Hydraulics Research
Wallingford

# PLOTTING OF AUTOMATICALLY LOGGED DATA FROM CURRENT METERS

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ABSTRACT

Current meters are used in both rivers and tidal water. In tidal water the direction of flow is also required.

Current measurements are required to calculate bulk flow of water and are also used in the study of siltation pollution and wave refraction.

Current speed and direction are sampled at regular intervals and the data are recorded on magnetic tape. In addition, current meters usually detect and record temperature. Different studies require the recorded data to be displayed in a variety of forms such as: time series graphs; scatter diagrams; frequency tables; exceedence diagrams and progressive vector plots.

A suite of programs has been written at Hydraulics Research to validate, calibrate and display current meter data in these various forms.

The system will be developed to accept data from other loggers.

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**CONTENTS (cont'd)**

FIGURES



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APPENDICES

# 1 INTRODUCTION

The current meters contain data loggers which record velocity, direction and temperature on ½" magnetic tape. The data recorded by the meter is scaled and dependent on the calibration of the individual meter. This data is usually recorded at regular intervals (normally of 10 minutes). The tapes are collected from the field every 7 to 14 days and returned to HR to be read and analysed. Analysis is usually required within the week so that any necessary action can be taken at the next site visit.

There are two types of current meter in use at HR: Plessey and Aanderaa. Their logger tapes are not compatible and have different hardware and software requirements.

The Aanderaa tapes are read on its own reader directly connected to a PDP11/34 mini computer.

The Plessey tapes are read on a tape reader built at HR connected to a PDP8F mini computer. The Plessey meters append a (negated) word count to the end of each record which is used in data validation.

The data from either logger is to be transferred to the mainframe and displayed in any of the required forms viz:-

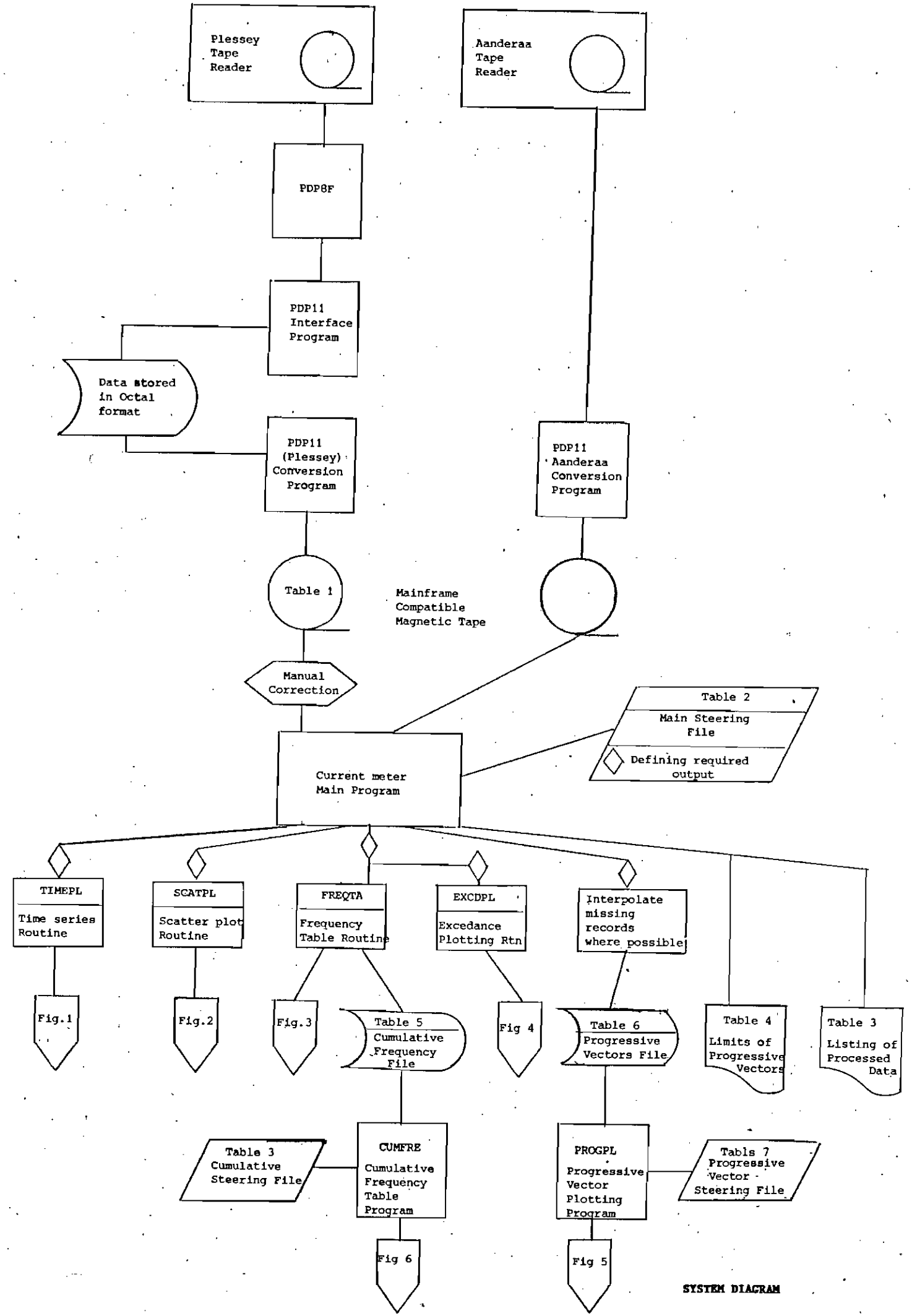
(a) Time series graphs: flow velocity, direction and temperature are plotted as a function of time (Fig 1)

(b) Scatter Diagrams: Samples of flow speed and direction are plotted as points on a polar diagram (Fig 2)

(c) Frequency Tables: A table of the number of samples which fall into certain ranges of flow speed and direction (Fig 3).

(d) Exceedance Diagrams: A graph indicating the percentage of samples with flow rates exceeding the specified flow rate (Fig 4).

(e) Progressive vector plots: Velocity vectors are added to together progressively. This shows the net current summed over a number of tides (Fig 5).




**SYSTEM DIAGRAM**

## 2 SYSTEM DESCRIPTION

### 2.1 Summary

The input and output requirements of the system have been described. The diagram opposite shows the flow of data from input to output giving the major components of hardware and software.

The logger tapes are converted using the software on the PDP system and the data is written to the mainframe computer (ICL 2972) via magnetic tape.

The Plessey meters are liable to give occasional bad records. These can be detected using the word count in each record. Plessey meter files are edited manually before being processed.

Each current meter has its own calibration factors, these factors have been written into the calibration routines so that the appropriate calibration is used for a specified meter.

The main steering file specifies the data files to be read from tape and the output that is required. Each data record is scaled, verified and printed out. The date, time and an error flag is also printed.

The data is plotted in the requested form for the first four output options. For progressive vectors additional data interpolation is performed and the resultant vectors are stored. The limits of the progressive vectors are printed out to assist the preparation of the progressive vector steering file. Program PROGPL is used to produce the progressive vector plot. Frequency tables can be accumulated over a period of several weeks and plotted as a single table using the program CUMFRE.

