Woods Hole Oceanographic Institution

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

by

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Technical Report

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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 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
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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).
Available CTD Deck Units (binary mode only):
- MARK III (modified)
- 1150 (optional 9T tape)
- 1401

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):

\[ srate = \frac{1}{5 \text{ kHz}} \times (\text{number of bytes} + 1) \times 11 \text{ bits/byte} \leq \text{scan rate} \]

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 CTD 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 4M of memory)

The AQUI89 system consists of software modules which perform the following tasks:
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 allowing 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 WI00 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
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); 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):

<table>
<thead>
<tr>
<th>variable</th>
<th>type</th>
<th>description</th>
</tr>
</thead>
<tbody>
<tr>
<td>flags</td>
<td>unsigned 8-bit integer</td>
<td>indicates cast direction, frame synch error and record tag</td>
</tr>
<tr>
<td>pres</td>
<td>signed 24-bit integer</td>
<td>pressure</td>
</tr>
<tr>
<td>temp</td>
<td>signed 24-bit integer</td>
<td>temperature</td>
</tr>
<tr>
<td>cond</td>
<td>unsigned 16-bit integer</td>
<td>conductivity</td>
</tr>
<tr>
<td>oxyC</td>
<td>unsigned 16-bit integer</td>
<td>oxygen current</td>
</tr>
<tr>
<td>oxyT</td>
<td>signed 16-bit integer</td>
<td>oxygen temperature</td>
</tr>
</tbody>
</table>

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 CTDLOG. 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)
cccc = 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 ser
- 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 = 3-digit station number (eg. 0003)
cccc = 3-digit cast number (eg. 001)
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:

\[ \text{disk space (blocks)} = \text{time (hours)} \times 3116 \text{ blocks/hour} \]

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: CTD-AQUI

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.MMII DDD MM.MMII *
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.MMII DDD MM.MMII *
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.MM
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
CTD> STATION 33
CTD> CAST 1
CTD> DATA 0033A001.RAW
CTD> START-POS 34 15.ON 45 30.OI
CTD> PRINT 100
CTD> START
CTD> LOG
CTD> TAG
CTD> TAG
CTD> PAUSE
CTD> LOG
CTD> TAG
CTD> EXIT

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

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 preceding 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 15.0 10.3N 140.3 33.8W
CTD> EXIT
or:

$ CTD EPOS "15.0 10.3N 140.3 33.8W"

To end a cast, type

$ STOP_AQUI

30-DEC-1988 12:32:02.30: %CTDLOG-I-STOPPED, Station 33, Cast 1

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.TD_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 AQUI80 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 ZET 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.
If it appears that nothing is happening, try stopping the process (via **STOP.AQUI**) and starting it up again (via **START.AQUI**). If there is still a problem, check for diagnostic messages in the log file:

```
CTDROOT:[LOG]CTD78.AQUILOG
```

If all else fails, reboot the system and start over.

### 3.3.1 Data files

This section describes the data files that are created by AQUI89 and their location on the disk.

The directory `CTDROOT:[DATA]` (or the directory specified in **START.AQUI**) will contain the following files:

(eg for station 23, cast 1)

- `0023A001_RAW` - binary file in CTD78 disk file format, if logging to disk
- `0023A001.ERR` - ASCII file of error information - frame synch errors
- `0023A001.HED` - ASCII file of header information
- `0023A001.WRW` - ASCII file of tagged scans (raw)
- `0023A001.WSC` - ASCII file of tagged scans (scaled)

The files containing tagged scans are for merging with water sample data if desired. Values are an average of the num_water_samp (default=5) good scans preceding the tag.

After the **STOP.AQUI** command has been issued, the CTD78 disk data file may be reviewed using the program `R_CTD78_DISK`, invoked via the command:

```
$ READ_DISK
Enter file to read: CTDROOT:[DATA]0023A001.RAW
```

Appendix G shows an example of this program.

### 4 Notes on AQUI89 Version 1.0

**AQUI89** version 1.0 contains some special features which are described in this section.

The binary data that is output to the 9 track magnetic tape in CTD78 format is written to emulate an HP 16-bit word configuration, i.e. every two bytes on the VAX are swapped in order.

The conductivity calculation (subroutine **CON** uses a parameter (**ALPHA**) from the CTD78 scale factor record (attribute 1 of conductivity). This parameter is a negative number (default = -6.5e-6) in the CTD78 scale factor record and the equation used is:

\[
\text{COND} = \text{COND} \times (1.0 + \text{ALPHA} \times (\text{TEMP} - \text{CTZ}) + \text{BETA} \times (\text{PRES} - \text{CPZ}))
\]

In the **URI** portion of the code and in the configuration file `CTDROOT:[CONFIG]DEFAULT.CTD_CFG`, the parameter **ALPHA** is positive (default = 6.5e-6). The default value is defined in the file:

```
CTDROOT:[URISRC.LIBS]CTD_VARIABLES.H
```

The equivalent equation used is:

\[
\text{COND} = \text{COND} \times (1.0 - \text{ALPHA} \times (\text{TEMP} - \text{CTZ}) + \text{BETA} \times (\text{PRES} - \text{CPZ}))
\]
The results produced are the same, but the user should note carefully that the parameters are
signed correctly in the CTD78 scale factor record (negative) and in the configuration file (positive).
If this is not the case, the conductivity values listed using the CTD PRINT command (uses ALPHA from the configuration file) will not agree with the conductivity values from the GET_SCAN command (uses ALPHA from the CTD78 scale factor record), and at least one of them will be wrong!

In version 1.0 of AQUIS9, the configuration file is a binary file. It should only be modified by running the program CTD78_CONFIG, which creates the default configuration file from a template file.

There is a URI program, CTD_CONFIG, which allows the user to create a new configuration file but this program must be run on a VT100 terminal in order for the drop-down menus to work properly. Users of AQUIS9 should not find it necessary to run this program.

4.1 Known bugs

There is one known bug in the system that occurs infrequently. The CTD_LOG process will appear to start normally, but before data logging begins, the following message will appear:

% RUN-S-PROC_ID, identification of created process is 00000071
Waiting for AQUI process to initialize...
16-OCT-1990 10:58:37.72 CTDLOG-I-NEW, starting ...
% SYSTEM-W-NONEXPR, nonexistent process
\00000071
CTD_LOG up and running

Station number:

The CTD_LOG process receives commands from the CTD_CONTROL process via a system-wide mailbox, CTD_CONTROL_MAILBOX. If an extra STOP_AQUI command (or an extra CTD STOP) is issued, then the extra STOP command is stored in the command mailbox until the next time the CTD_LOG process is active. The STOP command is then the first command read from the mailbox, which causes the CTD_LOG process to immediately abort. A CLEAR_MBX command has been added to the START_AQUI command procedure to clear the system mailbox of any commands before the CTD_LOG process is initiated.

If this bug still occurs, there are three options to try:

- type the command: CLEAR_MBX
- type the command: START_AQUI again, assuming that the mailbox has now been flushed empty
- reboot the system
Appendices

A Template file

This appendix includes a listing of a sample template file, a description of the variables and an explanation of the special parameters stored in the template files.

