VEMCO VRAP SYSTEM

HARDWARE MANUAL

9-12-2011

VEMCO, *A Division of AMIRIX Systems Inc.*

AMIRIX Systems Inc.
Warranty and Disclaimer

WARRANTY

AMIRIX Systems Inc., doing business under its trade name VEMCO, provides a one (1) year warranty period for the Product from date of shipment.

VEMCO warrants that on the date of shipment all Products manufactured by VEMCO are free from defects in material and workmanship under normal use and service. This warranty applies to the components necessary for equipment upgrades, i.e. the VR1/VR2 to VR2W upgrade. With respect to transmitter products, while VEMCO is able to predict battery life with some certainty, VEMCO cannot guarantee that these Products will remain functional while submerged for extended periods of time. This warranty does not apply to any equipment, materials or design supplied by Buyer or a third party; re-battery services provided by VEMCO; Products for which VEMCO has not received payment; problems that results from: external causes such as accident, abuse, misuse; servicing not authorized by VEMCO; usage not in accordance with Product instructions; failure to follow the Product instructions or failure to perform preventative maintenance; usage of accessories, parts or components not supplied by VEMCO.

This warranty shall survive delivery only on the conditions and subject to the limitations set forth below.

NOTICE PERIODS

To receive a warranty remedy for a Product, Buyer must contact VEMCO's Customer Support Department during the warranty period to receive the Return Material Authorization ("RMA") instructions. Each defective Product returned for warranty remedy must be shipped at the Buyer's expense according to the RMA instructions and must include reasonable proof that the claimed defect is due to a matter embraced within the warranty set forth above and that such defect did not result from any act or omission of Buyer, including but not limited to any failure to operate and maintain the Product in accordance with VEMCO's applicable written instructions.

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VEMCO's liability, and the Buyer's exclusive remedy under this warranty, as to a defect in material or workmanship, is limited to the repair of such defect in the accessory, equipment or part in which the defect appears or, at VEMCO's option, to the replacement of such accessory, equipment or part with a similar item free from defect. As to any item repaired by VEMCO or furnished as a replacement by VEMCO, VEMCO's liability and the Buyer's exclusive remedy to the repair or replacement of such item for any further defect in material or workmanship, provided VEMCO receives written notice at Halifax, Nova Scotia, of such further defect from BUYER within ninety (90) days after the repaired or replaced item is shipped to BUYER and provided that BUYER returns same to VEMCO as provided under "Notice Periods".

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All repairs, replacements and corrections described above shall be performed by VEMCO at its plant at Halifax, Nova Scotia, or at such other place as may be mutually agreeable, and with reasonable care and dispatch in order that the Product, accessory, equipment or part will not be kept out of service longer than necessary. Return to BUYER of a repaired, replacement, or corrected accessory, equipment, part or Product shall be at VEMCO's expense. Title to and risk of loss of the Product, accessory, equipment, or part returned to VEMCO pursuant hereto shall at all times remain with the BUYER, except that title to a returned accessory, equipment, part, or Product shall pass to VEMCO concurrently with shipment to BUYER of any item furnished by VEMCO to BUYER as a replacement therefore. VEMCO shall have only such responsibility for any Product, accessory, equipment, or part owned by the BUYER and in the possession of VEMCO as is chargeable by law to a bailee for hire, but shall not be chargeable for loss of use thereof.

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Normal wear and tear and the need for regular maintenance shall not constitute a defect under this warranty.

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EXPORT

Products and associated materials supplied or licensed hereunder may be subject to various export laws and regulations. It is the responsibility or BUYER to comply with such laws and regulations.

NEGOTIATED AGREEMENT

It is fully understood by the parties that the price of the Product and other mutual agreements of the parties set forth in this agreement were arrived at in consideration of this warranty, SPECIFICALLY INCLUDING THE WAIVER, RELEASE AND RENUNCIATION BY BUYER SET FORTH ABOVE (DISCLAIMER AND RELEASE).

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INTRODUCTION

ABOUT VEMCO

VEMCO, a division of AMIRIX Systems Incorporated, is a leader in the design and manufacture of oceanographic research tools and systems since 1979. Located in Halifax, Nova Scotia, VEMCO's product line ranges from miniature acoustic transmitters and data loggers to large tracking, positioning, and monitoring systems. Data communication methods include acoustic telemetry, radio modem and cellular telephone modem.

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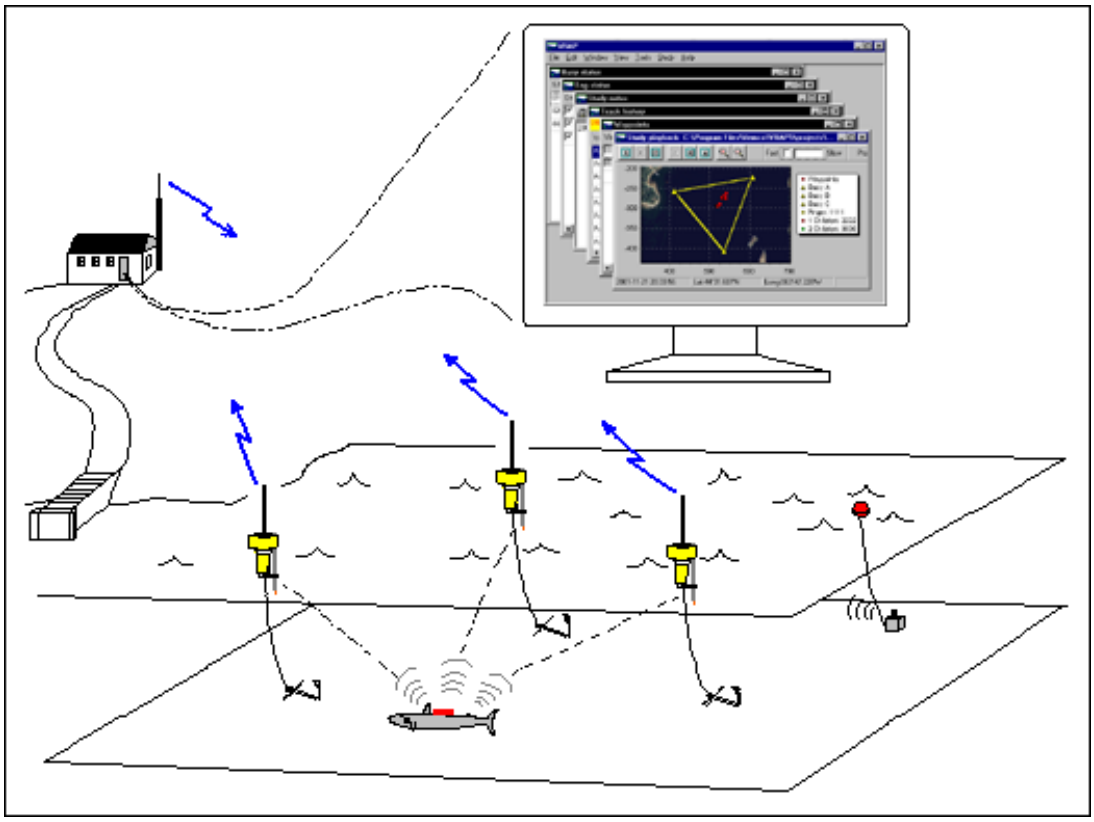
SYSTEM OVERVIEW

The VEMCO Radio-linked Acoustic Positioning (VRAP) System consists of a computer controlled base station and three buoys. The base station controls the buoys by using line-of-sight radio modems. The buoys receive acoustic pulses from free running pingers and/or telemetry transmitters in the area. This received information is transmitted to the remote base station where the position of each tag is calculated based on the arrival times of the acoustic pulses. The positions of the buoys and the tags are displayed on the computer screen and stored in a database.

A typical buoy positioning system is depicted in the diagram below:



QUICK START

This Quick Start list is designed as a review for customers who are familiar with the VRAP equipment and software. NOTE: Any number of studies may be performed once a project is setup.

To setup a new project:

1. Setup Hardware:
   - Setup the Base Station (see *Base Station Installation* section).
   - Setup the buoys (see *Buoy Installation* section).
   - Deploy the buoys (see *Deployment* section).
2. Install the VRAP software on the user supplied IBM compatible computer (see *Software Installation* in VRAP Software manual) and open the software.
3. Setup new project:
   - Select *New* under the *File* menu.
   - Create a new folder in the *Open* window for the new project, and open the new folder (double click on the folder name).
   - Enter the name of the new project in the *File name* line at the bottom of the *Open* window and click the Open button. The *Project settings* (see *Project settings* under the *Edit menu* in the VRAP Software manual) window will automatically open.
   - Setup the project (see *Project* in the *Project settings* portion of the VRAP Software manual). This includes the com port, the background image, the speed of sound value, etc.
   - Setup the buoys (see *Buoys* in the *Project settings* portion of the VRAP Software manual). This includes the serial number, the hydrophone depth, the status, etc.
   - Setup the tags (see either *Continuous Tags* or *Coded Tags* in the *Project settings* portion of the VRAP Software manual, depending on the type of tags to be setup). This includes the tag type, the tag parameters, the visual settings, the scan options, the calculation algorithm, etc.
4. Test the communication between the base station and each buoy (see *Test communication* under the *Tools menu* in the VRAP Software manual). This is necessary to load the settings in the buoys.
5. Calibrate the positions of the buoys (see *Calibrate* under the *Tools menu* in the VRAP Software manual).
6. Start a study (see *Start* under the *Study menu* in the VRAP Software manual).
7. After the study is ended, view the results in *Playback* (see *Playback* under the *Study menu* in the VRAP Software manual).

THEORY OF OPERATION

Calculating Transmitter Position (using three acoustic buoys)

The default algorithm for calculating transmitter positions solves a set of simultaneous equations. There are four unknowns:

1. The X horizontal coordinates of the transmitter position.
2. The Y horizontal coordinates of the transmitter position.
3. The Z depth coordinate of the transmitter which is the height difference between the transmitter and the plane formed by the hydrophones.
4. The transmitter transmit time.

For a free-running pinger or telemetry transmitter, the time the transmitter fires its pulse is not known - only the arrival times at each hydrophone is known. Therefore, with three buoys, the depth must be either known or estimated through user input or by using a depth transmitter. For pingers and temperature transmitters, the depth is estimated by the user and entered into the transmitter setup window. Provided the Z depth coordinate is much smaller than the X and Y horizontal coordinates, errors in estimating depth do not significantly affect the X & Y results in the calculation.

Accuracy of Transmitter Position

Positioning Algorithms

The algorithm used to calculate the position of a tag may be selected from the three listed below, namely *Fast track*, *Time average*, and *Position average*. The selection occurs when the tag information is entered in the software (explained in the VRAP Software manual). The *Pulses to avg* value is the percentage of pulses that are to be averaged for use in position calculations.

Fast Track - An average time is compiled and used with *Pulses to avg* to determine the best data times. The position is calculated for each of these best data times and all best data positions are plotted on the chart.

Time Average - An average time is compiled and used with *Pulses to avg* to determine the best data times. A new average is taken from these best data times and a position is calculated. This single position from the new average is plotted on the chart.

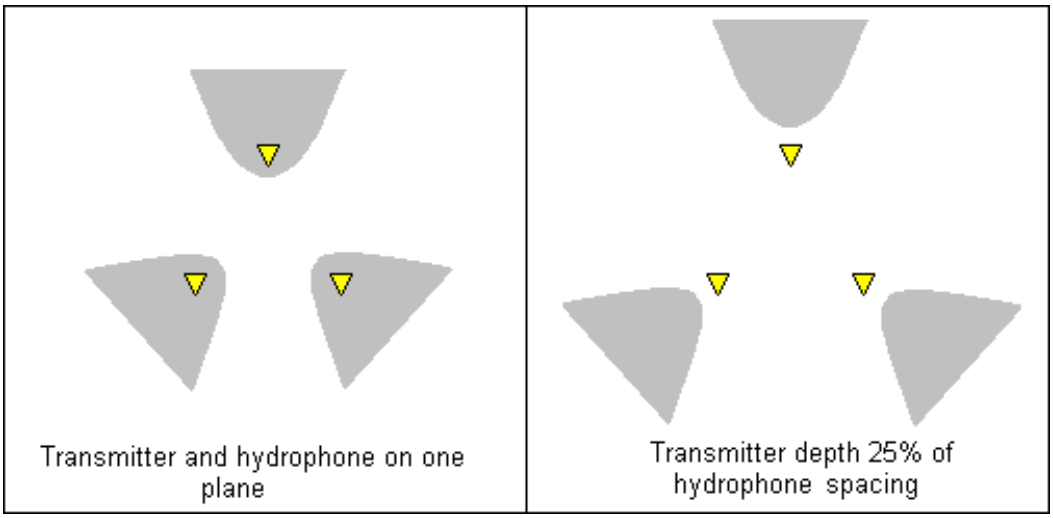
Position Average - All positions are calculated. An average position is complied from the positions and used with *Pulses to avg* to determine the best data positions. A new average is taken of these best data positions and this single position is plotted on the chart.

For best performance, the buoys should be arranged in an equilateral triangle (see *Recommended Buoy Deployment Configuration* in the Hardware section). With good acoustic conditions, the transmitter can be positioned with an accuracy of 1 to 2 meters inside the buoy triangle. As the transmitter moves outside the buoy triangle the accuracy decreases.

Echoes and reverberations received in poor acoustic conditions, and during the first 5 milliseconds of an acoustic pulse, can interfere with the direct line of sight signal and cause the pulse to be received late, or missed altogether. The *Time average*, and *Position average* algorithms aid in reducing position errors from the occasional late pulse.

