

PUB. NO. 606-C (THIRD REVISION): BATHYTHERMOGRAPH OBSERVATIONS

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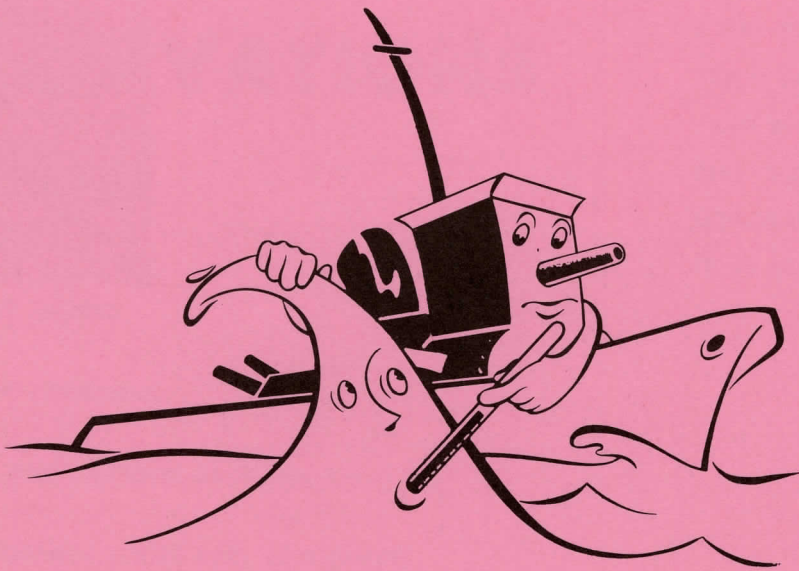
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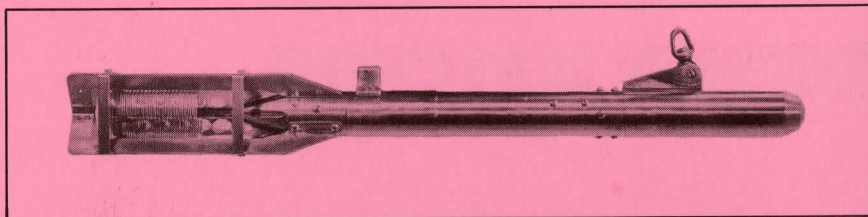
PUB. NO. 606-c

OCEANOGRAPHIC OFFICE OBSERVERS MANUAL



BATHYTHERMOGRAPH OBSERVATIONS





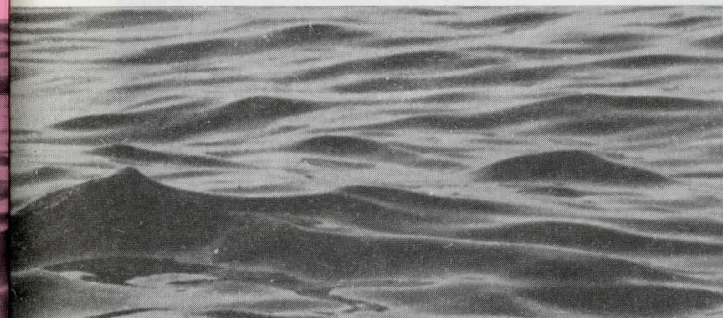
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HOW A BT WORKS

The bathythermograph is designed to obtain a record of the temperature of sea water at various depths.

BATHYTHERMOGRAPH



OBSERVATIONS

HOW A BT WORKS

MAKING A LOWERING

LABELING AND SHIPPING BT SLIDES

HOW TO OBTAIN SLIDES AND LOG SHEETS

TURNING IN BT FOR REPLACEMENT OR REPAIR

For both submarine and antisubmarine operations, knowledge of the weather at the surface and beneath the surface of the sea is of vital importance. It is essential for strategic planning of convoy routes, speeds of advance, and sailing times. It determines the allocation of escort craft to afford adequate protection in each operations area. It determines whether it is safer to use fast unescorted ships or slower vessels moving in convoy. And it delineates those areas where air escort is needed.

Subsurface weather information is equally important in the strategy of submarine operations. It outlines the patrol areas where enemy shipping losses are most likely. It determines the size of the areas allotted to each submarine as well as the most efficient number of submarines that can be used in any area of operations. It also determines the placement of submarine listening posts for monitoring the movements of enemy task groups.

Apart from its strategic importance, information concerning the weather beneath the surface of the sea is a fundamental contribution to the science of oceanography upon which the development of improved sonar, sofar, underwater communications, and underwater weapons and mines is so dependent.

The best single index to subsurface weather conditions is the temperature distribution in the top layers of the ocean. The best instrument for measuring this distribution is the bathythermograph (BT)--the device which records how the sea temperature varies with depth.

Temperature-depth measurements vary, but their variations are not random; they vary with area and with time of year. If enough BT observations are made, the average conditions can be determined. Since the strategic and research value of bathythermograph information increases as the number of recorded BT observations increases, it is essential that ships of the Navy continue to make observations and to forward the resulting information to the National Oceanographic Data Center.

