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Woods Hole Oceanographic Institution

W.H.O.I. CTD MicroVAX II Data Acquisition System Part II Operator's Guide

by

J.M. Allen

January 1992

Technical Report

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Approved for Distribution:

Robert C. Groman

Robert C. Groman, Director
Information Systems Center

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Related publications

WHOI CTD MicroVAX II Data Acquisition System Part I:	Installation Manual
WHOI CTD MicroVAX II Data Acquisition System Part III:	Reference Manual
WHOI CTD MicroVAX II Data Acquisition System Part IV:	Guide to Writing Programs to Access the Global Section
WHOI CTD MicroVAX II Data Acquisition System Part V:	Directory Structure, Source Code and DCL files

Acknowledgements

I would like to thank the University of Rhode Island Technical Services Group for their invaluable assistance in the development of the **AQUI89** CTD MicroVAX data acquistion system. In particular, Lorne Covington, Bill Fanning, Bill Hahn and Joe Lewkowicz were helpful in providing source code, information, and assistance.

Much of the **CTD78** portion of the code was modeled after the original **CTD78** acquisition system written for use on the HP 2100 series computer by George Power and modified later for an LSI/11 system by Tom Danforth. Mary Hunt designed and documented the **CTD78** disk data format.

Skip Little helped with many of the structural diagrams, and reviewed the documentation. Robert Millard assisted with technical details. Carol MacMurray and Maggie Cook were most helpful in testing the system on land and at sea and made many suggestions for improvements. Warren Sass helped to solve some of the more obscure bugs in the system.

1 Introduction

AQUI89 is a real-time shipboard Conductivity Temperature Depth profiler (CTD) data acquisition system used at the Woods Hole Oceanographic Institution to collect, preview and store (log) data from the WHOI/Brown Mark III CTD microprofiler (Brown and Morrison, 1978) on a MicroVAX II computer, running the VAX/VMS operating system, version 5.3. This manual describes **AQUI89** version 1.0.

AQUI89 is a modification of a system developed for the University of Rhode Island (URI) by Lorne Covington of the Technical Services group at the Graduate School of Oceanography (GSO). The URI system was designed to run on a VAXstation II workstation. **AQUI89** is intended to run on a MicroVAX II computer which is basically a subset of the VAXstation II, having less memory and no DEC graphics development unit.

The **AQUI89** system, as implemented on the microVAX II, allows a certain amount of time-shared processing to take place without interfering with the acquisition process. However, we strongly recommend that the microVAX II that is to be used for at sea data acquisition be completely dedicated to the acquisition process while data logging is in progress, since there is no adequate means at present to determine exactly how much extra processing can be done without interfering with the acquisition process.

The **CTD_GRAB**, **CTD_LOG**, **CTD_CONTROL** programs and most of the DCL command files were written by Lorne Covington and other members of the Technical Services Group at URI/GSO. The plotting and display routines, the **CTD78** formatting code and the documentation were written by Julie Allen, W.H.O.I. The archived data is stored in **CTD78** format (Millard, et.al, 1978).

Chapter 1 is an overview of the CTD data acquisition system. Chapter 2 contains a description of the **AQUI89** software. Chapter 3 is a step-by-step set of instructions for operating and testing the acquisition system. Chapter 4 outlines some particular features of **AQUI89** version 1.0.

The appendices contain information important to the operator and are referred to throughout this manual.

An overview of the CTD data acquisition system is shown in Figure 1. As the instrument package is lowered and raised through the water column, the serial FSK (frequency shift key) modulated data stream from the CTD underwater unit is transmitted up the instrument cable to the CTD deck unit where it is converted to serial RS232 format and sent to the MicroVAX II computer. The RS232 data are typically transmitted at 9600 baud.

The software allows for a variable number of bytes between frame synchs; it unpacks the byte string, and rearranges the data in **CTD78** format before archiving. This system uses frame synchs to detect a scan. The CTD scans are marked with a frame synch byte which alternates between 11110000B and the compliment 00001111B. The number of bytes in an observation can be obtained from the scale factor record, parameter **WDS_PER_SCAN** (Millard, et. al., 1978).

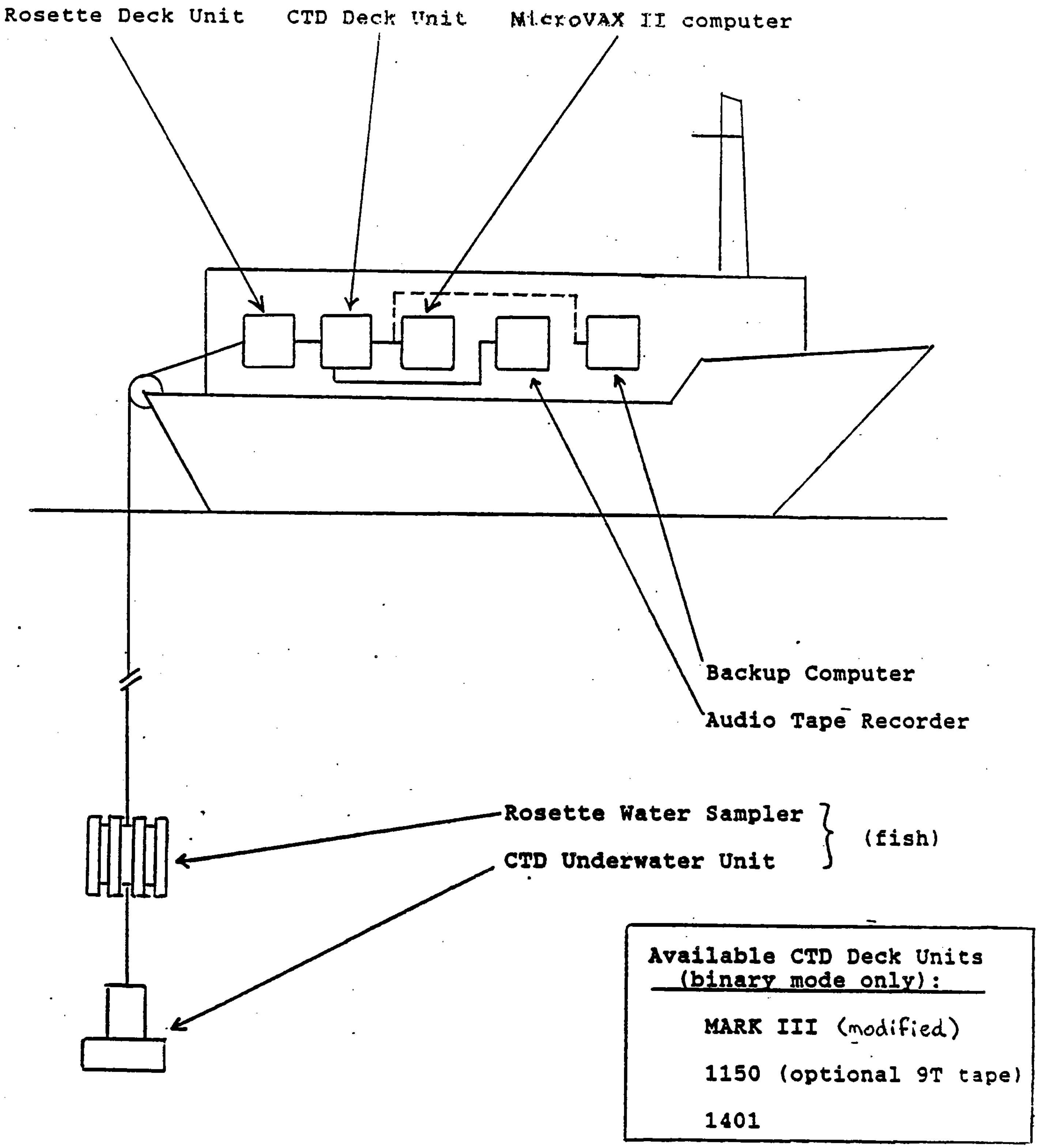

Figure 1: CTD Data Acquisition System Overview

A standard CTD instrument configuration would consist of records comprising the following bytes:

frame synch	1 byte
pressure	2 bytes
temperature	2 bytes
conductivity	2 bytes
signs	1 byte
dissolved oxygen current	2 bytes
dissolved oxygen temperature	1 byte