A.1 Sample template file

Template file: CTDROOT:[TEMPLATE]CTD09.TPL

<table>
<thead>
<tr>
<th>CTD09</th>
<th>&quot;template file for CTD instrument # 9&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>32</td>
<td>&quot;project code&quot;</td>
</tr>
<tr>
<td>114</td>
<td>&quot;cruise number&quot;</td>
</tr>
<tr>
<td>OC</td>
<td>&quot;ship code (OC = Oceanus)&quot;</td>
</tr>
<tr>
<td>9</td>
<td>&quot;CTD instrument number&quot;</td>
</tr>
<tr>
<td>7</td>
<td>&quot;words/scan&quot;</td>
</tr>
<tr>
<td>3125</td>
<td>&quot;scan rate&quot;</td>
</tr>
<tr>
<td>10000</td>
<td>&quot;time unit frequency&quot;</td>
</tr>
<tr>
<td>7</td>
<td>&quot;# variables per data scan&quot;</td>
</tr>
<tr>
<td>34</td>
<td>&quot;descriptor length&quot;</td>
</tr>
<tr>
<td>5</td>
<td>&quot;# float values&quot;</td>
</tr>
<tr>
<td>5</td>
<td>&quot;number of scans for water sample file&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>v#</th>
<th>descrit</th>
<th>units</th>
<th>id</th>
<th>lag</th>
<th>win</th>
<th>qual</th>
<th>res</th>
<th>sensor</th>
<th>yr</th>
<th>mo</th>
<th>da</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>pressure</td>
<td>decibars</td>
<td>PR</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>38965</td>
<td>90</td>
<td>7</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>temp</td>
<td>deg Cel</td>
<td>TE</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>14279</td>
<td>90</td>
<td>7</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>cond</td>
<td>millimhos</td>
<td>CO</td>
<td>3</td>
<td>0</td>
<td>16</td>
<td>C86</td>
<td>90</td>
<td>7</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>sign ud</td>
<td>SW</td>
<td>3</td>
<td>0</td>
<td>-8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>oxy c</td>
<td>microamps</td>
<td>OC</td>
<td>156</td>
<td>0</td>
<td>12</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>oxy t</td>
<td>deg Cel</td>
<td>GT</td>
<td>156</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>quality</td>
<td>QU</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>v#</th>
<th>sb</th>
<th>wrd</th>
<th>sb</th>
<th>msk</th>
<th>lab</th>
<th>wrd</th>
<th>lab</th>
<th>msk</th>
<th>dig per</th>
<th>data msk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>177777</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>177777</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>177777</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7777</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>32</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>377</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>177777</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>v#</th>
<th>attribute 1</th>
<th>attribute 2</th>
<th>slope</th>
<th>bias</th>
<th>sens</th>
<th>lag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.933999E-08</td>
<td>-0.102206E-12</td>
<td>0.998763E-01</td>
<td>-0.178000E+02</td>
<td>0.000000E+00</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.282170E-11</td>
<td>0.000000E+00</td>
<td>0.499999E+03</td>
<td>-0.554621E-02</td>
<td>0.250000E+00</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.650000E-05</td>
<td>0.150000E-07</td>
<td>0.998550E-03</td>
<td>-0.995867E-02</td>
<td>0.000000E+00</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.280000E+01</td>
<td>0.300000E+04</td>
<td>0.100000E+01</td>
<td>0.000000E+00</td>
<td>0.000000E+00</td>
<td></td>
</tr>
</tbody>
</table>

33
Plot setup parameters

<table>
<thead>
<tr>
<th>id</th>
<th>axis</th>
<th>label</th>
<th>start val</th>
<th>end val</th>
<th>units/in</th>
<th>first dif</th>
<th>annot</th>
<th>int</th>
<th>p</th>
<th>cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>PRESSURE</td>
<td>DBARS</td>
<td>0.0000</td>
<td>4500.0000</td>
<td>250.0000</td>
<td>0.0000</td>
<td>0</td>
<td>0.0000</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>TE</td>
<td>TEMP</td>
<td>DEG C</td>
<td>0.0000</td>
<td>30.0000</td>
<td>3.0000</td>
<td>0.0000</td>
<td>1.0000</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>COND</td>
<td>MMHO/CM</td>
<td>30.0000</td>
<td>60.0000</td>
<td>3.0000</td>
<td>0.0000</td>
<td>1.0000</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td>SALINITY</td>
<td></td>
<td>33.0000</td>
<td>36.0000</td>
<td>0.3000</td>
<td>0.0000</td>
<td>1.0000</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>OX</td>
<td>OXYGEN</td>
<td></td>
<td>0.0000</td>
<td>6.0000</td>
<td>0.6000</td>
<td>0.0000</td>
<td>1.0000</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>
A.2 Variable descriptors

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>v#</td>
<td>relative position of the given variable in the scan</td>
</tr>
<tr>
<td>desc</td>
<td>variable label</td>
</tr>
<tr>
<td>units</td>
<td>physical units of variable</td>
</tr>
<tr>
<td>id</td>
<td>two-character ASCII tag for variable - must be unique</td>
</tr>
<tr>
<td>lag win</td>
<td>lag correction window</td>
</tr>
<tr>
<td>qual</td>
<td>quality flag</td>
</tr>
<tr>
<td>res</td>
<td>total number of bits for the variable, including sign bit and least significant bits (if any) with the following conventions:</td>
</tr>
<tr>
<td></td>
<td>&gt; if the item is a sensor variable, length is positive</td>
</tr>
<tr>
<td></td>
<td>&gt; if a non-sensor variable (sign word or lsb word), length is negative</td>
</tr>
<tr>
<td></td>
<td>&gt; if program-supplied, (quality word), length set to 0 but is actually 16 bits.</td>
</tr>
<tr>
<td>sensor</td>
<td>identification number of the sensor</td>
</tr>
<tr>
<td>yr</td>
<td>calibration date - year</td>
</tr>
<tr>
<td>mo</td>
<td>calibration date - month</td>
</tr>
<tr>
<td>da</td>
<td>calibration date - day</td>
</tr>
<tr>
<td>sb wrd</td>
<td>sign bit word - the location within the data scan of the sign bit word for this variable (=0 if no sign bit)</td>
</tr>
<tr>
<td>sb msk</td>
<td>sign bit mask - defines where in the sign bit word the sign bit for this variable is located. (=0 if no sb word)</td>
</tr>
<tr>
<td>lsb wrd</td>
<td>least significant bits word - the location within the data scan of the least significant bits word (=0 if no lsb word)</td>
</tr>
<tr>
<td>lsb msk</td>
<td>least significant bits mask - defines where in the least significant bits word any least significant bits for the variable are located (=0 if variable has no significant bits)</td>
</tr>
<tr>
<td>dig per</td>
<td>digitizing period - number of scans between actual data samples for this variable (e.g. dig per = 32 for oxygen current means data updated every second, at 31.25 Hz)</td>
</tr>
<tr>
<td>data msk</td>
<td>data mask - defines which bits in the magnetic tape word (always 16 bits) actually contain data</td>
</tr>
<tr>
<td>attribute 1</td>
<td>used for 2nd order corrections</td>
</tr>
<tr>
<td>attribute 2</td>
<td>used for 3rd order corrections</td>
</tr>
<tr>
<td>slope</td>
<td>slope to be applied to data</td>
</tr>
<tr>
<td>bias</td>
<td>bias (offset) to be applied to data</td>
</tr>
<tr>
<td>sens lag</td>
<td>sensor lag - time constant of sensor</td>
</tr>
<tr>
<td>plot setup parameters</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>---</td>
</tr>
<tr>
<td>id</td>
<td>two-character ASCII tag for variable (must be unique)</td>
</tr>
<tr>
<td>axis label</td>
<td>20-character ASCII string for plot axis label</td>
</tr>
<tr>
<td>start val</td>
<td>start data value, in physical units</td>
</tr>
<tr>
<td>end val</td>
<td>end data value, in physical units</td>
</tr>
<tr>
<td>units/inch</td>
<td>number of physical units per inch on plot</td>
</tr>
<tr>
<td>first dif</td>
<td>first difference check (not implemented in AQUI89 version 1.0)</td>
</tr>
<tr>
<td>annot int</td>
<td>annotation interval (inches)</td>
</tr>
<tr>
<td>p</td>
<td>plot type</td>
</tr>
<tr>
<td></td>
<td>blank = independent variable</td>
</tr>
<tr>
<td></td>
<td>l = line</td>
</tr>
<tr>
<td></td>
<td>p = point</td>
</tr>
<tr>
<td></td>
<td>s = Calcomp centered symbol</td>
</tr>
<tr>
<td>cs</td>
<td>Calcomp centered symbol (if plot type = s)</td>
</tr>
<tr>
<td></td>
<td>0 = square</td>
</tr>
<tr>
<td></td>
<td>1 = circle</td>
</tr>
<tr>
<td></td>
<td>2 = triangle</td>
</tr>
<tr>
<td></td>
<td>3 = plus (+)</td>
</tr>
<tr>
<td></td>
<td>4 = cross (x)</td>
</tr>
<tr>
<td></td>
<td>5 = diamond</td>
</tr>
</tbody>
</table>
A.3 Calculation parameters

