NATIONAL OCEANOGRAPHIC DATA CENTER

MANUAL SERIES

MANUAL FOR PROCESSING BATHYTHERMOGRAPH DATA

PART II

PROCEDURES FOR PROCESSING
BATHYTHERMOGRAPH DATA IN ANALOG FORM

PUBLICATION M-3
(Provisional)

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FOREWORD

During recent years, NODC, in consultation with the oceanographic community, has gradually revised its procedures for processing bathythermograph (BT) data in analog format. It is hoped that the processing methods currently used strike an acceptable balance between the requirements for rapid processing of a steadily mounting inflow of BT data and the obligation to maintain an optimum degree of quality.

The prime purpose of this provisional manual is to acquaint users of BT data and field activities with the quality criteria and the revised basic processing methods which are currently used at NODC for the production of analog BT prints. It is not necessarily intended to serve as a guide for those who may wish to establish their own BT processing system.

W. C. JACOBS
Director
National Oceanographic Data Center

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INTRODUCTION

In spite of the technological advancements made over recent years in the development of oceanographic instrumentation, the mechanical bathythermograph continues to provide the greatest volume of data on the thermal structure of the ocean. Unfortunately, the BT data system is poorly suited to automated processing techniques. The initial input to the processing sequence consists of a glass slide bearing the analog record (Figure 1) obtained during a lowering of the BT

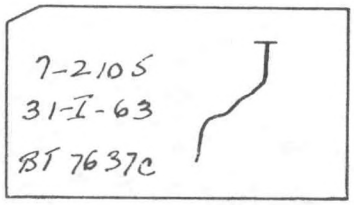


Figure 1. Bathythermograph slide (actual size).

instrument, a log sheet or data form, and a specific temperature depth grid applicable to the BT instrument. Numerous processing steps and considerable quality control are required in order to obtain an analog record of temperature against depth correctly located in time and space. It should be noted that the BT processing sequence begins with the "raw" data and in contrast with most other data records processed at NODC, all basic data reduction routines must first be performed.

To facilitate processing of BT slides and data submitted to NODC and to provide for some degree of standardization of the data record, NODC issues, without charge, two basic forms for the use of the field observer. On these forms are entered for each slide information necessary for processing such as time, position, instrument number, etc., as well as environmental data. The "Bathythermograph Data Form," NODC-EXP-3167/24 (3-64), (Appendix I) is intended for general use by field observers. The same form is also issued by World Data Center A, Oceanography, (WDC-A) bearing the WDC-A imprint and is intended for those activities which exchange data through the WDC's. The "Bathythermograph Log, PRNC-NODC-3167/10 (4-63), (Appendix II) must be used by activities participating in the Synoptic Oceanographic Network. Its content is similar to the "Bathythermograph Data Form," but in addition provides for entries to be used for radio transmission of BT data. Both forms are provided with an explanatory wrapper (carrying detailed instructions on the use of the forms), explanation of the nature of required entries, and instruction on the marking and mailing

of the BT slides. In addition, NODC provides a mailing label, NHO-NODC-3167/11 (9-61), (Figure 2) for mailing and proper identification of BT slides.

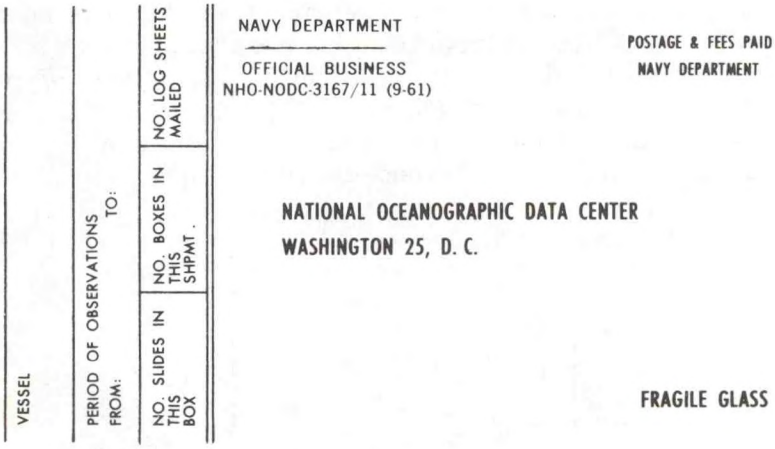


Figure 2. Mailing label for bathythermograph slides.

Although NODC would prefer the use of its forms, NODC will by special arrangement process BT slides accompanied by other types of BT data forms.

The processing of BT slides and related information on log sheets submitted to NODC results in a reproducible photographic enlargement of the analog BT trace positioned in temperature-depth coordinates. The analog BT data are released on 3" x 5" ozalid prints containing the photo image on one side and identifying and environmental data on the other. Appendix III contains illustrations and an explanation. In exchange for submitting BT data for processing at NODC, the originator is provided with one set of ozalid prints of the processed slides.

The processing sequence described in this manual is the revised, simplified processing method which has been in effect at NODC since September 1963. Prior to that date, BT's processed at NODC were adjusted to an averaged reference temperature. This adjustment, referred to as "temperature correction, slide" (TCS), was intended to improve accuracy of the temperatures yielded by the BT record. Background information on the NODC decision to discontinue the TCS adjustment can be found in NODC Progress Reports P-13, "Some Problems in Determining the Reference Temperatures for Bathythermograph Observations," and P-31, "Report on the TCS Problem." In brief, the decision was based mainly on these considerations:

1. The temperatures furnished as a reference record for the computation of the TCS may often be quite inaccurate and thus do not necessarily improve the accuracy of the BT record.