The above data configuration is variable; the **AQUI89** program is designed to accept any instrument configuration and scan rate. Other sensors may be added, although pressure, temperature and conductivity are assumed to always be present. The data scan rate is dependent on the number of variables being measured. The scan rate for instruments configured for 13 bytes or less is normally 31.25 scans/sec; for 14 to 26 bytes the scan rate is normally 16 scans/sec. The following equation is used to determine scan rate (srate):

$$\text{srate} = 1/5 \text{ kHz} * (\text{number of bytes} + 1) * 11 \text{ bits/byte} <= \text{scan rate}$$

where: scan rate is either 31.25 scans/sec or 16 scans/sec and
11 bits/byte is figured as follows:

8 data bits
1 start bit
2 stop bits

The Rosette deck unit controls the Rosette water sampler by transmitting a signal down the instrument cable instructing the sampler to "fire" the next successive bottle.

Raw FSK data are recorded on audio tape cassettes which can be played back to the deck unit for post-processing in the event of system failure. When the older type 1150 CTD unit is used, raw data may also be recorded digitally on an off-line 9T magnetic tape. A backup computer system can be used to capture the RS232 data stream in parallel with the MicroVAX II system.

The RS232 data stream enters a time-sharing port on the MicroVAX II computer where the **AQUI89** software monitors, processes, and logs the data to 9T magnetic tape and/or disk storage in standard **CTD78** format (Millard, et. al, 1978).

The operator begins data acquisition by setting up a template file for each instrument. This file contains the laboratory calibrations (used to scale the raw data to physical units) for each sensor within the instrument, along with other cruise and instrument specific data. The template files can be modified at any time during a cruise, prior to a cast. The information contained in the template file includes the calibration data required to write the **CTD78** format scale factor record to the disk and/or tape archive file. Appendix A shows a typical **AQUI89** template file, explains its contents, and shows where the parameters used to calculate the various physical properties of seawater (Fofonoff and Millard, 1983) are stored in the **CTD78** scale factor record.

Before each instrument deployment (cast), the operator must specify a device name (e.g. msa0:) if logging to tape, the data filename and directory if logging to disk, the station and cast numbers, and the start position (latitude and longitude). Offline printing and plotting parameters may be entered at any time before or during a cast. A shared dynamic block of memory (a global section called **CTDGBL**) contains the data for the offline printing and plotting. The data in the global section has been masked for the sign bit (section 5 of the **AQUI89** Programmer's Reference Manual) but is otherwise uncorrected. Depending on the size of the global section, all or (the most recent) part of a cast will be available in the global section.

The data interrupt which occurs during transmission of the signal to fire a water bottle is detected by the acquisition program which automatically "tags" the corresponding CTD data record. A record tag is indicated in the flags byte of the CTD data scan. When a record tag is detected, CTD data are extracted to separate ASCII disk file(s) for later merge with water data. The user may tag a scan manually via the command `$ CTD TAG` (Section 3.2).

The logging program also automatically checks and reports the following data errors:

frame synch
no data
range errors on pressure

Errors detected during acquisition are written to an ASCII disk file for bookkeeping purposes and marked in the **CTD78** data record quality word (Millard, et. al, 1978) where appropriate. Fatal errors are broadcast to the user terminals.

Offline processing includes the creation of 'real-time' plots of selected parameters (scaled to physical units) as well as listings of subsets of the data.

Time used in the system is based on the VAX/VMS system clock, which is normally set to GMT at system boot.

The user interface is friendly, with clear prompts and default options for most input. Help files and menus are used to facilitate data entry.

The documentation package for the **AQUI89** system consists of the following manuals:

Part I	Installation Guide
Part II	Operator's Guide
Part III	Reference Manual
Part IV	Guide to writing programs to access the **CTDGBL** global section
Part V	Source Code Manual

2 Software description

The **AQUI89** software is designed to operate under VAX/VMS version 5.3 and requires the following utilities:
EDT or **EVE** editor
VAX/VMS **Backup**

If program modification is necessary, the following VAX utilities may also be required (see **AQUI89** Programmer's Reference Manual):

C compiler (version 2.4)
FORTRAN compiler (version 4.5)
Symbolic debugger (only on systems with at least 4mB of memory)

The **AQUI89** system consists of software modules which perform the following tasks:

installation
initialization
acquisition and data logging
quality control
bookkeeping

An overview of these modules is presented in figure 2. Some of the major programs in the **AQUI89** system include:

CTD_GRAB	detached	archives data from the CTD deck unit into a global section (CTD_COM_BUF)
CTD_LOG	detached	collects data from the global section (CTD_COM_BUF) and writes it to: global section (CTDGBL), CTD78 format tape and/or CTD78 format disk file.
CTD_CONTROL	interactive	passes commands to CTD_LOG
PLOT_CTD78	detached	controls the plotter in response to commands sent by the **CTD78_PLOT** interactive process
CTD78_PLOT	interactive	initiates plot setup and sends commands to the detached plotting process, **PLOT_CTD78**
CTD78_CONFIG	interactive	creates a configuration file from the **CTD78** template file; allows **CTD_LOG** to process data from CTD instruments having different sensor configurations; called automatically by the **START_AQUI** command file
GET_SCAN	interactive	allows the user to look at selected scans in the current **CTDGBL** global section; data is scaled to physical units; **CTD_LOG** must be active
R_CTD78_DISK	interactive	allows the user to view portions of the **CTD78** disk data file after completion of a logging session; **CTD_LOG** must be inactive
R_CTD78_TAPE	interactive	allows the user to view portions of the **CTD78** magnetic tape file after completion of a logging session; **CTD_LOG** must be inactive
JOURNAL	detached	writes a journal file of significant events reported by **CTD_GRAB** and **CTD_LOG**; usually disabled
SCAN_JOURNAL	interactive	reads and prints the journal file; not used for normal WHOI **AQUI89** operation

Several VMS DCL command files are utilized during the initialization and operation of the **AQUI89** system.. Flow diagrams illustrating how these are used appear in Figures 3-7. The command files are also listed in the **AQUI89** Source Code Manual, together with lists of the VMS logical names and VMS global symbols used by **AQUI89**.

2.1 Installation

The CTD data acquisition system is installed on a MicroVAX II via the VAX/VMS **BACKUP** facility, using a TK50 cartridge tape containing the latest release (**AQUI89** version 1.0). The details of the installation procedure are described in the **AQUI89** Installation Guide.

