

tr45c-ma7.doc, tr45c-ma7.htm, Revised on 1-15-2007.

## INSTRUCTIONS FOR UNDERWATER TIMER RELEASE SYSTEM.

(TR-45 release, TRP-45C programmer, and  
LK-40, LK-80 erosion links).

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### **Overall description of system:**

This underwater timer release system consists of two units. The unit that is deployed underwater has model number TR-45 and performs the release action by rapid erosion of a release link after a preset time period. This preset time period is referred to herein as the time-until-release (TUR). It is set by the user into a programming unit (TRP-45C) that is then used to transfer this time into the underwater unit (TR-45). This transfer is made by direct touch dual contact between the programmer (TRP-45C) and the underwater release unit (TR-45). The timing starts at this moment of transfer.

### **Features:**

Much lower cost vs. acoustic release system

Smaller size vs. an acoustic release

No mechanical release mechanism to foul or fail

Releases by “solid state” accelerated electrolysis

No mechanical moving parts to be fouled or hang-up

Longest time: 170 days (7.5 minute steps)

Shortest time: 0 minutes (useful for checkout)

Reprogramming: Okay to reprogram at any time

Release link rapid change by unscrewing retainer cap

Battery voltages measured under load and reported

## **Programmer preparation and use (TRP-45C):**

### **BATTERY INSTALLATION FOR PROGRAMMER.**

Remove the four corner screws that hold the box top and bottom halves together. Install two 9 volt batteries into the two 9 volt battery holders. Inspect the 9 volt battery contacts and positions in the holders to insure reliable correct. As an aid in this inspection the battery can be removed and each contact watched closely during reinsertion for the spreading of the leafs of the larger contact. Re-assemble the two halves of the box using the four corner screws.

### **TURNING ON AND OFF THE PROGRAMMER:**

Press the 'ON' switch to turn-on the programmer. It automatically shuts itself off if not used. It can also be shut off with the fifth menu item. In typical use battery life will be nearly the same as battery shelf life. When first turned on a banner will show on the LCD display [Sub Sea Sonics – subseasonics.com – Timer Release – Model TRP-45C – Firmware Ver x.x – Press 'STOP']. To get to the main menu press 'STOP'. A test of the programmer battery will occur displaying its voltage under a heavy load and indicate GOOD, OK, or BAD. This battery test with display can be terminated by pressing 'STOP' again. The start of the main menu should appear [MENU FOLLOWS: - Press 'NEXT'].]

### **FINDING AND SELLECTING A MENU ITEM:**

Successive pressing of 'NEXT' advances through each of the menu items. When the desired one is found press 'ACCEPT' to accept and act on it.

## MENU ITEMS AS DISPLAYED ON LCD [Menu items in brackets]:

1. [Set the time until release.] Permits entering the desired time-until-release (TUR). This is the time from the moment of programming a release unit (third menu item) until that release unit initiates the release erosion process. The physical release occurs typically 10 to 15 minutes after erosion starts. The display shows days, hours, and minutes. To set the TUR press 'INCREASE' or 'DECREASE' as needed until unit displays the desired TUR.
2. [Check the time until release.] Permits checking the desired time-until-release (TUR). Again, this is the time from the moment of programming a release unit (menu item #3 next) until that release unit initiates the release erosion process. This check can be omitted. It is included as a way to double check the time-until-release (TUR).
3. [Transfer time to release unit.] This transfers the time-until-release (TUR) stored in the programmer to the release unit before deployment underwater. Once this menu item is selected by pressing the 'ACCEPT' switch, there is up to 40 seconds in which to make dual contact between the programmer probes and the underwater release unit. Make this dual contact by holding the top curved wire probe in contact with the small exposed stainless steel sections at the base of the erosion loop. Simultaneously, hold the lower contact in contact with the coil of stainless steel wire wrapped around the body of the release. The instant this dual contact is made, maintain it without interruption for at least three seconds for the transfer of the time (TUR), battery checking, and verification. Watch the LCD display. Within 3 seconds the display should change from the slowly flashing [Make 2 contacts to release unit.] to displaying [Successfully programmed unit.]. This is followed by the display of the time-until-release (TUR); the display of the release battery voltage (loaded with a 47 ohm resistor); the voltage sag measured over 0.3 seconds; and last an advisory as to the battery state: HIGH, GOOD, LOW, or BAD. The [Successfully programmed unit.] display repeats several times. It can be interrupted by pressing 'STOP'. If LOW or BAD is displayed then repeat the programming to see if it still shows LOW or BAD. It could have been that the contacts made were not solid giving a LOW or BAD reading. In either case when the message displayed is [Successfully programmed unit.] followed by the time-until-release