The rest of this section describes the mainframe programs in greater detail.

### 2.2 Main program (CURRENT)

The program CURRENT reads the data from the magnetic tape produced on the PDP11. For Plessey meters the length of the record is checked. If this check fails the record is flagged as erroneous rejecting all data in the record. The calibration factors for each meter are used to calculate the velocity (m/s) the direction (degrees true north) and the temperature (degrees Celsius). The processed data is then checked according to given limits of the maximum and minimum values. Also checked is that the change in velocity

(or temperature) from one sample to the next does not exceed a given value. These limits are defined in the steering file.

Each current velocity is resolved into its northerly and easterly components. Optionally the velocity may be resolved into the components normal and parallel to a given direction (the coastline).

Data sets which span up to 8 days are analysed in one batch. Longer data sets are analysed in weeks.

The processed data is then passed to the output routines as required (by the steering file).

(a) Time series plots (subroutine TIMEPL)

TIMEPL plots time series of current velocity, current direction and temperature in seven or eight day sections. An example of a time-series plot is shown in Fig 1.

(b) Scatter diagrams (subroutine SCATPL)

SCATPL plots a scatter diagram of current velocity against direction on a circular grid. Fig 2 shows an example of the type of plot produced by this subroutine.

(c) Frequency tables (subroutine FREQTA)

FREQTA produces tables of frequencies within 15° direction bands and a choice of 0.1 or 0.2 m/s velocity bands. These tables can be output to a data file so that they can be accumulated at a later date (i.e. to include more than 1 weeks data). Fig 3 shows an example of a frequency table.

(d) Exceedance plots (subroutine EXCDPL)

Using data from FREQTA, EXCDPL plots out current velocity exceedance curves for each week of data. Fig 4 shows an example of an exceedance plot.

If progressive vectors plots are required the velocity and direction data are patched (see Appendix 3 for details of patching used) and output to a file in the form of eastings and northings.

### 2.2.2 Progressive vector plots (program PROGPL)

After running CURRENT to produce a data file, PROGPL is run which plots out progressive vector plots either as A4 plots with the position of the current meter at the centre of the page or to a specified scale with the current meters at given positions (up to 5 meters per sheet). See Fig 5 for an example of the plot.

### 2.2.3 Cumulative exceedance plots (CUMFRE)

A call to FREQTA in CURRENT causes tables to be stored. The tables are then accumulated. The program CUMFRE is used to produce an exceedance curve for the data accumulated over a number of weeks. Examples of the output are shown in Fig 6.

## 3 OPERATING INSTRUCTIONS

Refer to the system diagram to see the different stages of the data processing. In summary they are:

(1) Converting the ¼" tapes onto ½" tapes.

(2) Running the Program CURRENT.

(3) Running the Progressive Vector Program PROGPL.

(4) Running the Cumulative Frequency Task Program CUMFRE.

(5) Plotting.

The users requirements are specified on the Current Meter Processing Form shown in Appendix 1. This is used to provide the data for the various steering files and program options.

The programs on the mainframe are run using operating system procedures. These procedures are made available by use of the command USE_SOFTWARE (SURVEY).

### 3.1 Minicomputer Instructions

### 3.1.1 Conversion of Plessey Tapes

(a) On the PDP8

Load the program Plessey and start address 0200.

Load Tape onto reader and selects position 4.

Run the program.

Output is sent to the PDP11 file DM1:[30,6]DATAFILE.DAT with data written as octal characters.

(b) On PDP11 - under user DM1:[30,6]

DIR to find generation number of file to be processed.

RUN DMO:PCONV

Type generation numbers(s) as requested. <gen>

Diagnostics are sent to VER.DAT

Corrected data is sent to DAT<gen>.OUT

3.1.2 Conversion of Aanderaa Tapes

On PDP11 under DM1:[30,20]

AANDERAA provides a menu driven system to:-

(1) Read the tape.

(2) Convert the file to a standard form in any filename required. The diagnostics are sent to CONVERT.DAT

3.1.3 Transfer of files to mainframe

Use the program TAPEWRITE with options /VME and /LIS.

3.2 Running the Main Current Meter Program CURRENT

3.2.1 Preparation of steering file for CURRENT

Set up a steering file to enable the current meter plotting program to be run. The format of the steering file is as follows:-

LINE 1 N number of current meters to be analysed in this run.

LINE 2 NMET(1), NMET(2) ..... NMET(N) Meter reference numbers in order of reading in up to 80 characters, identifying site of current meter.

LINE 3 Title.

LINE 4 Meter type PLESSEY or AANDERAA.

LINE 5 Sampling interval (integer), max current velocity (real), maximum change in velocity (real).

LINE 6 Minimum temperature (real), maximum temperature (real), maximum change in temperature (real).

LINE 7 Start time, start date, end time, end date (I4,IX,A6,IX,I4,IX,A6) e.g. 1300 ∇ 840701 ∇ 840708 ∇.

LINE 8 1 or 0 0-coastal vectors not required.
1- coastal vectors required, .

LINE 8b If line 8 = 1 angle of coast in degrees (real).

LINE 9 Three Option numbers:

| | | |
|---|---|---|
| First Option | 1 | Time Series plots required. |
| | 0 | Time Series plots not required. |
| Second Option | 0 | No Scatter plot, Frequency Table or exceedence plot. |
| | 1 | Scatter plot. |
| | 2 | Frequency Table. |
| | 3 | Scatter plot and Frequency Table. |
| | 4 | Scatter plot and Frequency Table and exceedence plot. |
| Third Option | 1 | Progressive vector output required (for PROGPL). |
| | 0 | Not required. |

LINE 9b Maximum Velocity for Scatter Plot needed where second option >1

LINE 9c Division of Velocity Scale for Frequency Table needed where Second Option >2.

Note: Lines 3 to 9 are repeated for each file to be analysed from a tape.

### 3.2.2 Use of Procedure RUNCUR

RUNCUR is used to run the Current meter program CURRENT. The information about tape files is taken from the Current meter processing forms. Filenames should include the location code and the site name where appropriate

```
RUNCUR (literal INPUT_TAPE =,
        superliteral DATA FILES =,
        superliteral POSITION OF_FILES_ON_TAPE =,
        literal      STEERING_FILE =,
        literal      TABULAR_OUTPUT = 'NONE',
        superliteral PROGOUT = ""
        literal      GRIDFILE=,
        response     RESPONSE = RESULT)
```

Parameters

INPUT_TAPE = Name of Magnetic tape holding the tape files written on the PDP11

DATA_FILES = Names of the files to be introduced on the INPUT TAPE

POSITION_OF_FILES_ON_TAPE = Position of each data file to be introduced

STEERING FILE = File describing input data and the required output see Section 4.2

TABULAR_OUTPUT = If frequency tables are produced, this parameter specifies the file to be created which will hold the information to be used in the generation of the cumulative frequency tables (program CUMFRE). The default value 'NONE' indicates that no frequency tables are being generated.

PROGOUT = This parameter specifies the names of files to hold progressive vector information. One file is created for each input file.