Shadow Zones - Areas of Indeterminacy

Shadows Zones are three areas around the buoy configuration where the position calculation of a transmitter will have two solutions. The software assumes the pseudo position closest the last valid position is correct, and this position will be plotted. This assumption is reasonable since the other solution is often hundreds or thousands of meters away from the last valid position. The location of these areas depends upon the buoy hydrophones and the received signal being on the same plane. The example shown below and on the left indicates the locations of the shadow zones when the transmitter and buoy hydrophones are at the same depth. The example on the right shows the locations of the shadow zones when there is a 25% difference between the depth of the transmitter and the distance between the buoy hydrophones.



CYCLE OF EVENTS

During Communication Between Base Station and Buoy

1. The base station communicates with one buoy at a time.
2. Each radio packet is checked for errors using two checksum bytes. If radio errors are detected then the base station will repeat the message. The number of times the message is unsuccessfully repeated is determined in the *Radio retries* box in the *Project settings* window (see the VRAP Software manual). When this number has been reached and successful communication has not yet occurred, the VRAP software will wait the Failure delay period (also set in the *Project settings* window) before again attempting radio communication.
3. Each time the buoys begin receiving acoustic pulses their internal timers are synchronized to the base station timer.

During Calibration of Buoy Positions

The position of the buoys may be calibrated automatically during a study according to the *Calibration interval* value assigned in the VRAP software (*Project settings* window), or may be initiated by the user during a study. The cycle of calibration events are listed below.

1. Buoy A is instructed by the base station to activate its local pinger, which operates at 34kHz.
2. The base station instructs Buoy B and Buoy C to receive at 34kHz and record incoming data.
3. After an elapsed period of time, Buoy A is instructed to deactivate its local pinger and transmit its data to the base station. Buoy B and Buoy C are instructed to transmit the data pertaining to the signals received from Buoy A.
4. Steps 1-3 are repeated with Buoy B transmitting an acoustic signal from its local pinger and Buoy A and Buoy C listening.
5. Steps 1-3 are repeated with Buoy C transmitting an acoustic signal from its local pinger and Buoy A and Buoy B listening.
6. The position of each buoy is calculated.

After all the data has been collected, the position of each buoy is calculated.

During Calculation of Transmitter Positions

1. Each buoy is instructed to receive on a certain frequency for a specified period of time according to the scanning cycle list (entered in the software).
2. The base station requests and receives the data from each buoy.
3. The position of the transmitter, relative to the buoys, is calculated by the VRAP software.

VRAP HARDWARE

MAJOR COMPONENTS

The major components of the Radio Acoustic Positioning System are as follows:

Base Station

The base station is the "brain" of the VRAP system, allowing commands to be sent to the individual buoys, information to be received from the buoys, and data to be stored in the computer. The base station consists of the following components:

1. User supplied personal computer (see *System Requirements* in VRAP Software manual).
2. VRAP software for computer and VRAP System manual.
3. VRAP Base Station box with internal microprocessor and radio modem.
4. Serial cable for connection to computer.
5. Power cable.
6. User supplied +12VDC power supply.
7. Antenna coax cable.
8. Antenna.
9. Optional user supplied VHF/UHF radio scanner for troubleshooting and monitoring of base station and buoy communications.

Acoustic Buoy (3 or more)

The buoy receives acoustic signals from free-running transmitters within the study area. This data is temporarily stored in the buoy's memory until a request is received from the base station for the data. The data is then transmitted to the base station via the radio modem. Each buoy consists of the following components:

1. Buoy hull, with floatation collar, side mooring lug, and bottom ballast lug.
2. Internal VR20 acoustic receiver.
3. Internal radio modem.
4. Internal 24 amp-hour gel cell battery.
5. External waterproof Hydrophone Bulkhead connector.
6. External waterproof 4 pin male Activation Bulkhead connector.
7. External charging vent with removable plug.
8. External antenna mount and antenna.
9. Antenna Mount Hole Cover (for when the antenna is removed).
10. Hydrophone.
11. Activation Plug which shorts pins 2 and 3 to activate the buoy.
12. Activation Protection Cap to protect the male pins on the Activation Bulkhead connector when the Activation Plug is removed.

Detailed diagrams of some major components are shown in the *System Diagrams* section of the Appendix.

INSTALLATION

Before installing the VRAP system, unpack and inspect the equipment. A complete listing of parts and accessories is found in the *RAP (3) Buoy System Equipment List*, along with pictures identifying the parts. Verify that all parts and accessories are included.

Base Station Installation

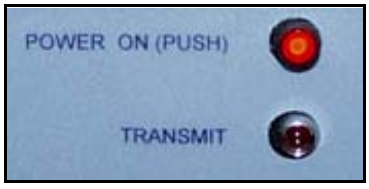
The personal computer (PC) and the Base Station unit must be installed in a dry place. The Base Station antenna must be mounted to provide a direct line of sight to each of the Acoustic Buoy antennas. The antenna cable supplied is a 15 meter length of RG8/U coaxial cable with a connector on each end. If a longer cable is required, please contact VEMCO for further information.

Installing the Base Station:

1. Unpack the Base Station unit.
2. Setup the personal computer supplied by the user.
3. Install the VRAP software on the computer (see *Software Installation* in the VRAP Software manual).
4. Connect to the computer:
   - Connect the male end of the supplied serial cable to the DB-9 connector on the back of the Base Station (see photo on next page). The connector is in the top left corner of the back panel.
   - Connect the other end of the serial cable to a serial port on the IBM compatible computer. The computer serial port can either be a male DB-25 or a male DB-9 (an adapter may be needed).
   - Record the serial port (Com port) number to which the Base Station is connected. This will be entered in the VRAP software in step 8.c.
5. Mount antenna:
   - Mount the Base Station's antenna where it will have a line of sight to the buoys when they are deployed. The antenna cable to the base station should be as short as possible for best performance.
6. Connect antenna to Base Station:
   - After mounting the antenna, connect the antenna to the Base Station using the supplied coax cable. The connector is found on the bask panel of the Base Station, on the left side (see photo on next page).
   - Arrange the antenna coax cable so it does not come near the power cable to the Base Station or the serial cable to the computer. This is to prevent interference with the operation of the antenna.
   - **Always connect the antenna to the Base Station BEFORE applying power to the Base Station.** Damage may occur to the radio if it attempts to transmit while no antenna is connected.

7. Connect power to the Base Station:
   - Connect a 12 Volt DC power supply to the back panel of the Base Station. The connector is on the right side of the back panel, directly below the serial cable connector (see photo below). The power supply must be capable of supplying sufficient current during radio transmission (typically 2 Amp). The best arrangement is to use a 12 volt car battery to power the base station and charge it periodically, or continually, with a float charger.
8. Test the Base Station:
   - Power the Base Station by pressing the Power On button on the front of the Base Station. The button will light up when power is on, as it is in the photo below.
   - Run the VRAP software.
   - Enter the com port number in the VRAP software (see *Project settings* in the VRAP Software manual).
   - Setup a buoy in the *Project settings* section of the VRAP software (see VRAP Software manual). Enter the serial number of the buoy and select the status as Buoy A.
   - Use *Test Communications* under the *Tools* menu in the VRAP software to send a radio packet to the acoustic buoy that was setup in step 8.d.
   - Verify that the *Transit* light on the front panel (see photo below) lights momentarily, indicating that the Base Station is transmitting. If a VHF/UHF radio scanner is tuned to the radio modem frequency, the base station message can be heard repeating three times.
   - The software should report that the buoy is not responding. This is the expected response because the buoys have not yet been setup.
9. Power down the base station.

Back pannel of Base Station - antenna (left); computer (top right); power (bottom right).



Lights on front of Base Station.

Buoy Installation

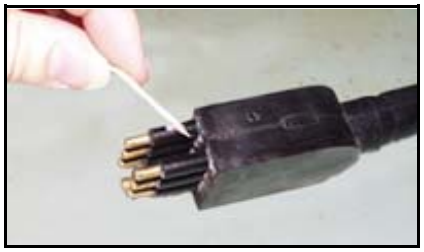
When a buoy is shipped, the Activation Plug has been removed from the 4-pin male Activation Bulkhead connector and a threaded cap has been installed to protect the male pins. The antenna has also been removed, and the Antenna Mount Hole Cover installed to prevent the antenna connector from falling inside, and to waterproof the buoy. The hydrophone has been clamped in the safe position to prevent damage during transit. It is suggested that the hydrophone remain in this position until just before the buoy is lowered into the water.

WARNING: Do not allow any metal object to short the 4-pin male Activation Bulkhead connector or damage will result to the internal battery and wiring harness. Pins 1 and 4 on the connector are connected directly to the battery negative and positive terminals for charging.

Installing a buoy:

1. Unpack the buoy:
   - Open the wooden packing box by removing the screws marked with orange paint.
   - Remove the strapping from inside the crate (remove the screws inside that have been marked with orange paint).
   - Carefully remove the buoy from the box. It may be necessary to first remove some of the packing material from the box.

2. Connect hydrophone:
   - Apply a thin coat of O-ring grease to the rubber covering the pins on the hydrophone cable connector. DO NOT get the grease on the metal tips of the pins (see photo below).
   - Line the connector pins up with the connector on the buoy lid (see photo below).
   - Place one hand on the Hydrophone Bulkhead connector on the buoy to keep it stable (see photo below) and push the connector on the hydrophone cable in to the connector on the buoy.
   - Ensure the hydrophone is properly connected and that the connection is tight (see photo).


Apply grease to connector pins.


Align connector halves.


Press halves together.


Hydrophone properly connected.

3. Connect the antenna to the buoy:
   - Ensure that the Activation Protection Cap is securely covering the 4-pin Activation Bulkhead connector (see photo below).
   - Remove the Antenna Mount Hole Cover (gray PVC) from the buoy lid by removing the four SAE 3/8" hex head bolts (see photo below) with a 9/16" wrench.
   - Disconnect the antenna cable connector from the underside of the Antenna Mount Hole Cover by turning the **connector outer ring** in a counter-clockwise direction. NOTE: **Do not allow the antenna cable connector to drop inside the buoy** or the buoy lid will have to be removed to retrieve it.
   - Ensure that the O-ring on the bottom of the Antenna Mount is greased with silicone grease and that both the O-ring and the grove it sits in are clean from grit or other debris.
   - Prepare the bolts for insertion by standing them upside-down and sliding the split locking washer and the flat washer (in that order!) on them, as shown in the photo below.
   - Attach the internal antenna cable to the end of the antenna protruding from the base of the Antenna Mount (see photo below). DO NOT TWIST THE COAX CABLE, only the outer ring on the connector.
   - Ensure the O-ring mating surface on the buoy lid is free of grit or other debris.
   - Align the four holes in the Antenna Mount with the holes in the buoy lid and insert the four bolts taken from the Antenna Mount Hole Cover and prepared in step 3e.
   - Tighten each bolt until the split washer is compressed to ensure the bolt will not loosen during use (see photo below). ***Do not over tighten***. Over tightening will strip the threaded holes in the lid.

Activation Protection Cap

Removing Antenna Mount Hole Cover

Attaching antenna (bolts and washers are ready)

Compressed split washer

4. Pressure test the buoy (also found in *Testing* section):

   NOTE: The buoy should be pressure tested for leaks whenever the antenna has been re-connected to the buoy.

   - Remove the Lid Pressure Relief Plug from the buoy lid.
   - Check that the O-ring in the Buoy Pressure Test Valve is debris free, greased, and in place (see photo below).
   - Insert the Buoy Pressure Test Valve into the Charging Vent hole (previously occupied by the Lid Pressure Relief Plug) as shown in the photo below.
   - Remove the Schrader valve cap from the end of the Buoy Pressure Test Adapter.
   - Pressurize the inside of the buoy to approximately **15 psi**, but no more than 15 psi. Make note of the exact pressure.
   - Allow the buoy to stand for 30 to 60 minutes. It is important to keep the buoy at approximately the same temperature during the test. A large temperature change will cause a change in pressure within the buoy and will result in invalid test results.
   - Measure the pressure in the buoy after the elapsed time.
   - Compare the two pressure values. If the pressure has dropped significantly there is a leak. To locate the leak cover the following areas with soapy water, watching for air bubbles: Buoy Pressure Test Valve, Hydrophone Bulkhead connector, Activation Bulkhead connector, Antenna Mount, and circumference of the buoy lid. Afer the test, be sure to lubricate any O-rings which have come in contact with the soapy water.
   - Depressurize the buoy through the Buoy Pressure Test Valve and replace the Schrader valve cap.
   - Remove the Buoy Pressure Test Valve and replace the Lid Pressure Relief Plug. Be sure to securely tighten the Lid Pressure Relief Plug to the lid of the buoy or water will enter the buoy after deployment.

Buoy Pressure Test Valve with Schrader valve cap and O-ring

Buoy Pressure Test Valve in buoy lid (without Schrader valve cap)

Inserting pressure (air) in the buoy

5. Power the buoy:
   - Remove the treaded cap that is protecting the Activation Bulkhead connector (see photo on next page).
   - Apply a thin coat of O-ring grease to the rubber on the bottom of the Activation Bulkhead connector (see photo on next page). DO NOT get the grease on the metal pins or it will interfere with the electronic connection.
   - Power the buoy by connecting the Activation Plug (see photo) to the 4-pin Activation Bulkhead connector. In quiet conditions, a long pulse can be heard through the buoy casing indicating the buoy is powered. The buoy can be powered prior to deployment.

Activation Bulkhead connector


Greasing Activation/ Charge connector

6. Test the communication link to the buoy:
   - Run the VRAP software (see VRAP Software manual for details)
   - Use Test Communications under the Tools menu to verify that the buoy will respond. This also initializes important settings on the buoy and should be done each time the buoy is deployed, or when the Blanking Interval is changed.
   - A VHF/UHF scanner tuned to the radio modem frequency is useful because transmissions from both the base station and the buoy can be monitored.

When the base station and all buoys have been installed, an in-air test of the system should be performed to verify that all components are working correctly. The procedure for this test is found in the Testing part of the Hardware section of the manual.

