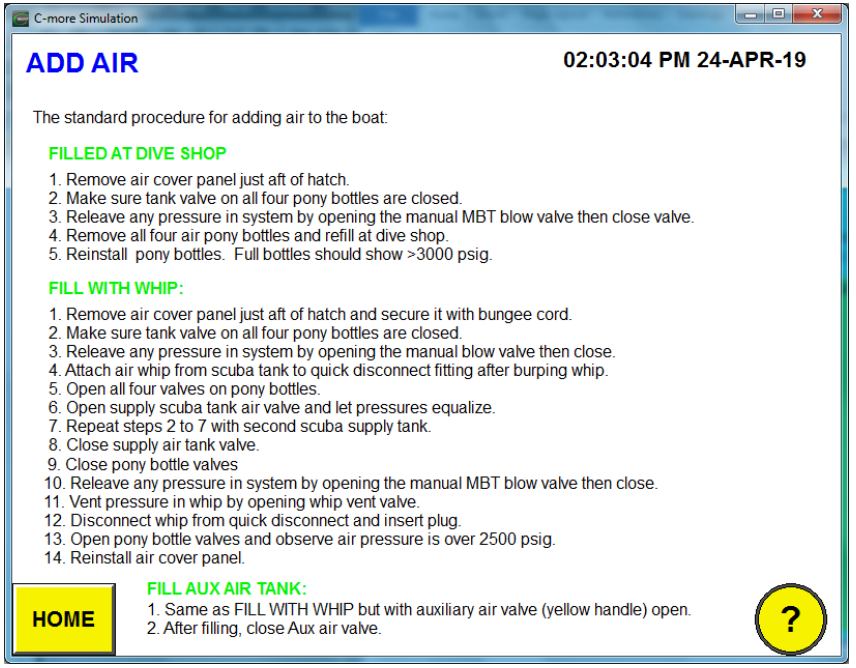
Screen Navigation Buttons – The buttons bring up the following screens:

1. **HOME** – Go to the Home Screen
2. **ENVIROMENT** – Go to the Environmental Systems Screen

j. Refilling Air and O_2

From **INFO** screen, go to the **ADD AIR** screens to add air both in the shop and in the field. To prevent water from being inadvertently injected into the air supply when filling with a whip, make sure to purge or burb the line with a shot of air to remove in water that might have

accumulated in the whip before connecting to the submersible air fill port.



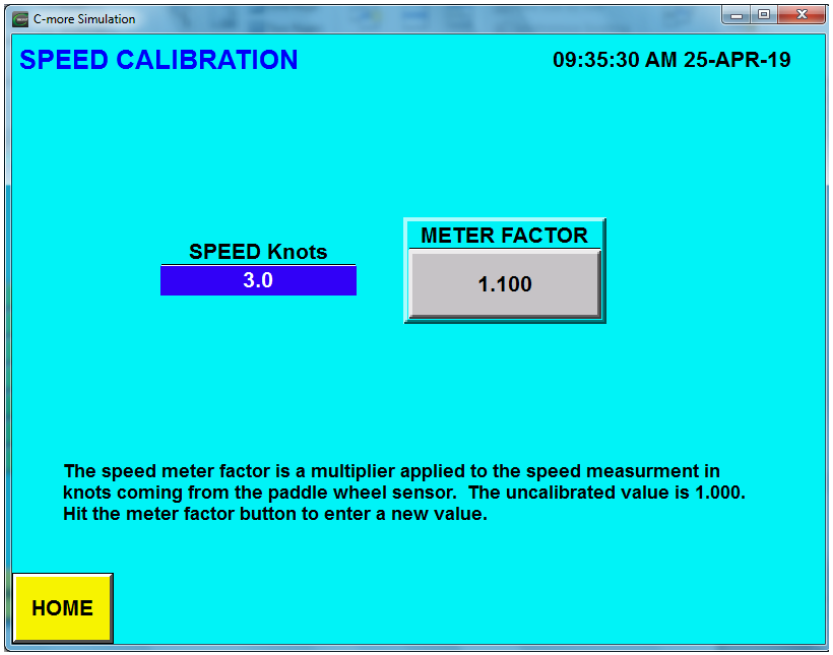
k. Refilling O_2

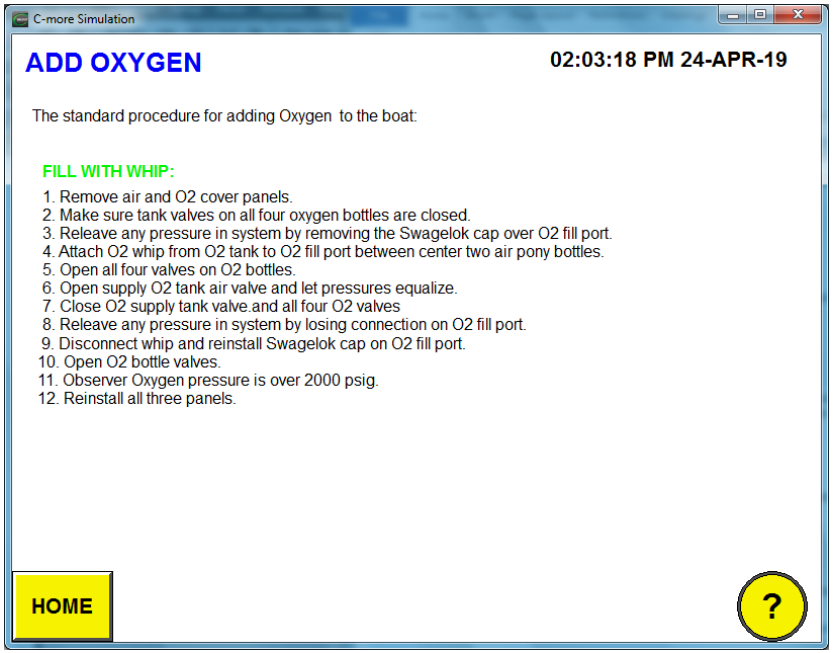
From **(?)** screen, go to the **ADD O2** screen to add oxygen both in the shop and in the field.

As with the air fill procedure, to prevent water from being inadvertently injected into the oxygen supply when filling with a whip, make sure to purge or burb the line with a shot of oxygen to remove in water that might have accumulated in the whip before connecting to the submersible oxygen fill port.

l. Speed Calibration

From **SYS** screen, if the **SPEED CAL** button is pressed, the following screen is displayed. The purpose of the screen is to calibrate speed paddle wheel sensor. The default value is 1.1. By touching the **METER FACTOR** button on the screen, a numerical input screen will be displayed. After the meter factor for the sensor has been updated, it will remain active even if the boat is powered off and on.