2. There is reason to believe that the majority of BT instruments are accurate to within ± 2°F. without any temperature adjustment.

3. The heavy and growing inflow of BT data requires efficient and standardized processing methods; the computation of a plausible TCS requires a complex processing sequence and greatly increases the required processing effort.

It must be emphasized that all BT's processed by the simplified method are intended to serve as a precise record (within the design limitations of the BT instrument) of the vertical change in temperature; i.e., a precise record of thermal structure and vertical thermal gradients. Further, the processing will not introduce any temperature bias greater than that of the instrument and the relative precision of successive traces in respect to temperature is maintained (provided the instrument bias is constant). Although the processed BT record may not be accurate in respect to the absolute sea temperatures, every effort is made to discern and clearly mark grossly inaccurate records. BT traces that are suspected of differing by more than 5°F. from probable true sea temperatures are specially marked.

Upon request of the data originator, NODC will process his BT's by special methods such as adjustment of individual traces to a precisely determined reference temperature or adjustment by a TCS computed and verified as accurate by the originator.

PROCESSING SEQUENCE

GENERAL. The BT analog processing can be divided into a number of successive steps reflecting the basic operational sequence: Acquisition, initial screening, pre-photography processing, photography, post-photography processing, monitoring, and archiving-distribution. The processing sequence has been formulated to achieve optimum standardization of procedures and optimum use of personnel. Some redundancy has been deliberately introduced, especially in respect to quality control. NODC receives BT's from many activities with widely differing field practices and from all ocean areas (and inland waters) of the world. Undoubtedly, area specialists processing their own data would find portions of this processing sequence superfluous.

During processing at NODC, a number of auxiliary and often ephemeral records are generated. A detailed description of these have not been included in this provisional manual considering that they: (a) are for internal use only; (b) are subject to frequent change or modification; and (c) do not materially affect the processing sequence.

ACQUISITION. Immediately upon receipt of slides and log sheets from the field, the following items are checked.

1. The BT slides referred to on the BT log sheet are compared to the slides actually received. Any missing or broken BT slides are noted as are BT slides for which no log sheet information can be located. This step is much facilitated when the field observer has marked both the glass slides and the BT log sheet in accordance with the instructions on the NODC log. It has been found that the consecutive slide number in conjunction with

time-date entry provides the most positive cross index of slides and related log sheet information. Lack of a time entry on the BT slide and the use of complex, repetitive (non-consecutive) numbering systems make proper identification difficult or impossible.

2. The log sheets are screened for presence of entries vital to processing. These are: BT instrument number, time-date, and position.

3. Identification of the ship(s) and activity operating the ship or collecting the data is determined from the log sheets. For record control and information purposes, the date of receipt of the data, number of potentially usable slides, and inclusive dates of the observations are entered in a master ship file which thus provides for each ship a record of data received for processing and time period of observations.

It should be noted that the box containing the slides can be readily related to the proper log sheets only when the name of the ship and the inclusive dates of the operational period are placed inside the slide box. (Identification on the outside of the package may become illegible in the mails.) A standard mailing label has been designed by NODC for this purpose (Figure 2). When slides are received without ship identification, efforts are made to correlate slides and log sheets based on the number of slides referred to on the log, the time period, and BT instruments referenced. In many cases this introduces considerable additional effort considering that as many as 8,000 slides may be received at NODC in a single month. It is not always possible to identify such information and, in this event, the data cannot be processed.

4. After completion of Steps 1 through 3, an acknowledgment of receipt of the BT slides and log sheets is sent to the originator. The originator is also advised of broken and missing slides and of any problem discerned in the steps above which prevent processing of all or part of the data.

INITIAL SCREENING. This is the beginning of the processing sequence. NODC recognizes that it would be desirable to perform certain steps in this phase, such as grid verification, during the acquisition phase. At times there is a considerable time lag between acquisition and the beginning of production. While it is hoped that this can be done in the near future, present limitation of the staff make the present sequence more compatible with efficient production scheduling.

1. Assignment of NODC BT cruise reference number. As a first step in production, an NODC BT cruise reference number is assigned to a specific batch of data to be processed. In general a "cruise" constitutes an individual shipment of BT data as received from a specific originator. It is at times, however, convenient to process large shipments as several cruises or to combine several small shipments from a single originator as one cruise. The word "cruise" in this context does not, therefore, necessarily refer to a continuous ship's cruise, expedition, or operation. The NODC BT cruise number is the basic reference number for purposes of archiving and retrieval. The cruise number serves also as a "work lot" number; i.e., a cruise moves as a unit through all processing steps described below. At present, the originator's own cruise number, if any, is not retained as part of the

final record. However, to allow for ready identification of data from specific expeditions, it is planned to eventually include this item in the Remarks space of the BT print.

