AD-A051 403 NAVY ELECTRONICS LAB SAN DIEGO CALIF F/G 20/1

INSTRUCTIONS FOR USE OF PUNCH CARDS IN AMBIENT NOISE ANALYSIS.(U)

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UNCLASSIFIED NEL-TM-155 NL

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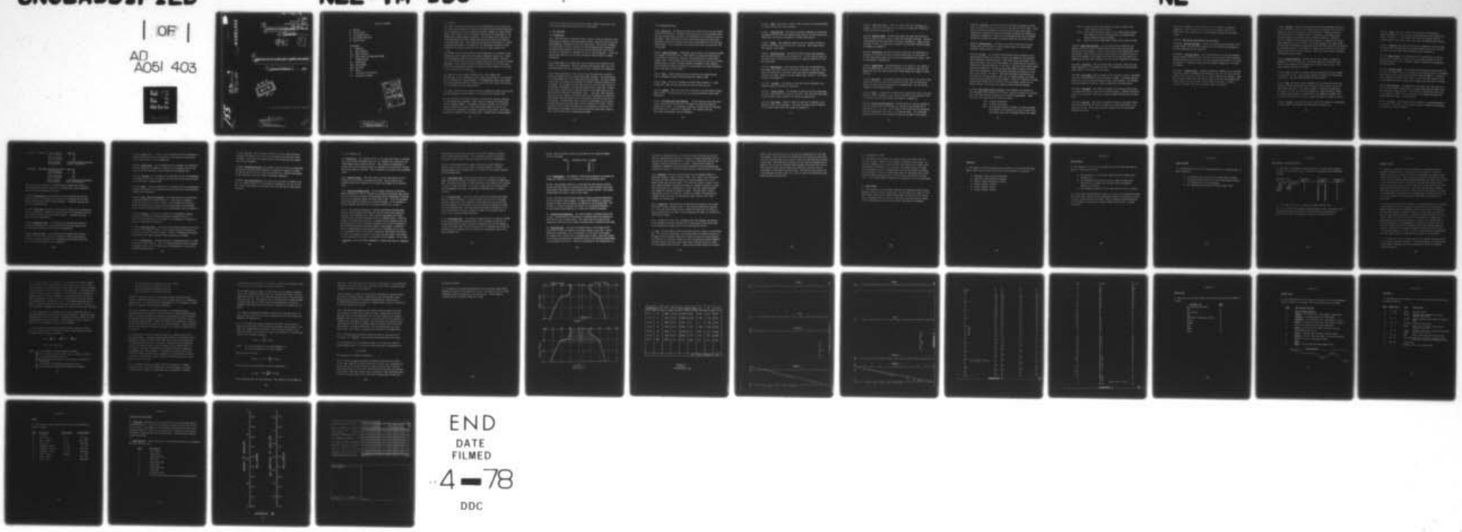

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SUBTASK 36

PROBLEM NEL 12-40

**technical memorandum no.** TM-155

9 January 1956
*date*

44p.

# INSTRUCTIONS FOR USE OF PUNCH CARDS IN AMBIENT NOISE ANALYSIS.


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## 1. GENERAL

1.1 This memorandum constitutes a set of instructions for the use of an IBM punch card technique for storing and handling marine ambient noise data. It is intended for use as instructions by those involved in marine ambient noise at NEL and as a guide to others at NEL who may be interested in establishing a similar punch card system. It may further be of interest to other laboratories who have similar problems in the storing and sampling of ambient noise data. This memorandum should not be construed as a report as its only function is to present for the information of others a small portion of the work in progress in the study of marine ambient noise.

1.2 Ambient noise in the ocean has been established as a function of many parameters, such as sea state, wind speed, biological noises, etc. Hence, it is necessary to perform large sample statistical analyses to investigate the effects which each of the various sources has on the noise spectrum. Therefore, an IBM system has been developed to record all the supporting data on each measurement and also to record the final results of the third-octave analysis of each sample.

1.3 Most of the work with the cards, that is the sorting, tab computations, will be carried out in the Section by the use of an available IBM card sorter and a desk calculator. The Computation Center will handle the larger sampling automatic operations that will not require the operator to be familiar with the subject matter.

1.4 Other services to be carried out by the Computation Center include tape-to-card punching, and interpreting and duplicating the punched cards.

1.5 Two different IBM cards are used to carry out two separate functions of the ambient noise analysis. These cards are known as the "Data Card" and the "Analysis Card". In addition to these two cards, a 5" x 8" Keysort edge-punch card, known as the "Master Test Card", is used to log details of the equipment and operating schedule of the tests. The Master Test Card is punched by serial number only. A fourth set of cards designed to fit in a Cardex file book, and known as "Key Cards", are used to carry the necessary coding information for the other cards.

## 2. THE DATA CARD

### 2.1 Description

2.1.1 The Data Card is designed to keep a record of all the supporting data concerning any ambient noise measurement or test. One such card is made for each channel of recorded data for each measurement. This card is intended to provide both a written record of the test parameters and a duplication of parts of this record in the form of punched information which allows the cards to be sorted as a function of any of these parameters. A new card must be made each time one of these parameters changes enough to change the coding.

2.1.2 Both sides of a printed data card are shown on the fold-out at the back of this memorandum. The card contains rows numbered from 0 to 9 and two extra rows at the top designated by X and Y as shown on the fold-out.

2.1.3 Before attempting to fill out the Data Card note that a specific space is provided for each item of information required. One digit should be written above each of the underlined spaces provided. The small numbers printed below the space lines indicate the column in which the digit is to be punched. If no number appears below the space line the digit is not to be punched, for instance, the last two digits in the "time" box. In some of the boxes a blank space is provided ahead of the stated units and the space line is enclosed in parentheses, i.e. [ fms (__)]. This indicates that the data is entered in the blank space but the punching is actually a code number which is found on the appropriate Key Card and entered in the parentheses. In other boxes only the space in parentheses (__) is found. In these cases only the punch code is to be entered on the card. Some of the column numbers under the space lines are followed by the letter "Y". These spaces are checked if the condition described occurs and a punch is made in the "Y" row of the corresponding column.

## 2.2 Preparing the Card

2.2.1 Filling in The spaces provided at the left side of the card should be filled in as soon as possible after completion of the measurement while the data is still warm, and before any analysis of the recorded material is completed. Spaces calling for unknown information should be left blank. Information should be written on the card in accordance with the following instructions. It is suggested a ball-point pen be used to record the data on the card.

2.2.1.1 Data Card Number A five-digit serial number, commencing with 00001, is assigned to each data card. These numbers are assigned consecutively as the tests are performed. However, they need not be in strict chronological order. For instance, if tests are being made in more than one place simultaneously, a block of numbers should be assigned to each location. Cards relating to different channels of information on the same individual test should bear the same number.

2.2.1.2 Time Local Standard Time is recorded to the nearest minute. Time is recorded in standard Navy fashion from 0000 to 2359.

2.2.1.3 Date The date is entered in standard Navy fashion, i.e. day/month/year. Only the last two digits of the year will be used.

2.2.1.4 Weekday The day of the week is entered in its box using standard abbreviations. The days of the week are coded numerically, Sunday being numbered 1.

2.2.1.5 Test Ship, Name and Condition If the tests are being made from a ship, the name of the ship and the condition of operation should be entered on the card. The operating condition is chosen from the following list which will be augmented as necessary. The existing list is: (1) moored, (2) drifting, and (3) underway.

2.2.1.6 Range The range in miles of the test ship from the hydrophone is entered to the best known accuracy.

2.2.1.7 Operation Code The type of operation performed is entered in accordance with the list of operation types found on the Key Card marked "Operation" and listed in Appendix I to these instructions.

2.2.1.8 System The measuring system in use is assigned a number as listed on the Master Test Card for the operation. Each unique system will require a new number.

2.2.1.9 Relative Motion Any relative motion between the hydrophone and the water is entered to the nearest knot. If the relative motion is less than 1 knot, enter it to the nearest 0.1 knot and code an "x" with the rate shown.

2.2.1.10 Ship Distance The distance in miles from the hydrophone to the nearest ship other than the test ship is entered in this box. If no ships are detectable in the area, enter the range of maximum detection instead, and place a check in the box marked "Max. Detect.". For further comment see Appendix II.

2.2.1.11 Location The location of the test site is entered to the nearest minute of latitude and longitude.

2.2.1.12 Shore Distance The distance in miles of the test hydrophone from the nearest shore is entered on the card. Also enter the code given on the Key Card "Shore Distance" and listed in Appendix III.

2.2.1.13 Water Depth Enter the depth of the water in fathoms at the position of the test hydrophone. Also enter the depth code as found on the Key Card "Water Depth" and listed in Appendix IV.

2.2.1.14 Hydrophone Depth  Enter the depth of the test hydrophone in fathoms. Also enter the depth code as found on the Key Card "Hydrophone Depth" and listed in Appendix IV.

2.2.1.15 Limiting Range  In this space enter the range from which the limiting rays leave the surface to reach the hydrophone directly. Complete instructions for this computation are found in Appendix V. Space is also provided to enter the range code as found on the Key Card "Limiting Range" and listed in Appendix V.

2.2.1.16 Bottom Type  The type of bottom beneath the test hydrophone is entered on the card by choosing the correct type from the list found on the Key Card "Bottom Type" along with its corresponding code number. This is illustrated in Appendix VI.