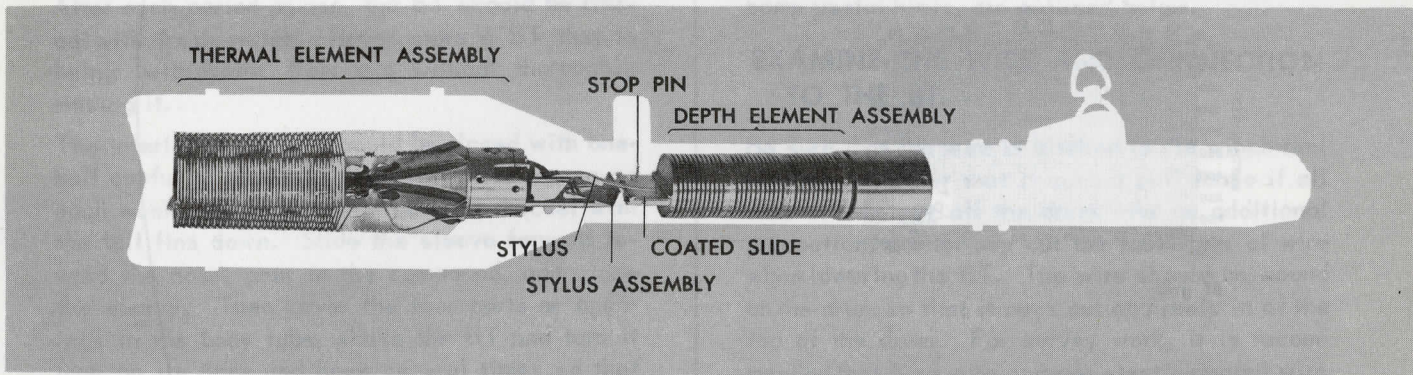


Just as climate and terrain affect the strategy of armies, so seasonal and geographical characteristics of the oceans enter into the planning of the Navy. Today, waves and currents and ocean temperatures are influencing modern naval warfare in ways that are different but no less real than the limitations they placed on the old navies of sailing ships.

HOW A BT WORKS

The bathythermograph is designed to obtain a record of the temperature of sea water at moderate depths. It can be operated while the ship is underway at speeds up to 18 knots. It works most satisfactorily, however, at speeds of 12 knots or less.

The thermal element, corresponding to the mercury column in a glass thermometer, consists of about 45 to 50 feet of fine copper tubing filled with xylene. The tubing is wound around inside the tail fins of the BT and comes into direct contact with the sea water.

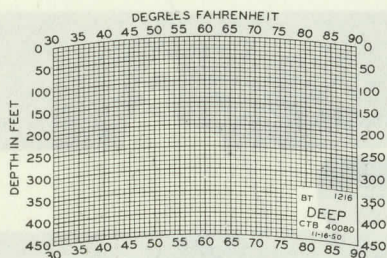


As the xylene expands or contracts with the changing water temperature, the pressure inside the tubing increases or decreases. This pressure change is transmitted to a Bourdon tube, a hollow brass coil spring which carries a stylus at its free end. The stylus records the movements of the Bourdon, as it expands or contracts with changes of temperature, on a coated glass slide. The slide is held rigidly on the end of a coil spring enclosed in a copper bellows or syphon. The temperature range is from 28° to 90° F.

Water pressure, which increases in proportion to water depth, compresses the syphon as the BT sinks. This pulls the slide toward the nose of the BT, at right angles to the direction in which the stylus moves, to record temperature. When the BT is raised toward the surface, the spring expands the syphon to its original shape. Thus, the trace scratched on the coated surface of the slide is a combined record of temperature and pressure, the pressure being proportionate to depth. The depth range is stamped on the nose of the BT.

Since external pressure slightly affects the internal pressure of the xylene in the Bourdon, and since temperature changes also influence the movement of the syphon, each instrument must be carefully calibrated by the manufacturer.

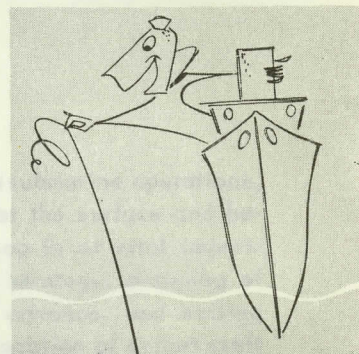
A special grid is supplied for each instrument for converting the stylus trace to temperature and depth readings. These grids are not interchangeable between instruments. From an examination of the grid, it will be noted that the temperature lines are not exactly straight and vertical, but curve slightly to the left with increasing depth. Likewise the depth lines are not exactly arcs of circles with radius equal to the length of the stylus, but also allow for thermal expansion of the syphon.



BT grid

A temperature of 105°F. will bring the recording stylus up against a stop pin; if this temperature is exceeded, permanent deformation of the brass coil of the Bourdon will occur, and the calibration of the instrument will be ruined. For this reason, the BT must always be kept out of the sun and away from the vicinity of fire rooms, steam pipes, and other sources of heat. An instrument that has been overheated may have the stylus arm jammed by the pen-lifter bar in the high temperature position. If another BT is aboard, use it, and turn in the damaged instrument for adjustment. If a spare is not available, gently lift the stylus arm from the pen-lifter bar and let the arm swing back toward the low temperature side. The temperature calibration will henceforth be in error as a result of deformation of the Bourdon.

Record on the oceanographic log sheet that the calibration is uncertain beginning with the next slide, and turn in the instrument at the first opportunity.



The BT should be turned in if the date of the last calibration of the BT is more than 18 months past. Do not disassemble the BT. It is a precision instrument with delicate internal mechanisms, and even with the greatest care possible it is difficult to avoid damage if disassembling is attempted aboard ship. If for any reason the BT fails to operate satisfactorily, it should be turned in for repair with a report indicating the symptoms to aid the repair facility in correcting the trouble. Standard failure reports also should be submitted in accordance with current directives.