(TUR), it is certain that the release unit was programmed to the correct time. If a message appears [Failed. Interrupted contact.] then do not proceed to deploy as the time-until-release (TUR) was not transferred correctly. Repeat the programming insuring good dual contact for the maximum of three seconds needed for programming.

4. [Measure programmer battery.] Displays the programmer battery voltage measured with a heavy load (520 ohm). Do not confuse these programmer batteries with the batteries in the underwater release unit. The underwater release unit batteries are tested only during the programming of the release unit in menu item #3 above.

5. [Shut unit off. (Time is saved.)] The programmer can be shut off without waiting for the automatic time-out shut off. The time-until-release (TUR) is saved inside the micro-controller in flash memory to save operator time from having to re-enter it upon power up.

The next and last main menu item (#6) is not needed. It is included as an extra for those who might be interested. Pressing 'ACCEPT' to select it puts the programmer into a submenu mode. Once in this submenu mode there are abbreviated directions, a diagnostic 1800 x release clock speeded up test mode, a way to recall past programmed time-until-release times (the 'successful' ones only), and a submenu item used to clear all past release data.

6. [Optional submenu items (ACCEPT)] Pressing 'ACCEPT' here enters a submenu of items including the following: [Directions: ...] a brief directions check list. [Diagnostic test: 1800x speedup] speeds the clock in the release unit up by a factor of 1800 for accelerated checkout. This is normally used only by the factory; but is included for those interested. If this test is used the message [DIAGNOSTIC TEST DO NOT DEPLOY!] is displayed in place of the message [Successfully programmed unit.] to prevent the user from accidentally deploying a release running 1800 times faster than expected. The submenu also includes a way to look at past data. [Look at past release data.] This saved past data includes only the data on 'successful' transfers to an underwater release unit. Last the submenu item [Clear memory of past releases.] permits the clearing of memory of all past data.

Again, none of these submenu items mentioned in this paragraph and called [Optional submenu items (ACCEPT)] need be used.

#### BATTERY INFORMATION FOR RELEASE UNIT:

The TR-45 release unit batteries can be either three Lithium L91 Energizer AA batteries (in series) or four Alkaline AA batteries (in series). The Lithium batteries are recommended and are supplied with the TR-45 underwater release. They should give an average of 100+ releases over a period of years without having to change them (assumes using the LK-40 release link). They have a shelf life of 15 years and work well in cold water. (Expect 33+ releases with the heavier LK-80 release link).

The battery voltage and voltage sag are measured during menu item #3 above [Transfer time to release unit.]. The battery voltage measured is the voltage put out by the release (through a FET switch dropping 0.2 volts) and to a 47 ohm resistor in the programmer. The measurement is made in the programmer across the resistor during communication between the two units. The 'sag' is the decrease in voltage which occurs over a 0.30 second period due to the 47 ohm load. A large 'sag' would indicate batteries that can't maintain output under a load.

Release battery states displayed:

HIGH - - - - - above 4.60 volts and sag < 0.02 volts

GOOD - - between 4.00 and 4.59 volts and sag < 0.05 volts

LOW - - - between 3.70 and 3.99 volts and sag < 0.11 volts

BAD - - - - - below 3.70 volts or sag > 0.10 volts

A fresh set of three AA lithium L91 batteries made by Energizer typically measures 4.83 volts with sag of 0.01 volts. A 50% discharged set of three AA lithium batteries should measure > 4.40 volts with sag < 0.03 volts. If the release batteries become LOW as displayed during a programming then repeat the programming to insure it was not just poor hand-held contact during programming. If they still measure LOW then consider replacing them. If they

measure BAD then the risk of failure of release is even higher. (For replacement see the special procedure explained here-in).

