Underwater Acoustic Release System

Acoustic Release Model AR-60-E

(underwater acoustic release unit)

Acoustic Release Interrogator Model ARI-60

(topside command unit)

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OVERVIEW:

This underwater acoustic release system permits the underwater release of an instrument package, a float, a rubber-cord tensioned line that when released performs a desired action, etc. The acoustic release interrogator sends the acoustic command to the underwater acoustic release. Additional features include commands to make the release unit become a pinger to acknowledge operation or permit tracking, a transponder to permit range display, and a battery report that tests the battery under load and reports its condition via a ping rate. Additional commands are available to use in system checkout.

Each underwater release has a specific four digit unit identification number assigned to it by Sub Sea Sonics. To send an action command to the underwater release first enter the identification number selected using the interrogator keys while viewing it on an LCD display. Second, the specific action command is selected using the keys and LCD display. Third, both are transmitted to the underwater release unit.

The interrogator comes with a transducer on a cable that is placed in the water for use. The interrogator must be connected to a 12 VDC battery such as a gel-cell or lead acid battery to supply 5 amps during transmit.

DEPLOYMENT OF A RELEASE UNIT:

A. Installation of batteries inside a release unit:

1. Remove the two ¼-20 button head screws on the sides of the unit which secure

the end plug in place (Use caution; see SAFETY WARNINGS herein). (Note that the two small metal posts near the LED are only the water contacts for unit activation and have nothing to do with battery access.) To aid in the removal of the end plug use a tool such as a Phillips head screwdriver inserted into the non-threaded 25/64 inch (0.391 inch) clear through hole in the center of the end plug. Use this screwdriver as a handle to help work out the end plug.

2. Check or Install an 18 volt battery pack such as the BH-60L (normally supplied). It must have the red wire to positive and black wire to negative. With the BH-60L battery holder it must have all 12 cells installed with the correct orientation. (Inadvertent backward installation of one or more cells will result in rapid discharge of those cells through an adjacent diode and resistor causing the diode and resistor to get hot. These diodes exists as a reliability feature to permit continued operation should any one, two, or three of the individual cells go bad or fail to make contact. Be certain that each battery is inserted correctly. If desired the total battery pack voltage can be checked with a voltmeter. Reposition the Velcro as snug as possible as extra insurance that the batteries will stay in their respective holders.

3. Slip the battery pack into the housing keeping the end of the battery pack with the red and black connecting wires oriented to the outside. Dress all wires to the side of the battery pack. The battery holder BH-60L has a long tie wrap "tail" on one end. This is the end with the red and black connecting wires and this is the end that goes in last. This long tie wrap ("tail") can be used to pull out the battery holder.

4. Prepare the end plug using o-rings that have been inspected for nicks and cuts. O-rings are rubber and can 'rot' with time and exposure. Slightly stretching them while inspecting them can reveal defects. The three o-rings used are #223 EPDM 70 durometer. Put ample silicon grease into the o-ring grooves and add a thin coating to the housing bore. Use a silicon grease that does not attack rubber such as Dow Corning #4 available at McMaster-Carr and others .

5. Replace the end plug. Replace the ¼-20 button head screws being careful not to cross thread them. Do not over tighten them as the housing is a PVC plastic and does not have the strength of a metal.

B. Installing a new erosion release link:

1. Obtain a new link with its o-ring groove greased with Silicon grease followed by putting its o-ring in place. (13/16 OD, 9/16 ID o-ring #207 EPDM 70 durometer)

2. Verify the presence of the two small unpainted places at the base of each upside down 'U' shaped release loop. At these points the metal of the loop must be directly in contact with the salt water at the time of release. As an extra precaution verify that the metal isn't covered with any hard to see coating of some sort by scraping part of it to inspect it (small 1/16 inch tip long nose pliers works well or use a small knife blade to scrape a part of it to inspect it).

3. Remove the ‘L’ shaped pin that holds the expired link in place.

4. Remove the expired link while avoiding pulling the attached tinned braided wire out more than 8 inches. (If pulled too far then the larger braided wire further down inside that is attached to it may be pulled out and have to be tucked back into the bottom third of the cavity with an improvised push tool. A plastic or wood 3/8” dowel works to push the braided tinned copper wire back in place.)