The BT is an accurate measuring instrument and while the construction is reasonably rugged, the internal mechanisms are delicate. Careful handling is essential to maintain the accuracy of the measuring elements.

After each period of use, the BT should be rinsed with fresh water. Never store a BT that is being withdrawn from use without thoroughly rinsing it.

The interior of the BT should be rinsed with one-half cupful of grade III rust-preventive compound each week. Place the BT in a clean bucket with the tail fins down. Slide the sleeve forward toward the nose, pour in the compound, and close the sleeve. Then cover the four ports or openings in the body tube, shake the BT and turn it over on its nose and back several times so that every part is thoroughly covered. Let the compound drain out. The compound can be reused several times. Do not oil the BT - fresh water or rust-preventive compound is all the lubrication necessary.

BT slides are packed in plastic boxes of 50 each. The slides have a very stable alloy coating on one side; nevertheless, the slides should be handled by their edges only. An inspection should be made of the slides when a new box is opened, and any defects should be reported in accordance with current Bureau of Ships instructions.

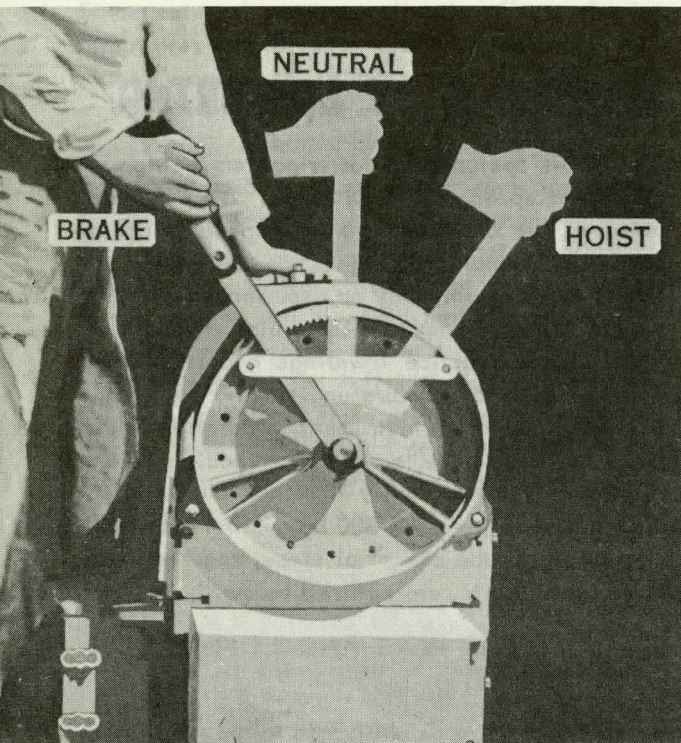
MAKING A BT LOWERING

The BT is designed for lowering from a ship underway at speeds up to 18 knots. Best results, however, are obtained when the speed is not in excess of 12 knots. At higher speeds, unless the sea is very smooth, only an experienced operator should attempt to operate the winch. New operators should practice lowerings and recoveries with a dummy BT, before undertaking the operations with an actual instrument. Operation of the BT winch cannot be learned from reading a description any more readily than one can learn to pitch a baseball or bowl 300 by reading a manual. Nevertheless, the essential steps, together with some useful hints, are outlined below.

EXAMINE THE WIRE AND CONNECTION TO THE BT.

Be sure that the wire is hitched to the winch reel in such a manner that it cannot pull loose if all wire should pay off the drum. As an additional precaution, do not pay out the last layer of wire when lowering the BT. The wire should be wound on the drum so that it pays out and reels in at the top of the drum. For survey work, it is recommended that bare wire and not plastic-coated wire be used. If a 900-foot-depth BT is used, at least 2,000 feet of 3/32-inch 7 x 7 stainless steel wire should be used. As the plastic-coated wire usually comes in 1,200-foot lengths and cannot be spliced, it is not long enough for use with a 900-foot BT. Run the free end of the wire through the towing block at the end of the boom. This block is of a special counterbalanced design for BT use.

The type of cable hitch used to connect the BT to the wire differs slightly with different models. The instruction book accompanying each BT shows the method of attachment for that model. If the connection is frayed, rusted, kinked, or in any way doubtful, cut off the faulty part of the wire and make a new connection. Check the swivel carefully. On those models that use a Fiege-type swivel connector make sure the Fiege sleeve is screwed into the socket as tightly as possible. More BTs are lost by poor connections than from any other cause.



CHECK THE WINCH

The hand lever on the winch serves as both brake and clutch. It has three positions: (1) When it is vertical, the winch is in neutral and the drum can be turned in either direction; (2) When it is pushed outboard to the engaged, or hoist, position the motor turns the drum and spools on the wire; (3) When the lever is pulled inboard, or toward the operator, to the brake position, the drum is locked and cannot be rotated.

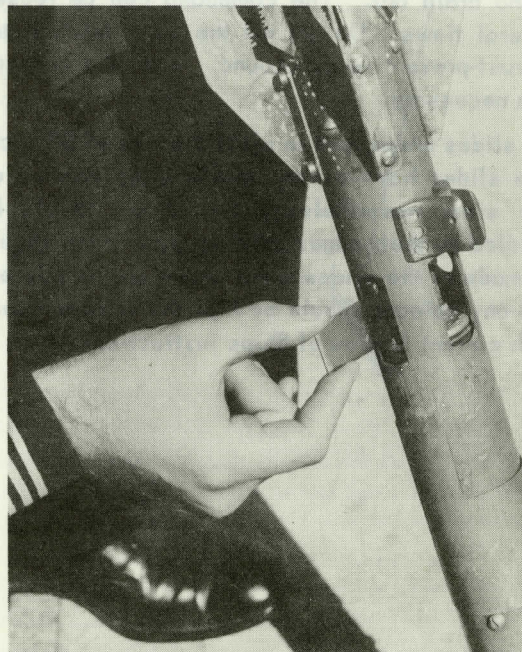
With the winch lever in neutral, turn on the motor to make sure the power is available. The shaft bearings should be kept well lubricated according to the instructions provided with each model winch. The drum should turn freely.