The template file contains the conductivity cell geometry factors used to calculate salinity. Salinity is used in the calculation of various physical properties of sea water (Fofonoff and Millard, 1978). These parameters are read from the template file at run time and stored in the shared common area. They are also written to the CTD78 format scale factor record (Millard, et. al., 1978) on tape and/or disk. The parameters are stored as follows:

<table>
<thead>
<tr>
<th>Conductivity constants (Fofonoff, et al., 1974)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>variable</strong></td>
</tr>
<tr>
<td>alpha (variable cona in subroutine con)</td>
</tr>
<tr>
<td>beta (variable conb in subroutine con)</td>
</tr>
<tr>
<td>T (variable ctz in subroutine con)</td>
</tr>
<tr>
<td>P (variable cpz in subroutine con)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Oxygen calculation (Owens and Millard, 1985)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>variable</strong></td>
</tr>
<tr>
<td>Pc (variable oxpc in subroutine oxyg)</td>
</tr>
<tr>
<td>Tc (variable oxct in subroutine oxyg)</td>
</tr>
<tr>
<td>C1 (variable oxc1 in subroutine oxyg)</td>
</tr>
<tr>
<td>C2 (variable oxc2 in subroutine oxyg)</td>
</tr>
</tbody>
</table>
## Ranges for CTD variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Units</th>
<th>Resolution</th>
<th>Oceanic Minimum</th>
<th>Range Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRES</td>
<td>decibars</td>
<td>xxxx.x</td>
<td>0.0</td>
<td>6500.0</td>
</tr>
<tr>
<td>TEMP</td>
<td>Celcius</td>
<td>-xx.xxxx</td>
<td>-2.0</td>
<td>30.0</td>
</tr>
<tr>
<td>COND</td>
<td>MMIO/CM</td>
<td>xx.xxx</td>
<td>30.0</td>
<td>60.0</td>
</tr>
<tr>
<td>SALT</td>
<td>PPS78</td>
<td>xx.xxxx</td>
<td>2.0</td>
<td>42.0</td>
</tr>
<tr>
<td>OXYG</td>
<td>ML/L</td>
<td>xx.xx</td>
<td>0.0</td>
<td>10.0</td>
</tr>
<tr>
<td>OXCU</td>
<td>M AMP</td>
<td>x.xxx</td>
<td>0.0</td>
<td>3.0</td>
</tr>
<tr>
<td>OXTM</td>
<td>Celcius</td>
<td>-xx.x</td>
<td>-2.0</td>
<td>30.0</td>
</tr>
</tbody>
</table>
C Sample logging session

Welcome to MicroVMS V5.3
This is a CTD GROUP MicroVax
CTD03 SYSTEM

Username: CTDAQUI
Password:

Last interactive login on Friday, 23-FEB-1990 08:40
Last non-interactive login on Thursday, 28-DEC-1989 15:29
23-FEB-1990 08:44:22
$ init msa0: ctdaqu
$ start_aqui
%DCL-I-SUPERSEDE, previous value of USER_TERM has been superseded

killing the print queue

%DCL-I-ALLOC, _CTD03$TTA2: allocated

Enter the CTD instrument number: 1
%DCL-I-SUPERSEDE, previous value of TEMPLATE_FILE has been superseded
CTDROOT:[TEMPLATE]CTDO1.TPL
Creating configuration file...

*** configuration file created: CTDCFG:DEFAULT.CTD_CFG
Logging to mag tape? (y/n): y

Enter mag tape device (eg. msa0): msa0:
%DCL-I-SUPERSEDE, previous value of CTD_MOUNT_DEVICE has been superseded

Mount tape on MSA0:, type <ret> when ready:

Logging to disk file? (y/n): y
Default data directory is CTDROOT:[DATA]
CTD_Log up and running

Station number: 60
Cast number: 0
Logging to disk file: CTDROOT:DATA\0060A000.RAW
Start latitude degrees (DD): 35
Start latitude minutes and hemisphere (MM.MMH): 40.44n
Start longitude degrees (DDD): 63
Start longitude minutes and hemisphere (MM.MMH): 013w

When ready, put CTD in water.
At the $ prompt, type CTD LOG to start logging data.

Enter the command STOP_AQUI to terminate the cast and perform post-cast operations.

$ ctd log
23-FEB-1990 08:47:02.33: %CTDLOG-I-LOGGING, Station 60, Cast 0
$ ctd print 1875
23-FEB-1990 09:00:00.40: %CTDLOG-W-MAXCAST, maximum specified cast duration reached.
23-FEB-1990 09:00:02.64: -CTDLOG-W-BADSEC, global section data is now corrupted.
$
23-FEB-1990 10:24:23.64: %CTDLOG-I-TAG, tagged scan 131222
23-FEB-1990 10:27:56.36: %CTDLOG-I-TAG, tagged scan 136039
23-FEB-1990 10:30:39.94: %CTDLOG-I-TAG, tagged scan 139678
23-FEB-1990 10:36:25.67: %CTDLOG-I-TAG, tagged scan 147372
23-FEB-1990 10:42:01.92: %CTDLOG-I-TAG, tagged scan 154904
$ stop_aqui
23-FEB-1990 10:46:30.62: %CTDLOG-I-STOPPED, Station 60, Cast 0
VAX/VMS V4.4 on node CTD03 23-FEB-1990 10:46:47.64 Uptime 021:51:25