BUOY BATTERY USE AND CARE

The buoy battery is located at the bottom of the buoy chassis. **The batteries should be charged before the buoys are stored.**

Buoy Battery Life

It is best to charge the batteries when they near a voltage of 10.5 volts. The length of time between recharging depends on how the study being performed is configured. The size of the Scanning cycle delay and the Upload interval (see the Continuous Tags or Coded Tags pages of the Project settings window in the VRAP Software manual) both affect how long the system can run before needing recharging.

WARNING: Do not allow the battery voltage to drop below 10 volts or the batteries may be permanently damaged.

Measuring Buoy Battery Voltage

If the battery voltage on the buoy is too low, the extra current drawn when the radio attempts to transmit will cause a voltage dip and the microprocessor will reset itself. With a correctly functioning buoy, the voltage can be measured using the Test Communications feature of the base station software. When a buoy is contacted via this method, it will return its battery voltage to the base station to be displayed in the Test Communications window. The buoy battery voltage is also updated each time a buoy transmits its data to the base station and is displayed in the Buoy status window.

If the radio link is not functioning, use the playback feature of VRAP to review the data file of the last study conducted using this buoy. Check the battery voltage displayed for the buoy in question. If it was approaching 10.5 Volts, or is otherwise unknown, the battery should be recharged following the procedures outlined below. After recharging the battery, if the buoy still can not be contacted via the radio link then it should be removed to a dry location for further trouble shooting.


Lid Pressure Relief Plug

Charging the Buoy Internal Battery

1. Remove the buoy from the water.
2. Remove the Activation Plug from the 4-pin Activation Bulkhead connector.
3. Remove the Lid Pressure Relief Plug (see photo) from the buoy lid.
4. Connect the AC Battery Charger supplied with the system to the Activation Bulkhead connector on the buoy lid by aligning the dot on the exterior of the plug with the largest pin on the connector. **WARNING:** ***Reverse connection of the charger*** or shorting of the pins of the Activation Bulkhead connector ***will result in internal damage***.
5. Leave the charger connected until the FLOAT light on the charger is lit.
6. After charging, remove the Battery Charger and tighten the Lid Pressure Relief Plug. The Lid Pressure Relief Plug ***must be tightened*** to prevent water from entering the buoy.

Daily Care

- Charge the battery promptly after every use.
- Use an approved charger.
- Do not drop the battery or drop anything on it.
- Do not allow any metal object (like a wrench) to touch the terminals simultaneously.
- Do not modify the battery or terminals in any way.

Storage

- The battery is stored within the buoy.
- Charge the battery fully before buoy storage! Never store the battery in a discharged or partially discharged condition.
- Store the battery in a cool dry place at 20°C (68°F) or less, if possible.
- Charge the battery at least once a year, even if it is not used.

DEPLOYMENT

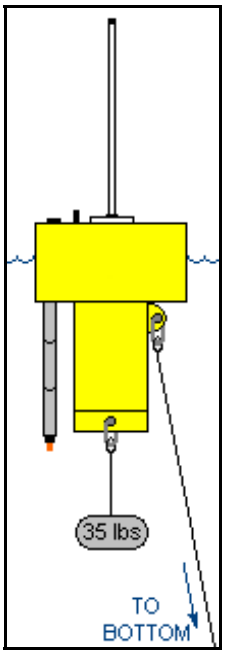
Buoy Mooring

The buoy mooring can be attached to the buoy bottom lug with a shackle or, if a separate mooring float is used, to the side mooring lug (see photo). Care must be taken when designing the mooring for the buoys to ensure that it will not affect performance or damage the buoy. Each buoy requires approximately 16 kilograms (35 lbs) of ballast attached to the shackle at the bottom of the buoy to ensure it floats correctly (see drawing).

Chain will rattle and add to background noise so it is recommended that chain not be attached directly to the buoy for mooring. An acceptable method is to attach a strong rope to the buoy and then connect the rope to a chain many feet below the depth of the hydrophone. This method reduces the noise in the water and provides a suitable mooring for the buoy.

The hydrophone must be kept clear of mooring lines and should be closer to the center of the buoy triangle for better signal reception.

Shackle identification



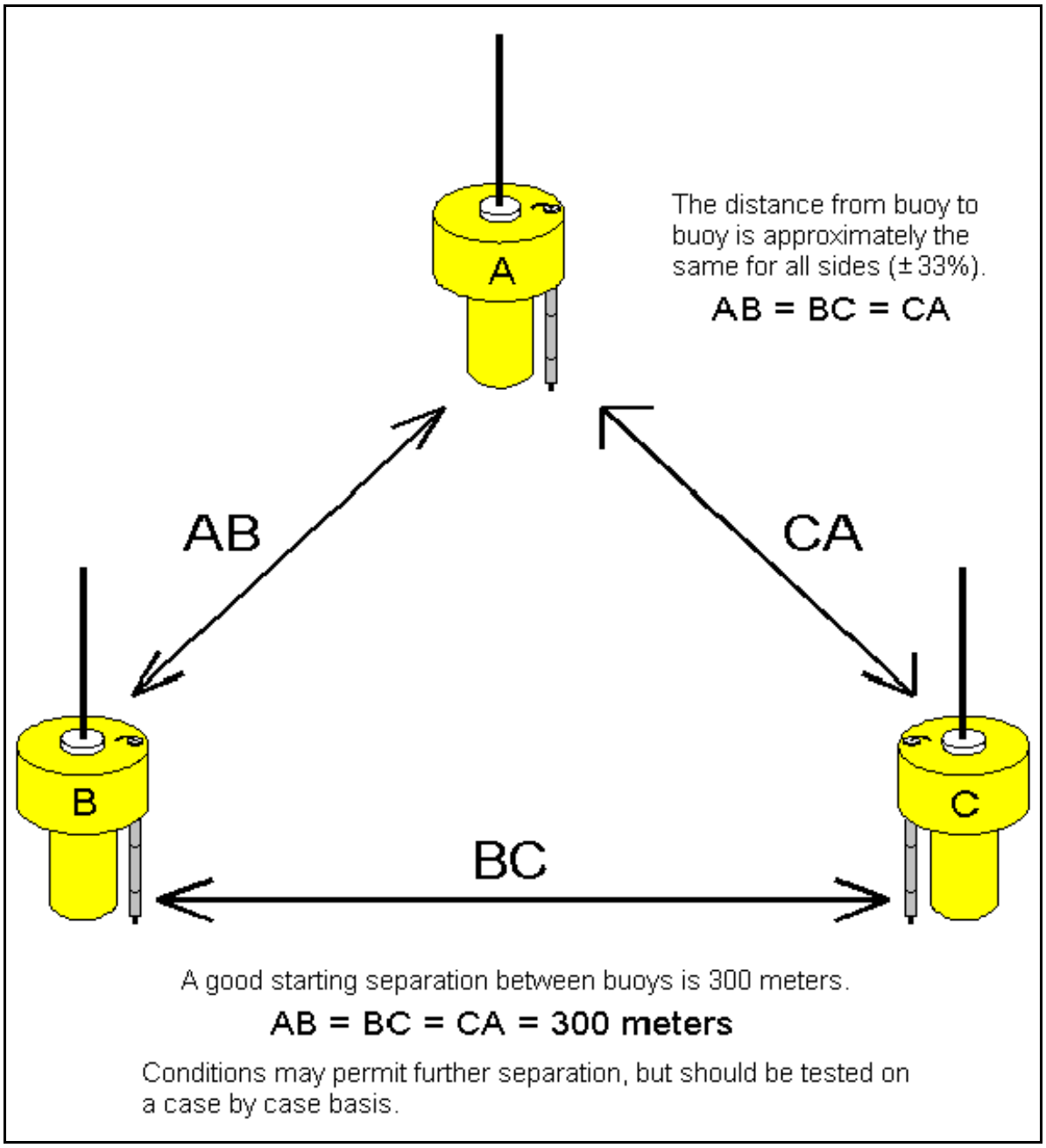
Buoy mooring

Recommended Buoy Deployment Configuration

The maximum distance between the buoys varies with the conditions under which they are operating. Background noise, such as a busy harbour and weather conditions, can affect the maximum distance between the buoys. The type of transmitter tag being used will also play a large role in determining the maximum distance possible. The more powerful tags allow for larger separation, not withstanding the other limiting effects mentioned.

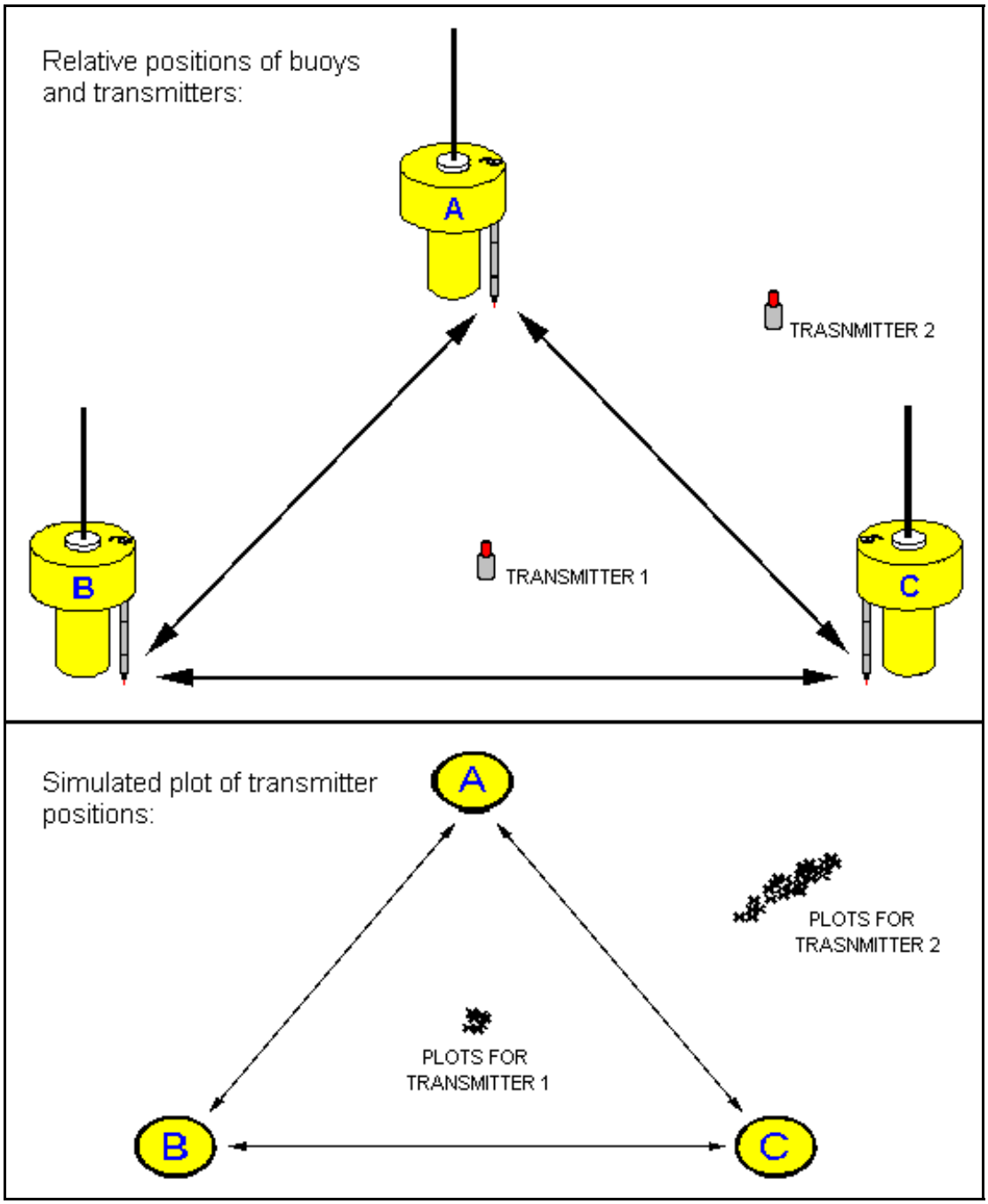
The key to communicating with the buoys from the Base Station is to have an unobstructed line of sight between the buoys and the Base Station antenna. Under good conditions, a range of two to three kilometers can be expected. If there is no line of sight, communicating with the buoys may be impossible. Also, communications may be affected when seas are rough and the buoys are rocking a great deal.

The ideal three buoy deployment shape is an equilateral triangle, with approximately equal distances from buoy to buoy (see diagram below). Begin with a separation of 300 meters between buoys as a starting distance. Deploy the buoys with this separation and conduct tests to determine how well the system is performing. If satisfied at this distance, try moving the buoys farther apart. Depending on the variables mentioned above, greater separation between buoys may be achievable.



Optimum three buoy deployment configuration

To achieve best performance from the system, keep the transmitter tags within the triangle formed by the buoys. As the transmitters move outside of the triangle, increased errors in their position will result. The plots for a stationary transmitter outside of the triangle will appear to "jitter" in a direction perpendicular to the side of the triangle due to slight errors (see diagram below).



A simulated plot of transmitter positions

It is strongly suggested that an in-air test be performed on the beach immediately before deploying the buoys (see *In-Air Testing of the VRAP System* in the Testing section). Communication with the buoys also initializes important settings on the buoy and should be done each time the buoy is deployed, or when the *Blanking Interval* is changed.

Before placing the buoys in the water, place the hydrophone tip in the deployed position. For standard hydrophones, this involves loosening the two clamps that are holding the hydrophone in the safe position and lowering the hydrophone until the top of the hydrophone (the end with the cable) stops against the buoy hull. Tighten the bolts so the hydrophone will not move. The deployed position is shown in the photo here.