Since alkaline AA batteries are inferior to lithium AA batteries it is not recommended that they be used. If used then divide all of the life times by a factor of 4 for warm water and 6 for cold water. Note that four alkaline AA batteries are needed not the three needed for lithium AAs. It may be necessary to extend the tube with some extra pvc pipe and a coupling. A fresh set of four typically measures > 5.60 volts with sag < 0.04. Tests show that a 50% discharged set of four AA alkaline batteries typically measures 5.05 volts with sag of 0.03 volts. If the alkaline release batteries measure worse than this consider replacing them. With 4 alkaline AAs the LOW should be reinterpreted as BAD. (For replacement see the special procedure explained here-in).

#### UNDERSTANDING THE THREE MODES OF A RELEASE UNIT:

The release unit has three modes. At any one time it is in one of these three modes. When not in use it is in its SLEEP mode and draws no battery current. When it is programmed by contact with a programmer it goes into its TIMING mode and draws 40 uA. Here it stays until the time-until-release (TUR) is up. It then changes into its RELEASE mode. Here it switches the full battery voltage to the release link to start its erosion process. The battery current varies in RELEASE mode starting high and tapering to near zero when the link has been eroded away. The unit stays in this mode for a fixed exactly four hours and then reverts back to the SLEEP mode. It remains in sleep mode until it is programmed again.

#### UNDERWATER RELEASE UNIT PREPARATION AND USE (TR-45):

To prepare a release unit (TR-45) first remove the old erosion link by unscrewing the retainer cap and removing the expired erosion link (save one for use during TR-45 storage). Second, inspect the stainless steel contact on the top end of the release unit by pressing on it with a metal tool such as a screwdriver. Verify that it has not been damaged by electrolysis. This will not happen if the O-ring is in place and does not leak excessively. The O-ring can leak a little

without damage; but, if it leaks a lot and especially if it was missing during last use then after the water leaks in electric current can flow through the leaking area and this may damage this contact by electrolytic erosion, the same erosion upon which this release system is based. Third, reassemble with a new erosion link and an O-ring (#205, 11/16" OD x 1/8" cross-section, durometer 70). The O-ring gets positioned between the top end of the release body and the erosion link. In its correct position the O-ring will surround the contact. The retainer cap is tightened hand tight on the heavy side to maintain electric contact, keep the O-ring squeezed, and hold the erosion link in place for handling its load. The cap can be felt to "bottom out" when tight. AGAIN NOTE: THE O-RING MUST BE CORRECT AND IN THE RIGHT PLACE. IF IT IS NOT, ELECTROLYTIC DAMAGE TO THE TR-45 POSITIVE CONTACT MAY OCCUR DURING RELEASE.

#### DEPLOYMENT NOTES:

Do not obstruct the outside part of the release link from making contact with the salt water. Salt water must be able to reach the two small unpainted sections of the stainless steel painted loop on the release link. Tests have shown that oil on the two small exposed stainless points of the link is no problem. Oil rinses off immediately upon immersion in water. Fourth, program the release unit. FAILURE TO PROGRAM THE RELEASE UNIT WILL RESULT IN FAILURE OF RELEASE. The time to release starts when the release unit is programmed. Fifth, deploy the release unit. There are many possibilities for deployment. It is best to keep the pull on axis. (E.g. Do not permit side-to-side heavy pulling since it could bend the erosion link back and forth until it breaks off.) Consider releasing a work line pulled by a powerful rubber band or bungee. Use the work line to release a coil of line and a float or some other desired action. This gives a definite release force that is consistent in strength and direction compared to the variable and sometimes weak tug of just a float (especially that of a small float or one that has been compressed by depth).

## Extra notes:

1. METAL TOUCHING EROSION LINK STAINLESS STEEL LOOP. WARNING: DO NOT LET METAL TOUCH THE EROSION LOOP. If something metallic rubs through the epoxy paint on the erosion link and makes electrical contact it will cause the voltage to get to it as well as the erosion link stainless steel. If the extra metal in question is small it will simply be eroded away with extra drain on the batteries possibly shortening their life. If it is large it may prevent the release and completely drain the batteries in the release unit. The piece itself will also be damaged. If it is desired to use a hook to clip onto the erosion link loop then be sure it is nonmetallic or adequately insulated to prevent electrical contact.