2. Grid verification. BT slides can be processed only if the proper grid is available at NODC. NODC maintains a continually updated file of BT calibration grids which now contains more than 16,000 individual grids (Figure 3). A separate grid index file is maintained to record the initial

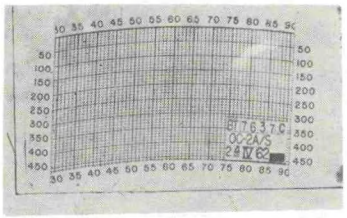


Figure 3. Bathythermograph grid (actual size).

and recalibration date of each BT instrument. The grids carry the same number as the corresponding BT instrument; each recalibration of an instrument results in a new calibration grid distinguished from the others by a letter suffix. Updating of the grid file also entails checking the photographic and technical quality of the grids received.

Although each instrument should have a unique number, some duplication of numbering between instruments of various manufacturers has occurred. This has at times greatly complicated the retrieval of correct grids for processing.

All BT instrument numbers referenced on the log sheets of a cruise are verified by: (a) checking the grid index file to determine whether the instrument referenced was valid at the time of the cruise; and (b) checking the grid file for availability of the grid. (At times instrument numbers scribed

on the BT slide do not match the numbers given on the log; in this case, both are verified.) If, as indicated by the calibration suffix for a specific instrument, the grid referenced on the log was obsolete at the time of the cruise, NODC will process the data (and so note on the BT Summary Card) substituting the correct recalibration grid. Data processing is deferred when a grid more recent than that available at NODC is referenced. If no valid calibration grid for the instrument referenced can be located, data are not processed. The originator is advised by letter of any problem relating to the procurement of the proper grids required to process the data. Originators who have reason to believe that NODC does not have a copy of the grids for the instruments used to procure their data are urged to transmit these grids together with the slides; this will greatly speed processing of the material. Such grids are, upon request, returned to the originator upon completion of processing.

PRE-PHOTOGRAPHY PROCESSING. In this phase of processing, a detailed review is made of each slide and associated log sheet entries and information prerequisite to photography is obtained. The following basic steps are performed. These steps are predicated on the use of NODC's BT log or data form; older forms or forms of other activities often require additional processing steps.

1. Comparison of slide--log sheet entries. The time-date group given on the log is screened for continuity and obviously erroneous entries. The time and date given on each slide are compared with the log entries. If discrepancies of more than 20 minutes are noted, the time on the log sheet

(and eventually on the final analog BT print) is marked doubtful. At this point, the time check serves mainly to verify agreement between the consecutive numbers assigned to the BT slides and associated consecutive numbers entered on the log sheets. (The originator's numbering system is generally retained; only rarely is it necessary, for control during photography, to renumber. When necessary, renumbering is done on both the logs and on the slides.) In the absence of any discrepancy, the time is accepted as given unless an error in the month entry is suspected, in which case the data are not processed.

2. Verification of positional data. The positions of all observations for the cruise are plotted on a plotting chart and if applicable the cruise track (if any) is shown. Suspected erroneous positions are checked, utilizing ship's maximum speed of advance (as given in various reference volumes), time lapse between observations, reported depth to bottom,and, in some cases, thermal structure shown on the slides. In checking speed of advance, the pertinent time entries on the log are rechecked for potential error. It has been NODC's experience that positional errors are very common and much useful data, at times entire cruises, are lost to processing for this reason. Ship's log books are not available at NODC and are not routinely used for the verification of position. A position is in general considered doubtful and is not processed to completion if it is suspected to deviate by more than one degree from the true position. However, certain obviously erroneous entries on the log, such as transpositions of numerals and occasional erroneous designation of hemisphere, are corrected if the applied correction results in a plausible position. The plotted cruise track also serves a

useful function in faciltating the final quality control phase of the BT prints.

3. Surface environmental information. The surface environmental data, including sounding, weather, clouds, etc., are not evaluated for plausibility. These are accepted as given by the originator except for the deletion of entries which are easily distinguishable as incorrect codes or erroneous entries. Attempts to control the quality of these items in the past have revealed a high rate of inconsistencies and implausibilities which could not be readily resolved. Since these items are informational only and are not directly related to the prime data record (i.e., the BT trace), it is felt that the heavy effort required to control the quality of these fields during processing is not justified. It should be noted that the major portion of such data reported in conjunction with BT's is also reported, often at closer time intervals, on various meteorological forms.

4. Set-up determination. This step is primarily designed to facilitate the subsequent photographic processing of the BT slides. It is also the first time in the processing sequence that slides and grids are seen in context and the plausibility of the grid calibration or grid-slide relations can be evaluated.

The grids used in processing BT's at the NODC are not mounted in metal frames as are the grids used at sea. Therefore, to use these unmounted grids, special holders have been constructed which fit on the field viewer in place of the conventional frame of the mounted grid. These holders, similar to those used in the calibration of the original grid, are made of stainless steel and have a heavy, solid-metal, stop pin that is an integral part of the frame. These holders can be adjusted laterally together with the grid

to center the trace and grid together under the lens to minimize parallax. The bottom of this sliding assembly of the grid holder is fitted with double springs which firmly seat the top of both the grid and the slide being viewed against the opposite edge of the sliding assembly. The inner spring holds the grid and the outer spring holds the slide. The left edge of both the grid and slide are seated firmly against the heavy metal stop fixed to the sliding assembly. This stop enables the slide and grid to be placed in the same position each time for viewing.