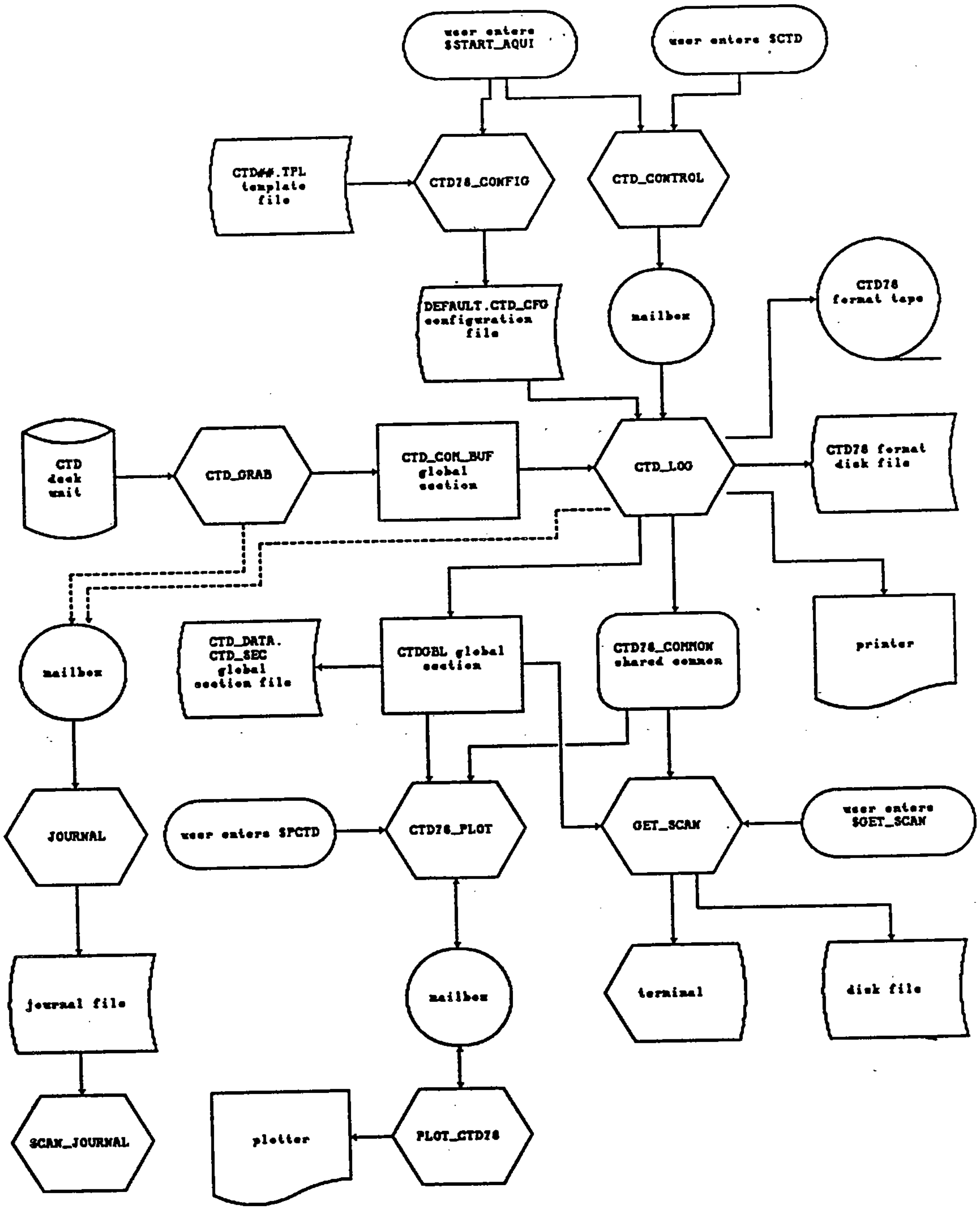

Figure 2: AQUI89 Software Overview

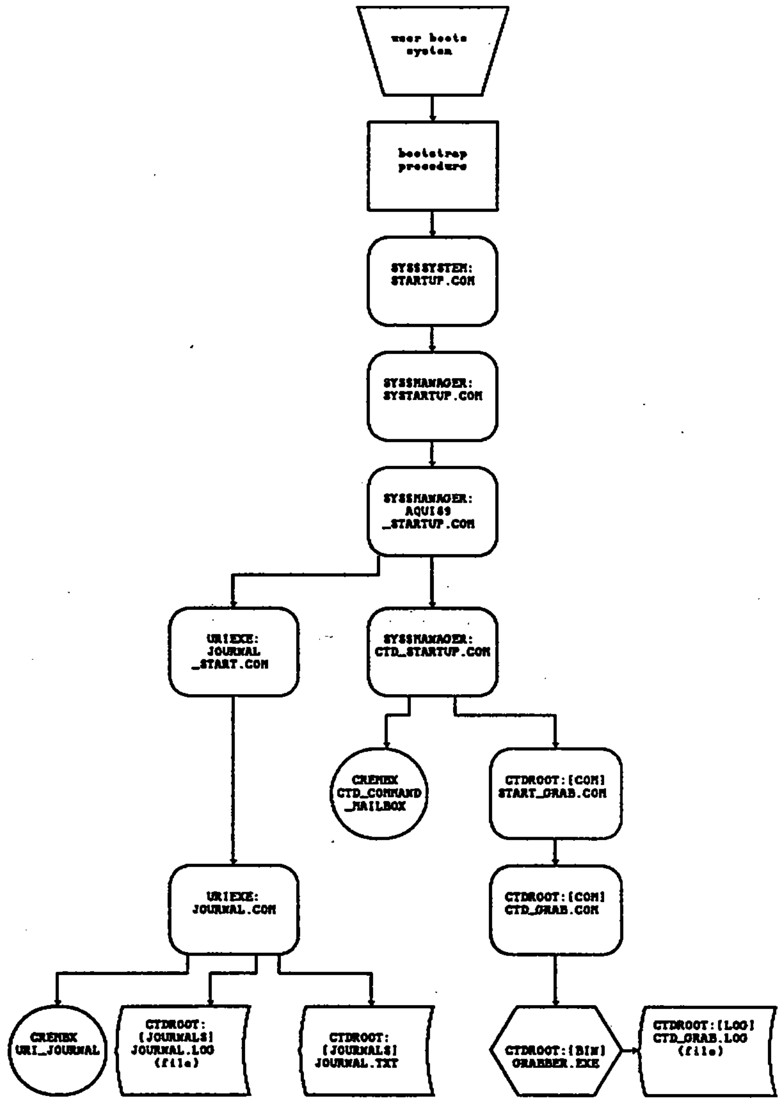

Figure 3: Start VMS, initiate **CTD_GRAB** and **Journal**

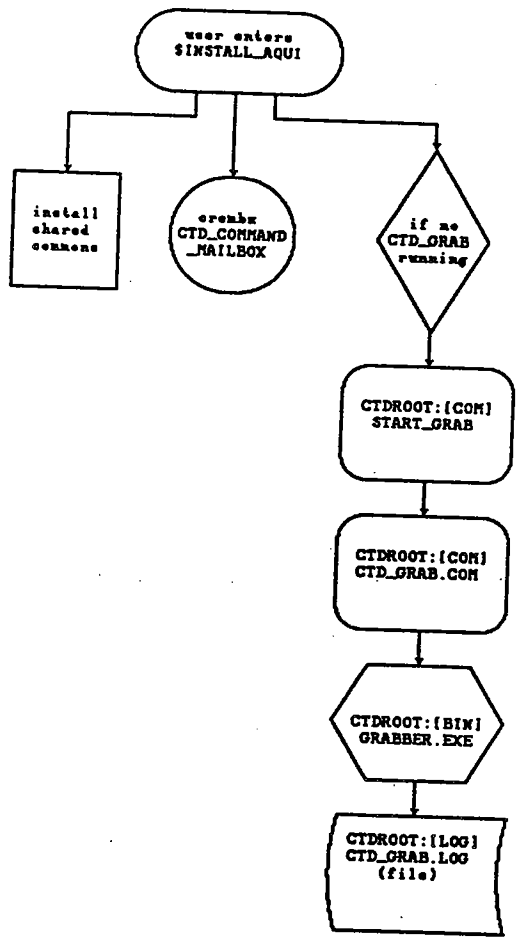

Figure 4: Install AQUI89 data acquisition system

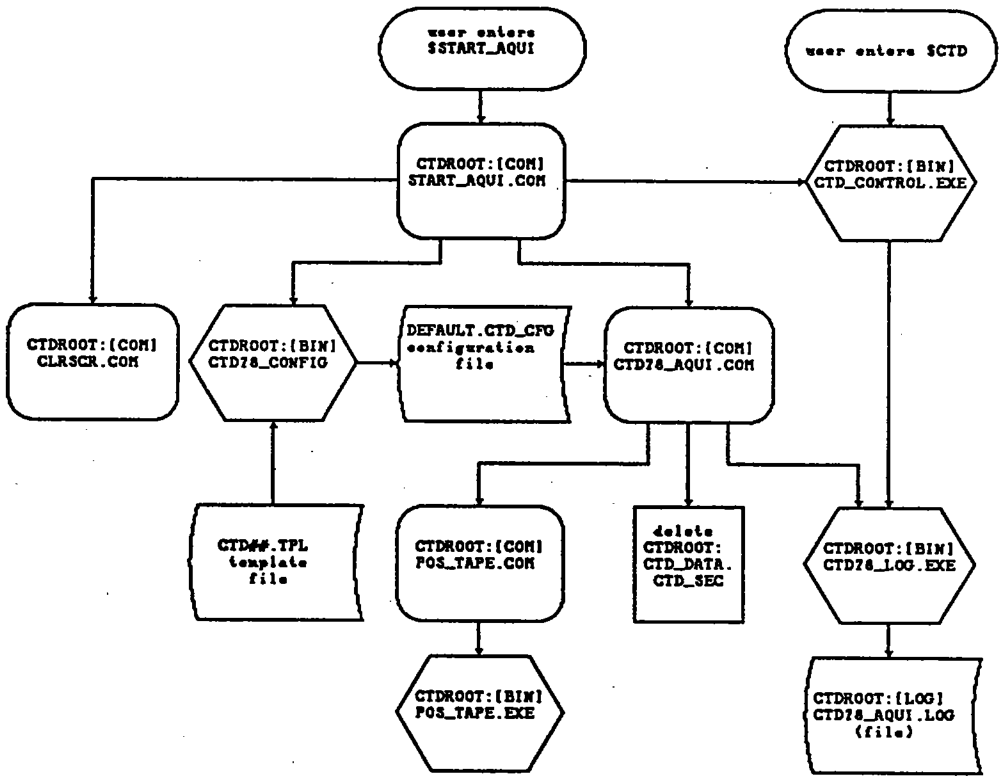

Figure 5: Initiate data logging process and control of data logging operations

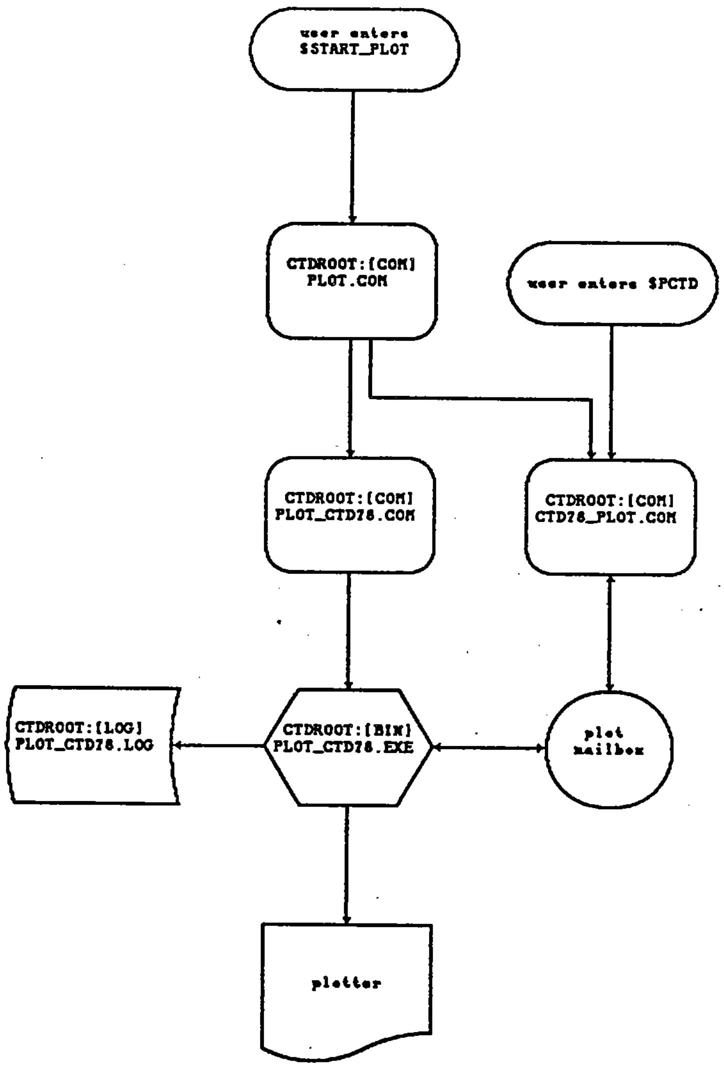

Figure 6: Initiate plotting operation

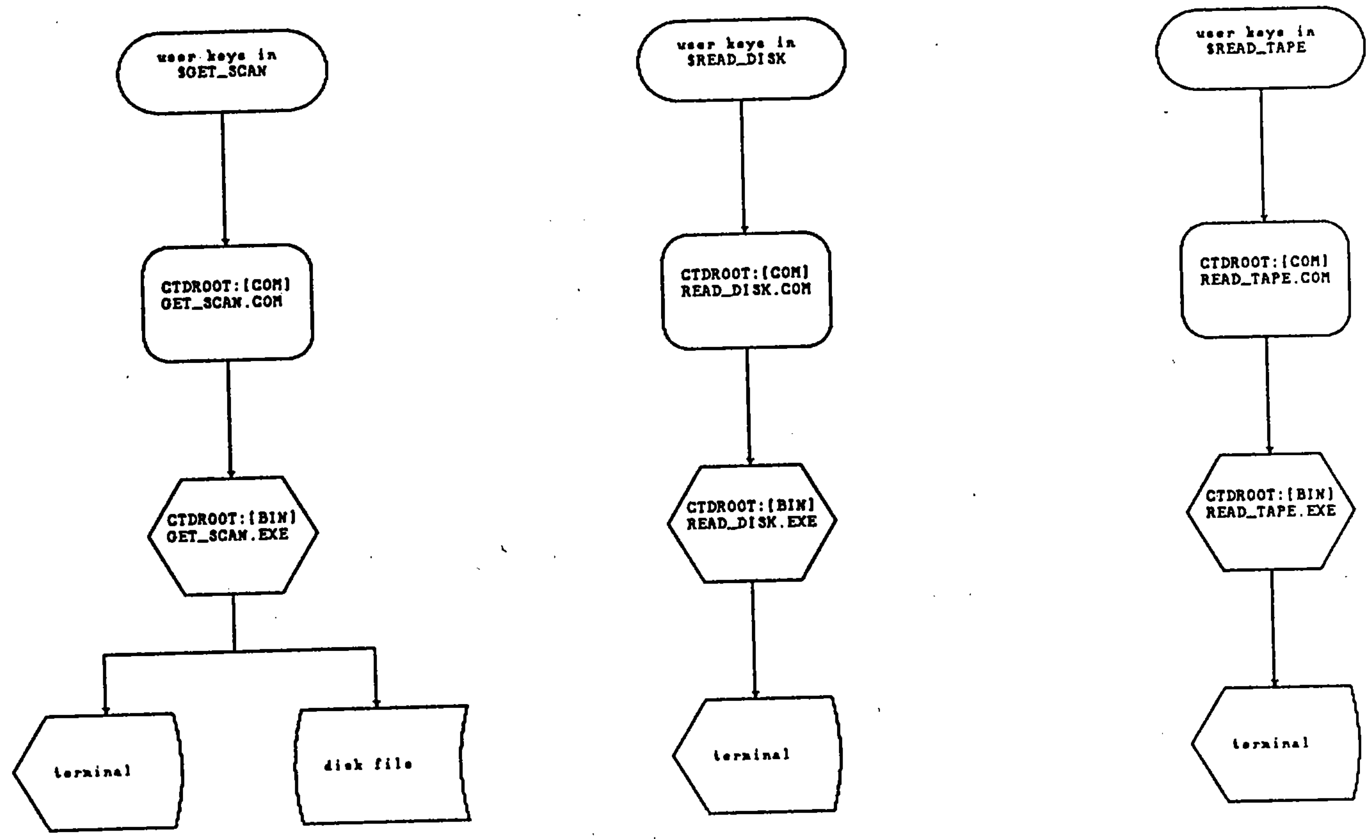

Figure 7: Initiate **GET_SCAN**, **READ_DISK** and **READ_TAPE** processes

2.2 Initialization

The acquisition program requires template files containing the cruise information and calibration parameters for each CTD instrument. These template files are in ASCII format and can be modified using the editor. The template files are identified by the instrument number (i.e. **CTD01.TPL** for instrument #1) and are located in the directory **USER:[CTD.AQUI.TEMPLATE]**.

2.3 Acquisition and data logging

The data acquisition portion of the software system consists of two detached processes, **CTD_GRAB** and **CTD_LOG**, and a user-interface, **CTD_CONTROL**.

CTD_GRAB	- invoked at system startup or reboot
CTD_LOG	- started for each cast
CTD_CONTROL	- invoked for each command sent to **CTD_LOG**

The **CTD_GRAB** program runs as a detached process at VMS internal scheduling priority 5. **CTD_GRAB** issues read QIO (queued input/output operations) system calls to a terminal device and places the data received into a ring buffer in common memory (global section).

The **CTD_LOG** program also runs as a detached process, at the normal VMS internal scheduling priority of 4. **CTD_LOG** stores the data in a large common memory buffer (global section) for use by other programs. **CTD_LOG** also processes and arranges the data in **CTD78** format and writes the formatted data to disk, 9T magnetic tape, and the line printer. Commands sent to **CTD_LOG** (via program **CTD_CONTROL**) allow the operator to initialize and modify parameters in the header structure, start or stop printing of data scans and start, pause and stop logging of data to the specified archive devices (disk and/or tape). When **CTD_LOG** receives the **START** command, it reads the ring buffer and starts logging the 'oldest' data. For this reason, for normal operation, the CTD deck unit should be turned on before the **START** command is sent to **CTD_LOG**. Otherwise, there could