

TR-6001

RECOVERABLE ACOUSTIC TRANSPONDER

User's Manual

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TELEDYNE BENTHOS

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Preface

This manual describes the installation, operation, and maintenance of the Teledyne Benthos, Inc. TR-6001 Recoverable Acoustic Transponder. This manual is divided into the following eight sections:

- 1 Introduction**
- 2 Description**
- 3 Specifications**
- 4 Theory of Operation**
- 5 Operating Instructions**
- 6 Maintenance**
- 7 Return Procedures**
- 8 Warranty**

Proprietary Information

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Changes

Teledyne Benthos, Inc. reserves the right to make changes to meet new specifications at any time without incurring any obligation to modify previously installed units. This manual is provided for informational and reference purposes only and is subject to change without notice.

Notes and Warnings

Where applicable, special notes and warnings are presented as follows:

NOTE:	A reminder to check that certain criteria are met before proceeding further in a step or sequence.
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WARNING:	A reminder that dangerous consequences could result if certain recommended procedures are not followed
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Table of Contents

1	Introduction	1
2	Description	4
	Construction	4
3	Specifications	6
	General Specifications	6
4	Theory of Operation	8
5	Operating Instructions	9
	Pre-Deployment Tests	9
	<i>Rigging</i>	10
	Deployment	10
	<i>Surface Preparation</i>	10
	<i>Anchor Line Configuration</i>	10
	<i>Operation</i>	10
	<i>Recovery</i>	10
	<i>Receiver Lockout Time</i>	11
	<i>Transmit Pulse Length</i>	11
	<i>Turnaround Delay</i>	11
	<i>Command Theory</i>	11
	<i>Command Release</i>	12
	<i>Transmitter</i>	12
	<i>Minimum Detectable Signal (MDS)</i>	13
	<i>Command Enable/Timed Disable Feature</i>	13
	<i>Backup Timer Feature</i>	14
	<i>The Re-arming Kit</i>	14
	<i>Replacing the Dissolving Wire</i>	14
	<i>Replacing the Ground Wire</i>	14
	<i>Redeployment</i>	15
6	Maintenance	16
	<i>Opening the Glass Housing</i>	16
	<i>Changing the Battery Pack</i>	18
	<i>Closing the Glass Housing</i>	18
7	Return Procedure	20
8	Warranty	21

List of Figures

TR-6001 Recoverable Acoustic Transponder 2

Figure 1-1 2

The Deployed/Released Positions of the TR-6001 3

Figure 1-2 3

P.C. Boards – 1 AND 2 Top View 5

Figure 3-1 5

Separating the Glass Hemispheres 17

Figure 6-1 17

1 Introduction

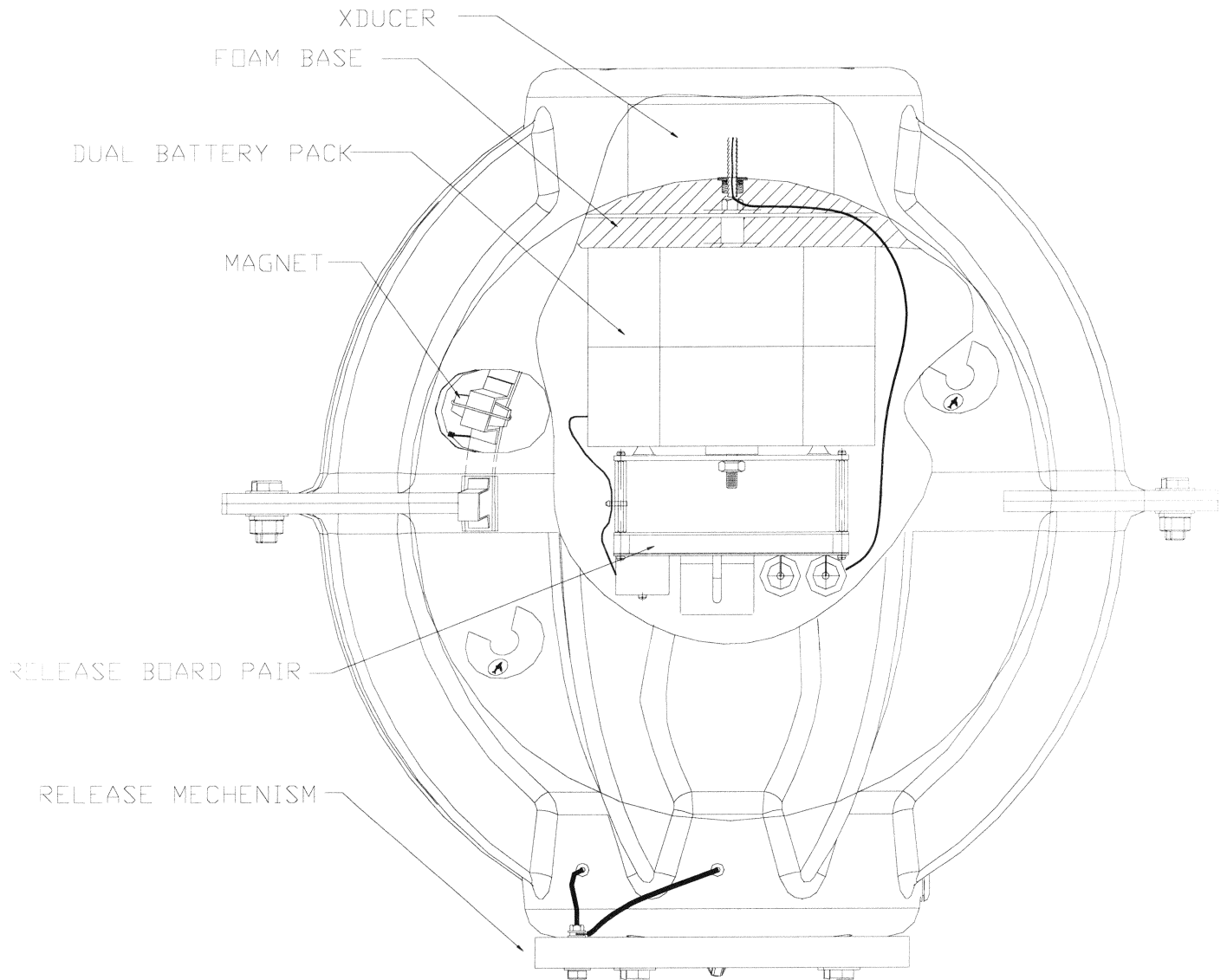
The TR-6001 Transponder, (shown in Figure 1-1), consists of a deep sea acoustic transponder in either a 17-inch glass housing and a 17-inch super ribbed hardhat or a 13-inch glass housing and a 13-inch super ribbed hardhat. A releasing mechanism, bolted to the bottom of the hardhat, provides a 12:1 mechanical advantage, and includes a release lever which is tripped by a dissolving wire when activated by the acoustic transponder. The entire assembly is a self-buoyant package which will flip over from the transducer - up position when deployed to the transducer - down position when released and on the surface (see Figure 1-2). Two molded handles in the hardhat are provided for ease of recovery and shipboard handling.