The winch installation should be such that the wire comes across the top of the drum. The hand lever should move away from the operator to engage the motor and toward the operator to set the brake. On some winch models the operation is different. Check the operating instructions to make sure that the installation is correct and that the winch is in good operating condition.

PUT THE SLIDE IN THE BT

Insert the slide into the hole on the side of the BT and push it into its bracket. The edge of the slide with the bevelled corners goes in first, the longer bevel towards the nose of the BT, making certain that the coated surface of the slide is toward the stylus. Push the slide all the way in against the stop pin. It is important that the slide is fully in, otherwise the temperature will be recorded fictitiously low.

Occasionally check the grooves of the slide holder to make sure they are clean, free of glass chips, and that the spring holds the slide firmly against the opposite groove. With the slide fully in, the stylus will be brought against the coated surface when the sleeve is moved back to cover the opening. To reduce extraneous scratches on the slide do not move the sleeve back until the BT is ready to be put over the side.

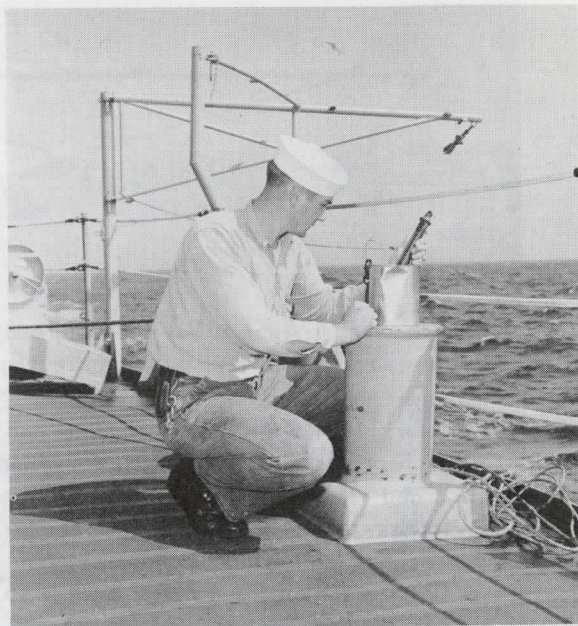


PUT THE BT OVER THE SIDE

When permission has been obtained from the Officer of the Deck, pick up the BT, pull the sleeve down over the slide holder, and set the winch lever in neutral. With one hand, hold the BT at the rail, and with the other take up the slack wire, turning the winch drum by hand. When all slack is retrieved, set the brake. Set the counter at zero.

DROP THE BT INTO THE WATER

Turn on the winch motor, so that power is instantly available for the rest of the operation. Lower the BT into the water to such a depth that it rides smoothly, just below the surface. Put on the brake and hold the BT there for 30 seconds to enable the thermal element to come to the temperature of the surface water.



If the surface bucket is not available, use the small, metal-guarded bucket thermometer provided in the BT kit. This thermometer can be read to the nearest one-half degree.

A bucket can be made by obtaining a gallon can from the galley and attaching a line to it. Attach the bitter end of the line to the lifeline or rail. Throw the can over the side and let it fill and empty several times before hauling a surface sample aboard. As soon as it is aboard set it on deck and insert the thermometer into the bucket so that at least 3 inches of the bulb end is immersed in sea water. Stir the thermometer with a circular motion for 15 to 20 seconds, and then read it with the stem still immersed in the water. Stir it once or twice more and check the reading.

It is important that the bucket sample be taken at the time the BT is being towed and that the temperature reading be made as soon as possible after the sample is on deck. If the sample is allowed to stand for more than 45 seconds, the temperature reading will no longer be valid. It is also important to stir the thermometer to bring it to temperature more rapidly and accurately.

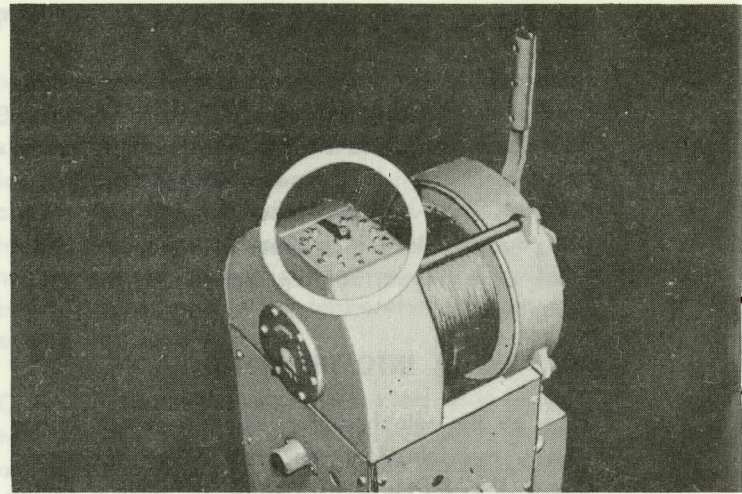
TAKE THE BUCKET TEMPERATURE

While the BT is being towed at the surface, take the bucket temperature of the surface water and record it on an oceanographic log sheet. If a surface bucket is available, it is equipped with an internally mounted, 12-inch-long, 3-inch-immersion thermometer, which is graduated in 0.5° F increments. Such a bucket, of metal or plastic, is lowered to the sea surface and towed for about 30 seconds. It is then retrieved and the thermometer is read immediately to the nearest 0.1° F.

