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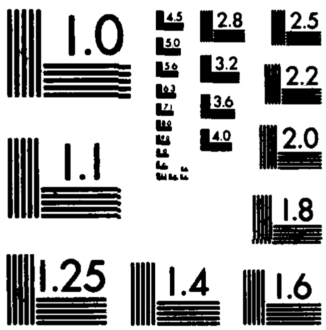

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OCUMENTATION OF WAVE-HEIGH
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HYDRAULICS LABORATORY

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Detailed documentation of two major programs, Wave Height and Tidal Analysis, for the Automated Data Acquisition and Control Systems (ADACS) is presented in this report. The wave-height program is used to analyze model data from hydraulic wave models and calculates various statistical parameters of wave height for specified model tests at selected locations in the model. Similarly, the Tidal Analysis program analyzes model data from hydraulic
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20. ABSTRACT (Continued).

tidal models and calculates various tidal parameters for specified model tests at selected locations in the model. For each of these programs, the program functions, specifics, input (output), listing, tape formats, etc., are discussed in detail.

PREFACE

The model automation techniques and model data analysis procedures, which are documented in this report, were supported in part by many U. S. Army Corps of Engineer Districts through authorization of various model studies that supported and used the techniques and methods presented herein. In addition, support for development of the various programs for Automated Data Acquisition and Control Systems was provided in part through Plant Replacement and Improvement Program funds.

The authors wish to acknowledge the various projects that provided funding and express their appreciation to the many U. S. Army Engineer Districts for authorizing the model studies that supported this work.

This report was prepared by Mr. K. A. Turner and Dr. D. L. Durham of Wave Processes Branch, U. S. Army Engineer Waterways Experiment Station (WES), under the general supervision of Mr. H. B. Simmons, Chief of the Hydraulics Laboratory, Mr. F. A. Herrmann, Jr., Assistant Chief of the Hydraulics Laboratory, and Dr. R. W. Whalin and Mr. C. E. Chatham, Jr., former and present chiefs, respectively, of the Wave Dynamics Division.

Commanders and Directors of WES during the conduct of this work and the preparation and publication of this report were COL G. H. Hilt, CE, COL John L. Cannon, CE, COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Technical Director was Mr. F. R. Brown.

CONTENTS

DOCUMENTATION OF WAVE-HEIGHT AND TIDAL ANALYSIS PROGRAMS FOR AUTOMATED DATA ACQUISITION AND CONTROL SYSTEMS

PART I: INTRODUCTION

Background

1. Over the past decade, automated processing technology has evolved from large, expensive computers to minicomputers and microprocessors. With this evolution, the physical size and cost of automated processing systems have greatly decreased with a minimal decrease in system capabilities. Cost reductions for such systems have resulted in economic justification of the use of minicomputers and microprocessors to a specific task or group of specific operations, whereas large computers can be justified economically only for multiple operations and tasks. The automation of physical, hydraulic modeling techniques has lagged automation efforts in many other fields mainly because of cost justification and the requirements of highly specialized instrumentation (e.g., sensors). However, needs for such automation have existed for many years. These needs are the results of requirements for (a) real-time model control decisions, (b) quasi-real-time data analyses, and (c) more accurate and reliable model data for engineering and environmental interest studies.

2. In the Wave Dynamics Division (WDD) of the Hydraulics Laboratory, U. S. Army Engineer Waterways Experiment Station (WES), recent increases in the number and complexity of physical model studies conducted each year and the use of such models to solve hydraulic problems of extremely large harbors (Whalin et al. 1974, Outlaw et al. 1977) and estuaries (requiring large model areas) have vividly demonstrated a need for automation of modeling procedures including operation, data collection, and data analysis. The physical size of models involving the study of long-wave phenomena, the vast complex of basins and channels requiring detailed study, and the large number of tests necessary to evaluate the effect of improvement plans on harbor circulation and oscillation eliminate manual procedures for data collection and analysis. Over the last several years the WDD has been very successful in automating (Durham and Downing 1978) major aspects of its physical models for wave (Durham and Greer 1975) and tidal inlet studies (Durham, Greer, and Whalin 1976). Major

automation efforts were devoted to: (a) model control, (b) model data acquisition, and (c) model data reduction and analyses. The two automated systems of WDD have been given the title "Automated Data Acquisition and Control System," whose acronym is ADACS. Although each physical model has some unique requirements, many automation requirements are similar and are shared by all physical models. Therefore ADACS for the wave and tidal inlet models of WDD were developed with as much generality and flexibility designed into each system as was possible considering the specific requirements of various models. Such approach to the design of each ADACS provides each system with the capability of being used by future physical models and sharing transducers for measuring various model parameters and for making major modifications to each system. The general configuration of each ADACS consists of the following four subsystems: (a) a data recording and control generating subsystem which is basically a minicomputer with required peripheral devices and appropriate interfacing to other subsystems; (b) model sensors and interfacing equipment for measuring model parameters such as water velocity, temperature of water and/or air, changes in water-surface elevations (waves and/or tides), etc.; (c) model controls and interfacing equipment for wave and tide generators, sensor calibrations, etc.; and (d) a data reduction, analysis, and display subsystem which, in most cases, is the minicomputer in the first subsystem with mass storage and display devices. The design, development, and general application of ADACS to wave and tidal inlet models are presented in detail by Whalin et al. (1974), Outlaw et al. (1977), Durham and Downing (1978), Durham and Greer (1975), and Durham, Greer, and Whalin (1976), which are suggested to readers requiring detailed information on ADACS. However, for general information as to system configuration and subsystem makeup, a schematic of ADACS for wave and tide models is presented in Figure 1 for reference during reading of this report.

Data Analyses

3. Digital computer programs have been written to process hydraulic model wave and tide data which are collected by the ADACS and are time-based voltages representing water-surface elevations. In addition, velocity measurements (time-based voltages) are collected and processed by ADACS. These programs accept model and testing parameters as well as model wave data

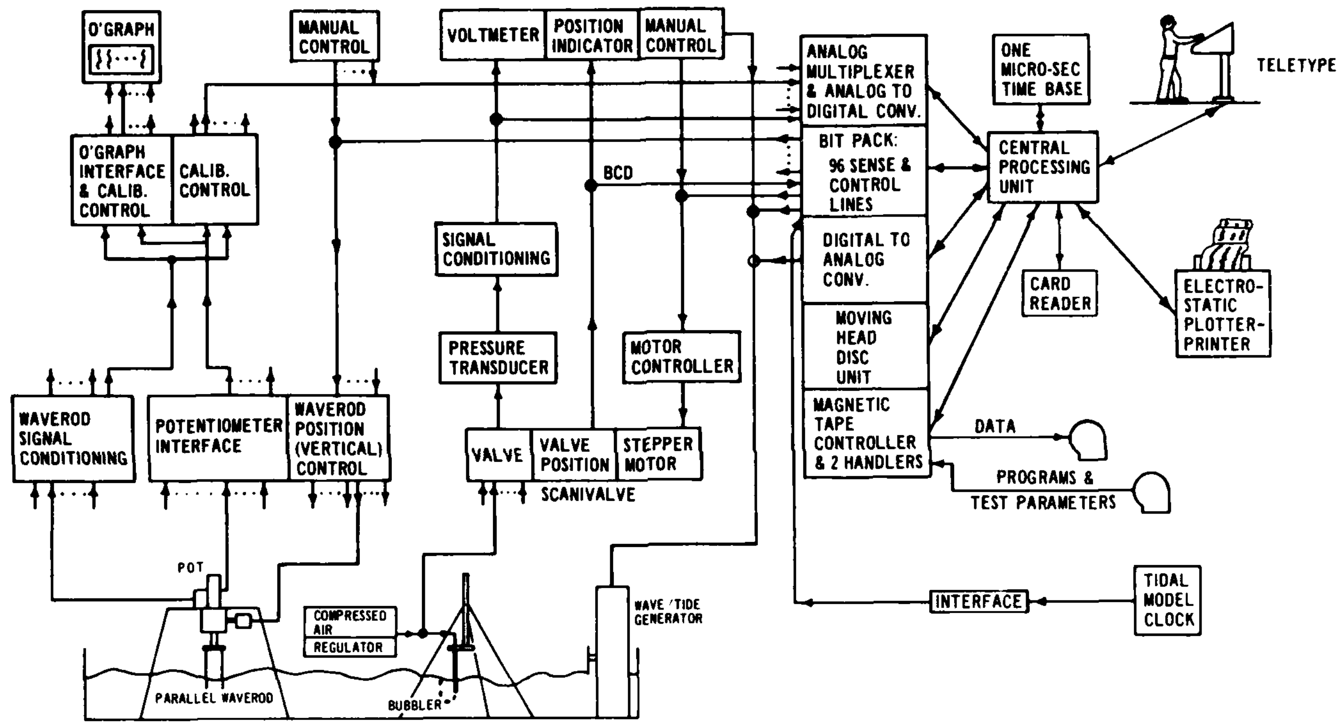

Figure 1. Automated Data Acquisition and Control System (ADACS) for hydraulic wave and tidal inlet models

from a magnetic tape generated by ADACS. ADACS computer programs for the acquisition of wave and tide data and control of various model operations are documented elsewhere.

4. Previous model data reduction techniques were time-consuming, subjective analyses performed by individuals. These manual techniques were confined to analyzing analog wave and tide records. For wave data, significant wave heights of progressive waves and heights and periods of standing waves were obtained. For tide data, mean tide level, tidal ranges, and phases were obtained. With the development and installation of ADACS on hydraulic models, an opportunity and need existed to automate such analysis techniques. Such automated procedures provide uniformity and accuracy of results, allow sophisticated mathematical and statistical procedures to be employed, expedite the reduction of large volumes of data, and provide model results in a report quality format.

5. Data analyses can be performed by either the ADACS or the Honeywell DPS-1 of the Automatic Data Processing Center at WES. Schematically, the various procedures for wave and tidal data analyses are as follows:

- a. Program initialization.
  - (1) Input test parameters and option flags.
  - (2) Read and decode data files.
  - (3) Demultiplex data files and scale data.
- b. Wave record analyses.
  - (1) $\bar{H} \pm \sigma_H$ and $\bar{T} \pm \sigma_T$.*
  - (2) H_{rms} .
  - (3) H_x where x is a specified percent of the highest wave heights, normally $x = 0.333$; thus $H_{1/3}$ is significant wave height.
  - (4) Option to plot wave heights versus time.
- c. Least-squares harmonic analysis for tide records.
  - (1) Amplitude and phase for specified periods.
  - (2) Relative phases and amplification factors between gages.
  - (3) Analysis of residual variance.
  - (4) Graphic output of above results.

---

* For convenience, symbols and unusual abbreviations are listed and defined in the Notation (Appendix A).

Scope of Report

6. The major purpose of this report is to document the ADACS computer programs that were developed for wave and tidal record analyses. The wave record analysis program, which is routinely used to analyze all model wave data, and tide record analysis programs, used in analyzing model tide data, are documented in detail in this report. Required inputs for each program and various tabular, graphic, and magnetic tape output options are fully described and illustrated. These computer programs are designed to be used (a) by ADACS configured as described in this report (Figure 1), and (b) for analyses of wave and tide data collected from all physical wave models in WT`

PART II: WAVE-HEIGHT PROGRAM

Program Functions

7. This program can process up to 50 channels of wave data which are recorded on 9-track magnetic tape by ADACS. Wave-height estimates and dominant wave period are computed for each channel of data with options to list in several tabular forms these results and various other data statistics. These wave-height estimates can be recorded in permanent data files on a magnetic tape for later reference or generation of report tables, etc. Also, plots of the scaled data with wave peaks and troughs labeled can be generated for each data channel.

Program Specifics

Crest-trough search techniques

8. Wave data taken by ADACS consist of a number of samples of water-surface elevations, $f(N\Delta t)$, taken at equally spaced time intervals, Δt, for N samples with $n = 1,\ldots,N$. Thus the sampling duration or record length is $N\Delta t/T$ wave periods and $T/\Delta t$ samples per wave period in the record. Estimations of these parameters assume that the waves for each wave gage or data channel are monochromatic.

9. A simple procedure for analyzing this wave record is to bracket the elevation data in each of the $N\Delta t/T$ data segments or windows and search these windows for maximum and minimum water-surface elevations (crests and troughs). The most difficult part of this procedure is choosing the windows correctly.

10. Starting at the beginning of the record it is possible to bracket each of $N\Delta t/T$ wave periods successively to find the maximum elevations during each period. Before the crests and troughs are used to define a wave height, they are checked for acceptability according to the following two conditions:

a. Each crest follows a trough.

b. Computed time intervals between deviations of crest to crest and trough to trough are less than a specified variation in the period of the generated wave.

A general flow chart of the wave peak-trough search routine is given in Figure 2. Using these selected wave heights (crest-trough), various statistics (mean, root mean square, and mean of largest one-third wave heights) are calculated. The positions relative to time of the crests and troughs, which are used to define the wave heights, are also used to calculate a dominant wave period of the record.

Scaling of data

11. All values output by this program are scaled to prototype feet by using either linear, quadratic, or spline interpretation schemes based on a spline fitting of the calibration data. However, as mentioned previously, the data as recorded on magnetic tape are voltage readings in either integer or scaled fraction form which, when scaled by the chosen technique, represent water-surface elevations. The analysis procedure mentioned previously is applied to the unscaled data (voltages). Since the analysis procedure is searching only for maximums and minimums, the procedure will work on any type of data whether the data are voltages or water-surface elevations. Extreme voltages also are the extreme water-surface elevations when the voltages are scaled.

12. The analysis is done on the unscaled data for the following two reasons:

a. Integer voltages require one-half of the memory required for real scaled water-surface elevations.

b. ADACS can execute integer arithmetic faster than real arithmetic. Thus, by performing the analysis on the unscaled data, computer memory and computer run time are minimized.

All values to be printed or saved on magnetic tape are scaled to water-surface elevations. The scaling technique and scaling coefficients are input from magnetic tape files generated during data acquisition.

13. Data are scaled by calibration coefficients located in the calibration coefficient record (Appendix C) on magnetic tape. Flags located in the transducer flag record on magnetic tape contain information yielding the type of fitting procedure to use with the calibration coefficients. As mentioned previously, the three fitting procedures are linear, quadratic, and spline. The following equation is used for both linear and quadratic fitting procedures

$$SE = [(SF3 \times USE + SF2) \times USE + SF1] \times MSF + MWL$$

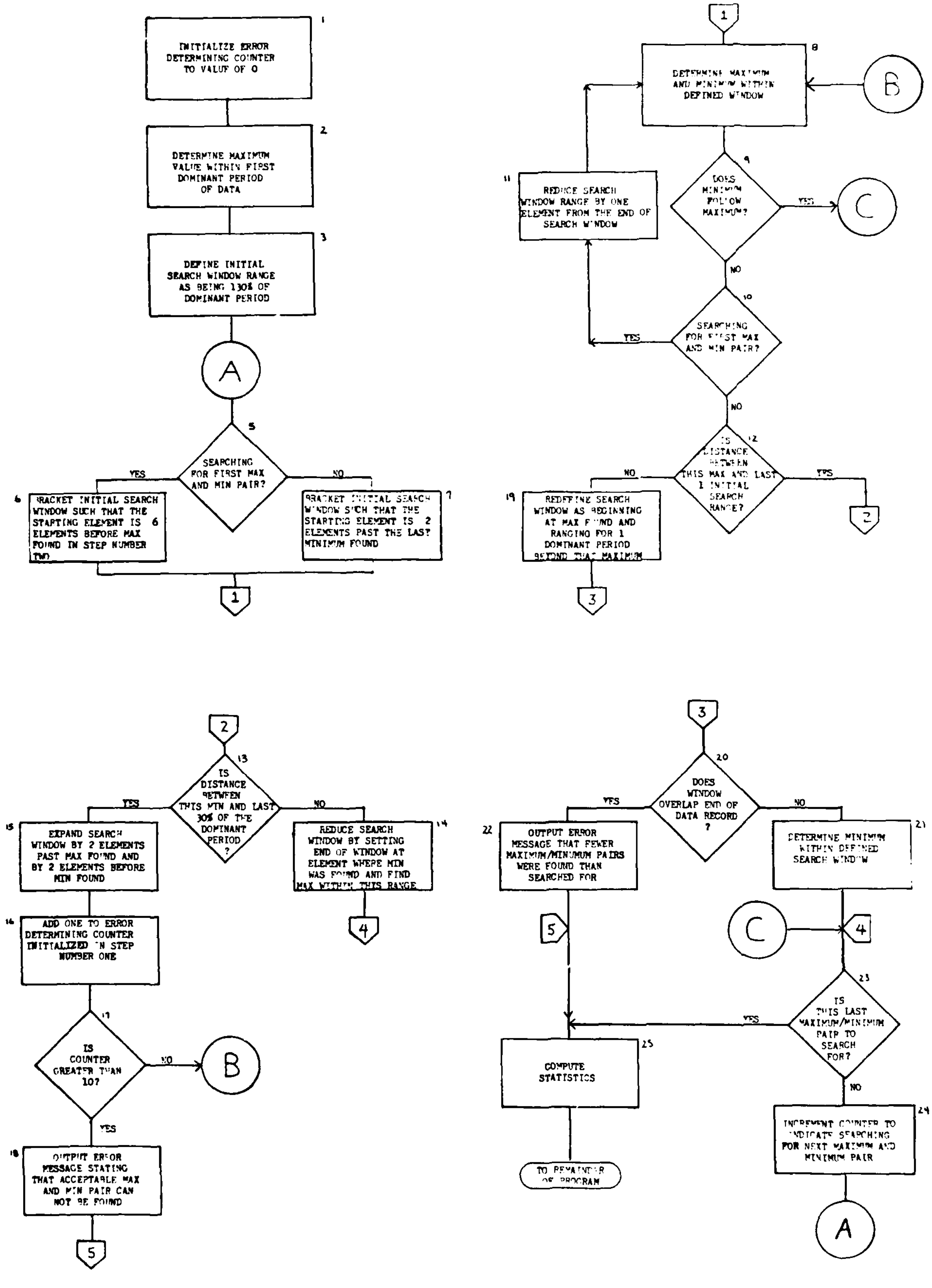

Figure 2. General flow chart of wave peak-trough search routines

where

SE = scaled water elevation

USE = unscaled water elevation

SF1 = scale factor constant

SF2 = scale factor linear term

SF3 = scale factor quadratic term

MSF = model scaling factor

MWL = reference mean water level

This one equation can be used for both linear and quadratic fits since SF3 will be zero when the linear fit is used. SF1, SF2, and SF3 come from the calibration coefficients record on magnetic tape. For the cubic spline fitting (Cheek, Radhakrishnan, and Tracy 1971) procedure, the necessary inputs include the actual observations from which the spline coefficients were derived. This information is stored in the calibration voltage record (Appendix C). Thus it is necessary to provide some information regarding the calibration of the sensor.

14. In order to calibrate each sensor, the output voltage from the sensor is monitored and recorded as the sensor is moved vertically a known distance into or out of the still water. A precision, linear-position potentiometer is located on the sensor stand and is coupled directly to the sensor by a gear-train driven by an electric motor. By moving vertically the coupled sensor and potentiometer wiper with the electric motor and by monitoring the output voltage from the potentiometer, the sensor can be moved vertically a precise distance. By systematically moving the sensor through 11 quasi-equally spaced locations over the range being used, 21 voltage samples are obtained from which an averaged voltage value for each of the 11 locations is calculated (Figure 3). This averaging technique minimizes the effects of any slack in gear drives and any hysteresis of the sensors response. The 21 voltage readings taken from both the sensor and the potentiometer wiper are recorded on magnetic tape in the calibration voltage record. The 11 averaged readings are fitted to a least squares linear fit. If the maximum deviation from the fit is greater than a previously specified tolerance, a least squares quadratic fit is performed. If the maximum deviation from this fit is greater than a previously specified tolerance, the cubic spline fit is computed. If the spline fit fails a specified tolerance for the slopes of the end points, the previously calculated quadratic fit is used and

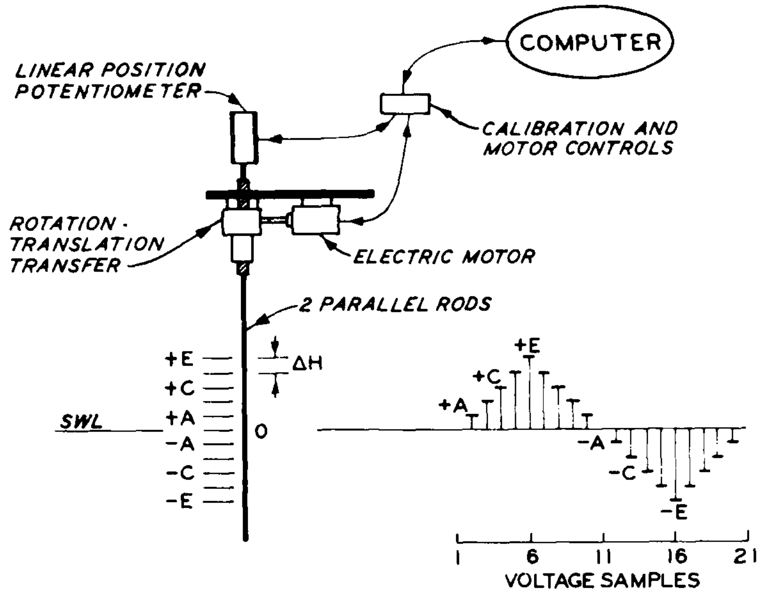

Figure 3. Waverod calibration

a message to this effect is supplied to the operator.

15. In computing the information that the spline fit routine must use, the 21 voltage readings from both the sensor and the potentiometer wiper must be averaged for the 11 locations recorded during the sensor's calibration. In turn, the voltages recorded from the potentiometer wiper must be scaled to a displacement by the proper potentiometer calibration coefficient recorded in the reference potentiometer calibration coefficient record (see Appendix C). Thus, for each displacement that is scaled from the potentiometer wiper voltages, a corresponding voltage from the sensor is available. This is the information the spline fitting procedure must have.

In-line assembly language

16. The EAI Pacer 100 FORTRAN compiler allows the programmer to use some EAI Pacer 100 assembly language instructions in line with FORTRAN coding. The only three assembly language instructions used in this program are the Jump, Link, and Octal instructions.

17. The Octal instruction is used in this program simply to set aside one memory cell and has the following form:

```
123   OCT   0
```

where 123 is a statement number.

18. The Link instruction is very much like the FORTRAN CALL instruction and has the following form:

L .123

where 123 is the statement number upon which the link instruction will act and is always an Octal instruction in this program. If the instruction

L .123

were executed, program execution would transfer to the statement following statement number 123 and a return pointer would be stored in statement number 123.

19. The Jump instruction is used in the following two forms in this program:

J .123

J .123,2

where 123 is the statement number to be acted upon. In the first form (J .123), the Jump instruction is used exactly like the FORTRAN "GO TO" statement. That is

J .123 and

GO TO 123

both cause program execution to transfer to statement number 123. The latter form (J .123,2) is used similarly to the FORTRAN "RETURN" statement. After a Link (L .123) instruction has been executed, a return pointer is stored in statement number 123. A Jump instruction of the following form

J .123,2

causes program execution to transfer to the return pointer stored in statement number 123.

20. In the following sample program, all forms of the three assembly language instruction (Link, Jump, and Octal) are demonstrated. Program execution follows sequentially the statement numbers associated with each statement.

```
1  L   .2
5  J   .6
2  OCT   0
3  I = 1
4  J   .2,2
6  END
```

Program Inputs

Teletype inputs

21. Several program initializations are input by teletype. The functions and pertinent related information for each of these inputs are discussed in this section.

- a. Tape Unit=? - The magnetic tape unit on which the data tape is located is input as either 14 or 15 for an EAI Pacer 100 with two tape drives.
- b. List Gage Numbers? - A "YES" response is input to cause each gage's number to be listed to the teletype as its data are processed. This is done so that the operator can monitor program progression and alter sense switch settings for different gages if desired. A "NO" response suppresses gage number listing.
- c. Title=? - If a title for the tabular output and plots is desired, it is input. A maximum of 40 characters may be input.
- d. Data Scaled Fractions? - Data as recorded on magnetic tape can be in either integer or scaled fraction form. Integers will be ranged from ±10,000 representing millivolts. Scaled fractions also will be ranged from ±10,000 millivolts but their bit configuration is much different than that for integers. Voltages as read by the EAI Pacer 100 always will be in scaled fraction form. However, since integers are more commonly used and are more readily understood, the analysis procedure expects data to be in integer form. If this input is "YES," the analysis program converts the data from scaled fraction form to integer form. If the input is "NO," the analysis program expects the data to have already been converted to integer form.

e. Average Model Depth=? - The average model depth is input as model feet. This is used in computing model scale factors for a distorted model.

f. File Name=? - The data file name to analyze is input as ASCII characters.

g. #PER to Analyze and #REC to Skip=? - The number of wave periods to analyze and the number of magnetic tape data records to skip before the analysis begins are input.

Sense switch settings

22. Sense switches are single throw switches located on the control panel of the Pacer 100. They are manually set and can be read by the CPU. The FORTRAN statement, IF (SENSW(1)) GO TO 10, causes program execution to branch to statement number 10 if sense switch A (1) is set or is .TRUE. It follows that sense switches are treated as logical variables.

23. The advantage to using sense switches is that they may be set or reset while a program is executing without impeding program execution. The functions of the sense switches in this program are as follows:

a. Sense Switch A [SENSW(1)] - If sense switch A is set, the "limited" printer output, described in paragraphs 29-35 of the Program Outputs section, is generated.

b. Sense Switch B [SENSW(2)] - If sense switch B is set, the operator may change the number of data cycles to analysis and also may skip data records on magnetic tape before the analysis begins.

c. Sense Switch C [SENSW(3)] - If sense switch C is set, a plot of the scaled prototype data is generated.

d. Sense Switch D [SENSW(4)] - If sense switch D is set, the original data are copied to a disc file and demultiplexed from the disc file. This is done to speed program execution.

e. Sense Switch E [SENSW(5)] - If sense switch E is reset, this program analyzes consecutive data files until two consecutive end of file marks are encountered or until the end of tape mark is encountered. If sense switch E is set, program execution is halted upon completion of the current data file being analyzed.

f. Sense Switch F [SENSW(6)] - If sense switch F is set, magnetic tape output, described in paragraphs 36-38 of the Programs Output section, is generated.

g. Sense Switch G [SENSW(7)] - If sense switches G and A are set, the summary output, described in paragraphs 29-35 of the Program Outputs section, is generated.

h. Sense Switch H [SENSW(8)] - If sense switch H is set, analysis of the next data gage is omitted. By exercising the option, described in paragraph 21 of the Program Inputs section of listing gage numbers, program progression can be monitored and any gage's analysis can be omitted by setting this sense switch.

Magnetic tape

24. Testing parameters, gage identification, scaling factors, test identification, and test data are all recorded or either derived from information recorded on magnetic tape. A general tape format is described in this section with more specific information available in Appendix C. The data tests are recorded in files on magnetic tape. There are two general file formats containing a variable number of records.

25. The two file formats can be called a calibration file and a noncalibration file. In a calibration file, several records are devoted to gage identification and data scaling coefficients. Since this information remains constant for a series of data tests, there is no need to record it in every data file. A calibration file and a noncalibration file are similar except that some records included in the calibration file are excluded from the noncalibration file. Thus this exclusive information recorded in a calibration file is applicable to all succeeding data files until updated by another calibration file.