The TR-6001 is intended for acoustic navigation and release of light loads at a 22,000 foot (6700 meter) water depth. For ease of relocation, the unit will transpond when interrogated to determine slant range, and will transpond in different modes for confirmation of release.

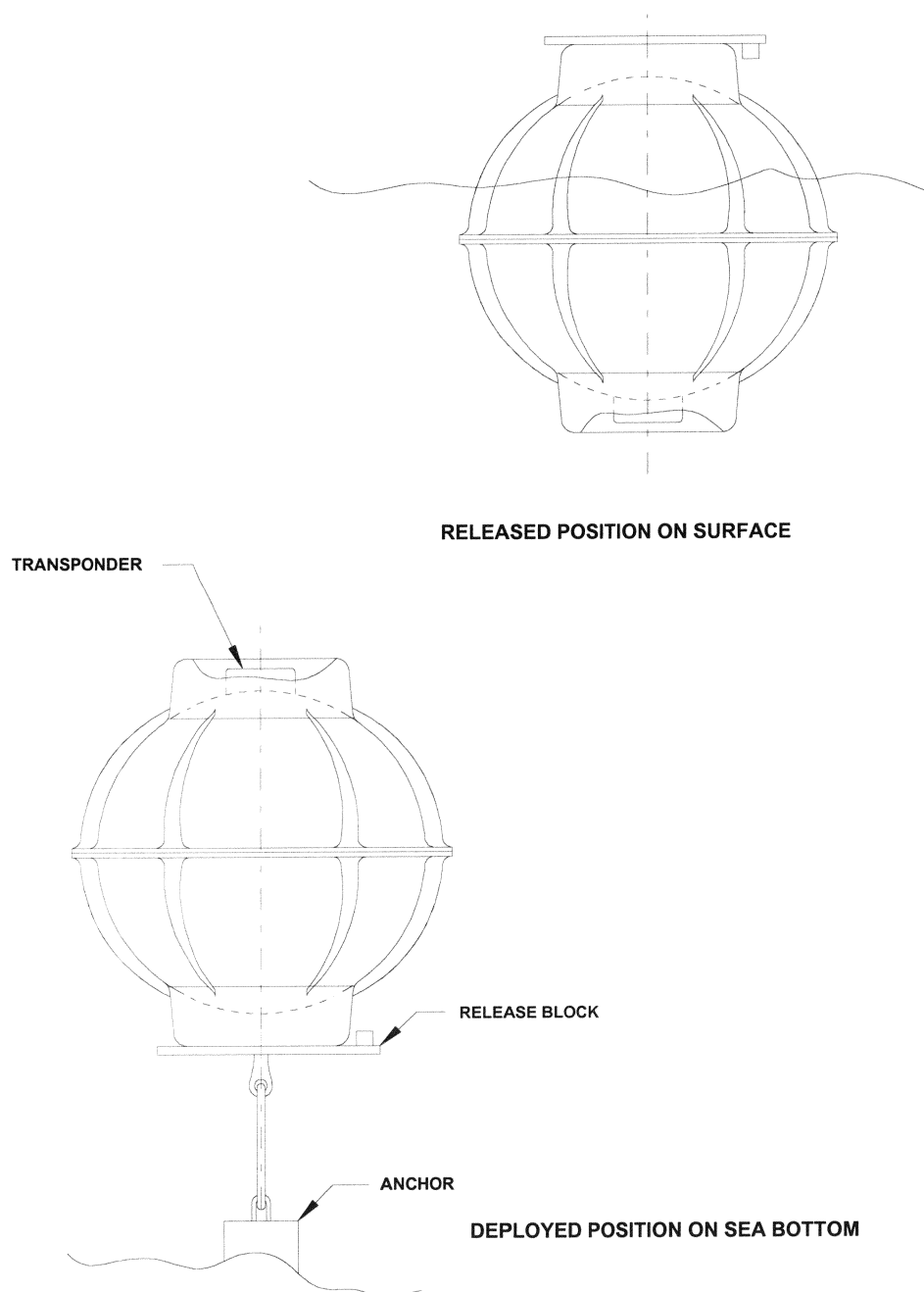
Interrogations and commands are transmitted by a Model DS-8000 Deck Unit, which also provides a four-digit readout of slant range up to 33,000 feet (10,000 meters). The deck unit can provide all available interrogate frequencies and eight different command codes per receiver frequency. The Model DS-7000/DS-8000 Deck Unit has its own manual and is not described in detail here.