<table>
<thead>
<tr>
<th>Pid</th>
<th>Process Name</th>
<th>State</th>
<th>Pri</th>
<th>I/O</th>
<th>CPU</th>
<th>Page</th>
<th>flts</th>
<th>Ph.Mem</th>
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<tbody>
<tr>
<td>00000010</td>
<td>NULL</td>
<td>COM</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>20:51:07.28</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>00000011</td>
<td>SWAPPER</td>
<td>HIB</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>00:00:03.58</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>00000042</td>
<td>CTD_AQUI,RTA1</td>
<td>CUR</td>
<td>4</td>
<td>1105</td>
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<td>00:01:21.87</td>
<td>4432</td>
<td>321</td>
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<td>HIB</td>
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<td>1618</td>
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<td>2586</td>
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<td>839</td>
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<td>90</td>
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<td>00000016</td>
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<td>LEF</td>
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<td>LEF</td>
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<td>12707</td>
<td>123</td>
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<td>CTD_GRAB</td>
<td>CEF</td>
<td>9</td>
<td>14305</td>
<td>0</td>
<td>00:00:32.46</td>
<td>3155</td>
<td>200</td>
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<td>0000001A</td>
<td>METACP</td>
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<td>65</td>
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<td>00:00:15.13</td>
<td>265</td>
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<td>REMACP</td>
<td>HTB</td>
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<td>41</td>
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<td>00:00:00.25</td>
<td>73</td>
<td>42</td>
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</table>

printer is not spooled - starting print queue
$ lo
CTDAQUI logged out at 23-FEB-1990 10:53:05.23
<table>
<thead>
<tr>
<th>State</th>
<th>Acid</th>
<th>Base</th>
<th>Cond</th>
<th>Salt</th>
<th>Ox/C</th>
<th>Ox/V</th>
<th>D.I.</th>
<th>Brine</th>
<th>PdF</th>
<th>Filter</th>
<th>Flux</th>
<th>Flow</th>
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<tbody>
<tr>
<td>Albed</td>
<td>10.1</td>
<td>18.20</td>
<td>49.23</td>
<td>59.78</td>
<td>26.28</td>
<td>18.2</td>
<td>5.00</td>
<td>107.5</td>
<td>161.0</td>
<td>-48.5</td>
<td>-48.4</td>
<td>-48.3</td>
</tr>
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<td>5.00</td>
<td>107.5</td>
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<td>59.78</td>
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<td>18.2</td>
<td>5.00</td>
<td>107.5</td>
<td>161.0</td>
<td>-48.5</td>
<td>-48.4</td>
<td>-48.3</td>
</tr>
</tbody>
</table>
E  Sample terminal output

The GET_SCAN program allows the user to view data in the global section during acquisition. This program must map to the CTDGBL global section and therefore can only run if the CTD.LOG process is active.

$ get-scan
Output to a disk file as well as terminal (y/n)? n
maximum # scans in global section: 18750

Global section has wrapped around 3 times.
Scans 1 - 39563 have been overwritten.

current scan: 58313  Logging time (secs): 1866.016
Logging time: 0:31:6.02

Enter start, end, increment (0,0,0 to end): 50000 60000 1000

<table>
<thead>
<tr>
<th>scan num</th>
<th>FR</th>
<th>TE</th>
<th>CO</th>
<th>OC</th>
<th>OT</th>
<th>SA</th>
<th>OX</th>
<th>PT</th>
<th>SV</th>
<th>DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>50000 D</td>
<td>2534.73</td>
<td>3.549</td>
<td>33.199</td>
<td>0.643</td>
<td>4.35</td>
<td>34.967</td>
<td>5.879</td>
<td>3.3</td>
<td>1506.8</td>
<td>2501.2</td>
</tr>
<tr>
<td>51000 D</td>
<td>2598.12</td>
<td>3.451</td>
<td>33.130</td>
<td>0.634</td>
<td>4.22</td>
<td>34.960</td>
<td>5.886</td>
<td>3.2</td>
<td>1507.5</td>
<td>2563.4</td>
</tr>
<tr>
<td>52000 D</td>
<td>2663.33</td>
<td>3.362</td>
<td>33.072</td>
<td>0.628</td>
<td>4.10</td>
<td>34.955</td>
<td>5.919</td>
<td>3.1</td>
<td>1508.2</td>
<td>2627.3</td>
</tr>
<tr>
<td>53000 D</td>
<td>2728.83</td>
<td>3.324</td>
<td>33.061</td>
<td>0.619</td>
<td>4.10</td>
<td>34.953</td>
<td>5.895</td>
<td>3.1</td>
<td>1509.2</td>
<td>2691.5</td>
</tr>
<tr>
<td>54000 D</td>
<td>2793.73</td>
<td>3.241</td>
<td>33.009</td>
<td>0.613</td>
<td>3.97</td>
<td>34.949</td>
<td>5.925</td>
<td>3.0</td>
<td>1509.9</td>
<td>2755.1</td>
</tr>
<tr>
<td>55000 D</td>
<td>2857.83</td>
<td>3.191</td>
<td>32.987</td>
<td>0.607</td>
<td>3.97</td>
<td>*** Lost scan error ***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56000 D</td>
<td>2922.44</td>
<td>3.132</td>
<td>32.956</td>
<td>0.598</td>
<td>3.97</td>
<td>34.943</td>
<td>5.905</td>
<td>2.9</td>
<td>1511.6</td>
<td>2881.2</td>
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<tr>
<td>57000 D</td>
<td>2986.94</td>
<td>3.106</td>
<td>32.958</td>
<td>0.592</td>
<td>3.84</td>
<td>34.944</td>
<td>5.922</td>
<td>2.9</td>
<td>1512.6</td>
<td>2944.3</td>
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<tr>
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<td>32.922</td>
<td>0.586</td>
<td>3.71</td>
<td>34.940</td>
<td>5.945</td>
<td>2.8</td>
<td>1513.4</td>
<td>3006.9</td>
</tr>
<tr>
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<td>3.020</td>
<td>32.925</td>
<td>0.577</td>
<td>3.58</td>
<td>34.939</td>
<td>5.927</td>
<td>2.8</td>
<td>1514.4</td>
<td>3068.1</td>
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<td>60000 D</td>
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<td>2.976</td>
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<td>0.571</td>
<td>3.58</td>
<td>34.937</td>
<td>5.926</td>
<td>2.7</td>
<td>1515.3</td>
<td>3129.9</td>
</tr>
</tbody>
</table>

Global section has wrapped around 3 times.
Scans 1 - 41250 have been overwritten.

current scan: 60000  Logging time (secs): 1927.000
Logging time: 0:32:0.00

Enter start, end, increment (0,0,0 to end): 0 0 0
FORTRAN STOP
$

$ get-scan
Output to a disk file as well as terminal (y/n)? n
maximum # scans in global section: 18750

Global section has wrapped around 8 times.
Scans 1 - 140349 have been overwritten.