2.2.1.17 Bottom Shape  The configuration of the bottom in the region of the test hydrophone is entered by choosing the appropriate term and code number from the list found on Key Card "Bottom Shape" and listed in Appendix VII.

2.2.1.18 Sea State  A subjective estimate of sea state at the time of the measurement should be made and entered on the card. The sea state list found on the Key Card "Sea State", and in Appendix VIII, may be used for guidance in making this estimate.

2.2.1.19 Swell  A subjective estimate of the swell at the time of the test should be made and entered on the card in terms of the code numbers on the list found on the Key Card "Swell" and listed in Appendix IX.

2.2.1.20 Wind Speed and Direction  The wind speed in knots is entered in this box together with the direction of the wind to the nearest 45° in terms of N, NE, E, SE, etc. In the event of low winds where the direction cannot be determined, write "9" in the direction space. For unobserved direction, write "0" in the direction space. See Appendix X for details.

2.2.1.21 Barometer In this box enter the barometric pressure in millibars, neglecting the 900 or 1000, at the place and time of the test. Also enter the change in pressure in millibars for the past three hours. A nomogram for converting inches or millimeters of mercury to millibars is included in Appendix XI. Space is also provided in this box to indicate whether the mercury was rising or falling within the last three hours.

2.2.1.22 Precipitation If there is any form of precipitation check either "Rain, Snow or Hail" in this box and circle the letter which indicates "light, medium, or heavy".

2.2.1.23 BT Data Any available bathythermetic data applicable to the tests should be kept in an orderly fashion and assigned a serial number for the purpose of identification. This serial number is entered in the box on the card. Below the BT Data Number, two check marks may be made to indicate the velocity structure of the water. The first check mark is made after the letters "S.C." if the surface sound channel exists at the position of the hydrophone. The second check indicates the existance of the deep sound channel. "T.L.D.C." indicates top-limited deep channel and is checked if the deep channel exists and the bottom velocity is greater than the maximum velocity above the channel. "B.L.D.C." indicates a bottom-limited deep channel and is checked if the deep channel exists and the bottom velocity is less than the maximum velocity near the surface.

2.2.1.24 Hydrophone Vertical Position This describes the position of the hydrophone with respect to the vertical velocity structure of the water. There are several spaces provided to be checked as appropriate. These catagories are explained in the following table:

| | |
|---|---|
| A.T. | is above thermocline |
| B.T. | is below thermocline |
| A.D.C. | is above deep channel; if there is a bottom limited deep channel, this denotes the range of depths above the channel where fully refracted rays do not reach. |

I.D.C. in deep channel; this denotes the range of depths where fully refracted rays do reach.

B.D.C. below deep channel; if there is a top limited deep channel, this denotes the range of depths below the channel where fully refracted rays do not reach.

U.I. under ice; if the hydrophone is below an ice layer or pack.

2.2.1.25 Aural Noise Estimate In this space there is provision for checking off one or more of several types of noise which may be heard during the test recordings. There is also space for more descriptive notes as required. These checks or notes in the log of the operation should be made by the operator on the spot at the time of the test and verified or enlarged by further aural examination at the time of playback and analysis.

2.2.1.25.1 Sea Noise This is checked when the operator feels that the noise contained in the recording is free of interference of any definable nature and is a good measure of sea noise.

2.2.1.25.2 Biological This is checked if the operator is able to recognize any of the many identifible marine biological sounds. If further identification can be made it should be noted in the space provided. The presence of these sounds may or may not prevent checking the sea noise space.

2.2.1.25.3 Equipment This space is checked if the operator feels there is interference from any part of the measuring system. Further descriptive notes may be inserted. This may or may not prevent checking the sea noise space.

2.2.1.25.4 Man Made This space is checked if there is any aural indication of sound arising from the activities of man other than those of the test ship itself. The presence of these sounds may or may not prevent checking sea noise.

2.2.1.25.5 Platform This is checked if it is possible to identify sounds due to the presence of the test ship in the noise field of the hydrophone. These sounds may or may not prevent checking the sea noise space.

2.2.1.26 Information on the back of the Data Card

2.2.1.26.1 Master Card Number In this box enter the serial number of the Keysort Master Test Card which contains the more detailed information on the test equipment and its operation.

2.2.1.26.2 Analysis Numbers The serial numbers of any and all analyses of the recorded material of the particular test along with their respective calibrate numbers are entered in the space appropriately titled on the card. Distinguish the calibrate numbers from the analysis numbers by a "c" after the number.

2.2.1.26.3 Recording Data Specific information relating to the recording of the test sample is entered at the bottom of the card. The reel and take number of the recording is entered, as is the channel of the recorder. Each day's operation will start with "Reel 1, Take 1" so that these numbers will always refer to the date entered on the front of the card. A space is provided to indicate the type of recorder used for the tests.

2.2.2 Punching Certain selected portions of the information filled in at the left side of the card are punched into the remainder of the card in accordance with the coding system established here. Punching starts in the 31st column of the IBM Data Card. In addition to the number codes using the digits 0 to 9 and X, certain selected fields are punched in row Y to provide a direct code of additional data. A punch in the X position indicates 10 is to be added to the number punched in the same column or such other information as designated on the Key Cards and in the Appendices. The following instructions specify the columns to be punched for the various items of data and the manner of coding. The actual code number assignments are found on the Key Cards.

2.2.2.1 Data Card Number The five digit serial number is punched in columns 31, 32, 33, 34, and 35. The serial number is a direct code and zero must be punched in all columns where no other digit appears. The serial numbers thus start at 00001.

2.2.2.2 Time The first two numbers which represent the hour are punched in columns 36 and 37. A zero must be punched in column 36 for hours preceding 1000. Thus both 0601 and 0659 are punched "06".

2.2.2.3 Date The date is copied complete from the date box on the card. The day is punched in columns 38 and 39 with a zero in column 38 for all days before the tenth. The month is punched in column 40 by numbering the months 1 to 12. The first nine months are punched directly, October is punched "X0", November is punched "X1", and December is punched "X2". The last two digits of the year are punched directly in columns 41 and 42.

2.2.2.4 Weekday The day of the week is punched in column 43 by numbering the days of the week consecutively starting with Sunday as 1.

2.2.2.5 Range The range of the test ship from the hydrophone is punched in column 44. The range is punched directly to the nearest mile from 1 to 9 miles. A punch in the X position will indicate that the range is shown to the nearest tenth of a mile, for ranges below one mile.

2.2.2.6 Operation The type of operation is punched in column 45 using the number code corresponding to the name written on the card. The code is found on the Key Card titled "Operation" and in Appendix I.

2.2.2.7 System Number The designation of the system used to make the measurement is coded and punched in the two columns numbered 46 and 47. The code designation for a particular system is found on the appropriate Master Test Card.

2.2.2.8 Relative Motion The relative motion between the hydrophone and the water is punched directly in column 48 to the nearest knot, in accordance with the code shown on the Key Card titled "Relative Motion". A punch in the X position will indicate the motion is to the nearest tenth of 1 knot. If the relative motion is greater than 9 knots, punch only the X position.

2.2.2.9 Ship Distance The distance to the nearest ship other than the test ship is punched in column 49 in accordance with the code shown on the Key Card titled "Ship Distance". If no ships are detectable in the area, a Y is punched to denote that the distance in the column represents the maximum detection range. See Appendix II.

2.2.2.10 Location The location of the test ship is entered directly as it is written on the card, to the nearest minute of latitude and longitude. The punches are made as follows:

| | | | |
|---|---|---|---|
| 2.2.2.10.1 | Latitude: | tens of degrees | column 50 |
| | | units of degrees | " 51 |
| | | tens of minutes | " 52 |
| | | units of minutes | " 53 |
| | | North latitude | no additional punch necessary |
| | | South latitude | punch X in column 50 |

| | | | |
|---|---|---|---|
| 2.2.2.10.2 | Longitude: | hundreds of degrees | column 54 |
| | | tens of degrees | " 55 |
| | | units of degrees | " 56 |
| | | tens of minutes | " 57 |
| | | units of minutes | " 58 |
| | | West longitude | no additional punch necessary |
| | | East longitude | punch X in column 54 |

Note this means locations in the North-Eastern Pacific will require no additional punches, and sorting of the X punches will not be required as long as data is confined to this area.

2.2.2.11 <u>Shore Distance</u> The distance of the test hydrophone from the nearest shore is to be punched in column 59 in accordance with the code found on the Key Card titled "Shore Distance". A detailed list may also be found in Appendix III.

2.2.2.12 <u>Water Depth</u> The depth of the water in fathoms at the position of the test hydrophone is punched in columns 60 and 61 in accordance with the code found on the Key Card titled "Water Depth". A detailed list may also be found in Appendix IV.

2.2.2.13 <u>Hydrophone Depth</u> The depth of the hydrophone in fathoms is punched in columns 62 and 63 in accordance with the code found on the Key Card titled "Hydrophone Depth" and in Appendix IV.

2.2.2.14 <u>Limiting Range</u> The range along the surface from which the limiting rays leave the surface of the water to reach the hydrophone directly is punched in column 64 in accordance with the code on the Key Card titled "Limiting Range" and in Appendix V.