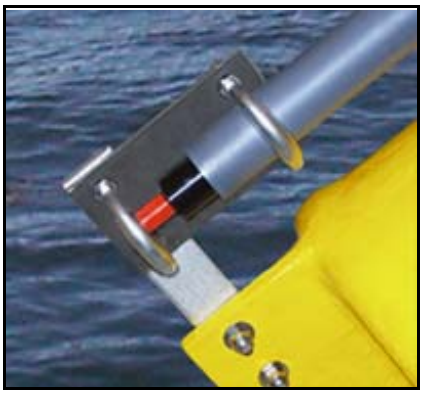

Standard buoy hydrophone in deployed position

Buoys with a non-standard hydrophone will require that the hydrophones be inserted in the buoy hull until the top of the hydrophone (the end with the cable) stops against the buoy hull. Tighten the 3/8" bolts so the hydrophone will not move.

RETRIEVING BUOYS FROM DEPLOYMENT

Removing Buoys from Water

When a buoy is removed from the water, immediately place the hydrophone in its safe position. To do this, first loosen the two steel clamps that hold the hydrophone in place (see photo below). For standard length hydrophones, draw the hydrophone rod up until the tip (the orange and black section) of the hydrophone is between the clamps (see the photo on the left below). It is not necessary to disconnect a standard length hydrophone as the cable will reach (see the photo on the right below). If the hydrophone is not a standard one, then power down the buoy (remove the activation plug), disconnect the hydrophone from the buoy (connector on top), loosen the clamps completely, and remove the hydrophone from the buoy by sliding it through the buoy float.


Standard buoy hydrophone in safe position


Hydrophone cable when standard hydrophone is in safe position

Disconnecting the Antenna from the Buoy

The steps listed below are to be followed when removing the buoy antenna to prevent damaging the unit:

7. Ensure that the Activation Plug has been removed from the 4-pin Activation Bulkhead connector and that the threaded cap (see photo below) has been installed in its place. This powers down the buoy and protects the male pins from being shorted.
8. Remove the Antenna Mount from the buoy lid by removing the four SAE 3/8" hex head bolts (see photo below) with a 9/16" wrench.
9. Prepare the bolts for insertion by standing them upside-down and sliding the split locking washer and the flat washer (in that order!) on them, as shown in the photo below.
10. Disconnect the internal antenna cable from the underside of the antenna mount by turning the ***connector outer ring*** in a counter-clockwise direction. **DO NOT TWIST THE COAX CABLE**. **IMPORTANT:** ***Do not*** allow the antenna cable to drop inside the buoy or the buoy lid will have to be removed to retrieve it.
11. Ensure that the O-ring on the bottom of the Antenna Mount is greased with silicone grease and that both the O-ring and the grove it sits in are clean from grit or other debris.
12. Attach the internal antenna cable connector to the threaded nipple on the Antenna Mount Hole Cover. **DO NOT TWIST THE COAX CABLE**.
13. Fasten the Antenna Mount Hole Cover to the buoy lid using the four bolts (see photo below). The split locking washers should be compressed to ensure proper tightness (see photo below), but ***do not over tighten***. Over tightening the bolts will strip the threaded holes in the lid.

Activation Protection Cap

Removing antenna

Attaching Antenna Mount Hole Cover (bolts ready)

Compressed split washer

TESTING

O-Ring Inspection

O-rings located in the lid of the buoy chassis are key to the watertight seal of the buoy. Each time an O-ring is disturbed, for any reason, it ***must*** be checked before the unit is sealed again. O-rings are located under the buoy lid (2), the buoy antenna collar, the Antenna Mount Hole Cover, the Lid Pressure Relief Plug, and the Buoy Pressure Test Valve.

When checking the O-rings, ensure that they are free from dirt or debris and have been covered with a ***light*** coat of O-ring grease for lubrication. If too much grease is used, the O-rings may pop out of their grooves and not seal correctly. Each O-ring should be inspected for any damage, such as nicks or cracks. A damaged O-ring should be replaced ***immediately*** with an O-ring of the same size and type. Ensure that the O-rings are properly seated in their grooves as the piece is moved into place.

Pressure Testing the Buoy Hull for Leaks

The buoy should be pressure tested for leaks whenever the antenna has been re-connected to the buoy or the buoy has been disassembled. This is the same pressure testing procedure performed when the buoy was installed (see the *Buoy Installation* section).

1. Pressure test the buoy:
   NOTE: The buoy should be pressure tested for leaks whenever the antenna has been re-connected to the buoy.
   - Remove the Lid Pressure Relief Plug from the buoy lid.
   - Check that the O-ring in the Buoy Pressure Test Valve is debris free, greased, and in place (see photo below).
   - Insert the Buoy Pressure Test Valve into the Charging Vent hole (previously occupied by the Lid Pressure Relief Plug) as shown in the photo below.
   - Remove the Schrader valve cap from the end of the Buoy Pressure Test Adapter.
   - Pressurize the inside of the buoy to approximately **5 psi**. Make note of the exact pressure.


Buoy Pressure Test Valve with Schrader valve cap and O-ring


Buoy Pressure Test Valve in buoy lid (without Schrader valve cap)


Inserting pressure (air) in the buoy

   - Allow the buoy to stand for 30 minutes. It is important to keep the buoy at approximately the same temperature during the test. A large temperature change will cause a change in pressure within the buoy and will result in invalid test results.
   - Measure the pressure in the buoy after the elapsed time.

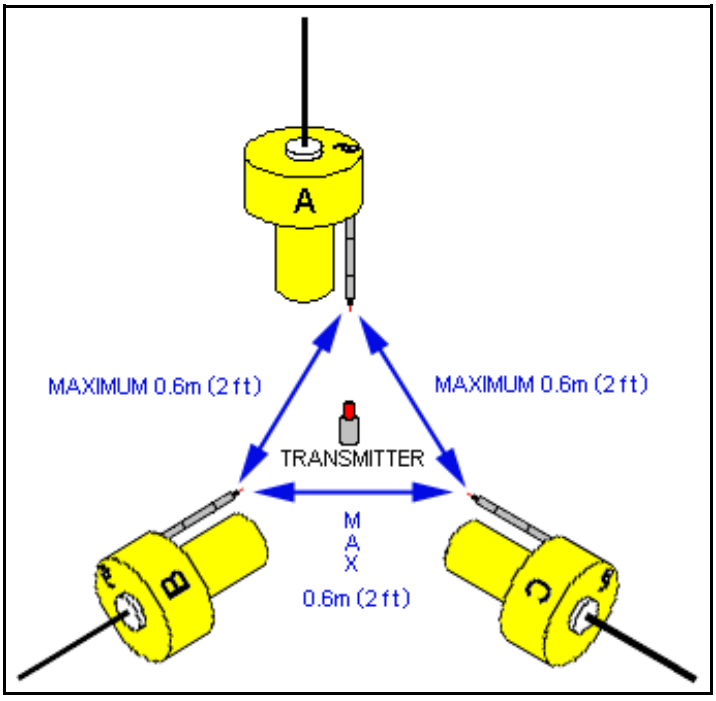
- Compare the two pressure values. If the pressure has dropped significantly there is a leak. To locate the leak cover the following areas with soapy water, watching for air bubbles: Buoy Pressure Test Valve, Hydrophone Bulkhead connector, Activation Bulkhead connector, Antenna Mount, and circumference of the buoy lid. Afer the test, be sure to lubricate any O-rings which have come in contact with the soapy water.
- Depressurize the buoy through the Buoy Pressure Test Valve and replace the Schrader valve cap.
- Remove the Buoy Pressure Test Valve and replace the Lid Pressure Relief Plug. Be sure to securely tighten the Lid Pressure Relief Plug to the lid of the buoy or water will enter the buoy after deployment.

In-Air Testing of the VRAP Buoy System

This test should be done both when the system arrives and just before deployment.

The VRAP System should be tested on land prior to deployment to ensure that the acoustic and communication sections are working properly. Keep in mind that the system is not designed to work in air and therefore the range of detection is greatly reduced.

After the buoys and the base station have been setup following normal procedures (see the *Installation* section), position the buoys in a star arrangement (see the diagram below). The hydrophones should be no more than 0.6 meters (approximately 2 ft.) from each other. Place the buoys on a soft surface, such as grass, carpet, or sand. Each buoy must have the hydrophone extended (in the listen position) and as far from the ground as possible (see photo below). The buoys will probably need to be held in this position to prevent them from rolling. Place a tag in the center of the buoy triangle and approximately on the same horizontal plane as the orange tips on the hydrophones.



Star arrangement of buoy hydrophones for in-air testing


Buoy hydrophone in air for test

Use the *Test Communications* option within the *Tools* menu (see the VRAP Software manual) to individually test the communication link with each buoy. This test requires that the proper serial numbers for each buoy and the correct transmitter information for the test tag have been entered (see the *Buoys* and appropriate *Tags* section within *Project settings* in the VRAP Software manual). The test is successful when the *Buoy communication test* window displays the battery voltage and last rollover for the buoy. The line at the bottom of that window will also verify that the buoy replied.

Each acoustic section should also be tested to ensure that it is functioning. With the activated tag in the center of the buoys, begin a study within the VRAP software. Do not calibrate the buoy positions as this is very difficult to accomplish in air and is not necessary for this stage of the test. Within the study, select the *Buoy status* window to bring it to the front and watch the number of pulses (in the *Pulses* column) received by each buoy. If this number is comparable to the approximate number of pings transmitted by the pinger then the buoy is functioning properly. For example, if the pinger being used has a period of 1000ms (1 second), and the test period is ten seconds, then the pinger has transmitted approximately ten pings. The number of pulses reported by the buoy should be close to ten.

To test the local pingers on each buoy, initiate a calibration of the buoys (click the *Calibrate buoys* button on the left side of the *Chart* window) and view the number of received pulses in the *Buoy status* window (in the *Pulses* column). The local pinger on Buoys A will transmit first. *Only one local transmitter will be active at any one time.* The number of pulses received by each of the buoys should be relatively equal, although slight differences between the numbers are common. The local pinger on Buoy B will then transmit, followed by the local pinger on Buoy C. If a local pinger is not functioning, the *Pulses* column will report that no pings were heard by any of the buoys. Disregard the calibrated positions calculated in air as it is not valid and stop the study.

In-air testing of there buoys before deployment

In-water Testing of the VRAP System

The VRAP system can be tested after the buoys are deployed to ensure that the acoustic and communication sections of each buoy are working properly. It is strongly recommended that an in-air test be performed on land prior to deploying the system, to ensure a minimal chance of deploying malfunctioning equipment.

Once the buoys have been deployed, a communication test should be performed on each buoy individually using the *Test Communications* function (see *Tools* menu section of the Software portion of this manual). If a buoy can not be contacted via the *Test Communications* function it should be checked immediately for the source of the problem. Suggestions may be found in the trouble shooting section of the Appendix, or contact VEMCO for further information.

After it has been established that each buoy is working, a transmitter should be placed (preferably stationary) in the middle of the triangle formed by the three buoys. The depth of the transmitter must be recorded and entered into the tag setup information for that transmitter (unless it is a pressure transmitter that is being used). It is recommended to have at least one stationary transmitter within the array during the test, even if other transmitters are moved through the area. After the desired transmitter(s) are in place and activated, begin a study. It is assumed that the project has already been setup, but if it hasn't then follow the instructions in the *Project settings* of the VRAP Software manual.

After the study has begun, select the *Calibrate buoys* button in the *Chart* window (see VRAP Software manual) to start a calibration of the buoy positions. During the calibration, each buoy (starting with Buoy A) will turn on their local transmitter for a short time while all the buoys listen. *Only one local transmitter will be active at any one time.* The buoy positions relative to each other will be calculated by the VRAP software, used in the tracking algorithm, and displayed in the *Chart* window. The time between calibrations may be selected within the VRAP software (prior to starting the study), or a calibration may be forced during the study by selecting the *Calibrate buoys* button in the *Chart* window. The length of time between calibrations depends on the amount of movement experienced by the buoys during the course of the in-water test.

The test can now proceed to gather position data on the transmitter(s) within the array. Do not be alarmed if the moored transmitter appears to move slightly during the course of the test. This is caused by acoustic reflections and variances in arrival times of the pulses. A successful test is one where the plots of the moored transmitter are clustered in one relatively small area over the total test, and the plots of any moving transmitters accurately reflect its path. Variables such as sea conditions, water temperature and transmitter type can combine to effect the performance of the system. Best results are obtained if the transmitters remain within the buoy triangle.

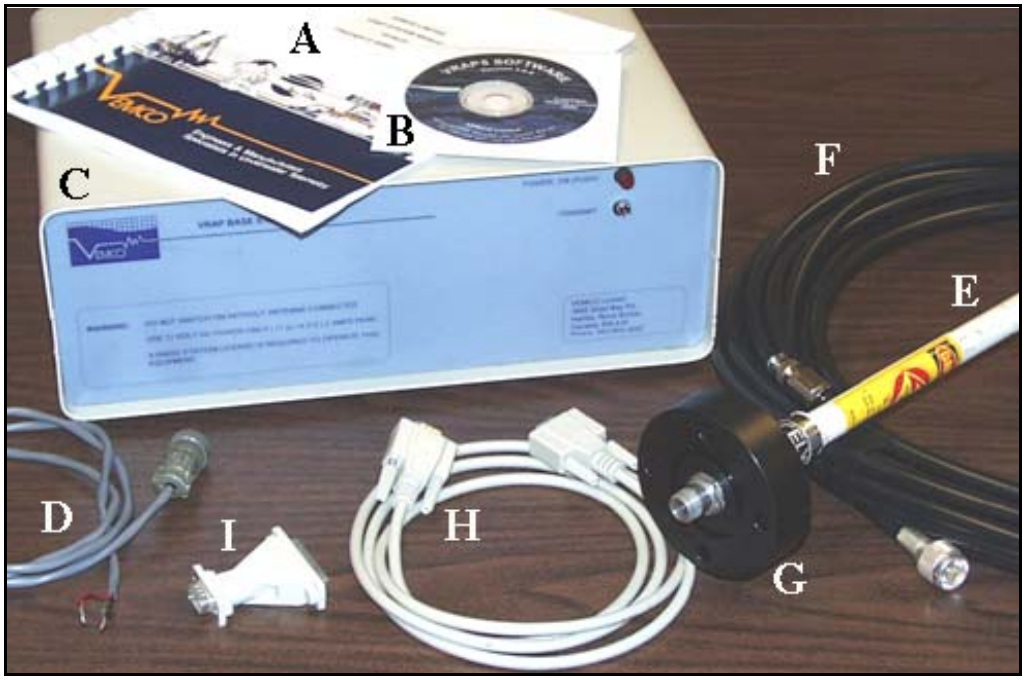
It is important to realize that a correct position can only be obtained if a tag is acoustically "in view" of all three buoys. If it is behind a reef which blocks direct signals then the reflected signals may be the only ones that reach one or more buoys. These reflected signals will require a longer time to arrive at the buoys and therefore will not be plotted in the correct location.