26. Each file is separated by an end-of-file (EOF) mark and the file formats are as follows:

a. File Identification Record - This record is five 16-bit words long. The first three words contain a six-character ASCII code denoting the file name. The fifth word contains the length of the next record (usually 20 words).

b. First File Header Record - Testing and model identification information is contained in this record. The 15th element of this record determines whether this is a calibration file or a noncalibration file. The 20th word of this record contains the length of the next record (usually 50 words).

c. Second File Header Record - This record contains testing parameters and model control information. The model control information is not used in reducing the data.

d. Transducer Flag Record - This record contains two flags for each sensor sampled during data acquisition. These flags contain data scaling information, gage type, gage number, and information revealing calibration coefficient record and calibration voltage record lengths. This record exists only in a calibration file.

e. Calibration Coefficient Record - This record length is determined by the number of gages having calibration coefficients associated with them. A flag in the Transducer Flag Record determines whether a gage has coefficients in the Calibration Coefficient Record. There are 11 coefficients for each gage having coefficients recorded in this record. If no gages have entries in this record, the record is not recorded on tape. This record exists only in a calibration file.

f. Gage Name Record - This record contains two elements (four ASCII characters) for each gage. These ASCII characters are used for gage labeling and identification. This record exists only in a calibration file.

g. Weighted Mean Depth Record - This record contains an entry for each wave gage representing the average model depth in feet between the gage and the wave generator. These values are used in computing Keulegan's friction coefficients (Keulegan 1950). This record exists only in a calibration file.

h. Gage Distance Record - This record contains an entry for each wave gage representing the distance between each gage and the wave generator in prototype feet. This record exists only in a calibration file.

i. Gage Coordinate Record - This record contains three floating point coordinates for each gage. An X and Y coordinate determining location and a Z coordinate representing water depth for each gage are recorded. This record exists only in a calibration file.

j. Reference Potentiometer Calibration Coefficient Record - This record contains the coefficients necessary to convert the millivoltage readings collected from the reference potentiometers (discussed in PART III) to inches. There is one coefficient (slope) for each of the gages calibrated. This record exists only in a calibration file.

k. Calibration Voltage Record - The 21 voltage samples collected from both the reference potentiometer and the wave sensor during calibration (paragraph 14) are recorded in this record. These actual readings are necessary if the data scaling requires that a cubic spline technique be used. This record exists only in a calibration file.

l. Data Records - The remaining records are data records. The length of these records is equal to the number of data gages times the number of data samples per wave cycle divided by the number of data records per wave cycle. The number of data records is equal to the number of wave cycles sampled times the number of records per wave cycle.

Program Outputs

Teletype

27. All teletype outputs generated by this program are to aid in

program operation. The teletype inputs described in paragraph 21 are input upon request from teletype outputs; that is, each teletype input is requested by a teletype output in a question-answer fashion. The only other teletype outputs that may be generated by this program are gage numbers. If requested, as each gage is processed the gage's number is output to the teletype. This would be done so that the operator could monitor program progression and alter sense switch settings for different gages if desired.

28. Examples of teletype output as well as teletype input are illustrated in Plates 1 and 2. Notice that all teletype outputs except gage number listings in Plate 2 are followed by question marks. All other listings represent teletype inputs. Notice also that the analysis in Plate 2 will be for 20 wave periods with the first two data records on magnetic tape skipped or not analyzed.

Printer

29. There are three general forms of printer output for this program. The output can vary from very descriptive analysis to little more than a summary of the analysis results. The form of output desired is selected by sense switch options. For this documentation the three forms of output will be referred to as full (Plate 3), limited (Plate 4), and summary (Plate 5) outputs.

30. The first lines of output generated by the program (Plate 6) are test identification information. This is information that comes from the first and second header records on magnetic tape. For the full and limited output options, this information is output on a separate page. For the summary output, the test identification is on the same page as the analysis output.

31. For the full output analysis, a page is devoted to each gage with gage number, gage arrangement, prototype water depth, and gage coordinates printed out. The crest-trough search technique itemizes the crests and troughs found, in prototype minutes, from the start of the test. The wave-height value and time also are listed. Statistics in both model inches and prototype feet of the data are then printed out which include average wave height with standard deviation, rms, average of highest one-third wave heights with standard deviation, average of highest one-third wave heights with Keulegan's (1950) friction coefficients applied, and computed wave period with standard deviation.

32. There are two error messages that the search routine may output. The first is shown in Plate 7 as "*** only 23 periods of Data Found ***." This is not a critical situation since the program was only searching for 24 wave periods. In fact, it is quite common to find one or two less periods than searching for due to the nature of the gage arrangement in the model, the data acquisition technique, and the search technique. However, the other error situation may be more critical. Plate 8 illustrates a search error. A search error simply means that a crest-trough pair as found by the search technique did not meet the acceptability requirements described in PART III. The number of periods analyzed before the error occurred is printed out to show how much good data were considered before the error occurred. As a note, a search error usually occurs on gages with extremely low amplitudes (e.g., <0.05 prototype feet), or if data were acquired before a model had properly set up.

33. A limited output option is identical in every respect with the full output option except that the crests, troughs, and wave heights are not itemized.

34. The summary output is designed to provide a minimum amount of printout but still provide the most commonly needed statistics from the analysis. This form of output fits on one page of computer paper. The test identification information in Plate 6 is located at the top of the output page for summary output (Plate 5). Each gage has one line of output containing gage name, average wave height in prototype feet with standard deviation, average of highest one-third wave heights in prototype feet with standard deviation, calculated model and prototype periods in seconds with standard deviations, average of highest one-third wave heights with Keulegan's friction factors applied, error code, and number of data cycles or periods found by the search technique.

35. The columns of information at the extreme right of Plate 5 refer to the error code and the number of data cycles found. First the gage number is listed again, then an error code of 0, 1, or 2 is listed. An error code of 0 means that no error occurred. An error code of 1 means that the search routine found fewer cycles of data than it was searching for. This is the same error as shown in Plate 7 by "*** only 23 Periods of Data Found ***." An error code of 2 means that a "search error" was encountered. The last column refers to the number of data cycles found by the search technique. For an

error code of 0, the number of cycles found will be the same number searched for. For an error code of 1 the number of cycles should be no less than three or four cycles less than the number searched for. For an error code of 2 the number of cycles found will be unpredictable. However, the statistics listed will correspond only to those wave cycles found.

Magnetic tape

36. As an option, an output magnetic tape may be generated by this program. Since this program was written to be run on an EAI Pacer 100 minicomputer with only two magnetic tape units, the program will automatically consider the output tape to be the tape unit which is not declared to be the input tape unit.

37. The output tape is simply a direct copy of some (not all) of the input tape records with the addition of another record containing analysis results. This output tape is desirable for later data comparison in the form of computer-generated analysis result tables or plots.

38. There is no differentiation between a calibration file and a non-calibration file for the output tape. The file format is aa follows:

a. File Identification Record - Same as input tape.

b. First File Header Record - Same as input tape.

c. Second File Header Record - Same as input tape.

d. Transducer Flag Record - Same as input tape.

e. Gage Name Record - Same as input tape.

f. Weighted Mean Depth Record - Same as input tape.

g. Gage Distance Record - Same as input tape.

h. Gage Coordinate Record - Same as input tape.

i. Analysis Results Record - This record contains the average highest one-third of the wave heights for each gage's data. There is one entry in this record for each gage.

Graphics

39. As an option, this program is capable of generating a plot of the scaled prototype data. The peaks and troughs as found by the search technique described in paragraph 10 are labeled on the plot by asterisks. Only the first 3000 data points may be plotted; this is due to buffer limitations within the program. Plate 9 is an example of a data plot.

PART III: TIDAL ANALYSIS PROGRAM

Program Functions

40. The tidal analysis program can process three types of data: water-surface tidal elevations, velocities, and temperatures. The latter two types of data (velocities and temperatures) are both handled in the same manner. They are simply scaled, using scaling factors which are input from magnetic tape, and plotted with respect to model time.

41. Water-surface elevation data are scaled, using scaling factors computed from informatiom on magnetic tape, and also plotted. The data are fitted to a series of cosine functions (harmonic analyses) by a Legendre method of least squares approximation (Hamming 1950), which is fully described in the following sections of PART III. Results of the least squares analysis is printed in tabular form. At this point, the analysis can take one of two possible courses. The model data can be compared with the least squares fit or it can be compared with a reference data set (usually prototype data). An overlay plot of the original and comparison data can be generated.

42. The residual of the comparison and original data may be plotted with the option of computing a power spectral density on the residuals. The power spectral density estimate is computed by means of FFT (Fast Fourier Transform) techniques (Electronics Associates Inc. 1976). The procedure is to first compute the direct FFT of residual data and then compute the absolute value squared. Thus, if the result of the FFT is

$$FFT(n) = fft_1(n) + fft_2(n)$$

then

$$PSD(n) = [fft_1(n)]^2 + [fft_2(n)]^2$$

where

$FFT(n)$ = the Fast Fourier Transform results

$fft_1(n)$ = real part of FFT results

$fft_2(n)$ = imaginary part of FFT results

$PSD(n)$ = results of power spectral density

The result of the power spectral density can be plotted as an option.

Program Specifics

Least squares harmonic analysis

43. The least squares fitting procedure mentioned earlier considers the data to be an equally spaced series, $f(n\Delta t)$, with $n = 1,\ldots,N$ where N is the total number of data samples in the series and Δt is the time interval between consecutive samples. The series is assumed to be periodic of the form

$$f(n\Delta t) = f'(n\Delta t) + \varepsilon(n\Delta t) = a_o + \sum_{i=1}^{J} [a_i \cos(\omega_i n\Delta t) + b_i \sin(\omega_i n\Delta t)] + \varepsilon(n\Delta t) \quad (1)$$

where

$f'(n\Delta t)$ = séries less noise (true signal)

$\varepsilon(n\Delta t)$ = noise associated with transfer function of instruments, etc.

a_o = mean of $f(n\Delta t)$

J = total number of components and is $\leq N/2$

$\omega_i = 2\pi/T_i$

T_i = wave period of i^{th} component

44. The fitting procedure minimizes the error produced by $\varepsilon(n\Delta t)$ by using a Legendre method of least squares such that the following is true:

$$E = \sum_{n=1}^{N} \varepsilon^2(n\Delta t) = \sum_{n=1}^{N} [f(n\Delta t) - f'(n\Delta t)]^2 \rightarrow \text{minimal} \quad (2)$$

where E = error that the least squares procedure minimizes. To minimize the error, set

$$\frac{\partial E}{\partial a_j} = 0 \quad \text{and} \quad \frac{\partial E}{\partial b_j} = 0 \quad \text{for} \quad j = 1,\ldots,J$$

Since

$$\frac{\partial E}{\partial a_j} = \frac{\partial}{\partial a_j}\left(\sum_{n=1}^{N} \left\{[f'(n\Delta t)]^2 - 2f'(n\Delta t)\right\} \times \left\{\sum_{i=1}^{N} [a_i \cos(\omega_i n\Delta t) + b_i \sin(\omega_i n\Delta t)]\right\} + \left\{\sum_{i=1}^{J} [a_i \cos(\omega_i n\Delta t) + b_i \sin(\omega_i n\Delta t)]\right\}^2\right)$$

for $j = 1,\ldots,J$ and

$$\frac{\partial}{\partial a_j}(\Sigma) = \Sigma\left(\frac{\partial}{\partial a_j}\right),$$

then

$$\frac{\partial E}{\partial a_j} = \sum_{n=1}^{N}\left[-2f'(n\Delta t)\cos(\omega_j n\Delta t) + 2\cos(\omega_j n\Delta t)\right]\sum_{i=1}^{J}[a_j \cos(\omega_i n\Delta t)$$

$$+ b_i \sin(\omega_i n\Delta t)] \quad \text{for} \quad j = 1,\ldots,J$$

Similarly,

$$\frac{\partial E}{\partial b_j} = \sum_{n=1}^{N}\left[-2f'(n\Delta t)\sin(\omega_j n\Delta t)\ 2\sin(\omega_j n\Delta t)\right]\sum_{i=1}^{J}[a_i \cos(\omega_i n\Delta t)$$

$$+ b_i \sin(\omega_i n\Delta t)] \quad \text{for} \quad j = 1,\ldots,J$$

By setting $\frac{\partial E}{\partial a_j} = 0$ and $\frac{\partial E}{\partial b_j} = 0$ for $j = 1,\ldots,J$ the equations reduce to

$$\sum_{n=1}^{N}\left\{\cos(\omega_j n\Delta t)\sum_{i=1}^{J}[a_i \cos(\omega_i n\Delta t) + b_i \sin(\omega_i n\Delta t)]\right\}$$

$$= \sum_{n=1}^{N}[f'(n\Delta t)\cos(\omega_j n\Delta t)] \quad \text{for} \quad j = 1,\ldots,J$$

and

$$\sum_{n=1}^{N}\left\{\sin(\omega_j n\Delta t)\sum_{i=1}^{J}[a_i \cos(\omega_i n\Delta t) + b_i \sin(\omega_i n\Delta t)]\right\}$$

$$= \sum_{n=1}^{N}[f'(n\Delta t)\sin(\omega_j n\Delta t)] \quad \text{for} \quad j = 1,\ldots,J$$

which is a set of 2J simultaneous equations for a_i and b_i.

45. In matrix notation, these equations can be written in the following form:

$$[C]\ [A] = [F]$$

with

$$
\overset{[C]}{\begin{bmatrix}
C_1\,C_1 & C_1\,C_2 \ldots C_1\,C_j & C_1\,S_1 & C_1\,S_2 \ldots C_1\,S_j \\
C_2\,C_1 & C_2\,C_2 \ldots C_2\,C_j & C_2\,S_1 & C_2\,S_2 \ldots C_2\,S_j \\
\vdots & \vdots \qquad \vdots & \vdots & \vdots \qquad \vdots \\
C_j\,C_1 & C_j\,C_2 \ldots C_3\,C_j & C_j\,S_1 & C_j\,S_2 \ldots C_j\,S_j \\
S_1\,C_1 & S_1\,C_2 \ldots S_1\,C_j & S_1\,S_1 & S_1\,S_2 \ldots S_1\,S_j \\
S_2\,C_1 & S_2\,C_2 \ldots S_2\,C_j & S_2\,S_1 & S_2\,S_2 \ldots S_2\,S_j \\
\vdots & \vdots \qquad \vdots & \vdots & \vdots \qquad \vdots \\
S_j\,C_1 & S_j\,C_2 \ldots S_j\,C_j & S_j\,S_1 & S_j\,S_2 \ldots S_j\,S_j
\end{bmatrix}}
\times
\overset{[A]}{\begin{bmatrix} a_1 \\ a_2 \\ \vdots \\ a_j \\ b_1 \\ b_2 \\ \vdots \\ b_j \end{bmatrix}}
=
\overset{[F]}{\begin{bmatrix} C_1\,f \\ C_2\,f \\ \vdots \\ C_j\,f \\ S_1\,f \\ S_2\,f \\ \vdots \\ S_j\,f \end{bmatrix}}
$$

where C is a symmetric matrix with

$$C_j = \sum_{n=1}^{N} \cos\,(\omega_j n\Delta t) \quad j = 1,2,\ldots,J$$

$$S_j = \sum_{n=1}^{N} \sin\,(\omega_j n\Delta t) \quad j = 1,2,\ldots,J$$

$$C_j f = \sum_{n=1}^{N} [f'(n\Delta t)\ \cos\,(\omega_j n\Delta t)] \quad j = 1,2,\ldots,J$$

$$S_j f = \sum_{n=1}^{N} [f'(n\Delta t)\ \sin\,(\omega_j n\Delta t)] \quad j = 1,2,\ldots,J$$

The method of solution for a_j and b_j for $j = 1,\ldots,J$ is:

$$[A] = [C]^{-1}\ [f]$$

46. It can be shown that $\sum_{i=1}^{J} a_i \cos(\omega_i n\Delta t) + b_i \sin(\omega_i n\Delta T)$ is equal to

$$\sum_{i=1}^{J} Amp_i \times \cos\,[\omega_i(n\Delta t) - PHS_i]$$

where

$Amp_i = a_i^2 + b_i^2$, commonly called amplitude

$PHS_i = \text{ARCTAN}\left(\frac{b_i}{a_i}\right)$, commonly called phase angle

The latter equation is easier to work with and is used in this program where results of the lease squares harmonic analysis are expressed as Amp_i and PHS_i .

Scaling data

47. As mentioned previously, both velocity and temperature data are scaled from scaling factors read directly from magnetic tape. Tidal data are handled much differently. There is only one transducer for all tidal gages, with a multiplexer selecting which gage the transducer is acting upon; thus the same scaling factors can be applied to all tidal gages.

48. With every data scan during data acquisition, reference tidal gages also are scanned (usually three). These reference gages are located in a still-water pool that does not oscillate with the model. The sensors of each reference gage are extended a known displacement into the water. This "known" displacement is recorded in the gage coordinate record in the "depth" location for each reference gage (Appendix F). By relating this known displacement to the reading obtained from each reference gage during a scan, it is possible to compute new calibration coefficients for the tidal transducer with each data scan. The purpose for computing new update coefficients with each scan is to counteract any electronic drift within the sensor.

49. These tidal calibration coefficients are computed by performing a linear least squares fit on the reference channels.

Reference elevations

50. Each tidal gage has a zero reference reading recorded on magnetic

tape. This zero reference reading is taken at a known elevation on the model with the model water surface still. This zero reference reading is considered to be the known elevation of the model. Thus each virtual reading is computed in the following manner:

$$VR = (AR - ZRR)SFS + KE + SFC$$

where

VR = virtual reading

AR = actual reading

ZRR = zero reference reading

SFS = scale factor slope

KE = prototype water elevation at time zero reference readings made

SFC = scale factor constant

51. Reference gages are read prior to being moved to their known displacements. That is to say that all reference gages are at the same displacement when they are read for their zero reference readings.

Phase adjustment

52. As described previously, results of the least squares harmonic analysis are expressed as amplitude and phase. A data series can be reconstructed from this analysis by using the following equation:

$$f'(n\Delta t) = a_o + \sum_{i=1}^{J} Amp_i \cos [\omega_i(n\Delta t - PHS_i)] \quad (3)$$

where

$f'(n\Delta t)$ = reconstructed data series

a_o = mean of data series

Amp_i = amplitude of component i

ω_i = 2π period of component i

PHS_i = phase angle of component i

53. It is a program option to compare this reconstructed data series with the original data on tape. Another option, as previously mentioned, is to compare the original data with a reference data set such as prototype data, data from another test, etc. However, it is not possible to compare the original data with both a reference data set and the analysis in the same

execution run of the program. The program must be executed twice to exercise both options.

54. In comparing the original data with reference data, components from previous analysis are input. Phases, amplitudes, periods, and mean water level are input to Equation 3. Thus a data series is generated for comparison. It is unlikely that values of phase angles for the comparison data will agree with that of the original data; therefore the phase for the two data sets should be adjusted. Whenever original data are to be compared with reference data, the program considers the first gage that it analyzes to be a deepwater reference gage. The deepwater reference gage should most closely represent the tide that is being applied to the estuary. Thus the deepwater gage should be remote enough from the estuary such that modification or changes in the estuary would not affect data on the deepwater reference gage. Therefore the amplitudes should remain constant from data series to data series on the deepwater gage for a particular tide. The phase angles should also remain constant relative to one another. Thus, with the deepwater gage remaining constant from data series to data series, it is possible to adjust phases so that they will closely relate to this deepwater reference gage. This is done by subtracting the phase of the M_2 component of the reference data from the phase of the M_2 component of the original data and adding this difference to all phases of all components of the reference data for all gages. This effectively adjusts the phases for the entire run if the phases for all gages on the reference data set are correlated. It is only necessary to take the difference of the M_2 component phase since for the deepwater reference gage the phase gage angles for each component should remain constant relative to one another. It also should be noted that the M_2 component is the most influential component (that is, the component with the largest amplitude) and that component should have the least error in phase.

<u>In-line assembly language</u>

55. The EAI Pacer 100 FORTRAN compiler allows the programmer to use some EAI Pacer 100 assembly language instructions in line with FORTRAN coding. The only three assembly language instructions used in this program are the Jump, Link, and Octal instructions. These instructions have been explained in detail in paragraphs 16-20 of PART II and will not be repeated here.

Program Inputs

Teletype inputs

56. Several program initializations are input by teletype. The functions and pertinent related information of each of these inputs are defined in this section.

a. Force Shift - If reference data are to be compared with the model data, a shift in phase is performed on the reference data so that it will more closely relate to the model data. This automatic shift may or may not be desirable so an overriding force shift may be performed to further enhance or counteract the automatic shift. This shift is input in degrees. Thus a value of Ø for the force shift causes no further shift action to be taken or a value of 180 would cause a shift of 180 deg for the reference data.

b. Taper Residual - If it is desirable to apply a taper cosine bell function to the residual of the model data and the comparison data before power spectrum is performed, this would be input as "Y." If not, an "N" would be input.

c. Calibration Fit Option - As mentioned previously, a least squares linear fit is performed on the reference gages (usually three) to determine scale factors for the tidal gages. This option allows the fit to be performed on any two of the reference gages or all three of them. A value of 1 would cause the least squares fit to be performed on the reference gage with a positive displacement and the reference gage at zero. A value of 2 would cause the least squares fit to be performed on the reference gage with a negative displacement and the reference gage at zero. A value of 3 would cause the least squares fit to be performed on the reference gage with a positive displacement and the reference gage with the negative displacement. A value of 4 would cause the least squares fit to be performed on all three of the previously mentioned reference gages.

d. Number of Components for the Analysis - The number of least squares harmonic analysis components is input.

e. Component Period - A component period in prototype hours is input for each component.

f. List Update Calibrations - If this is answered by "Y," the update calibration coefficients for the tidal gages are listed as they are computed. If "N" is input, the coefficients are not listed.

g. Reference Data to be Input - If this is answered by "Y," reference components will be read from cards as each data channel is reduced. These reference components will be used to generate reference data to compare with the particular gage data.

h. Number of Reference Components to be Input - If reference data are to be input, the number of components to be read from cards is input here.

i. How Often Update Calibration - The number of data scans to skip between computing update calibration coefficients is input. If the value is 1, update calibration coefficients will be computed for every scan. It follows that a value of 3 would cause new coefficients to be computed for every third data scan.

j. Label - If a label for the tabular output and plots is desired, it is input. A maximum of 20 characters may be input.

k. Number of Records to Skip - If it is desired to skip some data before the analysis is done, the number of data records (on tape) to be skipped is input.

l. Tape Unit - The magnetic tape unit on which the data tape is located is input here. It will be either 14 or 15 for an EAI Pacer 100 with two tape drives.

m. Average Model Depth - The average model depth is input as model feet. This is used in scaling a distorted model.

n. File Name - The data file name is input as ASCII characters.

o. Number of Data Cycles to Analyze - The number of cycles of data to analyze for this program execution is input.

Sense switch settings

57. Sense switches are single throw switches located on the control panel of the Pacer 100. They are manually set and can be read by the CPU. The FORTRAN statement, IF (SENSW (1)) GO TO 10, causes program execution to branch to statement number 10 if sense switch A or switch (1) is set or is .TRUE. It follows that sense switches are treated as logical variables. The advantage to using sense switches is that they may be set or reset while a program is executing without impeding program execution. The functions of the sense switches in this program are as follows:

a. Sense Switch A [SENSW (1)] - If sense switch A is reset, a plot of the original data is generated for each channel. If set, the plot is not generated.

b. Sense Switch B [SENSW (2)] - If sense switch B is reset, an overlay plot of the original data and comparison data is generated. The mean of the comparison data will be included in the comparison data and the mean of the original data will be included in the original data.

c. Sense Switch C [SENSW (3)] - If sense switch C is reset, an overlay plot of the original data with its mean removed and the comparison data with its mean removed is generated.

d. Sense Switch D [SENSW (4)] - If sense switch D is reset, a plot of the residual of the original data and the comparison data is generated.

e. Sense Switch E [SENSW (5)] - If sense switch E is reset, the power spectral density option is performed on the residual with a plot of the results generated.

f. Sense Switch F [SENSW (6)] - The program will skip data channels as long as sense switch F is set. Once the switch is reset, the program will continue to process data channels in sequential order.

g. Sense Switch G [SENSW (7)] - If sense switch G is reset, the original scaled data will be listed in tabular form.

Magnetic tape

58. Testing parameters, gage identification, scaling factors, test identification, and test data are all recorded or either derived from information recorded on magnetic tape. A general tape format is described in this section with more specific information available in Appendix F. The test data are recorded in files on magnetic tape. There are two general file formats containing a variable number of records.

59. The two file formats can be called a calibration file and a noncalibration file. In a calibration file, several records are devoted to gage identification and data scaling coefficients. Since this information remains constant for a series of data tests, there is no need to record it in every data file. A calibration file and a noncalibration file are similar except that some records included in the calibration file are excluded from the noncalibration file. Thus this exclusive information recorded in a calibration file is applicable to all proceeding data files until updated by another calibration file.

60. Each file is separated by an end-of-file (EOF) mark and the file formats are as follows:

a. File Identification Record - This record is five elements long. The first three elements contain a six-character ASCII code denoting the file name. The fifth element denotes the length of the next record.

b. First File Header Record - The fifth element of the file identification record contains the elemental length (usually 20) of this record. This record contains testing and model identification information. The 20th element of this record contains the length of the next record.

c. Second File Header Record - The 20th element of the first file header record contains the elemental length of this record. This record contains testing parameters and model control information. The model control information is not used in reducing the data.

d. Transducer Flag Record - This record contains two flags for each sensor sampled during data acquisition. These flags contain data scaling information revealing the length of the calibration coefficient record and calibration voltage record. This record exists only in a calibration file.

e. Calibration Coefficient Record - This record length is determined by the number of gages having calibration coefficients associated with them. A flag in the transducer flag record determines whether a gage has coefficients in the coefficient record. There are 11 coefficients for each gage that has coefficients recorded in this record. If no gages have entries in this record, the record is not recorded on tape. This record exists only in a calibration file.

f. Gage Name Record - This record contains two elements (4 ASCII characters) for each gage. These ASCII characters are used for gage labeling and identification. This record exists only in a calibration file.

g. Gage Coordinate Record - This record contains three floating point coordinates for each gage: an X and Y coordinate determining location and Z coordinate determining water depth for each gage that is recorded. This record exists only in a calibration file.

h. Reference Potentiometer Calibration Coefficient Record - This record is not used by this program and is skipped during program execution. This record exists only in a calibration file.

i. Calibration Voltage Record - This record is not used by this program and is skipped during program execution. This record exists only in a calibration file.

j. Zero Reference Reading Record - This record contains the zero reference readings for each tidal gage and each tidal reference gage. This record exists only in a calibration file.

k. Data Records - The remaining records are data records. The length of these records is equal to the number of the data gages times the number of data samples per tidal cycle divided by the number of data records per tidal cycle. The number of data records is equal to the number of tidal cycles sampled times the number of records per tidal cycle.

Cards

61. As mentioned previously, if original data are to be compared with reference data, the components of the reference data are input on cards. This is the only information that is input on cards and if reference data are not to be compared, no cards are needed for program execution. The necessary information to be input from cards is a period, phase, and amplitude for each component of the reference data as well as a mean of the data. There will be one card for each component in the following FORTRAN format, 3F10.5. The

the first "F" field will be for the period in prototype hours, the second "F" field will be for phase angle in degrees, and the third "F" field will be for amplitude in prototype feet. The last card will contain the average depth or "mean" in model feet. Thus, if the reference data were to be generated for three components having the following periods, phase, and amplitudes:

Component No.	Period hr	Phase deg	Amplitude ft
1	10	45	5
2	5	50	2
3	2.5	90	0.5

and have an average depth of 3.52 ft, the cards for that particular gage would be as follows:

Card #1

Column 1	11	21
10.0	45.0	5.0
5.0	50.0	2.0
2.5	90.0	0.5
3.52		

Program Outputs

Teletype

62. All teletype outputs generated by this program are to aid in program operations. The teletype inputs described in paragraph 56 are input upon request from teletype outputs; that is, each teletype input is requested by a teletype output in a question-answer fashion.

63. The only other teletype outputs generated by this program are gage numbers. As each gage is processed, the gages's number is output to the teletype. This is done so that the operator can monitor program progression and alter sense switch settings for different gages if desired.

64. Examples of teletype output as well as teletype inputs are illustrated in Plates 10 and 11. Notice that all teletype outputs except the gage number listings are followed by question marks. All other listings represent teletype inputs. Notice also that Plate 10 depicts the analysis of three components and Plate 11, only one component. The reference data consisting of

two components are input for Plate 11 whereas reference data are not input for Plate 10.

Printer

65. The first page of printer output is test identification information. This information comes from the first two header records on magnetic tape.

66. The test identification information is followed by a listing of update calibration coefficients if such a listing is requested. Plate 12 illustrates the test identification output including the list option for calibration coefficients.

67. For each tide gage analyzed, a page of output is generated similar to Plates 13-15. The difference between Plates 13 and 14 is that sense switch G was .TRUE. when Plate 14 was generated causing the two cycles of scaled prototype data to be analyzed to be listed. In Plate 15, a taper function was applied to the residual data prior to performing the power spectral density; thus the statistics of the residual data are listed. Also, gage and test identifications are printed on each analysis page so if a page is misplaced it can still be identified. The mean and variance of the original and residual data as well as results of the least squares harmonic analysis are listed. Plate 13 illustrates a three-component analysis, Plate 14 two components, and Plate 15 four components.