Before viewing the slides and grids, it is convenient (if more than one instrument is used for the cruise) to sort the slides by instrument number. This permits all slides with one grid to be viewed in context and facilitates photography (see also section on PHOTOGRAPHY).

Each slide is now viewed with its respective grid and (on a special record to be used in photography) the number of feet (or meters or fathoms as applicable to the grid) that the initial point of the trace lies above or below the zero depth line of the BT grid is estimated. By convention, a negative value is used to indicate that the initial point of the trace lies below the zero grid depth line; a positive value indicates that the initial point of the trace lies above the zero depth line of the grid. This value is known as the depth correction or DSP.

If the depth bias is constant, every fifth slide is read for set-up temperature in the following manner: The temperature at the beginning of the trace, at its unadjusted initial depth, is read to the nearest tenth of a degree. If the trace begins above the zero depth grid line, the isotherms of the grid must be visually projected to the initial point of the trace. If the initial point of the trace is indistinct, the set-up temperature is

read at a depth where the trace is clear and preferably nearly isothermal. The set-up depth is then determined by adding the previously determined DSP algebraically. The set-up temperature is also determined for every slide with a change in DSP from the preceding slide.

Slides which require a DSP exceeding eight percent of the grid depth range are not generally processed; excessive depth correction may be an indication of instrument malfunction or the use of an improper grid.

During the slide viewing process, slides that have illegible traces or bear evidence of gross instrument malfunction are removed from processing.

PHOTOGRAPHY. The camera used at the NODC is a modified, commercial, photographic enlarger (Figure 4). The light source is beneath the table;

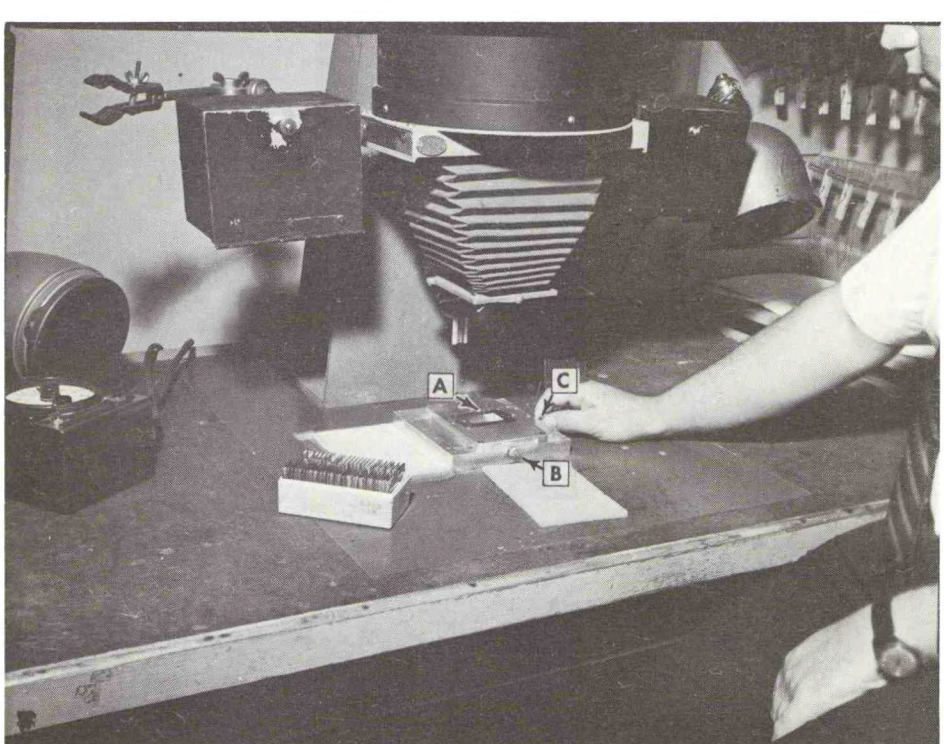


Figure 4. Close-up of camera.

light passes upward first through the grid and then through the superimposed slide (A). The position of the grid may be adjusted by two set screws. One of the set screws (B) moves the grid quasi-parallel to the grid isotherms so that the position of the zero depth line of the grid can be aligned with the initial point of the trace. The other set screw (C) moves the grid quasi-parallel to the depth field and normal to the previous adjustment so that the grid can be adjusted to the set-up temperature determined during the pre-photographic phase.

Before photographing the slide and grid, the set screws are adjusted so that the initial point of the trace falls on the zero depth line of the grid. Additionally, the temperature given at the set-up depth according to the special set-up record prepared in the previous processing steps is attained (See page 11). Slide numbers and instrument numbers are also recorded on this record for additional control during photography. Since the slides have been pre-sorted by grid and are arranged in the order of the set-up record, the camera holder setting is not adjusted until a new set-up depth and/or set-up temperature is given. Each slide inserted into a constant setting of the camera holder is, however, inspected for precise zero depth adjustment of the initial point of the trace. If a zero setting is not obtained, the slide is re-read in the hand viewer and a correct set-up temperature determined.