GRIDFILE = The name of the file to hold GRAPHICAL Intermediate Data (for plotting using CILPLOT).

RESPONSE = Default value allows appropriate error messages to be output.

## 3.3 Running the Progressive Vector Program (PROGPL)

### 3.3.1 Preparation of the steering file for PROGPL

The steering file should be created in the following format.

| | |
|---|---|
| Line 1 | Number of current meters to be plotted this run |
| Line 2 | Meter location code (A3) |
| Line 3 | Location of current meter as Easting, Northing (I6,2X,I6) |
| | Lines 2 and 3 are repeated for each meter. |
| Line 2N +2 | Day, month & year at start. Day, month & year at end of period required. |
| Line 2N +3 | Type of plot required A4 or CHART |
| For 'A4' | - A separate A3 or A4 figure is plotted for each current meter. |
| Line 2N +4 | 1 - Plot aligned to coast<br>0 - Plot aligned to compass (N-S) |
| Line 2N +5 | Maximum excursion East, max excursion North (obtained from output from CURRENT) |
| Line 2N +6 | Size of graticule distance between tick marks. |
| Lines 2N +4 to 2N +6 are repeated for each current meter. | |
| For 'CHART' | - all current meters plotted on one figure. |
| Line 2N +4 | Scale of chart (e.g 25000). |
| Line 2N +5 | Western and Eastern limits of chart. |

Line 2N +6 Southern and Northern limits of chart.

Line 2N +7 Size of graticule distance between tick marks.

### 3.3.2 Use of Procedure PROGVE

Description of procedure for running current meter progressive vector plotting program.

```
PROGVE          (super literal DATA_FILES =,
                integer NO_OF_FILES_COVERING_THE_
                PERIOD =    ,
                literal STEERING_FILE =    ,
                literal GRID_FILE     =    ,
                response RESPONSE     = RESULT)
```

Parameters

DATA_FILES — files containing progressive vector output from CURRENT (i.e. PROGOUT = ). If more than one file is required to cover the period for each current meter then the order the files first by meter then by week, e.g. METER 1 WK 1, METER 1 WK 2, METER 2 WK 1, METER 2 WK 2 etc.

NO_OF_FILES_COVERING_THE_PERIOD — Usually 1 but if period required covers end of 1 week and start of next (say) it can be 2 (or more).

STEERING_FILE — Data file giving start and end dates of period required, positions of current meter etc. (see operating instructions 4.3.1).

GRID_FILE — Name of a GRID file for the graphical output.

RESPONSE — Default value allows appropriate error messages to be output.

## 3.4 Running the Cumulative Plotting Program (CUMFRE)

### 3.4.1 Preparation of input

1) Merge into one file all the TABOUT files created from previous runs of the procedure RUNCUR (i.e. those files created by the TABOUT parameter of RUNCUR).

2) Create a steering file as follows.

LINE 1 - Title to be output on figure.
LINE 2 - No of weeks to be combined, Maximum Velocity to be tabulated, Sampling interval.

3.4.2 Using the Procedure RUNCUM

This procedure creates Cumulative Frequency tables and Cumulative Exceedences Curves.

```
RUNCUM (literal  TABOUT_FILE,
        literal  STEERING FILE,
        literal  GRIDFILE,
        response RESPONSE_RESULT)
```

| | |
|---|---|
| TABOUT_FILE | see paragraph 1 of 3.4.1 |
| STEERING FILE | see paragraph 2 of 3.4.1 |
| GRIDFILE | to be plotted using CILPLOT |
| RESPONSE | default value allows appropriate error messages to be output. |

The grid file will contain two A4 plots:- one of a frequency table the other of an exceedance curve.

3.5 Plotting

The GRIDfile produced by any program can then be plotted using

```
CILPLOT (GRIDfile name, SIZE = 2800)  for A4 plots
            "           SIZE = 5600)  for A3 plots
            "           SIZE = 8000)  for CHART
            "                         plots.
```

## 4 USER INSTRUCTIONS

4.1 Preparation of input

When the tape is submitted for analysis, a unique logger tape number should be affixed to the tape and a current meter processing form filled in, see Appendix 1. This requests all the information necessary for the complete processing of the data.

The Logging information should be readily available from the survey sheet. The Title and Meter Location Code are for identification purposes.

The verification data should be defined from the users knowledge of the limits and fluctuations of flowrate and temperature. These limits are used to check for bad data.

The processing options may be chosen from the example outputs. The following notes should aid the completion of these options.

The coastal vectors option allows one to study the components of current that are normal and parallel to a user defined coastal direction. The sign convention is that the coastline direction is taken as the direction of the right hand shoreline when viewed from land. In this case parallel currents are positive in the coastline direction and normal currents are positive onshore.

The maximum velocity defined for the scatter plot diagram need not be the same as that used for verification.

The velocity divisions on the frequency table are normally 0.1 and 0.2 meters/second. One progressive vector plot may be produced for each meter normally at A4 size. Alternatively a chart with all the meters in the run may be produced. The two options require different steering information.

## 4.2 Interpretation of Output

The output from the programs contains headings which describe the data. The units are all SI. The data is checked according to the parameters defined on the processing form - if any record fails this test it will be printed out with an appropriate error flag. Any of 5 flags may be set in the column headed DATA ERROR they are