68. Plate 15 is an example of an output page when reference data are compared with the original data. The difference between Plate 13 and Plate 15 is that the shifts, mentioned in paragraphs 50-54, are listed in Plate 15.

Graphics

69. Plate 16 is an example of a one cycle original data plot. Plates 17-19 all are plots of the original data (solid line) and comparison data (dotted line). Plates 17 and 18 have the means of the original data removed from both the original data and the comparison data. Plates 18 and 19 have comparison data input from cards while Plate 17 uses the least squares harmonic analysis results for comparison data. Plate 19 has the mean of the original data included and the comparison data (dotted line) is shifted by 90 deg. Plate 17 depicts only one cycle of data while Plates 18 and 19 depict two cycles of data.

70. Plate 20 is an example of a residual plot, which is simply the comparison data subtracted from the original data. This residual plot is the residual of the two data sets in Plate 17.

71. Plates 21 and 22 are examples of the power spectral density results. Both plates are plots of the data sets in Plate 20 with Plate 22 illustrating the results of the taper function performed on the residual prior to the power spectral density.

72. Plate 23 is an example of velocity data. This plate is a plot of the scaled original velocity data. The original data plot is the only output that this program will generate for velocity data or temperature data. Plate 24 is an example of a temperature plot.

REFERENCES

Cheek, J. B., Jr., Radhakrishnan, N., and Tracy, F. T. 1971 (July). "Application of Spline Interpolation Methods to Engineering Problems," Miscellaneous Paper 0-71-2, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Durham, D. L., and Downing, G. C. 1978 (Jan). "Automation Techniques for Physical Hydraulic Models," Miscellaneous Paper H-78-3, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Durham, D. L., and Greer, H. C., III. 1975 (Feb). "Automated Data Acquisition and Control Systems for Hydraulic Wave Models," Paper presented at 1975 Army Numerical Analysis Conference, St. Louis, Mo.

Durham, D. L., Greer, H. C., III, and Whalin, R. W. 1976 (Sep). "Automated Control, Data Acquisition, and Analyses for Hydraulic Models of Tidal Inlets," Proceedings 1976 Army Numerical Analysis Conference, U. S. Army Research Office Report No. 76-3.

Electronics Associates Inc. 1976 (Jan). "Pacer 100 Digital Computing System Applications Programming Manual," Publication Number 00827.0051-3RBO.

Hamming, R. W. 1950. Numerical Methods for Scientists and Engineers, McGraw Hill, New York, N. Y.

Keulegan, G. H. 1950 (May). "The Gradual Damping of a Progressive Oscillatory Wave with Distance in a Prismatic Rectangular Channel" (Unpublished data), National Bureau of Standards, Washington, D. C.

Outlaw, D. G., et al. 1977 (Feb). "Los Angeles and Long Beach Harbors Model Study; Model Design," Technical Report H-75-4, Report 4, U. S. Army Engineer Waterways Experiment Station, CE, Vicksburg, Miss.

Whalin, R. W., et al. 1974 (Sep). "A Case History of Los Angeles-Long Beach Harbors," ASCE Proc. of International Symposium on Ocean Wave Measurement and Analysis, Vol 1.

```
TAPE UNIT=?
15

LIST CHANNELS?
YES
ANY OUTPUT?
YES

TITLE=?
WAVE DATA

DATA SCALED FRACTIONS?
YES

DEPTH=?
.2
FILE NAME?
NDT001

#REC & #PER TO SKIP=?
20,0

CH    1


CH    2


CH    3


CH    4


CH    5


CH    6


CH    7


CH    8


CH    9


CH   10


CH   11


CH   12
```

PLATE 1

```
TAPE UNIT=?
15

LIST CHANNELS?
NO
ANY OUTPUT?
YES

TITLE=?
WAVE DATA

DATA SCALED FRACTIONS?
YES

DEPTH=?
.[illegible]
FILE NAME?
[illegible]
```

PLATE 2

*** WAVE ANALYSIS BASED ON SIMPLE SEARCH TECHNIQUES ***
WAVE DATA
CHANNEL 8 GAGE ARR. 0

XY COORDINATES .0000 .0000
WATER DEPTH IS 60.0000
GAGE # IS RD08

CRESTS		TROUGHS		WAVEHEIGHT		
VALUE	POSITION	VALUE	POSITION	VALUE	POSITION	
3.198	.000	-3.232	2.888	6.430	1.494	1
3.131	5.876	-3.117	8.864	6.248	7.370	2
3.096	11.852	-3.122	14.839	6.218	13.345	3
3.107	17.728	-3.192	20.715	6.300	19.221	4
3.091	23.703	-3.107	26.790	6.198	25.297	5
3.068	29.679	-3.056	32.766	6.125	31.272	6
3.051	35.654	-3.102	38.642	6.153	37.148	7
3.062	41.630	-3.122	44.618	6.185	43.124	8
3.068	47.605	-3.122	50.593	6.190	49.099	9
3.102	53.481	-3.142	56.569	6.243	55.075	10
3.107	59.457	-3.112	62.445	6.219	60.951	11
3.085	65.433	-3.122	68.420	6.208	66.926	12
3.080	71.408	-3.112	74.296	6.192	72.902	13
3.074	77.384	-3.107	80.272	6.181	78.878	14
3.080	83.260	-3.138	86.247	6.217	84.754	15
3.085	89.235	-3.117	92.223	6.203	90.729	16
3.068	95.211	-3.092	98.099	6.161	96.705	17
3.051	101.186	-3.067	104.075	6.118	102.680	18
3.096	107.062	-3.097	110.050	6.192	108.556	19
3.091	113.038	-3.082	115.926	6.173	114.532	20
3.091	119.014	-3.112	121.902	6.203	120.507	21
3.119	124.889	-3.092	127.877	6.212	126.383	22
3.107	130.865	-3.082	133.753	6.190	132.359	23
3.125	136.841	-3.117	139.729	6.242	138.335	24

	MODEL - INCHES		PROTOTYPE - FEET	
WAVEHEIGHTS				
AVERAGE	.993 +/-	.010	6.208 +/-	.060
RMS	.993		6.209	
33.33 PCT	1.002 +/-	.011	6.265 +/-	.067
	MODEL - SECONDS		PROTOTYPE -SECONDS,	
WAVEPERIOD				
	.685 +/-	.042	5.928 +/-	.362

PLATE 3

*** WAVE ANALYSIS BASED ON SIMPLE SEARCH TECHNIQUES ***

WAVE DATA

CHANNEL 12 GAGE ARR. 0

XY COORDINATES .0000 .0000

WATER DEPTH IS 60.0000

GAGE # IS RD12

	MODEL - INCHES		PROTOTYPE - FEET	
WAVEHEIGHTS				
AVERAGE	1.077 +/-	.011	6.734 +/-	.068
RMS	1.077		6.734	
33.33 PCT	1.088 +/-	.002	6.802 +/-	.013
	MODEL - SECONDS		PROTOTYPE -SECONDS,	
WAVEPERIOD				
	.685 +/-	.042	5.929 +/-	.362

PLATE 4

***** WAVE RECORD ANALYSIS *****

```
WVAE DATA
TEST RUN      1    74 TH DAY OF 1977 AT 1300 HOURS
MODEL PLAN WCAL         GAGE ARR.    0   GEN. POS.     0
HOR. SCLAE 1= 75  VER. SCALE 1= 75  WATER TEMP. 63.60
```

	MODEL	PROTOTYPE
PERIOD	.690 SECONDS	5.976 SECONDS
WAVEHEIGHT	.437 INCHES	2.734 FEET

14 CHANNELS OF 60 SAMP/PER. FOR 24 PERIODS
*REC./PER. 2 SWL ADJ .000

CHANNEL	WAVEHEIGHT PROTOTYPE - FEET AVERAGE HEIGHT		HIGHEST 1/3		WAVEPERIOD - SECONDS MODEL PERIOD		PROTOTYPE PERIOD	
RD01	6.177 +/-	.069	6.253 +/-	.054	.684 +/-	.042	5.927 +/-	.367
RD02	5.843 +/-	.055	5.907 +/-	.043	.685 +/-	.042	5.929 +/-	.367
RD03	6.269 +/-	.050	6.317 +/-	.034	.685 +/-	.042	5.929 +/-	.365
RD04	6.298 +/-	.057	6.358 +/-	.022	.685 +/-	.042	5.929 +/-	.366
RD05	6.614 +/-	.099	6.734 +/-	.037	.684 +/-	.042	5.927 +/-	.366
RD06	6.600 +/-	.061	6.666 +/-	.024	.684 +/-	.042	5.927 +/-	.366
RD07	6.304 +/-	.066	6.370 +/-	.023	.684 +/-	.042	5.926 +/-	.366
RD08	6.208 +/-	.060	6.265 +/-	.067	.685 +/-	.042	5.928 +/-	.362
RD09	5.902 +/-	.075	5.991 +/-	.047	.684 +/-	.045	5.928 +/-	.393
RD10	6.429 +/-	.113	6.552 +/-	.046	.684 +/-	.045	5.927 +/-	.392
RD11	6.279 +/-	.078	6.367 +/-	.064	.684 +/-	.045	5.928 +/-	.394
RD12	6.734 +/-	.068	6.802 +/-	.013	.685 +/-	.042	5.929 +/-	.362
RD13	6.362 +/-	.050	6.418 +/-	.041	.684 +/-	.045	5.926 +/-	.393
RD14	6.157 +/-	.138	6.319 +/-	.105	.685 +/-	.042	5.929 +/-	.362

CH	CODE	PER
1	0	24
2	0	24
3	0	24
4	0	24
5	0	24
6	0	24
7	0	24
8	0	24
9	1	23
10	1	23
11	1	23
12	0	24
13	1	23
14	0	24

PLATE 6

*** WAVE RECORD ANALYSIS ***

```
WAVE DATA
TEST RUN       1    74 TH DAY OF 1977 AT 1300 HOURS
MODEL PLAN WCAL         GAGE ARR.    0   GEN. POS.     0
HOR. SCLAE 1= 75  VER. SCALE 1= 75  WATER TEMP. 63.60
```

```
                      MODEL               PROTOTYPE
PERIOD               .690 SECONDS          5.976 SECONDS
WAVEHEIGHT           .437 INCHES           2.734 FEET
14 CHANNELS OF 60 SAMP/PER. FOR            20 PERIODS
#REC./PER.      2    SWL ADJ  .000
```

*** WAVE ANALYSIS BASED ON SIMPLE SEARCH TECHNIQUES ***

WAVE DATA

CHANNEL 10 GAGE ARR. 0

XY COORDINATES .0000 .0000

WATER DEPTH IS 60.0000

GAGE # IS RD10

*** ONLY 23 PERIODS OF DATA FOUND ***

	MODEL - INCHES		PROTOTYPE - FEET	
WAVEHEIGHTS				
AVERAGE	1.028 +/-	.018	6.428 +/-	.113
RMS	1.029		6.429	
33.33 PCT	1.048 +/-	.007	6.552 +/-	.046
	MODEL - SECONDS		PROTOTYPE -SECONDS,	
WAVEPERIOD				
	.684 +/-	.045	5.927 +/-	.392

PLATE 7

*** WAVE ANALYSIS BASED ON SIMPLE SEARCH TECHNIQUES ***

MODEL WAVE DATA

CHANNEL 1 GAGE ARR. 0

XY COORDINATES .0000 .0000

WATER DEPTH IS 60.0000

GAGE # IS RD01

CRESTS VALUE	CRESTS POSITION	TROUGHS VALUE	TROUGHS POSITION	WAVEHEIGHT VALUE	WAVEHEIGHT POSITION	
2.624	1.021	2.627	2.449	-.003	1.755	1
2.624	2.694	2.628	4.776	-.003	3.756	2
2.624	5.225	2.627	5.797	-.002	5.511	3
2.624	6.083	2.628	8.981	-.003	7.552	4

SEARCH ERROR--PERIOD 5

2.626	9.430	2.626	9.349	.000	9.389	5
2.624	10.002	2.627	10.859	-.002	10.451	6
2.626	11.471	2.627	11.635	-.000	11.553	7
2.624	12.451	2.626	12.492	-.002	12.492	8
2.589	15.595	2.914	17.595	-.326	16.615	9
2.570	19.881	2.929	20.208	-.359	20.044	10
2.593	22.371	2.926	22.657	-.333	22.535	11
2.573	24.453	2.873	24.984	-.300	24.739	12
2.536	27.025	2.877	27.515	-.341	27.270	13
2.578	29.434	2.916	29.883	-.339	29.679	14
2.551	32.047	2.875	32.373	-.324	32.210	15
2.555	34.496	2.883	34.904	-.327	34.700	16
2.568	36.823	2.924	37.272	-.356	37.068	17
2.615	39.272	2.953	39.721	-.338	39.517	18
2.601	41.722	2.941	42.252	-.340	42.008	19
2.596	44.294	2.939	44.865	-.343	44.579	20
2.595	46.947	2.919	47.396	-.324	47.192	21
2.574	49.274	2.914	50.009	-.340	49.642	22
2.558	52.050	2.913	52.581	-.356	52.336	23
2.565	54.622	2.904	54.989	-.339	54.826	24
2.572	56.949	2.904	57.480	-.332	57.235	25
2.553	59.358	2.887	59.970	-.335	59.684	26
2.570	62.093	2.860	62.460	-.289	62.297	27
2.565	64.583	2.832	64.991	-.268	64.787	28
2.535	67.114	2.885	67.441	-.349	67.277	29
2.552	69.523	2.895	69.849	-.342	69.686	30

	MODEL - INCHES		PROTOTYPE - FEET	
WAVEHEIGHTS				
AVERAGE	-1.463 +/-	.882	-.244 +/-	.147
RMS	1.709		.285	
33.33 PCT	-.344 +/-	.664	-.057 +/-	.111
	MODEL - SECONDS		PROTOTYPE -SECONDS.	
WAVEPERIOD				
	1.691 +/-	.252	2.392 +/-	.357

PLATE 8

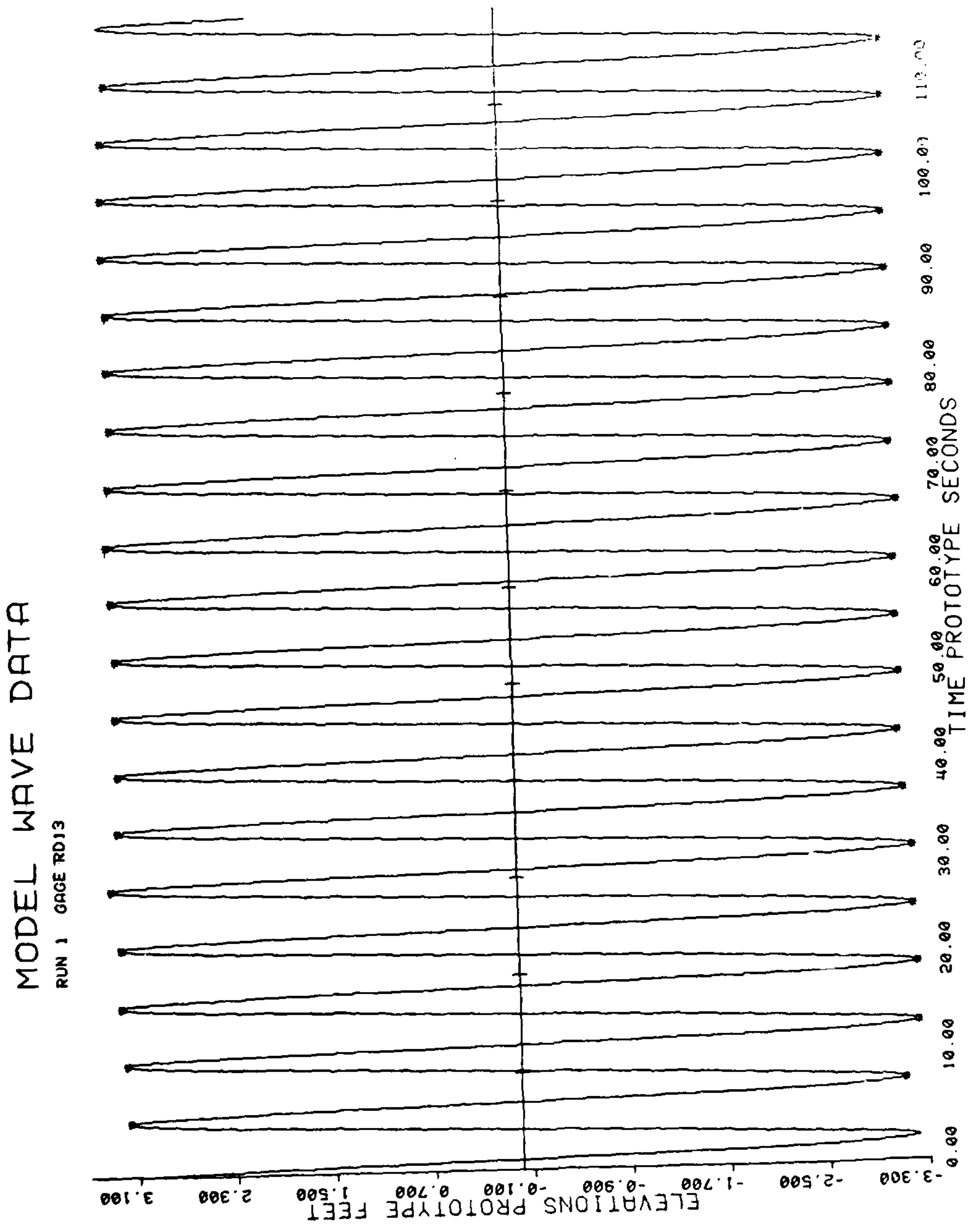
MODEL WAVE DATA
RUN 1 GAGE RD13
TIME PROTOTYPE SECONDS
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
100.00
ELEVATIONS PROTOTYPE FEET
-3.300
-2.500
-1.700
-0.900
-0.100
0.700
1.500
2.300
3.100

PLATE 9

```
FORCE SHIFT=?
90.

TAPER RESIDUAL ?
NO

CALIBRATION FIT OPTION=?
4

#COMPS TO ANALIZE FOR?
3

COMP PER=?
12.4206

COMP PER=?
6.2103

COMP PER=?
4.1402

LIST UPDATE CALS?
YES

REFERENCE DATA TO BE INPUT?
NO

HOW OFTEN UPDATE CAL ?
1

LABEL=?
MODEL TIDE DATA

#REC TO SKIP=?
0

TAPE UNIT=?
14

AVERAGE MODEL DEPTH=?
.2

FILE NAME?
OPI003

# OF CYCLES TO ANALYSE=?
2

GAGE #=      1

GAGE #=      2

GAGE #=      3

GAGE #=      4

GAGE #=      5

GAGE #=      6

GAGE #=      7

GAGE #=      8
```

PLATE 10

```
FORCE SHIFT=?
90.

TAPER RESIDUAL ?
YES

CALIBRATION FIT OPTION=?
4

#COMPS TO ANALIZE FOR?
1

COMP PER=?
12.4206

LIST UPDATE CALS?
NO

REFERENCE DATA TO BE INPUT?
YES

NUMBER OF REFERENCE COMPONENTS=?
2

HOW OFTEN UPDATE CAL ?
2

LABEL=?
MODEL TIDE DATA

#REC TO SKIP=?
2

TAPE UNIT=?
15

AVERAGE MODEL DEPTH=?
.2

FILE NAME?
OPI033

# OF CYCLES TO ANALYSE=?
1

GAGE#=      1

GAGE#=      2

GAGE#=      3

GAGE#=      4

GAGE#=      5

GAGE#=      6

GAGE#=      7

GAGE#=      8

GAGE#=      9
```

PLATE

*** TIDE RECORD ANALYSIS PROGRAM ***

TEST RUN 3 202 TH DAY OF 1976 AT 1000 HOURS
MODEL PLAN VER GAGE ARR. 1
HOR. SCALE 1=300 VER. SCALE 1= 60 WATER TEMP. 67.00

	MODEL	PROTOTYPE
PERIOD	1154.5 SECONDS	12.4 HOURS

15 CHANNELS OF 60 SAMP/PER. FOR 1 PERIODS
#REC./PER. 2

UPDATE CALIBRATIONS			INTERCEPT	SLOPE
SCAN #	1	COEF =	.2118377E-01	.5700070E-03
SCAN #	2	COEF =	.2210692E-01	.5698883E-03
SCAN #	3	COEF =	.2118377E-01	.5700070E-03
SCAN #	4	COEF =	.2210692E-01	.5698883E-03
SCAN #	5	COEF =	.2118377E-01	.5700070E-03
SCAN #	6	COEF =	.2210692E-01	.5698883E-03
SCAN #	7	COEF =	.2118377E-01	.5700070E-03
SCAN #	8	COEF =	.2210692E-01	.5698883E-03
SCAN #	9	COEF =	.2118377E-01	.5700070E-03
SCAN #	10	COEF =	.2210692E-01	.5698883E-03
SCAN #	11	COEF =	.2210692E-01	.5698883E-03
SCAN #	12	COEF =	.2118377E-01	.5700070E-03
SCAN #	13	COEF =	.2210692E-01	.5698883E-03
SCAN #	14	COEF =	.2210692E-01	.5698883E-03
SCAN #	15	COEF =	.2210692E-01	.5698883E-03
SCAN #	16	COEF =	.2210692E-01	.5698883E-03
SCAN #	17	COEF =	.2210692E-01	.5698883E-03
SCAN #	18	COEF =	.2396701E-01	.5700070E-03
SCAN #	19	COEF =	.2297306E-01	.5683691E-03
SCAN #	20	COEF =	.2396701E-01	.5700070E-03
SCAN #	21	COEF =	.2396701E-01	.5700070E-03
SCAN #	22	COEF =	.2210692E-01	.5698883E-03
SCAN #	23	COEF =	.2310115E-01	.5715380E-03
SCAN #	24	COEF =	.2310115E-01	.5715380E-03
SCAN #	25	COEF =	.2396701E-01	.5700070E-03
SCAN #	26	COEF =	.2396701E-01	.5700070E-03
SCAN #	27	COEF =	.2396701E-01	.5700070E-03
SCAN #	28	COEF =	.2488957E-01	.5698883E-03
SCAN #	29	COEF =	.2488957E-01	.5698883E-03
SCAN #	30	COEF =	.2396701E-01	.5700070E-03
SCAN #	31	COEF =	.2488957E-01	.5698883E-03
SCAN #	32	COEF =	.2488957E-01	.5698883E-03
SCAN #	33	COEF =	.2396701E-01	.5700070E-03
SCAN #	34	COEF =	.2574830E-01	.5683691E-03
SCAN #	35	COEF =	.2574830E-01	.5683691E-03
SCAN #	36	COEF =	.2488957E-01	.5698883E-03
SCAN #	37	COEF =	.2589186E-01	.5715380E-03
SCAN #	38	COEF =	.2574830E-01	.5683691E-03
SCAN #	39	COEF =	.2574830E-01	.5683691E-03

PLATE 12

```
 **** TIDE ANALYSIS PROGRAM ****
MODEL TIDE DATA

CHANNEL     1      GAGE ARRANGEMENT      1  RUN NUMBER   3

XY COORDINATES       .0000       .0000
WATER DEPTH IS      -.1200
GAGE # IS      1


STATISTICS OF THE ORIGINAL DATA
MEAN =  -.1679494E+00           VARIANCE = ,  .8431425E+00


***** HARMONIC ANALYSIS *****

      (HRS)        (FT)        (DEG)
     PERIOD     AMPLITUDE     PHASE
   1.242E+01   1.287E+00   9.165E+01
   6.210E+00   1.485E-02  -7.290E+01
   4.140E+00   1.558E-02  -1.158E+02


STATISTICS OF THE RESIDUAL DATA
MEAN =  -.1285430E-04           VARIANCE = ,  .2595286E-03
```

PLATE 14

*** TIDE ANALYSIS PROGRAM ***
MODEL TIDE DATA

CHANNEL 1 GAGE ARRANGEMENT 1 RUN NUMBER 3

XY COORDINATES .0000 .0000
WATER DEPTH IS -.1200
GAGE # IS 1

-.1888543E+00	-.5006501E-01	.8872427E-01	.2320706E+00	.3187808E+00	.4402135E+00	.5650992E+00	.6577603E+00
.7454898E+00	.8381864E+00	.9258804E+00	.9952614E+00	.1058779E+01	.1128360E+01	.1162973E+01	.1185159E+01
.1162973E+01	.1129644E+01	.1115765E+01	.1058779E+01	.9813852E+00	.9120042E+00	.8169929E+00	.7339575E+00
.6232437E+00	.5263692E+00	.3879769E+00	.2772632E+00	.1349372E+00	-.4465383E-02	-.1379135E+00	-.2486273E+00
-.3685160E+00	-.5254110E+00	-.6361256E+00	-.7606786E+00	-.8990709E+00	-.1016787E+01	-.1134338E+01	-.1232637E+01
-.1306467E+01	-.1388292E+01	-.1412033E+01	-.1425833E+01	-.1439633E+01	-.1450142E+01	-.1445310E+01	-.1417784E+01
-.1404021E+01	-.1356834E+01	-.1292664E+01	-.1197574E+01	-.1101233E+01	-.1030419E+01	-.9223121E+00	-.8048471E+00
-.7021024E+00	-.5749409E+00	-.4497116E+00	-.3304985E+00	-.1882658E+00	-.4147322E-01	.8757292E-01	.1970227E+00
.3129273E+00	.4402355E+00	.5547905E+00	.6604450E+00	.7292606E+00	.8235155E+00	.9201133E+00	.9907595E+00
.1059575E+01	.1114627E+01	.1155917E+01	.1168508E+01	.1147717E+01	.1128391E+01	.1099509E+01	.1045912E+01
.9769964E+00	.9081810E+00	.8393654E+00	.7315863E+00	.6262052E+00	.4809652E+00	.3896669E+00	.2658241E+00
.1374471E+00	-.1839364E-03	-.1332246E+00	-.2567320E+00	-.3717878E+00	-.4900850E+00	-.6332868E+00	-.7524382E+00
-.8810227E+00	-.1018654E+01	-.1144192E+01	-.1240260E+01	-.1308880E+01	-.1377500E+01	-.1413822E+01	-.1423497E+01
-.1437224E+01	-.1459844E+01	-.1459843E+01	-.1410685E+01	-.1424373E+01	-.1336328E+01	-.1267708E+01	-.1199088E+01
-.1118477E+01	-.1034400E+01	-.9383314E+00	-.8285394E+00	-.7324712E+00	-.5128872E+00	-.5034852E+00	-.3207511E+00

STATISTICS OF THE ORIGINAL DATA
MEAN = -.1592577E+00 VARIANCE = , .8496584E+00

**** HARMONIC ANALYSIS ****

(HRS) PERIOD	(FT) AMPLITUDE	(DEG) PHASE
1.242E+01	1.298E+00	9.131E+01
6.120E+00	1.561E-02	-7.671E+01

STATISTICS OF THE RESIDUAL DATA
MEAN = -.4589763E-04 VARIANCE = , .4542359E-03

```
 *** TIDE ANALYSIS PROGRAM ***
MODEL TIDE DATA

CHANNEL     1      GAGE ARRANGEMENT       1  RUN NUMBER   3

XY COORDINATES        .0000       .0000
WATER DEPTH IS      -.1200
GAGE * IS      1


STATISTICS OF THE ORIGINAL DATA
MEAN =   -.1592577E+00            VARIANCE = ,   .8496584E+00



**** HARMONIC ANALYSIS ****

      (HRS)         (FT)         (DEG)
      PERIOD      AMPLITUDE      PHASE
   1.242E+01    1.298E+00    9.131E+01
   6.210E+00    1.587E-02   -8.701E+01
   4.140E+00    1.476E-02   -1.067E+02
   3.105E+00    1.451E-02    4.761E+01

COMPUTED SHIFT IN MODEL HOURS =    .4510917E-01
FORCE SHIFT IN DEGREES =    .9000000E+02




STATISTICS OF THE RESIDUAL DATA
MEAN =    .6143107E-03            VARIANCE = ,   .2464685E+01

STATISTICS OF THE TAPERED RESIDUAL DATA
MEAN =   -.5559496E+00            VARIANCE = ,   .3516450E+01
```

