TR-37

TECHNICAL REPORT

PROCESSING BATHYTHERMOGRAPH DATA AT THE HYDROGRAPHIC OFFICE

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U. S. NAVY HYDROGRAPHIC OFFICE
WASHINGTON, D. C.

ABSTRACT

Since the beginning of the U. S. Navy's expanded bathythermograph (BT) program, in 1941, the system of processing the data has changed very little. Log sheet data were slowly and laboriously hand copied onto the bathythermogram prints. Slides and log sheets were the only negatives. In 1955 a new method was developed and put into operation at the Hydrographic Office which places all the BT slide and log sheet data onto 35-mm. motion picture film. Any number of prints can be made, and the film can be used for automatic transcription onto punch cards.

FOREWORD

The adoption of the method of bathythermograph processing described herein makes it possible for one central agency to conduct all the various phases of collecting, evaluating, and compiling the data observed by a wide variety of cooperating vessels, at a considerable saving over the procedures heretofore employed.

The growing bulk of bathythermograms now on hand, together with the increased observational activity anticipated in the immediate future indicates the desirability of establishing procedures, such as authorized herein, that will permit the rapid and economical processing of these data.

J. B. COCHRAN
Captain, U. S. Navy
Hydrographer

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A. INTRODUCTION

In 1941 the U. S. Navy expanded the program for taking bathythermograph (BT) observations. As a result, a system of processing these observations was developed at Woods Hole Oceanographic Institution and at the University of California, Division of War Research, San Diego. This method has been followed with few modifications to the present time. In general, it consists of 4 steps: (1) recording; (2) plotting; (3) photographing (printing); and (4) transcribing. These steps are briefly described as follows:

1. Recording consists of assigning a file designation or cruise number and checking the slides and log sheets for proper entry of date and other required information.

2. Plotting consists of plotting the position of each observation and correcting the log sheet when necessary.

3. Photographing (Printing) is carried out by superimposing a transparent temperature depth grid on a slide and adjusting the relative positions of the grid and slide to correct for any instrumental error. The superimposed grid and slide are used as a negative in making the photographic prints (LaFond, 1951).

4. Transcribing is the most time consuming of all steps (Leipper, 1948). It consists of stamping the back of each print to provide spaces for entering pertinent meteorological and other data. Then log sheet data are copied by hand onto the back of each print.

The stamping was eliminated in 1950 when imprinted photographic paper became available (Schroeder, 1955).

In 1947 a transparency method was proposed by Scripps Institution of Oceanography in which the slides were imposed upon transparent sensitized paper (Leipper, 1947). A space was provided on an unused portion of the slide and grid where the log sheet data were inserted and exposed separately. The transparent paper was then developed in the usual manner and additional prints could be made by contact printing. A negative became available by this method to make additional prints that required no additional transcribing of data. Initial transcribing was necessary in preparation of the negative. The method apparently was never extensively used.

In 1953 a recording camera for reproduction of BT slide data was developed by the Navy Underwater Sound Laboratory (Selvidio, 1953). This type of light, portable equipment is very useful at sea. It uses a small 35-mm., 36-exposure still camera for photographing the slide and grid. The developed film can be viewed

through a microfilm reader or a 35-mm. projector. Individual frames may be cut from the film strip and inserted into electronic accounting machine (E.A.M.) punch cards for filing. Station number, Greenwich mean time, and sonic information are punched onto the E.A.M. card. However, none of the pertinent log sheet information was included.

The same year, the Navy Electronics Laboratory developed a similar type of light, portable copy camera (Schaniel, 1953). This camera utilizes a Polaroid Land-back camera. This further reduces the time required to obtain finished prints but does not produce negatives suitable for reproduction or filing. Although this camera is useful at sea for rapid photographing of prints, no provision is made for transcribing the log sheet data.

Since early in 1954 a new method has been in use at Woods Hole Oceanographic Institution, which utilizes an ammonia vapor (ozalid) processing method of producing multiple prints (Schroeder, 1955). This excellent method provides a type of negative to reproduce the data on both sides of the prints, thus considerably reducing the time previously required to prepare prints and hand-copy data onto the back of each. It is necessary to copy the data only once for each slide.

In 1955 the Hydrographic Office together with the Naval Research Laboratory developed a method for photographing the BT slide, grid, and the pertinent line of log sheet data in a single operation. This recorder-camera was designed and built by N. R. L. It is described in section B.(3). below.