Upon completion of a RELEASE command, the TR-6001 will change its transponder reply from one to four pings for every interrogate pulse from the deck unit. At the deck unit, the verification that the RELEASE command has been received and acted on is seen as multiple flashes of the Receive LED and the data displayed for the multiple evenly spaced pings. The multiple ping sequence will be present only during the time in which current is flowing to the release mechanism. When the wire dissolution is complete, the unit will revert to single ping upon interrogation.

Upon recovery, the transponder can be re-armed and used again. The standard battery pack will easily provide twenty-four months use, with many releases and a minimum of 300,000 transponds. The TR-6001 reverts to a single ping when the unit is re-armed.



TR-6001 Recoverable Acoustic Transponder
Figure 1-1



***The Deployed/Released Positions of the TR-6001
Figure 1-2***

2 Description

The Model TR-6001 Transponder is supplied to the customer with the major components as follows:

- Model TR-6001-17 Transponder in 17-inch Glass Instrument Housing in Super Ribbed Hardhat with attached transducer and release mechanism. One (1) release link ($\frac{1}{4}$ inch stainless shackle) and one (1) burn wire module should be installed in the release assembly.

Or

- Model TR-6001-13 Transponder in 13-inch Glass Instrument Housing in Super Ribbed Hardhat with attached transducer and release mechanism. One (1) release link ($\frac{1}{4}$ inch stainless shackle) and one (1) burn wire module should be installed in the release assembly.
- On/off magnet attached to release inside hardhat cutout
- Spare Re-arming Kit (see Section 8)
- Spare Parts Kit (see Section 8)
- Instruction Manual.

Upon receipt of equipment, the customer should check the shipment to insure that the order is received complete and undamaged. Please contact Teledyne Benthos, Inc. or refer to Section 7 of this User's Manual before returning any equipment damaged in shipment.

Construction

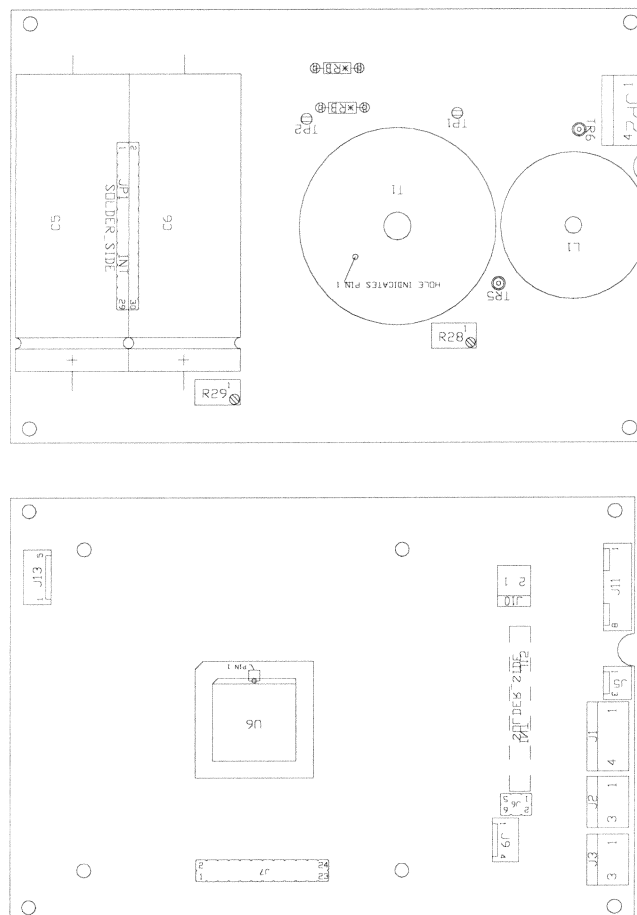
The Model TR-6001 Transponder consists of a board pair and battery pack fastened inside the self-buoyant 17-inch or 13-inch glass instrument housing. One penetrator through the glass housing is used to connect to the transducer in the upper hemisphere and two electrical penetrators through the glass housing are used for the dissolving wire electrodes. A hose clamp and bail assembly is used to hold the two instrument housing halves together. The entire glass assembly is enclosed in a two piece polyethylene hardhat. The top half has a cutout in the top for the transducer and the bottom half has the release assembly bolted to the bottom, as shown in Figure 1-1.

The printed circuit board assembly consists of 2 circuit boards back to back separated by spacers.

- a.) 865 board1, (Teledyne Benthos, Inc. PN C-855-130)
Board No. 1 contains all the large components required for transmitting, i.e. output transformer, inductor, power transistors and capacitors. It also contains the circuitry for transmit pulse gating, and sensitive receiver preamplifier. The transducer is connected to this board. (See figure 3-1)
- b.) 865 board 2, (Teledyne Benthos, Inc. PN C-855-132)
Board No. 2 contains the remaining receiver circuitry including the limiter amplifier, detector and the microprocessor based command decoder. Other functions on this circuit board are:

- Transmit frequency synthesizer.
- RELEASE acknowledgment (four extra pings).
- RELEASE motor drive.
- 5-volt regulation.