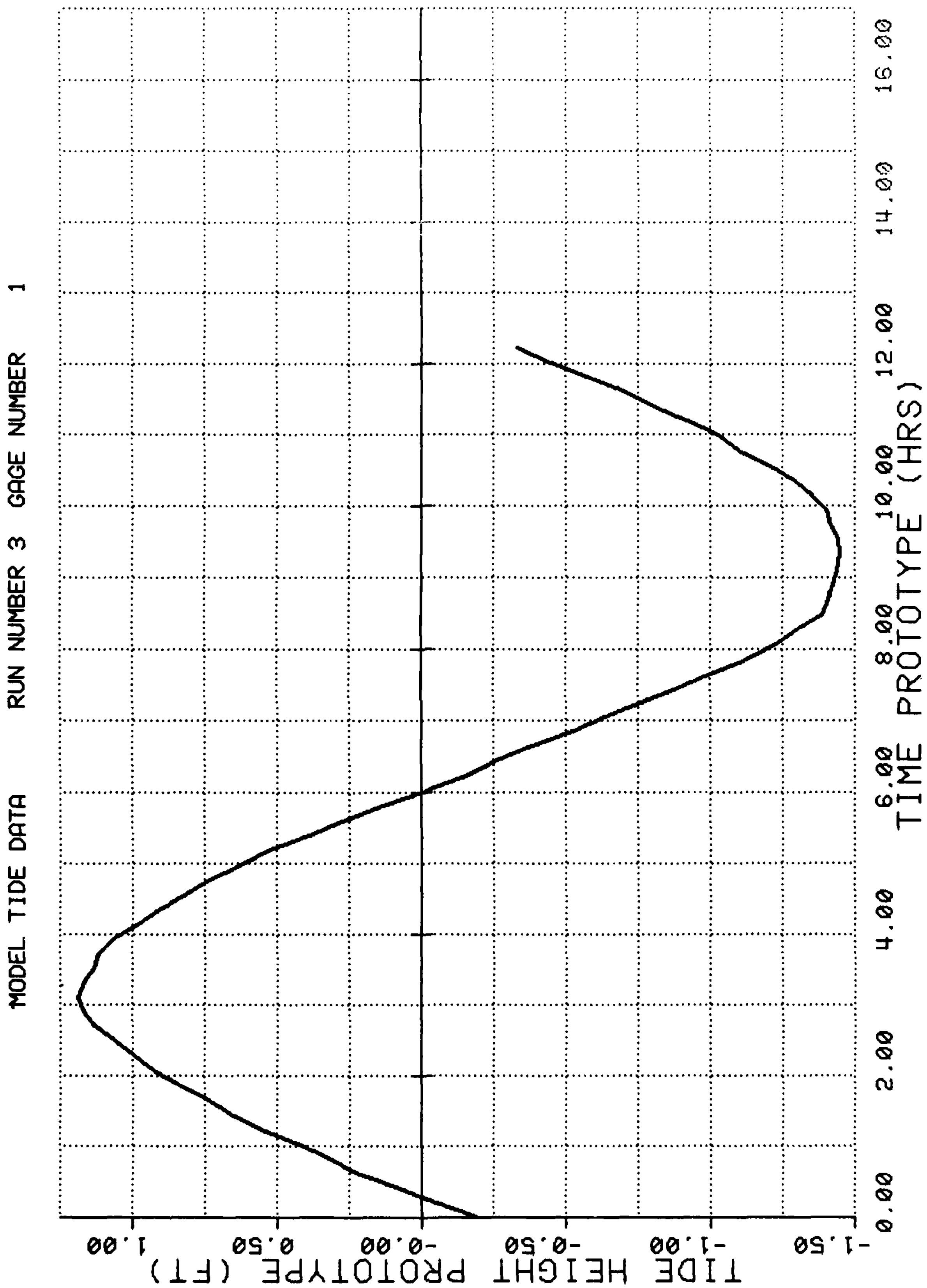
MODEL TIDE DATA
RUN NUMBER 3
GAGE NUMBER 1
TIME PROTOTYPE (HRS)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00
TIDE HEIGHT PROTOTYPE (FT)
1.00
0.50
-0.00
-0.50
-1.00
-1.50

PLATE 16

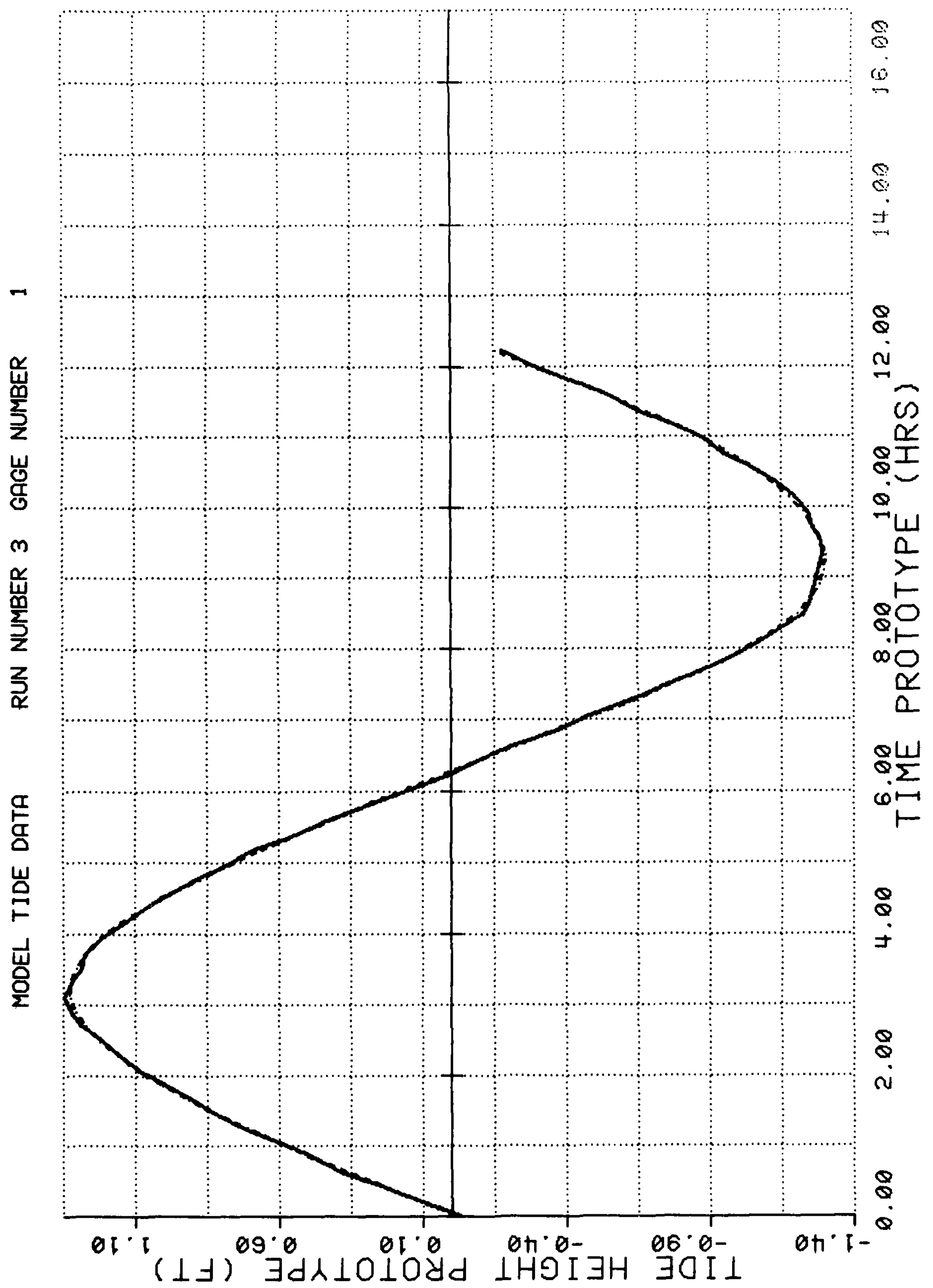
MODEL TIDE DATA
RUN NUMBER 3
GAGE NUMBER 1
TIDE HEIGHT PROTOTYPE (FT)
1.10
0.60
0.10
-0.40
-0.90
-1.40
TIME PROTOTYPE (HRS)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00

PLATE 17

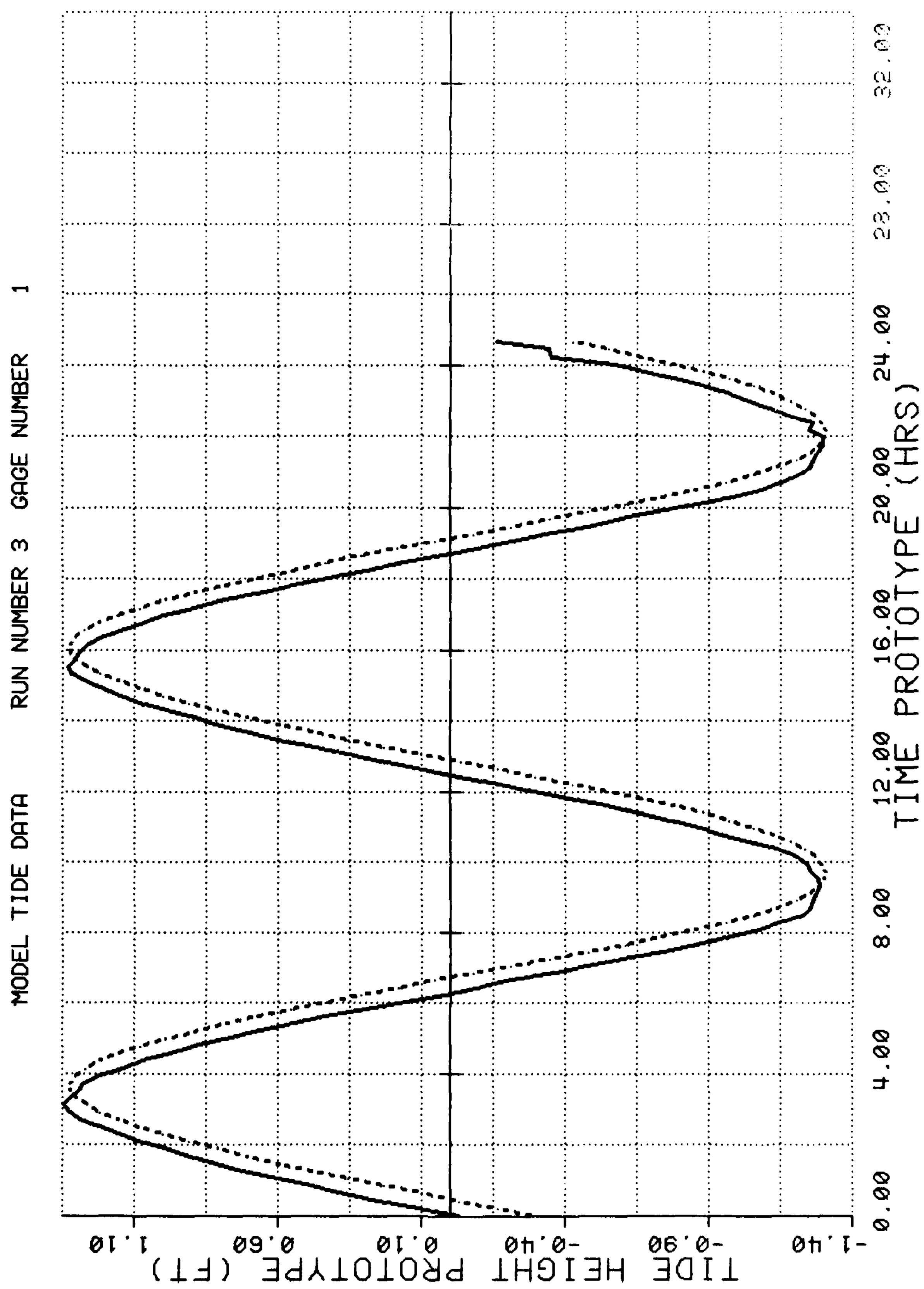
MODEL TIDE DATA
RUN NUMBER 3
GAGE NUMBER 1
TIDE HEIGHT PROTOTYPE (FT)
1.10
0.60
0.10
-0.40
-0.90
-1.40
TIME PROTOTYPE (HRS)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00

PLATE 18

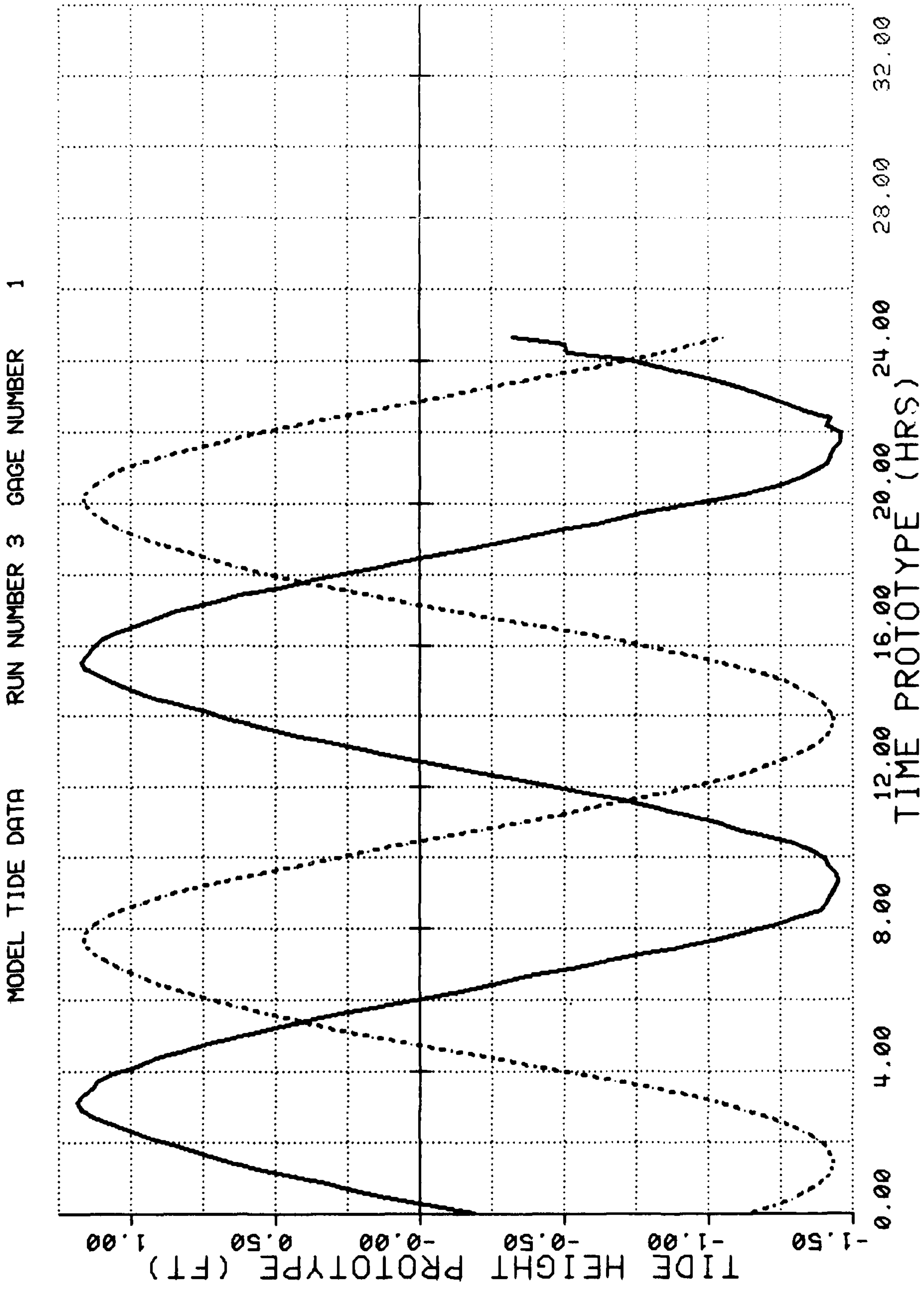
MODEL TIDE DATA
RUN NUMBER 3
GAGE NUMBER 1
TIDE HEIGHT PROTOTYPE (FT)
1.00
0.50
-0.00
-0.50
-1.00
-1.50
TIME PROTOTYPE (HRS)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00

PLATE 19

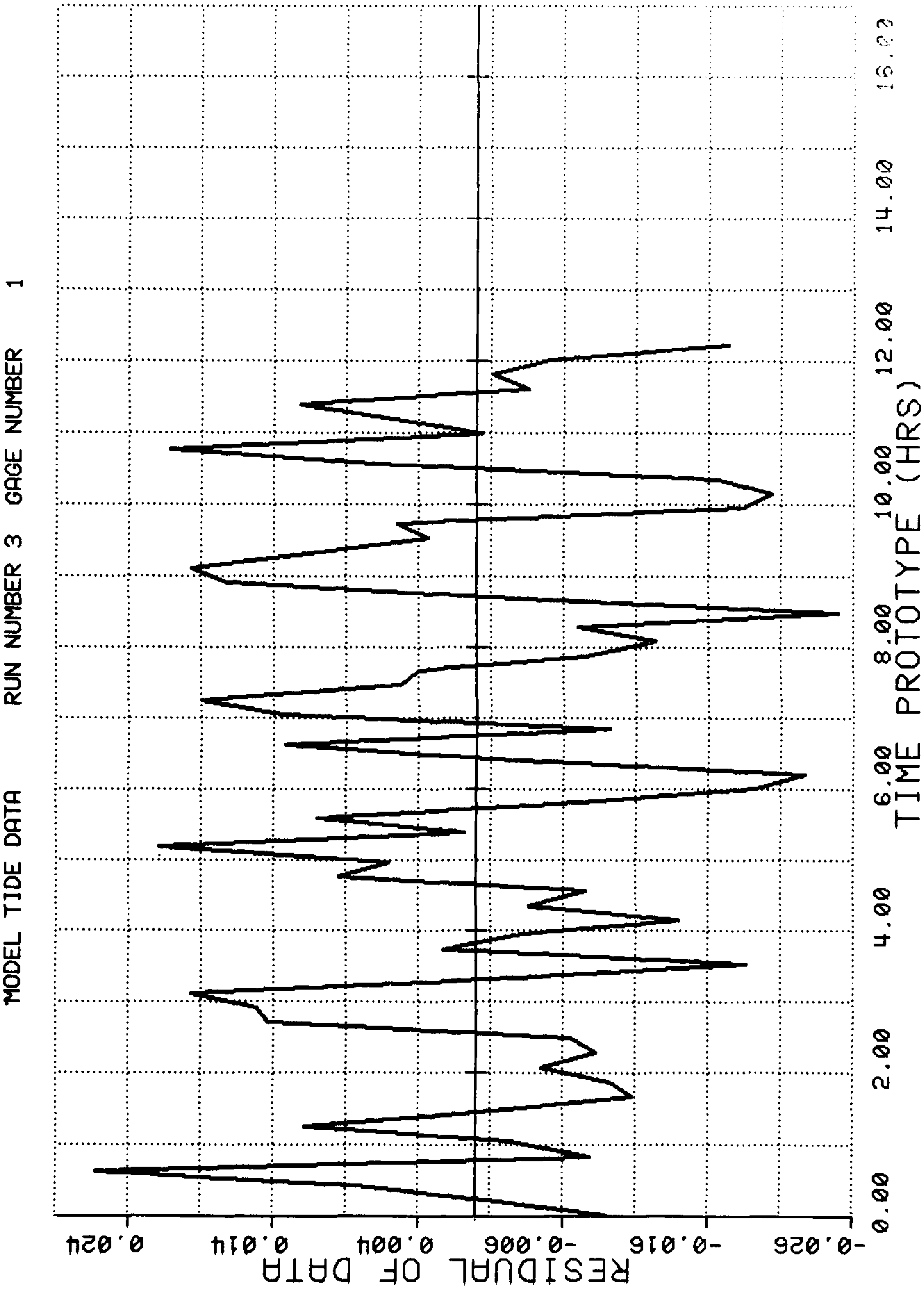
MODEL TIDE DATA
RUN NUMBER 3
GAGE NUMBER 1
RESIDUAL OF DATA
0.024
0.014
0.004
-0.006
-0.016
-0.026
TIME PROTOTYPE (HRS)
0.00
2.00
4.00
6.00
8.00
10.00
12.00
14.00
16.00

PLATE 20

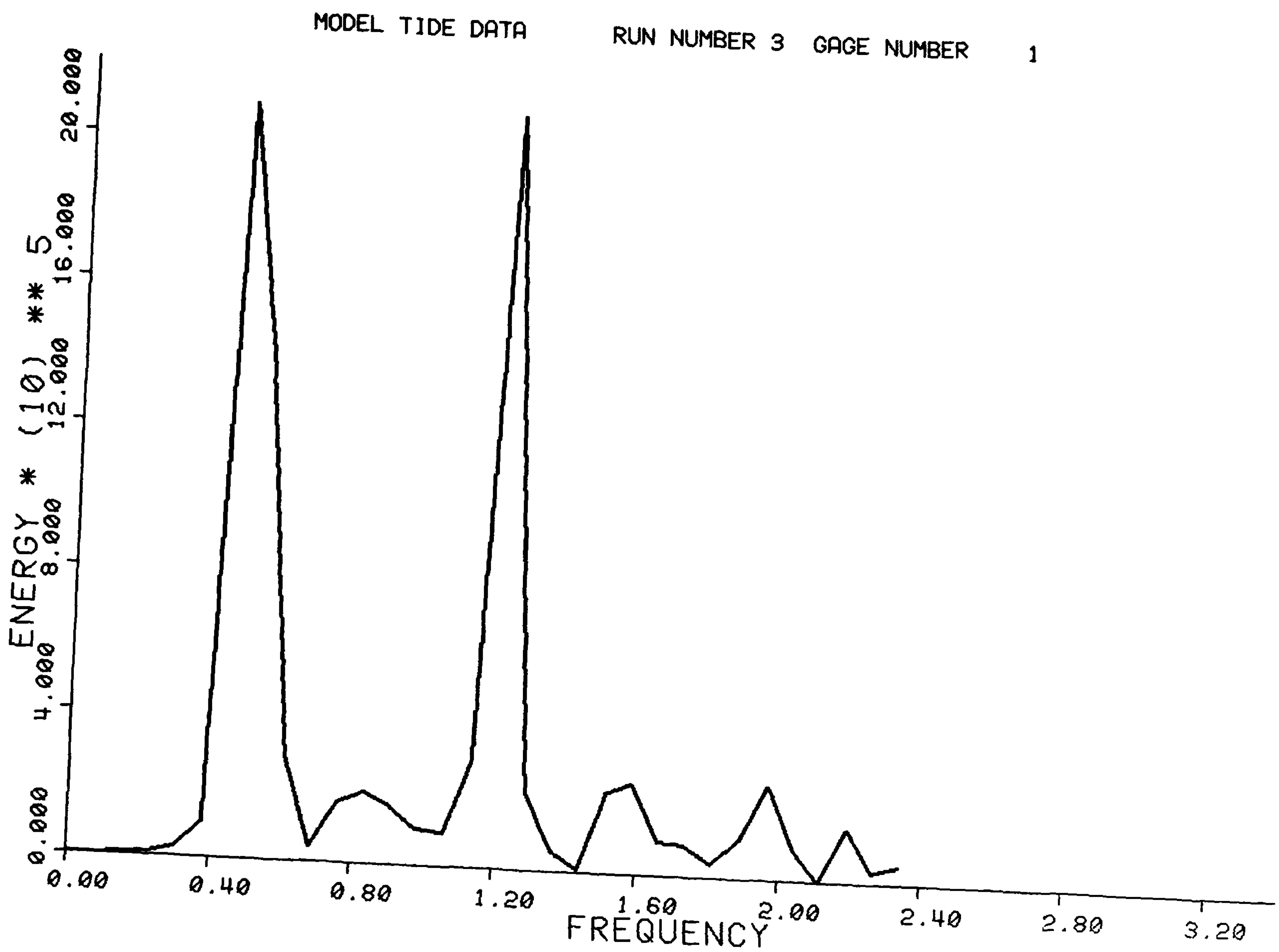
MODEL TIDE DATA
RUN NUMBER 3 GAGE NUMBER 1
ENERGY * (10) ** 5
0.000
4.000
8.000
12.000
16.000
20.000
FREQUENCY
0.00
0.40
0.80
1.20
1.60
2.00
2.40
2.80
3.20

PLATE 21

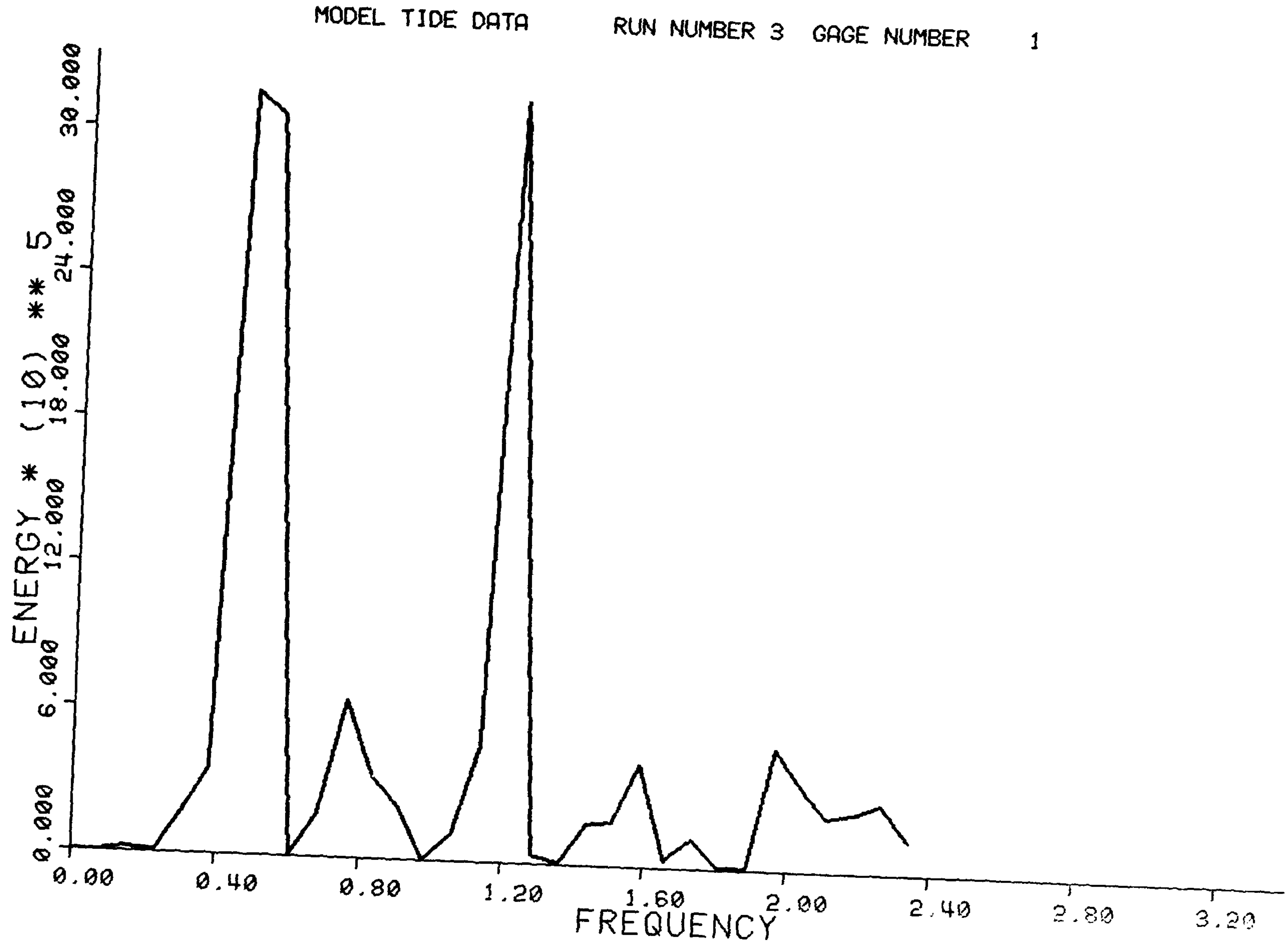
MODEL TIDE DATA
RUN NUMBER 3 GAGE NUMBER 1
ENERGY * (10) ** 5
0.000
6.000
12.000
18.000
24.000
30.000
0.00
0.40
0.80
1.20
1.60
2.00
2.40
2.80
3.20
FREQUENCY