be some data in the buffer from a previous cast which would get logged at the beginning of the current cast. For the standard WHOI CTD instrument (fish) configuration, with a scan rate of 31.25 scans/sec, it takes approximately 80 seconds to 'flush' the ring buffer. As a safety precaution, if the operator forgets to send the **START** command to the **CTD_LOG** process, logging will start automatically when a conductivity greater than 5 is detected (i.e. when the CTD instrument enters the water).

At the beginning of each cast, a command file is executed (**START_AQUI**) which queries the operator for the necessary information. This command file invokes the logging program (**CTD_LOG**) which logs data continuously. Once the logging process is active, the user may pass commands to the logging process in two ways:

A. type the command:
   `$ CTD`
   after which the program prompts with:
   `CTD>`
   The user may then use the online help facility by typing:
   `CTD> HELP`
   or enter any other valid command(s):
   `CTD> STATION 15`

```
CTD> CAST 1
CTD> SPOS 15 10.2N 140 33.8W
CTD> START
CTD> LOG
CTD> EPOS 15 10.3N 140 33.7W
CTD> EXIT
```

B. Commands may also be entered from DCL (note that commands with multiple parameters require double quotes):

```
$ CTD HELP
$ CTD STATION 15
$ CTD CAST 1
$ CTD SPOS "15 10.2N 140 33.8W"
$ CTD START
$ CTD LOG
$ CTD EPOS "15 10.3N 140 33.7W"
```

During the upcast, firing a water bottle causes a record tag to be written to the archive device. Record tags are marked in the data scan quality word (**CTD78** format, Millard, et. al, 1978), bit 12; if bit 12 is set (= 1) then that scan was marked.

2.4 Quality control

The **CTD_LOG** process writes the CTD data scans to a global section which other processes may access (read-only) during acquisition. The quality control part of **AQUI89** allows the operator to list and/or plot portions of the global section **CTDGBL**. The data in the global section is in the following format (assuming a standard CTD instrument sensor configuration of pressure, temperature, conductivity, oxygen current and oxygen temperature):

flags,pres,temp,cond,oxyc,oxyt

variable	type	description
flags	unsigned 8-bit integer	indicates cast direction, frame synch error and record tag
pres	signed 24-bit integer	pressure
temp	signed 24-bit integer	temperature
cond	unsigned 16-bit integer	conductivity
oxyc	unsigned 16-bit integer	oxygen current
oxyt	signed 16-bit integer	oxygen temperature