2.2.2.15 Bottom Type The type of bottom beneath the test hydrophone is punched in column 65 in accordance with the code shown on the Key Card titled "Bottom Type" and in Appendix VI.

2.2.2.16 Bottom Shape The configuration of the bottom in the region of the test hydrophone is punched in column 66 in accordance with the code shown on the Key Card titled "Bottom Shape" and in Appendix VII.

2.2.2.17 Sea State The sea state at the position of the test hydrophone is punched in column 67 in accordance with the code on the Key Card titled "Sea State" and in Appendix VIII.

2.2.2.18 Swell The swell observed at the position of the test hydrophone is punched in column 68 in accordance with the code on the Key Card titled "Swell" and in Appendix IX.

2.2.2.19 Wind - Speed and Direction The wind speed to the nearest knot is punched directly in columns 69 and 70. A zero must be punched in column 69 if the wind is below 10 knots. The direction of the wind is punched in column 71 in accordance with the code shown on the Key Card titled "Wind Speed and Direction" and the instructions given in Appendix X.

2.2.2.20 Barometer The last two figures of the barometric pressure expressed in millibars is punched directly in columns 72 and 73. A table for converting inches to millibars and millimeters to millibars of mercury is included in Appendix XI.

2.2.2.21 Barometric Change The change in barometric pressure in the last three hours is punched in column 74 in accordance with the code shown on the Key Card titled "Barometric Change". Punch X to indicate the pressure was falling; leave blank to denote rising pressure or no change.

2.2.2.22 Precipitation Any precipitation is classified into one of three groups: rain, snow, or hail. These are punched directly in the Y position in columns 31, 32, or 33. If there is no precipitation the card is left unpunched in these spaces.

2.2.2.23 <u>BT Data</u> The information checked in the box marked "BT Data" is punched in columns 34,35, and 36 as indicated on the Key Card titled "BT Data". Since these are yes-no types of information they are punched only in the Y position.

2.2.2.24 <u>Hydrophone Position</u> The vertical position of the test hydrophone as checked in the box titled "Hydrophone Position" is punched in columns 37, 38, 39, 40, and 41 and 42 in the Y position only. Further information may be found on the Key Card titled "Hydrophone Position".

2.2.2.25 <u>Aural Noise Estimate</u> The aural noise estimate as checked on the card is punched directly in the Y position in columns 43, 44, 45, 46, and 47. Further information may be found on the Key Card titled "Aural Noise Estimate".

## 3. THE ANALYSIS CARD

3.1 Preparation The Analysis Card is an IBM punch card which is prepared on a tape-to-card converting punch from the teletype tape produced by the Third-Octave Digital Analyzer (TODA)[1]. This analyzer is programmed to produce data in the proper sequence for punching on the card and to control the entire punching operation. Data is punched on the card in the following order.

3.1.1 Analysis Number The serial number of this card consists of two letters and three numbers starting with AA001. This is known as the Analysis Number and is punched in the first five columns of the Analysis Card.

3.1.2 Third-Octave-Band Levels The 70 columns following the Analysis Number (columns 6 to 75) are reserved for carrying 35 two-digit band levels. The layout of these 70 spaces is specialized for the measurement of Ambient Noise in the frequency region from about 2cps to 8kc. It is not necessary all of this range be included in any single analysis. It is possible to analyze magnetic tape recordings at playback ratios of 1, 2, and 4.

3.1.2.1 For maximum utilization of machine computational methods each original recorded filter band must have its own column pair permanently assigned on the Analysis Card. Thus original frequencies will always appear in the same columns despite changes in playback ratios. Since the purpose of playback tape speed-up is to extend the low frequency range of the analyzer, the first column pair (columns 6 and 7) will be assigned to the lowest frequency band obtainable which is band number 4 centered at 2.5cps. Column pairs are then assigned to each frequency band in order up to columns 74 and 75 which are the columns for band number 38 centered at 6.3kc. If a playback ratio of 4 is used, data may appear in all bands, and the corresponding columns of the card all may be punched. If the play-

[1] Memorandum From: Code 2323, NE120221-36, Problem NEL L2-4c of 4 November 1955

back ratio is 2, no data will appear in the first 3 bands and columns 6 to 11 will remain unpunched. If the playback ratio is 1 there will be no data in the first 6 bands and columns 6 to 17 will be unpunched.

3.1.2.2 In the event that the signal level in any filter channel is too low or too high for the analyzer to operate properly, a special symbol appears on the teletype tape and no level for that band is punched in the Analysis Card.

3.1.3 Broad Band Level The broad band level of the signal on the magnetic tape will be entered in columns 76 and 77 in decibels re 0.0002 microbar. Since this level never is less than 40 db, small numbers will indicate a value in excess of 100 db. This gives a dynamic range of nearly 100 db to the broadband level which is considered sufficient for all intended purposes.

3.1.4 Playback Ratio This is the ratio between the playback tape-speed and the record tape-speed. It will be either 4, 2, or 1 for the present analysis card system. The appropriate ratio number must be set manually into the analyzer and this number is then automatically punched in column 78 of the Analysis Card. This same setting controls the placement of the filter band levels in their appropriate columns of the Analysis Card in terms of the original recorded frequency.

3.1.5 Integration Time The analysis integration time is coded and punched in the 79th column of the Analysis Card. This operation is carried out automatically upon setting the desired integration time into the analyzer. It must be recalled that this is the actual time of integration and must be multiplied by the playback ratio to obtain the integration period in original recorded time.

3.1.5.1 Seven integration times are available and are coded by numbers 1 to 7 as follows:

| | | |
|---|---|---|
| code 1 | integration time | 1 second |
| 2 | | 5 " |
| 3 | | 10 " |
| 4 | | 15 " |
| 5 | | 20 " |
| 6 | | 30 " |
| 7 | | 60 " |

3.1.6 Verification Two separate verification procedures are carried out during the production of the teletype tape and the Analysis Card.

3.1.6.1 One procedure serves as a check that the tape and the card are in sync and that values are appearing in their proper columns on the card. This check is made several times during the punching process. Any irregularity causes the punch to stop at that point.

3.1.6.2 The second verification procedure indicates certain malfunctions in the operation of the analyzer. As long as the analyzer is operating properly a "zero" will be punched in column 80 of the Analysis Card. The presence of a punch in any but the "zero" row in column 80 indicates the data shown on the card may be in error and should be discarded.

3.2 Copying and Distribution Two complete decks of Analysis Cards will be made. One deck will be interpreted as outlined below and delivered to Code 2322 for use in computations. The second deck will remain in the Computation Center for use in machine computations as required by Code 2322.

3.3 Interpretation One deck of Analysis Cards is fed through an IBM Interpreter to have the punched information printed on the card. Due to interpreter limitations it is not possible to print out all 80 columns in a single line, so two lines of printing must be used. This will require the cards to pass through the interperter twice, with different instructions to the machine on each pass. Since the arrangement of the punched data on the card, as explained above, is chosen for ease in analysis and not for ease in computation and handling, a slightly different arrangement will be used in the printed interpretation. Each line of interpeted material may contain a total of 60 characters or spaces , hence the 80 columns of information punched on the card may be expanded to 120 spaces during the printing out process. The two 60 column rows will than be filled as follows.

3.3.1 First Row The first row will start with the Analysis Number in the first 5 spaces. Space 6 will be blank. The first 17 band levels will follow in the next 50 spaces written as two-digit numbers with a blank space between each pair of digits. The first band level in spaces 7 and 8 will always represent frequency band number 4, midband frequency of 2.5cps. The last band level, or seventeenth, on this line will always represent band number 20, midband frequency of 100cps. The last digit of these band levels appears in column 56. Column 57 is blank, 58 represents the playback ratio, 59 is the integration-time code, and 60 is the "zero" punched for verification.

3.3.2 Second Row The second row is indented three spaces and the broadband level appears in spaces 4 and 5. For purposes explained in Section 3.4, the second row of band levels is offset one space from the first row, hence spaces 6 and 7 are blank. In the remaining 53 spaces are printed the other 18 band levels.

3.3.3 Columns which were left unpunched at the low frequency end because of low playback ratios or throughout the card because of excessively high or low levels become blank spaces in the printing-out process.

3.4 Use The two separate decks of analysis cards are used in two different ways. At the time of analysis, the Analysis Number is recorded manually on the back of the appropriate Data Card. Later sorting of the Data Cards for a certain set of parameters yields a list of corresponding Analysis Numbers. For small sample computations the local deck of Analysis Cards is sorted and the required cards selected. These cards are then placed in a special holder which aligns the cards so only the two printed lines of each card are visable. Since the second line band-levels are offset one space from the first line band-levels, the several levels for each band form a unique column pair. This multi-card tabulation is then used for computations as desired. If the list of Analysis Cards produced by the Data Card sort is long enough to make machine computations desirable, then this list is reproduced in a new deck of punched cards. This deck is then turned over to the Computation Center where it is used to select the required analysis cards for use in computation.

## 4. THE MASTER TEST CARD

4.1 The third set of cards in use in this system are Keysort two-hole edge-punch cards. Only the serial number is punched on these cards. The cards are filled out at the conclusion of each operation and contain such information as the dates of the operation, the general pattern of tests or measurements made, the equipment used for the measurements, the manner of operations, the types of calibrations used, the information put on each recorder channel, other logs kept, and where other information is available. A new serial number is assigned each operation or set of measurements.