It should be noted that the present NODC camera slide--grid holder does not allow for any rotational adjustment. Thus, BT grids that have been calibrated without reference to the unmounted edges of the grid calibration slide cannot be processed at NODC at this time. It has also been determined that many copies of recently manufactured grids, while correctly

mounted in the field grid holders, unmounted show a slight degree of skew. This cannot be compensated for with present equipment. If the skew is of such magnitude as to distort the thermal gradient information of the trace (as evidenced by divergence of the grid isotherm and verified isothermal portions of the traces) the slides cannot be processed unless a better copy of the grid can be obtained from the manufacturer.

Photography is completed as follows:

The film is placed on the clear glass top of the camera and a piece of ground glass is placed over it. In addition to holding the film down, this glass plate also serves as a screen for focusing the image. The film is exposed, using a predetermined exposure time and aperture opening and a negative is obtained. The film used at the NODC has a dimensionally stable polystyrene base 0.01 inch thick, of a type such as Kodak Ortho P.B. Type 3, or Di-Noc Dinographic Film PN Ortho or their equivalent. The film is cut to 3" x 5" size by the manufacturer.

The most useful negative is one that has high contrast and clarity between the trace and the grid. Sometimes very dark slides or very faint grids must be processed. In this case, the film is first exposed with the slide superimposed upon the grid; then the slide is removed and the film exposed to the grid for a short period of time in order to "burn" the grid into the film. The film is developed according to the manufacturer's instructions, using standard darkroom procedures.

POST-PHOTOGRAPHY PROCESSING. In this phase of processing, the photo negatives and the related information from the log sheet are recombined into a single record and the initial 3" x 5" analog ozalid print is produced.

The following operations are performed.

1. Negative editing. Each negative is inspected for photographic quality, zero depth adjustment, verification of set-up temperatures, and use of proper grids.

2. Computation of temperature means. For each BT instrument used during the cruise, BT and reference temperature means are computed. The BT surface temperatures are read from the photo negative with a precision of 0.1°; the surface reference temperature is obtained from the log. If the units of reference temperature differ from the grid temperature units, the reference mean temperature is converted to the units of the grid. If there are less than twelve observations from a BT instrument, means are not computed. "Insufficient observations for computing temperature means" is typed in the space where the temperature means normally would appear on the BT print. Only paired temperature values are used in the determination of the means. If a BT observation does not have an associated surface reference temperature, or if the reference temperature is doubtful, the BT surface temperature associated with the missing or doubtful reference temperature is omitted from the mean.

There are instances when surface reference temperatures are obtained by two or more methods while the same BT is being used. When surface reference temperatures are taken by both bucket and injection thermometers, either a bucket or injection thermometer reference temperature mean is computed, depending upon the percentage of reference surface temperatures taken by each method. If thirty percent or more of the reference temperatures were taken by a bucket thermometer, the bucket temperatures are used

in the calculation of the surface reference temperature mean. The BT surface mean is then based only on those observations that had an associated bucket reference temperature. If seventy percent or more of the reference temperatures were taken by an injection thermometer, the injection temperatures are generally used in the calculation of the reference temperature mean. The reference mean on such prints will be followed by a B or K, respectively, to indicate the source of the reference mean.

The inclusion of the temperature means on the BT print is intended to provide the user with information on the average relationship between the BT instrument temperatures and the reference temperatures; when BT's are read in geographic context rather than in cruise sequence, it serves to qualify the individual difference between the individual reference temperature and the surface temperature of the trace. Further, if the reference temperature is deemed precise by the user, the difference between the means serves as a crude approximation of the TCS; i.e., as an indication of instrument bias. As noted earlier, when large discrepancies occur between the temperature means, an effort is made to determine the relative reliability of the two records. If the reference mean is believed to be in error, it is marked with a question mark on the final print. If, however, the BT is suspected of large bias (> 5°F.), the negatives are not processed. It has been found that BT's with large temperature bias may also be inaccurate in respect to vertical temperature differences.

3. Negative inspection. At this stage in processing, the negatives are also inspected for evidence of incompletely inserted slides. Such slides have a temperature bias differing from the instrument bias. In many cases, incomplete insertions, in areas with uniform thermal structure, can be

searched for by overlaying of negatives of successive observations. If a particular trace is uniformly offset in temperature at all depths by more than 1°F. and if no similar shift can be observed in the reference temperature of the offset trace, the slide is rephotographed with an additional temperature adjustment to bring it in line with the other prints. The additional temperature correction is referred to as a TSP (temperature correction special) and is noted on the final BT print. In many cases, however, with the inadequate information available to NODC, incomplete insertions cannot be detected or positively identified during processing. Further processing is also suspended at this stage for prints with evidence of excessive hysteresis in the thermal element of the BT. In general, if a dual trace extends over the entire length of the record and the separation of traces amounts to more than 1°F. at near-isothermal portions of the record, it is not processed.

4. Processing of BT print information. Using the log sheets and various work sheets and notations generated during processing, the various identifying and informational entries provided for on the back of the analog print (shown in Appendix III) are entered on specially designed velum. The nature of entries, units, and codes currently used are also given in Appendix III. After completion, the velum is stapled to its corresponding negative.

5. Proofing. All items appearing on the velums are line-proofed against the entries on the various logs and work sheets.

6. Cruise Summary Card. The cruise summary card shown in Appendix IV summarizes pertinent data concerning the BT cruise as it is archived at

NODC. A copy of the cruise summary card is transmitted with the data to the originator and serves as the official notification of completion to the processing of the cruise, NODC BT cruise number assigned, and number of slides processed. Consecutive numbers of slides not processed are shown in the appropriate category.