To remove Board No. 2, power OFF, disconnect the interface connector; and remove the four corner screws and unplug the board (see Figure 3-1).



P.C. Boards – 1 AND 2 Top View
Figure 3-1

3 Specifications

This section provides information on the operating and environmental specifications on the Teledyne Benthos, Inc. TR-6001 Recoverable Acoustic Transponder, for the 13" and 17" option.

General Specifications

Transmit Frequency:	User selectable 7.5 to 15.0 kHz (± 3 Hz), 250 Hz increments
Receive Frequency:	User specified 7 and 15 kHz, .5 kHz increments (12.5 Hz is reserved, not a standard receive freq.) (Receiver bandwidth ± 125 Hz)
Receive Lockout Time:	1.5 seconds standard (re-triggerable)
Detection Jitter (repeatability):	± 0.1 ms
Turnaround Delay:	3 ms (standard), 3-30 ms (optional)
Minimum Detectable Signal:	>85 dB re 1 μ Pa
Operating Depth:	22,000 ft. (6700 m) max
Transmit Pulse Length:	10 ms (± 1 Hz),
Operating Range:	10 km slant range with Teledyne Benthos, Inc. DS-7000/DS-8000 Deck Box.
Battery:	18 alkaline 'D' cells two strings in parallel at a nominal 13.5 vdc (P/N 865-SB-13)
Operating Life:	Two year with 300,000 transponds. (based on 10 ms transmit pulse length) 22 Amp-hours (de-rated for cold temp. use and two year deployment time)
Acoustic Output:	> 192 dB re 1 μ Pa @ 1 meter (9.0 to 16.0 kHz) > 187 dB re 1 μ Pa @ 1 meter (7.0 to 8.5 kHz)
Activation:	Fresh or salt water immersion
Beam Pattern:	Near omnidirectional from upper hemisphere
Dimensions:	
TR-6001-17	17 in. Glass Instrument Hsg. 24 in. max. diameter x 22.5 in. max. height
TR-6001-13	13 in. Glass Instrument Hsg. 19 in. max. diameter x 17.5 in. max. height

Released Method:	Inconel Electrolytic Dissolving Wire
Released Indication:	Change from single to five ping when RELEASE command is received. (Reverts back to single ping when wire completely dissolved.)
Command Channels:	Eight standard Channels (A,B,C,D,E,F,G, or H). Combination of these and the channels available from the Deck Box provide 128 different codes of non-interfering operation.

NOTE: The enable feature and the release feature require on command code each.

Weight:	
TR-6001-17	60 lbs (26 kg) in air 38 lbs (17 kg) in water
TR-6001-13	46 lbs (20.9 kg) in air 5.8 lbs (2.6 kg) in water
Anchor Requirements:	Weight (in seawater) 75-100 lbs (33 to 44 kg)

NOTE: Anchors not supplied by Teledyne Benthos, Inc.

4 Theory of Operation

The dissolving wire loop that is used to support the release lever tip will break and trip the lever when it receives a proper signal from the TR-6001. The method in which the wire loop breaks is electrochemically driven where the wire loop is the anode, the ground screw is the cathode, and the water between them is the electrolyte. During non-releasing deployed periods of time, the wires from the electrodes are not connected to each other or any other metallic objects in seawater. The release command closes a switch which places 26 volts across the electrodes with the wire loop positive (the anode).

The 26 volt potential will polarize the electrodes such that metallic dissolution occurs at the anode and hydrogen reduction or calcium carbonate deposition occurs at the cathode. The initial battery current drain is approximately 2.0 amps. These reactions will slow down as the surface area of the anode (the wire loop) becomes smaller.

After approximately 6 to 10 minutes, the wire loop will break through and trip the lever tip, which in turn releases the shackle and anchor weight. As the TR-6001 floats to the surface, the metallic dissolution reaction will continue until the wire loop strand ends have dissolved away outside the insulation jacket and worked their way up inside the jacket by approximately 1/8 inch. When the reactions occur at a rate such that the battery current drain is less than approximately 30 milliamps, the SCR will switch off the battery power to the dissolving wire loop and the TR-6001 will respond with single pings again when interrogated.

5 Operating Instructions

Pre-Deployment Tests

Before deployment, test that the unit is operational by using the following procedure:

1. Remove the on/off magnet from the hose clamp band bracket; this will turn the unit on. After about 1-2 seconds, the unit will signal that it has been powered-up successfully by transmitting four pings about 200ms apart.
2. To test the transmit and receive frequencies, place the deck unit transducer near the TR- 6001 transducer and verify that it will only respond to the proper receive frequency and that it is replying at its proper transmit frequency.
3. To test the RELEASE command, attach both leads of a voltmeter to the electrode wires; the positive voltmeter lead goes to the exposed portion of the burn wire loop and the negative lead to the ground screw. Send the proper RELEASE command from the deck unit. The RELEASE command lasts for about four seconds. After about two to three seconds into the RELEASE command, the RELEASE command will be received and the voltmeter will indicate approximately 25 volts until just after the command is over (or about two or three seconds more). If the measured voltage is less than 22 volts, the battery pack should be replaced. See Section 6.3 for checking and changing the battery pack.