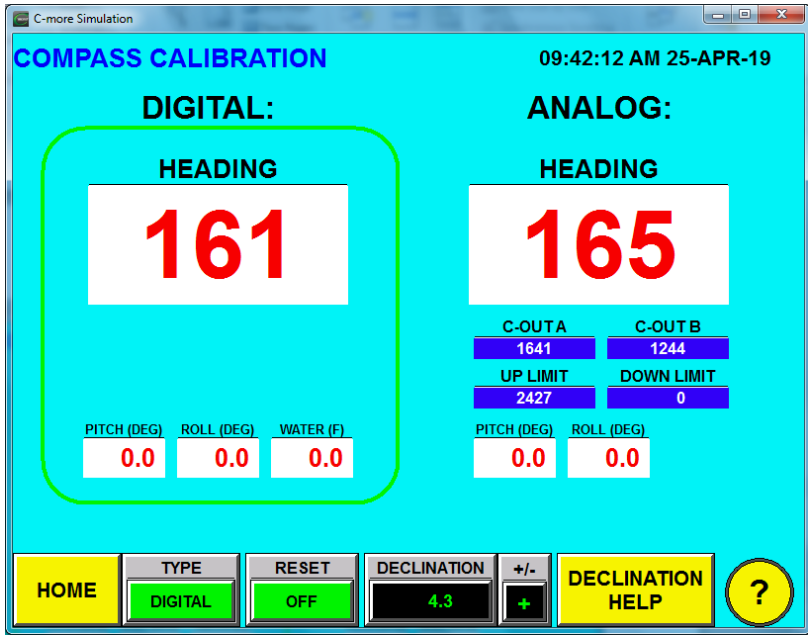


m. Compass Calibration

From the **SYS** screen, if the **COMPASS CAL** button is pressed, the following screen is displayed. The purpose of the screen is twofold. The first is to select which compass, the digital compass (OceanServer OS5000) or the Analog Compass (Dinsmore R1655 Analog Sensor) will be displayed on the **HOME** screen. To do this, press the Compass **TYPE** button at the bottom of the Compass Calibration Screen. A green rectangular box encloses the compass that is currently being displayed. Both compass headings are data logged.

The second is to set the declination angle for the compasses. See the Compass Declination Help screen for a map of US showing the current declination values. To display magnetic heading instead of true heading, set the declination angle to zero.

The **RESET** button on the compass calibration screen is used to toggle on and off the power to the digital compass. The default positon OFF means the digital compass is powered.



A description of both compass systems is given below.

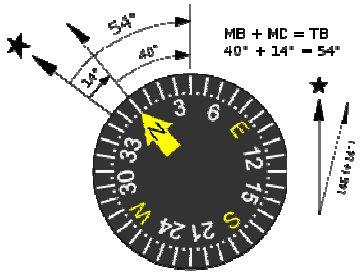
OceanServer OS5000 Compass

The OS5000-S is an extremely small form factor (1x1" square) three axis, tilt compensated digital compass. It is located in a 1-atm anodized aluminum pod that is external to the pressure hull and located just behind the pilot. It can be accessed for servicing by removing the cover over the four 19 scf scuba bottles. The compass design uses a simple RS232 serial connection for system integration. The OS5000-S provides precise heading, roll and pitch data ideal for rapid attitude measurement. The compass offers an easy to use ASCII interface which includes hard-iron calibration and simple data configuration for this application.

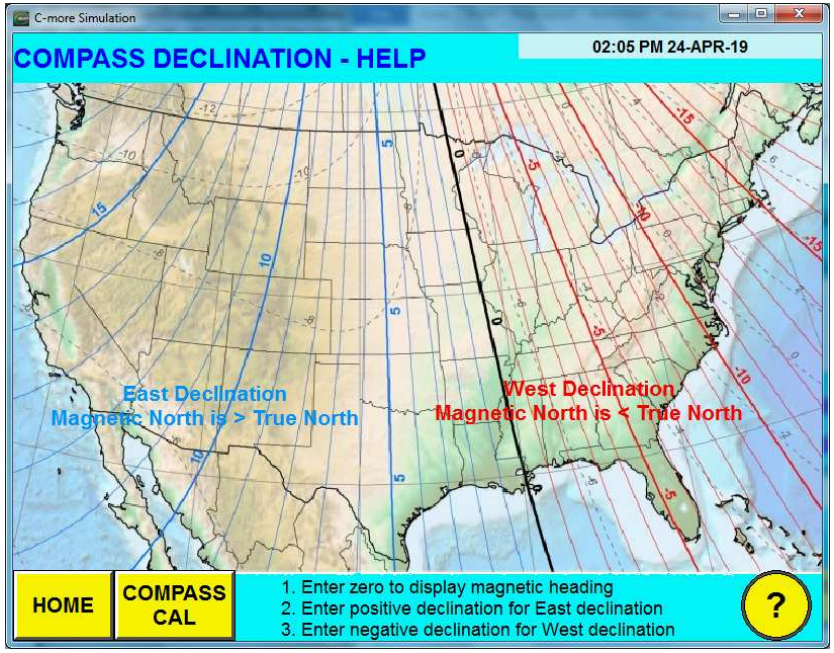
Dinsmore R1655 Analog Compass

Dinsmore Instrument Company has been making digital compass products based on switching Hall technology for some time. The compass module (1655) is based on linear Hall technology. It has two Hall devices at a 90 degree separation and by reading the two analog voltages the PLC can determine the direction of magnetic north. The PLC ladder logic has code that takes the two analog voltage signals and converts to a compass heading. The sensor is located in a 316 stainless steel enclosure that sits just aft of the aft lifting lug.

Declination Angle (Variance)



Magnetic declination, or magnetic variation, is the angle on the horizontal plane between magnetic north (the direction the north end of a magnetized compass needle points, corresponding to the direction of the Earth's magnetic field lines) and true north (the direction along a meridian towards the geographic North Pole). This angle varies depending on position on the Earth's surface and changes over time.



The true bearing or heading is calculated based on this relationship:

T = M + V Where:

T = True Bearing in degrees
M = Magnetic Bearing in degrees
V = Variation or declination in degrees
V < 0, for westerly Variation
V > 0, for easterly Variation

V. CHAIN OF COMMAND

The duty assignments which follow constitute the formal delegation of authority to persons assigned those duties. In addition, they provide a description of responsibilities and accountability for the management and operation of the R300.

The Submersible Operations Coordinator and the Operator are required on all dives. It is up to them to use their experience and expertise to coordinate the successful completion of the mission. Their duties are as follows:

Submersible Operations Coordinator (SOC)

The SOC is responsible for the safe and efficient operation of the submersible and its associated systems. He/she is responsible for scheduling dives, interfacing mission related gear to the submersible and determining if conditions are favorable for a successful launch and recovery. His/her authority is absolute.

The SOC must know the capabilities and limitations of the submersible, and balance that against the needs of the pilot. The SOC is responsible for maintaining an overview of the entire operation.

Pilot

The operator of the R300 is designated as the pilot. The operator will work closely with the SOC to develop an acceptable mission plan to include location, depth, tasks, equipment required. In matters of operational safety, the SOC must always defer to the operator of the vehicle. In practice, the operator informs the SOC of what he/she desires and unless it is unsafe, illegal, or against accepted procedure it will be carried out.