B. PROCESSING BATHYTHERMOGRAPH DATA AT THE HYDROGRAPHIC OFFICE

1. Receiving and Logging Bathythermograph Observations

As is indicated by the flow chart (fig. 1), the greatest portion of bathythermograph slides and log sheets are received from the following sources:

a. U. S. Navy ships
b. Hydrographic and Oceanographic Survey ships
c. Weather ships
d. Other U. S. and foreign government agencies and private institutions

After the log sheets and slides are received at the Hydrographic Office they are logged in and assigned a priority number and a consecutive file, or cruise number. The log sheets are filed in manila folders upon which a form has been printed that is used to record evaluation of condition of the slides and log sheets and the progress of the processing. A ship record is maintained in a Kardex file with one card for each observing ship. On each card is recorded the following information:

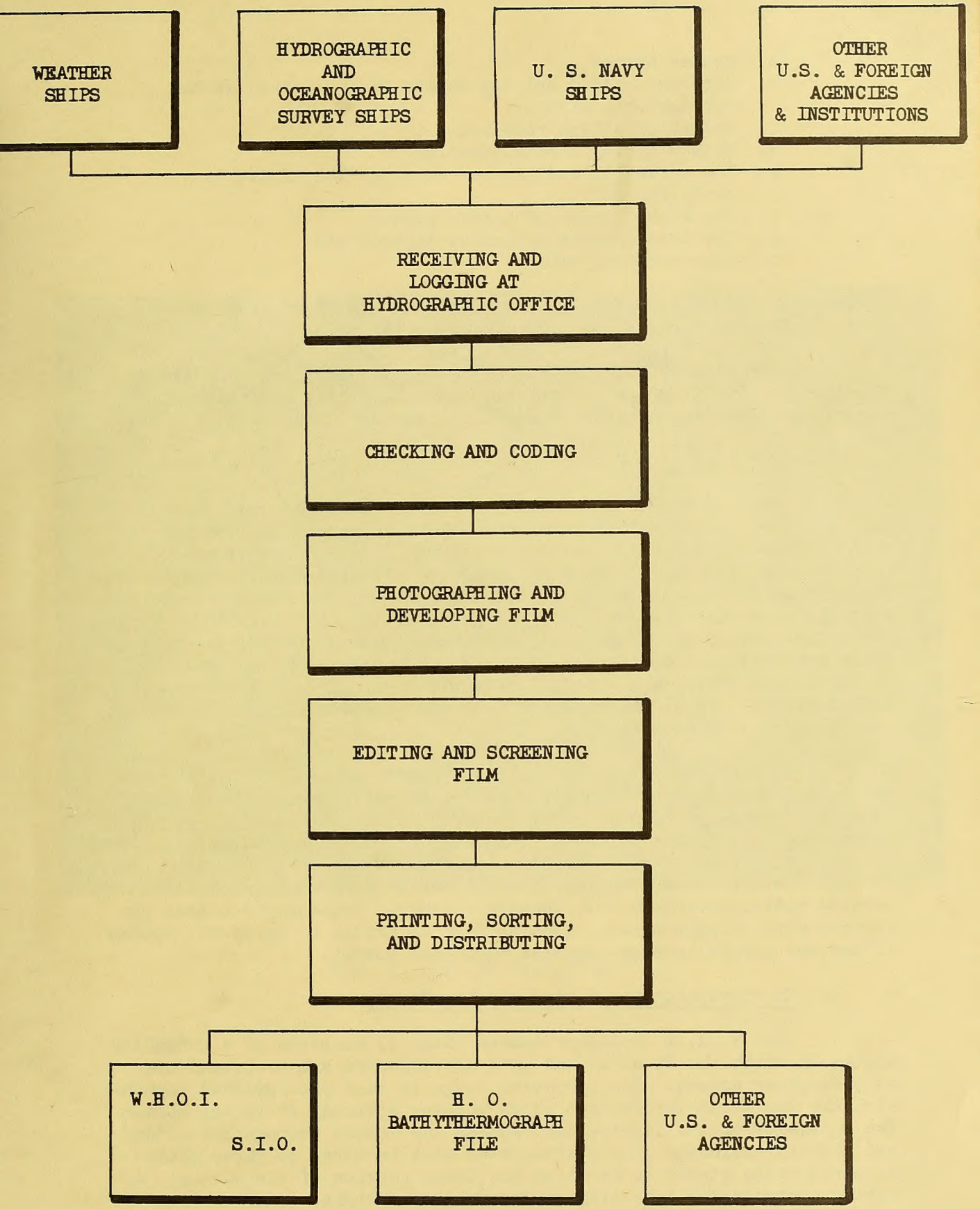

FIG. 1. GENERAL FLOW CHART
BT Data Processing

a. Cruise number
b. Date the slides and log sheets were received at the Hydrographic Office
c. Number of slides received
d. Number of log sheets received
e. The microfilm reel number on which the cruise is photographed
f. The final number of usable prints
g. The total number of prints distributed
h. Any pertinent remarks

A file is maintained for all reports and other correspondence received from and transmitted to each observing ship.

A master file of bathythermograph grids (fig. 2) has been set up in which nearly 14,000 grids have been sorted, filed, and indexed according to instrument model numbers and serial numbers.

2. Checking and Coding the Log Sheets and Slides

The log sheets are checked for correctness of position quadrants and associated meteorological data. Those observations that have been incorrectly coded are recoded. In the photographic process used, the log sheet is photographed with the slide and grid. It has been found that the usual method of making red pencil corrections directly above the original data is confusing and difficult to read on the bathythermograms. Therefore, a method is used in which the corrections are made on a corresponding log sheet column. The columns are then cut into strips and attached over the original data by means of rubber cement. Thus, the original data are preserved and the strip can be removed if desired.

The slides are checked against the log sheets and, where required, corrections are made for slide numbers, times, dates, and BT instrument numbers. Cruise numbers are not added to the slides as they appear on the log sheet heading strip at the top of each bathythermogram.

Slides that are fogged are placed in a defogging box containing cotton saturated with lacquer thinner. Unlacquered slides are sprayed with a light plastic coating such as Krylon or Spray-It. Broken slides are carefully edge-cemented with Duco cement.

3. Photographing the Slides and Log Sheets