10000 - whole record incorrect,

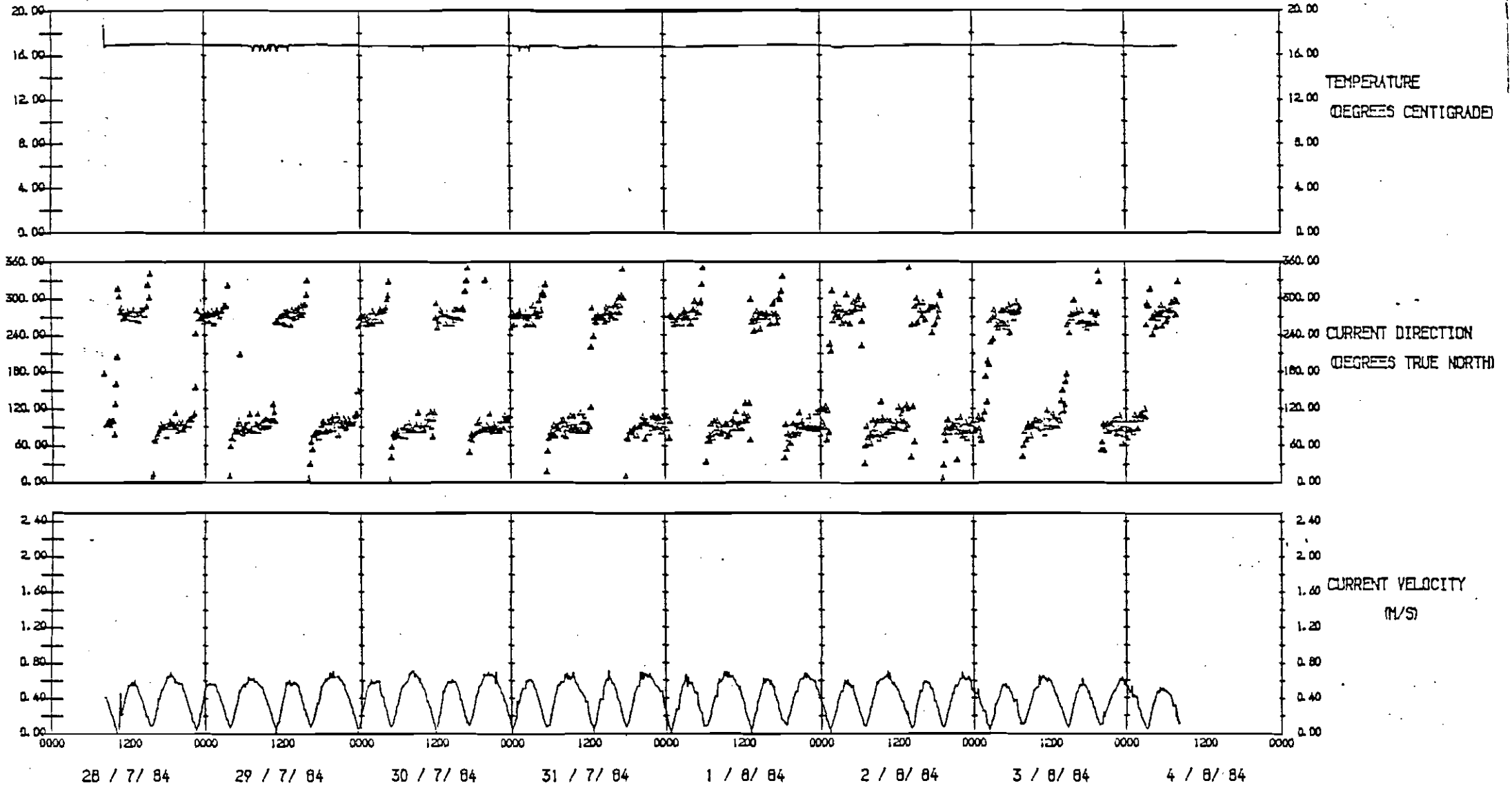
1000 - temperature exceeds the given maximum,

100 - temperature changes from previous record by more than the given difference,

10 - current velocity exceeds the given maximum,

1 - current velocity changes from previous record by more than the given difference.

For errors in current velocity, the program RUNCUR attempts to correct single or double errors. Usually the erroneous records are replaced by velocity and direction values which are the mean of the surrounding valid records. Addition correction is performed for plessey meters where the velocity may be recorded as twice the true velocity. The corrected values are not listed but are used only in the generation of progressive vector plots. Appendix 3 gives details.




SAMPLING INTERVAL = 10 MINS

WINFRITH - WORBARROW BAY - CURRENT METER C10 (-4M ODN)
CURRENT METER TIME SERIES

FIG 1

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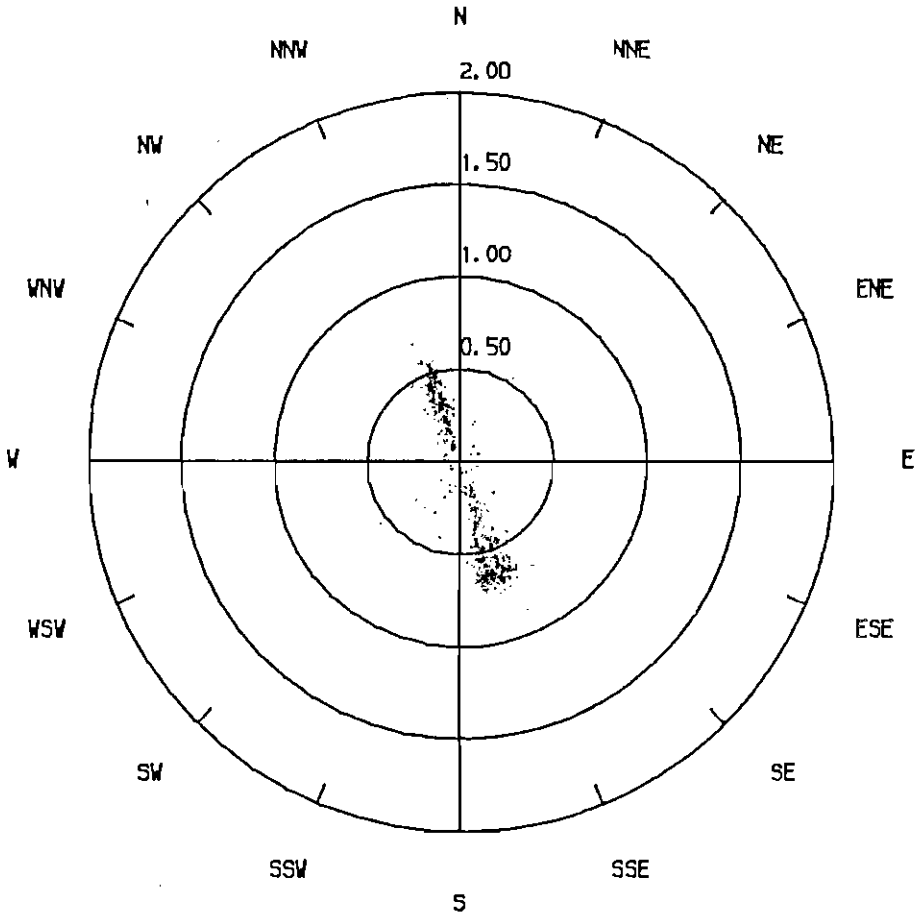
TEST CURRENT METER DATA