LOWER THE BT

Move the winch lever to the Neutral position, and allow the wire to pay out freely. Success in reaching the maximum desired depth depends primarily on two factors; (1) having the winch drum and towing block bearings well lubricated to minimize friction and (2) getting the BT down below the ship's screw wash as soon as possible. After the 30 seconds of towing at the surface is completed, skip the BT off the crest of a wave so that it swings forward, and then lower rapidly. This enables the BT to plunge into the water, and its momentum will carry it more rapidly past the turbulence of the wash and will enable it to reach a greater depth. This technique is especially useful with the 900-foot instrument. It takes practice, but to the experienced operator is easier to use and more effective than the diving lug assembly attached to some models.

When the ship is making more than 12 knots, there usually is enough drag on the wire while the BT is diving to insure that it will not slacken and backlash. At lower speeds and during heavy rolling, the wire may slack between the winch and the towing block. This may cause backlash on the winch drum or a kink at the towing block. The operator should provide himself with a round stick about 15 inches long to be used to gently slow the drum when excessive slack appears. Do not apply too much pressure to the drum with the stick because once the diving motion of the BT is arrested it will not dive farther regardless of the amount of wire payed out. Do not touch the wire with your hands when the drum is in motion; you may be seriously injured.



STOP AT THE PROPER DEPTH

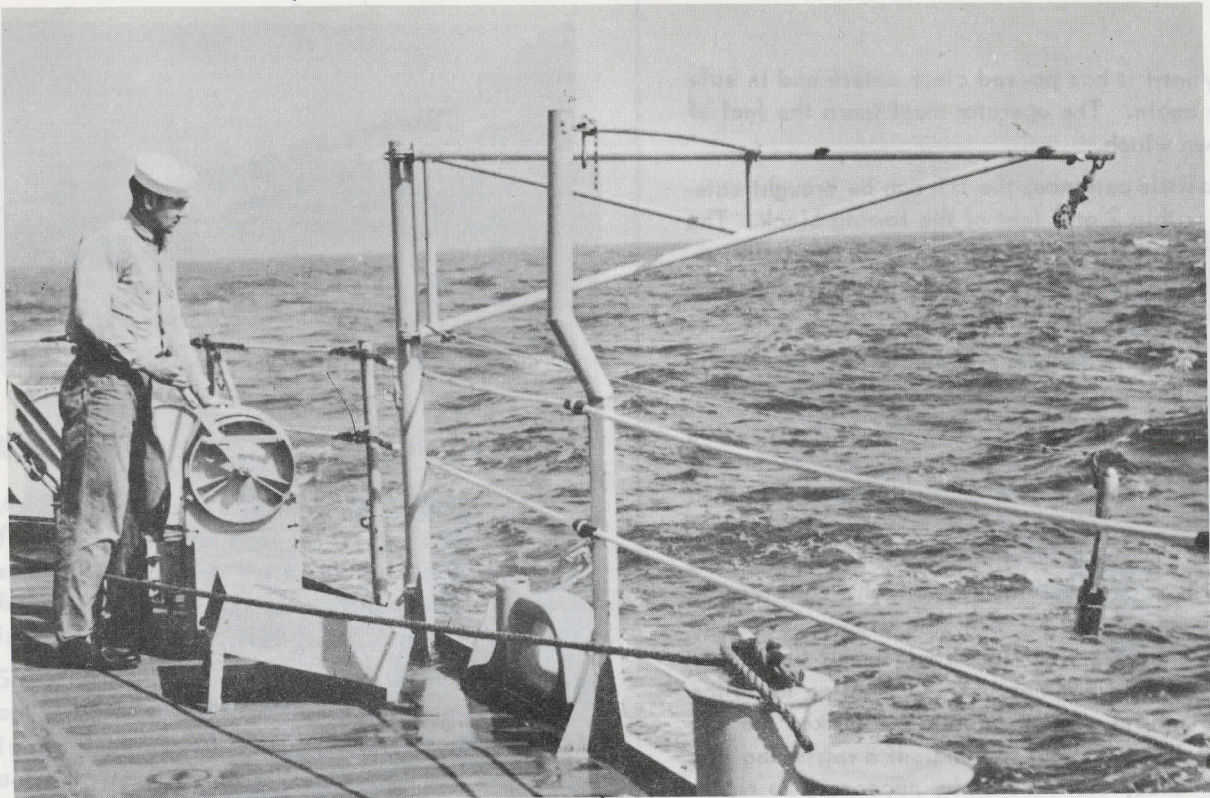
To reach a given depth, the amount of cable to be payed out will depend upon the speed of the ship, the type of BT, and whether or not the nose sleeve is attached. The table below provides a rough estimate of speeds at which full depth may be expected to be reached when using 1,000 feet of wire.

BT depth (feet)	Maximum speed without nose sleeve (knots)	Maximum speed with nose sleeve (knots)
200-----	15	22
450-----	10	13
900-----	3	6

Care must be exercised to insure that the BT is not lowered to a depth greater than that for which it was designed.

The observer should take data on the length of wire payed out and the actual depths recorded by the BT, and plot a graph showing counter reading against depth for various ship's speeds.