REFERENCES

1. “ASME PVHO-1b-2000 ADDENDA to ASME PVHO-1-1997 Safety Standard for Pressure Vessels For Human Occupancy” September 22, 2000.

2. Redus, C.L.: “R300 Plans and Design”, Redus Engineering Technical Report, August 20, 2005.

3. “Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities” American Bureau of Shipping & Affiliated Companies, 2002, Second Printing October 1993.

4. “Naval Ships’ Technical Manual Chapter 594 Salvage – Submarine Safety Escape and Rescue Devices”, US Navy S9086–T9–STM–010/CH–594, 31 January 1995

5. HBOI Research Vessels, CLELIA Operating Manual, Aug. 2001.

GLOSSARY

Term	Description
ABS	American Bureau of Shipping
AC	Alternating Current
ADP	Air Distribution Panel
AGM	Absorbent Glass Mat (battery type)
AMOC	Air Management Oxygen Control
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
BIBS	Built In Breathing System
BCD	Buoyancy Compensation Device
CO_2	Carbon Dioxide
DC	Direct Current
DCS	Decompression Sickness (bends)
FSW	Feet Sea Water
GPM	Gallons Per Minute
GPS	Global Positioning System
GVW	Gross Vehicle Weight
HMI	Human Man Interface (Touch Screen)
HP	High Pressure
LP	Low Pressure
MBT	Main Ballast Tank
O_2	Oxygen
PD	Positive Displacement Pump Type
PID	Proportional, Integral and Differential loop controller
PLC	Programmable Logic Controller
PPM	Parts per million (1% = 10,000 ppm)
PSIA	Pounds per Square Inch Absolute
PSIG	Pounds per Square Inch Gage
PVHO	Pressure Vessels for Human Occupancy
PWM	Pulse Width Modulation
RH	Relative Humidity
ROB	Reserve of Buoyancy
SCF	Standard Cubic Feet (at Standard T & P)
SD	Secure Digital (nonvolatile memory card)
SLPM	Standard Liters Per Minute
SOC	State of Charge or Submersible Operations Coordinator
USCG	United States Coast Guard
VBS	Variable Ballast System
VDC	Voltage Direct Current
VHF	Very High Frequency (marine radio)

APPENDIX A – EMERGENCY INFORMATION

Step a. Don't panic; there is three days life support in the submersible (water, food, etc.). The submersible electronics will automatically power up from emergency batteries if power from the main batteries is lost.

Step b. You can bring the submersible to the surface by using the following procedure:

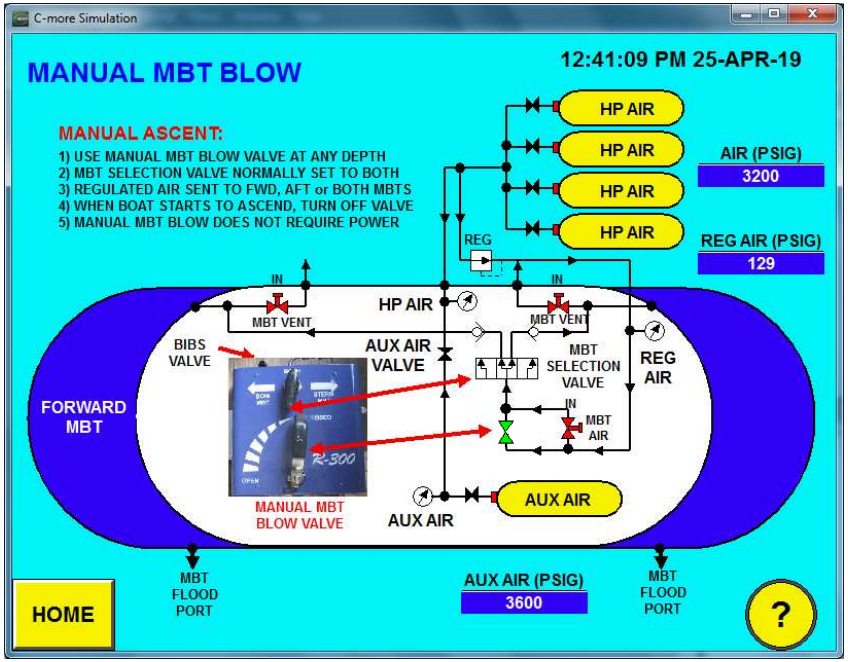
1. Depress MBT blow button on main control box as circled in red on the picture of the control box to right. Sub will then surface on its own.

2. If all power is lost, open manual MBT blow valve until sub starts to move upward then secure. Sub will then surface on its own.

3. The drop-weight can be released with the hydraulic hand pump on the pilot's starboard side. Locate handle near the forward starboard interior light. Insert handle and pump several times until the weight is released.

4. Once on the surface, you can use VHF radio to communicate with the support vehicle.

On the on the touch screen display, if the **MANUAL BLOW** button is pressed from the **(?)** screen, the following screen is displayed.



Step c. At this point, the operator is stranded on bottom, and all means of surfacing have failed. Because the submersible is designed with provisions to stay three days in an emergency, the preferred next step in this situation is to wait for rescue in which a diver would assess the situation and initiate rescue. This might be to clear an entanglement or manually add air to MBT to surface the submersible.

WHILE WAITING FOR RESCUE

1. Monitor the O_2 and CO_2 levels from the Environmental Systems Screen and keep in communication with OTS radio on the channel called out in the dive plan.

2. Scrubber blower should be left in the "ON" position.

3. Turn off the thrusters from the **THRUST** screen to conserve power.

4. O_2 makeup should be in the "**O2-AUTO**" mode. While in this mode, the PID controller will try to keep the O_2 at 21%. The O_2 makeup

controller will bleed O_2 into the cabin at a rate required to hold the O_2 level at 21%.

5. If, for any reason, the O_2 level drops below 19%, switch to the "**O2-MANUAL**" on the **ENV** screen. On the AMOC box, close the O2 makeup needle valve. Closed is full clockwise as viewed from the front of the AMOC panel. Monitor the O_2 level and keep it between 20 and 22% by adjusting the valve.

6. Monitor the CO_2 level. The scrubber should keep the CO_2 level below 5,000 ppm or 0.5%. A fresh package of CO_2 absorbent should last approximately 12 hours. When the CO_2 absorbent is consumed, the CO_2 level will begin to increase. At this time, the absorbent should be replaced. Steps to replace the SodaSorb absorbent:

   a. Locate support bag and stow within reach
   b. Retrieve scrubber by disconnecting and unplugging
   c. Retrieve scrubber top removal tool from support bag
   d. Remove scrubber fan and dump SodaSorb on cabin floor
   e. Secure spare SodaSorb and fill scrubber to top
   f. Reattached fan to top of scrubber
   g. Set scrubber in position and attach strap
   h. Reconnect electrical connection
   i. Confirm fan is back on
   j. Stow top removal tool and stow support bag
   k. Stow spare SodaSorb container
   l. Monitor CO_2 level and confirm dropping concentration

For a detailed description of the procedure to change out the SodaSorb absorbent, see Appendix G.