## 5. THE KEY CARD

5.1 The fourth set of cards which completes the punch-card system of data handling is not in itself a punch-card. The Key Cards are a set of 5" x 8" plain cards containing the coding instructions for the punch card information. These Key Cards are kept in a folder for easy reference and contain all the instructions necessary to encode the Data Cards for punching.

APPENDIX I

OPERATION

1. The manner in which the hydrophone is operated is coded by the following table. This is not a complete list and may be augmented as necessary.

1. Permanent, bottom-mounted hydrophone
2. Temporary, bottom-mounted hydrophone
3. Mobile, captive hydrophone, sinking
4. Mobile, captive, hovering
5. Mobile, captive, rising
6. Mobile, captive, pendant

APPENDIX II

SHIP DISTANCE

1. The distance in miles to the nearest ship other than the test ship is coded for punching as follows.

1. For distances up to 9.5 miles, punch distance directly to the nearest mile.
2. For distances from 9.5 to 19.5 miles, punch the unit digit directly to the nearest mile and punch in the X position to denote the ten-digit.
3. For distances greater than 19.5 miles punch only the X position.

1.1 If no ships are detectable as shown by a check in the maximum dectection box on the card, enter the limit of detection using the same coding as above and add a Y punch in the same column. Thus the greatest maximum detection range available is XY punches, meaning "greater than 20 miles , maximum detection."

APPENDIX III

SHORE DISTANCE

1. The distance in miles of the test hydrophone to the nearest shore is coded as follows.

1. For distances from 0 to 9.5 miles, punch number directly.
2. For distances from 9.5 to 19.5 miles, punch number directly and also punch X in the same column.
3. For distances greater than 19.5 miles, punch X only.

APPENDIX IV

WATER DEPTH AND HYDROPHONE DEPTH

1. The water and hydrophone depths are coded by a system which expresses the depth in logarithmic bands. The depth is expressed to two significant figures.

| For depths from | | | First Digit Code | For numbers between | | | Second Digit Code |
|---|---|---|---|---|---|---|---|
| 0.9 | to | 8.9 fathoms | 0 | 9 | to | 11 | 0 |
| 9.0 | | 89.0 | 1 | 12 | | 14 | 1 |
| 90.0 | | 890.0 | 2 | 15 | | 18 | 2 |
| 900.0 | | 8900.0 | 3 | 19 | | 23 | 3 |
| 9000.0 | | up | 4 | 24 | | 28 | 4 |
| | | | | 29 | | 35 | 5 |
| | | | | 36 | | 45 | 6 |
| | | | | 46 | | 56 | 7 |
| | | | | 57 | | 71 | 8 |
| | | | | 72 | | 89 | 9 |

1.1 For depths from 0 to 1.1 fathoms, the dode would be "00".

1.2 For a depth of 58.7 fathoms, the code would be "18". The first digit, 1, signifies the region is between 9 and 89 fathoms; the second digit, 8, signifies the first two significant numbers are between 57 and 71.

APPENDIX V

LIMITING RANGE

1. One of the parameters encoded and punched on the IBM Data Card is entitled "Limiting Range". This item has been included to serve as a measure of the ocean surface from which the hydrophone can receive direct sound at any given time. This area will vary with the velocity structure of the water and under certain conditions may change radically with a change of only a few feet of depth. Since it is apparent that surface sources account for at least a part of the ambient noise at any point in the ocean, it is to be expected that the noise will vary with the area of surface from which sound can be received. Rather than the area itself, the radius of a circle which encloses the area is being used as a measure of the area. A set of nomograms has been designed to facilitate the calculation of this radius.

2. Before proceeding to the computation, the limiting range may be defined as the radius of the largest circular area which has its center on the surface directly above the hydrophone and from every point of which sound can reach the hydrophone without reflection. It will also be necessary to make a few assumptions which are reasonable approximations to the situation. First, it is assumed that the sound velocity is a function of depth alone within the area of interest. Second, it is assumed that the velocity structure can be approximated by a series of layers in each of which the velocity gradient is constant and that the limiting range may be taken as the sum of the ranges traveled by the limiting ray in each of these constant gradient laminae. It will be further assumed that temperature and salinity data are available to the depth of the hydrophone.

3. The computation of the limiting range may be divided into three parts each of which is treated separately. The first involves the determination of the velocity gradients and the separation into laminae of constant velocity gradients.

3.1 The first step in this process is to determine the location, number, and thickness of the various laminae. This requires the use of a bathythermogram type graph of temperature versus depth, and a graph of salinity versus depth, both good to the depth of the hydrophone. An example of such a pair of curves is shown in figure 1. The first step is to approximate these curves as a series of straight line segments as shown in figure 2. The more segments per curve, the more accurate and also the more tedious the computations of the limiting range. A reasonable compromise must be made. It has been assumed in the nomograms no lamina will be more than 100 feet thick. Straight line segments that exceed 100 feet must be divided.

3.2 The second step in the procedure is to draw a horizontal line at each discontinuity in either curve as shown in figure 2. Number the lines starting with zero on the surface. The laminae are thus defined and their characteristics can be tabulated. A table similar to Table 1 should be used with the nomograms to program the computations.

3.3 For purposes of computation the actual change in velocity across the lamina rather than the gradients is used. This change in velocity is derived from the following equation.

$$\Delta v = \frac{\partial v}{\partial z} \Delta z + \frac{\partial v}{\partial t} \Delta t + \frac{\partial v}{\partial s} \Delta s$$

$$\Delta v = \Delta v_z + \Delta v_t + \Delta v_s$$

where: $\Delta v$ is the change in velocity across the lamina,

$\frac{\partial v}{\partial z}$ is the change in velocity with depth; the pressure effect,

$\Delta z$ is the thickness of the lamina,

$\frac{\partial v}{\partial t}$ is the change of velocity with temperature; a function of temperature,

$\Delta t$ is the change in temperature across the lamina,

$\frac{\partial v}{\partial s}$ is the change of velocity with salinity; a constant,

$\Delta s$ is the change in salinity across the lamina,

$\Delta v_z$ is the change in velocity due to $\Delta z$,

$\Delta v_t$ is the change in velocity due to $\Delta t$,

$\Delta v_s$ is the change in velocity due to $\Delta s$.

If $\Delta v$ is negative the ray will bend downward during its travel in the lamina. A positive $\Delta v$ indicates the ray is bending upward and a channeling effect occurs. Thus in the case of weak gradients, it is extremely important that the value of $\Delta v$ be accurately determined.

3.4 These nomograms are designed primarily for computing limiting ranges in water with a negative velocity gradient. With reasonable concern for the physical situation of temperature and salinity they may be applied to the cases where a region of positive gradient water overlies a region of negative gradient water. Recall that under these conditions the limiting ray has zero angle at the depth of zero velocity gradient. These nomograms will be equally valid in tracing the course of the ray both directions from this level.

3.5 Nomograms 1 and 2 are identical except for a scaling factor on the $\Delta t$ and $\Delta v_t$ scales. The first nomogram covers changes in temperature across the layer, $\Delta t$, from $+0.2^{\circ}$ F to about $-2^{\circ}$F, and the effect of temperature on velocity extends from +2 to -10 ft/sec. Nomogram 2 covers changes in $\Delta t$ from $-1^{\circ}$F to about $-20^{\circ}$F , and the velocity change extends from 0 to -100 ft/sec. The change-in-salinity and thickness-of-layer graduations are identical for both nomograms. On nomogram 1 the scales are labeled A through G with instructions for obtaining the desired solution, a value on scale D. Nomogram 2 has scales labeled from H through N and the solution is found on scale K.

3.5.1 Taking the values from table 1 for the temperature in degrees Fahrenheit and the change in temperature across each layer, the change in velocity with respect to temperature, $\Delta v_t$, may readily be found by connecting the proper value of T on scale A with the corresponding value of $\Delta t$ on scale C and reading the result on scale B.

3.5.2 Other known parameters for each layer are the change in salinity, $\Delta s$, and the thickness of each layer, $\Delta z$. Joining these values on their appropriate scales, G and E, a point is located on line F which represents their sum, $\Delta s + \Delta z$. This point on line F connected to the value obtained on scale B will give a value on scale D which represents the desired velocity change arising from temperature, salinity, and thickness of the layer.

3.6 Having determined the change in velocity, $\Delta v$, for each layer, the next step is to determine the range traveled by the ray which leaves the surface at $0^\circ$ inclination.

3.6.1 It is first necessary to determine the angles at which the ray enters and leaves each of the laminae and from these values obtain a mean angle, $\bar{\theta}$, within each of the laminae. The angle $\theta_b$ at which the ray leaves the lamina is related to the angle, $\theta_a$, at which the ray enters the lamina by the following equation.

$$\cos \theta_b = \frac{V_b}{V_a} \cos \theta_a$$

where: $V_b$ is the velocity at the lower boundary, and
$V_a$ is the velocity at the upper boundary.

This may also be written

$$\cos \theta_b = \left( 1 + \frac{\Delta v}{V_a} \right) \cos \theta_a$$

and for purposes of computations, it may be expressed as

$$\cos \theta_b = \left( 1 + \frac{\Delta v}{4950} \right) \cos \theta_a$$

with negligible error for all conditions. Now starting at the surface of the water (or where $dv/dz = 0$), with $\theta_a = 0$ and $\cos \theta_a = 1$, the successive angles may be computed with only a knowledge of $\Delta v$ and the preceding angle. Nomogram 3 performs this computation.