Depending on the size of the global section, a whole cast or the most recent portion of the cast will be available. If a small global section has been allocated, the data in the section will "wrap-around" when it is full, overwriting the oldest data. See section 3.7.3 of the **AQUI89** Installation Guide for instructions if the size of the global section needs to be changed.

The data in the global section has been sign-bit masked but not converted to physical units. The plotting and display programs read data from the global section; these programs scale the raw data to physical units and compute the other physical properties of sea water, using the parameters from the **CTD78** scale factor record.

2.4.1 Plotting

The plotting software consists of two programs: **CTD78_PLOT** and **PLOT_CTD78** (a detached process) which communicate via VMS mailboxes and Common Event Flags. The plotting programs read data from the global section and allow the user to interactively change plot parameters and replot any portion of the current cast that is contained in the global section.

The plotting programs, **CTD78_PLOT** and **PLOT_CTD78** (detached), run separately from the acquisition program. The **AQUI89** plot system includes a menu of derived and sensor parameters from which the user may select variables to be displayed in near 'real-time'. The plotting software version 1.0 runs on a 12" ZETA plotter. Depending on the size of the global section (i.e. whether or not the entire cast will fit in the global section), the user also has the option to replot with parameter and/or scale changes. The operator defines one independent variable and up to four dependent variables in the template file; the user is allowed to change plot parameters during acquisition.

If the global section (**CTDGBL**) is small and the plot interval is set too small, the plotter may not be able to keep up with the data and some data may not be plotted. This situation may be corrected by increasing the plot interval.

The plotting program maps to the global section that is created by **CTD_LOG**. Therefore, the plotting program can only be started after the **START_AQUI** command has been issued. The operator may initiate the plotting programs and draw plot axes before data acquisition begins. Note, however, that attempts to read from the global section (via plot commands SCAN or LOOK) will cause the plotting program to wait until there is data in the global section before responding.