43
current scan: 159009 Logging time (secs): 5091.168
Logging time: 1:24:51.17

Enter start, end, increment (0,0,0 to end): 158000 159000 100

<table>
<thead>
<tr>
<th>scan num</th>
<th>PR</th>
<th>TE</th>
<th>CO</th>
<th>OC</th>
<th>OT</th>
<th>SA</th>
<th>OX</th>
<th>PT</th>
<th>SV</th>
<th>DE</th>
</tr>
</thead>
<tbody>
<tr>
<td>158000</td>
<td>U</td>
<td>182.19</td>
<td>18.223</td>
<td>47.968</td>
<td>1.712</td>
<td>16.90</td>
<td>36.509</td>
<td>5.309</td>
<td>18.2</td>
<td>1521.2</td>
</tr>
<tr>
<td>158100</td>
<td>U</td>
<td>182.69</td>
<td>18.223</td>
<td>47.969</td>
<td>1.700</td>
<td>17.02</td>
<td>36.510</td>
<td>5.256</td>
<td>18.2</td>
<td>1521.2</td>
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<tr>
<td>158200</td>
<td>U</td>
<td>183.39</td>
<td>18.222</td>
<td>47.968</td>
<td>1.670</td>
<td>17.15</td>
<td>36.509</td>
<td>5.147</td>
<td>18.2</td>
<td>1521.2</td>
</tr>
<tr>
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<td>U</td>
<td>183.19</td>
<td>18.222</td>
<td>47.968</td>
<td>1.682</td>
<td>17.15</td>
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<td>5.184</td>
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<td>1521.2</td>
</tr>
<tr>
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<td>U</td>
<td>180.79</td>
<td>18.223</td>
<td>47.968</td>
<td>1.700</td>
<td>17.28</td>
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<td>5.222</td>
<td>18.2</td>
<td>1521.1</td>
</tr>
<tr>
<td>158500</td>
<td>U</td>
<td>175.89</td>
<td>18.230</td>
<td>47.974</td>
<td>1.727</td>
<td>17.28</td>
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<td>1521.1</td>
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<tr>
<td>158600</td>
<td>U</td>
<td>169.40</td>
<td>18.252</td>
<td>48.001</td>
<td>1.749</td>
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<td>36.516</td>
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<td>163.81</td>
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<td>17.41</td>
<td>*** Range error ***</td>
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<td>1.779</td>
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<td>5.394</td>
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<td>1520.7</td>
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</table>

Global section has wrapped around 8 times.
Scans 1 - 140349 have been overwritten.

current scan: 159009 Logging time (secs): 5091.168
Logging time: 1:24:51.17

Enter start, end, increment (0,0,0 to end): 140500 150000 500

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<tr>
<th>scan num</th>
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<th>TE</th>
<th>CO</th>
<th>OC</th>
<th>OT</th>
<th>SA</th>
<th>OX</th>
<th>PT</th>
<th>SV</th>
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<td>35.028</td>
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<td>0.683</td>
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<td>35.061</td>
<td>4.562</td>
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<td>35.096</td>
<td>4.164</td>
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<td>35.131</td>
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<td>35.558</td>
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<td>41.170</td>
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<td>7.42</td>
<td>35.576</td>
<td>3.571</td>
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<td>12.225</td>
<td>41.162</td>
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<td>783.45</td>
<td>13.092</td>
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<td>8.58</td>
<td>35.712</td>
<td>3.645</td>
<td>13.0</td>
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<td>U</td>
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<td>14.157</td>
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<td>0.864</td>
<td>9.22</td>
<td>35.891</td>
<td>3.896</td>
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</tbody>
</table>
Global section has wrapped around 8 times.
Scans 1 - 140349 have been overwritten.

current scan: 159099 Logging time (secs): 5091.168
Logging time: 1:24:51.17

Enter start, end, increment (0,0,0 to end): 0 0 0
FORTRAN STOP
$
F Sample AQUI89 plotting session

$ START_PLOT
%RUN-S-PROC_ID, identification of created process is 0000001E
Waiting for plot process to initialize...

PLOT_CTD78 up and running

CTD_PLOT> LIS

Current plot/print setup parameters
Plot factor: 1.0
Plot interval: 10
Start plotting at scan # 1
Number of plot variables: 3

<table>
<thead>
<tr>
<th>id</th>
<th>axis label</th>
<th>start val</th>
<th>end val</th>
<th>units/in</th>
<th>first dif</th>
<th>annot</th>
<th>int</th>
<th>p</th>
<th>cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR</td>
<td>PRESSURE DBARS</td>
<td>0.0000</td>
<td>4500.0000</td>
<td>250.0000</td>
<td>0.0000</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE</td>
<td>TEMPERATURE DEG C</td>
<td>0.0000</td>
<td>30.0000</td>
<td>3.0000</td>
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<td>1</td>
<td>1</td>
<td>-1</td>
<td></td>
</tr>
<tr>
<td>SA</td>
<td>SALINITY</td>
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<td>37.0000</td>
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<td>1</td>
<td>1</td>
<td>-1</td>
<td></td>
</tr>
</tbody>
</table>

CTD_PLOT> LOD

Current scan number is 2351
Enter start,end,inc for scans to examine (0.0,0 to end): 700 1000 100

<table>
<thead>
<tr>
<th>scan num</th>
<th>pres</th>
<th>temp</th>
<th>cond</th>
<th>oxy c</th>
<th>oxy t</th>
<th>oxyg</th>
<th>ptmp</th>
<th>sal</th>
<th>svel</th>
<th>depth</th>
</tr>
</thead>
<tbody>
<tr>
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<td>4.2</td>
<td>18.993</td>
<td>48.705</td>
<td>1.887</td>
<td>19.584</td>
<td>5.237</td>
<td>18.993</td>
<td>36.520</td>
<td>1520.4</td>
</tr>
<tr>
<td>800</td>
<td>D</td>
<td>4.1</td>
<td>18.993</td>
<td>48.705</td>
<td>1.891</td>
<td>19.584</td>
<td>5.245</td>
<td>18.993</td>
<td>36.520</td>
<td>1520.4</td>
</tr>
<tr>
<td>900</td>
<td>D</td>
<td>3.9</td>
<td>18.993</td>
<td>48.705</td>
<td>1.872</td>
<td>19.712</td>
<td>5.178</td>
<td>18.993</td>
<td>36.520</td>
<td>1520.4</td>
</tr>
<tr>
<td>1000</td>
<td>D</td>
<td>4.1</td>
<td>18.994</td>
<td>48.705</td>
<td>1.894</td>
<td>19.584</td>
<td>5.253</td>
<td>18.993</td>
<td>36.520</td>
<td>1520.4</td>
</tr>
</tbody>
</table>

Current scan number is 2788
Enter start,end,inc for scans to examine (0.0,0 to end): 0 0 0

CTD_PLOT> MOD

Plotting setup menu

h: print this menu
i: specify the independent variable
d: specify a dependent variable
r: remove a plot variable
p: specify a plot factor
s: specify plot sample interval
l: list the active plot variables and parameters
n: change the start scan number
q: quit (done)
Enter option: i  (modifying the axis limits for pressure)

Available variable IDs:
PR TE CO OC OT SA PT DE ST SV OX
Enter id for independent variable: PR
Enter axis label (max 20 chars): PRESSURE DBARS
Enter start value, end value, units/inch: 0,5000,250
Enter 1st difference maximum (0 = no check): 0

Enter option: d  (adding a dependent variable - CO)