5. Remove the #8 nut and bolt that attaches the link electrically to the release unit.

6. Replace the link with the two #8 lugs held together with a #8 nut and bolt and an internal tooth lock washer between the two lugs to insure reliable contact. Align the two #8 lugs in a straight line so they will poke down the center of the cavity without hanging up on the internal ledge inside the cavity. Verify that they are tight for reliable electrical contact (critical for release).

7. Apply silicon grease to the o-ring groove, the link o-ring and a thin coat to the link holder bore. A soft toothbrush has been found useful for applying silicon grease.

8. Carefully insert the link insuring that the two lugs with their nut and bolt pass into the center of the cavity. (Avoid forcing to avoid scratching the o-ring sealing bore surface and avoid loosening the #8 bolt, lock-washer, and nut.)

9. Replace the ‘L’ shaped securing pin. (It passes through the link-holder and through the link to hold the link in place.)

10. Replace the two o-rings acting like rubber bands to retain the ‘L’ shaped securing pin. If there is a chance of something rubbing this area during deployment then the ‘L’ shaped pin can be further secured using tape over the o-rings.

C. Verify that the release unit is operating:

1. Short the water contacts (the two small metal posts near the LED) together with an alligator clip lead to turn the release unit on in air. The led will flash its unit identification code (see Theory of Operation section herein) for about 15 seconds and then go into listening mode. In listening mode it will flash the led once every 11.5 seconds +/- 30%. Verify this.

2. Optionally perform in-water or in-air tests on the release unit using the interrogator with its transducer connected. For checkout in-air place the release unit within a few feet of the interrogator's transducer. Any of the commands can be checked. In still water the ‘Brief Erosion’ action which causes erosion for 10 seconds can be selected (watch for bubbles on the coil water contact). In air the full release can be checked [put a voltmeter with or without a 33 ohm 10 watt resistor load between the link (positive) and "coil" (negative). With alkaline batteries verify greater than 14 volts. With Lithium L91 size AA batteries verify greater than 16 volts.

3. The short across the water contacts (the two small metal posts near the LED) should be removed for final deployment in water. The presence of water around

these two contacts will keep the unit turned on. These contacts exists so that the unit will be turned off when in air and not in use. These contacts also permit interrupting the 15 minute release time. To do this remove the jumper for greater than 60 seconds. This feature can save operator time by interruption of the 'Release …' commands making it unnecessary to wait out the full 15 minutes of busy time. By having these two water switch contacts it makes it impossible for the operator to forget to turn the unit on when the unit is deployed in water.

D. Final deployment:

1. Remove any jumper wire which was used for check out in air from the two water switch contacts.

2. Note the release unit's four digit unit identification number needed for sending it commands.

3. Attach the release unit in the specific deployment configuration. If it is desired to balance the load between the two loops on the erosion link then one way to achieve this is the following: Use a ¾ inch diameter stainless steel ring and a 24 inch piece of small size extra strong line such as 1/16 inch Spectron. Loop the 24 inch line separately through each loop on the erosion link and through the ring such that the load is distributed evenly to the two loops on the erosion link and does not bend the loops. To achieve this pass the 24 inch line through the ring, through one erosion link loop, through the ring a second time, through the other erosion link loop, and then tie the two ends of the line together. A square knot in Spectron line will slip; so add extra half hitches and further secure the two loose ends by melting them with a small flame such as from a cigarette lighter There are many possible deployments. Beware of such problems as the ring snagging on something after it is released, etc.

4. Verify that no metallic material is touching the link (e.g. a metal hook) as this could radically extend the erosion time and even prevent a release.

5. Verify that the pull on the link will be steady in one direction as continual bending of the link metal might eventually break it off.

6. Verify that the ships RADAR is off (not likely a problem, but a worthwhile precaution with the high power focused beam from RADAR).

7. To prevent a premature release from a prior release command verify that it has been at least 15 minutes since the last release command was sent.

OPERATION OF THE INTERROGATOR:

Hookup of the acoustic release interrogator (topside command unit):

Supply 12 VDC from a gel-cell battery or equivalent (needs 12 VDC at 5 amps for transmit, but only 10 ma when not transmitting). Connect the transducer to the interrogator and place the transducer in the ocean or near the release unit if testing in air. If testing is done in air the range readings will be approximately five times greater then the actual range and occasionally poor results in air may occur. If poor results are observed then try moving the transducers relative positions slightly. Ranges of zero to 20 feet or more in air are typical.