7. The operator should tap the pressure hull periodically to signal divers of the boats location.

There are situations which would favor escaping the submersible while at depth. These are discussed in the next section.

Criteria Supporting the Decision to Escape:

Escape should be considered if one or more of the following criteria are met[4]:

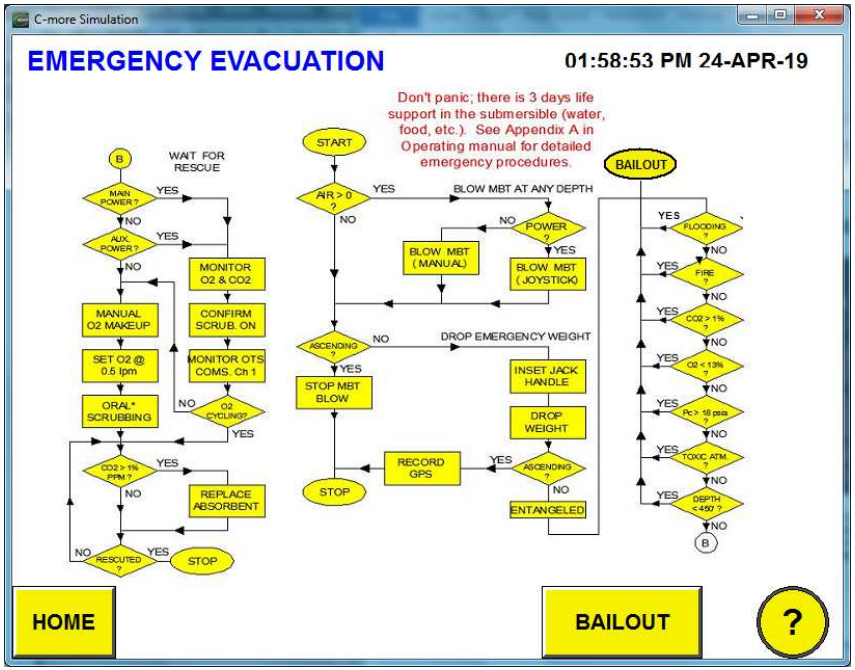
1. Uncontrolled flooding or fire exists.
2. The carbon dioxide concentration is approaching 1 percent (10k ppm) and is continuing to increase after all means to control carbon dioxide buildup have been used. Waiting until the carbon dioxide levels are intolerable will give survivors only a few extra hours to safely remain on board and will greatly complicate the escape sequence as the survivors' mental capacities deteriorate.
3. The oxygen concentration is approaching 13 percent and is decreasing after using all onboard reserves.
4. The internal atmospheric pressure of the boat is increasing and rescue is not immediately anticipated. Escape should be made before the internal pressure reaches 20 psia to minimize the risk of DCS in survivors when they reach the surface.
5. Persistent toxic atmosphere exists.
6. Surface support is present to retrieve and care for survivor, especially in colder waters.
7. Escape operations are conducted at a depth of 450 feet of seawater (fsw) or less. Successful escapes from greater depths are possible but are riskier.
8. The pilot's physical condition will allow survival in the open water until rescue personnel arrive.

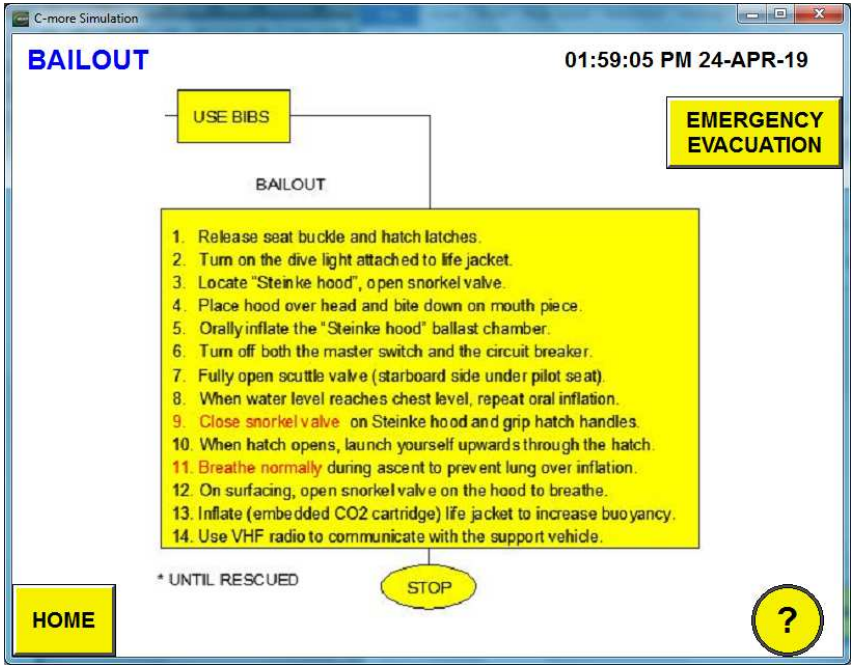
If it becomes necessary to exit the submersible at depth (300' max), the operator should:

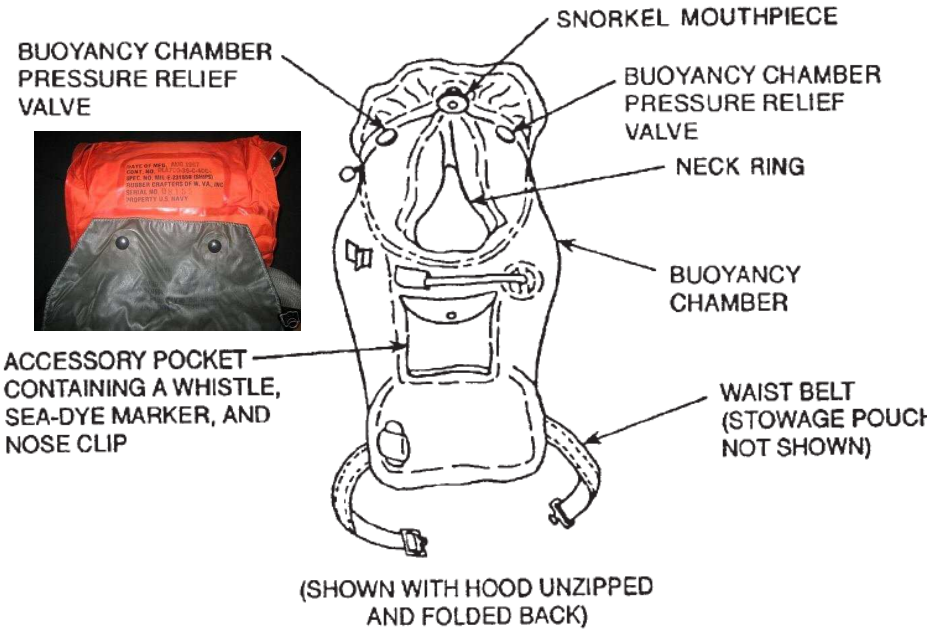
1. Release hatch latches.
2. Turn on the dive light attached to life jacket.
3. Locate "Steinke hood", set snorkel valve to "open position" and place hood over head and bite down on mouth piece.
4. Orally inflate the "Steinke hood" ballast chamber.
5. Turn off both the master switch and the circuit breaker.
6. Fully open scuttle valve.
7. When water level reaches level A (approximately chest level), repeat oral inflation of Steinke hood ballast chamber, close snorkel valve on Steinke hood and grip hatch handles.
8. When hatch opens, launch yourself upwards through the hatch. Breathe normally during ascent to prevent lung over inflation.
9. On surfacing, open snorkel valve to breathe surface air then inflate (embedded CO2 cartridge) life jacket to increase buoyancy. If calm sea state, remove Steinke hood.
10. Once on the surface, you can use VHF radio to communicate with the support vehicle