3.6.2 Nomogram 3 is made up of five scales involving the velocity change, $\Delta v$, and the angles $\theta_a$ and $\theta_b$. Scales $\theta_a'$ and $\theta_b'$ are expanded scales of $\theta_a$ and $\theta_b$ to assure more accuracy in measuring the smaller angles. By taking a value for $\Delta v$ and $\theta_a$, the resultant value of $\theta_b$ can be found for any angle between $0.3^\circ$ and $21^\circ$.

3.6.3 The computations start at the surface where the angle of the ray $\theta_a$, entering the first layer is taken as zero. Connecting zero on the $\theta_a$ scale with the value found for $\Delta v$ in the first layer on the previous nomogram, will give an angle $\theta_b$ which is the angle of the ray leaving the first layer and entering the second. The same value of $\theta_b$ should now be substituted for the $\theta_a$ of the second layer and together with $\Delta v$ for this second layer, a new $\theta_b$ is noted and in turn substituted for $\theta_a$ in the third layer. This process is continued to the depth of the hydrophone.

3.6.4 To complete the information needed on table 1, the mean of the two angles, i.e. $\frac{\theta_a + \theta_b}{2}$, must be found arithmetically for each layer.

3.7 The final step is to compute the range, r, in each layer and the total limiting range, R. The range in each layer may be approximated by

$$r = \Delta z \operatorname{ctn} \bar{\theta}$$

This equation is expressed in Nomogram 4.

3.7.1 Nomogram 4 gives the range in kiloyards for each layer in terms of the mean angle, $\bar{\theta}$, and the thickness of the layer, $\Delta z$. Connecting the proper value of $\bar{\theta}$ on scale U with the value for $\Delta z$ on scale W for the layer will produce a value on the range scale V for the range of the layer in kiloyards. This same process is to be applied to each succeeding layer. The total of these ranges will be the total limiting range for the test hydrophone position.

4. To encode the computed limiting range on the Data Card, punch values directly for ranges in kiloyards from 0 to 9. For values from 9.5 to 19.5 kiloyards, punch X in addition to the unit figure. If the range is greater than 19.5 kiloyards, punch the X only.