CURRENT VELOCITY SCATTER DIAGRAM




PERIOD OF DATA IS 24/ 10/ 81 AT 0 TO 31/ 10/ 81 AT 730

SAMPLING INTERVAL = 10 MINS VELOCITIES IN M/S

NO. OF DATA POINTS PLOTTED = 993

NO. OF POINTS OMITTED AS SUSPECT VALUES = 61

NO. OF ZERO POINTS = 17

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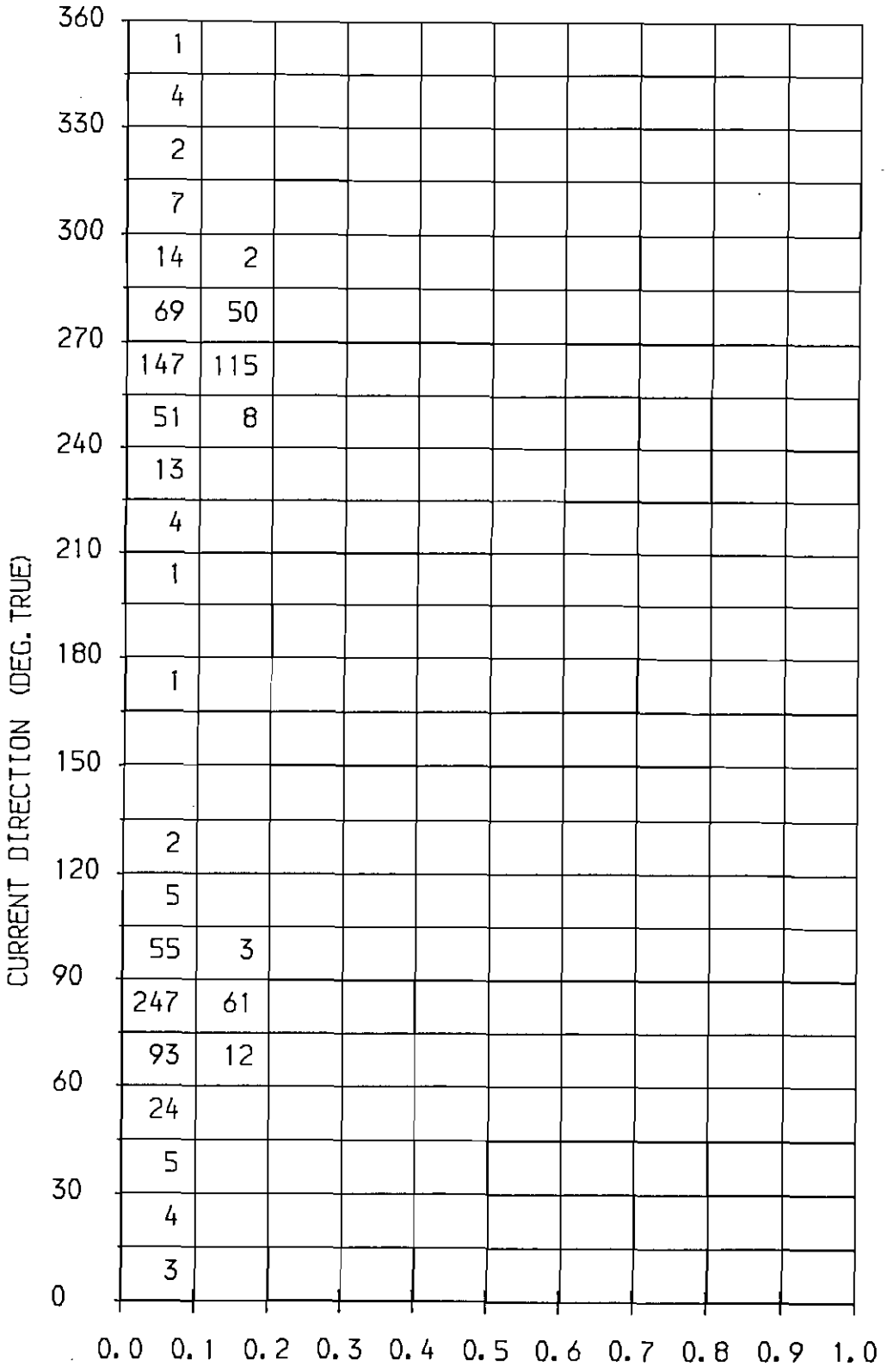
**FIG 2**