2.4.2 Printing

There are two methods of looking at the CTD data during acquisition. To get a printed listing, specify the print option to the ctd command:

```
$ CTD
CTD> PRINT N        !where N is the scan increment
CTD> PRINT 100      !will print once every 100th scan
CTD> PRINT 1875     !will print every minute, assuming a scan_rate
                    ! of 31.25 scans per second
CTD> NOPRINT        !to stop output to line printer
or use the alternative method:
$ CTD PRINT N       !where N is the scan increment
$ CTD PRINT 100     !will print once every 100th scan
$ CTD PRINT 1875    !will print every minute, assuming a scan_rate
                    ! of 31.25 scans per second
$ CTD NOPRINT       !to stop output to line printer
```

If this print option has been chosen, the current values, in engineering units, of scan number, flag, pressure, temperature, salinity, conductivity, oxygen current, oxygen temperature and dissolved oxygen are listed on the printer (assuming a 'standard' fish configuration).

The **GET_SCAN** program allows the user to examine scans anywhere in the global section from the beginning (unless the global section has wrapped around) to the current scan. **GET_SCAN** prints the data (scaled to physical units) to the user's terminal and has the option to also output to an ASCII file which can be printed if a hard copy is required:

```
$ GET_SCAN
```

The printer is assigned to the **CTD_LOG** process during the entire cast and the normal VMS print queue is restarted in the command procedure stop_aqui. Therefore, hardcopy of the ASCII file produced by **GET_SCAN** can only be produced after the **CTD_LOG** process has terminated.

2.4.3 Error logging

During acquisition, informational messages, warnings and errors are reported to the display terminal and any other terminal on the system which has not been set to /NOBROADCAST mode. Frame synch errors, data gap and range errors are added to the quality word and recorded in the ASCII disk file:

CTDROOT:[DATA]ssssAccc.ERR (eg. 0029A002.ERR)

where ssss = station number (eg. 0029)
ccc = cast number (eg. 002)

The program checks and reports data errors for:

frame synch	- sets bit 15 in the data quality word for that scan
no data	- data gaps are filled with the value of the last good scan to preserve the time seri
range errors	- sets bit 0 in the data quality word if pressure jumps > 1 decibar (see Appendix

Data gaps are assumed by **CTD_LOG** to be caused by the signal transmitted to fire the Rosette water bottles. Therefore, when a data gap is detected, the following message is broadcast:

```
18-JAN-1989 12:58:2683:  %CTDLOG-I-TAG, tagged scan 28869
```

2.5 Bookkeeping

During acquisition, ASCII disk files are written for bookkeeping purposes. On completion of a station, these files can be printed and logged for station archives and cruise reports. The following ASCII files are produced:

filename = **ssssAccc.***

where	ssss = 4-digit station number	(eg. 0053)
	ccc = 3-digit cast number	(eg. 001)

	(eg. station 53, cast 1)
station log file	**CTDROOT:[LOG]CTD78_AQUI.LOG**
error file	**CTDROOT:[DATA]0053A001.ERR**
header record	**CTDROOT:[DATA]0053A001.HED**
water sample data (scaled)	**CTDROOT:[DATA]0053A001.WSC**
water sample data (raw)	**CTDROOT:[DATA]0053A001.WRW**
data file	**CTDROOT:[DATA]0053A001.RAW**

The station log file (***.LOG**) contains all system messages and error messages from the logging session; the maximum pressure, scan number and **CTD78** record number at maximum pressure are also recorded in the log file.

The error file (***.ERR**) contains the errors logged during the session.

The header record (***.HED**) is an ASCII file containing the scale factor record and header record information (Millard, et. al, 1978) that was written to tape (in binary format).

The water sample data files (***.WRW** and ***.WSC**) contain the averaged data scans which are archived when a water bottle is triggered (causing a data interrupt which is interpreted as a water tag). The water sample files are in ASCII format and contain the average values for the data immediately prior to detection of the tag. The ***.WRW** file contains the uncorrected (raw) data; the ***.WSC** file contains the scaled (corrected) data.

Appendix H contains examples of log, header, error and water sample files.

3 Operation

The following describes the steps to initialize and log data using **AQUI89**, assuming that VMS version 5.3 is operational on the MicroVAX. For instructions on how to restore the VMS operating system and utilities and modify standard sysgen parameters, see the **AQUI89** Installation Guide.

Following installation, the operator should:

- prepare the deck unit and associated equipment,
- initialize the tape (if necessary) and physically mount it (when archiving to tape)
- set up the plotter, if plotting
- enter the **START_AQUI** command before the CTD sensor is placed in the water; enter the station number, cast number and start position (latitude, longitude)
- specify whether or not a data listing is desired
- when the deck unit has been checked and adjusted, begin data logging; logging should commence before the CTD instrument goes in the water
- start the plotting process, if plots are desired
- monitor the cast with the **GET_SCAN** utility

3.1 Calibration

Calibration data are used to scale raw data into real engineering units. Before a cruise, calibrations are calculated for each instrument and entered into the template file for that instrument. Archive versions of the template files may be kept and the operator can change calibration values during a cruise if desired. See Appendix A and the **CTD78** scale factor record (Millard, et. al, 1978) for structure and information content.

3.1.1 Template files

Before each cruise, a template file should be prepared for each CTD instrument to be used. The template files are located in the directory:

CTDROOT:[TEMPLATE]

The template file names are based on the instrument number:

CTDROOT:[TEMPLATE]CTD##.TPL !where ## is the instrument number

CTDROOT:[TEMPLATE]CTD09.TPL !template file for instrument #9

Since the template files are in ASCII format, they may be easily modified using the available VMS text editor.

3.1.2 Configuration files

A configuration file named **CTDROOT:[CONFIG]DEFAULT.CTD_CFG** is required for operation of **CTD_LOG**. This configuration file is automatically created (via program **CTD78_CONFIG**) from the WHOI **CTD78** template file immediately prior to starting the **CTD_LOG** detached process. For more information on configuration files, see section 3.6 and Appendix A of the **AQUI89** Programmer's Reference Manual.

3.2 Data acquisition

If logging to disk file, first ensure that there is enough free disk space available. If free disk space falls below 1000 blocks while logging to disk, the disk data file will be closed; logging to tape will continue. The following banner message will appear on all of the user terminals:

```
30-DEC-1988 14:12:06.18: %CTD-W-SPACELOW, Disk space low.
                                          Disk files closed.
```

The **CTD78_AQUI.LOG** file will contain the following messages:

```
%WARNING: SPACELOW, Disk space low
```

```
-WARNING: SPACELOW, Disk files closed
Disk space has fallen below        1000 free blocks.
Closing disk data file at scan #       99572.
```

If you attempt to start **CTD_LOG** with disk space below 100 free blocks, **CTD_LOG** will abort with a message notifying the user that there is not enough disk space to log data:

```
30-DEC-1988 14:12:06.18:  %CTD-W-NOSPACE, Not enough disk space to log data.
```

To calculate the amount of disk space required for a cast:

~disk space (blocks) = time (hours) * 3116 blocks/hour

assuming: standard CTD instrument configuration (7 bytes of data)
data sampling rate is 31.25 scans/sec
1 block = 512 bytes

If logging data to 9T tape, and this is the first cast on the tape, the tape must first be initialized:

```
$ INIT MSAO:  CTDAQU
```

If this is not the first cast on the tape, the **START_AQUI** command procedure will check to see if there is already data logged to the tape and automatically position the tape at the end of the last station (program **POS_TAPE**).

There is no check in the current release of **AQUI89** for magnetic tapes that run out. Appendix I contains information on how to determine the amount of CTD data that will fit on a 9T magnetic tape.