The N. R. L. recorder-camera (fig. 3) consists of a projector system in which the BT slide and grid are inserted and projected onto an opal-glass screen. The projected image is then photographed together with the log sheet information which appears directly above the screen. The intensity of the light which reaches the screen through the slide and grid is indicated on a microammeter that is wired to three photoelectric cells placed in front of the lower portion of the screen. A variac controls the intensity of the projector light.

Fig. 2. The BT Grid File

Fig. 3. The BT Recorder-Camera

Directly above the screen, onto which the slide and grid are projected, is a long narrow slot the length and width of a single line of the BT log sheet. Behind the slot is a roller system, similar to that of a typewriter, which holds the log sheet in position for photographing. Immediately above the slot are two channels into which are inserted strips of paper on which are printed the log sheet headings and the data column headings.

A constant intensity lumiline-type lamp is used to illuminate the log sheet information. The log sheet headings are filled out before insertion to show the assigned file or cruise number, the sheet number, name of the ship, month, year, time zone, and survey cruise name or number if given. A space for writing in the key number on the finished print is provided at the right-hand end of the strip. Facing this data setup is mounted a Bell and Howell, Eyemo, 35-mm. motion picture camera. It is electrically operated and automatically advances the film and resets the shutter as each photograph is taken. The type of film used is extremely fine grain panchromatic Micro-file. It is loaded on number 10 spools in 100-foot lengths. Approximately 1500 slides can be photographed on each spool. About 400 slides a day can be filmed.

Briefly, the operating procedure is as follows: After loading the camera with film, the log sheet heading strip is filled out to provide the same information as given on the log sheet. It is inserted into the top channel. The log sheet is inserted into the roller assembly and the data line corresponding to the first slide to be photographed is aligned to show in the slot. The data heading strip, showing the proper geographic quadrants, is inserted into the center channel and aligned with the log sheet columns. The BT grid is placed in a long handled frame (fig. 4) and inserted into a vertical stage. Fine positioning adjustments to the grid can be made both vertically and horizontally by means of thumbscrews. In a similar manner, the slide is inserted into a second stage immediately behind the grid in such a manner that the smoked surface of the slide and the emulsion surface of the grid are nearly in contact. Parallax is thus reduced to a minimum. The BT slide stage is also adjustable both vertically and horizontally. The slide is adjusted horizontally to bring the trace at the 50-foot level to the corrected "set-up temperature", by the method described in H. O. Pub. No. 614, Processing Oceanographic Data. It is adjusted vertically so that the surface trace is aligned with the surface (zero) depth line of the grid.