Operation of the interrogator (general concepts):

When first connected to a battery the LCD display on the unit displays a banner with company name, model name, model number, firmware version number, etc. To break out of this banner and get to the main menu hold the STOP key. The LCD now shows "MENU FOLLOWS: press N for next". From here the NEXT key can be pressed repeatedly to cycle through all of the activities that can be performed from this topside box. When advanced to one of interest press the ACCEPT key to accept it. Note that the second one down "Select Action…(unit action)" when selected with the ACCEPT key puts the unit into a sub menu. This sub menu is the only sub menu on the topside box. It is used to select the action desired by the underwater release. Once in this sub menu the NEXT key cycles through all possible actions (actions by the underwater release unit). See "ACTION = xxxxxx" headings on page 8.

Vocabulary: 'Box activity' generally refers to what the topside box is commanded to do (selected from the main menu). 'Action' generally refers to what the underwater release will be commanded to do (selected from the sub menu).

Interrogator box keys descriptions.

NEXT (N): Advances to next item on main menu or sub menu.

ACCEPT (A): Accepts the item currently displayed. If in the main menu it starts the box activity currently displayed. If in the "Select Action " sub menu it accepts the action for future transmission.

STOP (S): Stops the current box activity permitting changing to a new one. Has no effect on the underwater acoustic release.

RELEASE (R): Used only to verify that it is okay to proceed with transmitting the release command. It will not by itself cause the box to send a release command.

INCREASE (I) and DECREASE (D): Used for selecting the ID four digit number.

Operation of the interrogator (most common sequence):

After battery connection advance to the main menu by holding the STOP key. The display will show "MENU FOLLOWS: press N for next".

1. Press the NEXT key once to get to the box activity "Select unit Id.. (release number)". Press ACCEPT to permit entering the unit ID. This four digit ID number identifies the unit which is to receive the command. Use the INCREASE and DECREASE keys to select the desired unit ID. Use the ACCEPT key to accept it as ready for transmission. The display flashes and then goes back to the top of the main menu, "MENU FOLLOWS: press N for next".

2. Press the NEXT key twice to get to the sub menu for entering the action to be sent to the underwater release unit. The LCD will show "Select Action…(unit action)". Press ACCEPT. The box has now entered a sub menu (the only sub menu in this interrogator box). By pressing the NEXT key repeatedly all of the actions that the underwater release can perform are displayed. As NEXT is repeatedly pressed the list loops back on itself. The only way to break out of the sub menu and get back to the main menu is to display one action and press ACCEPT. This accepts it as the action that will be sent to the underwater release unit when transmission (next step) is performed. As an example pick "Range Enable (for 60 sec)" by pressing NEXT until "Range Enable " is displayed and then press ACCEPT.

3. Press the NEXT key three times to get to the box activity "Transmit once…. (send command)". When the ACCEPT key is pressed the box will transmit both the ID and the action selected above to the underwater release unit. During this transmission process the transducer must be connected and in water (unless testing in air). The single red LED on the topside box illuminates only during the actual acoustic transmissions. Transmission takes about 12 seconds.

Understanding the 'busy time' of the underwater release unit:

Whenever a command has been sent and received by a specific release unit this release unit is busy carrying out the command until the command is completed and it times out. During this busy time the release unit will not alter its action and will not be listening for another command. Sending another command will not confuse it; but, this too-soon command will be ignored. The busy times for each action are listed in the next paragraph and in a table below. Be particularly aware of the relatively long 15 minutes busy times for the two release commands. Trying to send another command to a unit that is busy could be confusing if one does not understand that the underwater release is not listening. If the unit is busy for 15 minutes performing a release then deployment in salt water before this 15 minutes is up will cause unwanted erosion of the release link. In other words, after testing in water or air with one of the release commands the unit is busy for the 15 minutes applying the release voltage to the link. **BESURE TO NOT DEPLOY IN SALT WATER UNTIL IT HAS BEEN GREATER THAN 15 MINUTES SINCE THE LAST RELEASE COMMAND WAS SENT.** An alternative to waiting 15 minutes is to reset the unit by keeping the water switch contacts dry for 60 seconds or more.