NOTE: Receiving acoustic commands through air is often difficult. Adjust the position of the deck unit transducer and try the RELEASE command again until an acceptable position is found.

NOTE: If the measured voltage is negative, then the voltmeter leads are reversed. Confirm that a positive voltage is sent to the burn wire module (the anode) upon receipt of a RELEASE command prior to deploying the unit.

4. After the TR-6001 receives a RELEASE command, the unit will verify with four pings, 200ms seconds apart. After each interrogation the unit will reply with 5 pings.

Rigging

Before deployment, be sure that the dissolving wire module and the ground screw are properly installed and securely tightened. The disposable ballast should weigh between 75 and 100 pounds in seawater and be attached to the release base with the Benthos provided ¼ inch stainless steel shackle. Insure that additional hardware will not cause jamming of the release mechanism.

Deployment

Surface Preparation

After the unit is tested and rigged, remove the on/off magnet prior to deployment. Listen for the four power-up pings. Gently lower the transponder and anchor into the water. Try to minimize the impact loads on the release linkage during deployment

Anchor Line Configuration

The length between the anchor and transponder should be long enough to provide a clear acoustic path, and short enough to minimize the watch circle errors, or 4 to 10 feet. However, this figure will vary dependent upon bottom relief and individual applications.

Operation

To interrogate a TR-6001 Transponder, first set the TRANSMIT FREQUENCY SELECT switch of the deck unit to the receive frequency of the transponder you wish to command. Send a single transpond from the deck unit and the TR-6001 Transponder will reply with a single ping.

Recovery

To send the RELEASE command, again make sure the TRANSMIT FREQUENCY SELECT switch is set to the receive frequency of the transponder you wish to command. The RELEASE command, or options, and their corresponding codes (A,B,C,D,E,F,G,H) are clearly indicated on the TR-6001 hardhat label. Set the COMMAND SELECT switch to the proper letter code, as indicated by the label, and send the command transmission. The TR-6001 will respond with four pings, 3.2 seconds apart, after the command has been properly received. These will show up on the display and may also be heard on headphones, if available. To verify that the release wire is, in fact, dissolving, send a single interrogate ping to the transponder. The TR-6001 will respond with five (5) pings, 200ms seconds apart while the current is flowing through the dissolving wire electrode circuit. The first reply may be used to obtain slant range to the instrument. Repeat the process periodically to verify that the wire is still dissolving and to check slant range. A normal period of time for release is 5

to 10 minutes for the wire loop to break through; however, the wire loop ends will continue to dissolve until the wire strands are dissolved inside the jacket of the original wire loop. This process will take an additional 5 to 10 minutes during the ascent of the transponder. Once the wire dissolution circuit has shut down, the transponder will revert back to replying with one ping when interrogated. It will float transducer-down when on the surface for acoustic relocation.

There are two handles molded into the hardhat opposite each other on the 17" hardhat flange which can be used for grappling to aid in recovery.

Retest the unit after recovery to verify that the battery voltage is still adequate, and then insert the on/off magnet back into the hose clamp bracket.

Receiver Lockout Time

This is the amount of time that the receiver is inhibited after receiving a pulse of the correct frequency. This helps prevent undesirable multiple interrogations which would result from multipath phenomena, thus saving battery energy. The standard lockout time is 1.5 seconds, although .5 second and 2.5 seconds are available as options

Transmit Pulse Length

This is the duration of the transmit frequency burst. The standard pulse length is 10 milliseconds, and this is the proper pulse length when using Benthos deck units. However, other manufacturers' deck units may require different pulse lengths. Therefore, as an option, any pulse length from 2 to 20 milliseconds may be specified at time of order.

Turnaround Delay

This is the time delay between reception and transmission. It is a constant delay which should be subtracted from the measured travel time in order to obtain the most accurate slant range. In the standard unit this delay is 3 milliseconds; however, any delay between 3 and 30 milliseconds may be requested as an option when ordering the TR-6001.

Command Theory

The standard Benthos acoustic command consists of two separate frequencies alternating at a specific shift rate. One frequency, called the "in-band" frequency, is set to the RECEIVE frequency of the release. The other frequency, called the "out-of-band" frequency, is arbitrarily fixed at 12.5 kHz (actually the "out-of-band" frequency alternates between 12.5 kHz and 18 kHz on successive command transmissions) which are otherwise unused frequencies. The detector in the underwater release will respond "true" for the in-band frequency and "false" for the out-of-band frequency. Its output, therefore, will be a square wave whose frequency is the shift rate of the command. The

command receive circuit then checks for a specific frequency of this square wave and, if it is correct for two complete seconds, the release function will be executed.

There are a total of thirteen shift rates, although only eight are supported in the standard release (A-H) and they are designated by the letter part of the code. The shift rates are:

A: 82.5 Hz	B: 110.9 Hz
C: 136.5 Hz	D: 100.0 Hz
E: 71.9	F: 77.0
G: 118.8	H: 127.3 Hz

Codes I thru M require special release software and are typically reserved for special applications, they are:

I: 123.0 Hz	J: 131.8
K: 107.2 Hz	L: 114.8 Hz
M: 103.5 Hz	

The command code is decoded by a microprocessor on the logic board.