Available variable IDs:
PR TE CO OC OT SA PT DE ST SV OX
Enter id for dependent variable: CO
Enter axis label (max 20 chars): COND MMHO/CM
Enter start value, end value, units/inch: 30,60,3
Enter 1st difference maximum (0 = no check): 0
Enter annotation interval (inches): 1
Enter plot type (p=point,l=line,s=symbol): 1

Enter option: d  (adding a dependent variable - OX)

Available variable IDs:
PR TE CO OC OT SA PT DE ST SV OX
Enter id for dependent variable: OX
Enter axis label (max 20 chars): OXYGEN
Enter start value, end value, units/inch: 0,6,.6
Enter 1st difference maximum (0 = no check): 0
Enter annotation interval (inches): 1
Enter plot type (p=point,l=line,s=symbol): s
Enter CALCOMP symbol number: 3

Enter option: r  (removing a variable - SA)
Enter id for plot variable to remove: SA

Enter option: p
Enter plot factor (  1.0): 1

Enter option: s
Enter plot interval (  10): 100
Enter print interval ( 100): 100

Enter option: 1

Current plot/print setup parameters
Plot factor: 1.000000
Plot interval: 100
Start plotting at scan # 1

47
Number of plot variables: 4

id      axis label  start val  end val  units/in  first dif  annot  int  p  cs
PR      PRESSURE DBARS  0.0000  4500.0000  250.0000  0 0000  0 0000  0 0
TE      TEMP DEG C  0.0000  30.0000  3.0000  0.0000  1.0000  1 -1
CD      COND MMHO/CM  30.0000  60.0000  3.0000  0.0000  1.0000  1 -1
OX      OXYGEN  0.0000  6.0000  0.6000  0.0000  1.0000  s  3

Enter option: q

Initialization of plot/print parameters complete.
Plot parameters have been modified, enter the command AXES and PLOT to begin the next plot.
Last scan plotted: 0
Current scan number is 33559

CTD_PLOT> AXE       !note that axes may be plotted prior to data logging but the CTD_LOG detached process must be running before any plotting may begin

CTD_PLOT> PLO       !starting a new plot

Plot options:
0 plot from current scan
1 plot from beginning of cast
N plot from scan number N
Enter plot option: 1000

CTD_PLOT> EXIT       !exit the interactive plot process, return to DCL

$ <<< do anything here - edit files, etc. >>>

$ PCTD       !to return to interactive plot process

CTD_PLOT> PAUSE     !plotting will be temporarily interrupted, key in the PLO command to continue plotting or the END command to finish the current plot

CTD_PLOT> RAT
Current plot interval is 10 scans
Enter new plot interval (scans): 100

CTD_PLOT> SCA
Current scan number is 40442

CTD_PLOT> PLO
Plot options:
c: continue plotting from current scan (gap)
p: continue from where pause started (no gap)
Enter option: C

CTD_PLOT> END

CTD_PLOT> STO

Background plotting process terminated, Type EXIT to return to command level.

CTD_PLOT> EXI

$ (returned to DCL)
G Reading a CTD78 disk data file

$ sddata
$ read_disk
Enter data filename: 0060a001.raw
%DCL-I-SUPERSEDE, previous value of SYS$INPUT has been superseded
Print station header? (y/n): y

Station header:
words per scan: 7
station #: 60
cast #: 1
ship code: EN
Print scale factor record? (y/n): y

Scale factor record:
keyword: -4
number of variables: 7
descriptor length: 34
words per scan: 7
number of float values: 5

variable, id, attr_1, attr_2, slope, bias
1 PR 0.933999E-08 -.102206E-12 0.998763E-01 -.178000E+02
2 TE 0.282170E-11 0.000000E+00 0.499916E-03 -.554621E-02
3 CO -.650000E-05 0.150000E-07 0.998550E-03 -.995867E-02
4 SW 0.280000E+01 0.300000E+04 0.100000E+01 0.000000E+00
5 DC -.325000E+01 0.139500E-03 0.302000E-02 0.000000E+00
6 OT 0.750000E+00 0.000000E+00 0.128000E+00 0.000000E+00
7 QU 0.000000E+00 0.000000E+00 0.100000E+01 0.000000E+00
Read data records? (y/n): y
Convert raw data to physical units? (y/n): y

Reading data header records and data records

Enter record number to read (0 to end): 1
Data records start at record #3
Enter record number to read (0 to end): 3

Data header record at record # 3
Enter record number to read (0 to end): 4
<table>
<thead>
<tr>
<th>scan #</th>
<th>PR</th>
<th>TE</th>
<th>CO</th>
<th>SW</th>
<th>OC</th>
<th>OT</th>
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</thead>
<tbody>
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Enter record number to read (0 to end): 200
Data record, irec # 200: 146 scans
Enter start,end,inc scans: 1 146 20

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<th>OC</th>
<th>OT</th>
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<tr>
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<tr>
<td>141</td>
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<td>6.720</td>
<td>35.561</td>
<td>0.00</td>
<td>0.735</td>
<td>12.6</td>
</tr>
</tbody>
</table>

Enter record number to read (0 to end): 600
Errans # 36 on unit 11
Attempt to read beyond end-of-file
Enter record number to read (0 to end): 584
Data record, irec # 584: 146 scans
Enter start,end,inc scans: 1 146 20

<table>
<thead>
<tr>
<th>scan #</th>
<th>PR</th>
<th>TE</th>
<th>CO</th>
<th>SW</th>
<th>OC</th>
<th>OT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4186.1</td>
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<td>0.471</td>
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</tr>
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<td>41</td>
<td>4185.5</td>
<td>2.342</td>
<td>32.673</td>
<td>0.00</td>
<td>0.474</td>
<td>2.8</td>
</tr>
<tr>
<td>61</td>
<td>4185.5</td>
<td>2.343</td>
<td>32.671</td>
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</tr>
<tr>
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<td>-32.762</td>
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<td>255.00</td>
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<td>65.433</td>
<td>255.00</td>
<td>12.375</td>
<td>-32.7</td>
</tr>
<tr>
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<td>-32.762</td>
<td>65.433</td>
<td>255.00</td>
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<td>-32.7</td>
</tr>
<tr>
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<td>-6494.3</td>
<td>-32.762</td>
<td>65.433</td>
<td>255.00</td>
<td>12.375</td>
<td>-32.7</td>
</tr>
</tbody>
</table>

Enter record number to read (0 to end): 0

FORTRAN STOP
<< Note: last four records output represent the default data values used to fill the CTD78 disk data file records >>>

$ read_disk
Enter data filename: 0060a001.raw

%DCL-I-SUPERSEDE, previous value of FOR011 has been superseded
%DCL-I-SUPERSEDE, previous value of SYS$INPUT has been superseded
Print station header? (y/n): y  
Station header:
  words per scan: 7
  station #: 60
  cast #: 1
  ship code: EN  
Print scale factor record? (y/n): y  
Scale factor record:
  keyword: -4
  number of variables: 7
  descriptor length: 34
  words per scan: 7
  number of float values: 5

variable, id, attr_1, attr_2, slope, bias  
1 PR 0.933999E-08 -1.02206E-12 0.998763E-01 -.178000E+02
2 TE 0.282170E-11 0.000000E+00 0.499916E-03 -.554621E-02
3 CO -.650000E-05 0.150000E-07 0.998550E-03 -.995867E-02
4 SW 0.280000E+01 0.300000E+04 0.100000E+01 0.000000E+00
5 OC -.325000E-01 0.139500E-03 0.302000E-02 0.000000E+00
6 OT 0.750000E+00 0.000000E+00 0.128000E+00 0.000000E+00
7 QU 0.000000E+00 0.000000E+00 0.100000E+01 0.000000E+00