Release unit time-out (busy) times:

Pinger Action = 60 sec (one ping per sec). Battery Report = 30 pings (60 sec on high battery). Range Enable = 60 sec. Fast Ping Check = 10 sec. Brief Erosion = 10 sec. Release with range = 15 min. Release with ping = 15 min.

Information about the other box activities:

The following box activities are selectable from the main menu and are generally not needed.

"Transmit Loop . . automatic repeat": This transmits the command in the same way that "Transmit once" does except it doesn't switch over at the end of transmission to ranging mode or pinger reception mode. Instead it continuously repeats the transmission of the ID and the action that the underwater release unit is to perform. If there were to be a problem getting the command through due to signal travel problems then this box activity could be used to save operator time. Use the STOP key to terminate this "Transmit Loop" box activity.

"Receive pings… must turn-on 1st": This immediately turns the box into a pinger receiver without sending a command . This box activity would normally be entered automatically after the end of the transmission of the "Release w/ pings" or "Pinger Action" or "Battery Report" or "Fast Ping check" or "Brief Erosion" commands. The "must turn-on first" is a reminder that this box activity does not cause the underwater unit to become a pinger (i.e. this box activity does not transmit a command). This box activity is generally not needed but could be used to listen to an underwater release unit which had already been commanded to ping. Use the STOP key to terminate this box activity. The STOP key does not stop the underwater release unit's action.

"Display Range . . . must enable 1st": This immediately turns the box into a range interrogator. No command is sent. This activity would normally be entered automatically after the end of the transmission of the "Release w/ range" or the "Range Enable" action. The "must enable first" is a reminder that this box activity does not cause the underwater unit to become a transponder. This box activity is generally not needed but can be used to send ranging pings and display the range to an underwater release unit which had already been commanded to "Release w/ Range" or "Range Enable" Use the STOP key to terminate this box activity. The STOP key does not stop the underwater release unit's action.

"Suppression . . . . .Is now ON" or "Suppression . . . .Is now OFF": For all known applications leave it ON (the default). When ON the box precedes each timed pulse transmission with a 'suppression' transmission with energy in the lower inhibit channel frequency band. This prevents any acoustic signals that are weaker than the box transmitted signal from interfering with the box transmitted signal. In short it blocks out any man or animal interference as long as this interference is not as strong as the box 'suppression' signal.

"Directions . . . summary": This displays a brief directions-for-use summary.

An example of sending the command "Release with Range":

Supply 12 VDC to the interrogator. Hold S for main menu. Press N once to get to Select Unit Id. Press A to be able to select the unit identification number desired. Use the I or D keys to set the unit Identification number. Once set use the A key to accept the one selected. The LCD display will flash the selected unit identification number and return to the main menu. Use the N key twice to advance to Select Action. Use the A key to accept the "select action" sub menu. Use the N key repeatedly to get to ‘Release w Range’. Use the A key to accept this action. Display will flash the action accepted and return to the main menu. Use the N key three times to advance to Transmit Once. Use the A key to accept and perform this activity. Since releasing is a non-reversible activity you will be asked to verify that you want to perform a release with the choice of S for stop or R for release. Press R. The unit will display TRANSMITTING…, etc. as the transmission of the 2.5 second steady synchronization/wake-up pulse followed by seven 20 ms precisely timed pulses occurs. The command will have been completed when the LCD displays END XMIT CYCLE. In this case of ‘Release w Range’ the interrogator will automatically switch over to the ranging mode to interrogate and display the range.

All of the other command setups and transmissions are similar to this one.

A list of the 'actions' which can be sent to the underwater release unit follows:

These are accessed by the sub menu "Select Action" described above.

Action = Pinger (AR-60-E):

Sending this action command causes the release unit to behave like a pinger for 60 seconds after which it times out. While acting as a pinger it emits a single 20 ms ping once per second (1.00 sec +/- 2%). These pings can be picked up on a pinger receiver or by the topside box with box activity set for "Receive Pings". If a pinger receiver with tracking antenna is available the direction to the release unit can be obtained.