PLATE 22

MODEL TIDE DATA RUN NUMBER 3 GAGE NUMBER VEL1

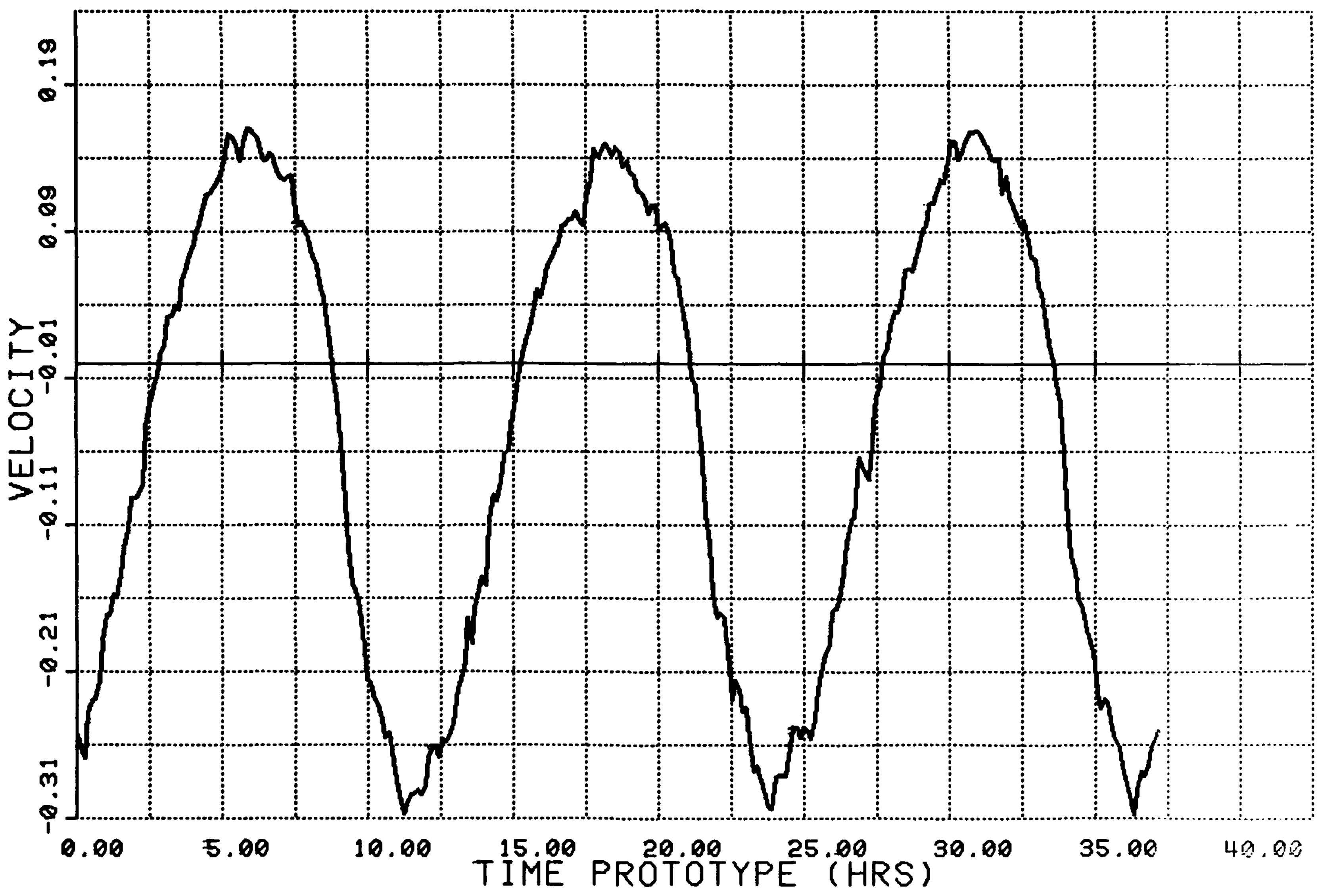

PLATE 23

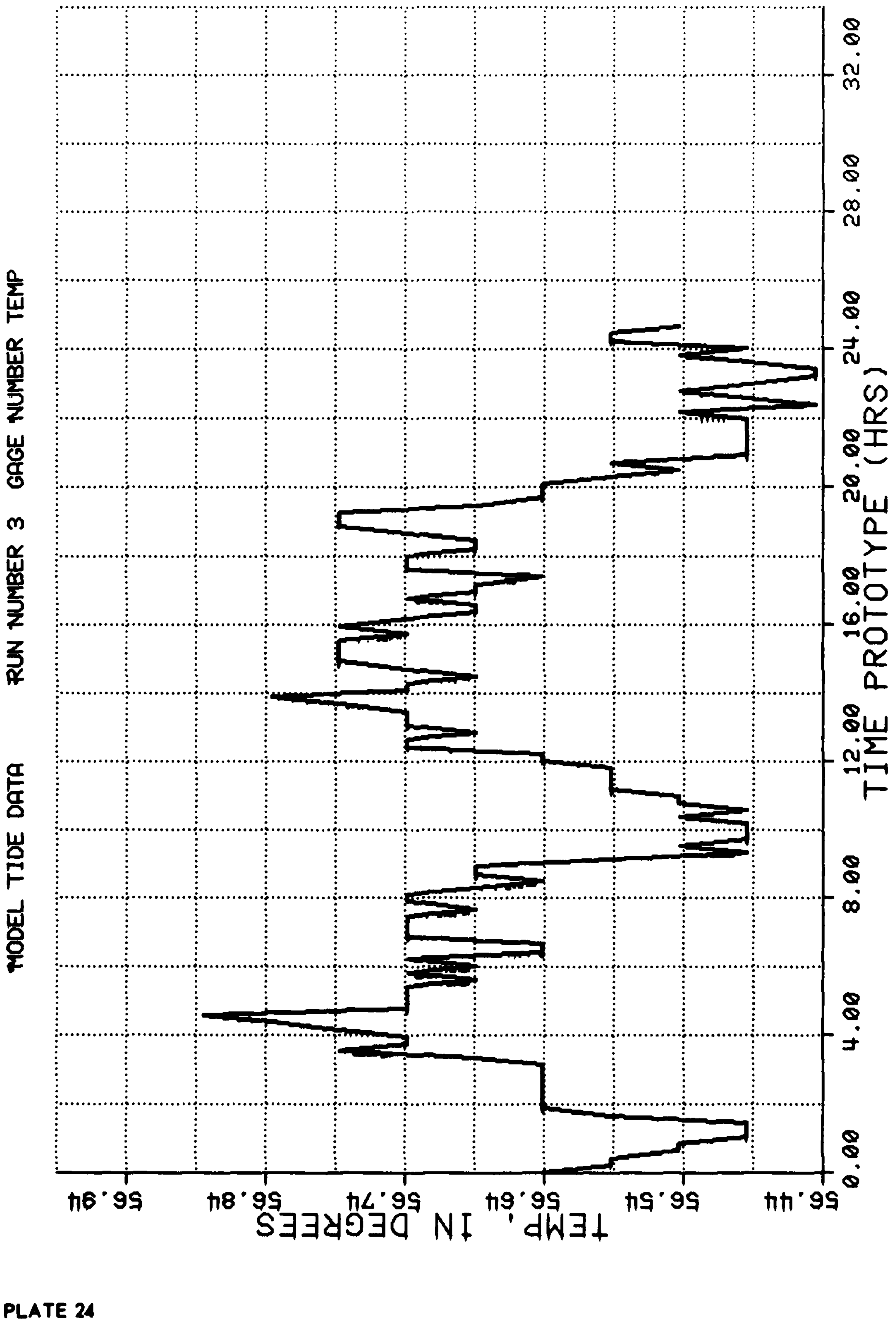
MODEL TIDE DATA
RUN NUMBER 3
GAGE NUMBER TEMP
TEMP, IN DEGREES
56.44
56.54
56.64
56.74
56.84
56.94
TIME PROTOTYPE (HRS)
0.00
4.00
8.00
12.00
16.00
20.00
24.00
28.00
32.00

PLATE 24

APPENDIX A: NOTATION

a_i	Constant value of i^{th} component
a_o	Mean of water-surface elevation data series
[A]	Vector of coefficients
AR	Actual reading
Amp_i	Amplitude $(a_i^2 + b_i^2)$ for i^{th} component
b_i	Constant value for i^{th} component
[C]	Real, symmetric matrix of sine or cosine terms
E	Error that least squares procedure minimizes
f	Water-surface elevation data series
f'	Water-surface elevation data series less noise associated with transfer function
fft_1	Real part of FFT
fft_2	Imaginary part of FFT
[F]	Vector of products of observed signal and sine or cosine terms
FFT	Results of Fast Fourier Transform
$\bar{H}$	Average wave height for record
H_x	Average wave height of highest x percent of wave height, e.g., $H_{1/3}$ is significant wave height
H_{rms}	Root-mean-square wave height for record
i	Integer variable
j	Integer variable
J	Total number of components
KE	Prototype water elevation at time zero reference readings made
M_2	Semidiurnal principal lunar tidal harmonic component
MSF	Model scaling factor
MWL	Reference mean water level
n	Integer variable
N	Total number of data samples
PHS_i	Phase [ARCTAN (b_i/a_i)] for i^{th} component
PSD	Result of power spectral density
SE	Scaled water elevation
SFC	Scale factor constant
SFS	Scale factor slope
SF1	Scale factor constant
SF2	Scale factor linear term
SF3	Scale factor quadratic term

T	Wave period
T_i	Wave period for i^{th} component
$\bar{T}$	Average wave period for record
USE	Unscaled water elevation
VR	Virtual reading
x	Specified percent of highest wave heights, normally $x = 0.333$
X	Cartesian coordinate
Y	Cartesian coordinate
Z	Water depth, ft
ZRR	Zero reference reading
Δt	Time interval for consecutive observation
ε	Noise associated with transfer function, etc.
σ_H	Standard deviation of average wave height
σ_T	Standard deviation of average wave period
ω_i	$2\pi/T_i$, radian frequency