WINFRITH - RINGSTEAD BAY - CURRENT METER C1 (-4M ODN)
FREQUENCY TABLE OF CURRENT VELOCITY VS DIRECTION



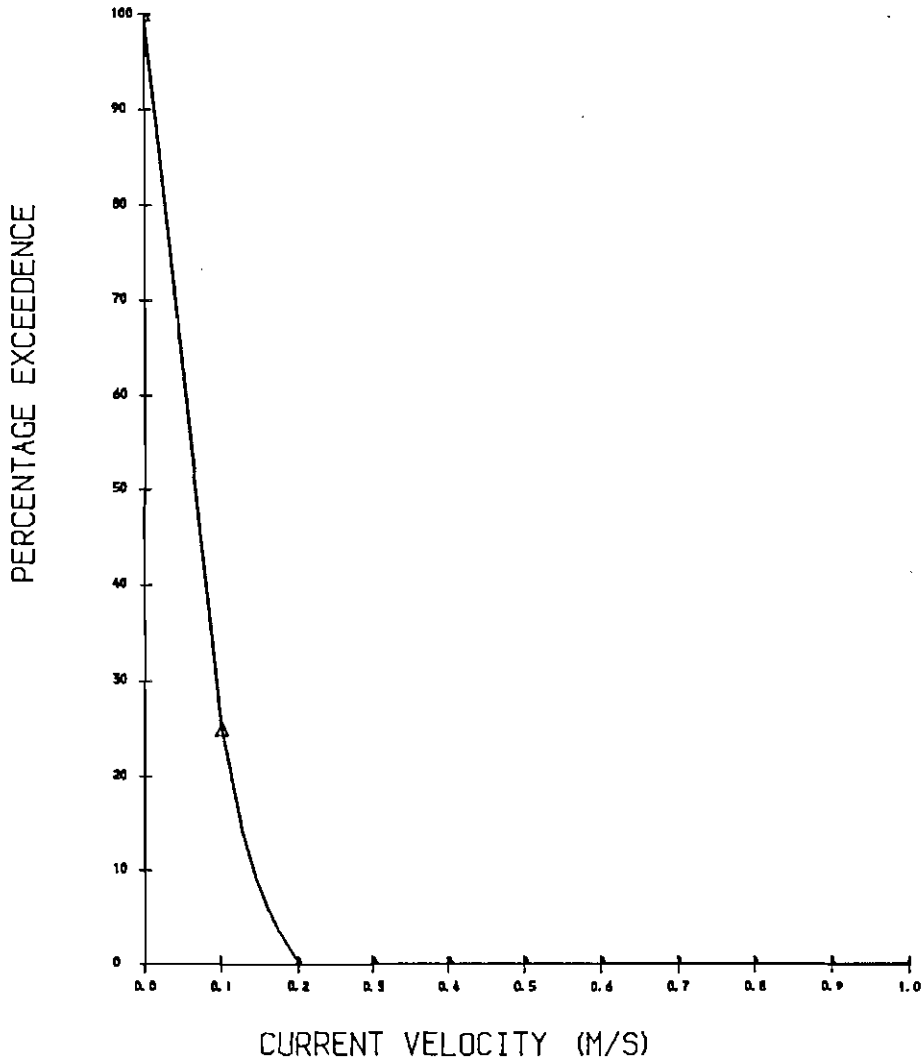

PERIOD OF DATA IS 16/ 7/ 84 AT 5 TO 22/ 7/ 84 AT 2355

SAMPLING INTERVAL = 10 MINS

NO. OF DATA POINTS TABULATED = 1003

NO. OF POINTS OMITTED AS SUSPECT VALUES = 5

**FIG 3**




PERIOD OF DATA IS 16/ 7/ 84 AT 5 TO 22/ 7/ 84 AT 2355

SAMPLING INTERVAL = 10 MINS

NO. OF DATA POINTS INCLUDED = 1003

NO. OF POINTS OMITTED AS SUSPECT VALUES = 5

WINFRITH - RINGSTEAD BAY - CURRENT METER C1 (-4M ODN)
CURRENT VELOCITY EXCEEDENCE PLOT

HYDRAULICS RESEARCH LTD. WALLINGFORD

**FIG 4**

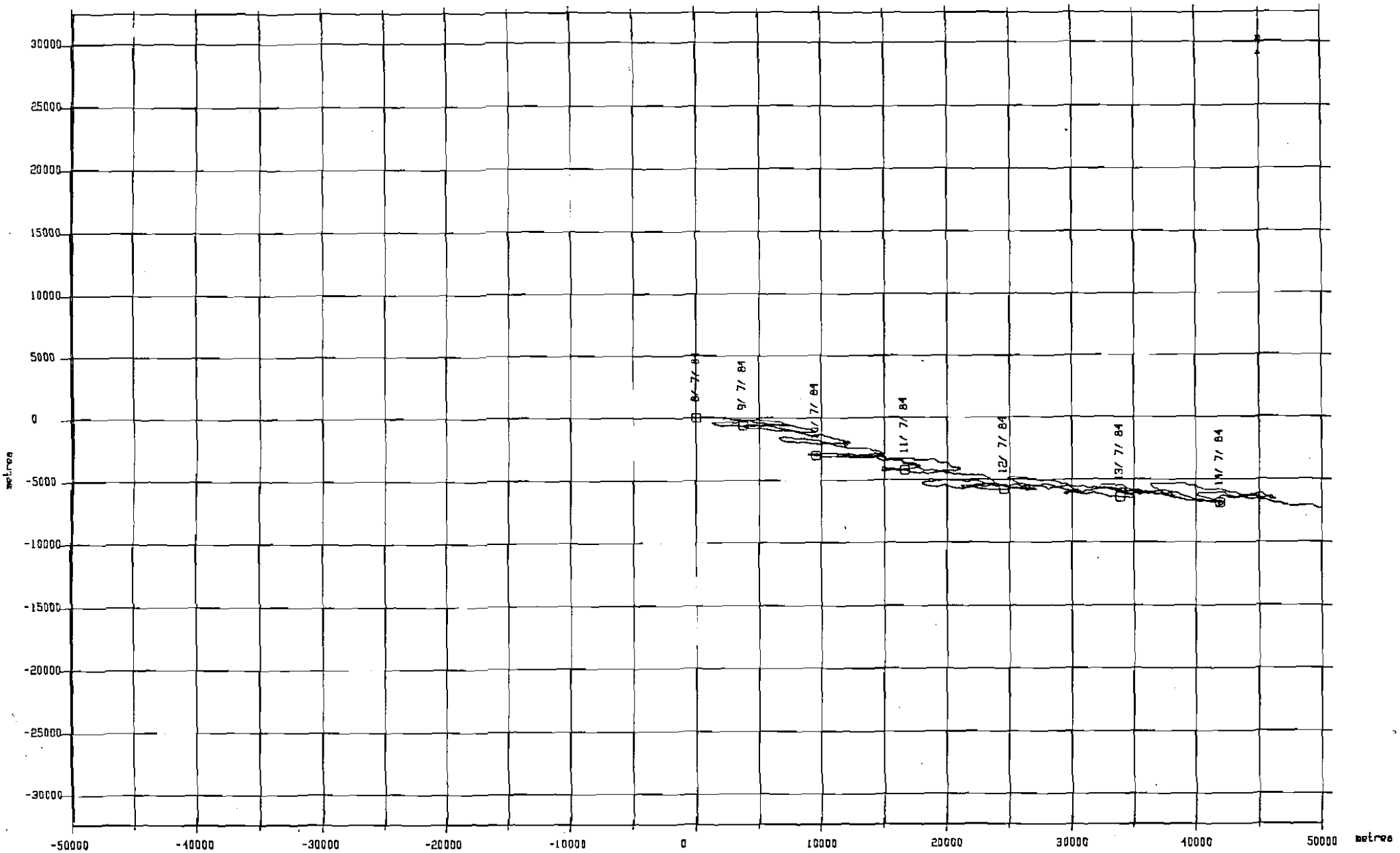
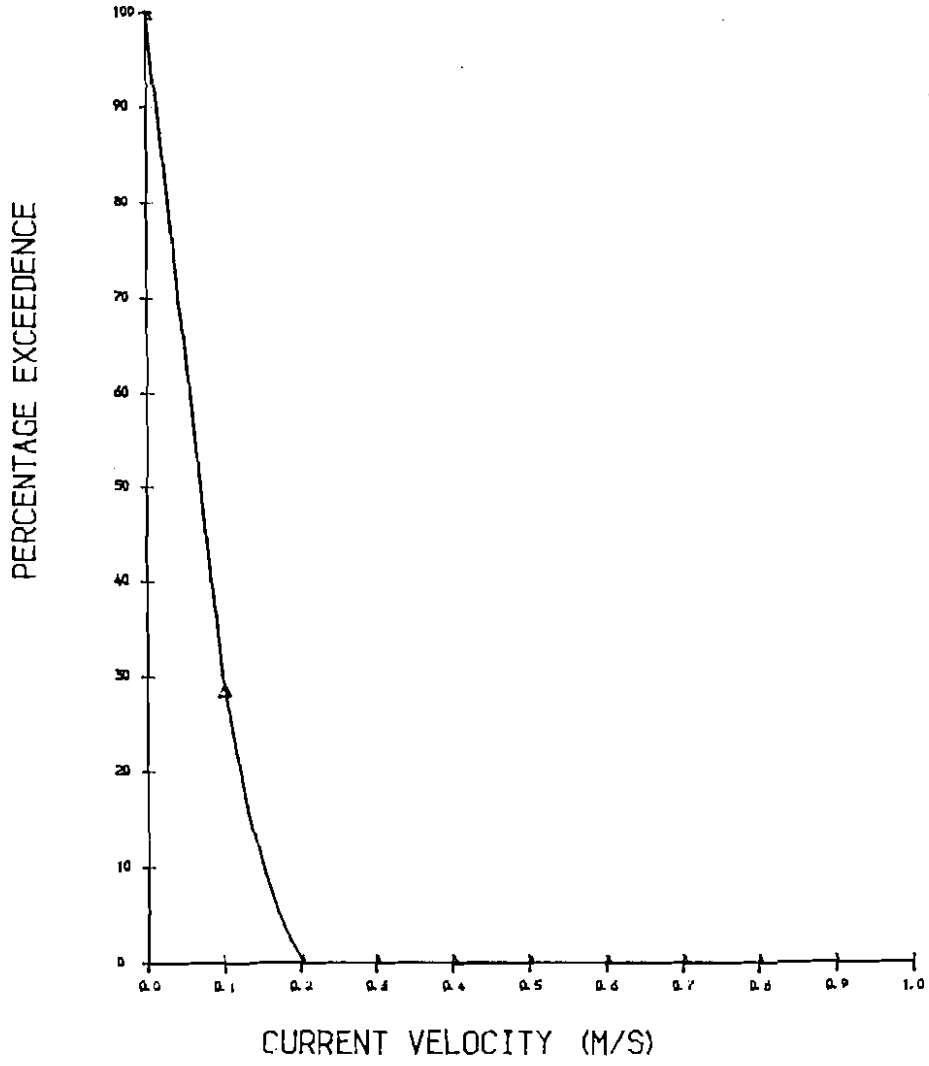