When the counter indicates that the proper length of wire has been payed out, or when the last layer of wire on the drum has been reached, the brake should be applied smoothly, allowing the drum to stop without a sudden jerk. An excessive jerk will part the wire. The BT will now swim back up to near the surface far astern. Check to see that the wire leads properly for hauling in. If it does not lead from the towing block to the center of the drum, adjust the boom guys until it does.

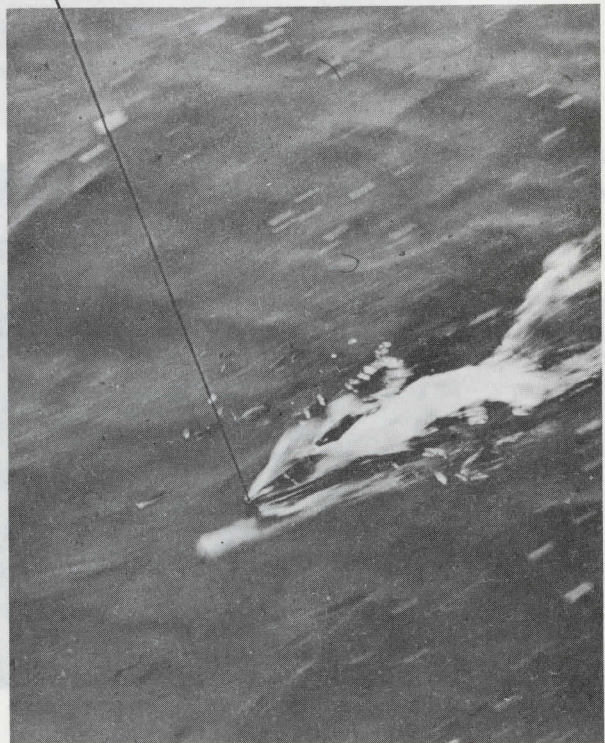


HAUL IN THE BT

Move the hand lever smartly from the brake position to the hoist position. Do not pause while going through neutral or more wire will pay out. Guide the wire back and forth in even layers on the drum using the 15-inch stick. The end of an old swab handle will do. Do not use a metal guide. If kelp or gulfweed fouls the wire, ease on the brake and clear the wire with a boathook. Haul in at full speed until it is seen from the counter and by rapid decrease in the wire angle, that the BT is close astern but still a safe distance from the ship's screws.

BRING THE BT ABOARD

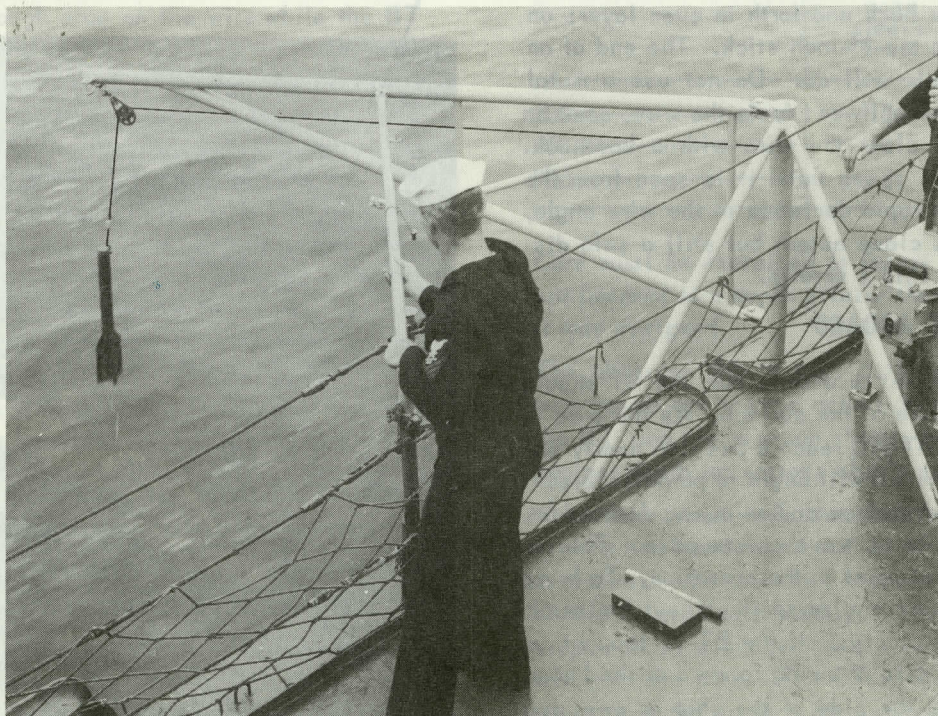
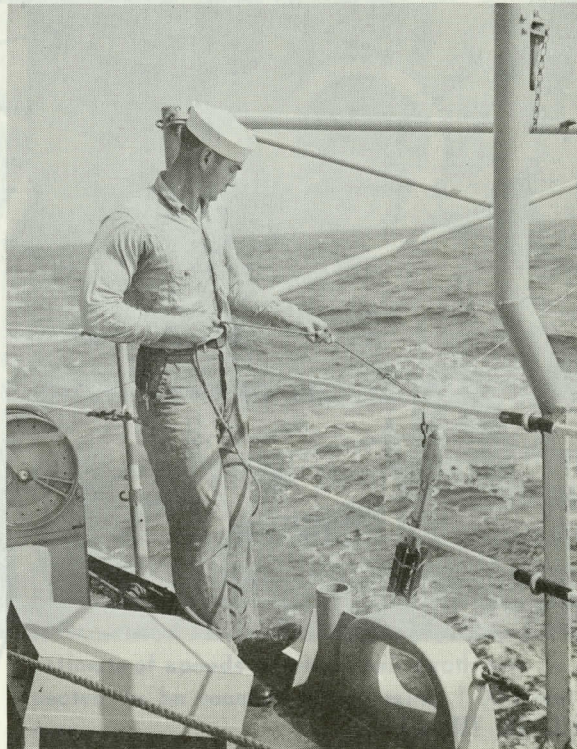
When only 100 feet of wire is out, the BT should be readily visible at the surface. As the wire is hauled in, the BT will reach a position nearly under the boom where it will begin to porpoise, breaking clear of the surface and swinging forward as the ship rolls or as wave crests pass. This is the most critical point in the operation. To bring the BT alongside and raise it without too much swing requires practice. If the BT is brought in too fast, it may skip or swing forward of the boom, perhaps hitting the side of the ship or swinging completely over the boom. If the BT skips or swings forward of the boom, it is advisable to shift at once to neutral and allow the BT to sink