RAP (3) BUOY SYSTEM EQUIPMENT LIST

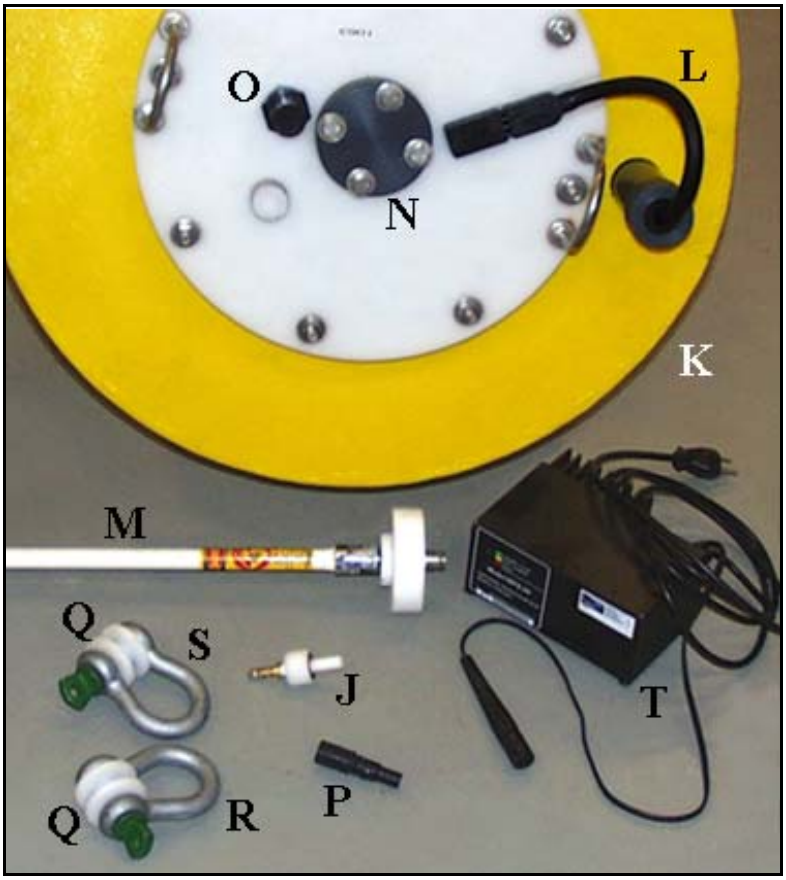
The ID column in the equipment list below refers to the labels in the photos on the next page.

QTY	DESCRIPTION	ID
1	MANUAL	A
1	VRAP SOFTWARE	B
1	BASE STATION	C
1	BASE POWER CABLE (3M)	D
1	BASE ANTENNA	E
1	BASE STATION ANTENNA RG-8 CABLE (15m)	F
1	BASE ANTENNA N275-F MOUNT	G
1	BASE SERIAL CABLE	H
1	BASE SERIAL CABLE ADAPTER	I
1	BUOY PRESSURE TEST ADAPTER with O-Ring	J
3	BUOY - serial number stamped on lid	K
3	BUOY LOCAL PINGER/HYDROPHONE on external conduit (clamped)	L
3	BUOY ANTENNA with ANTENNA MOUNT installed with O-Ring	M
3	BUOY ANTENNA MOUNT HOLE COVER installed on buoy lid	N
3	BUOY BLIND LOCKING SLEEVE - PROTECT ACTIVATION CONNECTOR	O
3	BUOY ACTIVATION PLUG (pins 2 & 3 shorted)	P
6 pairs	BUOY DELRIN SHACKLE BUSHINGS	Q
3	BUOY 5/8" SHACKLES mounted on side mooring lug	R
3	BUOY 5/8" SHACKLES for bottom mooring lug	S
1	BUOY AC CHARGER 120V, 60Hz SOURCE	T

CRATES: Addressed
Packing Lists
Lid marked to indicate which screws to remove (marked with orange paint)



Base Station equipment



Buoy equipment

APPENDIX

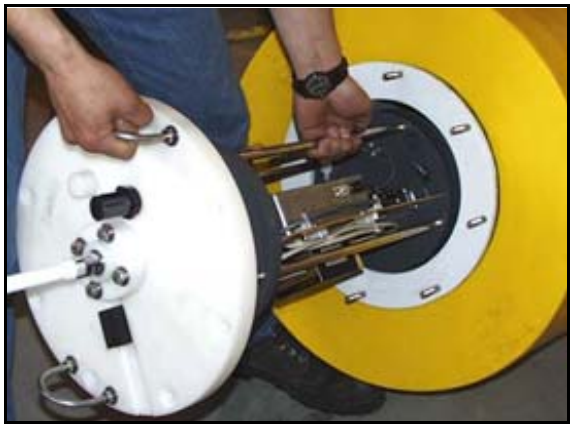
RELATED BUOY TECHNICAL INFORMATION

Opening the Buoy Lid

Opening the buoy lid is not normally required. If it is required, follow the steps listed below. The tools required for this procedure are: 9/16" wrench
9/16" deep-socket ratchet (optional)
Small container (suggested)

1. Secure the buoy hull so it will not move during the procedure.
2. Be sure the buoy lid and the top of the buoy hull are completely dry.
3. Ensure that the Activation Plug has been removed from the 4-pin Activation Bulkhead connector and that the threaded cap has been installed in its place. This powers down the buoy and protects the male pins from being shorted and damaging the electronics.
4. Remove the hydrophone connector by placing one hand on the Hydrophone Bulkhead connector on the buoy lid to keep it stable (see photo below) and pulling the other half of the connector. DO NOT pull on the hydrophone cable.
5. Remove the hydrophone from the buoy hull by sliding the hydrophone out the top of the hull.
6. Loosen the Lid Pressure Relief Plug to depressurize the buoy. Pressure may be present in the buoy due to changes in temperature.
7. Remove the eight nuts, spilt locking washers, and flat washers from around the lid circumference. A 9/16" deep-socket ratchet can be used, but a 9/16" wrench will be required for the nuts under the two handles (U-Bolts).
8. Place the nuts and washers in the small container to prevent them from being lost.
9. Lift the buoy chassis from the buoy hull by the handles on the buoy lid. When the buoy is half out of the hull, the four bars that run the length of the buoy may be used to stabilize the chassis (see photo below). **NOTE:** Be sure to keep the buoy chassis in line with the buoy hull until the chassis has completely cleared the hull. If the antenna is still attached to the buoy, use great care not to damage the antenna.

Procedure to connect/disconnect hydrophone

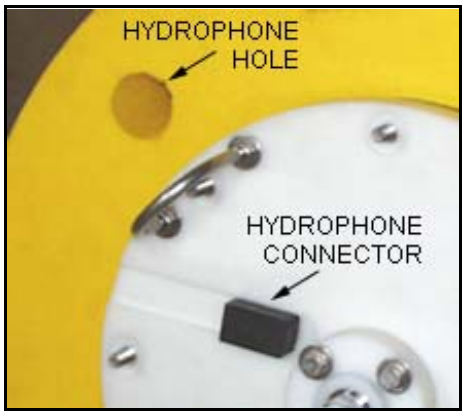


Inserting/removing buoy from hull

Replacing Buoy Lid

When replacing the buoy in the hull, follow the steps listed below. The tools required for this procedure are: O-Ring grease
9/16" wrench
9/16" deep-socket ratchet (optional)

1. Clean and inspect the O-rings on the underside of the buoy lid according to the procedures in *O-Ring Inspection* found in the *Testing* section.
2. Clean the buoy hull flange (white surface with eight bolts protruding from it) to make sure there is no grit or dirt in the area where the O-Rings will sit.
3. Position the buoy so the Hydrophone Bulkhead connector on the buoy lid is as close to the hydrophone hole in the edge of the hull as possible (see photo below).
4. Slide the chassis and lid into the buoy hull until the lid is approximately four inches from the top of the bolts on the top of the hull (see photo on previous page).
5. Verify that the O-rings have not come out of their respective groves.
6. Carefully align the holes in the buoy lid with the bolts in the hull. ***DO NOT allow the bolts on the hull to come in contact with the O-rings or the O-ring groves.***
7. Slowly easy the buoy lid onto the bolts. If the lid does not seem to be fitting correctly once in place, remove it and check the O-ring placement. Check for dirt and/or damage again before attempting to reseal the buoy. If the O-ring seal is not correctly in place before the buoy is deployed, water can enter the buoy upon deployment and cause serious damage to the electronics inside.
8. Replace the washers and nuts on the eight bolts in the following order:
   Flat washer, split locking washer, nut.
9. Tighten the eight 3/8" nuts in a circular pattern with a small force. A 9/16" deep-socket ratchet can be used, but a 9/16" wrench will be required for the nuts under the two handles (U-Bolts).
10. Repeat the tightening until the lid meets the hull flange. The split locking washers should be compressed to ensure proper tightness (see photo below) but **do not over tighten the nuts**.
11. Reconnect the hydrophone by placing one hand on the connector half on the buoy to keep it stable (see photo on previous page) and pushing the other half of the connector. DO NOT push on the hydrophone cable.
12. Whenever a buoy lid has been opened, the buoy should be pressure tested before being deployed (see the *Pressure Testing the Buoy* section for details).



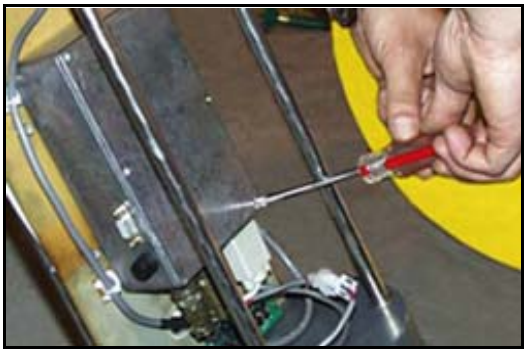
Correctly aligning buoy lid and hull.


Compressed split washer

Upgrading Buoy ROM

When VEMCO instructs to replace the current ROM in a buoy receiver, follow the steps listed below. The tools required for this procedure are: Phillips screw driver
ROM extractor (recommended)
Grounding strap (recommended)

1. Remove the buoy chassis from the buoy hull by following the procedure listed in the *Opening the Buoy Lid* section.
2. Use the Phillips screwdriver to remove all 6 screws from the gray VR20 case (see photo below) and store the screws in a container to prevent them from being lost.
3. Remove the VR20 case cover to expose the circuit board.
4. Place the strap of the grounding strap over the wrist of one hand, and connect the alligator clip to the side of the VR20 case (see photo below). The metal piece on the grounding strap should be in contact with the shin on your wrist.
5. Use the IC extractor to remove the old VR20 ROM by placing the hooked portions of the extractor under the ends of the VR20 ROM and gently pulling (see photo below).
6. Position the new EPROM in the socket:
   - Identify the end of the EPROM with a half-circle notch.
   - Identify the end of the socket with the half-circle notch drawn in white on the green circuit board (see photo below).
   - Line the pins on the ROM up with the holes in the socket so the half-circle notchs line up. Be sure the tips of the pins are all in the holes and that the pins are straight (not bent).
7. ***Gently*** push the ROM into the socket, being careful no to bend any of the pins, until the thicker part of the pins are at the top of the socket holes (the ROM should not move any farther).
8. Remove the grounding strap from the VR20 case and screw the cover back in place.
9. Replace the buoy chassis in the buoy hull by following the procedure listed in the *Replacing Buoy Lid* section.


Removing / replacing the VR20 case cover


Alignment of new ROM


Removing the ROM with the extractor (note the static strap)

Radio Replacement

When VEMCO instructs to replace the current radio modem in a buoy, follow the steps listed below. The tools required for this procedure are: 11/32" wrench
Flat head screwdriver

1. Remove the buoy chassis from the buoy hull by following the procedure listed in the *Opening the Buoy Lid* section.
2. Cut the four cable ties holding the serial cable in place. The locations of the cable ties are marked with blue arrows in the photo below.
3. Detach the antenna coax cable and the serial cable from the top of the old radio modem.
4. Remove the four 10-24 nuts from the radio mounting plate using the 11/32" wrench and the flat head screw driver (see photo below).
5. Remove the old radio from the chassis.
6. Install the new radio modem in the same orientation as the old radio modem and attach it to the buoy chassis with the nuts and flat head screws through the mounting holes (see photo below).
7. Connect the antenna coax cable and the serial cable to the radio modem.
8. Loop the excess serial cable around the radio modem and secure it in place with four new cable ties (miniature size).
9. Replace the buoy chassis in the buoy hull by following the procedure listed in the *Replacing Buoy Lid* section.