2. BATTERY REPLACEMENT IN THE RELEASE UNIT (TR-45). The TR-45 release unit uses three Energizer L91 lithium size AA batteries wired in series. It is not recommended that the user replace the batteries. They are connected in series utilizing either welded tabs or a special battery-specific soldering technique. However, if field replacement is decided upon access is obtained by cutting off the bottom end just above the bottom  $\frac{3}{4}$ " slip cap, being careful to not cut the wires inside. A new  $\frac{3}{4}$ " slip PVC cap and some PVC cement is required. After repeated replacements a new coupling and some  $\frac{3}{4}$  inch schedule 40 PVC pipe may also be required. The three lithium L91 size AA batteries make up a 4.5 volt pack. The red wire goes to the positive end, the black wire goes to the negative end. (Do not connect the battery pack in reverse as this will likely damage the release electronics.) At this point stop and perform the POWER-ON-RESET described in the next paragraph. Then return to here. A nine inch long piece of  $\frac{3}{4}$  inch shrink tubing works well to slip over the battery train to help hold the batteries together. If not available consider forming a splint out of folded writing paper or stiffer manila folder and use tape to hold the batteries to the splint. This gives them some integrity when pushed in or pulled out. Insert the positive end first and keep the bulk of the wires outside until the batteries are inserted all the way. Tuck in a small piece of wet suit rubber (1" x 1.5" x  $\frac{1}{4}$ "). Tuck in the wires. Tuck in another small piece of wet suit rubber. Check the tube end to insure that the new PVC slip cap will fit. Last, glue on the slip cap.

3. SPECIAL POWER-ON-RESET REQUIREMENT WHEN CONNECTING NEW BATTERIES. Immediately upon connection of the new batteries and before slipping them into place in the PVC tube perform a POWER-ON-RESET. The easiest way to do this is to short out the batteries briefly. The batteries have enough internal resistance that if the battery pack is shorted out for one second then only 0.20% of the energy is drained from the batteries. Shorting them with a quick touch lasting much less than one second is fully adequate to achieve a correct POWER-ON-RESET. After this and before gluing on the new slip cap test the unit with a programmer. Verify that the unit does accept a time-until-release (TUR) as indicated by the LCD displayed message [Successfully programmed unit.].

4. USE OF AN 'AM' RADIO TO AID IN CHECKING THE OPERATION OF A UNIT. (Note that this is just an option which is not necessary and generally not used.)

An AM radio set on about 550 kHz can be used as an aid to checking out the operation of a release unit. Hold it touching the body of the release unit near the battery end (the end away from the erosion link). Hold it there while programming it. During the one second of programming, pulses will be heard on the AM radio. If programmed for zero time (immediate release which puts the unit in release mode) then pulse sounds will be heard precisely once per second. This can be used with a stop watch to check the time base of the release unit. When programmed for any non zero time (places unit in the main timing mode) it is usually possible to hear a steady sound from the release unit if the AM radio is held very close and all other AM signals are made low enough by careful positioning of the AM radio to minimize interference pick up. When finished, program the unit to zero time (puts it in release mode) and protect the contacts from accidental contact to something in the environment for at least the four hours that the unit is in release mode. In any case the installation of an expired link or a dummy link is recommended for protection when not in use.

5. IMMEDIATE STORAGE OF TR-45 RELEASE UNIT. Keep an old erosion link with O-ring installed on the end to protect the erosion link contact (located inside the O-ring) from accidental erosion. This also protects the batteries from accidental drain.

6. GENERAL STORAGE OF ALL COMPONENTS. Store out of direct sunlight in a moderate temperature environment. Keep a dummy or an old erosion link installed on the TR-45 release unit during storage. The batteries inside the release unit are not being drained when the unit has timed out and the release mode four hours have elapsed.