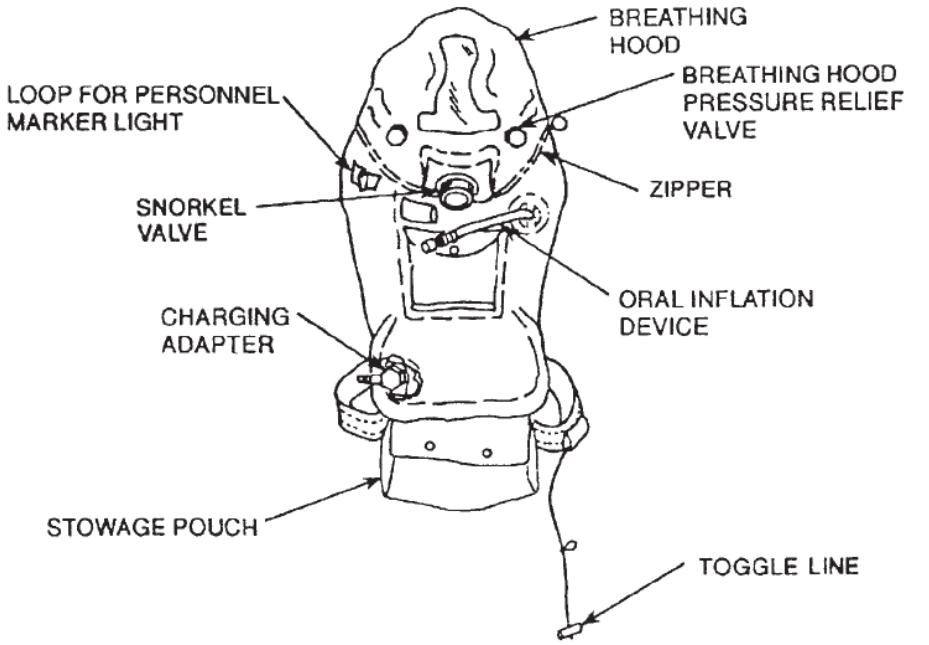
Notes:

1. Step 1 - high differential pressure will prevent hatch opening at this point.
2. Step 3 - open Snorkel valve enables operator to breath cabin air without building up CO_2 in hood.
3. Step 4 - oral inflation of the "Steinke hood" ballast chamber occurs twice to account for increasing pressure in the cabin compressing air in the appliance.
4. Step 7 - Level A: Pressure in boat has reached 44.3 psia (3 atmospheres) assuming boat was stranded at 300'. This should take 64 seconds if scuttle valve is fully open.
5. Step 8 - hatch opens at 94 seconds assuming a fully opened scuttle valve.
6. Assent rate will be approximately 425 ft/min with fully inflated Steinke hood.


C-more Simulation
EMERGENCY EVACUATION
01:58:53 PM 24-APR-19
Don't panic; there is 3 days life support in the submersible (water, food, etc.). See Appendix A in Operating manual for detailed emergency procedures.
START
BAILOUT
WAIT FOR RESCUE
MAIN POWER ?
AUX. POWER ?
MONITOR O2 & CO2
MANUAL O2 MAKEUP
CONFIRM SCRUB. ON
SET O2 @ 0.6 lpm
MONITOR OTS COMS. Ch 1
ORAL* SCRUBBING
O2 CYCLING?
CO2 > 1% PPM ?
REPLACE ABSORBENT
RESCUED ?
STOP
AIR > 0 ?
BLOW MBT AT ANY DEPTH
POWER ?
BLOW MBT (MANUAL)
BLOW MBT (JOYSTICK)
ASCENDING ?
DROP EMERGENCY WEIGHT
STOP MBT BLOW
INSET JACK HANDLE
DROP WEIGHT
RECORD GPS
ASCENDING ?
ENTANGELED
STOP
FLOODING ?
FIRE ?
CO2 > 1% ?
O2 < 13% ?
Pc > 18 psia ?
TOXIC ATM. ?
DEPTH < 450 ?
HOME
BAILOUT
?


C-more Simulation
BAILOUT
01:59:05 PM 24-APR-19
USE BIBS
EMERGENCY EVACUATION
BAILOUT
1. Release seat buckle and hatch latches.
2. Turn on the dive light attached to life jacket.
3. Locate "Steinke hood", open snorkel valve.
4. Place hood over head and bite down on mouth piece.
5. Orally inflate the "Steinke hood" ballast chamber.
6. Turn off both the master switch and the circuit breaker.
7. Fully open scuttle valve (starboard side under pilot seat).
8. When water level reaches chest level, repeat oral inflation.
9. Close snorkel valve on Steinke hood and grip hatch handles.
10. When hatch opens, launch yourself upwards through the hatch.
11. Breathe normally during ascent to prevent lung over inflation.
12. On surfacing, open snorkel valve on the hood to breathe.
13. Inflate (embedded CO2 cartridge) life jacket to increase buoyancy.
14. Use VHF radio to communicate with the support vehicle.
* UNTIL RESCUED
STOP
HOME
?


SNORKEL MOUTHPIECE
BUOYANCY CHAMBER PRESSURE RELIEF VALVE
BUOYANCY CHAMBER PRESSURE RELIEF VALVE
NECK RING
BUOYANCY CHAMBER
ACCESSORY POCKET CONTAINING A WHISTLE, SEA-DYE MARKER, AND NOSE CLIP
WAIST BELT (STOWAGE POUCH NOT SHOWN)
(SHOWN WITH HOOD UNZIPPED AND FOLDED BACK)