These adjustments are viewed on a mirror by the operator. The mirror is on hinges inside the recorder between the screen and the camera. A lever raises the lid of the viewing port in the top of the recorder casing and the mirror simultaneously. The lid of the viewing port is opened and the mirror is raised to the proper angle by a single motion of the lever. When the mirror is positioned, the log sheet, data column headings, and the log sheet heading strips are easily visible along with the projected image of the slide and grid. After the necessary alignments have been made, the lid is closed and the mirror lowered out of range of the camera by moving the lever forward.

Fig. 4. The BT Grid and Slide Frames

The light intensity of the projector is then adjusted to the required meter reading as indicated by the photoelectric cells. These three cells are located in front of the slide and grid screen just out of range of the camera. The photograph is taken when the operator presses the camera shutter control button located in the top of the lever handle. A check on the possible changes of strength, or aging, of the photoelectric cells is maintained by photographing a neutral density filter at a known light setting. This is then inspected in a densiometer after the film is developed. A neutral density filter is photographed at the beginning and end of each reel of film. It is mounted in a frame similar to that used for the BT grid and is inserted into the grid stage for photographing.

Before photographing a cruise, a slide is shot which shows the cruise number. Another slide is shot which indicates the number of prints to be made of each bathythermogram. Thus, the operator of the high speed printer is informed of the beginning and ending of each cruise and the varying number of prints to make as he advances the film through the printer. The cruise number provides a quick reference when inspecting film in a reader.

4. Editing and Screening the Film

After the film has been developed, it is inspected, frame by frame, in a Recordak Microfilm reader (fig. 5). Any errors that may have occurred in the photographing are marked during this inspection and cut out of the film. The film is then spliced and is ready for printing.

5. Processing the Bathythermogram Prints

The bathythermograms are made on an enlarging strip paper printer called a Pakomatic printer (fig. 6). This high speed printer uses roll paper in lengths up to 1,000 feet. The paper used for bathythermograms is a low contrast, semimatte type known as Resisto-Rapid. It is cut in 500-foot lengths, $4\frac{1}{2}$ inches wide. Because of the developing process now being used, it is only slightly heavier than single weight paper. It has a plastic backing to reduce absorption of water during the developing.

The Pakomatic printer is located in the darkroom adjacent to the developer. The paper is loaded into a large drum or magazine. The magazine is mounted on the upper left hand part of the printer and the paper is threaded over a series of rollers which holds it in the proper position on the paper carriage for making the exposures. It is then threaded around another roller and onto a windup reel. Exposure is automatically controlled by a photocell, with provisions for modification of the photocell readings according to the operator's judgement. (Pako Corp., 1955). As each exposure is made, a small knife makes a half inch cut in the paper at the center of the strip midway between consecutive prints. These cuts are three inches apart. They

Fig. 5. Editing the Film

Fig. 6. The Pakomatic Printer

provide the trigger for the automatic cutter to separate the individual prints from the roll after it has been developed and dried.

The exposed paper is developed, fixed, washed, and dried in a continuous system (fig. 7) of the type used for processing V-mail during World War II. This equipment has been at the Hydrographic Office for several years. No modifications were necessary to adapt it for BT print processing. It is still used for other work when BT prints are not being processed. The paper is attached to a 72-foot leader strip which threads it over and under a series of rollers. The paper is thus lead up and down into the succeeding tanks which contain developer, fixer, and wash water. The temperatures of the solutions are thermostatically controlled. From the tanks the paper is fed directly onto the drying drum and finally comes off the drum ready for the automatic cutter.

The dried paper is cut into individual prints by a Pakoline cutter (fig. 8). As processed dried prints are automatically fed through the cutter, the slit made by the printer accurately positions each print for cutting. Constant operating speed allows the operator sufficient time to check each print. As the slit in the paper strip reaches the cutter bar, a feeler spring is triggered by the slit in such a manner that the cutter bar cuts the paper exactly at the slit. The severed print then falls into a tray and is ready for sorting, checking, and distributing to the various agencies.