Command Release

Upon receipt of the proper command code for RELEASE, a power MOSFET transistor is latched on, thus allowing the motor to run. Once started, the motor will run until the pin is fully retracted. Once the pin is fully retracted, the RELEASE LIMIT switch is actuated causing the motor to stop. A backup timer will disable the motor drive after approximately 40 seconds has elapsed, if the shaft has failed to reach the release position (it normally takes approximately 20 seconds).

Transmitter

The transmitter consists of three basic blocks:

1. Transmit frequency synthesizer
2. Pulse control
3. Power amplifier.

The transmit frequency synthesizer is based on a 50 kHz crystal oscillator. This oscillator feeds a phase lock loop network which synthesizes a particular frequency based on the stored value within the microprocessor.

If the unit is ENABLED and the detector output goes true, then the pulse control circuitry allows the transmit frequency through to the power-amplifier for 10 milliseconds. The power-amplifier consists of two power MOSFET transistors, and a transformer steps up the AC signal to approximately 3,000 volts peak to peak. This is applied across the transducer which converts the electrical energy into acoustic energy. The same transducer element is used for both transmit and receive.

Minimum Detectable Signal (MDS)

Teledyne Benthos, Inc. specifies the MDS to be less than 85 dB re 1 μ Pascal for our underwater transponders. Most units typically test out to be between 75-80 dB re 1 μ Pascal during our standard acoustic pool test. The noise level in our pool approaches that of the deep ocean, i.e. approximately 50-60 dB re 1 μ Pascal at 10 kHz.

What does this mean in terms of ranging capability? Let's take an example at 10 kHz.

First, assume the Source Level Output (SLO) of the surface unit is 192 dB re 1 μ Pascal at 1 meter. Then, the transmission loss at maximum range is simply the difference between the SLO at the surface and the MDS on the bottom:

$$\text{Transmission Loss} = 192 \text{ dB} - 85 \text{ dB} = 107 \text{ dB}$$

From transmission loss tables, this figure corresponds to a maximum range of about 28 kilometers. This is more than adequate sensitivity, since the limiting factor in ranging capability is the reception at the surface, where the noise environment may be worse than the deep ocean by a factor of 30 dB or more, due to ship and surface noise.

Therefore, further improvement of the sensitivity of the underwater receiver is not only unnecessary, but in fact, somewhat detrimental. As the sensitivity is brought closer and closer to the ambient noise level, the False Alarm Rate goes up resulting in unnecessary transponds that will drain the battery and confuse the surface receiver. Thus, by specifying the MDS to be less than 85dB re 1 μ Pascal at 1 meter, Benthos has insured adequate ranging capability while maintaining a negligible False Alarm Rate.

It should also be noted that all Benthos receivers will maintain a Constant False Alarm Rate even if the ambient noise environment changes. This is known as a Constant False Alarm Rate or CFAR receiver. All Benthos deck units also have sensitivity controls that allow the operator to maximize the sensitivity for a particular noise environment. This essentially allows the operator to choose an acceptable False Alarm Rate, which is then held constant at that level by the electronics.

Command Enable/Timed Disable Feature

The ENABLE feature prevents unwanted transmissions from occurring due to unauthorized transponding, other sonar equipment, or random interference. Whatever the source, the result could be a large number of unnecessary transponds by the 865-A which could result in premature battery drain.

Basically it works as follows:

The release powers up in the ENABLED state; that is, it will reply when it receives the proper frequency. It will then remain ENABLED for the selected time, up to 255 hours (a setting of "0" hours will disable this function, leaving the release enabled all the time). The default enable time is 12 hours which will usually be enough time to deploy the unit and range on it (if desired). If not, the user may simply send it an "ENABLE" command to extend (reset the timer) the enable time. Once the enable time runs out, the

transmitter portion of the release is disabled until an ENABLE command is received or a release occurs.

NOTE: If for whatever reason the unit is not "ENABLED" when a RELEASE command is received, the release will still take place. Upon completion of the release operation the unit will automatically ENABLE itself so that its ascent may be tracked.

Backup Timer Feature

If requested at the time of order, the 865 features a BACKUP timer function that is both very powerful and very dangerous. All standard releases are shipped with this function disabled (value set to 0). Extreme care should be exercised whenever using this feature.

If enabled, the BACKUP timer will cause the 865 to automatically RELEASE a fixed number of hours (up to 65,535 hours, > 7 years!) after the unit is turned on. This feature can be used in the very special applications where a timed release function is desired. When this function is enabled, the unit will still respond to an acoustically transmitted RELEASE command.

The Re-arming Kit

In order to redeploy the TR-6001, the transponder should be re-armed with a new dissolving wire module and an expendable link. The Benthos Expendable Re-arming Kit (A-210-226) includes three (3) ¼ inch stainless steel shackles and three (3) expendable dissolving wire modules.

Replacing the Dissolving Wire

The old dissolving wire module should be unplugged from the single pin connector and unscrewed from the release base. A new shackle should be installed on the lever arm and a new dissolving wire module should be installed in the release base. These should be saved and returned to Benthos for remolding of new modules. The Delrin tip of the release lever should be inserted into the dissolving wire loop. Insure that the wire loop is installed in the necked down section of the delrin tip. Both the expendable dissolving wire module and the ground screw should be tightened and checked for integrity prior to redeployment.

Replacing the Ground Wire

When broken strands are observed, loosen the ground screw, remove the wire from the screw, cut off approximately one inch of wire, re-strip the insulation to expose approximately ½ inch of wire strands and reinsert back into the hole in the ground

screw. Make sure that the ground wire is firmly clamped by the large washers of the ground screw assembly.