7. INFORMATION ON THE STAINLESS STEEL 'COIL' SALT WATER CONTACT. This coil is the negative contact and is made from a high quality stainless steel alloy, 316L. When erosion is occurring tiny bubbles will form on it and rise off of it at the same time the release link is eroding away. Minerals may deposit on this coil at the same time. These may either be left alone or be occasionally rinsed off (if fresh) or scraped off (if hard). Accidental contact between this coil and other dissimilar metals (e.g. copper, tin, lead) should be avoided as ordinary electrolysis over extended periods of time might damage it.

8. DURATION OF RELEASE MODE: Preceding the release mode the release unit is deployed and is running in timing mode. When the time is up the release unit changes to release mode and stays in release mode for exactly four hours. It then goes to sleep. In this sleep mode no battery drain is occurring. This saves battery and stops the erosion from continuing through the plastic base of the erosion link and into the contact cavity, preventing damage to the link contact.

9. OUTPUT CIRCUIT DRIVE: This information is not needed for the intended use of the release where it drives a release link. If using the release to drive a relay or some other scheme then note the following. The release unit is short circuit proof for a zero ohm short. However, a partial short from a 1 ohm to 10 ohm load might burn out the internal power FET switch. Again, there is no concern if the unit is used as intended.

10. BATTERY DRAIN INFORMATION: The LK-40 erosion link consumes about 25 mA-Hr during release mode while eroding the stainless steel two pieces at the base of the hoop. Each piece assumed to be 0.100 inch of exposed stainless, 0.025 inch diameter wire. If the paint gets scraped off then more energy will be consumed (up to double for the LK-40). A single set of four alkaline batteries should give 40 releases if paint stays in tack or 20 releases if all paint gets rubbed off). With the LK-80 about three times the energy (vs. the LK-40) is consumed if the paint stays intact and ten times the energy consumed if all the paint gets scraped off. This equates to 13 releases with paint intact and only two releases if all the paint gets scraped off.

11. EROSION TIME INFORMATION: This is the additional time required for release after the unit switches to release mode (i.e. after the programmed time-until-release (TUR) completes). These are typically between 10 and 20 minutes. For estimates of these times see the specifications on release links LK-40 and LK-80.

13. RE-PROGRAMMABILITY: At any time an underwater timer release unit (TR-45) can be programmed or re-programmed. If the unit is already running (in a timing mode or in a release mode) then re-programming simply cancels the current operation and starts fresh with the new programmed time-until-release (TUR). The normal programming verification and battery tests are also performed upon re-programming. The timing countdown always starts at the moment of programming or reprogramming.

## **SPECIFICATIONS FOR TRP-45C TIMER RELEASE PROGRAMMER:**

Description: The TRP-45C is a programmer for the TR-45 underwater timer release units. First the time-until-release is manually entered into the programmer. Second, the time-until-release is transferred from the programmer to the TR-45 underwater release unit by direct contact of two electrical contacts between the two units.

Programmable times: Shortest = 0 days, 0 hours, 0 minutes (useful in checkout).  
Longest = 170 days, 15 hours, 52.5 minutes. Increment size = 7.5 minute.

Re-programmability: Can re-program at any time.

Start of timing: Timing starts at the moment of programming (or re-programming).

Data transfer time: 1 second. (After select 'Transfer time...' and make dual contact between programmer and release.)

Reliability of programming: Virtually certain when user checks the message displayed just after programming a unit. As part of the programming the time-until-release is returned to the programmer for verification. Further batteries are checked under load and their voltage displayed.

Display: LCD display having two lines each with 16 characters.

User Input: Three SPDT momentary switches.

Contacts: Stainless steel wire protrusions designed for making temporary connection to the link and coil contacts on the TR-45 unit being programmed.

Programmer Battery Life: Approximately 50 hours of active use time (5 mA average). Unit automatically shuts off if not in use providing one year or more of battery life for typical use. (Suggest the removal of batteries for long term storage to protect against possible battery "acid" leak).

Batteries: Two common 9.0 volt alkaline batteries (access by removing four screws to open box).

Size: 7.0 inch x 4.8 inch x 2.3 inch (17.8 cm x 12.2 cm x 53.8 cm) without contact protrusions. Add 1.0 inch (2.5 cm) to the long dimension for contact protrusions.

Weight: 1.4 pound (650 gram) with batteries.