Action = Battery Report:

Sending this action command causes the release to put a 60 ohm (about 240 ma) load on the battery for 2 seconds. Just before the end of the 2 seconds the battery voltage is compared with voltage references to determine whether the battery is High, Medium, or Low. This information is then sent to the surface via the time spacing between pings. This can be timed with a stop watch by listening to a pinger receiver or observing the signals received by the interrogator. The following table gives the battery voltage for the three different ping spacings:

Ping Spacing	Battery State	AR-60-E (12 size AA cells)
2.00 sec	High Battery	> 1.3 volts/cell (> 15.6 volt total)
3.00 sec	Medium Battery	1.1 to 1.3 volts/cell (13.2 v to 15.6 v total)
4.00 sec	Low Battery	< 1.1 volts/cell (< 13.2 volt total)

(Note: On units sold prior to 7-1-02 the battery state transition voltages were 1.1 and 0.9 instead of the above 1.3 and 1.1 respectively.)

Action = Range Enable:

Sending this action command causes the release unit to behave like a transponder for 60 seconds until it times out. While acting as a transponder it listens on frequency FM for a pulse, delays 40 ms, and then replies on frequency FR with a return pulse. [After this action command is sent the interrogator must be put into Range Display mode. If Transmit Once was used it automatically switches to this mode. If Transmit Loop was used then Transmit Loop must be stopped with the Stop (S) key and then the Next (N) key be pressed to reach Range Display then the Accept (A) key pressed.] With the interrogator in Range Display mode the range is displayed in feet from 0 to 10,000 feet. If no signal is received it displays 'No reply signal'. Remember that the transponder action by the release unit times out 60 seconds after it received the Range Enable command. Accordingly, if additional ranging is desired the command must be repeated.

Action = Fast Ping check:

Causes release to send out a rapid string of pings. Times out after only 10 seconds thereby quickly freeing the unit for another command.

Action = Brief Erosion:

Puts release into release mode for 10 seconds. If unit is in salt water and water is calm and visibility is good bubbles can be seen coming off of the 'coil' contact. If testing in air a voltmeter can be used to measure the output voltage. Times out after 10 seconds thereby quickly freeing the unit for another command.

Action = Release w/ Range:

Puts release into release mode for 15 minutes. In release mode the full battery voltage is switched to the link (positive) relative to the 'coil' (negative). The unit cannot be interrupted during this busy time period. The unit also becomes a transponder so that the topside box can interrogate it sending and receiving pings so as to obtain and display slant range. This action times out after 15 minutes.

Action = Release w/ Ping:

Puts release into release mode for 15 minutes. In release mode the full battery voltage is switched to the link (positive) relative to the 'coil' (negative). The unit cannot be interrupted during this busy time period. The unit also becomes a pinger. This action times out after 15 minutes.

BATTERY INFORMATION:

Battery holder (model BH-60L):

The release comes with a unique battery holder that puts a diode across each of twelve 'AA' cells. If any one, two, three or even four of the twelve cells happens to fail or have contacts that fail the diodes become active and there is enough voltage left for the release to still operate. Should some cells fail the erosion time will be somewhat longer; but this is a minor inconvenience for a significant increase in system reliability.

Battery type selection:

In the AA size the two candidates that will fit in the above battery holder are alkaline and lithium. Alkaline's perform poorly at low temperatures (e.g. five degrees centigrade). Considering this a conservative assumption for the energy content for alkaline's is 1000 mA-Hr. The one lithium available is made by Energizer p/n L91 and is far superior with excellent high current output performance when cold and a very long shelf life (claim of 14 years). A conservative assumption for the energy content of this lithium is 3000 mA-Hr. These have become readily available in the United States. They sell retail in small quantities for US$ 2.50 to 3.00. In larger quantities they are available at Shore Power, Inc sales@shorepowerinc.com (860) 581-4540 or Battery Station Phone 417-257-7799.

Battery life determination example:

Assume lithium AA cells are used. First calculate life with no release. The receiver draws 0.220 mA maximum. Dividing the ‘energy’ by the current gives the battery life assuming no releases. (i.e. 3000 / 0.220 = 13,636 Hr = 18.9 months).

Next, assume one release: Each release using a LKH-202-NI consumes 400 mA-Hr maximum. Subtract this from the total battery ‘energy’ and use the remaining energy to determine the life left. (i.e. 3000 - 400 => 2600 / 0.220 = 13,000 Hr = 18.0 months plus one release).