7. Ozalid. A preliminary ozalid print is prepared by inserting a 3" x 5" plastic-coated ozalid card, sensitized on both sides, between the negative and the velum, and passing it through the ozalid reproducer. Checking of the quality of the resultant ozalid print and assembly of prints in the original cruise sequence completes the post-photography phase of processing.

MONITORING

This phase is a final quality control routine prior to acceptance of the prints for archiving and distribution. The prints and all material generated during processing are reviewed by an experienced oceanographer. Mainly, two basic items are checked: (a) A general review of the processing steps and the correctness of decisions made during processing. The latter includes review of doubtful position, TSP adjustments, etc.; and (b) an evaluation of the oceanographic plausibility of the thermal structure appearing on the processed prints. Although this review is by necessity based on subjective judgment, use is made of available reference materials such as atlases, various archive products filed at NODC, and the geographically and time-sorted file of 1,000,000 BT prints covering all ocean areas. In no case, however, are data rejected because they do not fit a preconceived model. BT prints are rejected only if it can be clearly demonstrated that the implausibilities result from use of or reference to a wrong grid, incorrect location or time entry on the original log, or BT malfunction.

As an aid in determining plausibility of thermal structure of the analog BT print, NODC is developing, in conjunction with its BT digitization program, automated quality control models. It is hoped that with the growth of the digital BT files, envelopes of thermal gradients and temperatures for prescribed ocean areas can be generated by the computer; and that these will put quality control of analog BT prints on a more objective basis.

ARCHIVING AND DISTRIBUTION

Upon release of the cruise by the monitors, additional ozalid copies of the BT prints are prepared. One set of the BT prints is sent to the originator; additional copies are sent to various agencies with whom NODC has standing exchange agreements. One set of prints is sorted geographically and filed in the geographic master file of BT prints at NODC. The photo negatives and velums are archived in cruise sequence. Log sheets and all work sheets generated during processing are also retained. All glass BT slides are at present filed by cruise; eventually, however, space limitations may necessitate discarding of glass BT slides from processed BT cruises after a suitable time lapse.

APPENDIX I

BATHYTHERMOGRAPH DATA FORM

NATIONAL OCEANOGRAPHIC DATA CENTER
WASHINGTON, D. C. 20390

VESSEL	CRUISE	INSTITUTE (ACTIVITY)	COUNTRY	SHEET NO.

REMARKS

1 BT INSTRUMENT NUMBER and LETTER (Prefix and or Suffix)	2 CONSEC. SLIDE NUMBER	3 DATE			4 TIME		5 LATITUDE			6 * LONGITUDE			7 SOUNDING DEPTH	8 WIND		9 AIR TEMPERATURE °F. ☐ °C. ☐		10 BAROMETER (Mbs.)	11 WEATHER	12 CLOUD		13 WAVE		14 REF. TEMP.	
		DAY	MONTH	YEAR	HOUR	MIN.	°	′	N S	°	′	E W	Fms. ☐ M. ☐	DIR.	SPEED	DRY BULB	WET BULB			TYPE	AMT.	HEIGHT Ft. ☐ M. ☐	PERIOD (Sec.)	*CODE	°F. ☐ °C. ☐

NODC-EXP-3167/24 (3-64)

REF. TEMP. CODE: *1. BUCKET, 2. INJECTION, 3. REVERSING THERMOMETER, 4. THERMOGRAPH.

APPENDIX II

NATIONAL OCEANOGRAPHIC DATA CENTER
BATHYTHERMOGRAPH LOG

PRNC-NODC-3167/10 (4-63)

THIS LOG REPLACES BATHYTHERMOGRAPH RADIO LOG PRNC NHO 3167/35 AND OCEANOGRAPHIC LOG SHEET B PRNC-NHO 3167/2 (rev 10-58)

VESSEL	CRUISE	INSTITUTE (ACTIVITY)	COUNTRY	SHEET NO.

RADIO TRANSMIT SHADED PORTION ONLY

1 BT INSTRUMENT NUMBER and LETTER (Prefix or Suffix)	2 CONSECUTIVE SLIDE NUMBER	3 DATE: DAY	MONTH	YEAR	4 BATHY	5 DAY OF WEEK (Y)	6 OCTANT OF GLOBE (G)	7 LATITUDE: °	′	N S	8 LONGITUDE: °	′	E W	9 TIME: HOUR (G G)	MIN.	10 SOUNDING DEPTH: Fathoms ☐ Meters ☐	11 WIND: DIR.	SPEED (Knots)	12 AIR TEMPERATURE: °F ☐ °C ☐ DRY BULB	WET BULB	13 BAROMETER (Mbs.)	14 WEATHER	15 CLOUD: TYPE	AMT.	16 WAVE: HEIGHT Ft ☐ M ☐	PERIOD (Sec.)	17 SEA SURFACE REF. TEMP.: *CODE	°F ☐	°C ☐

BATHYTHERMOGRAPH READINGS FROM SLIDE — TRANSMITTED, DATE-TIME

DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	END MESSAGE
Z_o Z_o	T_o T_o T_o	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	1 9 9 9 1