6. Production Capacities of the Processing Equipment

Test runs of the various pieces of equipment show that they can process the following number of checked and correct slides and log sheets and bathythermogram prints per day:

BT Recorder-Camera	- - - - - - - - -	400 slides/day
Pakomatic Printer	- - - - - - - - -	2,000 prints/day
V-Mail Developer-Dryer	- - - - - - - - -	6,000 prints/day
Pakoline Cutter	- - - - - - ---	-32,400 prints/day

Each of these figures is for the average daily capacity of the particular machine and does not take into consideration the number of personnel available or the fact that one person may be called upon to operate more than one machine. Time required for mixing chemicals, heating solutions in the tanks, cleaning equipment, sorting slides and selecting grids was included.

7. Estimate of Costs

As the processing of BT data has not been in progress long at the Hydrographic Office, the following costs are based on an estimate of processing 38,300 slides and 153,200 prints per year. The number of slides is an average of the totals received at the Hydrographic Office during the years 1953, 1954, and 1955.

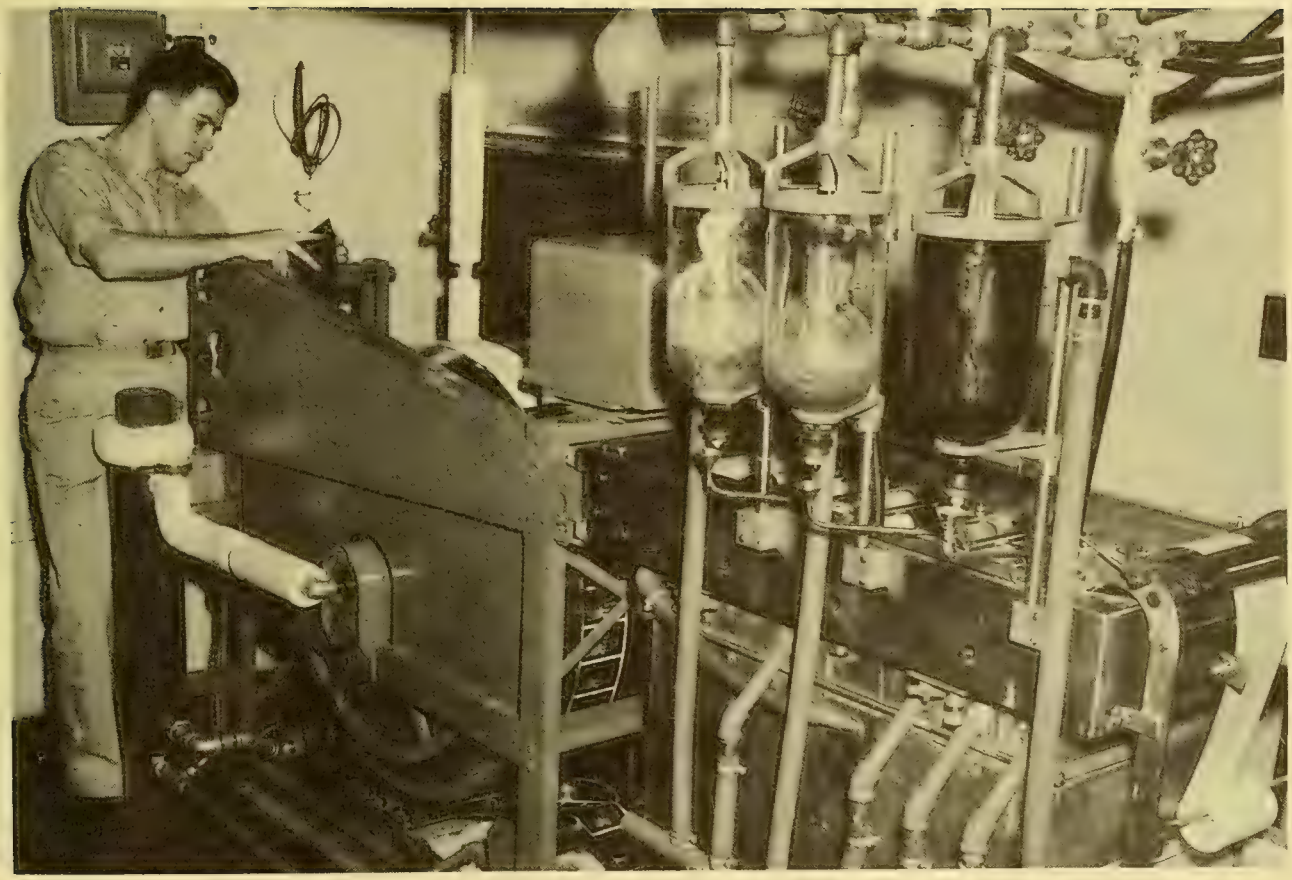

Fig. 7. The V-Mail Developer-Dryer

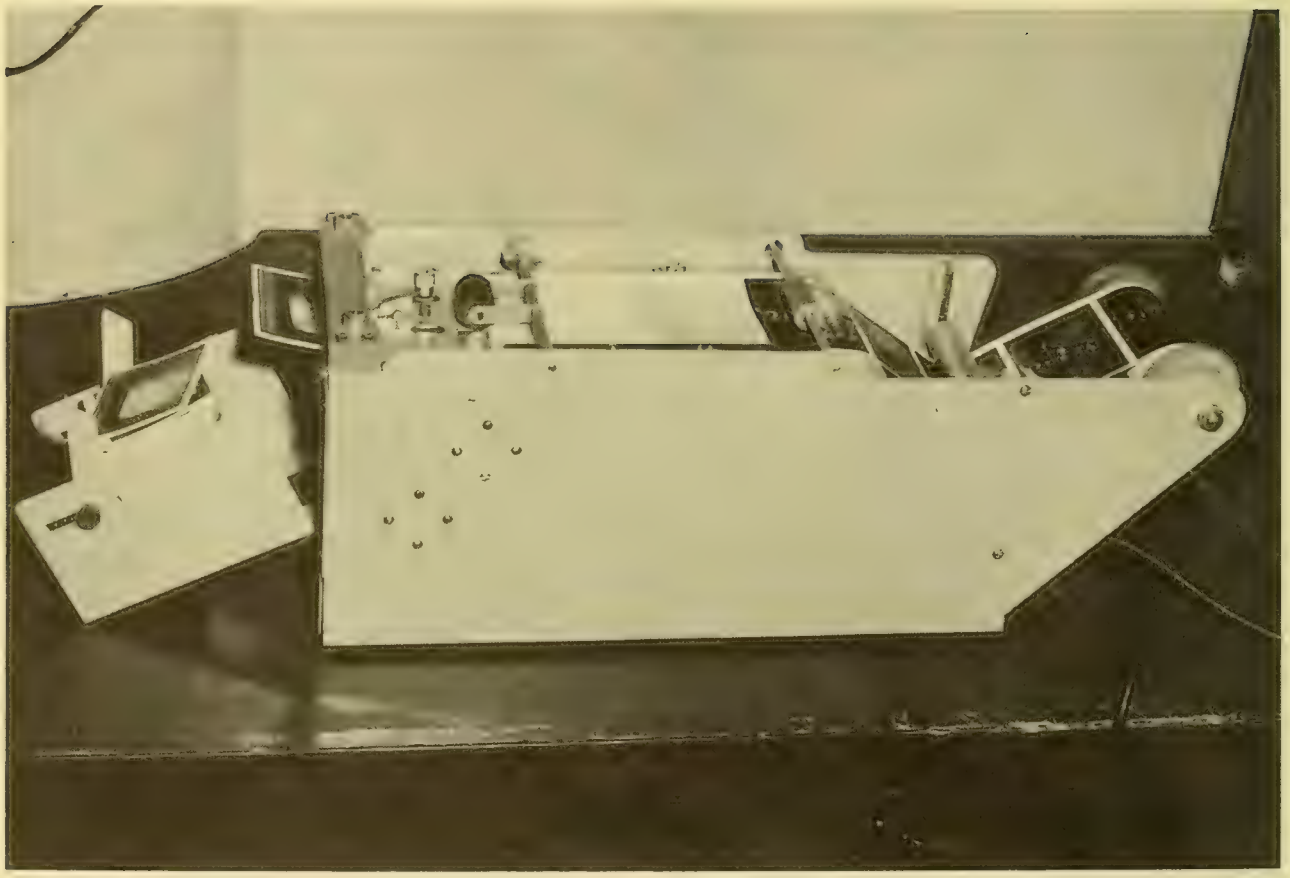

Fig. 8. The Pakoline Automatic Cutter

Materials - - - - - - - - - - - - - - - - -	$ 2,590.00
Labor - - - - - - - - - - - - - - - - - - -	20,560.00
Amortization of equipment - - - - - - - -	725.00
Overhead- - - - - - - - - - - - - - - - - -	20,560.00
Total yearly cost - - - - - - - -	$44,435.00
Cost per bathythermogram print- - - - -	$ 0.29