3.2.1 Initialization

At the beginning of each cruise, and again if the system has been rebooted, the command file **INSTALL_AQUI** must be run to set up the terminal ports and ensure that the shared commons have been installed:

```
$ INSTALL_AQUI
Port for plotter (tta3:):  TTA3:
Port for printer (tta2:):  TTA2:
Printer baud rate (9600):  9600
CTD78_COMMON installed
CTD78_PLOT_COM installed
%DCL-I-SUPERSEDE, previous value of CTD_REPORT_MAILBOX has been superseded
%DCL-I-SUPERSEDE, previous value of CTD_PRINTER has been superseded
CTD_GRAB up and running
$
```

Note that when **CTD_GRAB** is restarted via the **START_GRAB** command, the following message will sometimes appear and can be ignored:

```
15-MAY-1990 10:25:22.36 %CTDLOG-W-NOSCAN, error from ctd_scan()
15-MAY-1990 10:25:22.42 -CTDLOG-W-NOSCAN, GRESTART, GRABBER was restarted
```

The maximum amount of time for a cast will normally be set to 3 hours (180 minutes). If cast times are expected to exceed 3 hours, follow the instructions in the **AQUI89** Installation Guide, section 3.7.3 Note that if a cast exceeds the maximum time allowed, the data in the global section will 'wrap-around' and the data scans that are overwritten will not be available to the printing or plotting programs. The logging of data to tape and/or disk will continue with no interruption; the archived data will not be affected.

3.2.2 Logging data

For each cast, the command **START_AQUI** must be used to start the program **CTD_LOG**, which runs as a detached process at the normal VMS internal scheduling priority of 4. At the beginning of each cast, the operator issues the **START_AQUI** command and provides the necessary parameters interactively:

```
$ START_AQUI
```

Appendix C shows an example of an **AQUI89** session.

To ensure that **CTD_LOG** is running, type:

```
$ SHOW SYSTEM
```

The process **CTD_LOG** should be running in HIB state:

```
  Pid*     Process Name    State  Pri*    I/O*       CPU*        Page flts*  Ph.Mem*
00000021   CTD_LOG          HIB     7     111   0 00:00:07.49        4809       200
```

* your numbers will probably be different from the ones shown here

If the process does not start up properly, check the file

CTDROOT:[LOG]CTD78_AQUI.LOG for diagnostics.

3.2.3 Interactive control of AQUI89

This section describes the interactive control interface to the **CTD_LOG** program. Since most of the commands required to log data in **CTD78** format are entered via the **START_AQUI** command file, most of the information in this section will not be necessary under normal circumstances.

Once data logging has commenced, commands may be entered interactively via two methods:

```
$ CTD
```

after which the **CTD_CONTROL** process will issue the prompt:

```
CTD>
```

and wait for input. The following are the available ctd logging commands:

help	- online help facility
data filename	- where filename is the disk file name
print n	- to begin printing every n data scans
noprint	- halt printing
station n	- enter station number for header
cast n	- enter cast number for header
start_pos	DDD MM.MMH DDD MM.MMH *
start	- writes the header information to the archive device and bookkeeping files
log	- start logging data
tag n	- write record tag n to the archive device and bookkeeping files for bottle firing
pause	- stops logging (time series is NOT preserved)
end_pos	DDD MM.MMH DDD MM.MMH *
stop	- stops logging for this cast and writes closing information to the archive device and bookkeeping files
exit	- exit from interactive process, back to DCL

* latitude and longitude positions are denoted as: DDD MM.MMH

where DDD is degrees
MM.MM is decimal minutes
H is hemisphere (N or S for latitude, E or W for longitude)

A sample run might look like this (note that most of the following commands are automatically called when the command file **START_AQUI** is run):

```
$ CTD                                   (to enter acquisition command level)
CTD> STATION 33                         (identify station number)
CTD> CAST 1                             (identify cast number)
CTD> DATA 0033A001.RAW                  (log to data file)
CTD> START_POS 34 15.0N 45 30.0W        (start position)
CTD> PRINT 100                          (start printing every 100 scans)
CTD> START                              (initialize and write headers to tape and disk)
CTD> LOG                                (start logging data)
CTD> TAG                                (tag a scan)
CTD> TAG                                (tag a scan)
CTD> PAUSE                              (stop logging temporarily)
CTD> LOG                                (resume logging)
        .
        .
        .
CTD> TAG                                (tag a scan)
CTD> EXIT                               (exit to DCL)
$
```

Perform other DCL tasks here if you want - edit files, etc.

```
$ CTD                                   (re-enter acquisition command level)
CTD> TAG                                (tag a scan)
CTD> NOPRINT                            (stop the printer)
CTD> PRINT 200                          (print every 200 scans)
CTD> TAG                                (tag a scan)
CTD> PAUSE                              (stop logging temporarily)
CTD> LOG                                (resume logging)
        .
        .
        .
CTD> END_POS 34 15.0N 45 30.0W          (end position)
CTD> STOP                               (stop logging, write double EOF to tape)
CTD> KILL                               (stop the logging process)
CTD> EXIT                               (exit from acquisition command level to DCL)
$
```

The alternative method allows the operator to enter commands directly from the DCL command line:

```
$ CTD TAG
$ CTD NOPRINT
$ CTD PRINT 200
$ CTD TAG
$ CTD PAUSE
$ CTD LOG
        .
        .
        .
$ CTD STOP
```

Note that the following error and informational messages will occur if the STOP_AQUI command is issued before any actual data logging occurs:

```
5-OCT-1989 14:39:00.61: %CTDLOG-E-CTD78ERR, Error reading disk header
5-OCT-1989 14:39:03.02: %CTDLOG-E-CTD78ERR, Error writing header to disk
5-OCT-1989 14:39:06.29: %CTDLOG-I-STOPPED, Station 60, Cast 0
5-OCT-1989 14:39:10.57: %CTDLOG-I-DEAD, Stopped.
```

3.2.4 Water sample data

When a water bottle is fired, the data interrupt is detected by the acquisition system and the data scan is tagged. The data scans immediately preceeding the tag are extracted and used to compute averages which are output to the ASCII water sample files.

The NUM_WATER_SAMP values (defined in the template file) immediately prior to the tag are averaged for all parameters except dissolved oxygen current, which is averaged over 10 seconds (since oxygen current is only measured once each second).

The water sample files are as follows:

ssssAnnn.WRW !raw data (masked for sign bit)
ssssAnnn.WSC !data scaled to physical unit

where **ssss** = station number and
nnn = cast number.

Scans may be tagged without firing a bottle by sending the **TAG** command to **CTD_LOG**:

```
$ CTD
CTD> TAG
CTD> EXIT
$
```

or, simply:

```
$ CTD TAG
```

The following message will appear on the user's terminal following a **TAG**:

```
18-JAN-1989 12:58:2683:  %CTDLOG-I-TAG, tagged scan 28869
```

3.2.5 Terminating data logging

At the end of a cast (before entering the command **STOP_AQUI**), the user should enter an end position (latitude and longitude):

```
$ CTD
CTD> EPOS 15 10.3N 140 33.8W
CTD> EXIT
```

or:

```
$ CTD EPOS "15 10.3N 140 33.8W"
```

To end a cast, type

```
$ STOP_AQUI
30-DEC-1988 12:32:02.30:  %CTDLOG-I-STOPPED, Station 33, Cast 1
30-DEC-1988 12:32:11:18:  %CTDLOG-I-DEAD, Stopped.
printer is not spooled - starting print queue
```

This command terminates the logging and plotting processes and restarts the print queue. Note: if there is a problem with the printer after executing the **STOP_AQUI** command, try restarting the print queue via the command:

```
$ START_PRINT_Q
```

To save disk space, the global section file **USER:[CTD]CTD_DATA.CTD_SEC** can be deleted any time after the acquisition process has been stopped.