APPENDIX B: PROGRAM LISTING FOR WAVE-HEIGHT PROGRAM

FORTRAN COMPILER REV. LEV. J00

```
C
C     SENSE SWITCHES ARE SWITCHES LOCATED ON THE CONTROL PANEL
C      OF THE PACER 100. THEY CAN BE EITHER ON OR OFF (.TRUE. OR
C      .FALSE.). FOR OTHER MACHINES SENSW SHOULD BE DEFINED AS
C      BEING AN EIGHT ELEMENT LOGICAL ARRAY, AND SHOULD BE
C      INITIALIZED BY THE USER.
C
C  SENSE SWITCH A FOR LIMITED OUTPUT
C  SENSE SWITCH B TO CHANGE # PERIODS TO ANALYZE
C  SENSE SWITCH C TO PLOT DATA
C  SENSE SWITCH D TO USE DISK SCRATCH FILE
C  SENSE SWITCH E ENDS AUTOMATIC MODE
C  SENSE SWITCH F TO STORE RESULTS ON MAG TAPE
C  SENSE SWITCH G & A FOR SUMMARY OUTPUT
C  SENSE SWITCH H TO SKIP GAGES
C
C    MAXIMUM LIMITS FOR THIS PROGRAM
C       100 WAVE PERIODS
C       6000 DATA POINTS PER CHANNEL
C       1920 DATA POINTS PER RECORD ON MAG TAPE
C       64 GAGES OF DATA
C
C     THE FOLLOWING DEFINE STATEMENTS ARE PECULIAR TO THE EAI PACER
C      100 COMPILER. THE DEFINE STATEMENT USED IN THE FOLLOWING
C      MANNER FORCES THE VARIABLE DEFINED TO BE ASSIGNED TO THE
C      OCTAL MEMORY CELL CONTAINED IN PARENTHESIS. MEMORY AND
C      RUN TIME ARE SAVED BY USING THIS STATEMENT ON THE PACER 100.
C      THE STATEMENTS MAY BE OMITTED FOR USE ON ANY OTHER MACHINE.
C
      DEFINE BUF('200)
      DEFINE I1('254)
      DEFINE IODEV('255)
      DEFINE NPCT('256)
      DEFINE IU1000('257)
      DEFINE IERR('260)
      DEFINE IRL('261)
      DEFINE NRSKIP('262)
      DEFINE IHORZ('263)
      DEFINE IVERT('264)
      DEFINE IRUNNO('265)
      DEFINE NCH('266)
      DEFINE NRECPD('267)
      DEFINE IGAGAR('270)
      DEFINE ISPWPD('271)
      DEFINE NOWPD('272)
      DEFINE NSPTST('273)
      DEFINE MM('274)
      DEFINE NRODS('275)
      DEFINE NSAMP('276)
      DEFINE LC1('277)
      DEFINE LC2('300)
      DEFINE NCHAN('301)
      DEFINE NN('302)
      DEFINE ICC('303)
```

```
      DEFINE JJJJ('304)
      DEFINE IRLD('305)
      DEFINE II('306)
      DEFINE IERCD('307)
      DEFINE I2('310)
      DEFINE I3('311)
      DEFINE K('312)
      DEFINE N('313)
      DEFINE IR('314)
      DEFINE IP('315)
      DEFINE IIII('316)
      DEFINE IV('317)
      DEFINE I9('320)
      DEFINE NCOEF('321)
      DEFINE NCALV('322)
      DEFINE NC('323)
      DEFINE NPER('324)
      DEFINE IPOTPT('325)
      DEFINE I('326)
      DEFINE IER('327)
      DEFINE NPTPLT('330)
      DEFINE I8('331)
      DEFINE ICHSKP('332)
      DEFINE IST('333)
      DEFINE I4('334)
      DEFINE J('335)
      DEFINE IF1('336)
      DEFINE IF('337)
      DEFINE IF3('340)
      DEFINE KK3('341)
      DEFINE KK1('342)
      DEFINE KK2('343)
      DEFINE I1I('344)
      DEFINE J1('345)
      DEFINE I1I('346)
      DEFINE IBX('347)
      DEFINE NS('350)
      DEFINE NPS('351)
      DEFINE KGAGE('352)
      DEFINE IGAGE('353)
      DEFINE IU1020('354)
      DEFINE IU1030('355)
      DEFINE IU1040('356)
      DEFINE I11('357)
      DEFINE LZ('360)
      DEFINE LZP('361)
      DEFINE IZD('362)
      DEFINE L('363)
      DEFINE NPEAK('364)
      DEFINE NTROF('365)
      DEFINE IF2('366)
      DEFINE NP('367)
      DEFINE ICV('370)
      DEFINE IXX('371)
      DEFINE J11('372)
      DEFINE K11('373)
      DEFINE IJK('374)
```

```
      DEFINE NPK('375)
      DEFINE K9('376)
      DEFINE IFLAG('377)
      DIMENSION RESULT(64)
      DIMENSION IPOIT1(11),IPOIT2(10)
      DIMENSION NAME(3),ISAVE(9),IDATA(6000),IBUF(1920),ZP(2),
     &IXXX(100),TROFPS(100),PEAKPS(100),KTITLE(20),IYYY(100),
     &COOR(3,64),POT(64),X(11),ZY(11),S2(11),
     &XXX(100),YYY(100),DATA(3000),Z(3000),IX(100),IY(100),IW(100,2),
     &IGAGEN(2,64),BUF(22),IFLAG(2,64),COEF(11,64),ICALV(42,50),
     &WH(100)
      DIMENSION DIST(50),DEPTH(50),IKFTI1(4,2),IKFTI2(6,2)
      EQUIVALENCE (X(1),BUF(1)),(BUF(12),ZY(1)),(IDATA(1),
     &DATA(1),Z(1)),(IX(1),
     2IBUF(1)),(IY(1),IBUF(101)),(IW(1,1),IBUF(201)),
     3(WH(1),IBUF(401)),
     &(XXX(1),IBUF(601)),(YYY(1),IBUF(801)),
     5(IYYY(1),IBUF(1001)),(IXXX(1),IBUF(1101)),
     6(TROFPS(1),IBUF(1201)),(PEAKPS(1),IBUF(1401))
      EQUIVALENCE (WVHGT,IDATA(66)),(WMLL,IDATA(130))
      LOGICAL IOUT,ICAL,SENSW,ICHSKP
      LOGICAL ISFRCT
      SCALED FRACTION IFRACT
      DATA IUNIT2/'14/,PCT/33.33333333333/
      DATA NAME(1)/2HA1/,NAME(2)/2H11/,NAME(3)/2H11/
      DATA SAME/9999./
      DATA IRESP/1HY/
      DATA IPOIT1/15,14,13,12,11,0,1,2,3,4,5/
      DATA IPOIT2/0,16,17,18,19,10,9,8,7,6/
      DATA PIE/3.141592654/,TWOPIE/6.283185307/,FORPIE/12.56637061/
      DATA IKFTI1/2H  ,2H  ,2H  ,2H  ,2HAD,2HJU,2HST,2HED/
      DATA IKFTI2/2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2HWA,2HVE,2H H,2HEI,
     &2HGH,2HT /
      DATA KTITLE/2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,
     &2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2H  ,2H  /
      GO TO 8
    1 FORMAT(15HAUTOMATIC MODE?,/)
900   FORMAT(/,7HDEPTH=?,/)
901   FORMAT(F10.5)
    2 FORMAT(A1)
3311  FORMAT(20A2)
    9 FORMAT(11HANY OUTPUT?,/)
    3 FORMAT(10HFILE NAME?,/)
    6 FORMAT(1H?)
14    FORMAT(1H1,17X,28H*** WAVE RECORD ANALYSIS ***,/,85X,
     &5HMODEL,11X,9HPROTOTYPE,/,1X,20A2,29X,7HPERIOD ,
     &2(4X,F7.3,8H SECONDS),/,9H TEST RUN,2I6,14H TH DAY OF 197,
     &I1,3H AT,I5,6H HOURS,20X,10HWAVEHEIGHT,F8.3,7H INCHES,6X,
     &F6.3,5H FEET,/,12H MODEL PLAN ,4A2,3X,9HGAGE ARR.,I5,3X,
     &9HGEN. POS.,I6,15X,I2,12H CHANNELS OF,I3,14H SAMP/PER. FOR,
     &I4,,8H PERIODS,/,14H HOR. SCALE 1=,I3,15H  VER. SCALE 1=,
     &I3,13H  WATER TEMP.,F6.2,16X,10H*REC./PER.,I5,3X,
     &7HSWL ADJ,F6.3)
66    FORMAT(1H1,1X,
     X52H*** WAVE ANALYSIS BASED ON SIMPLE SEARCH TECHNIQUES ,
     &3H***,/,1X,20A2,/,8H CHANNEL,2X,I3,5X,9HGAGE ARR.,2X,I4,/)
67    FORMAT(15H XY COORDINATES,2X,2(F9.4,2X),/,15H WATER DEPTH IS,
```

```
     &2X,F9.4,/,12H GAGE # IS  ,2A2)
68    FORMAT(/,10X,7H CRESTS,14X,8H TROUGHS,13X,11H WAVEHEIGHT,/,3X,
     13(3X,6H VALUE,2X,9H POSITION,2X))
69    FORMAT(1X,5H*****,I5,36H TH WAVEHEIGHT > BREAKING WAVEHEIGHT)
7000  FORMAT(/,14HDISK I/O ERROR)
5012  FORMAT(1H ,6(F10.3,1X),1X,I4)
5011  FORMAT(1H ,//,23H SEARCH ERROR--PERIOD ,I5)
5013  FORMAT(1H /,21X,14HMODEL - INCHES,15X,16HPROTOTYPE - FEET,
     &/,12H WAVEHEIGHTS,/,5X,10HAVERAGE   ,2(F10.3,5H +/- ,F10.3,
     &5X),/,5X,5H  RMS,13X,F10.3,20X,F10.3,//,5X,F5.2,5H PCT ,
     &2(F10.3,5H +/- ,F10.3,5X),
     &/,21X,15HMODEL - SECONDS,11X,19HPROTOTYPE -SECONDS,
     &//,11H WAVEPERIOD,/,10X,2(5X,F10.3,5H +/- ,F10.3))
C  INPUT TAPE UNIT
8     TYPE 6201
6201  FORMAT(/,11HTAPE UNIT=?,/)
      ACCEPT 6202,IUNIT
6202  FORMAT(O8)
      IF(IUNIT.EQ.'14)IUNIT2='15
      ICHSKP=.FALSE.
C  LIST CHANNELS?
      TYPE 8209
8209  FORMAT(/,14HLIST CHANNELS?,/)
      ACCEPT 2,I
      IF(I.EQ.IRESP)ICHSKP=.TRUE.
      IOUT=.FALSE.
      IODEV=16
C  ANY OUTPUT?
7060  TYPE 9
      ACCEPT 2,I
      IF(I.EQ.IRESP)IOUT=.TRUE.
C  INPUT TITLE
      TYPE 8031
8031  FORMAT(/,7HTITLE=?,/)
      ACCEPT 3311,(KTITLE(I),I=1,20)
      ISFRCT=.FALSE.
C  DATA SCALED FRACTIONS?
      TYPE 7381
7381  FORMAT(/,22HDATA SCALED FRACTIONS?,/)
      ACCEPT 2,I
      IF(I.EQ.IRESP) ISFRCT=.TRUE.
C  INPUT MODEL DEPTH
      TYPE 900
      ACCEPT 901,DEPTH1
      CALL SELMT(IUNIT)
      IRL=20
C  INPUT DATA FILE NAME
      TYPE 3
      ACCEPT 3311,(IDATA(I),I=1,3)
C  POSITION TO DATA FILE
      CALL POSMT(IDATA(1),3,IRL,.FALSE.,IERR)
      IF(IERR.EQ.0)GO TO 5
    7 TYPE 6
      J    .8
5     IRL=20
C  READ HEADER
C  READ FIRST HEADER
```

```
   78 CALL RDMT(IDATA(51),IRL,.TRUE.,IERR)
      L    .99
      ICAL=.TRUE.
      IF(IDATA(65).GE.0)ICAL=.FALSE.
C  READ SECOND HEADER
      CALL RDMT(IDATA(101),IDATA(70),.TRUE.,IERR)
      IF(IERR.NE.0)GO TO 7
      IF(.NOT.SENSW(6))GO TO 7384
C  IF OUTPUTTING TAPE WRITE FILE NAME
      CALL SELMT(IUNIT2)
      CALL NMFMT(IDATA(1),3,IRL,.FALSE.,IERR)
      L    .99
C  OUTPUT FIRST HEADER
      CALL WRTMT(IDATA(51),IRL,.TRUE.,IERR)
      L    .99
C  OUTPUT SECOND HEADER
      CALL WRTMT(IDATA(101),IDATA(70),.TRUE.,IERR)
      L    .99
      CALL SELMT(IUNIT)
7384  NRSKIP=0
      IF(.NOT.SENSW(2))GO TO 111
C  INPUT NUMBER OF PERIODS TO ANALYZE AND NUMBER OF RECORDS TO
C   SKIP
      TYPE 6299
6299  FORMAT(/,21H#REC & #PER TO SKIP=?,/)
      ACCEPT 6252,IDATA(105),NRSKIP
6252  FORMAT(2I7)
C  RETRIEVE USABLE INFORMATION FROM FIRST TWO HEADERS
111   LC1=IDATA(54)/1000
      LC2=IDATA(54)-LC1*1000
      CWL=FLOAT(IDATA(62))/100.
      TEMP=FLOAT(IDATA(63))/10.
      WML=WMLL
      KFACT=2
      IF(IDATA(129).GE.0)KFACT=1
      WAVPD=DATA(51)
      IHORZ=IDATA(60)
      IVERT=IDATA(61)
C  COMPUTE SCALING FACTORS
      HORZ=FLOAT(IHORZ)
      VERTFT=FLOAT(IVERT)
      OMEGA=VERTFT/HORZ
      SWL=5.12*WAVPD*WAVPD
      C=SWL
902   ARG=TWOPIE*DEPTH1/SWL
      SWA=C*TANH(ARG)
      IF(ABS(SWA-SWL)-0.001*SWL)903,903,904
904   SWL=(SWA+SWL)/2.
      J    .902
903   THARG=TANH(ARG)
      IRUNNO=IDATA(53)
      ARGW=ARG*OMEGA
      THARGW=TANH(ARGW)
      TIME=SQRT(HORZ*THARG/THARGW)
      VERT=VERTFT/12.
      SA=WAVPD*TIME
      RR=WVHGT*VERT
```

```
      NCH=IDATA(64)
      NRECPD=IDATA(104)
      IGAGAR=IDATA(116)
      ISPWPD=IDATA(103)
      NOWPD=IDATA(105)
      NSPTST=ISPWPD*NOWPD
C  COMPUTE RECORD LENGTHS
      NRODS=IDATA(110)
      NSAMP=ISPWPD/NRECPD
      IRLD=ISPWPD*NCH/NRECPD
C  DETERMINE KENETIC VISCOSITY OF FRESH WATER FOR COMPUTING KEULEGAN
C     FACTORS
      AA=TEMP-60.
      BB=ABS(AA)
      IF(BB-10.)5050,5050,5005
5005  DD=BB-10.
      IF(AA)5014,5050,5021
5014  VISC=(1.41+(.0254*DD))*.00001
      J    .5060
5021  VISC=(1.059-(.0129*DD))*.00001
      J    .5060
5050  VISC=(1.217-(.0176*AA)+(.0017*BB))*.00001
5060  IF(.NOT.IOUT)GO TO 13
C  LIST INFORMATION FROM FIRST TWO HEADERS
12    WRITE (IODEV,14) (KTITLE(KK1),KK1=1,20),WAVPD,SA,IRUNNO,
     &LC2,LC1,IDATA(55),WVHGT,RR,(IDATA(KK1),KK1=56,59),IGAGAR,
     &IDATA(115),NRODS,ISPWPD,NOWPD,IHORZ,IVERT,TEMP,NRECPD,CWL
      IF(SENSW(7))WRITE (IODEV,6992) (IKFTI1(I,KFACT),I=1,4),
     &(IKFTI2(I,KFACT),I=1,6)
6992  FORMAT(//,16X,27HWAVEHEIGHT PROTOTYPE - FEET,20X,
     &20HWAVEPERIOD - SECONDS,14X,4A2,/,1X,7HCHANNEL,4X,
     &14HAVERAGE HEIGHT,
     &9X,11HHIGHEST 1/3,10X,12HMODEL PERIOD,7X,16HPROTOTYPE PERIOD,
     &6X,6A2,11X,12HCH  CODE PER)
C  IF NOT CALIBRATION FILE SKIP READING UNNECCESSARY RECORDS
   13 IF(ICAL)GO TO 17
      J    .16
C   READ TRANSDUCER FLAGS
17    IRL=NCH*2
      CALL RDMT(IFLAG(1,1),IRL,.TRUE.,IERR)
      L    .99
C  COMPUTE NUMBER OF GAGES HAVING CALIBRATION COEFFICIENTS
      NCOEF=0
      NCALV=0
      DO 6291 I=1,NCH
      L    .26
6291  CONTINUE
C  READ CALIBRATION COEFFICIENTS
      IF(NCOEF.EQ.0)GO TO 6292
      K=NCH*22
      CALL RDMT(COEF(1,1),K,.TRUE.,IERR)
      L    .99
C  READ GAGE NAMES
6292  CALL RDMT(IGAGEN(1,1),IRL,.TRUE.,IERR)
      L    .99
C  READ WEIGHTED MEAN DEPTHS
      IRL=NRODS*2
```

```
      IF(KFACT.NE.2)GO TO 8987
      CALL RDMT(DEPTH,IRL,.TRUE.,IERR)
      L    .99
C   READ DISTANCES FROM WAVE GENERATOR
      CALL RDMT(DIST,IRL,.TRUE.,IERR)
      L    .99
C  READ GAGE COORDINATES
8987  K=NCH*6
      CALL RDMT(COOR(1,1),K,.TRUE.,IERR)
      L    .99
C  READ POTENTIOMETER COEFFICIENTS
      IF(NRODS.EQ.0)GO TO 20
      CALL RDMT(POT(1),IRL,.TRUE.,IERR)
      L    .99
C   READ CALIBRATION VOLTAGE READINGS
20    IF(NCALV.EQ.0)GO TO 16
      IRL=NCALV*42
      CALL RDMT(ICALV(1,1),IRL,.TRUE.,IERR)
      L    .99
16    IF(.NOT.IOUT)GO TO 76
      IF(NRSKIP.LE.0)GO TO 8391
C  SKIP RECORDS IF ANY NOT DESIRED IN ANALYSIS
      DO 8392 K=1,NRSKIP
      CALL SRFMT(.TRUE.,IERR)
      L    .99
8392  CONTINUE
C  INITIALIZE COUNTERS FOR GAGE PROCCESSING
8391  NCOEF=0
      NCALV=0
      IPOTPT=0
      NPER=NOWPD*NRECPD
      IF(.NOT.SENSW(4))GO TO 7001
C  COPY DATA TO TEMPORARY DISK FILE
      CALL SELMD('21,0)
      CALL NMFMD(NAME(1),3,88,IER)
      IF((IER.EQ.0).OR.(IER.EQ.6))GO TO 7002
7004  TYPE 7000
      J    .7
7002  CALL SAVEMD(ISAVE(1))
      DO 7003 I1=1,NPER
      CALL RDMT(IBUF(1),IRLD,.TRUE.,IERR)
      L    .99
      CALL WRTMD(IBUF(1),IRLD,.TRUE.,IERR)
      L    .8999
7003  CONTINUE
      IF(IER.EQ.6)GO TO 7001
      CALL WEFMD(.TRUE.,IERR)
      L    .8999
C  COMPUTE NUMBER OF POINTS TO PLOT. CAN PLOT NO MORE THAN 3000 PTS
7001  NPTPLT=NSPTST
      IF(NSPTST.GT.3000)NPTPLT=3000
      DELT=WAVPD/FLOAT(ISPWPD)*TIME
      ZP(1)=0.
      ZP(2)=DELT*FLOAT(NPTPLT)
      DO 40 I=1,NCH
C  BUMP POINTERS FOR CALIBRATION COEFICIENTS & CALIBRATION VOLTAGES
      L    .26
```

```
      NTROF=0
      NPEAK=0
      IF(.NOT.ICHSKP)GO TO 8110
      TYPE 8010,I
8010  FORMAT(/,3HCH ,I3,/)
C  INTERPRET FLAGS FOR THIS GAGE
8110  IF1=IFLAG(1,I)/100
      IF2=IFLAG(1,I)-(IF1*100)
      IF(IF2.EQ.1)GO TO 42
      GO TO 40
42    IPOTPT=IPOTPT+1
      IF2=(IFLAG(2,I)/100)*100
      IF3=((IFLAG(2,I)/10)*10)-IF2
      IF2=IFLAG(2,I)-IF2-IF3
      IF(IF2.EQ.2)GO TO 40
      IF3=IF3/10+1
      IF(IF3.EQ.10)IF3=4
C
C
C  MOVE CALIBRATION COEFFICIENTS TO APPLICABLE BUFFERS
      DO 41 I1=1,11
41    S2(I1)=COEF(I1,NCOEF)
      IF(IF3.LE.3)GO TO 3303
      K=1
      L=1
      L    .2100
      K=12
      L=22
      L    .2100
      DO 48 I1=1,11
48    ZY(I1)=ZY(I1)*POT(IPOTPT)
C  SKIP THIS GAGE
3303  IF(SENSW(8))GO TO 40
      I3=1
      IF(.NOT.SENSW(4))GO TO 49
C  DEMULTIPLEX GAGE DATA FROM DATA RECORDS
      CALL RESETD(ISAVE(1),.TRUE.)
49    DO 43 I1=1,NPER
      IRL=IRLD
      IF(.NOT.SENSW(4))GO TO 7007
      CALL RDMD(IBUF(1),IRL,.TRUE.,IERR)
      L    .8999
      J    .7008
7007  CALL RDMT(IBUF(1),IRL,.TRUE.,IERR)
      L    .99
7008  DO 44 I4=1,IRLD,NCH
      IF(.NOT.ISFRCT)GO TO 8001
      J=IBUF(I4)
      LA   J
      STA  IFRACT
      SOUT=IFRACT
      SOUT=SOUT*10000.
      IBUF(I4)=SOUT
8001  IDATA(I3)=IBUF(I4)
   44 I3=I3+1
   43 CONTINUE
      IF(SENSW(4))GO TO 957
```

```
C  REWIND TAPE TO BEGINNING OF DATA RECORDS
7006   DO 45 I1=1,NPER
       CALL SRRMT(.TRUE.,IERR)
       L    .99
45     CONTINUE
957    III=I
C  INITIALIZE COUNTERS FOR WAVE ANALYSIS ROUTINE
       IERCD=0
       IBX=1
       NS=NOWPD
       NPS=ISPWPD
6110   BREAK=COOR(3,III)/1.28
       IF(SENSW(7))GO TO 943
       S=COOR(3,I)+CWL
C  LIST GAGE INFORMATION
       WRITE (IODEV,66) (KTITLE(KK1),KK1=1,20),III,IGAGAR
       WRITE (IODEV,67) COOR(1,I),COOR(2,I),S,IGAGEN(1,I),
      &IGAGEN(2,I)
943    IF(.NOT.SENSW(1))WRITE (IODEV,68)
       IXXX(1)=-32766
C  WAVE HEIGHT ANALYSIS ROUTINE BEGINS HERE
C  FIND FIRST PEAK WITHIN PERIOD WIDTH
       DO 6100 I11=1,NPS
       IF(IXXX(1)-IDATA(I11))921,6100,6100
921    IXXX(1)=IDATA(I11)
       IX(1)=I11
6100   CONTINUE
C  COMPUTE SEARCH WINDOW WIDTH, 30% MORE THAN PERIOD
       LZ=0.3*FLOAT(NPS)+0.5
       LZP=NPS+LZ
C  LOOP TO FIND MAXIMUM AND MINIMUM PAIRS (LOOKING FOR NS PAIRS)
       DO 6200 I11=1,NS
       IX(I11+1)=0
       IY(I11+1)=0
       IZD=0
C  FIRST PAIR?
       IF(I11-1)922,922,6210
C  BRACKET SEARCH WINDOW 6 ELEMENTS BEFORE FIRST MAXIMUM FOUND
922    J=IX(I11)-6
       IF(J.LT.1)J=1
       J    .6220
C  BRACKET SEARCH WINDOW 2 ELEMENTS PAST LAST MINIMUM FOUND
6210   J=IY(I11-1)+2
6220   KK1=J+LZP
       K=MIN0(KK1,NSPTST)
       IF(J+NPS-NSPTST)6230,6230,6320
6230   IXXX(I11)=-32766
       IYYY(I11)=32766
C  FIND MAXIMUM & MINIMUM WITHIN WINDOW
       DO 6240 L=J,K
       IF(IXXX(I11)-IDATA(L))923,6250,6250
923    IXXX(I11)=IDATA(L)
       IX(I11)=L
       J    .6240
6250   IF(IYYY(I11)-IDATA(L))6240,6240,924
924    IYYY(I11)=IDATA(L)
       IY(I11)=L
```

```
6240  CONTINUE
C  CHECK CREST - TROUGH PAIR FOR ACCEPTABILITY
C  DOES MINIMUM FOLLOW MAXIMUM?
      IF(IYYY(I11)-IXXX(I11))925,925,6500
C  FIRST PAIR?
925   IF(I11-1)926,926,6260
C  REDUCE SEARCH BY 1 ELEMENT
926   K=IX(I11)-1
      J    .6230
C  DISTANCE BETWEEN THIS MAXIMUM & LAST MAXIMUM ONE INITIAL SEARCH
C    WINDOW WIDTH?
6260  IF(IX(I11)-IX(I11-1)-LZP)927,927,6270
C  REDEFINE SEARCH WINDOW BEGINNING AT MAXIMUM FOUND & GOING 1 PERIOD
927   IYYY(I11)=32766
      KK1=IX(I11)+1
      KK2=IX(I11)+ISPWPD
      KK2=MIN0(KK2,NSPTST)
C  DOES SEARCH WINDOW OVERLAP END OF DATA SERIES?
      IF(KK1+NPS-NSPTST)6261,6261,6320
C  DETERMINE MINIMUM WITHIN WINDOW
6261  DO 6280 L=KK1,KK2
      IF(IYYY(I11)-IDATA(L))6280,6280,928
928   IYYY(I11)=IDATA(L)
      IY(I11)=L
6280  CONTINUE
      J    .6500
C  DISTANCE BETWEEN THIS MINIMUM & LAST MINIMUM 30% OF PERIOD?
6270  IF(IY(I11)-IY(I11-1)-LZ)6290,6290,929
C  REDUCE SEARCH WINDOW BY SETTING END OF SEARCH WINDOW TO LOCATION
C    THAT MINIMUM FOUND
929   IXXX(I11)=-32766
      KK1=IY(I11)
      KK1=MIN0(KK1,NSPTST)
      IF(J+NPS-NSPTST)6262,6262,6320
C  FIND MAXIMUM WITHIN SEARCH WINDOW
6262  DO 6300 L=J,KK1
      IF(IXXX(I11)-IDATA(L))930,6300,6300
930   IXXX(I11)=IDATA(L)
      IX(I11)=L
6300  CONTINUE
      J    .6500
C  EXPAND SEARCH WINDOW BY 2 ELEMENTS BEFORE MINIMUM FOUND & 2
C    ELEMENTS PAST MAXIMUM FOUND
6290  J=IY(I11)+2
      K=IX(I11)-2
C  ADD 1 TO ERROR DETERMINING COUNTER
      IZD=IZD+1
C  IF COUNTER  GREATER THAN 10 OUTPUT SEARCH ERROR MESSAGE
      IF(IZD-10)6230,6230,6000
6000  IERCD=2
      IF(SENSW(7))GO TO 942
      WRITE (IODEV,5011) I11
942   IYYY(I11)=IDATA(L)
C  ACCEPTABLE PAIR HAS BEEN FOUND
6500  IW(I11,1)=(IX(I11)+IY(I11)+1)/2
      IW(I11,2)=I11
      XB=FLOAT(IYYY(I11))
```

```
C  SCALE NUMBERS THAT ARE TO BE PRINTED
      GO TO (61,61,40,62),IF3
61    L   .72
      L   .8033
      L   .72
      J   .956
62    N=11
      L   .74
      L   .8033
      L   .74
956   XXX(I11)=FXX
      WH(I11)=XXX(I11)-YYY(I11)
C STORE MAXIMUM & MINIMUM FOR PLOTS
6310  PEAKPS(I11)=(FLOAT(IX(I11)-1))*DELT
      TROFPS(I11)=(FLOAT(IY(I11)-1))*DELT
      IF(PEAKPS(I11).LE.ZP(2))NPEAK=NPEAK+1
      IF(TROFPS(I11).LE.ZP(2))NTROF=NTROF+1
      IF(SENSW(1))GO TO 6200
      TT3=(FLOAT(IW(I11,1)-1))*DELT
      IF(WH(I11).GE.BREAK) WRITE (IODEV,69) I11
      WRITE (IODEV,5012) XXX(I11),PEAKPS(I11),YYY(I11),TROFPS(I11),
     1WH(I11),TT3,IW(I11,2)
6200  CONTINUE
      NP=NS
      J   .6330
C  OUTPUT ERROR MESSAGE THAT FEWER PAIRS FOUND THAN SEARCHED FOR
6320  NP=I11-1
      IERCD=1
      IF(SENSW(7))GO TO 6330
      WRITE (IODEV,6263) NP
6263  FORMAT(/,11H *** ONLY ,I4,26H PERIODS OF DATA FOUND ***)
C  CALCULATE STATISTICS TO BE OUTPUT
6330  IF(IBX)6400,932,932
932   S=0.
      SA=S
      ICV=0
      DO 1000 IXX=1,NP
      J11=NP-IXX
      DO 1200 K11=1,J11
      IJK=IXX+K11
      Q=FLOAT(IX(IJK)-IX(K11))/FLOAT(IXX)
      RR=FLOAT(IY(IJK)-IY(K11))/FLOAT(IXX)
      S=S+Q+RR
      SA=SA+Q*Q+RR*RR
1200  ICV=ICV+2
1000  CONTINUE
      PDEST=S/FLOAT(ICV)
      SDP=SQRT(ABS(SA-S*PDEST)/(FLOAT(ICV)-1.))
      NPK=NP
      L   .3001
      SMEN=PMEN
      VAR=PVAR
      WRMS=SQRT(VAR+SMEN*SMEN)
      DO 3100 IXX=1,NP
      DO 3200 K9=1,NP
      IF(WH(IXX)-WH(K9))3200,3200,3300
3300  TT=WH(K9)
```

```
      WH(K9)=WH(IXX)
      WH(IXX)=TT
      KK1=IW(K9,1)
      KK2=IW(K9,2)
      IW(K9,1)=IW(IXX,1)
      IW(K9,2)=IW(IXX,2)
      IW(IXX,1)=KK1
      IW(IXX,2)=KK2
3200  CONTINUE
3100  CONTINUE
      NPCT=IFIX(PCT*FLOAT(NP)/100.0+.5)
      NPK=NPCT
      L    .3001
      SOUT=SMEN/VERT
      VAROU=SQRT(VAR)
      VARO=VAROU/VERT
      WRMSO=WRMS/VERT
      PMOUT=PMEN/VERT
      PVARO=SQRT(PVAR)
      PVAO=PVARO/VERT
      PODE=PDEST*DELT/TIME
      SDPO=SDP*DELT/TIME
      DELTOU=DELT*PDEST
      SDPOUT=SDP*DELT
      RESULT(I)=PMEN
      IF(KFACT.NE.2)GO TO 6061
C  COMPUTE KEULEGAN COEFFICIENTS
      DEPTH1=DEPTH(IPOTPT)+CWL/VERTFT
      AAL=5.12478917*WAVPD*WAVPD
      BBB=TWOPIE*DEPTH1
      CCL=AAL
5001  CCC=EXP(BBB/CCL)
      SSH=1./CCC
      WL=AAL*((CCC-SSH)/(CCC+SSH))
      IF(ABS(WL-CCL)-.001)5020,5020,5010
5010  CCL=WL
      J    .5001
5020  AAA=FORPIE*DEPTH1/WL
      CCC=(WL/WAVPD)*WML
      ALPHA=2.5*SQRT(PIE*VISC/WAVPD)
      IF(AAA-10.)6020,6020,6010
6010  ALPHA=ALPHA/CCC
      J    .6060
6020  SINHY=EXP(AAA)
      IF(AAA-3.)6040,6040,6030
6030  SINHY=SINHY/2.
      J    .6050
6040  SINHY=(SINHY-1./SINHY)/2.
6050  ALPHA=ALPHA*(WL*SINHY+TWOPIE*WML)/(SINHY*WL+FORPIE*DEPTH1)
     &/CCC
6060  FACTOR=EXP(ALPHA*DIST(IPOTPT))
      PMENK=PMEN*FACTOR
6061  IF(.NOT.SENSW(7))GO TO 3305
      IF(KFACT.EQ.2)GO TO 8960
C  OUTPUT SUMMARY OUTPUT WITHOUT KEULEGAN COEFFICIENT CONSIDERED
      WRITE (IODEV,3320) IGAGEN(1,I),IGAGEN(2,I),SMEN,VAROU,
     &PMEN,PVARO,PODE,SDPO,DELTOU,SDPOUT,I,IERCD,NP
```

```
3320  FORMAT(2X,2A2,4X,2(2(F7.3,5H +/- ,F7.3,2X),1X),23X,I3,4X,
     &I2,1X,I3)
      J    .3310
C  OUTPUT SUMMARY OUTPUT WITH KEULEGAN COEFFICIENT CONSIDERED
8960  WRITE (IODEV,8961) IGAGEN(1,I),IGAGEN(2,I),SMEN,VAROU,PMEN,PVARO,
     &PODE,SDPO,DELTOU,SDPOUT,PMENK,I,IERCD,NP
8961  FORMAT(2X,2A2,4X,2(2(F7.3,5H +/- ,F7.3,2X)1X),1X,F7.3,15X,
     &I3,4X,I2,1X,I3)
      J    .3310
C  OUTPUT STANDARD OUTPUT
3305  WRITE (IODEV,5013) SOUT,VARO,SMEN,VAROU,WRMSO,WRMS,PCT,PMOUT,
     1PVAO,PMEN,
     1PVARO,PODE,SDPO,DELTOU,SDPOUT
      IF(KFACT.EQ.2)WRITE (IODEV,8972) FACTOR,PMENK
8972  FORMAT(3X,18HATTENUATION FACTOR,2X,F9.6,5X,
     &20HADJUSTED WAVE HEIGHT,2X,F7.3)
3310  IF(.NOT.SENSW(3))GO TO 40
C  SCALE DATA TO BE PLOTTED
      DO 8007 K9=1,NPTPLT
      L=NPTPLT-K9+1
      XB=FLOAT(IDATA(L))
      GO TO (8003,8003,40,8005),IF3
8003  L    .72
      J    .8006
8005  N=11
      L    .74
8006  Z(L)=FXX
8007  CONTINUE
      TT3=12.
      IF(NOWPD.GT.24)TT3=FLOAT(NOWPD)/2.
C  PLOT DATA
      CALL MODE(7,TT3,8.5,SAME)
      CALL MODE(2,TT3,SAME,SAME)
      CALL MODE(3,8.5,SAME,SAME)
      CALL SCAN(ZP,DELT,-2,480)
      CALL MODE(-8,TT3,DX,XB)
      DX=DELT/DX
      CALL SCAN(DELT,Z,-NPTPLT,840)
      CALL DRAW(DX,Z,NPTPLT,841)
      CALL MODE(5,SAME,SAME,440.)
      CALL NOTE(PEAKPS,XXX,42,-NPEAK)
      CALL NOTE(TROFPS,YYY,42,-NTROF)
      CALL AXES(22,2,22HTIME PROTOTYPE SECONDS,
     125,3,25HELEVATIONS PROTOTYPE FEET)
C  PLOT TITLE
      CALL MODE(3,9,4,SAME,SAME)
      CALL NOTE(2.,8.7,4HRUN ,4)
      CALL NOTE(SAME,SAME,IRUNNO,0)
      CALL NOTE(SAME,SAME,7H  GAGE ,7)
      CALL NOTE(SAME,SAME,IGAGEN(1,I),4)
      CALL MODE(4,.2,.167,0.)
      CALL NOTE(2.,9.,KTITLE,40)
      CALL MODE(4,.1,.067,0.)
      CALL DRAW(0.,0.,1,8000)
      J    .40
6400  CONTINUE
40    CONTINUE
```

```
      IF(.NOT.SENSW(6))GO TO 7382
C   OUTPUT RECORDS TO OUTPUT TAPE FILE
      CALL SELMT(IUNIT2)
      N=NCH*2
C   OUTPUT TRANSDUCER FLAG RECORD
      CALL WRTMT(IFLAG(1,1),N,.TRUE.,IERR)
      L    .99
      N=NRODS*2
C   OUTPUT GAGE NAME RECORD
      CALL WRTMT(IGAGEN(1,1),N,.TRUE.,IERR)
      L    .99
      IF(KFACT.NE.2)GO TO 8983
C   OUTPUT WEIGHTED MEAN DEPTH RECORD
      CALL WRTMT(DEPTH,N,.TRUE.,IERR)
      L    .99
C   OUTPUT DISTANCES FROM WAVE GENERATOR
      CALL WRTMT(DIST,N,.TRUE.,IERR)
      L    .99
8983  L=NCH*6
C   OUTPUT GAGE COORDINATE RECORD
      CALL WRTMT(COOR(1,1),L,.TRUE.,IERR)
      L    .99
C   OUTPUT ANALYSIS RESULT RECORD
      CALL WRTMT(RESULT(1),N,.TRUE.,IERR)
      L    .99
      CALL WEFMT(.TRUE.,IERR)
      CALL WEFMT(.TRUE.,IERR)
7382  IF(SENSW(3))CALL DRAW(0.0,0.9999)
      IF(SENSW(5))GO TO 8
C   POSITION TO NEXT INPUT TAPE FILE
76    CALL SELMT(IUNIT)
      CALL SFFMT(.TRUE.,IERR)
      IRL=5
      CALL RDMT(IDATA(1),IRL,.TRUE.,IERR)
      IF(IERR.EQ.'100002)GO TO 77
      IF(IERR.NE.0)GO TO 7
      J    .5
C
C LINKS
C
C   AVERAGE CALIBRATION VOLTAGE READINGS
2100  OCT 0
      DO 2901 LC1=1,11
      LC2=K+LC1-1
      KK1=0
      J=L+IPOIT1(LC1)
      L    .2902
      XP=1.
      IF((LC1.EQ.1).OR.(LC1.EQ.11))GO TO 2901
      J=L+IPOIT2(LC1)
      L    .2902
      XP=2.
      IF(LC1.NE.6)GO TO 2901
      J=L+20
      L    .2902
      XP=3.
2901  BUF(LC2)=FLOAT(KK1)/XP
```

```
      J    .2100.2
2902  OCT 0
      KK1=KK1+ICALV(J.NCALV)
      J    .2902.2
C  INTERPRET GAGE FLAGS
26    OCT 0
      I1=IFLAG(2.I)/10000
      IF((I1.EQ.1).OR.(I1.EQ.3))NCOEF=NCOEF+1
      IF(I1.GT.2)NCALV=NCALV+1
      J    .26.2
C  DETERMINE IF DISK I/O ERROR OCCURED
8999  OCT 0
      IF(IERR.NE.0)GO TO 7004
      J    .8999.2
C  DETERMINE IF MAGNETIC TAPE I/O ERROR OCCURED
99    OCT 0
      IF(IERR.NE.0)GO TO 7
      J    .99.2
C   LINEAR & QUADRATIC FITS
72    OCT 0
      FXX=((S2(3)*XB+S2(2))*XB+S2(1))*VERT+CWL
      J    .72.2
C  SPLINT ROUTINE FOR SPLINE FITTING PROCEDURE
74    OCT 0
      MM=0
      K=1
      XP=XB
      IF(XP-X(1))100.170.110
100   MM=-1
      XP=X(1)
      J    .170
110   IF(XP-X(N))130.150.140
120   IF(XP-X(K))160.170.130
130   K=K+1
      J    .120
140   MM=-1
      XP=X(N)
150   K=N
160   K=K-1
170   HT1=XP-X(K)
      HT2=XP-X(K+1)
      PROD=HT1*HT2
      DX=X(K+1)-X(K)
      DELY=(ZY(K+1)-ZY(K))/DX
      S3=(S2(K+1)-S2(K))/DX
      FPPXX=S2(K)+HT1*S3
      DELSQS=(S2(K)+S2(K+1)+FPPXX)/6.
      FXX=ZY(K)+HT1*DELY+PROD*DELSQS
      FPXX=DELY+(HT1+HT2)*DELSQS+PROD*S3/6.
      IF(MM.EQ.0)GO TO 180
      FXX=FXX+FPXX*(XB-XP)
180   CONTINUE
      FXX=FXX*VERT+CWL
      J    .74.2
C  COMPUTE MEAN AND VARIANCE
3001  OCT 0
      SUMM=0.
```

```
      SUM1=0.
      DO 3002 NN=1,NPK
      SUMM=SUMM+WH(NN)
3002  SUM1=SUM1+WH(NN)*WH(NN)
      PMEN=SUMM/FLOAT(NPK)
      PVAR=(SUM1-SUMM*PMEN)/FLOAT(NPK)
      J    .3001,2
C
8033  OCT 0
      YYY(I11)=FXX
      XB=FLOAT(IXXX(I11))
      J    .8033,2
77    CALL MONOUT
      END

PROGRAM SIZE = '44226
```

APPENDIX C: INPUT TAPE FORMAT FOR WAVE-HEIGHT PROGRAM

1. Wave data are recorded in data files on magnetic tape by ADACS data acquisition programs. These data files on magnetic tape are used as input to the wave analysis program.

2. Two general file formats are used by the wave analysis program--a calibration file and a noncalibration file. Several records containing gage identification and data scaling factors are included in a calibration file that are excluded from a noncalibration file. Since gage identification and data scaling factors remain constant for a series of data tests, there is no need to record this information in every data file. Thus this information, which is recorded exclusively in a calibration file, is applicable to all subsequent data files until updated by another calibration file. That is to say, before analyzing a particular noncalibration file, the wave analysis program must obtain, for the file, the correct calibration coefficients which are contained in the last preceding calibration file. It should be noted that floating point variables require two words for storage and two alpha characters are stored in one word.

3. All data files are separated by an end-of-file (EOF) mark with the individual file and records having the following format:

a. File Identification Record. This record, which is included in both calibration and noncalibration files, is used simply for file identification. It contains five words with the following definitions:

Word	Data Type	Definition
1	Alpha	File name ASCII Characters (3A2)
2	Alpha	File name ASCII Characters
3	Alpha	File name ASCII Characters
4	Integer	File Type Designator Always = 3
5	Integer	Record Length of Header Record #1 = 20

b. Header Record #1. This record, which is included in both calibration and noncalibration files, contains testing identification and testing parameters. It contains 20 words with the following definitions:

Word	Data Type	Definition
1		Not used by this program
2		Not used by this program
3	Integer	Test run number
4	Integer	Date of test = Julian date + last digit of year × 100
5	Integer	Time of test

(Continued)

Word	Data Type	Definition
6	Alpha	Model identification (4A2)
7	Alpha	Model identification
8	Alpha	Model identification
9	Alpha	Model identification
10	Integer	Horizontal model scale
11	Integer	Vertical model scale
12	Integer	Reference mean water level in prototype feet × 10
13	Integer	Model water temperature × 10
14	Integer	Number, N+M, of transducers sampled for this test
15	Logical	.TRUE. if this is a calibration file
16	Floating Point	Model-generated wave height in prototype feet
17		Not used by this program
.	.	.
19		Not used by this program
20	Integer	Record length of Header Record #2 = 50

c. Header Record #2. This record contains further testing parameters. It consists of 50 words with the following definitions:

Word	Data Type	Definition
1	Floating Point	Generated wave period in model seconds
2		Not used by this program
3	Integer	Number, J, of data samplings per gage per wave period
4	Integer	Number, K, of magnetic tape data records per wave period
5	Integer	Number, L, of wave periods of data recorded
6		Not used by this program
.	.	.
.	.	.
9		Not used by this program
10	Integer	Number, N, of wave gages sampled for this test
11		Not used by this program
.	.	.
.	.	.
.	.	.
15		Not used by this program
16	Integer	Transducer arrangement number
17	Integer	Generated wave direction in degrees from north
18		Not used by this program
.	.	.
.	.	.
.	.	.
28		Not used by this program

(Continued)

Word	Data Type	Definition
29	Logical	.TRUE. if weighted mean depth record and gage distance record recorded
30	Floating Point	Wave generator length in model feet
31	·	·
32	Floating Point	Wave machine length in model feet
33		Not used by this program
·	·	·
·	·	·
50		Not used by this program

d. Transducer Flag Record. This record is included only in a calibration file. Its record length is two times the fourteenth element (N+M) in Header Record #1. This record contains two integer flags for each computer channel read during a data scan including sequential wave gages that are scanned but not used. The flags are set up as follows:

(1) FLAG1 = Transducer type + (computer channel number) × 100 . Transducer types vary from 0 to 99 with 1 identifying wave gages. For any other value besides 1, this analysis program does not consider the gage data.