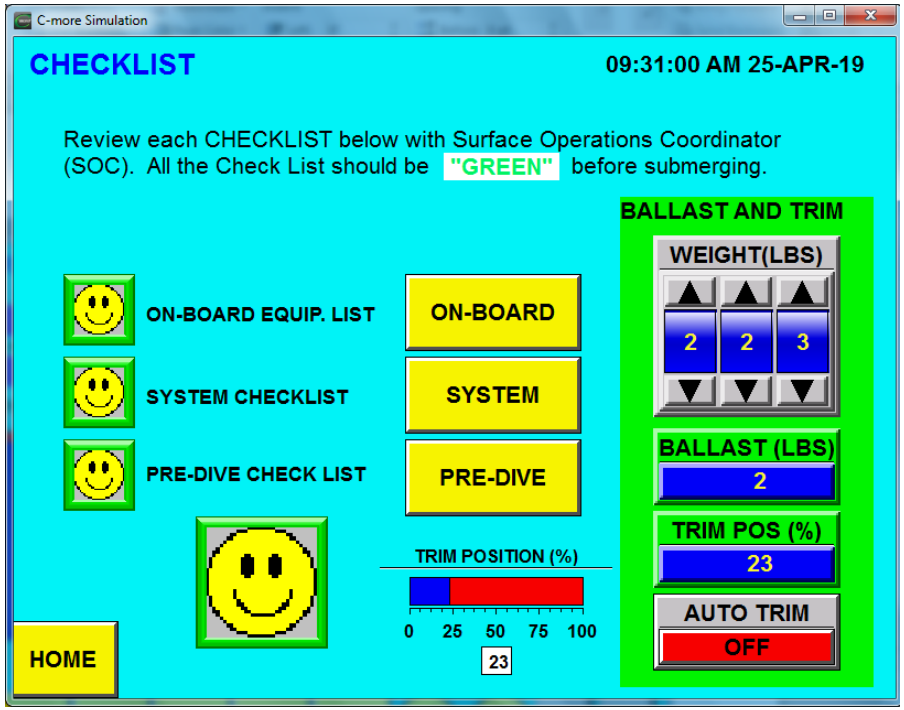

BREATHING HOOD
BREATHING HOOD PRESSURE RELIEF VALVE
LOOP FOR PERSONNEL MARKER LIGHT
ZIPPER
SNORKEL VALVE
ORAL INFLATION DEVICE
CHARGING ADAPTER
STOWAGE POUCH
TOGGLE LINE

US Navy Steinke Hood

APPENDIX B – CHECK LISTS

Review each CHECKLIST below with the Submersible Operations Coordinator (SOC).

Three checklist groups are displayed when the (✓) button is pressed. Hit the yellow button to access each list. A green-smiley/red-sad face indicator is shown besides each list. All three of these individual lists should be green before submerging the boat. The larger face indicator to the right will be green when each of these checklists is green.



On this screen in the area marked **BALLAST AND TRIM** is the Trim Wizard. Prior to submerging the boat, the operator should input his/her body weight into the Trim Wizard by using the scroll wheels. The default weight is 225 lbs. For this body weight the boat is slightly buoyant when diving in fresh water. For body weights different from this, positive or negative ballast is calculated to compensate for this new body weight. Because this new body weight shifts the center of gravity (CG) of the boat when submerged, it is necessary to compensate for this my moving the trim weight so that the boat will remain horizontal after the MBTs are flooded.

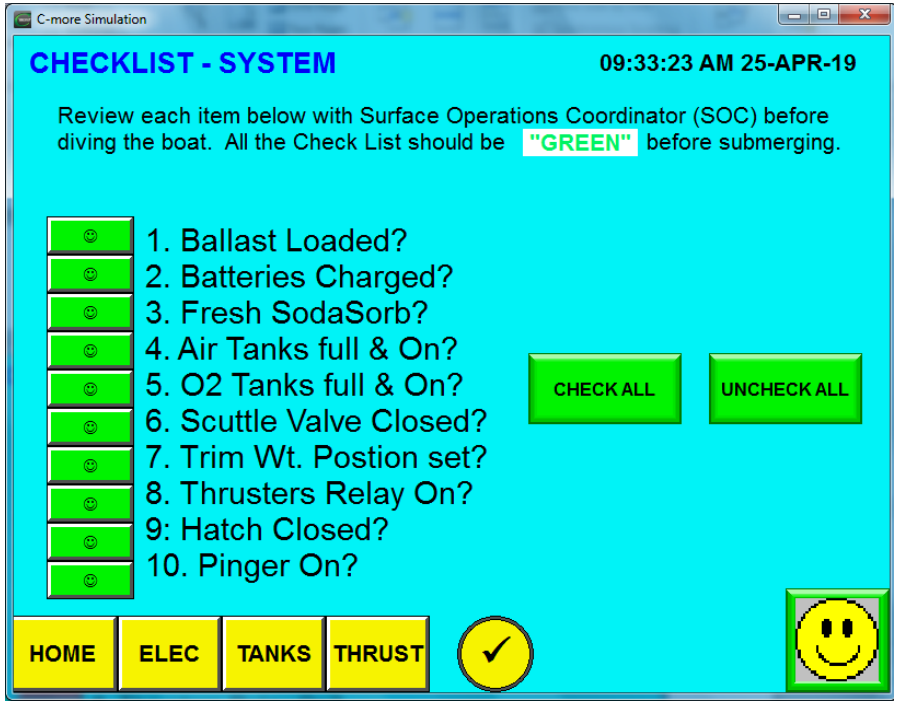
The required trim position is displayed. The Operator can either manually move the trim to this new position using the ↑ and ↓ trim buttons on the control box beneath the power switch or hit the **AUTO TRIM** button on the Trim Wizard. When this button is pressed, the trim weight will move to the calculated trim position and the system will drop back to manual trim mode. The trim position is shown beneath the three check list buttons and also on the main screen.

ON BOARD EQUIPMENT CHECKLIST – In the staging area, prior to launching the boat, or on the night before the dive, the operator should check that each item on the on-board equipment list is stowed in the boat and click on the icon next to the item to record its presence. The onboard Equipment check list is shown on the screen below.

When the boat powers up the default position for each item is Red indicating the item is not checked. If you are sure that all the items are on board then you can hit the **CHECK ALL** button to check all at one time. Likewise to uncheck all the items, hit the **UNCHECK ALL** button. The indicator face at

the bottom right of the screen will turn green when all items are checked and green. The (✓) button returns you to the main **CHECKLIST** screen.

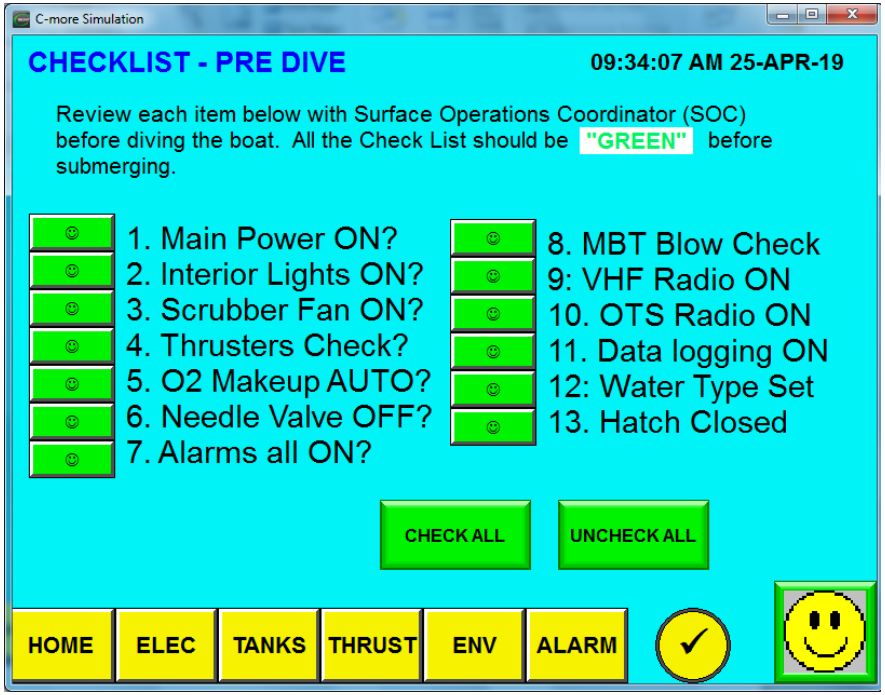
SYSTEMS CHECKLIST - In the staging area, the pilot, in conjunction with the SOC, should check that each item on the Systems list is stowed in the boat and click on the icon next to the item to record its presence. The Off-Loading check list is shown on the next screen.