freely until it has passed clear astern and is safe to try again. The operator must learn the feel of his own winch.

With a little patience, the BT can be brought safely to within 2 or 3 feet of the towing block. The winch motor should be turned off at this point, eliminating the possibility of accidentally jamming the BT against the towing block.

The BT can then be brought aboard in various ways, depending on how the boom is rigged. With the standard gate boom, the use of a retrieving line and ring is recommended. This consists of a metal ring of an inch to an inch and a half in diameter through which the wire is passed between the towing block and the BT. To the ring is attached a retrieving line which is secured to the lifeline or rail. With the proper amount of slack, the ring will ride freely when the BT is being lowered and hoisted. By hauling in on the retrieving line while easing the brake, the BT easily can be brought to hand. If a retrieving line is not used, then it will be necessary to rig in the boom by casting off the after guy and swinging the boom in with the forward guy. Two men can pull in the BT with a boathook - one man on the hook and the other to slack the wire with the winch. If the boom tops up, the BT can be brought aboard by one man hauling in on the topping lift.





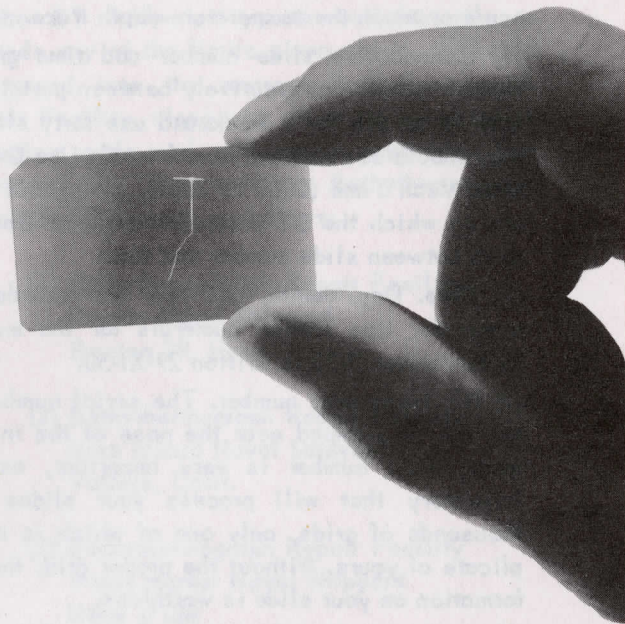
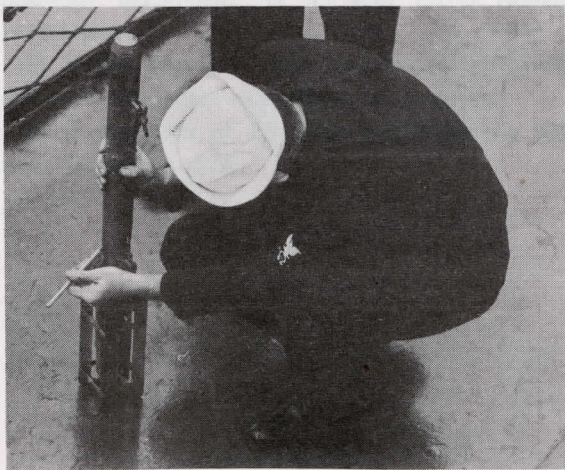
REMOVE THE SLIDE AND SECURE THE EQUIPMENT

As soon as the BT is in hand, move the sleeve forward toward the nose to lift the stylus off the slide. This prevents the upper portion of the trace from being affected by air temperature and becoming obscured as the instrument is handled.

Slack off the wire, place the BT in its deck rack, and set the brake. Notify the bridge that the BT is on deck. Partially eject the slide by pushing against its edge with the forefinger, the wire slideremover, or a pencil through the slide-ejecting port. Grip the slide carefully by the thumb and forefinger. Hold the slide only by the edges, being careful not to obscure the trace with smudges or fingerprints.

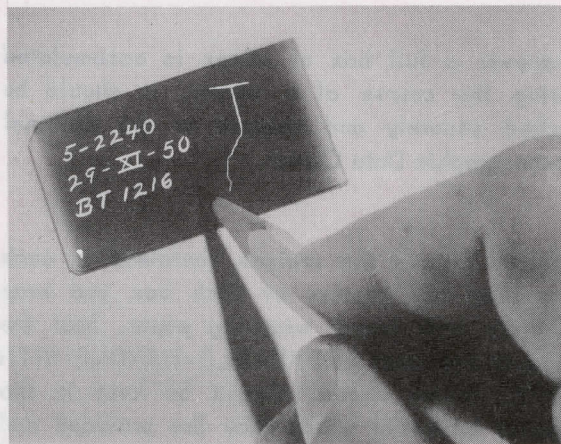
If another lowering is to be made soon and there is no danger of overheating the BT, it may be left in the deck rack connected to the wire; otherwise unshackle it and stow in a cool place.