Locations of cable ties and position of cable and radio modem

Removing/attaching radio modem

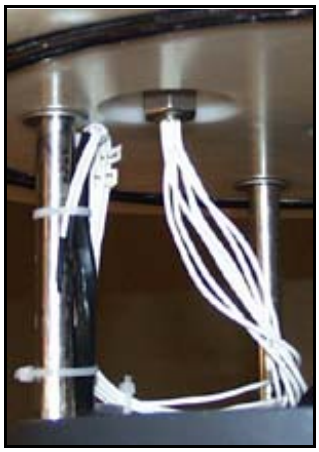
Hydrophone Bulkhead Connector Replacement

If the Hydrophone Bulkhead Connector requires replacement, follow the steps listed below. The VRAP Buoy Spare Parts kit can be purchased from VEMCO, or the connector may be purchased separately. Unless otherwise indicated, the tools are not included with the VRAP Buoy Spare Parts kit. The tools required for this procedure are:

Soldering iron
Solder (included)
3/18" heat shrink, 1.25" length each (7 pieces included)
Cigarette lighter
11/16" wrench
Wire snips
Wire stripper
Tube of O-ring sealant (included)

1. Remove the buoy from the hull (see *Opening the Buoy Lid* section) and place the buoy chassis in an upright position with the lid on the top.
2. Locate the wires for the Hydrophone Bulkhead Connector under the buoy lid. The wires are white and directly below the Hydrophone Bulkhead Connector. Each wire should have a numeric label on the wire.
3. Cut the wires between the bulkhead connectors and the wire labels, and approximately 2" from the wire labels.
4. Using an 11/16" wrench, remove the Hydrophone Bulkhead Connector bolt located under the buoy lid.
5. Remove the old bulkhead connector and set it aside.
6. Strip approximately 3/8" of the white insulation from the wires. The wires should still be connected to the buoy chassis by cable ties.
7. Using the heated soldering iron, apply a thin coat of solder to the exposed wire on each of the seven wires.
8. Remove the new Hydrophone Bulkhead Connector form the plastic bag in which it was shipped. Verify that the O-ring is either on the base of the base of the bolt or in the bag.
9. Carefully insert the wires for the new Hydrophone Bulkhead Connector through the bulkhead connector hole. ***Do not lose the wire labels - they will be needed later.***
10. Inspect the area where the Hydrophone Bulkhead Connector attaches to the buoy lid and remove any debris. This is very important because it is an O-ring surface.
11. Apply a thin coat of O-ring sealant around the Hydrophone Bulkhead Connector O-ring and ensure it is securely in its grove at the base of the bolt on the bottom of the connector.
12. Insert the connector bolt through the mounting hole and position it in place.
13. Slip the washer and nut over the connector wires and tighten the nut using the 11/16" wrench.
14. Place a length of 3/8" heat shrink over the new bulkhead connector wire labeled 1. Push this length at least 3 inches up the length of the wire.
15. Solder the wire labeled 1 on the new connector to the wire labeled 1 from the old bulk head connector (see photo on next page).
16. After the solder joint has cooled, slide the heat shrink over the join of the two wires. Apply brief heat tot he heat shrink using a cigarette lighter (keep the lighter moving or the heat shrink will burn). The heat shrink will contract around the joint of the two wires, protecting the wires from an accidental short.

17. Repeat from steps 14 - 16 for each of the remaining wires, connecting them in labeled pairs (wire 2 to wire 2, wire 3 to wire 3, etc.).
18. Replace the buoy chassis in the buoy hull by following the procedure listed in the *Replacing Buoy Lid* section.



Hydrophone Bulkhead Connector nut and wires

Solder the wire labeled 1 on the new connector to the wire labeled 1 from the old bulk head connector

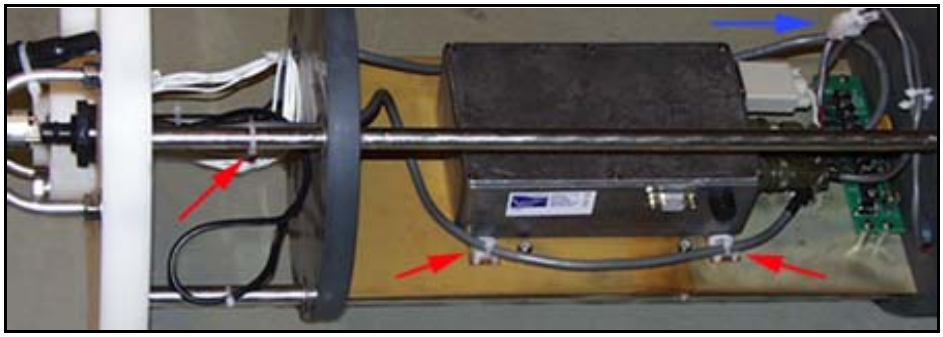
Activation Bulkhead Connector Replacement

If the Activation Bulkhead Connector requires replacement, follow the steps listed below. The VRAP Buoy Spare Parts kit can be purchased from VEMCO, or the connector harness may be purchased separately. Unless otherwise indicated, the tools are not included with the VRAP Buoy Spare Parts kit. The tools required for this procedure are:

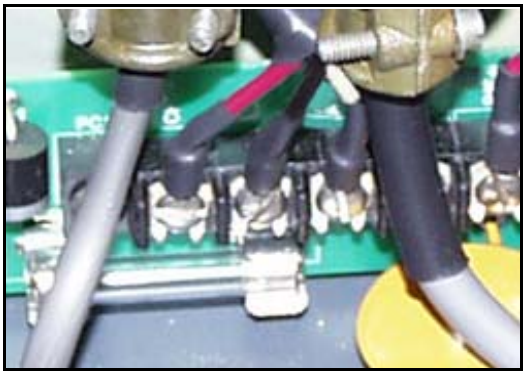
Monkey wrench capable if 1 3/8"
Cable ties (3 included)
Activation plug head connector (included)
Flat head screwdriver

1. Remove the buoy from the hull (see *Opening the Buoy Lid* section).
2. Disconnect the battery (white connector on battery cable, marked with a blue arrow in the photo on next page).
3. Disconnect the power lugs from the distribution strip (see photo on next page) with the flat head screwdriver.
4. Cut the cable ties holding the power cable. These cable ties are marked with red arrows in the photo on the next page.
5. Unscrew the old Activation Bulkhead Connector from the buoy lid using the monkey wrench.
6. Inspect the area where the Activation Bulkhead Connector attaches to the buoy lid and remove any debris. This is very important because it is an O-ring surface.
7. Place a thin coat of O-ring grease on the new Activation Bulkhead Connector O-ring (located in the bottom of the connector).
8. Feed the power lugs of the new Activation Bulkhead Connector through the hole in the buoy lid and then through the hole in the gray PVC piece. The lugs need to reach the distribution strip (on the green board at the bottom of the buoy chassis).

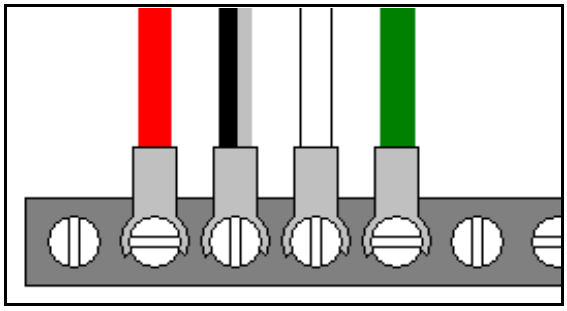
9. Screw the new Activation Bulkhead Connector in place using the monkey wrench.
10. Use the supplied cable ties to secure the bulkhead connector wire to the buoy chassis at the locations marked with red arrows in the photo below.
11. Connect the power lugs to the Activation distribution strip according to the colour of the wire attached to the lug, starting at the second screw from the left (see photo). The lugs are connected (left to right): red, black and silver, white, green. This is illustrated in the photo and sketch below.
12. Activate buoy using the activation plug. There should be a short beep to indicate that the buoy is powered. If there is no beep, recheck the distribution strip for proper connection.
13. Replace the buoy chassis in the buoy hull by following the procedure listed in the *Replacing Buoy Lid* section.



Activation Bulkhead Connector cable tie locations (red arrows)



Activation distribution strip



Connection order of lugs on Activation distribution strip (labeled CHG+, CHG-, ACT1, ACT2)

Replacing Fuses

There are two fuses in a buoy. One fuse (5 Amps) is located at the bottom of the buoy on a circuit board (see photo below). The other (1Amp) is in the side of the gray VR20 case (see photo below). The black fuse holder must be twisted to remove.

Buoy fuse (5A)

VR20 fuse (1A)

TROUBLE SHOOTING GUIDE

This guide provides basic insight into trouble shooting the VRAP system in the event that a problem arises. It does not deal with the internal circuits of the buoys or the base station. These units contain no user serviceable parts. Therefore the die cast boxes should never be opened except by VEMCO service personnel.

PROBLEM SYMPTOMS AND SUGGESTED COURSES OF ACTION	
PROBLEM	**RECOMMENDATION**
Base Station can not make contact with a buoy.	1. Check that the correct serial numbers are entered in the VRAP software for each buoy and the software is correctly configured for the study. 2. Attempt to contact the buoy in question using the *Test Communications* function in the VRAP software. Ensure that the range between the buoys and the base station is not too great. 3. Check that the Buoy Activation Plug is in place. 4. Check the battery voltage as outlined in *Measuring Buoy Battery Voltage*. If in doubt, charge the battery. 5. Remove the buoy from the water and remove the chassis from the buoy hull. Test the coaxial cable connecting the VR20 die cast box to the antenna for any damage. Check for any sign of water inside the buoy, indicating leaks. 6. If the source of the problem has not been located by this step, follow the instructions outlined in *Problem Isolation Using Two Units on Dry Land* and attempt to isolate the problem.
Buoy can be contacted, but fails to collect data when a study is conducted.	1. Ensure that the VRAP software is correctly configured for the study, and that the correct buoy serial numbers and transmitter information have been entered. 2. Check the hydrophone cable. Ensure that it is securely plugged into its connector on the buoy. 3. Is the transmitter within range of the buoy? If this can not be determined, place a transmitter in the water near the buoy in question and attempt to track the tag using the software. 4. Replace the hydrophone.
Buoy can only be contacted via radio when very close to the base station.	1. Check the antenna cable on the base station for damage. Is the cable too long for the type of cable being used? See *Base Station Installation* for details. 2. Check the antenna cable on the buoy. 3. Check the power supply for the base station to ensure proper voltage. The supply must be able to supply 2 Amp during transmission.

PROBLEM SYMPTOMS AND SUGGESTED COURSES OF ACTION	
PROBLEM	**RECOMMENDATION**
Buoys can not calibrate.	1. Move buoys closer together. A good starting distance for initial deployment is 300 meters between buoys.
Transmitter position is not being plotted or incorrect data is being returned from telemetry transmitters.	1. Is the transmitter within the triangle formed by the three buoys? For best performance, transmitters need to be in the triangular area covered by the buoys. 2. Is the transmitter selected as *Enabled* in the VRAP software? Ensure that the software is correctly configured for the transmitters you are tracking.

Problem Isolation Using Two Units on Dry Land

A problem with one unit can be isolated by using a second unit as a test device. Remove the problem unit and a working unit from their buoy hulls and place them side by side. To test the radio and antenna on the malfunctioning unit, disconnect the cable that connects the die-cast box to the radio on each. Connect the die-cast box on the malfunctioning buoy to the radio on the working buoy. Attempt to contact the malfunctioning buoy using the "Test Communications" option within VRAP software. If the buoy can now be contacted (while using the working buoy's radio and antenna) the problem must lie within the radio and/or antenna on the malfunctioning buoy. If the buoy can not be contacted, the problem must lie within the electronics and is thus not user serviceable.

If the radio and/or antenna proves to be faulty, the problem can be further isolated. Reconnect the cables to their appropriate radios, but connect the radio on the malfunctioning buoy to the antenna on the working buoy via the working buoy's coax cable. Test using VRAP software once again. If the malfunctioning buoy can now be contacted (while using the working buoy's antenna and coax connection) the problem must lie with the malfunctioning buoy's antenna and/or cable. If this appears to be the case, try connecting the working buoy to the malfunctioning buoy's antenna, via the malfunctioning buoy's coax cable. Attempt to contact the working buoy via the VRAP software. Radio failure with the previously working buoy will further confirm a problem with the antenna and/or connecting cable.

A continuity test on the coaxial cable connecting the radio to the antenna will reveal any problems with the cable. Check the cable by removing it from the buoy and test with an Ohm meter. There should be an open circuit between the connector center pin and the outer metal of the connector. There should be a short circuit between the center pins of the two connectors and short circuit between the two outer connector shells. Note that if the antenna is checked with a DC Ohm meter it will show a DC short circuit. This is normal. If the problem is isolated to the coaxial cable, replace and test the radio link again. If the problem is with the radio modem itself, contact VEMCO for assistance.

Testing Radio Communications

The VRAP software contains the *Test Communications* function (in the *Tools* menu) which is used in conjunction with the buoys. Each radio can be contacted individually using this function to determine if the radio link is working correctly. A detailed explanation of this software function is found in the VRAP Software manual.

Be sure the correct serial numbers are entered in the software for each buoy. A buoy will only respond to its correct serial number, which is stamped into the lid of the buoy.

To determine if communication difficulties are caused by radio trouble, try contacting the buoy in question 10 times. If the buoy replies to the majority of the attempts, then the problem is most likely not with the radio itself. If the buoy does not reply, test to see if the range is too great. This can be done by attempting to communicate with the buoy closest to the buoy of interest.

Broken Hydrophone Connection

If there is a short in the cable connecting the hydrophone to the receiver, the system could reset each time a command to begin a study is received and acted upon by the VR20 receiver within the buoy. The radio will work when the buoy is contacted via the *Test Communications* function, but will fail when a study is begun.