When the boat powers up the default position for each item of the **SYSTEM CHEKLEST** is Red indicating the item is not checked. The **ELEC** button will take you to the screen to determine the battery state. The **TANKS** button will take you to the screen to determine if the air and O_2 tanks are full. Hit the **THRUST** button to make sure that the thrusters have not been locked out. The **HOME** button will take you to the home screen to make sure the hatch closed indicator is green. If you are sure that all the items on the list should be checked, then you can hit the **CHECK ALL** button to check all at one time. Likewise to uncheck all the items, hit the **UNCHECK ALL** button. The indicator face at the bottom right of the screen will turn green when all items are checked and green.

PRE-DIVE CHECKLIST – Before diving, the pilot, in conjunction with the SOC, should check that each item on the Pre-Dive Checklist is complete. Click on

the icon next to the item to record that it has been completed. The Pre-Dive check list is shown on the next screen.



When the boat powers up the default position for each item of the **PRE DIVE CHECKLIST** is Red indicating the item is not checked. Each item on the list should be green before you are cleared to dive the boat. These items should be reviewed with the SOC to get approval to dive the boat.

1.Master Switch ON – If the HMI is powered up, then the switch is on.
2.Interior Lights ON – This can be set from the **HOME** screen.
3.Scrubber Fan ON – Go the **ENV** screen. Scrubber fan should be **ON**.
4.Thruster Check – Go the **THRUST** screen. Thruster button should be **ON**.
5.O2 Makeup AUTO – Go the **ENV** screen. O2-Makeup should be **O2-AUTO**.
6.Needle Valve closed – On AMOC panel, turn knob fully clockwise to close.
7.Alarms all On – No alarms should be disabled prior to dive.
8.MBT Blow Check – Use Manual MBT Blow valve for a short test blow.
9.VHF Radio On – Confirm VHF radio is on and channel set per dive plan.
10.OTS Radio On – Confirm OTS radio is on and channel set per dive plan.
11.Data Logging On – Confirm on **HOME** screen data logging is **ON**.
12.Water Type Set – Confirm on **ENV** screen water type **FRESH** / **SALT** is correct.
13.Hatch Closed – Confirm on **HOME** screen hatch indicator CLOSED.

APPENDIX C – BACKUP PARTS & EQUIPMENT

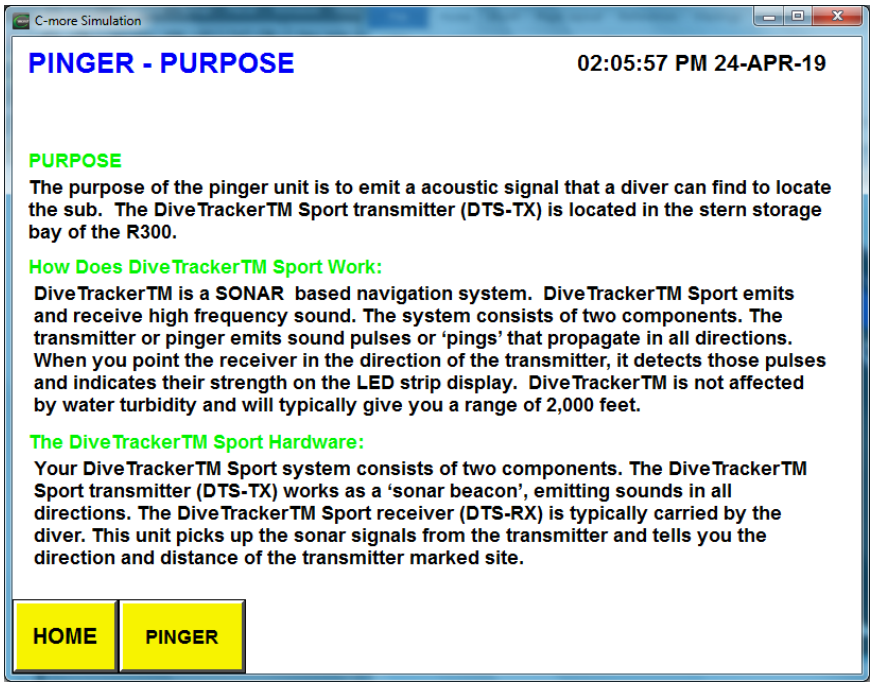
BACKUP PARTS AND EQUIPMENT	
Emergency Phone Numbers	Tools box
Spare R300 Operating Manual	Log Book
Towels	R300 documentation
Flash Lights (2)	Hydraulic Oil
Flash Light Batteries	Hydraulic Oil Funnel
Extra Ballast Weight	Acrylic Window Cleaner
Spare hatch O Ring	Multimeter
Tie Wraps (Assorted)	50 Amp Extension Cord
Spare SodaSorb	Note Pad (water proof)
Spare Fuses set: 1AX3, 2AX1, 3AX1, 5AX3, 10AX1, 15AX2, 20AX3 Total 14 fuses.	
Multi Tool	
SCUBA EQUIPMENT CHECK LIST	**GENERAL CHECKLIST**
Spare Tanks (4)	Sun Screen
Spare O2 tank (1)	Sun Glasses
Extra Tank O Rings	Hat
Regulators	Swim Suite
Masks	Clothes
Mask Straps	Deck Shoes
Mask Clear	Lawn Chairs
Snorkel	Road Maps
Scuba BCD	Drink Cooler
Weight Belt or integrated weights	
Fins	
Swim Suit	
Wet Suit	
Scuba Marker Float	
Chem. Lights	

APPENDIX D – ACOUSTIC PINGER

DiveTracker® is a SONAR (Sound Navigation and Ranging) based navigation system. SONAR systems like DiveTracker® Sport emit and receive high frequency sound. The system consists of two components. The transmitter or pinger emits sound pulses or 'pings' that propagate in all directions. When you point the receiver in the direction of the transmitter, it detects those pulses and indicates their strength on the LED strip display. DiveTracker® is not affected by water turbidity and will typically give you a range of 2,000 feet. The DiveTracker® Sport transmitter (DTS-TX) is located in the stern storage bay of the R300. After the scuba team using the receiver locates the submersible, a line with a buoy will be attached to the bow lifting lug and the divers will return to the base.