C. FUTURE PLANS

1. Revisions of Log Sheet and Manuals

The method of processing BT data, which has been described in this report, eliminates all hand copying of data onto the finished print, with the single exception of the key number used for filing. This must be added to the space provided in the upper right hand corner of each print. The method, however, places a greater burden on the accuracy and readability of the log sheet data. Errors on the log sheet could be corrected in the older process before or during copying data to the backs of the bathythermograms. The newer method requires that all corrections be made prior to photographing. Obviously the best place to make corrections is at the source. To this end the observer in the field must be provided with a precise set of instructions and all the codes and tables necessary to complete the log sheet properly. In addition, the log sheet information must be arranged in the easiest manner for the analyst to read the film or the print (fig. 9) and also to enable the E.A.M. punch-card operator to transscribe all the information in the desired order.

In order that these things may be accomplished, the BT log sheet, Oceanographic Log Sheet - B, PRNC-NHO 1189, has been revised. Each pad of 100 log sheets is provided with a cover jacket containing instructions for filling in the various columns and marking the slides. The jacket also contains all necessary codes and tables for making the meteorological entries. Examples of the entries are shown on a sample log sheet. H. O. Pub. No. 606-C, Bathythermograph Observations, is being rewritten and modernized to bring it into agreement with the new log sheet and the instructions contained in the new edition of H. O. Pub. No. 607, Instruction Manual for Oceanographic Observations. These instructions will be much more detailed and specific than previous ones. It has been found that where a choice of observational method was allowed such as injection or bucket sea temperatures and Beaufort or knots for wind, the observer rarely stated which he used. By eliminating choice much time will be saved that is now spent in determining which method the observer used. It is hoped that by providing all observers with these tools, the time spent in recoding and correcting log sheets can be considerably reduced, which in turn will greatly reduce the time required for processing each cruise.

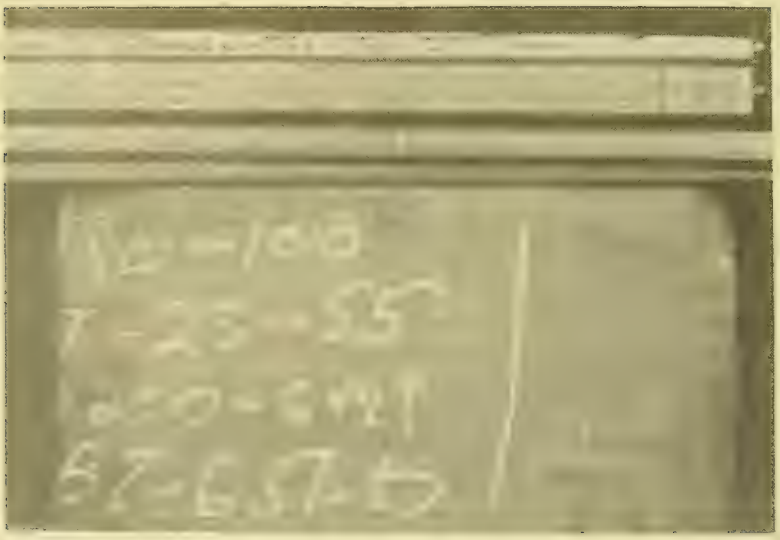

Fig. 9. A Sample Bathythermogram

2. Film storage

The problem of film storage is being investigated. One of the methods under consideration for filing negatives is the Filmsort technique. This is a method of machine mounting each negative into an E.A.M. punch card. Cards could be sorted by any of several keys such as Marsden squares, latitude and longitude, date, time, cruise, ship's name, surface temperature, layer depth, etc. Duplicate films can be made and retained in reels as an archive. This would permit the return of all processed slides to one of the BT repair facilities for resmoking and reissue and would be less expensive than new slides. The log sheets could then be destroyed.

3. Electronic Scanning of Traces

Consideration is being given to automatic or semi-automatic means of transcribing temperature data at selected depths from the film to a medium suitable for input to a digital data processing system. The present method of visual reading and manual transcription is laborious, time consuming, and productive of error. The mechanized methods under consideration make feasible the recording of many more points per BT trace, permitting more accurate reconstruction and analysis of the physical situation by the data processing system. Various available automatic transcription systems make possible the direct preparation of punched cards, punched paper tape or digital magnetic tape. Further study will determine which is most suitable.