NOTE: Depending on the deployment environment and amount of use, it is possible that the ground wire (the cathode) may become brittle in time and some of the strands of wire will break at the junction of the wire and the ground screw. Prior to deployment, the ground wire should be lightly flexed and checked for broken strands.

Redeployment

Once the transponder has been re-armed, follow the normal deployment procedures described in the beginning of Section 5.

6 Maintenance

Opening the Glass Housing

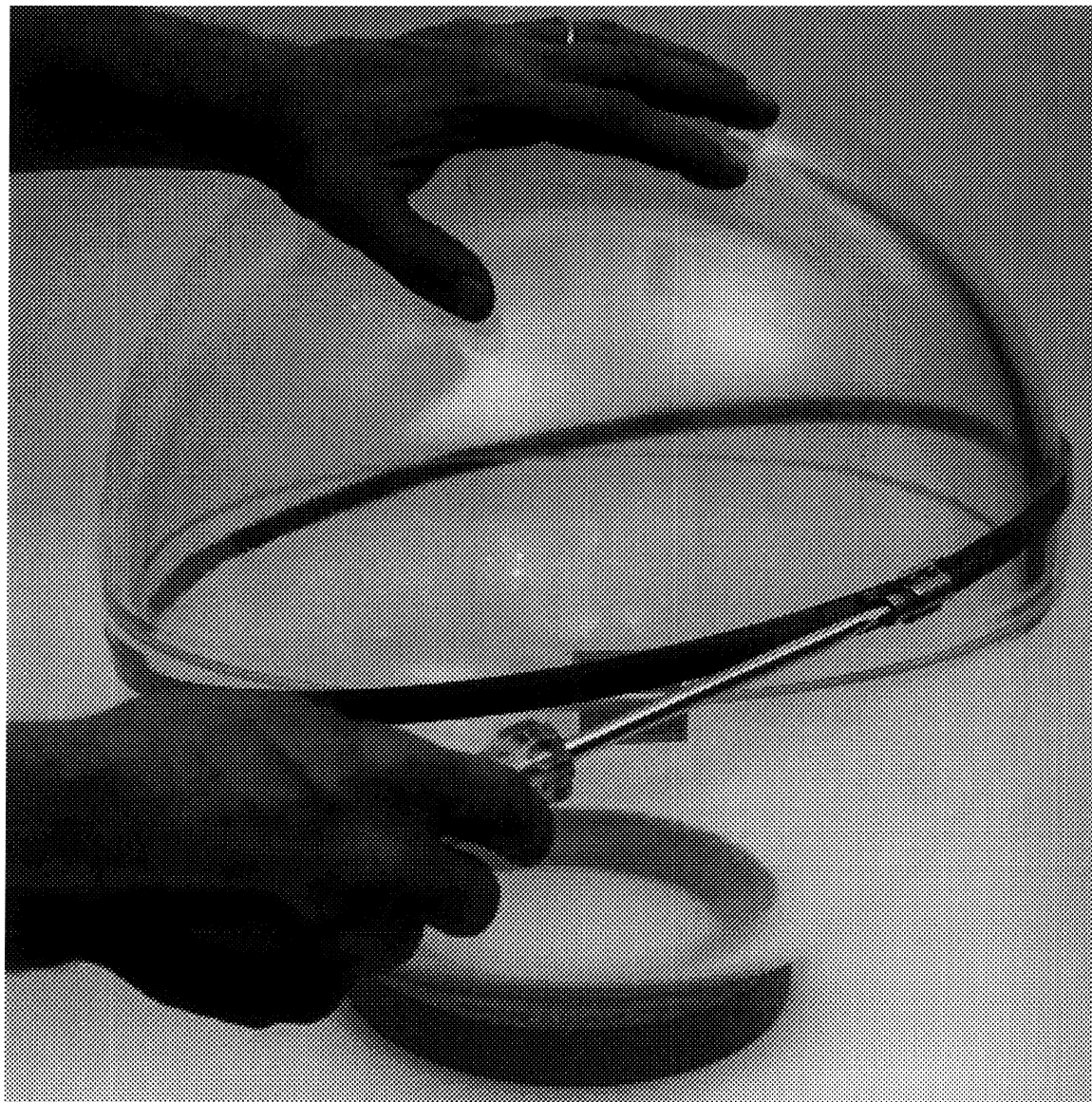
The following list details the steps required to open the glass housing of the TR-6001.

- a. Materials needed:
 - Heat gun
 - 18-inch diameter hose clamp
 - Small roller
 - Butyl sealant strip (Teledyne Benthos, Inc. P/N 0900-024)
 - Wide black tape (Teledyne Benthos, Inc. P/N 0903-013)
- b. Remove the hardhat assembly.
- c. Remove the hose clamp assembly.
- d. Place the transponder in some sort of a cup to prevent it from rolling.
- e. Turn the unit off by taping the supplied magnet over the "match arrow" mark near the equator on the lower hemisphere. Wait approximately two minutes for the capacitor to discharge, then test the transponder with a deck unit to be sure that it is, in fact, off.
- f. The two hemispheres are held together by the tape around the equator and by about four inches of vacuum. Carefully remove all tape and sealant from the equator. The vacuum inside should still hold the halves together.
- g. The best way to separate the halves is to slowly tighten a hose clamp diagonally across the equator, as shown in Figure 6-1. Often it is possible to tap them apart using the palm of your hand, but in either case you must be very careful not to chip the precision ground surfaces at the equator. Even small chips can ruin the pressure integrity of the housing.
- h. Now remove the upper hemisphere and place it upside down next to the lower half. The transducer makes a convenient stand for this half.