3.2.6 Printing

During data acquisition, the print command may be invoked in two ways, and can be toggled on and off:

```
$ CTD            (get into CTD command mode)
CTD> PRINT N     (where N is the decimation interval)
CTD> NOPRINT     (to halt printing)
CTD> PRINT N     (to restart printing)
CTD> EXIT        (to exit to DCL)
$
```

or, using the alternative method:

```
$ CTD PRINT N    (where N is the number of scans to skip)
$ CTD NOPRINT    (to halt printing)
$ CTD PRINT N    (to restart printing)
```

If the print option has been invoked, scans will continue to be printed on the line printer until the **NOPRINT** command is sent. Appendix D shows a sample of printer output during a CTD cast.

To look at the data in the global section on a user terminal, type the command:

```
$ GET_SCAN
Output to a disk file as well as terminal (y/n)?  N
current scan:  1523
Enter start, end, increment (0,0,0 to end):  700,1000,100
<<< data will appear here - see example in Appendix E >>>
Enter start, end, increment (0,0,0 to end):  0 0 0
$
```

Appendix E shows an example of using **GET_SCAN** during a logging session.

If data is output to a disk file as well as to the terminal, the ASCII file is:

CTDROOT:[DATA]CTD78_LIST.DAT.

3.2.7 Plotting

The plotting process is initiated via the command:

```
$ START_PLOT
%RUN-S-PROC_ID, identification of created process is 00000243
Waiting for plotting process to initialize...
PLOT_CTD78 up and running
%DCL-I-SUPERSEDE, previous value of FOR009 has been superseded
CTD_PLOT> HELP           !to print the following menu
You may abbreviate commands to 3 characters.
```

```
axes     - draw axes with current parameters
end      - finish current plot segment, reset origin
exit     - exit to DCL, no change in plotting status
help     - print this menu
list     - list the current plot setup parameters
look     - look at a given range of scans
mod_par  - modify plotting parameters, plotting stops
pause    - stop plotting temporarily
plot     - start plotting
rate     - change plot rate, plotting continues
scan     - get current scan number
stop     - stop detached plotting process
CTD_PLOT> EXIT
$
```

If a **CTD78** plot session has been started and the user has returned to DCL (via the **EXIT** command), the command **$PCTD** may be used to return to the **CTD_PLOT** prompt.

Appendix F illustrates an **AQUI89** plotting session; figure 3.2.7 shows a sample **AQUI89** plot.

In order to change pen color between the down and up casts, the operator must pause the plotter and manually change the pens. To do this, press the PAUSE button on the ZETA plotter to stop the plotter temporarily, make the required pen changes, moving the carriage if necessary, then press the RETURN button to return the carriage to its original position and press the PAUSE button again to resume plotting.

3.3 Diagnostics

If the **CTD_GRAB** and **CTD_LOG** processes are running, the following activities should be observed under normal operation:

- if logging to tape, tape moves every few seconds, when writing a **CTD78** data record

- in the directory containing the archived disk data file (default **CTDROOT:[DATA]**), the **file_name.dat** for the current cast grows in size:
  `$ D FILE_NAME.RAW` (to get size of data file)
  wait ~1 minute, then
  `$ D FILE_NAME.RAW` (file size should be increasing)

- **GET_SCAN** will allow you to look at the data in the global section during acquisition. See Section 3.2.6 for operating instructions.

- during logging, you can double check that data is being transferred by typing:
  `$ SH SYS` (to get the process id number for **CTD_LOG**)
  `$ SHO PROC/ID=pid/CONT`
  The buffered I/O (BIO) and direct I/O (DIO) counts should both increase. The direct I/O increases will coincide with each tape write. To exit, type:
  `$ <CTRL> C` (hold down the CONTROL key and press C)

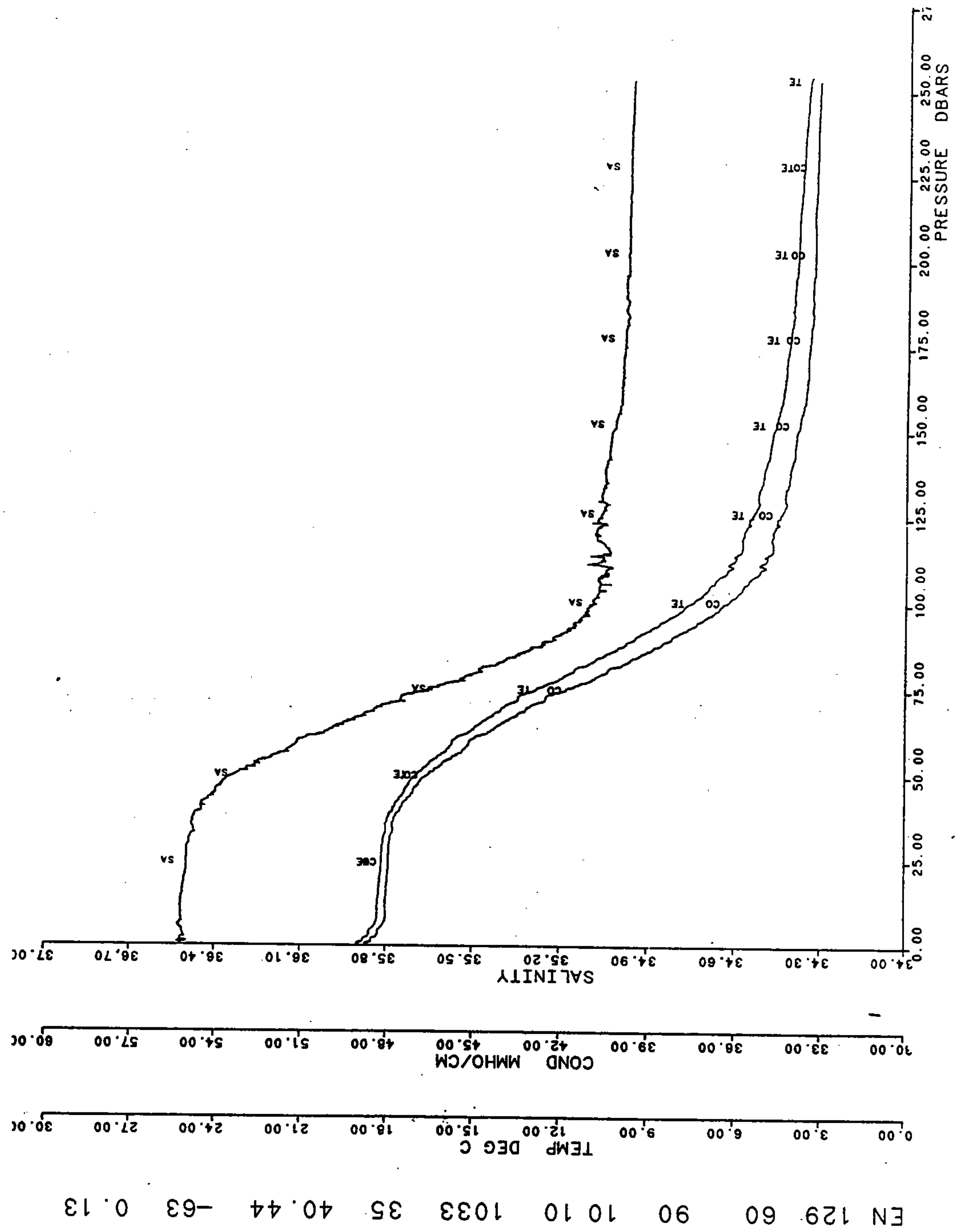

Figure 8: Sample AQUI89 plot