(2) FLAG2 = [= 2 Gage not used
= 0 Linear calibration fitting procedure
= 1 Quadratic calibration fitting procedure
= 9 Spline calibration fitting procedure]

+ [(number of calibration voltage readings per channel) × 100]

+ [= 0 No entry for gage in calibration voltage record or calibration coefficient record
= 10,000 entry for gage in calibration coefficient record only
= 20,000 entry for gage in calibration voltage record only
= 30,000 entry for gage in both calibration voltage record and calibration coefficient record]

The two (N+M) words in this record have the following definitions:

Word	Data Type	Definition
1	Integer	Flag 1 for first wave gage
2	Integer	Flag 2 for first wave gage
3	Integer	Flag 1 for second wave gage

(Continued)

Word	Data Type	Definition
4	Integer	Flag 2 for second wave gage
.	.	.
.	.	.
.	.	.
2N-1	Integer	Flag 1 for last (N^{th}) wave gage
2N	Integer	Flag 2 for last (N^{th}) wave gage
2N+1	Integer	Flag 1 for first of other type gages
2N+2	Integer	Flag 2 for first of other type gages
.	.	.
.	.	.
.	.	.
2(N+M)-1	Integer	Flag 1 for last (M^{th}) of other type gages
2(N+M)	Integer	Flag 2 for last (M^{th}) of other type gages

e. Calibration Coefficient Record. The length of this record is obtained by multiplying 22 times the number of gages indicated as having entries in this record by Flag 2 in the Transducer Flag Record. This record is included only in a calibration file. Eleven floating point calibration coefficients exist in this record for each gage having calibration coefficients. The reader is reminded that a floating point number requires two words in memory. The words in this record have the following definitions:

Word	Data Type	Definition
1	Floating Point	Mathematical fit coefficients for first wave gage
2	.	.
3	Floating Point	
4	.	.
.	.	.
.	.	.
.	.	.
23	Floating Point	Mathematical fit coefficients for second wave gage
24	.	.
25	Floating Point	
26	.	.
.	.	.
.	.	.
.	.	.
45	Floating Point	Mathematical fit coefficients for third wave gage
46	.	.
.	.	.
22N-21	Floating Point	Mathematical fit coefficients for last (N^{th}) wave gage

(Continued)

Word	Data Type	Definition
22N-20	.	.
.	.	.
.	.	.
22N+1	Floating Point	Mathematical fit coefficients for first of other type gages
22N+2	.	.
.	.	.
.	.	.
22(N+M)-21	Floating Point	Mathematical fit coefficients for last (M^{th}) of other type gages
22(N+M)	.	.

f. Gage Name Record. Record length is twice the fourteenth element (N+M) of Header Record #1. This record is included only in a calibration file and contains a four character name or number for each gage scanned during data acquisition. The 2(N+M) words of this record have the following definitions:

Word	Data Type	Definition
1	Alpha	First wave gage name (2A2)
2	.	.
3	.	Second wave gage name
4	.	.
.	.	.
.	.	.
.	.	.
2N-1	.	Last (N^{th}) wave gage name
2N	.	.
2N+1	.	First of other type gage name
.	.	.
.	.	.
.	.	.
2(N+M)-1	.	Last (M^{th}) of other type gage name
2(N+M)	.	.

g. Weighted Mean Depth Record. Record length is two times the tenth (N) element in Header Record #2. This record is included only in a calibration file if the twenty-ninth element of Header Record #2 is .TRUE. It contains an entry for each wave gage representing the average model depth in feet between the gage and the wave generator. The 2N words in this record have the following definitions:

Word	Data Type	Description
1	Floating Point	Weighted mean depth for first wave gage
2	.	.
3	Floating Point	Weighted mean depth for second wave gage
4	.	.

(Continued)

Word	Data Type	Description
.	.	.
.	.	.
2N-1	Floating Point	Weighted mean depth for last (N^{th}) wave gage
2N	.	.

h. Gage Distance Record. Record length is two times the tenth (N) element in Header Record #2. This record is included only in a calibration file if the twenty-ninth element of Header Record #2 is .TRUE. It contains an entry for each wave gage representing the distance between each gage and the wave generator in prototype feet. The 2N words in this record have the following definitions:

Word	Data Type	Description
1	Floating Point	Distance for first wave gage
2	.	.
3	Floating Point	Distance for second wave gage
4	.	.
.	.	.
.	.	.
.	.	.
2N-1	Floating Point	Distance for last (N^{th}) wave gage
2N	.	.

i. Gage Coordinate Record. Record length is six times the fourteenth element (N+M) of Header Record #1. This record is included only in a calibration file and contains three floating point coordinates (X, Y, and prototype water depth) for each gage scanned during data acquisition. The 6(N+M) words in this record have the following definitions:

Word	Data Type	Description
1	Floating Point	X coordinate for first wave gage
2	.	.
3	.	Y coordinate for first wave gage
4	.	.
5	.	Water depth for first wave gage
6	.	.
7	.	X coordinate for second wave gage
8	.	.
.	.	.
.	.	.
.	.	.
.	.	.
6N-5	Floating Point	X coordinate for last (N^{th}) wave gage
6N-4	.	.
6N-3	.	Y coordinate for last (N^{th}) wave gage
6N-2	.	.
6N-1	.	Water depth for last (N^{th}) wave gage
6N	.	.

(Continued)

Word	Data Type	Description
6N+1	Floating Point	X coordinate for first of other type gages
6N	·	·
·	·	·
·	·	·
·	·	·
6(N+M)-1	·	Water depth for last (M^{th}) of other type gages
6(N+M)	·	·

j. Reference Potentiometer Calibration Coefficient Record. Record length is twice the tenth element (N) of Header Record #2. This record is included only in a calibration file and contains the slope coefficient for the reference potentiometer of each wave gage calibration stand. The 2N words in this record have the following definitions:

Word	Data Type	Definition
1	Floating Point	Potentiometer coefficient for first wave gage
2	·	·
3	·	Potentiometer coefficient for second wave gage
4	·	·
·	·	·
·	·	·
·	·	·
2N-1	·	Potentiometer coefficient for last (N^{th}) wave gage
2N	·	·

k. Calibration Voltage Record. The length of this record is determined by multiplying 42 times the number of gages indicated as having entri s in this record by Flag 2 in the Transducer Flag Record. This record is included only in a calibration file and contains calibration voltage readings for wave gages calibrated under computer control prior to data acquisition. The words in this record have the following definitions:

Word	Data Type	Calibration Steps	Gage
1	Integer	Zero	First wave gage sensor
2	·	+A	·
3	·	+B	·
4	·	+C	·
5	·	+D	·
6	·	+E	·
7	·	+D	·
8	·	+C	·
9	·	+B	·

(Continued)

Word	Data Type	Calibration Steps	Gage
10	.	+A	.
11	.	Zero	.
12	.	-A	.
13	.	-B	.
14	.	-C	.
15	.	-D	.
16	.	-E	.
17	.	-D	.
18	.	-C	.
19	.	-B	.
20	.	-A	.
21	.	Zero	.
22	Integer	Zero	First wave gage potentiometer
23	.	+A	.
24	.	+B	.
25	.	+C	.
26	.	+D	.
27	.	+E	.
28	.	+D	.
29	.	+C	.
30	.	+B	.
31	.	+A	.
32	.	Zero	.
33	.	-A	.
34	.	-B	.
35	.	-C	.
36	.	-D	.
37	.	-E	.
38	.	-D	.
39	.	-D	.
40	.	-E	.
41	.	-D	.
42	.	-C	.
43	.	-B	.
44	.	-A	.
45	.	Zero	.
46	Integer	Zero	Second wave gage sensor
47	.	+A	.
.	.	.	.
.	.	.	.
.	.	.	.
45N-44	Integer	Zero	Last (N^{th}) wave gage sensor
.	.	.	.
.	.	.	.
.	.	.	.
45N-23	Integer	Zero	Last (N^{th}) wave gage potentiometer
.	.	.	.
.	.	.	.
.	.	.	.

(Continued)

Word	Data Type	Calibration Steps	Gage
45N+1	Integer	Zero	First other type gage sensor
.	.	.	.
.	.	.	.
.	.	.	.
45(N+M)-23	Integer	Zero	Last (M^{th}) other type gage potentiometer
.	.	.	.
.	.	.	.
.	.	.	.
45(N+M)	Integer	Zero	Last (M^{th}) other type gage potentiometer

l. Data Records. The length of this record can be determined by multiplying the third element, J, of Header Record #2 by the 14th element, N+M, of Header Record #1 and dividing this product by the fourth element, K, of Header Record #2. These data records are included in both calibration and noncalibration files. Since the number of data records in these files varies and depends upon the number of wave periods, L, acquired during each wave test, the number of data records can be determined by multiplying the fourth, K, and fifth, L, elements of Header Record #2. The (J/K)(N+M) words in this record have the following definitions:

Word	Data Type	Description
1	Scaled fraction	Sample from first scan of first wave gage
2	.	Sample from first scan of second wave gage
.	.	.
.	.	.
.	.	.
N	Scaled fraction	Sample from first scan of last (N^{th}) wave gage
N+1	Scaled fraction	Sample from first scan of first of other type gage
N+2	Scaled fraction	Sample from first scan of second of other type gage
.	.	.
.	.	.
.	.	.
N+M	Scaled fraction	Sample from first scan of last of other type gage
(N+M)+1	Scaled fraction	Sample from second scan of first wave gage
(N+M)+2	Scaled fraction	Sample from second scan of second wave gage
.	.	.
.	.	.
.	.	.

(Continued)

AD-A142 679 DOCUMENTATION OF WAVE-HEIGHT AND TIDAL ANALYSIS PROGRAMS FOR AUTOMATED DA..(U) ARMY ENGINEER WATERWAYS EXPERIMENT STATION VICKSBURG MS HYDRA.. 2/2

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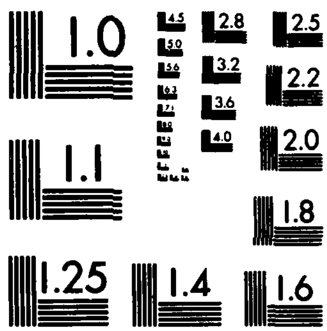

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Word	Data Type	Description
2(N+M)	Scaled fraction	Sample from second scan of last of other type gages
.	.	.
.	.	.
.	.	.
(J/K)(N+M)	Scaled fraction	Sample from last (J^{th}) scan of last (M^{th}) of other type gages.

APPENDIX D: OUTPUT TAPE FORMAT FOR WAVE-HEIGHT PROGRAM

1. An output tape may be generated by the wave analysis program containing wave analysis results, model and wave test identification, wave test parameters, and gage identification. This output tape is generated to provide permanent files of reduced wave data for each model wave test. These reduced data are used to produce computer-generated tables or plots for comparing results of various wave tests conducted in a particular wave model. The output tape is simply a copy of pertinent records contained on the input tape with the addition of one record containing the results of the wave analysis program. There is no differentiation between a calibration file and a noncalibration file on the output tape. That is to say, those files which were excluded on noncalibration input tape files are included on each output tape file.

2. Header Record #1, Header Record #2, Transducer Flag Record, Gage Name Record, Weighted Mean Depth Record, Gage Distance Record, and Gage Coordinate Record are included in every output tape file. These records are simply copied directly from input tape to the output tape using the same formats that are defined in Appendix C for these records. The last record included in the output tape file is the Analysis Result Record. This record length is twice the tenth element, N, of Header Record #2. This record contains the average highest one-third of the wave heights for each wave gage. There is one floating point entry in this record for each wave gage. The 2N words in this record have the following definitions:

Word	Date Type	Definition
1	Floating Point	Wave height for first wave gage
2	.	.
3	Floating Point	Wave height for second wave gage
4	.	.
.	.	.
.	.	.
.	.	.
2N-1	Floating Point	Wave height for last (N^{th}) wave gage
2N	.	.

APPENDIX E: PROGRAM LISTING FOR TIDAL ANALYSIS PROGRAM

FORTRAN COMPILER REV. LEV. J00

```
C
C  SENSE SWITCH A DELET ORIGINAL DATA PLOT
C  SENSE SWITCH B DELET ORIGINAL & COMPARISON DATA PLOT WITH MEAN
C        ADDED TO BOTH DATA SERIES
C  SENSE SWITCH C DELET ORIGINAL & COMPARISON DATA PLOT WITH MEAN
C        REMOVED FROM BOTH DATA SERIES
C  SENSE SWITCH D DELET RESIDUAL PLOT
C  SENSE SWITCH E DELET POWER SPECTRAL DENSITY & PLOT
C  SENSE SWITCH F SKIP CHANNELS
C  SENSE SWITCH G LIST DATA
C
C
C     PROGRAM LIMITS
C      1680 DATA POINTS PER GAGE MAXIMUM
C      20 LEAST SQUARES HARMONIC ANALYSIS COMPONENTS MAXIMUM
C      98 DATA CHANNELS MAXIMUM  48 TIDE GAGES MAXIMUM
C      DATA RECORD LENGTH 3362 WORDS MAXIMUM
C
C
      DIMENSION PERHLD(20)
      DIMENSION ZP(3),ZR(3),IDATA(3362),IBUF(3362),
     &IZAP(2),PERIOD(20),OMEGA(20),AMP(20),PHS(20),
     &INDEX(10),ZAP(2),PSDC(1681),S(5),AAA(3,4),IFLAG(2,98),
     &XCOR(98),YCOR(98),ZCOR(98),
     &IGAGEN(2,98),COEF(11,50),NSWL(48)
      DIMENSION DATA(1680),LABEL(10),
     &Z(1681),CHOLD(41,41)
      EQUIVALENCE (IBUF(1),PSDC(1),CHOLD(1,1))
      EQUIVALENCE (TX,IZAP(1)),(IDATA(1),DATA(1),Z(1))
      SCALED FRACTION IVOLT
      LOGICAL IADJCH,IREFD
      LOGICAL ICAL,SENSW,ITAPER,IGTYPE
      DATA TPP/0./
      DATA PI/3.1415927/,MODULO/'100/,SAME/9999./,T1/0./,T2/0./
      DATA LMASK3/'7417/
      DATA DX/0./,LMASK/'10421/,LMASK2/'177777/
      DATA IRESP/1HY/
      DATA IODEV/16/,RADDEG/57.2957795/,TWOPI/6.2831853/
8     TYPE 6501
6501  FORMAT(/,13HFORCE SHIFT=?,/)
      ACCEPT 901,FSHIFT
      ITAPER=.FALSE.
      TYPE 6092
6092  FORMAT(/,16HTAPER RESIDUAL ?,/)
      ACCEPT 2,I
2     FORMAT(A1)
      IF(I.EQ.IRESP)ITAPER=.TRUE.
      TYPE 6202
6202  FORMAT(/,24HCALIBRATION FIT OPTION=?,/)
      ACCEPT 6252,NOPTN
      TYPE 8111
8111  FORMAT(/,22H#COMPS TO ANALIZE FOR?,/)
      ACCEPT 6252,INCANL
6252  FORMAT(2I7)
```

```
      DO 6391 I=1,INCANL
      TYPE 6254
6254  FORMAT(/,10HCOMP PER=?,/)
6391  ACCEPT 901,PERHLD(I)
      IGTYPE =.FALSE.
      TYPE 6210
6210  FORMAT(/,17HLIST UPDATE CALS?,/)
      ACCEPT 2,I
      IF(I.EQ.IRESP)IGTYPE=.TRUE.
      IREFD=.TRUE.
      TYPE 6306
6306  FORMAT(/,27HREFERENCE DATA TO BE INPUT?,/)
      ACCEPT 2,I
      IF(I.NE.IRESP)GO TO 6307
      IREFD=.FALSE.
      TYPE 6308
6308  FORMAT(/,32HNUMBER OF REFERENCE COMPONENTS=?,/)
      ACCEPT 6252,NCANAL
6307  TYPE 101
101   FORMAT(/,22HHOW OFTEN UPDATE CAL ?,/)
      ACCEPT 6252,KALUPD
      TYPE 6392
6392  FORMAT(/,7HLABEL=?,/)
      ACCEPT 6393,(LABEL(I),I=1,10)
6393  FORMAT(10A2)
      TYPE 2092
2092  FORMAT(/,14H#REC TO SKIP=?,/)
      ACCEPT 6252,NRSKIP
      TYPE 6297
6297  FORMAT(/,11HTAPE UNIT=?,/)
      ACCEPT 6298,I1
      CALL SELMT(I1)
6298  FORMAT(O8)
      TYPE 900
900   FORMAT(/,21HAVERAGE MODEL DEPTH=?,/)
      ACCEPT 901,DEPTH
901   FORMAT(F10.5)
      IRL=0
      TYPE 3
3     FORMAT(/,10HFILE NAME?,/)
      ACCEPT 3311,(IDATA(I),I=1,3)
3311  FORMAT(3A2)
C  POSITION TAPE TO FILE
      CALL POSMT(IDATA(1),3,IRL,.FALSE.,IERR)
      IF(IERR.EQ.'100004)GO TO 5
      IF(IERR.EQ.0)GO TO 5
7     TYPE 6
6     FORMAT(1H?)
      J    .8
5     IRL=20
C  READ FIRST HEADER
   78 CALL RDMT(IDATA(51),IRL,.TRUE.,IERR)
      ICAL=.TRUE.
      IF(IDATA(65).GE.0)ICAL=.FALSE.
      IF(IERR.NE.0)GO TO 7
C  READ SECOND HEADER
      CALL RDMT(IDATA(101),IDATA(70),.TRUE.,IERR)
```

```
      IF(IERR.NE.0)GO TO 7
      TYPE 6299
6299  FORMAT(/,24H# OF CYCLES TO ANALYSE=?,/)
      ACCEPT 6252,IDATA(105)
C  BREAK OUT DATE AND TIME
      IDATA(1)=IDATA(54)/1000
      IDATA(2)=IDATA(54)-(IDATA(1)*1000)
      CWL=FLOAT(IDATA(62))/100.
      TEMPA=FLOAT(IDATA(63))/10.
      DATA(3)=DATA(51)
      IHORZ=IDATA(60)
      IVERT=IDATA(61)
      WAVPD=DATA(3)/3600.
C  COMPUTE MODEL SCALES TO CONVERT TO PROTOTYPE
      HORZ=FLOAT(IHORZ)
      VERT=FLOAT(IVERT)
      T1=VERT/HORZ
      SWL=5.12*DATA(3)*DATA(3)
      C=SWL
902   ARG=6.283*DEPTH/SWL
      SWA=C*TANH(ARG)
      IF(ABS(SWA-SWL)-0.001*SWL)903,903,904
904   SWL=0.5*(SWA+SWL)
      J    .902
903   THARG=TANH(ARG)
      ARGW=ARG*T1
      THARGW=TANH(ARGW)
      TIME=SQRT(HORZ*THARG/THARGW)
      VERT=VERT/12.
      DATA(4)=DATA(3)*TIME/3600.
C  MOVE (REAL) TIDE HEIGHT
      IDATA(9)=IDATA(66)
      IDATA(10)=IDATA(67)
      DATA(6)=DATA(5)*VERT
C  BREAK OUT TESTING PARAMETERS
      NCH=IDATA(64)
      NRECPD=IDATA(104)
      IGAGAR=IDATA(116)
      ISPWPD=IDATA(103)
      NOWPD=IDATA(105)
      NSPTST=IDATA(103)*IDATA(105)
      IRLD=IDATA(103)*NCH/IDATA(104)
      IRUNO=IDATA(53)
C  OUTPUT TEST HEADER INFORMATION
      WRITE (IODEV,15) IRUNO,IDATA(2),IDATA(1),IDATA(55),IDATA(56),
     &IDATA(57),IDATA(58),IDATA(59),IGAGAR,IHORZ,IVERT,TEMPA,
     &DATA(3),DATA(4),NCH,ISPWPD,NOWPD,NRECPD
15    FORMAT(1H1,//////,13X,36H*** TIDE RECORD ANALYSIS PROGRAM ***,
     &///,9H TEST RUN,1X,I5,3X,I3,14H TH DAY OF 197,I1,4H AT ,
     &I4,6H HOURS,/,11H MODEL PLAN,1X,4A2,3X,9HGAGE ARR.,1X,I4,
     &/,14H HOR. SCALE 1=,I3,15H  VER. SCALE 1=,
     &I3,2X,11HWATER TEMP.,1X,F5.2,//,16X,5HMODEL,13X,9HPROTOTYPE,
     &/,7H PERIOD,7X,F7.1,8H SECONDS,5X,F7.1,6H HOURS,/,
     &I3,13H CHANNELS OF ,I3,15H SAMP/PER. FOR ,I3,8H PERIODS,
     &/,11H #REC./PER.,1X,I4)
      IF(IGTYPE)WRITE (IODEV,106)
106   FORMAT(////,20H UPDATE CALIBRATIONS,5X,9HINTERCEPT,6X,5HSLOPE)
```

```
      IRL=NCH*2
C  READ TRANSDUCER FLAGS
      CALL RDMT(IFLAG(1,1),IRL,.TRUE.,IERR)
      IF(IERR.NE.0)GO TO 7
      IF=5
      J1=0
      NRE=0
      NCOEF=0
C  COMPUTE # OF CAL COEFFICIENTS & # OF REFERENCE ELEVATIONS
      DO 6291 I=1,NCH
      I2=IFLAG(1,I)-((IFLAG(1,I)/100)*100)
      I1=IFLAG(2,I)/10000
      IF(I2.EQ.2)NRE=NRE+1
      IF((I1.EQ.1).OR.(I1.EQ.3))NCOEF=NCOEF+1
      IF(I2.NE.3)GO TO 6291
      NRE=NRE+1
      J1=J1+1
      IF=IF+1
      INDEX(J1)=I
      INDEX(IF)=NRE
6291  CONTINUE
C  READ CAL COEF
      IRL=NCOEF*22
      CALL RDMT(COEF(1,1),IRL,.TRUE.,IERR)
      IF(IERR.NE.0)GO TO 7
C  READ GAGE NAMES
      IRL=NCH*2
      CALL RDMT(IGAGEN(1,1),IRL,.TRUE.,IERR)
      IF(IERR.NE.0)GO TO 7
C  READ GAGE COOR.
      IRL=NCH*6
      CALL RDMT(IDATA(1),IRL,.TRUE.,IERR)
      IF(IERR.NE.0)GO TO 7
      I=1
      DO 25 II=1,288,3
      XCOR(I)=DATA(II)
      YCOR(I)=DATA(II+1)
      ZCOR(I)=DATA(II+2)
25    I=I+1
C  SKIP 2 RECORDS POT COEF & CAL VOLTAGES NOT USED BY THIS PROGRAM
      CALL SRFMT(.TRUE.,IERR)
      CALL SRFMT(.TRUE.,IERR)
C  READ REFERENCE ELEVATIONS
      CALL RDMT(NSWL(1),NRE,.TRUE.,IERR)
      IF(IERR.NE.0)GO TO 7
16    IADJCH=.FALSE.
C  SORT REFERENCE TIDE GAGES IN ORDER OF DISPLACEMENT
      NPER=NOWPD*NRECPD
      DO 41 I=1,3
      DO 42 K1=I,3
      NN=INDEX(I)
      NP=INDEX(K1)
      IF(ZCOR(NN).GE.ZCOR(NP))GO TO 42
      K5=INDEX(K1)
      INDEX(K1)=INDEX(I)
      INDEX(I)=K5
      K5=INDEX(K1+5)
```

```
      INDEX(K1+5)=INDEX(I+5)
      INDEX(I+5)=K5
42    CONTINUE
41    CONTINUE
      IC1=INDEX(1)
      IC2=INDEX(2)
      IC3=INDEX(3)
      PRANGE=ZCOR(IC1)
      ZERO=ZCOR(IC2)
      QRANGE=ZCOR(IC3)
      NCCRC=0
      NSWLRC=0
      NN=INDEX(6)
      ASWL=FLOAT(NSWL(NN))
      NN=INDEX(7)
      BSWL=FLOAT(NSWL(NN))
      NN=INDEX(8)
      CSWL=FLOAT(NSWL(NN))
      DELT=WAVPD/FLOAT(ISPWPD)*TIME
C  SKIP DATA RECORDS IF DESIRED
      IF(NRSKIP.EQ.0)GO TO 2093
      DO 2091 IF=1,NRSKIP
2091  CALL SRFMT(.TRUE.,IERR)
2093  DO 40 I=1,NCH
C  TYPE PRESENT GAGE NUMBER TO TELETYPE
      TYPE 6281,I
6281  FORMAT(/,7HGAGE#= ,I5)
C  BREAK PRESENT CHANNEL FLAGS
      IF=IFLAG(1,I)
      IF1=IF/100
      IF3=IF-IF1*100
      IF=IFLAG(2,I)
      IF2=IF/10000
      IF((IF2.EQ.1).OR.(IF2.EQ.3))NCCRC=NCCRC+1
      IF((IF3.EQ.2).OR.(IF3.EQ.3))NSWLRC=NSWLRC+1
      IF((IF3.EQ.2).OR.(IF3.EQ.4).OR.(IF3.EQ.5))GO TO 46
      GO TO 40
46    IF2=IF-((IF/10)*10)
      IF(IF2.EQ.2)GO TO 40
      IF2=((IF/10)-((IF/100)*10))+2
      IF(SENSW(6))GO TO 40
C  READ & DEMULTIPLEX DATA FOR 1 GAGE
      I3=0
      ICALNM=1
      KALKT=KALUPD
      DO 43 I1=1,NPER
6200  CALL RDMT(IBUF(1),IRLD,.TRUE.,IERR)
      IF(IERR.NE.0)GO TO 7
      K8=0
      DO 44 I4=I,IRLD,NCH
      I3=I3+1
C  COMPUTE UPDATE CALS
      GO TO (6001,6002,6241,6003),NOPTN
6001  ZP(1)=ZERO
      ZP(2)=PRANGE
      K5=IC2
      L   .6111
```

```
      ZR(1)=XB-BSWL
      K5=IC1
      L   .6111
      ZR(2)=XB-ASWL
      K5=2
      L   .6261
      J   .6006
6002  ZP(1)=ZERO
      ZP(2)=QRANGE
      K5=IC2
      L   .6111
      ZR(1)=XB-BSWL
      K5=IC3
      L   .6111
      ZR(2)=XB-CSWL
      K5=2
      L   .6261
      J   .6006
6241  ZP(1)=PRANGE
      ZP(2)=QRANGE
      K5=IC1
      L   .6111
      ZR(1)=XB-ASWL
      K5=IC3
      L   .6111
      ZR(2)=XB-CSWL
      K5=2
      L   .6261
      J   .6006
6003  ZP(1)=PRANGE
      ZP(2)=ZERO
      ZP(3)=QRANGE
      K5=IC1
      L   .6111
      ZR(1)=XB-ASWL
      K5=IC2
      L   .6111
      ZR(2)=XB-BSWL
      K5=IC3
      L   .6111
      ZR(3)=XB-CSWL
      K5=3
      L   .6261
6006  K5=I4-K8
C
C
      L   .6111
      IF(IF3.NE.2)GO TO 6082
C  REMOVE ZERO REFERENCE
      XB=XB-FLOAT(NSWL(NSWLRC))
C  SCALE DATA
      DATA(I3)=(AAA(1,3)+AAA(2,3)*XB)*VERT+CWL
      J   .44
6082  DATA(I3)=XB*COEF(2,NCCRC)+COEF(1,NCCRC)
44    K8=K8+NCH
43    CONTINUE
      IGTYPE=.FALSE.
```

```
C  SKIP RECORDS REVERSE ON MAG TAPE
       DO 45 K2=1,NPER
       CALL SRRMT(.TRUE.,IERR)
       IF(IERR.NE.0)GO TO 7
45     CONTINUE
C
C  SET UP FOR PLOTS
C
       KBARY=11
       T2=5.5
       KBARS=17
       T1=8.5
       IF(NOWPD.LT.10)GO TO 6005
       T2=8.5
       KBARY=17
       T1=25.5
       KBARS=51
6005   CALL MODE(7,T1,T2,SAME)
       CALL MODE(2,T1,SAME,SAME)
       CALL MODE(3,T2,SAME,SAME)
       T99=T2
       K2=2
       ZAP(1)=0.
       ZAP(2)=DELT*FLOAT(NSPTST)
       CALL SCAN(ZAP,DELT,-K2,480)
       CALL MODE(-8,T1,DX,T2)
       DX=DELT/DX
C
C  SKIP PLOT
C  COMPUTE ORIGINAL DATA PLOT IF DESIRED
       IF(SENSW(1))GO TO 6059
C
       CALL SCAN(DELT,Z,-NSPTST,840)
       CALL DRAW(DX,Z,NSPTST,842)
C  TEMP GAGE
       IF(IF3.NE.4)GO TO 6242
       CALL AXES(20.2,20HTIME PROTOTYPE (HRS),16.2,
      116HTEMP. IN DEGREES)
       J    .6243
6242   IF(IF3.NE.5)GO TO 7242
       CALL AXES(20.2,20HTIME PROTOTYPE (HRS),
      18.2,8HVELOCITY)
       J    .6243
7242   CALL AXES(20.2,20HTIME PROTOTYPE (HRS),
      &26.2,26HTIDE HEIGHT PROTOTYPE (FT))
6243   CALL MODE(10,FLOAT(LMASK),SAME,SAME)
       CALL FORM(KBARS,.5,KBARY,.5)
       L    .6251
       CALL DRAW(0.,0.,1,8000)
C  DO NOT DO ANALYSIS UNLESS TIDAL GAGE
       IF(IF3.NE.2)GO TO 40
C
C  SET UP COMPONENTS FOR LEAST SQUARES HARMONIC ANALYSIS
6059   DO 6051 K2=1,INCANL
6051   PERIOD(K2)=PERHLD(K2)
       INC=INCANL
6091   J=I*2
```

```
C  PRINT HEADER FOR PRESENT GAGE
      WRITE (IODEV,66) (LABEL(K2),K2=1,10),IF1,IGAGAR,IRUNO
66    FORMAT(31H1 *** TIDE ANALYSIS PROGRAM ***,/,1X,10A2,//,
     &8H CHANNEL,2X,I3,5X,16HGAGE ARRANGEMENT,2X,I4,2X,
     &10HRUN NUMBER,I4,/)
      WEE=ZCOR(I)+CWL
      WRITE (IODEV,67) XCOR(I),YCOR(I),WEE,IGAGEN(1,I),
     1IGAGEN(2,I)
67    FORMAT(15H XY COORDINATES,2X,2(F9.4,2X),/,15H WATER DEPTH IS,
     &2X,F9.4,/,12H GAGE # IS  ,2A2)
      NDIM=21
C
C  LIST DATA ?
C
      IF(.NOT.SENSW(7))GO TO 6247
      WRITE (IODEV,7881) (Z(K2),K2=1,NSPTST)
7881  FORMAT(8E15.7)
C
C  COMPUTE & REMOVE MEAN
C
6247  XBAR=RMEAN(Z,NSPTST)
      XVAR=RVAR(Z,NSPTST,1,XBAR)
      WRITE (IODEV,6295)
6295  FORMAT(//,32H STATISTICS OF THE ORIGINAL DATA)
      WRITE (IODEV,6044) XBAR,XVAR
6044  FORMAT(8H MEAN = ,E14.7,10X,12HVARIANCE = ,E14.7)
      DO 6009 J=1,NSPTST
6009  Z(J)=Z(J)-XBAR
C
C  BEGIN LEAST SQUARES HARMONIC FIT
C
C  CALCULATE OMEGA = TWOPI/PERIOD
C
6269  DO 6004 K2=1,INC
6004  OMEGA(K2)=TWOPI/PERIOD(K2)
C  SET UP COUNTERS
      NC1=INC+1
      NC2=2*INC
      NCP=NC2+1
C
C  ZERO MATRIX
C
      DO 6010 K2=1,NDIM
      DO 6010 J=1,NDIM
6010  CHOLD(K2,J)=0.0
C  COMPUTE MATRIX
      DO 6011 L=1,NSPTST
      TT=FLOAT(L-1)*DELT
      DO 6012 J=1,INC
      A1=COS(OMEGA(J)*TT)
      DO 6013 K2=J,INC
      A2=COS(OMEGA(K2)*TT)
6013  CHOLD(J,K2)=CHOLD(J,K2)+A1*A2
      DO 6014 K2=NC1,NC2
      KON1=K2-INC
      A2=SIN(OMEGA(KON1)*TT)
6014  CHOLD(J,K2)=CHOLD(J,K2)+A1*A2
```

```
6012  CHOLD(J,NCP)=CHOLD(J,NCP)+A1*Z(L)
      DO 6015 J=NC1,NC2
      KON1=J-INC
      A1=SIN(OMEGA(KON1)*TT)
      DO 6016 K2=J,NC2
      KON1=K2-INC
      A2=SIN(OMEGA(KON1)*TT)
6016  CHOLD(J,K2)=CHOLD(J,K2)+A1*A2
6015  CHOLD(J,NCP)=CHOLD(J,NCP)+A1*Z(L)
6011  CONTINUE
C
C  FILL OUT REMAINDER OF MATRIX  ( REAL SYMMETRIC )
C
      DO 6018 J=2,NC2
      K1=J-1
      DO 6018 K2=1,K1
6018  CHOLD(J,K2)=CHOLD(K2,J)
C
C  SOLVE SYSTEM OF EQUATIONS BY GAUSS JORDAN METHOD
C
      DO 6021 J=1,NC2
      A1=CHOLD(J,J)
      DO 6029 M=1,NCP
6029  CHOLD(J,M)=CHOLD(J,M)/A1
      DO 6023 NN=1,NC2
      IF(J.EQ.NN)GO TO 6023
      A2=CHOLD(NN,J)
      DO 6024 K1=1,NCP
6024  CHOLD(NN,K1)=CHOLD(NN,K1)-A2*CHOLD(J,K1)
6023  CONTINUE
6021  CONTINUE
C
C  END INVERSE
C
      DO 6031 K1=1,INC
      KON1=K1+INC
      AMP(K1)=SQRT(CHOLD(K1,NCP)**2+CHOLD(KON1,NCP)**2)
6031  PHS(K1)=ATAN2(CHOLD(KON1,NCP),CHOLD(K1,NCP))*RADDEG
C
C  PRINT FIT RESULTS
C
      WRITE (IODEV,6072)
6072  FORMAT(///28H **** HARMONIC ANALYSIS ****//6X,
     128H(HRS)        (FT)        (DEG))
      WRITE (IODEV,6032) (PERIOD(KK),AMP(KK),PHS(KK),KK=1,INC)
6032  FORMAT(5X,29H PERIOD    AMPLITUDE    PHASE/(1X,1P3E12.4))
C
C  END HARMONIC ANALYSIS
C
      IF(IF3.EQ.4)GO TO 6301
C  IF COMPAIRING TO ANALYSIS GO TO 6301
      IF(IREFD)GO TO 6301
      INCHLD=INC
      INC=NCANAL
      PPHASE=PHS(1)
C  READ COMPARISON DATA FROM CARDS
      DO 29 K1=1,INC
```

```
29     READ(6,24)PERIOD(K1),PHS(K1),AMP(K1)
       READ(6,24)DEPH
24     FORMAT(3F10.5)
       IF(IADJCH)GO TO 6302
C  COMPUTE PHASE SHIFT SO THAT INPUT COMPARISON DATA CONFORMS TO PHASE
C   OF ORIGINAL DATA
       TPP=(PPHASE-PHS(1))*(PERIOD(1)/360.)
       IADJCH=.TRUE.
6302   DO 6305 K1=1,INC
6305   OMEGA(K1)=TWOPI/PERIOD(K1)
       WRITE (IODEV,6402) TPP,FSHIFT
6402   FORMAT(/,33H COMPUTED SHIFT IN MODEL HOURS = ,E14.7,/,
      &26H FORCE SHIFT IN DEGREES = ,E14.7,/)
C  COMPUTE COMPARISON DATA
6301   DO 6071 K1=1,INC
6071   PHS(K1)=PHS(K1)/RADDEG
       DO 6036 K1=1,NSPTST
       T2=0.
       TT=FLOAT(K1-1)*DELT
       DO 6037 K2=1,INC
6037   T2=T2+AMP(K2)*COS(OMEGA(K2)*(TT-TPP)-PHS(K2)-FSHIFT)
6036   PSDC(K1)=T2
C
C
C  PLOT ORIGINAL & GENERATED DATA
C
C
C  REMOVE MEAN PLOT
C
       IF(.NOT.SENSW(3))GO TO 6321
5010   DO 5000 K1=1,NSPTST
       Z(K1)=Z(K1)+XBAR
       IF(.NOT.IREFD)PSDC(K1)=PSDC(K1)+DEPH
       IF(IREFD)PSDC(K1)=PSDC(K1)+XBAR
5000   CONTINUE
       K1=0
C  DELET PLOT
5001   IF(SENSW(2))GO TO 6061
C
6321   CALL SCAN(DELT,Z,NSPTST,840)
       CALL SCAN(DELT,PSDC,-NSPTST,840)
       IF(K1.EQ.0)GO TO 7001
       IF(SENSW(7))GO TO 7001
       CALL AXES(20.2,20HTIME PROTOTYPE (HRS),
      138.2,38HTIDE HEIGHT PROTOTYPE(FT) MEAN REMOVED)
       J    .7002
7001   CALL AXES(20.2,20HTIME PROTOTYPE (HRS),
      &26.2,26HTIDE HEIGHT PROTOTYPE (FT))
7002   CALL MODE(10,FLOAT(LMASK),SAME,SAME)
       CALL FORM(KBARS,.5,KBARY,.5)
       CALL MODE(10,FLOAT(LMASK3),SAME,SAME)
       CALL DRAW(DX,PSDC,NSPTST,842)
       CALL MODE(10,FLOAT(LMASK2),SAME,SAME)
       CALL DRAW(DX,Z,NSPTST,842)
       L    .6251
       CALL DRAW(0.,0.,1,8000)
C
```

```
      IF(K1.EQ.0)GO TO 6061
      J    .5010
6061  IF(.NOT.IREFD)INC=INCHLD
C
      DO 6038 K1=1,NSPTST
6038  Z(K1)=Z(K1)-PSDC(K1)
C  COMPUTE MEAN & VARIANCE OF RESIDUAL
      XBAR=RMEAN(Z,NSPTST)
      XVAR=RVAR(Z,NSPTST,1,XBAR)
      WRITE (IODEV,6043)
6043  FORMAT(///,32H STATISTICS OF THE RESIDUAL DATA)
      WRITE (IODEV,6044) XBAR,XVAR
C
C  PLOT RESIDUAL
C
C
C  DELET PLOT
      IF(SENSW(4))GO TO 7003
C
      CALL SCAN(DELT,Z,-NSPTST,840)
      CALL DRAW(DX,Z,NSPTST,842)
      CALL AXES(20.2,20HTIME PROTOTYPE (HRS),16.3,
     116HRESIDUAL OF DATA)
      CALL MODE(10,FLOAT(LMASK),SAME,SAME)
      CALL FORM(KBARS,.5,KBARY,.5)
      L    .6251
      CALL DRAW(0.,0.,1,8000)
C
C  DO PSD ON DIFFERENCE
C
C
C  DELET PSDC
7003  IF(SENSW(5))GO TO 40
C  SET UP FOR POWER SPECRAL DENSITY
C
      NSPHLD=NSPTST
      IF(NSPTST.GT.1024)NSPTST=1024
      T1=FLOAT(NSPTST)
      M1=IFIX(ALOG(T1)/ALOG(2.)+1.E-5)
      NPTS1=2**M1
      IF(NSPTST.EQ.NPTS1)GO TO 6041
      M1=M1+1
      NPTS1=NPTS1+NPTS1
6041  MPTS=NPTS1-NSPTST
      MPTS2=MPTS/2
      NPT2=NPTS1/2
      ZBAR=RMEAN(Z,NSPTST)
      VAR=RVAR(Z,NSPTST,1,ZBAR)
      DO 6042 IFT=1,NSPTST
6042  Z(IFT)=Z(IFT)-ZBAR
C  TAPER DATA ?
      IF(.NOT.ITAPER)GO TO 6093
      K1=NSPTST+1
      K2=NSPTST/2
      DO 6049 IFT=1,K2
      T1=2.6667*(SIN(FLOAT(IFT-1)*(PI/FLOAT(NSPTST))))**2
      Z(IFT)=Z(IFT)*T1
```

```
      K3=K1-1
6049  Z(K3)=Z(K3)*T1
      XBAR=RMEAN(Z.NSPTST)
      XVAR=RVAR(Z.NSPTST.1.XBAR)
      WRITE (IODEV.6056)
6056  FORMAT(/.40H STATISTICS OF THE TAPERED RESIDUAL DATA)
      WRITE (IODEV.6044) XBAR.XVAR
6093  DO 6045 K1=1.NSPTST
      IFT=NSPTST-K1+1
      K2=IFT+MPTS2
6045  Z(K2)=Z(IFT)
      K1=MPTS2+NSPTST+1
      DO 6046 K2=K1.NPTS1
6046  Z(K2)=0.
      DO 6048 K2=1.MPTS2
6048  Z(K2)=0.
      CALL RPSDR(Z.PSDC.M1)
C
C  PERFORM PSD AND PLOT RESULTS
C
      K3=2**(M1-1)
      DO 6040 K2=1.K3
6040  PSDC(K2)=PSDC(K2)*10.E5
      CALL SCAN(DELT.PSDC.-K3.840)
      K2=2
      ZAP(1)=0.
      ZAP(2)=1./(2.*DELT)
      CALL SCAN(ZAP.DELT.-K2.480)
      CALL MODE(-8.T1.DX.T2)
      DX=(1./(DELT*FLOAT(NPTS1)))/DX
      CALL DRAW(DX.PSDC.K3.842)
      CALL AXES(9.2.9HFREQUENCY.18.3.18HENERGY * (10) ** 5)
      L    .6251
      CALL DRAW(0..0..1.8000)
      NSPTST=NSPHLD
40    CONTINUE
8028  CALL DRAW(0.0.0.9999)
      J    .77
C
C LINKS
C
C  UNSCALE SCALED FRACTIONS
6111  OCT 0
      K5=K5+K8
      K3=IBUF(K5)
      LA  K3
      STA IVOLT
      XB=IVOLT
      XB=XB*10000.0
      J    .6111.2
C  LEAST SQUARES POLYNOMIAL FITTING ROUTINE
6261  OCT 0
      IF(KALKT.NE.KALUPD)GO TO 103
      KALKT=0
      H=1.
      S(1)=FLOAT(K5)
      DO 6216 K1=1.2
```

```
      S(K1+1)=0.
      DO 6217 K2=1,K5
6217  S(K1+1)=S(K1+1)+ZR(K2)**K1
6216  CONTINUE
      DO 6218 K1=1,2
      K2=K1-1
      AAA(K1,3)=0.
      DO 6219 K3=1,K5
      IF(K2.EQ.0)GO TO 6219
      H=ZR(K3)**K2
6219  AAA(K1,3)=AAA(K1,3)+ZP(K3)*H
6218  CONTINUE
      DO 6220 K1=1,2
      K2=K1
      DO 6221 K3=1,2
      AAA(K1,K3)=S(K2)
6221  K2=K2+1
6220  CONTINUE
      DO 6222 K1=1,2
      H=AAA(K1,K1)
      DO 6236 K2=1,3
6236  AAA(K1,K2)=AAA(K1,K2)/H
      DO 6224 K2=1,2
      IF(K1.EQ.K2)GO TO 6224
      T1=AAA(K2,K1)
      DO 6225 K3=1,3
6225  AAA(K2,K3)=AAA(K2,K3)-T1*AAA(K1,K3)
6224  CONTINUE
6222  CONTINUE
      IF(.NOT.IGTYPE)GO TO 103
      WRITE (IODEV,105) ICALNM,AAA(1,3),AAA(2,3)
105   FORMAT(8H SCAN # ,I5,3X,7HCOEF = ,2(E14.7,1X))
103   KALKT=KALKT+1
      ICALNM=ICALNM+1
      J    .6261,2
C  PUTS LABELS ON PLOTS
6251  OCT 0
      T1=T99+1.
      CALL MODE(3,T1,SAME,SAME)
      T1=5.75
      IF(KBARY.GT.11)T1=8.75
      CALL NOTE(1.5,T1,LABEL(1),20)
      CALL NOTE(SAME,SAME,12H RUN NUMBER ,12)
      CALL NOTE(SAME,SAME,IRUNO,0)
      CALL NOTE(SAME,SAME,14H  GAGE NUMBER ,14)
      CALL NOTE(SAME,SAME,IGAGEN(1,I),4)
      CALL MODE(3,T99,SAME,SAME)
      J    .6251,2
77    END
```