WARNING: BE CAREFUL! If the unit is powered on, there may be potentially harmful high voltage on the board, particularly in the area of the transducer terminals

- i. The end cap with the water switch should remain free and clear of dirt, grease, and dust. The end cap should be cleaned with a detergent and dried thoroughly with a clean cloth. This process should be repeated periodically depending on the local environment.



Separating the Glass Hemispheres
Figure 6-1

Changing the Battery Pack

The battery life of the TR-6001 is very long, depending on its use, so rarely will this step be necessary; but if so, it is not difficult to change the battery pack. Replacement battery packs may be ordered from Teledyne Benthos, Inc. Please specify Teledyne Benthos, Inc. P/N C-210-301 when ordering.

- a. Open the glass housing by following the steps listed above.
- b. Unplug Battery Connector.
- e. Remove the 1/3-20 nut and washers in the center of the PC BRD mounting plate. Now lift out the circuit board and the battery packs.
- f. Unplug the old packs and discard them, in accordance with local regulations.
- g. Set the new battery packs in the hemisphere. Dry out or replace the desiccant packs if they are pink in color.
- h. Plug in the P.C. board, and replace it over the batteries. Replace the nylon washer, flat washer, lock washer and nut in that order. Do not over tighten.
- i. Remove the magnet and listen for the power-up ping.
- j. Close the glass housing following the instructions in listed below.

Closing the Glass Housing

- a. **Important:** Close the sphere in as "dry" a room as possible, preferably an air conditioned area. Avoid closing in a hot, humid environment, because in the low temperature deep ocean, much of this moisture will condense and may cause serious electrical problems.
- b. Very thoroughly clean off the precision ground mating surfaces of both hemispheres. Use a non-residue forming industrial solvent, such as Trichlorethelene or tolulene. **CLEANLINESS IS VITAL!**
- c. Align the match arrows and gently place the two hemispheres together.
- d. Slide the hemispheres slightly apart so that there is a gap. Using a hair dryer or a heat gun, blow hot air into the sphere for about 15 seconds.
- e. Immediately slide the halves back together, keeping the match arrows lined up. You will notice a considerable vacuum force now holding the halves together.

-
- f. Gently tap the halves in place with the palm of your hand in such a way as to get the best possible "match" at the equator. That is, with the match arrows lined up, try to minimize the overhangs at the equator.
 - g. Now thoroughly clean the outside of the equator area using a solvent. Again, **CLEANLINESS IS VITAL!**
 - h. Wrap the soft butyl sealant strip (Teledyne Benthos, Inc P/N. 0900-024) around the joint at the equator, keeping the paper on the outside. Carefully cut the strip so the ends butt together. Do not overlap the ends.
 - i. Still keeping the paper on, roll the sealant strip so that it flattens out to approximately double its width at starting. This may be done with a small roller. Be careful that the two halves do not slide during this operation.
 - j. After rolling, make certain that the strip is still centered on the glass joint and the sealant has fused together at the ends.
 - k. Remove the paper from the sealant strip.
 - l. Apply three complete turns of the wide black tape (Teledyne Benthos, Inc. P/N. 0903-013), centering the tape on the sealant strip. Stretch the tape as it is being wrapped so that it conforms to the curvature of the glass. Rub the tape smooth using hand pressure.
 - m. Replace the hose clamp assembly, centering the ring around the transducer. Carefully tighten the adjustment screws. Do not over tighten.

7 Return Procedure

If you need to return a TR-6001 Recoverable Acoustic Transponder for warranty service, contact Teledyne Benthos, Inc. for a **Return Material Authorization (RMA)** number and shipping instructions.

Teledyne Benthos, Inc.
Tel: 508-563-1000
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You will need to provide the following information to receive a **Return Material Authorization (RMA)**:

- Reason for return
- Number of transponders to be returned
- Serial number of each unit
- Shipping method, if applicable

NOTE: Do not ship a beacon without a **Return Material Authorization**.

8 Warranty

LIMITED WARRANTY. Teledyne Benthos, Inc. warrants that the products sold hereunder shall be free from defects in materials and workmanship under normal use and service when correctly installed, used and maintained for a period of one (1) year from date of shipment from Teledyne Benthos, Inc. Purchaser's receipt of any product delivered hereunder shall be an unqualified acceptance of and a waiver by Purchaser of the right of Purchaser to make a claim with respect to such product unless Purchaser gives Teledyne Benthos, Inc. notice of any claim within one (1) year after shipment from Teledyne Benthos, Inc. of such product. This warranty is limited to repair or replacement of the said product in the sole discretion of Teledyne Benthos, Inc., when at the Teledyne Benthos, Inc. plant in North Falmouth, Massachusetts, all freight and insurance prepaid, providing the product was not abused or operated other than in accordance with the Teledyne Benthos, Inc. instruction manuals. With respect to the sale of Teledyne Benthos, Inc. oceanographic instruments which are pressure tested to rated depth prior to shipment, Teledyne Benthos, Inc. does not assume responsibility for any damage due to leakage or implosion. Teledyne Benthos, Inc. reserves the right to modify its warranty at any time, in its sole discretion. THIS LIMITED WARRANTY IS NOT TRANSFERABLE FROM THE ORIGINAL PURCHASER.

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