CAUTION: Never let the temperature of the BT exceed 105° F (40.8° C). If the temperature is exceeded, the calibration of the instrument will be damaged. Never leave the BT on deck without protection from hot sun. Suitable protection to the thermal element can be afforded by keeping it covered with wet cloths.



LABELING AND SHIPPING BT SLIDES

As soon as the BT slide is removed from the BT, examine it to be sure that a suitable trace has been obtained.



LABEL THE SLIDE

With a sharp instrument, write the following information on the slide, being careful not to obscure or touch the temperature-depth trace.

(1) Consecutive slide number and time group. Number slides consecutively between ports. If a ship is at sea for a week and use forty slides, they should be numbered from 1 to 40. Use Greenwich Mean Time (0000 to 2359), giving the minute on which the BT entered the water. Enter a dash between slide number and time.

(2) Date. Day, month, and year are recorded in numerals. Use Roman numerals for the month. 29 November 1950 is written 29-XI-50.

(3) BT instrument number. The serial number of the BT is stamped near the nose of the instrument. This number is very important, as the laboratory that will process your slides has thousands of grids, only one of which is a duplicate of yours. Without the proper grid, the information on your slide is worthless.

Always enter the information in the order given here. Avoid the temptation to improve an apparently faint trace by enlarging or tracing over it at the time you enter the data. The processing laboratory can copy an actual trace, however faint, by the delicate photographic processes it uses; but will invariably detect a retouched trace and reject it as spurious.

STORING AND SHIPPING THE SLIDE

After the BT slide has been labeled, rinse it in fresh water and place it in the plastic storage box. Do not dip slide in lacquer.

Whenever a full box of slides is accumulated during the course of a survey, it should be packed securely and shipped to the National Oceanographic Data Center.

Indicate clearly the cruises contained in each box. Pad the corners of each box and wrap securely with heavy wrapping paper. Seal the wrapper and label **BREAKABLE—HANDLE WITH CARE**. Slides should always be kept in the special boxes in which they are provided and should not be shipped in any other type of container.

At times special instructions may be given for forwarding completed slides and log sheets. When such special instructions have not been received and when a box of slides has accumulated, send in slides, log sheets, BT position charts, and any special notes to:

National Oceanographic Data Center
Washington, D. C. 20390

All grids from BTs lost during operations at sea shall be forwarded to the above address on return to port or at the end of a survey cruise.

HOW TO OBTAIN SLIDES AND LOG SHEETS

LOG SHEETS

Additional pads of Oceanographic Log Sheets for Bathythermograph Observations may be obtained upon request from:

National Oceanographic Data Center
Washington, D. C. 20390

Reporting and Coding Procedures will be furnished with Oceanographic Log Sheets.

COATED GLASS SLIDES

New slides are a standard stock item in the Electronic system and are obtained through any normal supply support channel. The stock number and description is:

NS-6655-676-7987, SLIDE—Recording,
Bathythermograph, Glass, Metallic Coated,
(Staballoy)

Unit of Issue: Box

TURNING IN BT FOR REPLACEMENT OR REPAIR

The BT is a delicate precision instrument, and it is possible to damage the mechanism with excessive temperature and depths, as well as by shock which often occurs to the BT during handling, lowering, and storing. For this reason it is advisable to check the instrument, from time to time, for temperature and depth errors.

Malfunctions can be discovered by comparing the traces of two BT's which have been lowered in the same water; temperature errors can be determined by immersing the thermal element of the BT in a bucket of water and measuring the temperature with a bucket thermometer, and depth errors can be determined when the ship is "hove to" and the BT can be lowered with a zero wire angle.

WHEN TO TURN IN THE BT

The following limits of error should be used as a guide in determining need for repair or recalibration.

TURN THE BT IN:

- (1) if the temperature of the BT differs from the bucket temperature consistently by 4°F., or more.
- (2) if the temperature of the BT shifts erratically from reading to reading, as compared to the bucket temperature or another BT.
- (3) if the BT shows double traces over the entire length of the trace.
- (4) if the BT shows a depth error of more than 10 feet for a 200-foot instrument, 20 feet for a 450-foot instrument, or 40 feet for a 900-foot instrument.
- (5) if the stylus is dull and consistently produces a wide trace regardless of cleaning.
- (6) if the date of the last calibration is more than 18 months past.

WHERE TO TURN IN THE BT

If the BT fails to operate satisfactorily or exceeds any of the limits given above, it should be turned into the nearest Bathythermograph Repair Facility, along with all of its accessories including grids and grid mount assembly. The addresses for the existing Bathythermograph Repair Facilities are as follows:

- (1) Bathythermograph Repair Facility
Boston Naval Shipyard
Boston 29, Mass.
- (2) Bathythermograph Repair Facility
Mare Island Naval Shipyard
Vallejo, Calif.
- (3) Bathythermograph Repair Facility
Pearl Harbor Naval Shipyard
Navy #128
c/o Fleet Post Office
San Francisco, Calif.

TO GET REPLACEMENT

A request for replacement should be submitted to the Bureau of Ships in accordance with existing instructions.