Water resistance: Splash resistant but not water tight. Do not submerge.

## **SPECIFICATIONS FOR TR-45 UNDERWATER TIMER RELEASE:**

Description: Unit performs a release action underwater after being programmed before deployment for the desired amount of time-until-release (TUR).

Environment: Must be used in salt water (ocean or bay water). System will not work in fresh water (e. g. will not work in a fresh water river or lake).

Coil contact: Serves the dual function being a contact first used for programming and second being used as the negative water contact necessary to complete the circuit so that the accelerated erosion can occur. This contact does not erode.

Link contact: Serves the dual function being a contact first used for programming and second being used as the two points of erosion. After deployment when the release action starts this water contact is connected to the positive side of the internal battery and the accelerated erosion of it occurs.

Link retaining cap: A modified ½ inch threaded PVC cap holds the LK-40 or LK-80 erosion link in place.

Batteries: Three L91 lithium AA size batteries made by Energizer are wired in series for 4.5+ volts. These are sealed inside by gluing on a ¾ inch slip cap after inserting new batteries. Access to replace the batteries is only by cutting the cap off. (See 'Instructions' above for battery replacement suggestions).

Battery Life (LK-40): About 40 micro Amps is the drain on the three AA lithium batteries while in timing mode. This is the equivalent to using 12% of the battery energy over one year in timing mode. (Note: No drain exists when unit is not in use.) About 40 micro Amps plus whatever the link draws is the drain when in release mode. In release mode an LK-40 link can draw up to an additional 100 mA during the first high current part of the erosion phase. The energy used for one LK-40 erosion is 17 mA-Hr typical. The lithium batteries are conservatively rated at 3000 mA-Hr. So  $(3000-350)/17=156$  releases using the LK-40 can be obtained during a one year period. Or  $(3000-1750)/17=74$  releases using the LK-40 can be obtained during a 5 year period.

Battery life (LK-80): About 40 micro Amps is the drain on the three AA lithium batteries while in timing mode. This is the equivalent to using 12% of the battery energy over one year in timing mode. (Note: No drain exists when unit is not in use.) About 40 micro Amps plus whatever the link draws is the drain when in release mode. In release mode an LK-80 link can draw up to an additional 120 mA during the first high current part of the erosion phase. The energy used for one LK-80 erosion is 36 mA-Hr typical. The lithium batteries are conservatively rated at 3000 mA-Hr. So  $(3000-350)/36=74$  releases

using the LK-80 can be obtained during a one year period. Or  $(3000-1750)/36=35$  releases using the LK-80 can be obtained during a 5 year period.

Battery life vs. Link Paint: The yellow paint on the hoop of the release link focuses the erosion to two small points on the stainless steel hoop. By having the paint in place the battery drain is reduced. If it is found that it is getting scraped off significantly then the above number of releases expected per set of batteries should be reduced somewhat. If half of the paint is getting scraped off by the deployment then reduce the number of releases expected from one set of batteries by about 25%. If 100% of the paint gets scraped off (very unlikely as it is difficult to do) then reduce the number of expected releases by 60%.

Battery life in storage: Same as shelf life of batteries. (i.e. there is no battery drain when unit is not in use). At this time Energizer is marking these L91 lithium AA batteries with a "best if used by" date of 2021. Estimate 2% battery energy loss per year. The possibility of a single cell going bad increases with time making it a good idea for critical applications to replace the batteries every 10 years even if used little.

Time-until-release (TUR): Transferred from a programmer (TRP-45C) to a release unit (TR-45) by the two units being hand held in contact with each other. This time-until-release can be set to anytime between zero and 170 days in 7.5 minute steps. A setting of zero time-until-release is useful for testing. When programmed for zero time the release unit skips the timing mode and starts immediately in the release mode.

Start of timing: Timing starts at the moment of programming (or re-programming). Units can be reprogrammed over-and-over as many times as desired.

Time from start of erosion to release: 8 minutes typical with LK-40 (20 deg C). 15 minutes typical with LK-80 (20 deg C). Add 30% to these times for the erosion action time at 5 deg C. Note: The time-until-release (TUR) is not affected by battery voltage.