To test if there is a problem with the hydrophone, disconnect the hydrophone from the malfunctioning buoy and attempt to begin a study. It will not harm the buoy to attempt to initialize a study without a hydrophone connected to the system. If the buoy is functioning correctly, it will begin a study but no data will be collected. If the buoy appears to work correctly then stop the study, reconnect the hydrophone, and begin another study. If the buoy now fails to communicate, the problem lies in the hydrophone.

Testing Antenna (Coaxial) Cables For Damage

If the buoy antenna has been improperly installed or removed, the cable connecting it to the radio can become damaged due to twisting. Intermittent communication with the buoy may result. The buoy may appear to function normally when near the base station, but not at all when the distance between the two increases.

To test a coaxial cable for damage, remove it from the antenna and buoy (or base station). With an Ohm meter, check between the connector center pin and the outer metal of the connector. There should be an open circuit (infinite resistance). There should be a short circuit (zero resistance) between the two center pins of the connectors (one at each end of the cable). There should also be a short circuit between the outer shells of the connectors on either end of the cable. NOTE: if the antenna is checked with a DC Ohm meter it will show a DC short circuit.

Possible Sources of Leaks

If a buoy is opened and is found to contain water, the source of the leak(s) must be identified to prevent further damage. Check that all O-Rings are in place and that none are damaged or dirty. Check that the antenna is secure in the white collar attached to it, and that when mounted on the lid it is bolted down tightly. Likewise all bolts and lock washers should be used to secure the lid to the hull when the buoy is assembled to ensure a tight seal.

When recharging the buoys in the chassis, the vent plug must be opened to allow the escape of any fumes that may occur. This allows water to enter the buoy unless great care is taken. Recharging should not be undertaken when there is a good chance that water will be breaking over the buoys and thus be able to enter the buoy via the vent hole.

GLOSSARY

Activation Bulkhead connector - the connector on the cover of the buoy with four pins (see photo). This connector is used for both activation and charging the batteries. When connecting to the connector, the bump on the plug must match the notch on the connector base, which is in line with the largest pin on the connector. **WARNING:** Do not allow any metal object to short the 4-pin male Activation Bulkhead connector or damage ***will*** result to the internal battery and wiring harness.


Activation Bulkhead connector

Activation Plug - a rubber covered plug used to power up (activate) the buoy. The bump on the plug (see photo) must match the notch on the connector base, which is in line with the largest pin on the connector.


Activation Plug

Activation Protection Cap - a threaded cap used to protect the male pins on the Activation Bulkhead connector. This cap should be securely covering the connector whenever the buoy is not activated or not charging to prevent the pins from accidentally being shorted and damaging the buoy electronics.


Activation Protection Cap

Background Image - the bitmap used for the background in the *Chart* window during a study. This bitmap is imported into the VRAP software in the *Preview* page (tab) of the *Background image* section in the *Project* setup. The bitmap may be calibrated using latitude and longitude information (see *Calibrations* section of Appendix).

Blanking interval - the length of time after a valid pulse has been detected during which no further pulses can be detected. This is to prevent the receiver from double triggering on echoes. The blanking interval is normally set to less than 50% of the minimum transmitter period. Care must be taken when changing this value. If the interval is too short, false triggering will become a problem. If the interval is too long, data pulses may be missed.

Buoy Antenna Mount Hole Cover - a PVC cover with an O-Ring used to cover the antenna hole when the antenna is not connected to the buoy, and to hold the antenna cable in place when not connected to the antenna. When removing the antenna cable from the PVC cover, be extreme care not to allow the cable to drop into the buoy. If it does so, the buoy will have to be opened to retrieve it. Details for removing the hole cover are given in the Hardware section.


Buoy Antenna Mount Hole Cover

Calibrate buoys - When the *Calibrate buoys* box has a checkmark in it, the buoys will be automatically calibrated according to the time entered in the *Calibration interval* box. If the box is not checked then the buoys will not be automatically calibrated and the *Calibration interval* value shown is ignored.

Calibration interval - the time, in minutes, between automatic buoy position calibrations. The time value used depends on the conditions in which the buoys are operating. A calibration may be forced before the specified time has elapsed. This may be done by selecting *Buoys* in the *Calibrate* option of the *Tools* menu, or by clicking the Calibrate button in the *Chart* window.

Lid Pressure Relief Plug - a white plug used during battery charging and pressure testing the buoy case, shown here. The plug must be tight against the buoy cover during deployment to prevent water from entering the buoy. The plug is loosened during battery charging to allow any gases produced to leave the buoy case. The plug is removed when a pressure test is performed. Details of battery charging and pressure testing are given in the Hardware section of this manual.

Lid Pressure Relief Plug

Connect buoys with lines - Selecting the *Connect buoys with lines* option (checkmark in box) will connect the buoys shown in the *Chart* window with three lines. This aids in identifying the study area within the buoys.

Deviation - refers to the standard deviation between pulses in a set of aligned data.

Fast Track - An average time is compiled and used with *Pulses to avg* to determine the best data times. The position is calculated for each of these best data times and all positions are plotted on the chart.

Panning the graph - The graph can be repositioned with the pan feature. This is performed by clicking the right mouse button on the graph and dragging the mouse without releasing the mouse button. When the graph is in the desired location, release the mouse button.

Pinger - tags that emit an acoustic signal at a fixed period and frequency. They are used for locating and tracking purposes and transmit no depth or temperature information. Once a pinger is powered, it will broadcast its signal according to the factory setup until powered down. It is possible to have pingers with a delay start and/or cycle on/off times.

Position Average - All positions are calculated. An average position is complied from the positions and used with *Pulses to avg* to determine the best data positions. A new average is taken of these best data positions and the single position is plotted on the chart.

Positions to show - the number of pervious buoys positions (previous calibrations) to be displayed on the *Chart* window. This value is entered in the *Positions to show* box in the *Buoy* page of the *Project settings* window (see *Edit* menu).

Project - the geographical setup of the buoys and the information pertaining to those buoys and to the tags used in the area. After a project is setup (in the *Project setting* section of the *Edit* menu), any number of studies may be run using the project's settings.

Scanning cycle - The buoy receivers listen to only one frequency at a time. To use tags on more than one frequency during a study, the buoys cycle through frequencies and listen for each *Enabled* tag (see the *Tags* page of the *Project settings* window in the *Edit* menu) listed.

Scanning cycle delay - the length of time, in minutes, the buoys will wait between scanning cycles. This feature is used to conserve buoy battery life. The value is set in the *Buoy* page of the *Project settings* window (see *Edit* menu).

Shadows zones - three areas around the buoy configuration where the position calculation of a transmitter will have two solutions. The locations of these areas depends on if the buoy hydrophones and the received signal are on the same plane or not. For more detail, see the *Theory of Operation* portion of the Introduction section in this manual.

Study - the collection and storage of data, such as tag positions and times. Data received during a study is *automatically* stored to a database.

Sync (2 channel tags) - a value (in milliseconds) that allows a receiver to correctly receive the data for a two-channel transmitter. The value is currently factory set at 1150ms and must be entered as such in the VRAP software (see the *Tag* page of the *Project settings* window in the *Edit* menu).

Tag - term used to refer to all acoustic transmitter types. It is derived from the term "fish tag".

Tag types - three types of tags are available: pinger (transmits a ping at a constant interval, or period), one channel telemetry (transmits either temperature or depth telemetry data), and two channel telemetry (transmits both temperature and depth telemetry data).

Telemetry transmitters - either one or two channel devices transmitting information at a fixed frequency. The types of information transmitted are temperature and/or pressure. These transmitters are capable of transmission only. Once a transmitter is powered, it will continue to broadcast according to factory setup until powered down.

Time Average - An average time is compiled and used with *Pulses to avg* to determine the best data times. A new average is taken from these best data times and a position is calculated. This single position from the new average is plotted on the chart.

Waypoint - a location of significance or interest that can be recorded within a study. The location is marked with a red circle and may have an optional label. The waypoint may be viewed during playback of the study.