FIG 5

WINFRITH - WORBARROW BAY - CURRENT METER C10 (-4M ODN)
POSITION OF CURRENT METER 385375.0 EAST 78764.0 NORTH PROGRESSIVE VECTOR PLOT




PERIOD OF DATA IS 25/ 6/ 84 AT 1235 TO 31/ 8/ 84 AT 2355

SAMPLING INTERVAL = 10 MINS

NO. OF DATA POINTS INCLUDED = 9661

NO. OF POINTS OMITTED AS SUSPECT VALUES = 28

CURRENT METER 1
CURRENT VELOCITY EXCEEDENCE PLOT

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FIG 6

```
  949      0     55   1023      8
  767    503    255   1023      8
 1023    255    251    767      8
 1023    509    232    511      8
 1023    506    227   1023      8
 1023    506    223   1023      8
 1023    503    221   1023      8
 1023    503    214   1023      8
 1023    501    206   1023      8
 1023    500    204   1023      8
 1023    498    203   1023      8
  949    498   1023   1023      8
  949    501    990   1023      8
 1023    492    958   1022      8
 1023    486    956   1022      8
 1023    484    391   1022      8
 1023    482    306   1022      8
 1023    481    242   1022      8
 1023    481    204   1022      8
 1023    481    180   1022      8
 1023    480    165   1022      8
 1023    478    150   1022      8
 1023    475    143   1022      8
 1023    474    146   1022      8
 1023    474    143   1022      8
 1023    473    138   1022      8
 1023    472    139   1022      8
 1023    473    135   1022      8
 1023    472    137   1022      8
 1023    472    145   1022      8
 1023    470    138   1022      8
 1023    470    139   1022      8

END OF LISTING OF FILE :MJCWIN.WINFRITH.DATA(1,*,1).CURRINPUT(2) FOR USER

*****************************************************************************
```

**TABLE 1** **Example input for CURRENT (CURR INPUT)**

```
1
948
PRESTATYN TAPE C :SITES B2..A1..C2
PLESSEY
10 0.5 0.3
0.0 20.0 0.3
1431 850208 1020 850213
1
90.
1 2 1
1.5
0.2

END OF LISTING OF FILE :MJCWIN.WINFRITH.DATA(1,*,1).CURRSTEER(2) FOR USER :

**********
```

**TABLE 2. Example steering file for CURRENT (CURRSTEER)**

PRESTATYN TAPE C :SITES B2..A1..C2

TYPE OF CURRENT METER IS PLESSEY METER REFERENCE NUMBER = 948

SAMPLING INTERVAL = 10MINS

MAXIMUM VELOCITY ACCEPTED = 0.50M/S MAXIMUM CHANGE IN VELOCITY = 0.30M/S

ADJUSTMENT FOR TRUE NORTH =- 6.83 DEGREES

TEMPERATURE RANGE 0.00 TO 20.00 DEGREES CENTIGRADE

COASTAL ALIGNMENT SET AT 90.0TO270.0DEGREES TRUE

TABLE OF RAW CURRENT METER DATA

| METER REF NO | DAY | MONTH | YEAR | TIME G.M.T. | VELOCITY M/S | DIRECTION DEG.TRUE | TRUE VECTORS EASTINGS M | TRUE VECTORS NORTHINGS M | COAST VECTORS PARALLEL M | COAST VECTORS NORMAL M | TEMP DEG C | DATA ERRO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 949 | 8 | 2 | 85 | 1431 | 0.00 | 18 | 0 | 0 | 0 | 0 | 99.90 | 1100 |
| 767 | 8 | 2 | 85 | 1441 | 0.00 | 88 | 0 | 0 | 0 | 0 | 99.90 | 1100 |
| 1023 | 8 | 2 | 85 | 1451 | 1.57 | 87 | 941 | 49 | 941 | -49 | 99.90 | 1011 |
| 1023 | 8 | 2 | 85 | 1501 | 1.48 | 80 | 872 | 154 | 872 | -154 | 99.90 | 1010 |
| 1023 | 8 | 2 | 85 | 1511 | 99.99 | 78 | 9999 | 9999 | 9999 | 9999 | 99.90 | 1011 |
| 1023 | 8 | 2 | 85 | 1521 | 0.00 | 77 | 0 | 0 | 0 | 0 | 99.90 | 1001 |
| 1023 | 8 | 2 | 85 | 1531 | 0.00 | 76 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1541 | 0.00 | 73 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1551 | 0.00 | 70 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1601 | 0.00 | 70 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1611 | 0.00 | 69 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 949 | 8 | 2 | 85 | 1621 | 0.00 | 16 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 949 | 8 | 2 | 85 | 1631 | 0.00 | 340 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1641 | 0.11 | 327 | -35 | 54 | -35 | -54 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1651 | 0.00 | 326 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1701 | 0.00 | 135 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1711 | 0.00 | 108 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1721 | 0.00 | 84 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1731 | 0.00 | 70 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1741 | 0.00 | 61 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1751 | 0.00 | 56 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1801 | 0.00 | 51 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1811 | 0.00 | 48 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1821 | 0.00 | 50 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1831 | 0.00 | 48 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1841 | 0.00 | 47 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1851 | 0.00 | 47 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1901 | 0.00 | 46 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1911 | 0.00 | 46 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1921 | 0.00 | 49 | 0 | 0 | 0 | 0 | 99.90 | 1000 |
| 1023 | 8 | 2 | 85 | 1931 | 0.00 | 47 | 0 | 0 | 0 | 0 | 99.90 | 1000 |

END OF LISTING OF FILE :MJCWIN.WINFRITH.DATA(1,*,1).CURROUT(2) FOR USER :SYSMAN AT 1985/04/25__18:09:20

**********

**TABLE 3. Example output file from CURRENT (CURROUT)**

```
METER NO. =   948STARTING 1431     8     2    85ENDING 1021    13     2    85
MAXIMUM EAST         0MIN EAST    -6643MAXIMUM NORTH     7580MIN NORTH     -142
MAXIMUM NORMAL     214MIN NORMAL    -6480MAXIMUM PARALLEL        0MIN PARALLEL    -6643
```

**TABLE 4. Example "limits" file from CURRENT (CURRLIM)**

```
        948          1431            8            2           85         1021           13            2           85  0.2000000
384          45
  9  0  0  0  0  0  0  0  0  0 20  0  0  0  0  0  1  0  0  0 36 17  0  0  0  0  0  1  0  0
245  4  0  0  1  0  0  0  0  0 72  2  0  0  0  0  0  0  0  0 17  0  0  0  0  0  0  1  0  0
  3  0  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0
  3  0  0  0  0  0  0  0  0  0  3  0  0  0  0  0  0  0  0  0  6  0  0  0  0  0  0  0  0  0
 11  0  0  0  0  0  0  0  0  0 22  0  0  0  0  0  0  0  0  0 61  1  0  0  1  0  0  0  0  0
  8  0  0  0  1  1  0  0  0  0  7  4  1  1  0  1  0  0  0  0 33 28  0  1  0  0  1  0  0  0
 22  1  0  0  0  0  0  0  0  0  2  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
  4  1  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0  0  5  0  0  0  0  0  0  0  0  0

END OF LISTING OF FILE :MJCWIN.WINFRITH.DATA(1,4,1).CURRTAB(1) FOR USER :SYSMAN AT 1995/04/25__16:09:28

********************************************************************************************************************************
```