1 BT INSTRUMENT NUMBER and LETTER (Prefix or Suffix)	2 CONSECUTIVE SLIDE NUMBER	3 DATE: DAY	MONTH	YEAR	4 BATHY	5 DAY OF WEEK (Y)	6 OCTANT OF GLOBE (G)	7 LATITUDE: °	′	N S	8 LONGITUDE: °	′	E W	9 TIME: HOUR (G G)	MIN.	10 SOUNDING DEPTH: Fathoms ☐ Meters ☐	11 WIND: DIR.	SPEED (Knots)	12 AIR TEMPERATURE: °F ☐ °C ☐ DRY BULB	WET BULB	13 BAROMETER (Mbs.)	14 WEATHER	15 CLOUD: TYPE	AMT.	16 WAVE: HEIGHT Ft ☐ M ☐	PERIOD (Sec.)	17 SEA SURFACE REF. TEMP.: *CODE	°F ☐	°C ☐

BATHYTHERMOGRAPH READINGS FROM SLIDE — TRANSMITTED, DATE-TIME

DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	END MESSAGE
Z_o Z_o	T_o T_o T_o	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	1 9 9 9 1

1 BT INSTRUMENT NUMBER and LETTER (Prefix or Suffix)	2 CONSECUTIVE SLIDE NUMBER	3 DATE: DAY	MONTH	YEAR	4 BATHY	5 DAY OF WEEK (Y)	6 OCTANT OF GLOBE (G)	7 LATITUDE: °	′	N S	8 LONGITUDE: °	′	E W	9 TIME: HOUR (G G)	MIN.	10 SOUNDING DEPTH: Fathoms ☐ Meters ☐	11 WIND: DIR.	SPEED (Knots)	12 AIR TEMPERATURE: °F ☐ °C ☐ DRY BULB	WET BULB	13 BAROMETER (Mbs.)	14 WEATHER	15 CLOUD: TYPE	AMT.	16 WAVE: HEIGHT Ft ☐ M ☐	PERIOD (Sec.)	17 SEA SURFACE REF. TEMP.: *CODE	°F ☐	°C ☐

BATHYTHERMOGRAPH READINGS FROM SLIDE — TRANSMITTED, DATE-TIME

DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	END MESSAGE
Z_o Z_o	T_o T_o T_o	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	1 9 9 9 1

1 BT INSTRUMENT NUMBER and LETTER (Prefix or Suffix)	2 CONSECUTIVE SLIDE NUMBER	3 DATE: DAY	MONTH	YEAR	4 BATHY	5 DAY OF WEEK (Y)	6 OCTANT OF GLOBE (G)	7 LATITUDE: °	′	N S	8 LONGITUDE: °	′	E W	9 TIME: HOUR (G G)	MIN.	10 SOUNDING DEPTH: Fathoms ☐ Meters ☐	11 WIND: DIR.	SPEED (Knots)	12 AIR TEMPERATURE: °F ☐ °C ☐ DRY BULB	WET BULB	13 BAROMETER (Mbs.)	14 WEATHER	15 CLOUD: TYPE	AMT.	16 WAVE: HEIGHT Ft ☐ M ☐	PERIOD (Sec.)	17 SEA SURFACE REF. TEMP.: *CODE	°F ☐	°C ☐

BATHYTHERMOGRAPH READINGS FROM SLIDE — TRANSMITTED, DATE-TIME

DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	DEPTH	TEMP.	END MESSAGE
Z_o Z_o	T_o T_o T_o	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	Z Z	T_z T_z T_z	1 9 9 9 1

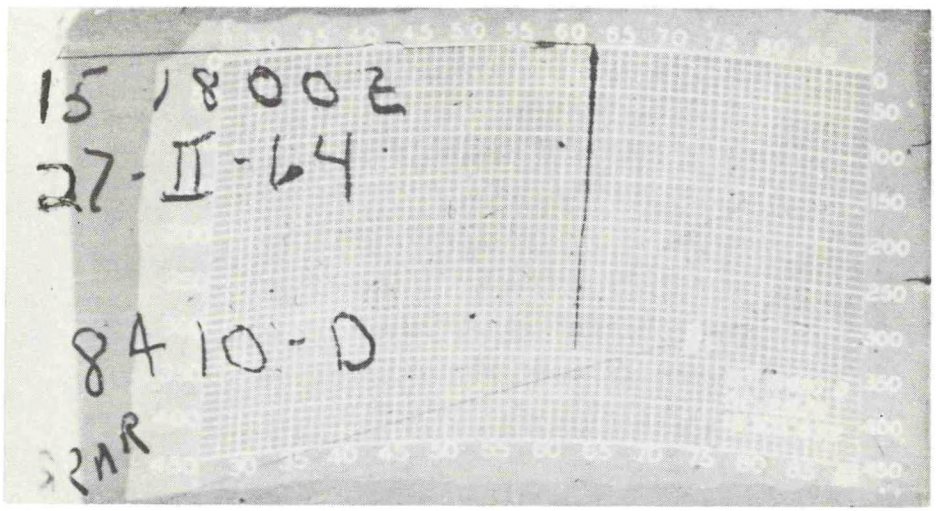
REMARKS:

*REF. TEMP. CODE: xx = Bucket °F, yy = Bucket °C, 98 = Injection° C, 99 = Injection °F, 88 = Thermograph °C, 78 = Reversing Thermometer, 68 = Electronic BT, 58 = Other.