Duration of release mode (battery voltage applied to link): Exactly 4.00 hours or until reprogrammed, which ever occurs first.

Operating Depth: Zero to 800 feet ( 244 meters).

Size: 1.35 inch max diameter x 15 inches long.

Weight in air: 0.65 pound (295 gram). Includes internal lithium batteries.

Weight in sea water: 0.10 pound (45 gram). Includes internal lithium batteries.

## **SPECIFICATIONS FOR LK-40 and LK-80 RELEASE EROSION LINKS:**

Operation: Release by means of accelerated electrolytic erosion. When a positive voltage is applied to the two exposed pieces of stainless steel wire on the erosion link the exposed places erode rapidly.

LK-40 rated at 40 pounds (18 kg) on-axis pull. Breaking point measured at 160 pounds typical. Note: Pull should be steady in one direction. (If there is a heavy side-to-side pull then the stainless steel wire hoop might be made to bend side-to-side and break off prematurely.)

LK-40 line acceptance size: 1/8 inch line minimum, 3/16 inch typical.

LK-80 rated at 80 pounds (36 kg) on axis pull. Typical breaking point estimated well above 200 pounds (91 kg). Note: Pull should be steady in one direction. If there is a heavy side-to-side pull then the stainless steel wire hoop might be made to bend side-to-side and break off prematurely. The LK-80s heavier wire (0.035" vs. 0.025") should handle significantly heavier side-to-side loading vs. the LK-40.

LK-80 line acceptance size: 1/8 inch line minimum, 3/16 inch typical.

Number of releases on one set of batteries: See 'Battery life (LK-x0)' above.

Erosion time once TR-45 times out and switches from timing mode to erosion mode: See 'Time from start of erosion to release:' above.

## APPENDIX

### NOTES ON PROGRAMMER SWITCHES:

ON: Turns unit 'on'. Automatically shuts off after about a minute to save on battery. (For operator shut off an additional menu item exists [Shut unit off. ... ])

STOP: Used to 'stop' any flashing or scrolling display. Can be used at any time to proceed without waiting. Does not affect any settings. Does not shut unit off (see ON above for shut off information).

NEXT: Used to advance to the 'next' menu item. (Advances without activating the currently displayed menu item).

ACCEPT: Used to 'accept' the menu item which is currently being displayed. (This is like an OK key or ENTER key on common electronic devices). When pressed it starts the programmer acting on the menu item in the current display.

INCREASE: Used to 'increase' the displayed time-until-release (TUR). Holding it causes acceleration of the 'increase'.

DECREASE: Used to 'decrease' the displayed time-until-release (TUR). Holding it causes acceleration of the 'decrease'.

### EXAMPLE OF PROGRAMMING A RELEASE:

Step 1. Press ON. (observe banner [Sub Sea Sonics ... ])

Step 2. Press STOP. (observe programmer battery test)

Step 3. Press STOP. (observe [MENU FOLLOWS: ...])

Step 4. Press NEXT. (observe [Set the time-until-release])

Step 5. Press ACCEPT. (observe [DAYS HOURS MIN ...])

Step 6. Press INCREASE and/or DECREASE to obtain the

time-until-release (TUR) which is desired.

Step 7. Press ACCEPT. (observe the just set time-until-release now flashing) (Verify that it is correct.)

Step 8. Have unit to be programmed available. It should have a new link properly installed with O-ring and securely hand tightened.

Step 9. Press NEXT, NEXT, NEXT, ACCEPT. (observe [Make 2 contacts to release unit]). This will be flashing. Between each flash the programmer is trying to communicate with the release. This flashing will continue for 40 seconds giving plenty of time for the following dual contact to be initiated.

Step 10. Hold the programmer box in your left hand and the release unit in your right hand. Quickly make secure dual electrical contact between the two units for three seconds. Watch for the display of [Successfully programmed unit.]. This will be followed by the time-until-release display, the battery voltage, the sag voltage, and the battery state; HIGH, GOOD, LOW, or BAD. If the message [Failed. ... ] is obtained then do not proceed to deploy. Try again. Probably good dual contact was not maintained for the one second needed to transfer and verify the time-until-release (TUR).