PROGRAM SIZE = '36577

APPENDIX F: INPUT TAPE FORMAT FOR TIDAL ANALYSIS PROGRAM

1. Tide data are recorded in data files on magnetic tape by ADACS data acquisition programs. These data files on magnetic tape are used as input to the tide analysis program.

2. Two general file formats are used by the tide analysis program--a calibration file and a noncalibration file. Several records containing gage identification and data scaling factors are included in a calibration file that are excluded from a noncalibration file. Since gage identification and data scaling factors remain constant for a series of data tests, there is no need to record this information in every data file. Thus this information, which is recorded exclusively in a calibration file, is applicable to all subsequent data files until updated by another calibration file. That is to say, before analyzing a particular noncalibration file, the tide analysis program must obtain, for the file, the correct calibration coefficients which are contained in the last preceding calibration file. It should be noted that floating point variables require two words for storage and two alpha characters are stored in one word.

3. All data files are separated by an end-of-file (EOF) mark with the individual file and records having the following format.

a. File Identification Record. This record, which is included in both calibration and noncalibration files, is used simply for file identification. It contains five words with the following definitions:

Word	Data Type	Definition
1	Alpha	File name ASCII Characters (3A2)
2	Alpha	File name ASCII Characters
3	Alpha	File name ASCII Characters
4	Integer	File Type Designator Always = 3
5	Integer	Record Length of Header Record #1 = 20

b. Header Record #1. This record, which is included in both calibration and noncalibration files, contains testing identification and testing parameters. It contains 20 words with the following definitions:

Word	Data Type	Definition
1		Not used by this program
2		Not used by this program
3	Integer	Test run number
4	Integer	Date of test = Julian date + last digit of year × 100

(Continued)

Word	Data Type	Definition
5	Integer	Time of test
6	Alpha	Model identification (4A2)
7	Alpha	Model identification
8	Alpha	Model identification
9	Alpha	Model identification
10	Integer	Horizontal model scale
11	Integer	Vertical model scale
12	Integer	Reference mean water level in prototype feet × 10 at time zero reference readings are made
13	Integer	Model water temperature × 10
14	Integer	Number N+M of transducers sampled for this test
15	Logical	.TRUE. if this is a calibration file
16	Floating Point	Model-generated tide height in prototype feet
17	Floating Point	Model-generated tide height
18		Not used by this program
19		Not used by this program
20	Integer	Record length of Header Record #2 = 50

c. Header Record #2. This record contains further testing parameters. It consists of 50 words, with the following definitions:

Word	Data Type	Definition
1	Floating Point	Generated tide period in model seconds
2	Floating Point	Generated tide period
3	Integer	Number, J, of data samplings per gage per tide period
4	Integer	Number, K, of magnetic tape data records per tide period
5	Integer	Number, L, of tide periods of data recorded
6		Not used by this program
.	.	.
.	.	.
.	.	.
11	Integer	Number, N, of tide gages sampled for this test
12		Not used by this program
.	.	.
.	.	.
.	.	.
16	Integer	Transducer arrangement number
17		Not used by this program
.	.	.
.	.	.
.	.	.
50		Not used by this program

d. Transducer Flag Record. This record is included only in a calibration file. Its record length is two times the fourteenth element (N+M) in Header Record #1. This record contains two integer flags for each gage sampled during a data scan. The flags are set up as follows:

(1) FLAG1 = Transducer type + (computer channel number) × 100 . Transducer types vary from 0 to 99 with type 2 identifying tide gages, 3 references tide gages, 4 temperature gages, and 5 velocity gages. For any valve besides 2, 3, 4, or 5 this analysis program does not consider the gage data. In all following records, entries for the various gages are ordered exactly as they are ordered in this record. That is, the first flag pair represents the first gage in all following records; the second flag pair, the second gage, etc. Therefore these flags are important in determining what information in following records is necessary for the execution of this program.

(2) FLAG2 = [= 2 Gage not used
= 0 Linear calibration fitting procedure
= 1 Quadratic calibration fitting procedure
= 9 Spline calibration fitting procedure]

+ {(number of calibration voltage readings per channel) × 100}

+ [= 0 No entry for gage in calibration voltage record or calibration coefficient record
= 10,000 entry for gage in calibration coefficient record only
= 20,000 entry for gage in calibration voltage record only
= 30,000 entry for gage in both calibration voltage record and calibration coefficient record]

The 2 (N+M) words in this record have the following definitions:

Word	Data Type	Definition
1	Integer	Flag 1 for first gage
2	Integer	Flag 2 for first gage
3	Integer	Flag 1 for second gage
4	Integer	Flag 2 for second gage
.	.	.
.	.	.
.	.	.
2(N+M)-1	Integer	Flag 1 for the last $(N+M)^{th}$ gage
2(N+M)	Integer	Flag 2 for last $(N+M)^{th}$ gage

e. Calibration Coefficient Record. The length of this record is obtained by multiplying 22 times the number of gages indicated as having entries in this record by Flag 2 in the Transducer

Flag Record. This record is included only in a calibration file. Eleven floating point calibration coefficients are in this record for each gage having calibration coefficients. If tide gages have entries in this record, they will not be utilized by this program. The reader is reminded that a floating point number requires two words in memory. The words in this record have the following definitions:

Word	Data Type	Definition
1	Floating Point	Mathematical fit coefficients for first gage with coefficients
2	.	.
3	Floating Point	.
4	.	.
.	.	.
.	.	.
.	.	.
23	Floating Point	Mathematical fit coefficients for second gage with coefficients
24	.	.
25	Floating Point	.
26	.	.
.	.	.
.	.	.
.	.	.
22(N+M)-21	Floating Point	Mathematical fit coefficients for last $(N+M)^{th}$
22(N+M)	.	.

f. Gage Name Record. Record length is twice the fourteenth element (N+M) of Header Record #1. This record is included only in a calibration file and contains a four character name or number for each gage scanned during data acquisition. The 2(N+M) words of this record have the following definitions:

Word	Data Type	Definition
1	Alpha	First gage name (2A2)
2	.	.
3	Alpha	Second gage name (2A2)
4		
.	.	.
.	.	.
.	.	.
2(N+M)-1		Last $(N+M)^{th}$ gage name
2(N+M)	.	.

g. Gage Coordinate Record. Record length is six times the fourteenth element (N+M) of Header Record #1. This record is included in a calibration file and contains three floating point coordinates (X, Y, and prototype water depth) for each gage scanned during data acquisition sequenced according to order appearing in the Transducer Flag Record. The 6(N+M) words in this record have the following definitions:

Word	Data Type	Definition
1	Floating Point	X coordinate for first gage
2		
3	Floating Point	Y coordinate for first gage
4		
5	Floating Point	Water depth for first gage
6		
7	Floating Point	X coordinate for second gage
8		
.	.	.
.	.	.
.	.	.
6(N+M)-1	Floating Point	Water depth for last $(N+M)^{th}$ gage

h. Reference Potentiometer Calibration Coefficient Record. Record length is twice the tenth element (N) of Header Record #2. This record is included only in a calibration file and contains the slope coefficient for the reference potentiometer of each wave gage calibration stand. This record is not used by the tide analysis program. The words in this record have the following definitions:

Word	Data Type	Definition
1	Floating Point	Potentiometer coefficient for first gage having potentiometer coefficient
2	.	.
3	Floating Point	Potentiometer coefficient for second gage having potentiometer coefficient
4	.	.
.	.	.
.	.	.
.	.	.
2N-1	Floating Point	Potentiometer coefficient for last gage having potentiometer coefficient
2N	.	.

i. Calibration Voltage Record. The length of this record is determined by multiplying 42 times the number of gages indicated as having entries in this record by Flag 2 in the Transducer Flag Record. This record is included only in a calibration file and contains calibration voltage readings for wave gages calibrated under computer control prior to data acquisition. This record is not used by the tide analysis program. The words in this record have the following definitions:

Word	Data Type	Calibration Steps	Gage
1	Integer	Zero	First gage sensor
2	.	+A	.
3	.	+B	.
4	.	+C	.
5	.	+D	.
6	.	+E	.
7	.	+D	.
8	.	+C	.
9	.	+B	.
10	.	+A	.
11	.	Zero	.
12	.	-A	.
13	.	-B	.
14	.	-C	.
15	.	-D	.
16	.	-E	.
17	.	-D	.
18	.	-C	.
19	.	-B	.
20	.	-A	.
21	.	Zero	.
22	Integer	Zero	First gage potentiometer
23	.	+A	.
24	.	+B	.
25	.	+C	.
26	.	+D	.
27	.	+E	.
28	.	+D	.
29	.	+C	.
30	.	+B	.
31	.	+A	.
32	.	Zero	.
33	.	-A	.
34	.	-B	.
35	.	-C	.
36	.	-D	.
37	.	-E	.
38	.	-D	.
39	.	-C	.
40	.	-B	.
41	.	-A	.
42	.	Zero	.
43	Integer	Zero	Second gage sensor
44	.	+A	.
.	.	.	.
.	.	.	.
.	.	.	.
45(N+M)-44	Integer	Zero	Last $(N+M)^{th}$ gage sensor
.	.	.	.
.	.	.	.
.	.	.	.

(Continued)

Word	Data Type	Calibration Steps	Gage
45(N+M)-23	Integer	Zero	Last $(N+M)^{th}$ gage potentiometer
.	.	.	.
.	.	.	.
.	.	.	.
45(N+M)	Integer	Zero	Last $(N+M)^{th}$ gage potentiometer

j. Zero Reference Reading Record. Record length is two times the eleventh element (N) of Header Record #2. This record contains a zero reference reading for each tide gage and each reference tide gage sequenced according to order appearing in the Transducer Flag Record. The 2N words in this record have the following definitions:

Word	Data Type	Definition
1	Floating Point	Zero reference reading for first gage
2	.	.
3	Floating Point	Zero reference reading for second gage
4	.	.
.	.	.
.	.	.
.	.	.
N-1	Floating Point	Zero reference reading for last (N^{th}) gage
N	.	.

k. Data Records. The length of this record can be determined by multiplying the third element, J, of Header Record #2 by the fourteenth element, N+M, of Header Record #1 and dividing this product by the fourth element, K, of Header Record #2. These data records are included in both calibration and noncalibration files. Since the number of data records in these files varies and depends upon the number of wave periods, L, acquired during each wave test, the number of data records can be determined by multiplying the fourth, K, and fifth, L, elements of Header Record #2. Each gage is scanned in the order in which their flags appear in the Transducer Flag Record. The (J/K)(N+M) words in this record have the following definitions:

Word	Data Type	Definition
1	Scaled fraction	Sample from first scan of first gage
2	.	Sample from first scan of second gage
.	.	.
.	.	.
.	.	.

(Continued)

Word	Data Type	Definition
N+M	Scaled fraction	Sample from first scan of last $(N+M)^{th}$ gage
(N+M)+1	Scaled fraction	Sample from second scan of first gage
(N+M)+2	Scaled fraction	Sample from second scan of second gage
.	.	.
.	.	.
.	.	.
2(N+M)	Scaled fraction	Sample from second scan of last $(N+M)^{th}$ gage
.	.	.
.	.	.
.	.	.
(J/K)(N+M)	Scaled fraction	Sample from last (J^{th}) scan of last $(N+M)^{th}$ gage

APPENDIX G: EXTERNAL FORTRAN SUBROUTINES

1. Several FORTRAN library subroutines are referenced in this report. Listings, which are voluminous, are not provided in this documentation. Therefore the general function of each of these subroutines is described concisely as follows:

a. Magnetic Tape Input and Output Routines:

(1) Call SELMT. This routine selects and initializes a specified magnetic tape unit.

(2) Call POSMT. This routine positions a previously selected magnetic tape to a specified magnetic tape file.

(3) Call RDMT. This routine reads one record from a previously selected magnetic tape.

(4) Call SRFMT. This routine skips one record in the forward direction on a previously selected magnetic tape.

(5) Call SRRMT. This routine skips one record in the reverse direction on a previously selected magnetic tape.

(6) Call SFFMT. This routine skips one file in the forward direction on a previously selected magnetic tape.

(7) Call NMFMT. This routine names a specified file on a previously selected magnetic tape.

(8) Call WRTMT. This routine writes one record on a previously selected magnetic tape.

(9) Call WEFMT. This routine writes an end-of-file mark on a previously selected magnetic tape.

b. Disc Input and Output Routines:

(1) Call SELMD. This routine selects and initializes a specified disc unit.

(2) Call RDMD. This routine reads one record from a previously selected disc.

(3) Call SAVEMD. This routine saves the status and position of a previously selected disc.

(4) Call RESETD. This routine is used to restore the discs to the identical status and position as they were when previously called SAVEMD routine was executed.

(5) Call NMFMD. This routine names a specified file on a previously selected disc.

(6) Call WRTMD. This routine writes one record to a previously selected disc.

(7) Call WEFMD. This routine closes an open file on a previously selected disc.

c. Versatec Plot Routines:

(1) Call DRAW. This routine plots a specified buffer against another specified buffer.

(2) Call NOTE. This routine plots Hollerinth characters.

(3) Call MODE. This routine sets specific parameters for plot specifications.

(4) Call AXES. This routine plots one or both axes.

(5) Call SCAN. This routine computes scaling factors for data to be plotted.

(6) Call FORM. This routine plots background grids.

d. Basic Statistical and Data Analysis Package Routines:

(1) RMEAN. This routine computes the mean of a specified buffer.

(2) RVAR. This routine computes the variance of a specified buffer.

(3) RPSDR. This routine computes the power spectral density of a specified buffer.

END

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