To see the help information on the pinger, hit the **PINGER** button on the **HOME** screen and the main **PINGER HELP** screen will be displayed.

This screen will let you navigate to the help screens for the pinger.



C-more Simulation

PINGER - RECEIVER

02:06:21 PM 24-APR-19

The Receiver (DTS-RX):

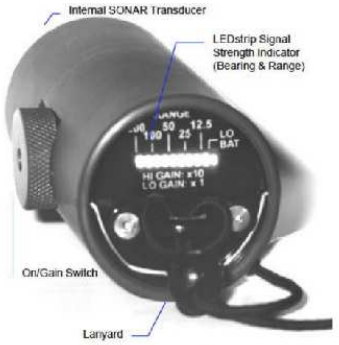
The DiveTracker™ Sport receiver (DTS-RX) is housed in a cylindrical PVC chassis. Located on the left side of the housing is a four-position thumb wheel switch. The function of that switch is as follows.

* The receiver is switched off whenever either of the two OFF indicators on the knob is aligned with the red mark on the housing.

*Low-gain mode The receiver sensitivity is reduced in order to facilitate operation at close range (less than 200 feet).

*High-gain mode In high-gain mode, the receiver is at full sensitivity in order to facilitate operation at far range (200-2000 feet).

Inside of the unit reveals the electronics module and the battery cavity which accommodates a 9V alkaline battery.



HOME PINGER SPECS

C-more Simulation

PINGER - SPECIFICATIONS

02:06:36 PM 24-APR-19

The Transmitter (DTS-TX):

Transmit Power:	4 W RMS, electrical
Pulse Sequence:	0 to 15 4 ms pulses per second, switch selectable
Frequency:	72.5 kHz, +/- 7.25 Hz
ON Switch:	Magnetic thumb wheel
Power:	Six AA alkaline cells
Battery Life:	168 hours, nominal at 4 pulses / second
Low Battery:	Red LED Inidicator
Size:	Cylinder, 2.5” D x 5.0” L
Weight:	22 ounces in air, 4 ounces in water
Operating Temp:	0°C to 70°C or 32°F to 158°F
Depth Rating:	1000 feet
Construction:	Precision machined out of solid PVC
Radiation Pattern:	Omni Directional

HOME PINGER

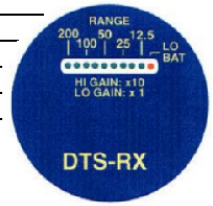
C-more Simulation

PINGER - SPECIFICATIONS

02:06:47 PM 24-APR-19

The Receiver (DTS-RX):

Receiver Range:	1000-2000 feet in normal range
Beam Pattern:	29° @ -3 dB, conical
Center Frequency:	72.5 kHz
Filter:	4th order active, Q=25
ON Switch:	Magnetic thumb wheel
Gain Control:	HI/LO gain via ON switch
Signal Strength:	9-element LED strip, 3 dB per LED, selectable
Distance Indicator:	Dual scale above LED strip
Low Battery:	Red LED Inidcator
Power:	9V alkaline battery
Battery Life:	6 hours continuous operation
Size:	Cylinder, 2.5”D x 5.0”L
Weight:	17 ounces in air, 3 ounces in water
Operating Temp:	0°C to 70°C or 32°F to 158°F



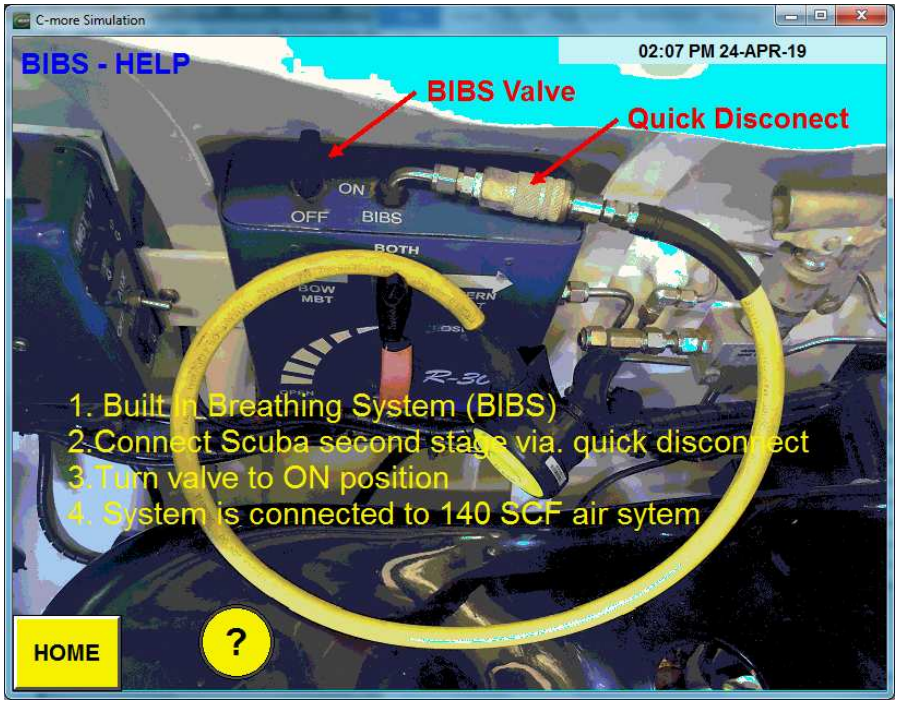
HOME PINGER

APPENDIX F – BUILT IN BREATHING SYSTEM (BIBS)

On the starboard side of the operator is the BIBS (Built In Breathing System) valve and quick disconnect as shown below.

The systems work with a scuba divers emergency second stage regulator.

To use the BIBS, connect the second stage regulator to the quick disconnect shown above and turn on the valve. The operator can insert the regulator mouth piece in his mouth and then breathe normally.



APPENDIX G – SCRUBBER CHANGE

The scrubber assembly is shown below. The steps for changing out the SodaSorb HP CO2 absorbent in an emergency are shown below:

1. Turn off the scrubber fan from the **ENV** screen.
2. Locate the tool bag below the pilot's seat and place in lap.
3. Loosen the restraining band at the top of the scrubber.
4. Lift scrubber into lap. Disconnect power if necessary.
5. Take the screwdriver from the tool bag and pry the top off.
6. Discard the spent contents on the floor of the cabin.
7. Take the funnel from the tool bag and insert in annulus space.
8. Reach behind starboard side of operator and locate one of the three spare SodaSorb containers.
9. Fill the scrubber annulus space being careful to keep absorbent out of the central area.
10. SodaSorb should be filled to the very top to prevent air bypassing over the top.
11. Put the scrubber top back on.
12. Return the spare container to its storage location behind the pilot.
13. Reinstall the scrubber making sure electrical power supply is connected.
14. Turn on the scrubber from the **ENV** screen. Fan should be blowing.

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