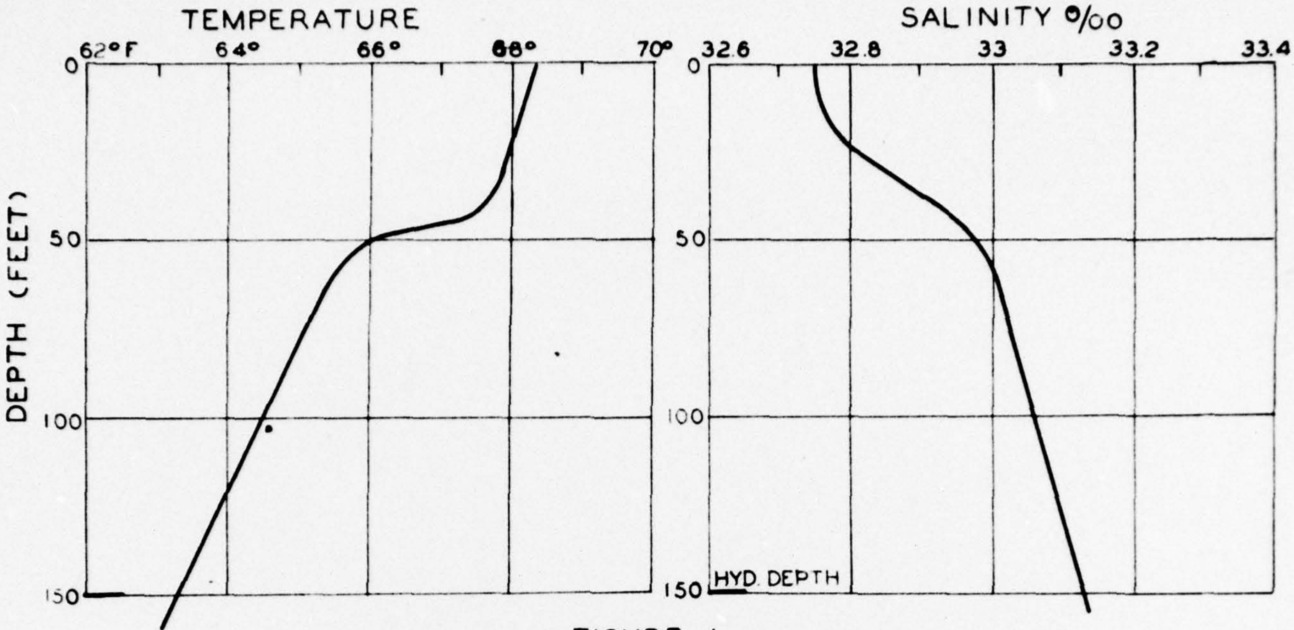



FIGURE 1

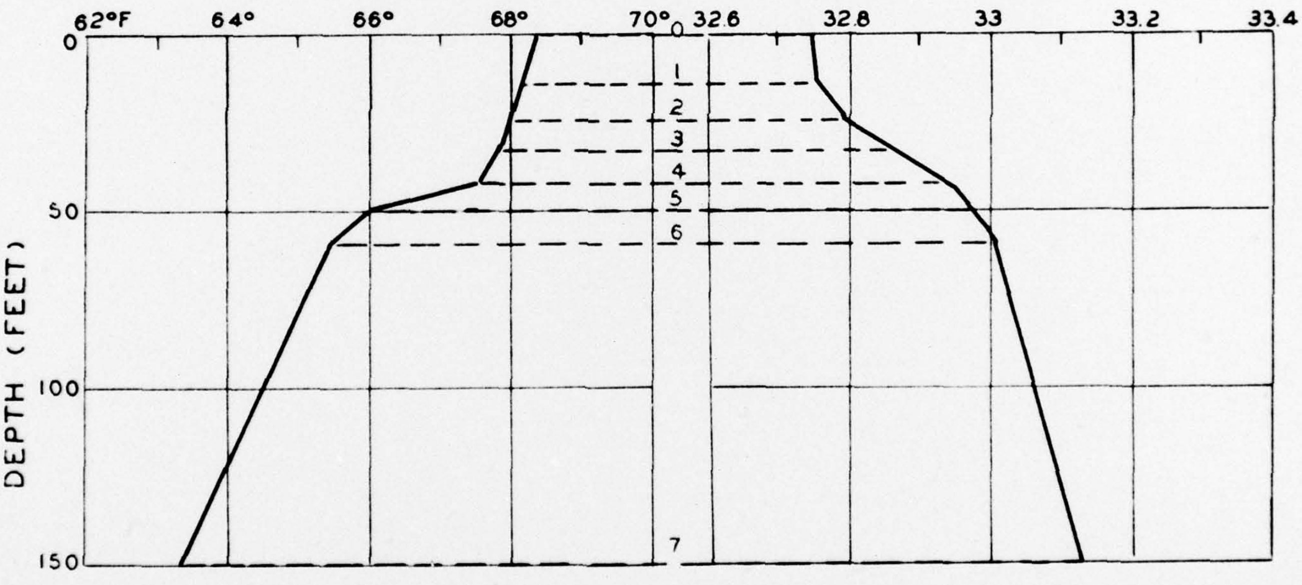


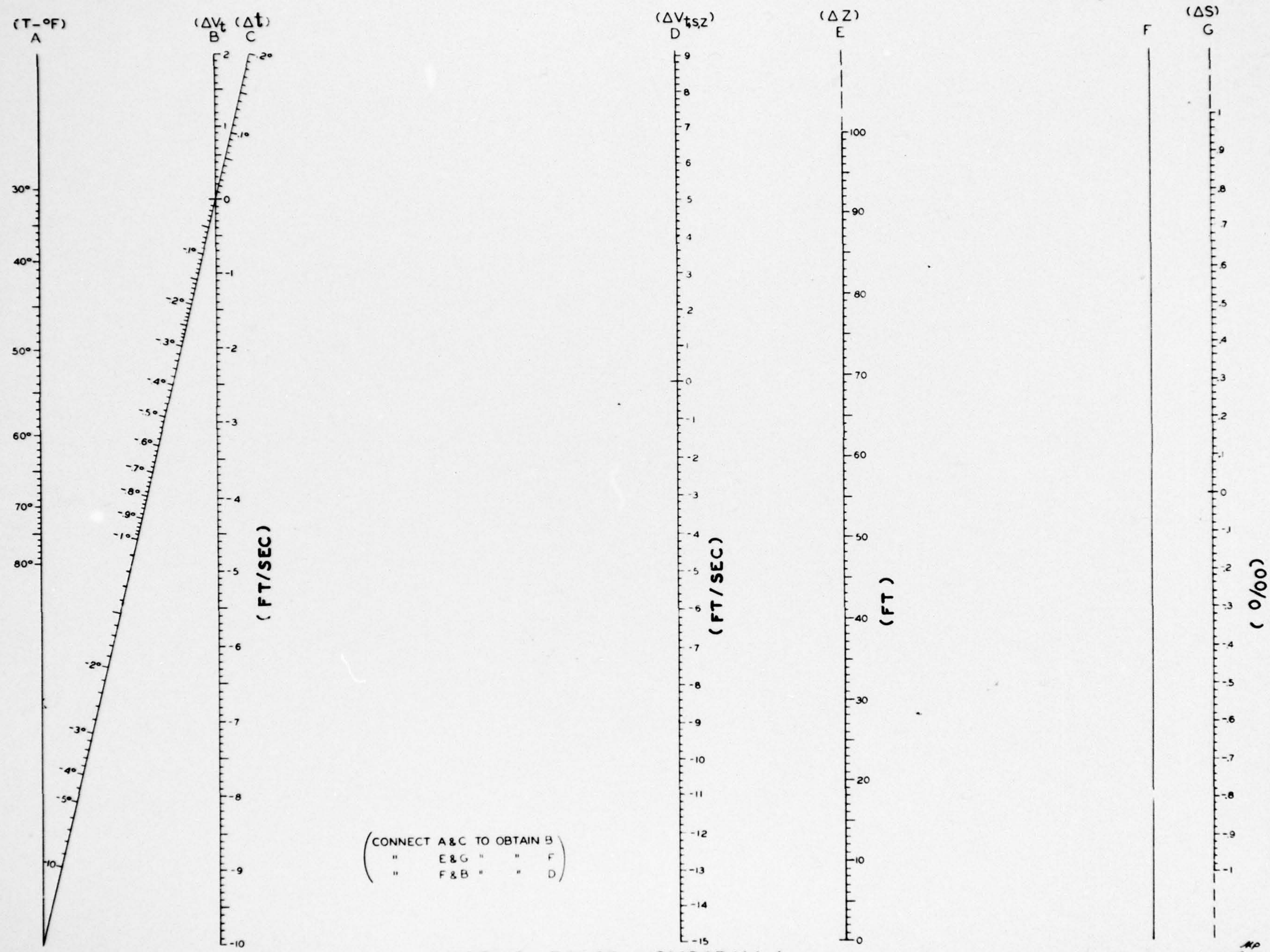

FIGURE 2

APPENDIX V

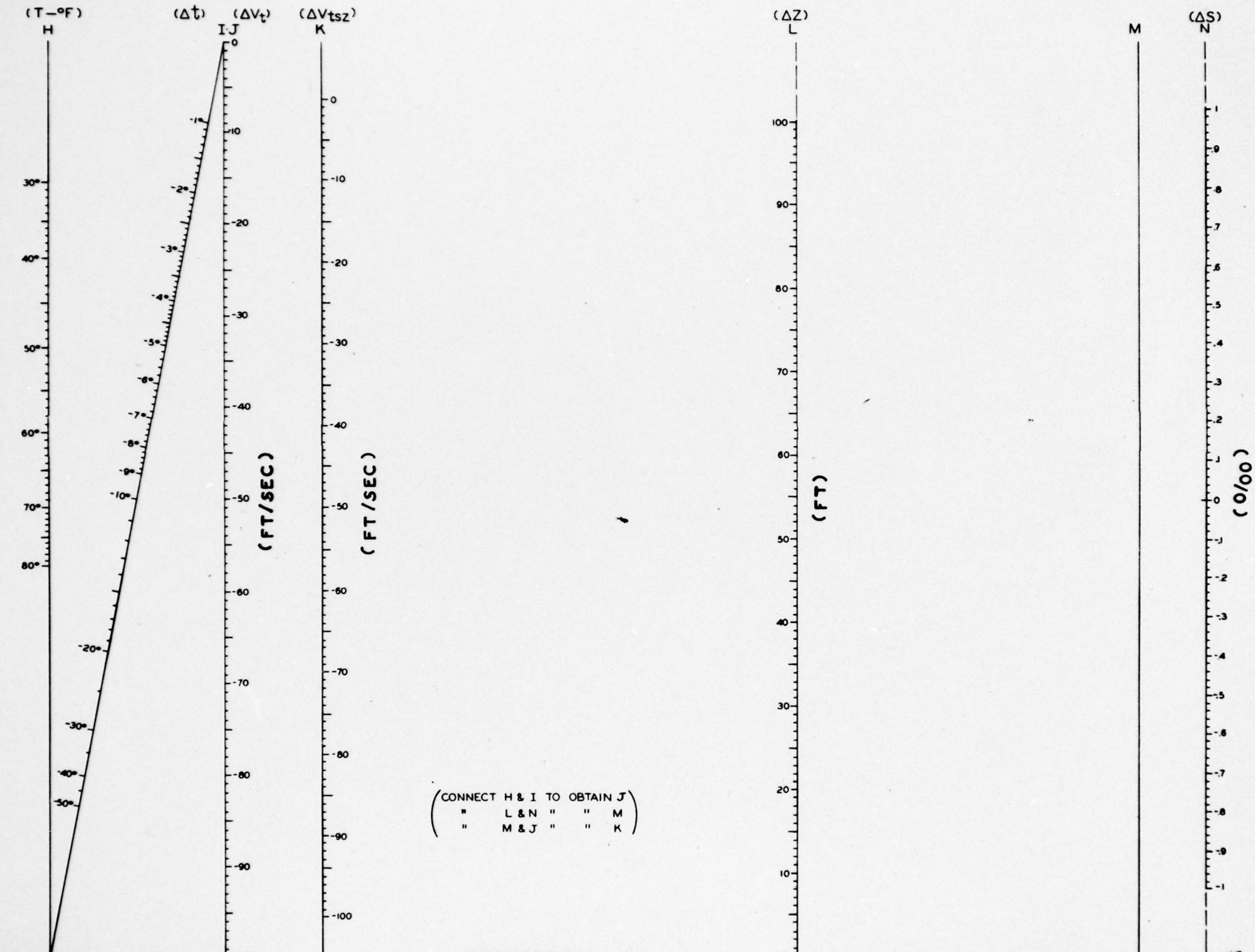
| LAMINA | ΔZ (FT) | T°F | ΔT(°F) | ΔS (‰) | ΔV (FT/SEC) | $\Theta_b$ | $\bar{\Theta}$ | r (KYD) |
|---|---|---|---|---|---|---|---|---|
| 0-1 | 14 | 68.5 | -0.25 | +0.005 | -0.95 | 0.95 | 0.47 | 0.58 |
| 1-2 | 11 | 68.0 | -0.14 | +0.048 | -0.25 | 1.06 | 1.00 | 0.215 |
| 2-3 | 8 | 68.0 | -0.11 | +0.07 | -0.1 | 1.1 | 1.08 | 0.145 |
| 3-4 | 9 | 67.5 | -0.3 | +0.08 | -1.0 | 1.49 | 1.28 | 0.165 |
| 4-5 | 8 | 66.5 | -1.5 | +0.025 | -7.5 | 3.8 | 2.6 | 0.059 |
| 5-6 | 10 | 65.5 | -0.5 | +0.025 | -2.3 | 4.3 | 4.0 | 0.048 |
| 6-7 | 90 | 64.5 | -2.2 | +0.13 | -9.8 | 5.7 | 5.0 | 0.36 |
| R = TOTAL RANGE = 1.57 | | | | | | | | |