(SEE INSTRUCTIONS ON COVER)

APPENDIX III

BATHYTHERMOGRAPH PRINT



CRUISE	NUMBER	DAY	MONTH	YEAR	G. M. T.	KEY
6061	15.	27	II	64	1800	31172E

VESSEL

USCGC WINNEBAGO

LATITUDE	LONGITUDE	DEPTH (FM.)	SPEED (KT.)	SURF. TEMP.
31°25' N	172°47' E	2975		62.8 B

WIND °		AIR TEMP		BAR. (M. B.)	WEA.	CLOUDS		VIS.	SEA	WAVE	
DIR.	SPEED	DRY	WET			TYPE	AMT.			HT	PER
02	16	58.8	54.7	16	2	6	8			08	08

TCS	DCS	0	30	50	100	150	200
0	1						

250	300	330	400	490	500	600	655	700

800	820	900	CLASS-	S.L.	MAX. +	REMARKS
						DSP -1'

Mean Temps: BT 58.4 Ref. 58.8

CODES GIVEN IN H.O. PUB. NO. 606-C BT DATA SHEET NHO-NODC-3167/7 (REV. 10-61)

BT OZALID CARD

A format for BT prints was revised in October 1961. Each entry of the format has been explained below to assist understanding of the print. This appendix assumes some previous knowledge by the reader, and basically limits itself to the differences that can appear on the BT print.

EXPLANATION OF ENTRIES ON BT PRINT

Cruise: NODC BT Cruise Number.

Number: NODC Consecutive Slide Number.

Day: The day in which the BT was taken according to GMT.

Month: The month in which the BT was taken according to GMT. The month is reported in Roman numerals.

Year: The year in which the BT was taken according to GMT.

GMT: Greenwich Mean Time of the BT lowering. Hour and minutes reported or hour and tenths.

Key: The first two numbers represent the latitude and the last three numbers the longitude in whole degrees. No hemisphere entry is given for north and west. S and E are entered for south and east. This number conforms to the filing systems used at certain institutions.

Vessel: Name and prefix of vessel or platform.

Latitude: The latitude is given in degrees and minutes or degrees and tenths. (Tenth of degrees are preceded by a decimal point.)

Longitude: The longitude is given in degrees and minutes or degrees and tenths. (Tenth of degrees are preceded by a decimal point.)

Depth: Sounding reported in fathoms; when given in meters, postscript M is given.

Speed (KT.): Speed that the vessel was making when BT was lowered. This field is not reported when NODC logs are used.

Surf. Temp.: Surface temperature reported in degrees Fahrenheit or Centigrade. If reported in Centigrade, °C. is entered. Notation B = bucket determination, K = injection intake reading, R = reversing thermometer, TG = thermograph.

Wind (Dir. - Speed): The wind direction is to the nearest ten degrees, in accordance with WMO Code 0877. The wind speed is in knots. When wind force is given in Beaufort Scale, b is suffixed.

Air Temp (Dry - Wet): Dry and wet bulb reading in Fahrenheit or Centigrade. Centigrade in noted by °C.

Bar (M.B.): Reported in millibars. Only tens and units (and tenths if available) are entered.

Wea: Present weather reported in accordance with WMO Code 4501.

Clouds (Type - Amt): The clouds reported using WMO Code 0500. The amount of cloud coverage reported using WMO Code 2700.

Vis.: The visibility is reported using WMO Code 4300.

Sea: The Sea State is reported using WMO Code 3700.

Wave (Ht - Per): Height of the waves reported in feet or meters. When in meters, an M will be suffixed. Period is reported in seconds.

TCS: Not generally given. When given, it is in degrees Fahrenheit or Centigrade depending upon the units of the grid.

DCS: The DSP is now entered in this field. Depth correction to the individual slide reported in feet, meters, or fathoms depending upon the units of the grid. The spaces following the DCS are for the convenience of those recipients who wish to enter BT temperatures read at BT standard depth levels. This information is not entered by NODC.

Remarks: Temperature means and special remarks are entered on the bottom line.

APPENDIX IV

BATHYTHERMOGRAPH CRUISE SUMMARY CARD

NODC

BATHYTHERMOGRAPH CRUISE SUMMARY

CRUISE NO:	VESSEL:
BT NO:	CONSEC. SLIDE NO:
	NO. MISSING:
	NO. RECEIVED:
	*NO. UNUSABLE:
	NO. DISTRIBUTED:

REMARKS:

PERIOD AREA

*CODE & CONSEC SLIDE NO. ON REVERSE SIDE OF CARD

CODE	CONSEC. SLIDE NO.
B— Slide Broken:	
BT-BT Malfunctional:	
D— Excessive Depth Error:	
G— Grid Not Available:	
H— Excessive Hysteresis:	
M— Slide Missing:	
O— Observations Not Taken:	
PD-Position Doubtful:	
U— Trace Unreadable:	
X— No Position Given:	

NODC-3167/7 (Rev. 1-64)

National Oceanographic Data Center
Manual for Processing Bathythermograph Data, Part II, Procedures for Processing Bathythermograph Data in Analog Form (Provisional). Publication M-3, Part II in NODC Manual Series. 1964.

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