**TABLE 5. Example TABOUT file (CURRTAB)**

```
WINFRITH - WORBARROW BAY - CURRENT METER C9 (-4M ODN)
  449    10     1     100.00
  954
  905     7     7    84 2355    13     7    84
      9999          9999          9999          9999         10000
       524         29992         -4693         29628            11
    -10036        -11146         -7948        -12719             1
         0             0             0             0             0
        22            45            14           -49             0
        41            44            33           -50             0
        59            22            55           -32             0
        49            23            44           -31             0
        58            31            52           -41             0
        54            38            47           -47             0
        60            29            54           -39             0
        63            28            58           -39             0
        78            12            74           -26             0
        91            -5            91           -11             0
        91             0            90           -16             0
        97             7            95           -24             0
       111            34           104           -53             0
       140            35           132           -59             0
       122            49           112           -70             0
       148            54           136           -79             0
       138            53           127           -76             0
       129            84           113          -105             0
       121            73           107           -93             0
        81            96            63          -109             0
      -115           -16          -111            36             0
        10            69            -2           -69             0
         0             0             0             0             0
         0             0             0             0             0
         4           -41            11            40             0
       -43           -10           -41            17             0
       -50            -9           -48            17             0

END OF LISTING OF FILE :MJCWIN.WINFRITH.DATA(1,*,1).PROGVECTORS(2) FOR USE
```

**TABLE 6. Example file for holding progressive vectors (*PROGVECTORS*)**

```
12
  1
374916  080846
  2
374853  079843
  3
380151  079503
  4
380214  078340
 5A
381315  079647
 5B
381315  079647
 6A
381296  078177
 6B
381296  078177
  7
383563  079088
  8
383527  077895
  9
385349  079842
 10
385375  078764
23 07 84 29 07 84
A4
0
6300  1000
5000  1000
0
11700  1000
5000  5000
0
5700  12700
5000 5000
0
20900  13100
5000  5000
0
17300  27000
5000  5000
0
10100  30100
5000  5000
0
12300  8600
5000  5000
0
15100  9500
5000  5000
0
9500  4700
5000  1000
0
11100  17000
5000  5000
0
51600  3400
5000  5000
0
34500  3800
5000  5000

END OF LISTING OF FILE :MJCWIN.WINFRITH.DATA(1,*,1).PROGSTEER(1) FOR USER

**********
```

**TABLE 7. Example Progressive vector steering file (PROGSTEER)**

```
CURRENT METER 4
  10   1.0   10

END OF LISTING OF FILE :MJCWIN.WINFRITH.DATA(1,*,1).CUMSTEER(1) FOR USER :S

**********************************************************************
```

**TABLE 8. Example cumulative plotting program steering file (CUMSTEER)**

APPENDIX 1

Current meter Processing Form

| | | |
|---|---|---|
| Logging Information | Title (A80) ..... | |
| | Meter location code (A3) ..... | |
| | Logger tape Number ..... | |
| | Meter Reference Number ..... | |
| | Meter Type PLESSEY/AANDERAA | |
| | Sampling Interval ..... (minutes) | |
| | Start time/Date ..... e.g. 1640/841021 | |
| | Stop time/Date ..... GMT | |
| Verification | Velocity : Maximum..., Maximum Increment (V) ..... (m/s) | |
| | Temperature: Maximum..., Maximum Increment (T) ..... | |
| | Minimum... | |
| Processing Options | Coastal Vectors Yes/No | Angle of Coast to North .... |
| | Time Series Plot Yes/No | |
| | Scatter Plots Yes/No | Maximum Velocity ..... |
| | Frequency Table Yes/No | Velocity divisions ..... |
| | Exceedance Plots Yes/No | |
| | Progressive Vector Plot Yes/No | |
| Progressive Vector Plots Only | Plot Type A4/CHARTS | Chart Scale ..... |
| | (for 'A4') Plot Alignment ..... Coast/Compass | |
| | Plot limits North ..... East ..... (metres) | |
| | (for 'CHART') South ..... West ..... (metres) | |
| | Size of Graticule .... Tick mark separation .. (metres) | |
| | Name of file to hold Progressive vector data ..... | |
| | Location Northing ..... Easting ..... | |
| | Date Start ..... Stop ..... | |

| | | |
|---|---|---|
| User Information | VME username | Operators Information |
| | Group name | File Position |
| | Account name | Transfer tape Name |
| | HR Job code | Blocksize |
| | Deadline | Filename |
| | Submitted by | Completed by |
| | Date | Date |

**APPENDIX 2** Equations used to convert recordings from current meters to standard units

PLESSEY current meters

1) Temperature

Temperature = (Value in Channel 2 on tape - 477.0)/16.8
in deg. C

2) Current Direction

Direction = 0.346 x Value in Channel 3 on tape + 5.0
in degrees
(magnetic North)

3) Current Velocity

$$\text{No of revolutions per second} = \frac{(N_{t-1} - N_t)}{T*60} \times \frac{10500}{1056}$$

Where $N_t$ = Value in channel 4 on tape for record t.
and T = Sampling Interval in minutes.

AANDERAA current meters

1) Temperature = $A_m - 0.399 + (B_m + 4.34) \times T - 8.388 \times T^2 + 4.3 \times T^3$

where $A_m$ and $B_m$ are determined by the actual meter in use.
where T = Value of channel 2 on tape ÷ 1000

2) Current Direction

Direction = 0.349 x Value in Channel 3 on tape + 1.5

3) Current Velocity

No of revolutions per interval = 4* value in Channel 4 on tape

There parameters (temperature, direction and velocity) are then corrected using the appropriate calibration factors for each meter. This correction includes the conversion of flow rate in number of revolutions per period to the current velocity in meters per second.

The calibration constants are held in the subroutines TEMCAL, DIRCAL AND VELCAL respectively.

**APPENDIX 3**

Rules used for patching erroneous data

Current velocities and directions

From the error flag it can be seen which current velocities are in error. If three or more velocities are in error in succession then no patching is attempted. If there are two or less consecutive errors one of two methods may be used for patching the data viz: interpolation and correction is to interpolate values from the surrounding valid data values. This is used for patching velocity and direction values.

For velocity values recorded by Plessey meters certain velocities can be recorded at twice their true value. The following test is performed to detect and correct this sort of error.

If a velocity ($V_t$) has failed only the difference test ($V_t - V_{t-1} < VDIFF$) and $V_{t-1}$ has not failed any test then the velocity is halved to see if it will then pass the difference test

$$V_t/2 - V_{t-1} < VDIFF$$

if so the halved velocity $V_t/2$ is recorded in the progressive vector file. If not interpolation is performed.

Note: VDIFF is the maximum allowable increment between consecutive velocity as specified in the verification section of the Current Meter Processing form in Appendix 1.