TABLE I

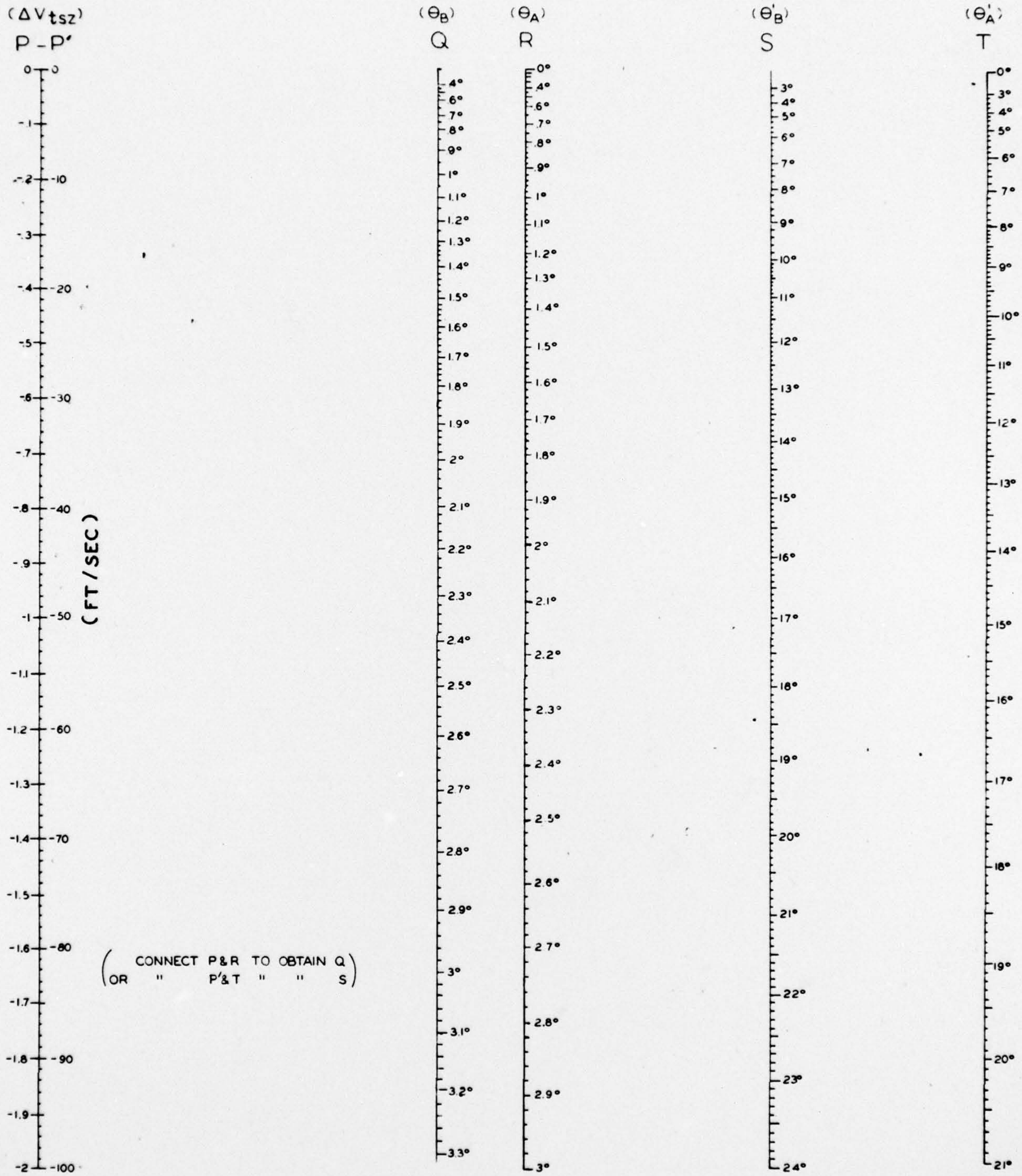
APPENDIX V



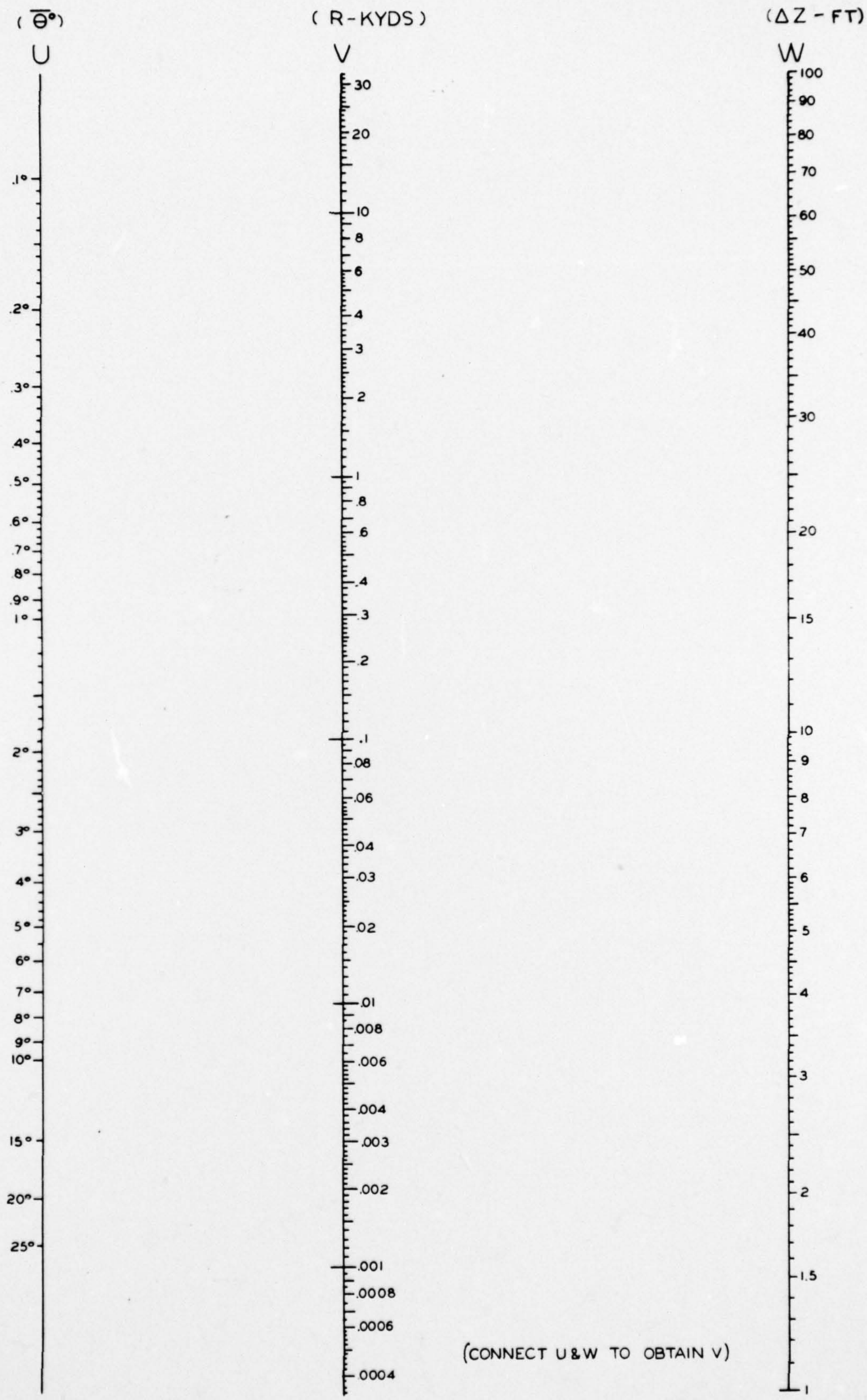

LIMITING RANGE NOMOGRAM I


(T—°F)
H
30°
40°
50°
60°
70°
80°
(Δt)
-1°
-2°
-3°
-4°
-5°
-6°
-7°
-8°
-9°
-10°
-20°
-30°
-40°
-50°
($\Delta V_t$)
I·J
0
10
20
30
40
50
60
70
80
90
100
(FT/SEC)
($\Delta V_{tsz}$)
K
0
10
20
30
40
50
60
70
80
90
100
(FT/SEC)
(ΔZ)
L
100
90
80
70
60
50
40
30
20
10
0
(FT)
M
(ΔS)
N
.1
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
.1
(0/00)
CONNECT H & I TO OBTAIN J
" L & N " " M
" M & J " " K

NOMOGRAM 2


(ΔV tsz)
P - P'
0 -.1 -.2 -.3 -.4 -.5 -.6 -.7 -.8 -.9 -1 -1.1 -1.2 -1.3 -1.4 -1.5 -1.6 -1.7 -1.8 -1.9 -2
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100
(FT/SEC)
(θB)
Q
.4° .6° .7° .8° .9° 1° 1.1° 1.2° 1.3° 1.4° 1.5° 1.6° 1.7° 1.8° 1.9° 2° 2.1° 2.2° 2.3° 2.4° 2.5° 2.6° 2.7° 2.8° 2.9° 3° 3.1° 3.2° 3.3°
(θA)
R
0° .4° .6° .7° .8° .9° 1° 1.1° 1.2° 1.3° 1.4° 1.5° 1.6° 1.7° 1.8° 1.9° 2° 2.1° 2.2° 2.3° 2.4° 2.5° 2.6° 2.7° 2.8° 2.9° 3°
(θ'B)
S
3° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18° 19° 20° 21° 22° 23° 24°
(θ'A)
T
0° 3° 4° 5° 6° 7° 8° 9° 10° 11° 12° 13° 14° 15° 16° 17° 18° 19° 20° 21°
(CONNECT P&R TO OBTAIN Q
OR " P'&T " " S)

**NOMOGRAM 3**




NOMOGRAM 4

MP
8-66

APPENDIX VI

BOTTOM TYPE

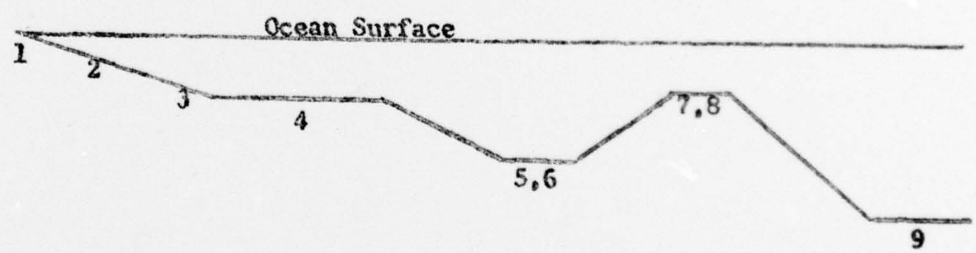
1. The type of the bottom beneath the test hydrophone should be coded as follows.

| If bottom is: | Code |
|---|---|
| Not otherwise specified | 0 |
| Mud | 1 |
| Sand and mud | 2 |
| Sand | 3 |
| Sand with shells and/or gravel | 4 |
| Shells | 5 |
| Gravel | 6 |
| Rock | 7 |
| Coral | 8 |
| Stone | 9 |

BOTTOM SHAPE

1. The configuration of the bottom in the region of the test hydrophone should be punched in accordance with the following code and sketch.