Likewise repeat this calculation for the number of releases of interest.

If alkaline's are used cut the number of releases and the reception time by a factor of three.

STORAGE:

Keep a new or used erosion link installed on each release unit when storing to keep dirt and water out of the replaceable link cavity. Store out of direct sunlight. If it is desired to not drain the batteries then keep the unit off by washing any salt off the area near the water contacts and keeping this area dry and free of anything with a conductivity that is greater than a what a 10 meg ohm resistor would be.

CAUTION - SAFETY WARNINGS:

Use caution when removing release links since a leak could have created compressed air in the link cavity which could shoot the link out when the 'L' shaped securing pin is removed.

Remove the housing end plug with extreme caution for the same reason. In the remote chance that the housing has leaked, pressure on the removable piece will be apparent as the two ¼ - 20 x 1" bolts are removed. If pressure is apparent then the housing has leaked and the electronics inside have been destroyed. At this point there is no point in trying to save the unit as the salt water which leaked inside has destroyed the electronics. At this point, to relieve the pressure for safety, one or more small holes can be drilled (e.g. 1/16" (0.063 inch) most anywhere in the housing to let the water and compressed gas escape (use a face shield). The unit can then be discarded as the insides once wet are not repairable and are of no use.

Do not touch the transducer while transmitting otherwise the sustained 2.5 second part of the transmission may overheat body tissues or cause other harm.

MISCELLANEOUS INFORMATION:

BUBBLES OFF OF THE "COIL" WATER CONTACT:

The stainless steel coil at the link end is the negative contact for the erosion process. During release erosion there will be bubbles coming off of it. A deposit can form on the 'coil' which can generally be left there but it is best to brush it off. It seems to rub or brush off easily when still wet from retrieval from the ocean.

EROSION TIME VS. WATER TEMPERATURE:

Lab tests indicate that the full time for release erosion increases 80% as the water temperature is lowered from 70 deg F (21 deg C) to 28 deg F (-2 deg C).

EROSION TIME VS. BATTERY VOLTAGE:

Lab tests indicate that the erosion time increases about 75% as the battery voltage decreases from 18 volts to 12 volts. The erosion time increases about 200% (3x) as the battery voltage drops from 12 volts to 6 volts.

EROSION TIME VS. CALCARIOUS CRITTERS:

Hard shelled biological fouling can cover the link or ‘coil’ water contacts thereby decreasing the water paths that the ions can travel on and result in increasing the time needed for the link to erode.

ACCIDENTAL LINK COATING INHIBITING EROSION:

Neither oil nor silicon spray applied as thick as possible right on the link metal exposed points inhibit erosion. Both seem to disappear even when very gently submerged into still water. However, if the contacts are covered with a thick covering of grease this will prevent erosion if the covering is 100%. Tests show that a 90% covering only doubles the erosion time. Accordingly, some accidentally deposited grease is very unlikely to cause a problem.

LINK CAVITY LEAK:

Should the link cavity happen to leak this will not prevent a release. The majority of the electric current will still flow to the intended erosion points. However, should the cavity be found to be full of water (and possibly air pressure; see SAFETY WARNINGS herein) inspect the tinned braided wire inside the cavity for adequate integrity for future use. A six month test of the link cavity full of salt water caused no significant problem. The tin-lead plated copper braid formed a slimy gray coating but did not noticeably reduce the size of the braid or other parts (two #8 lugs, etc). So should a leak into the link cavity occur rinse off the braid, etc and dry it out and stuff the braid back into the link holder cavity.

VERY LOW RELEASE BATTERIES:

If the release unit battery voltage drops below 5.5 VDC due to unintended weak batteries a special supervisory circuit resets the micro controller which shuts off the current action (such as release with range) and then the unit returns to listen mode. If this should happen the ranging or pinging will stop and the topside unit can be used to interrogate the state of the battery, wait for the batteries to recoup a bit, or try again. If trying again is selected consider sending a less current using command such as the Brief Erosion one. If it is sent with Transmit Loop it will turn the erosion on for 10 seconds once every other transmission cycle (about 10 seconds out of every 25 seconds) thereby reducing the average load on the batteries. But this is only a last resort and will not be necessary if adequate batteries are used.