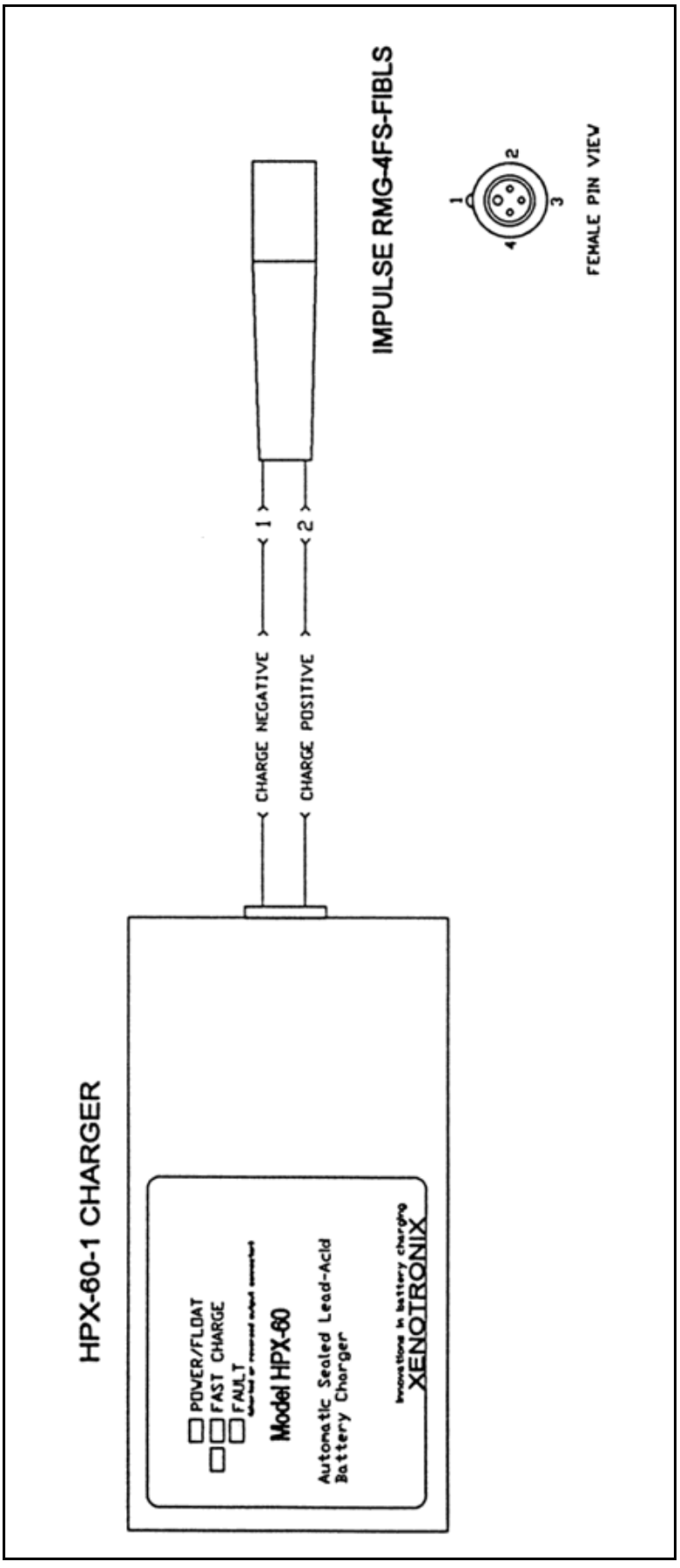


FIGURE 1: Buoy AC charger

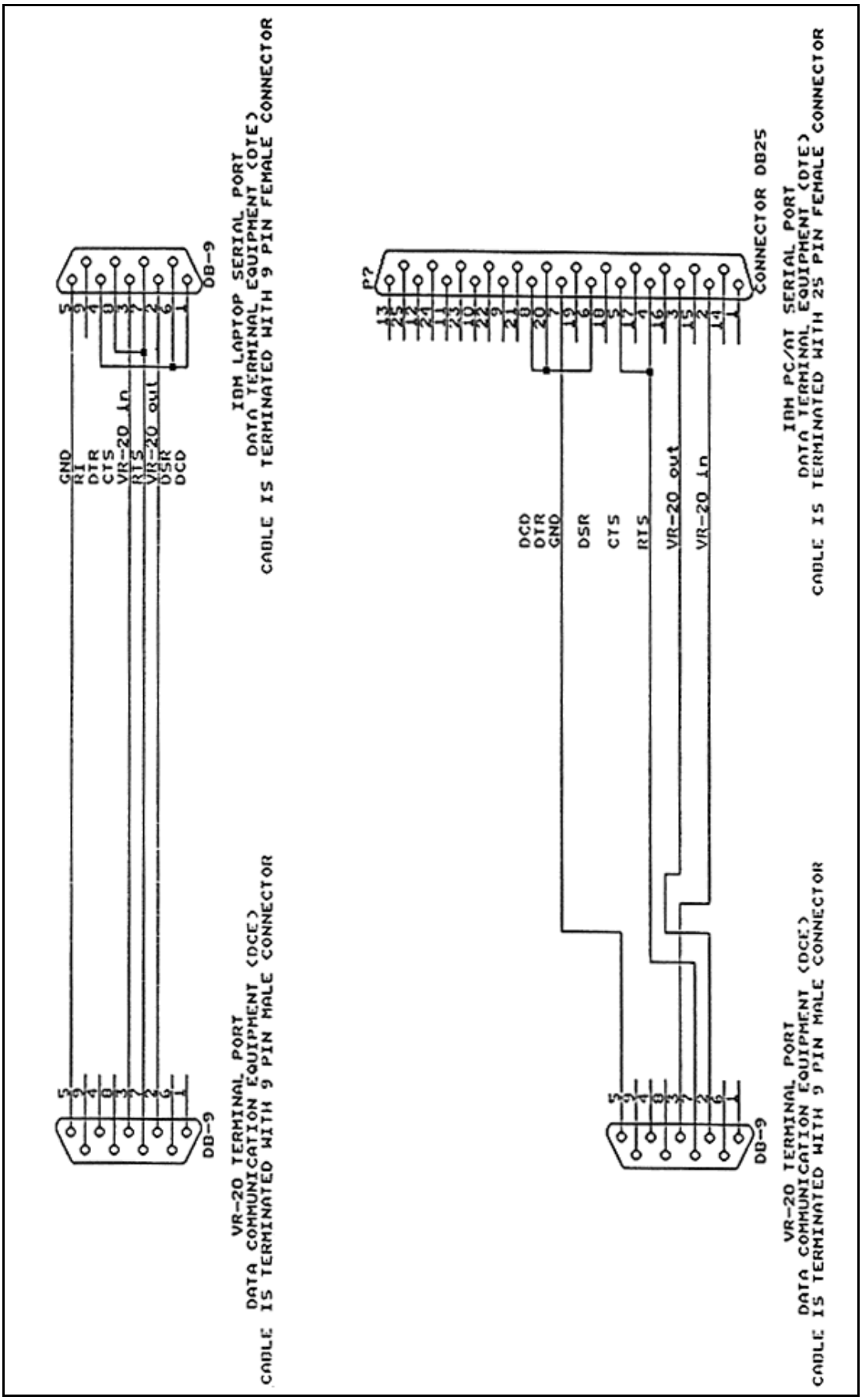


FIGURE 2: Serial cables for VR20 terminal port

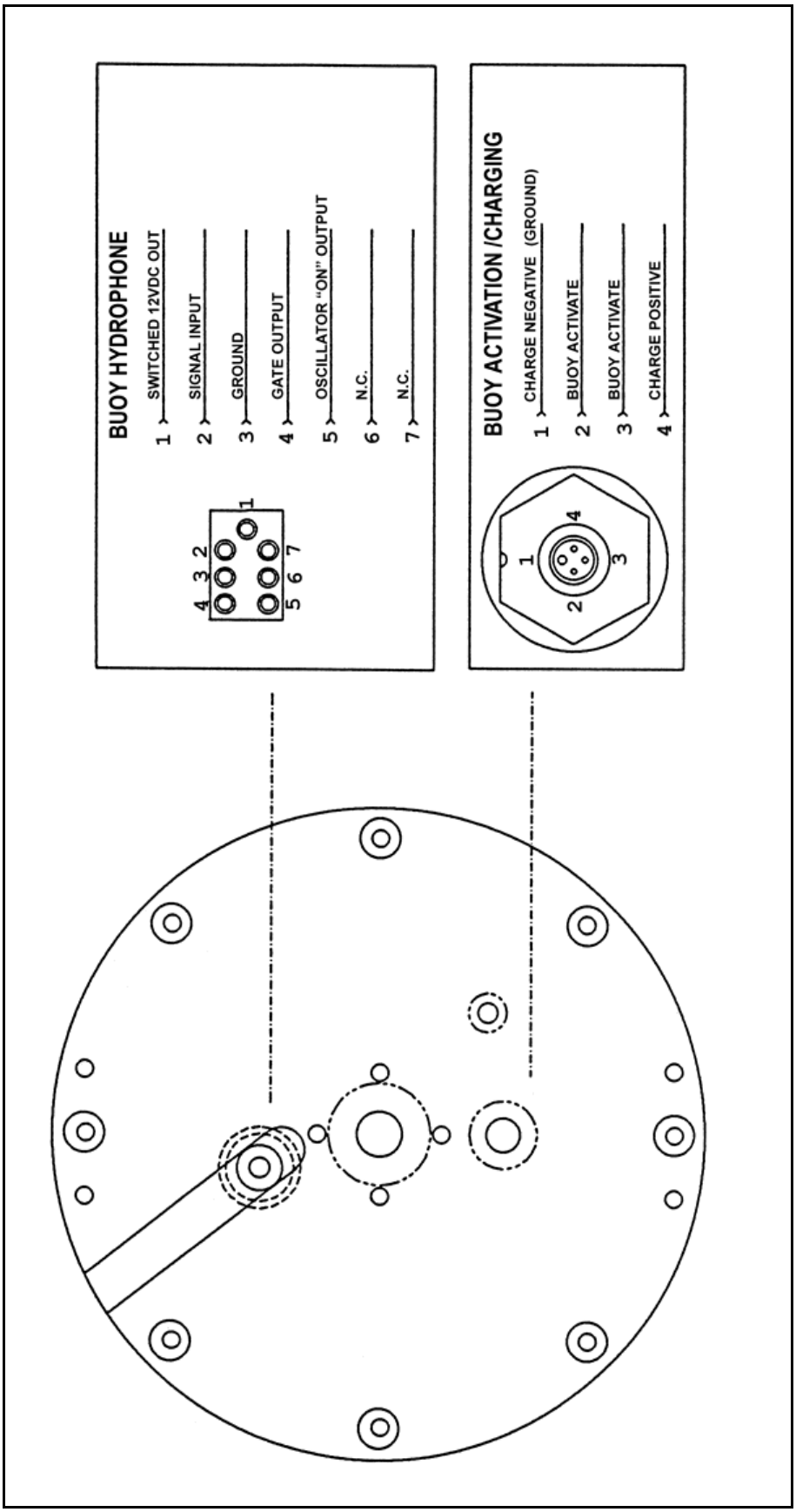
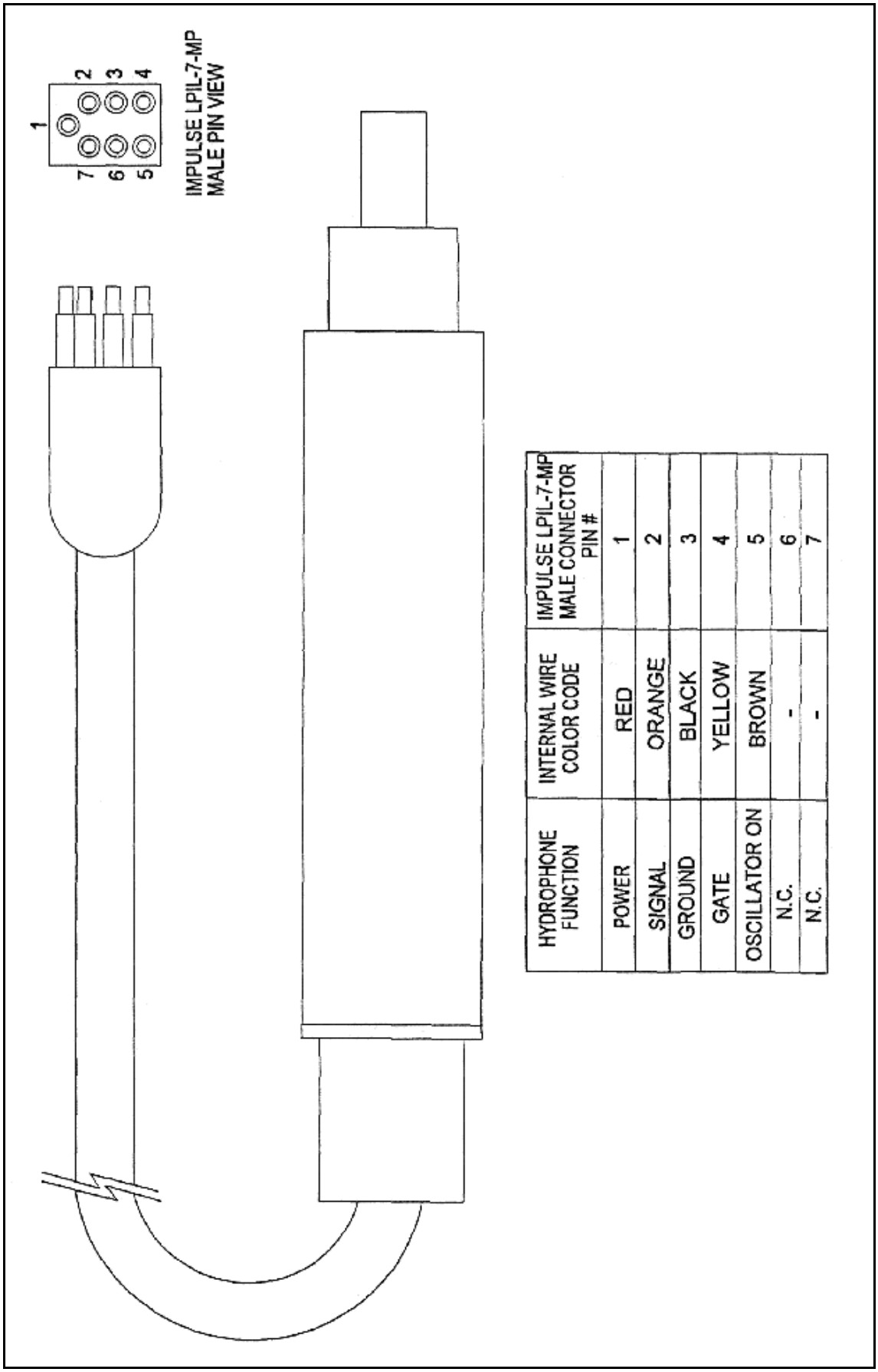


FIGURE 3: Buoy lid connectors.



HYDROPHONE FUNCTION	INTERNAL WIRE COLOR CODE	IMPULSE LPIL-7-MP MALE CONNECTOR PIN #
POWER	RED	1
SIGNAL	ORANGE	2
GROUND	BLACK	3
GATE	YELLOW	4
OSCILLATOR ON	BROWN	5
N.C.	-	6
N.C.	-	7

FIGURE 4: Buoy hydrophone

MOUNTING HARDWARE SUPPLIED:

STAINLESS STEEL HARDWARE SUPPLIED PERMITS THE ANTENNA TO BE MOUNTED WITH THE FEED CABLE RUNNING INSIDE A SUPPORT PIPE OF 33-40 MM (1 3/8 TO 1 1/2IN.) OUTER DIAMETER OR, WITH THE FEED LINE RUNNING OUTSIDE A SUPPORT PIPE OF 25-58MM (1 TO 2 1/4IN.) OUTER DIAMETER.

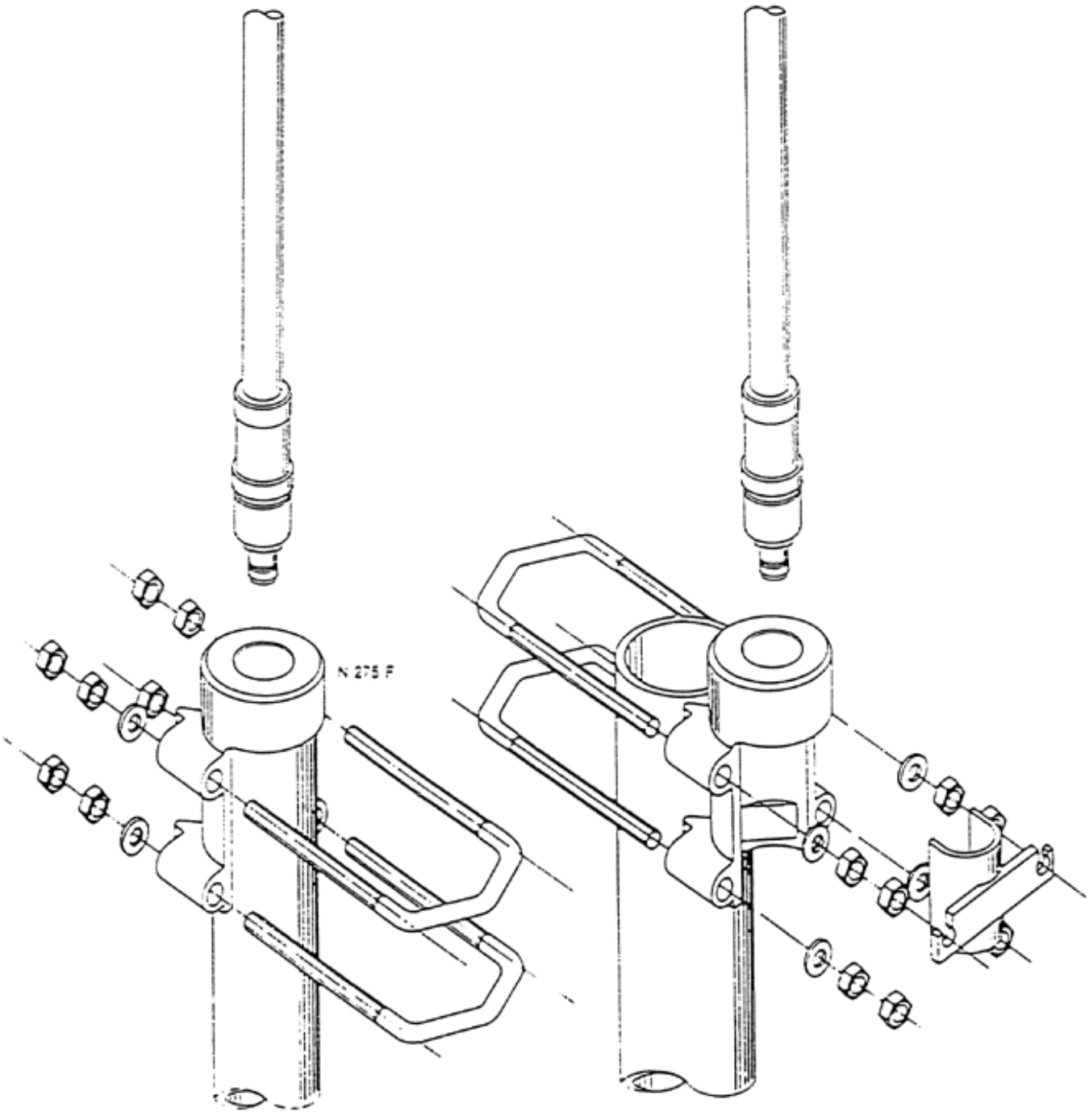


FIGURE 5: Mounting antenna.

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