| Code | For a bottom that is: |
|---|---|
| 0 | Not otherwise specified |
| 1 | Upslope - in shallow water that slopes to deep water |
| 2 | Midslope - in middle section of a long slope |
| 3 | Downslope - in deep water that is sloping to shallow |
| 4 | Shelf - an essentially flat area with shallower water on one side and deeper water on the other side |
| 5 | Basin - an area where the water is deeper than the surrounding area; a hole |
| 6 | Valley - used also for a greatly elongated basin |
| 7 | Plateau - an area where the water is shallower than the surrounding area; a seamount or guyot |
| 8 | Ridge |
| 9 | Floor - the area over the deep oceanic floor |



APPENDIX VIII

SEA STATE

1. The best available estimate of the sea state at the time of the test is coded as follows.

| Code | Mean Height | Name | Description |
|---|---|---|---|
| 0 | 0 feet | Calm | Sea like mirror |
| 1 | 0 - 1 | Smooth | Ripples with appearance of scales; without foam crests |
| 2 | 1 - 3 | Slight | Large wavelets; crest break with glassy foam |
| 3 | 3 - 5 | Moderate | Scattered white caps |
| 4 | 5 - 8 | Rough | Small waves becoming larger; fairly frequent white caps |
| 5 | 8 - 12 | Very Rough | Moderate waves with pronounced long form; chance of some spray |
| 6 | 12 - 20 | High | Large waves with white crests; spray |
| 7 | 20 - 40 | Very High | High waves with dense streaks of foam along the direction of wind; heavy spray |
| 8 | over 40 | Precipitous | |
| 9 | " " | Confused | Very rough confused sea |

APPENDIX IX

SWELL

1. The amount of swell present at the time of the measurement is coded ad follows:

| Code | Description | Height (feet) | Length (feet) |
|---|---|---|---|
| 0 | no swell | 0 | 0 |
| 1 | low - short | 1 - 6 | 0 - 300 |
| 2 | low - average | 1 - 6 | 300 - 600 |
| 3 | low - long | 1 - 6 | over 600 |
| 4 | moderate - short | 6 - 12 | 0 - 300 |
| 5 | moderate - average | 6 - 12 | 300 - 600 |
| 6 | moderate - long | 6 - 12 | over 600 |
| 7 | high - short | over 12 | 0 - 300 |
| 8 | high - average | " " | 300 - 600 |
| 9 | high - long | " " | over 600 |

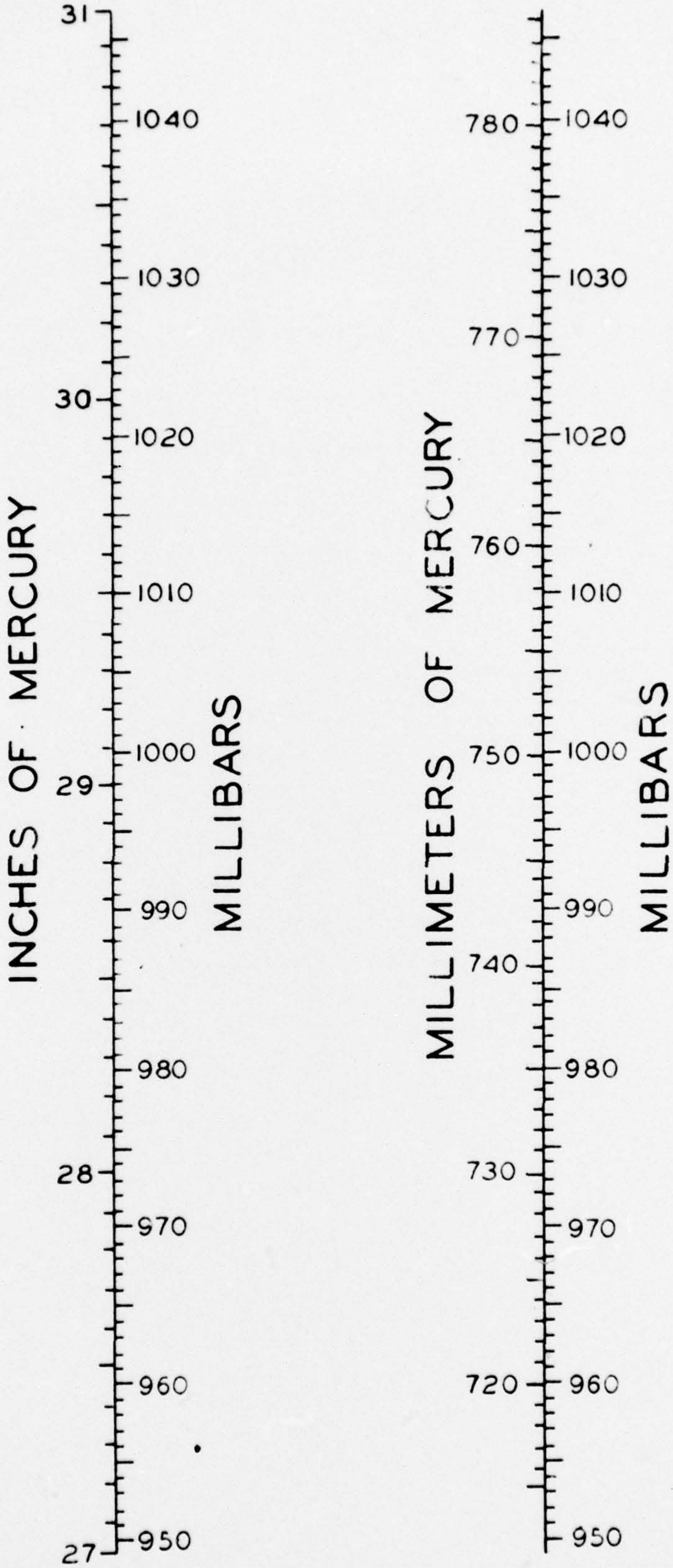
APPENDIX X

WIND SPEED AND DIRECTION

1. Wind Speed Wind speed to the nearest knot is to be punched directly in columns 69 and 70. A zero must be punched in column 69 if the wind is less than 10 knots. If equipment is not available to measure wind speed to this accuracy, punch X in column 69. A good subjective estimate of sea state is particularly necessary under these circumstances. Wind direction should be entered in any case.

2. Wind Direction Wind direction is to be punched in column 71 in accordance with the following code:

| Code | Description |
|---|---|
| 0 | not observed |
| 1 | North wind |
| 2 | North-East wind |
| 3 | East wind |
| 4 | South-East wind |
| 5 | South wind |
| 6 | South-West wind |
| 7 | West wind |
| 8 | North-West wind |
| 9 | low wind whose direction cannot be determined (calm) |


INCHES OF MERCURY
MILLIBARS
31
30
29
28
27
1040
1030
1020
1010
1000
990
980
970
960
950
MILLIMETERS OF MERCURY
MILLIBARS
780
770
760
750
740
730
720
1040
1030
1020
1010
1000
990
980
970
960
950

APPENDIX XI

DATA CARD NO. 31 32 33 34 35 | TIME 36 37 | DAY MONTH YEAR 38 39 | 40 | 41 42 | WEEKDAY (43)

TEST SHIP

NAME | CONDITION | RANGE 44 MILES

OPERATION CODE 45 | SYSTEM NO. 46 47 | REL. MOTION 48 KTS | SHIP DISTANCE 49 MI. | MAX DETECT 49Y

LOCATION ° / 50 51 52 53 N S 50X | ° / 54 55 56 57 58 E W 54X | SHORE DISTANCE MI. (59)

WATER DEPTH FMS (60 61) | HYDROPHONE DEPTH FMS (62 63) | LIMITING RANGE KYD (64)

BOTTOM TYPE (65) | BOTTOM SHAPE (66) | SEA STATE (67) | SWELL (68)

WIND SPEED & DIRECTION 69 70 KTS (71) | BAROMETER 72 73 MB | BAROMETER CHANGE 74 MB/3HR RISING FALLING 74X

PRECIPITATION

RAIN 31Y (L.M.H.)

SNOW 32Y (L.M.H.)

HAIL 33Y (L.M.H.)

B. T. DATA

NO.

S.C. 34Y

T.L.D.C. 35Y

B.L.D.C. 36Y

HYDROPHONE POSITION

A.T. 37Y | I.D.C. 40Y

B.T. 38Y | B.D.C. 41Y

A.D.C. 39Y | U.I. 42Y

AURAL NOISE ESTIMATE

SEA NOISE 43Y BIOL. 44Y EQUIP. 45Y MAN 46Y PLAT. 47Y

RAIN SNOW HAIL S.C. T.L.D.C. B.L.D.C. A.T. B.T. A.D.C. I.D.C. B.D.C. U.I. SEA N BIOL. EQUIP. MAN PLAT. MX DET

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 Y

DATA CARD NUMBER | TIME | DAY | MONTH | YEAR | WEEKDAY | RANGE | OPERATION | SYSTEM NUMBER | REL. MOTION | SHIP DIST. | LOCATION | SHORE DIST. | WATER DEPTH | HYDRO. DEPTH | LIM. RANGE | BTTM. TYPE | BTTM SHP | SEA STATE | SWELL | WIND SPEED | DIRECTION | BAROMETER | BARO. CHNG. X

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2

3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3

4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4

5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5

6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6

7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7

8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8

9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9

31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80

IBM 870834 | 11ND NEL 464

MASTER CARD NUMBER:

ANALYSIS NUMBERS:

RECORDING DATA

reel: take: chan:

RECORDER

IBM 870835