Based on a tentative selection of 40 points per trace, it is estimated the cost of purchasing the equipment and a year's operation would be approximately as follows:

Data reading system equipment - - - - -	$25,800.00
Rental (E.A.M. equipment) - - - - - - -	600.00
Labor - - - - - - - - - - - - - - - - - -	6,600.00
Materials - - - - - - - - - - - - - - - -	250.00

The production capacity of such a system is estimated at 60,000 BT slides per year.

D. CONCLUSIONS

The processing method established at the Hydrographic Office is more versatile than previous methods, because it provides in a single negative not only the BT trace but all the associated log sheet data; for example, previous methods omitted barometer and visibility readings. The new method eliminates all hand transcription of data to the print. All information is available on one side of the print thus eliminating the necessity to turn each card over to read the associated information. The negative is readily available for reproduction of additional prints at any time. Negatives can be duplicated thus eliminating the necessity

for retaining bulky boxes of slides and large files of log sheets. The film can be stored in reels or in individual E.A.M. punch cards. Film is more adaptable to the automatic data processing systems under consideration than prints produced by older methods. More rapid and detailed extraction of data, greater geographic coverage, and wider distribution of information at lower unit cost than ever before is possible by this method.

BIBLIOGRAPHY

LAFOND, E. C. Processing Oceanographic Data, H. O. Pub. No. 614, Washington, D. C., 1951

LEIPPER, D. F. Annual Report Bathythermograph Processing Unit, 1 July 1947, Oceanographic Report No. 8, Scripps Institution of Oceanography, La Jolla, Calif., July 1947

LEIPPER, D. F. & BURT, W. V. Annual Report Bathythermograph Processing Unit, 1 July 1948, Oceanographic Report No. 15, Scripps Institution of Oceanography, La Jolla, Calif., July 1948

SCHANIEL, C. L., Jr. A Copy Camera for Rapid Reproduction of Bathythermograph Information, U. S. Navy Electronics Laboratory Report 417, San Diego, Calif., 1953

SCHROEDER, Elizabeth H. A New Method of Bathythermograph Production, Woods Hole Oceanographic Institution Reference No. 55-5 (unpublished manuscript), Woods Hole, Mass., February 1955

SELVIDIO, J. F. Information on Bathythermograph Recording Camera, U. S. Navy Underwater Sound Laboratory Technical Memorandum No. 348-18-53, New London, Conn., March 1953

PAKO CORPORATION Instructions for the Installation, Operation and Maintenance of the Pakomatic Printer, Minneapolis, Minn., 1955

U. S. NAVY HYDROGRAPHIC OFFICE Bathythermograph Observations, H. O. Pub. No. 606-C, Washington, D. C., 1954

- - - - - - Instruction Manual for Oceanographic Observations, H. O. Pub. No. 607, Washington, D. C., 2nd ed. 1956

LIST OF ADDITIONAL REFERENCES

BRALOVE, A. L. & WILLIAMS, E. I., Jr. A Study of the Errors of the Bathythermograph, National Scientific Laboratories, Inc., Washington, D. C., June 1952

UNIVERSITY OF CALIFORNIA, DIVISION OF WAR RESEARCH Procedure for Handling Bathythermograph Data, U. S. Navy Electronics Laboratory (UCDWR M442), San Diego, Calif., July 1946

U. S. Hydrographic Office
Processing bathythermograph data at the Hydrographic Office, by Benjamin A. Richmond. Washington, June 1956.
19 p. 9 figs. (H. O. TR-37)
A brief history of bathythermograph processing since 1941 is given. A new method developed in 1955 and installed at the Hydrographic Office is described. Possible future uses for BT film data in automatic transcription to punch cards is discussed.

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Processing bathythermograph data at the Hydrographic Office, by Benjamin A. Richmond. Washington, June 1956.
19 p. 9 figs. (H. O. TR-37)

A brief history of bathythermograph processing since 1941 is given. A new method developed in 1955 and installed at the Hydrographic Office is described. Possible future uses for BT film data in automatic transcription to punch cards is discussed.

1. Bathythermographs
2. Cameras
3. Data Processing
4. Photography
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AUTHOR

PROCESSING BT DATA AT THE

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