Read data records? (y/n): y  
Convert raw data to physical units? (y/n): n  

Reading data header records and data records

Enter record number to read (0 to end): 584
Data record, irec # 584: 146 scans
Enter start, end, inc scans: 1 146 20

<table>
<thead>
<tr>
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<th>TE</th>
<th>CO</th>
<th>SW</th>
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<td>157</td>
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<tr>
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<td>4692</td>
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<td>156</td>
<td>22</td>
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<tr>
<td>41</td>
<td>41996</td>
<td>4693</td>
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<td>0</td>
<td>156</td>
<td>22</td>
</tr>
<tr>
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<td>4693</td>
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<td>0</td>
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<td>21</td>
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<tr>
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<td>-65535</td>
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<td>-65535</td>
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<td>255</td>
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<td>-256</td>
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<td>-65535</td>
<td>-65535</td>
<td>65535</td>
<td>255</td>
<td>4096</td>
<td>-256</td>
</tr>
</tbody>
</table>
141  -65535.  -65535.  65535.  255.  4096.  -256.
Enter record number to read (0 to end): 0
FORTRAN STOP
<<< Note: last four records output represent the default data values
     used to fill the CTD78 disk data file records >>>
$
H Sample output files from AQUI89 logging session

H.1 Log file

This appendix shows a sample log file created during a re-run of ENDEAVOR 129 Station 39. The AQUI89 program was run using analog cassette tapes played through the CTD deck unit, to simulate a real CTD cast.

The maximum size of the global section was set to 10 minutes, so that this log file would illustrate the messages that occur when the global section wraps-around.

$ if .not.f$trnlm("WHOI_VERIFY") then set noverify 'stop syslogin.com pr'nting
%DCL-W-SKPDAT, image data (records not beginning with "$") ignored
%SET-I-NEWLIMS, new working set: Limit = 149 Quota = 298 Extent = 298
"USER_TERM" = "_CTD03$CPAO:" (LNMPGROUP_000300)
"CTD_MOUNTDEVICE" = "MSAO:" (LNMPGROUP_000300)
"DATA_DIR" = "CTDROOT:[DATA]" (LNMPGROUP_000300)
%MOUNT-I-MOUNTED, CTDAGU mounted on _MSAO:
Enter tape device (msao:):
channel # 176 assigned to tape.
Only 80 bytes read, must be a new tape!
*** NEW TAPE ***
Writing EOF to tape...
Rewinding tape...
FORTTRAN STOP

"TEMPLATE_FILE" = "CTDROOT:[TEMPLATE]CTD01.TPL" (LNMPGROUP_000300)
%DCL-I-SUPERSEDE, previous value of ERROR_CODE has been superseded

CTD_LOG X4.01 - Background CTD Data Conversion and Logging Task
University of Rhode Island Graduate School of Oceanography
Nov 29 1989 16:10:03

Fish scan 10 bytes long.
Data scan 13 bytes long.
Max data capacity 18750 scans, or 10 minutes at 31.25 scans/sec.
Logging data in WHOI CTD78 format.

Logging 6 variables:
Status Flags
Pressure
Temperature
Conductivity
Oxygen Sensor Current
Oxygen Sensor Temperature

*** subroutine init_ctd78 ***
(ctd78_trnlm) logical name CTD_MOUNTDEVICE is assigned to: MSAO:
(read_template) plot parameters
num_plot_var: 5
Command: CTD_LOG001 0060A000.RAW Status: 1
Command: Status: 1
Command: CTD_LOG026 60 Status: 1
Command: Status: 1
Command: CTD_LOG027 0 Status: 1
Command: Status: 1
Command: CTD_LOG011 Status: 1
Command: Status: 1

*** subroutine start_cast_ctd78 ***
%INFO: START, Station 60. Cast 0
Command: CTD_LOG024 35 40.44N 63 00.13W Status: 1
Command: Status: 1
%INFO: POS, Start Lat: 035 40.44N Lon: 063 00.13W
%INFO: LOGGING, Station 60, Cast 0
*** subroutine start_log_ctd78 ***
(write_tape_h) channel # 416 assigned to tape.
*** subroutine write_scan_ctd78 ***
Command: CTD_LOG013 Status: 1
Command: Status: 1
%INFO: LOGGING, Station 60, Cast 0
Command: CTD_LOG004 1875 Status: 1
Command: Status: 1
Wrapping around on global section at scan #: 18750
%WARNING: MAXCAST, maximum specified cast duration reached.
-WARNING: BADSEC, global section data is now corrupted.
Wrapping around on global section at scan #: 37500
Wrapping around on global section at scan #: 56250
Wrapping around on global section at scan #: 75000
%INFO: TAG, tagged scan 76486
(write_scan) tagged scan # 76486 flags = 54 record tag = 1
Subroutine write_tag78, version of 20 December 1989
%INFO: TAG, tagged scan 78391
(write_scan) tagged scan # 78391 flags = 6 record tag = 2
%INFO: TAG, tagged scan 82458
(write_scan) tagged scan # 82458 flags = 54 record tag = 3
%INFO: TAG, tagged scan 86350
(write_scan) tagged scan # 86350 flags = 23 record tag = 4
%INFO: TAG, tagged scan 90121
(write_scan) tagged scan # 90121 flags = 6 record tag = 5
Wrapping around on global section at scan #: 93750
%INFO: TAG, tagged scan 93848
(write_scan) tagged scan # 93848 flags = 7 record tag = 6
%INFO: TAG, tagged scan 97564
(write_scan) tagged scan # 97564 flags = 6 record tag = 7
%INFO: TAG, tagged scan 101294
(write_scan) tagged scan # 101294 flags = 6 record tag = 8
%INFO: TAG, tagged scan 104875
(write_scan) tagged scan # 104875 flags = 6 record tag = 9
%INFO: TAG, tagged scan 108482
(write_scan) tagged scan # 108482 flags = 6 record tag = 10
%INFO: TAG, tagged scan 112137
(write_scan) tagged scan # 112137 flags = 6 record tag = 11
Wrapping around on global section at scan #: 112500
%INFO: TAG, tagged scan 115759
(write_scan) tagged scan # 115759 flags = 6 record tag = 12
%INFO: TAG, tagged scan 119663
(write_scan) tagged scan # 119663 flags = 7 record tag = 13
%INFO: TAG, tagged scan 123532
(write_scan) tagged scan # 123532 flags = 7 record tag = 14
%INFO: TAG, tagged scan 127265
(write_scan) tagged scan # 127265 flags = 6 record tag = 15
%INFO: TAG, tagged scan 131222
(write_scan) tagged scan # 131222 flags = 6 record tag = 16
Wrapping around on global section at scan #: 131250
%INFO: TAG, tagged scan 136039
(write_scan) tagged scan # 136039 flags = 7 record tag = 17
%INFO: TAG, tagged scan 139678
(write_scan) tagged scan # 139678 flags = 6 record tag = 18
%INFO: TAG, tagged scan 143431
(write_scan) tagged scan # 143431 flags = 6 record tag = 19
%INFO: TAG, tagged scan 147372
(write_scan) tagged scan # 147372 flags = 7 record tag = 20
Wrapping around on global section at scan #: 150000
%INFO: TAG, tagged scan 151096
(write_scan) tagged scan # 151096 flags = 6 record tag = 21
%INFO: TAG, tagged scan 154904
(write_scan) tagged scan # 154904 flags = 7 record tag = 22
%INFO: TAG, tagged scan 157114
(write_scan) tagged scan # 157114 flags = 7 record tag = 23
Command: CTD_LOG012 Status: 1
Command: Status: 1
*** subroutine end_cast_ctd78 ***
(end_cast) start position:
latitude: 35.67
longitude: -63.00
(end_cast) number of data records in CTD78 disk file: 1090
(end_cast) total # of records in CTD78 disk data file: 1100
Total number of scans logged: 159099
Total number of errors: 3734
Total number of sync errors: 0
Total number of scans lost: 3121
Total number of range errors: 613
Total number of scans tagged: 23
(end_cast) end position:

56
latitude: 0.00
No end longitude recorded.

maximum pressure: 5695.26
at scan #: 85877
CTD78 record #: 596

minimum pressure: 0.0
at scan #: 1
CTD78 record #: 4

header.max_pres: 5695.26
header.min_pres: 0.00

(End_cast) number of scans outstanding: 105
%INFO: STOPPED, Station 60, Cast 0
Command: CTD_LOG030 Status: 1
*** subroutine cleanup_ctd78 ***
Command: Status: 1
Unmapped section memory from 9A600H to D87FFH.
Ciao.
CTD_AQUI job terminated at 23-FEB-1990 10:46:38.35
Accounting information:
Buffered I/O count: 528  Peak working set size: 200
Direct I/O count: 1843  Peak page file size: 1838
Page faults: 250443  Mounted volumes: 1
Charged CPU time: 00:40:34.47  Elapsed time: 02:01:27.95
### H.2 Header file

**SHIP EN CRUISE 129 STATION 60 DATA VERSION 0**

**START** 35 40.44 N 63 0.13 W AT 846 90/2/23

**END** 0 0 00 N 0 0 00 E AT 1046

**WIND = 0 DEPTH = 0 POS. = STA. TYPE = CL**

**W/SCN = 7 SRATE = 3125 FREQ = 10000 INST. NO. = 1**

**EDIT DATE 0/0/0 QUAL = 0 WAT. SAM. = 0**

**PMIN = 0 PMAX = 5695**

**SHIP EN CRUISE = 129 STATION = 60**

<table>
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<th>ATTR.</th>
<th>1</th>
<th>SLOPE</th>
<th>ENG. BIAS</th>
<th>T.CONST.</th>
<th>ATTR.</th>
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<tbody>
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<td>-0.178000E+02</td>
<td>0.000000E+00</td>
<td>-0.102206E-12</td>
<td></td>
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<tr>
<td>TE</td>
<td>0.282170E-11</td>
<td>0.499916E-03</td>
<td>-0.554621E-02</td>
<td>0.250000E+00</td>
<td>0.000000E+00</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>0.650000E-05</td>
<td>0.998550E-03</td>
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<td>0.000000E+00</td>
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</tbody>
</table>

Plot setup parameters:

- **10000** 'plot factor
- **20** 'plot interval
- **100** 'print interval
- **5** 'number of plot variables

<table>
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<tr>
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<th>scale</th>
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<th>plot</th>
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<td>0.0000</td>
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</tr>
</tbody>
</table>
H.3 Error file

The error file contains the cumulative errors recorded during a deployment. The values listed are the cumulative number of scans that have been flagged for each CTD78 data record. The errors recorded are:

- bad frame synch - the number of bytes between frame synch bytes is not correct
- lost data - missed data scans, filled with last good scan to ensure time series
- range errors - check for variables within the allowable range (defined in configuration file); also checks for pressure jumps

Note that if the number of errors exceeds 32768, the counter variables (integer*2) are reset to zero to avoid an integer overflow error.

*** error file -- EN 129 ***

Errors are cumulative - recorded for each CTD78 data record

<table>
<thead>
<tr>
<th>ctd78 disk record #</th>
<th>bad frame synch</th>
<th>lost data</th>
<th>range errors</th>
<th>total errors</th>
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59
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### H.4 Raw water sample file

The values listed in the water sample files are averages of the num\_water\_samp values (defined in the template file) immediately preceding the record tag. The column labeled Tag # is the sequential number of the record tag. The column BT# is set to zero; this column can be edited with the actual bottle numbers post-cast. The column labeled dTP/dt is set to 0.00 if there is no measured Titanium pressure temperature.

When a CTD instrument is configured for more than the 'standard' 7 variables per scan, the water sample file may extend beyond 80 columns. To view the files on the screen, do the following:

```bash
$ wide (sets the terminal screen width to 132 characters)
$ ty 0060a000.wrw
$ unwide (sets the terminal screen width back to 80 characters)
```

*** Water sample data -- EN 129 ***

Records tagged during acquisition -- Raw data

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where:
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BT # = bottle number (set to zero)
Pres = average pressure
Con = average conductivity
OCTMP = average oxygen temperature
Tag # = record tag number
Scan # = tagged scan number
Temp = average temperature
OXcur = average oxygen current
dT/dt = rate of change of temperature (deg C/sec)
doc/dt = rate of change of oxygen current (m/sec)
dTP/dt = rate of change of Titanium pressure temperature (TP)
(this value is set to 0.0 if TP is not measured)
H.5  Scaled water sample file

The values for salt and oxygen listed in the water sample file are the derived, not the measured, values.

*** Water sample data -- EN 129 ***

Records tagged during acquisition -- Data scaled to physical units

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where:
- Sta # = station number
- BT # = bottle number (set to zero)
- Temp = average temperature
- OxCur = average oxygen current
- Salt = salinity 1978 PSS
- Tag # = record tag number
- Pres = average pressure
- Con = average conductivity
- OTMP = average oxygen temperature
- Oxygen = oxygen content
I Determining space on 9T magnetic tape

To determine the amount of data that will fit on a 1200' 9T magnetic tape at 1600 bpi.

given: inter-record gaps = 0.75"
1200' tape = 14400" tape

- CTD78 tape header record = 180 bytes
- CTD78 station file header record = 180 bytes
- CTD78 scale factor record = 2064 bytes
- CTD78 data records = 2064 bytes
- CTD78 file trailer record = 180 bytes

The header information will require "4.6"

tape header = .75" + 180/1600 = 0.8625"
station file header = .75" + 180/1600 = 0.8625"
scale factor record = 75" + 2064/1600 = 2.04"
file trailer = .75" + 180/1600 = 0.8625"

4.6275"

There will be approximately 14300" left for data records:

14400"/tape - 4.6"/headers = 14300"/data

Since data records require "2.04" per record, this gives:

14300"/2.04"/record = 7010 CTD78 data records/tape

For a standard fish configuration (10 bytes) collected at a data rate of 31.25 scans/sec, a 1200' tape could hold approximately 9 hours of CTD data:

7010 records * 146 scans/record = 1023460 scans

1023460 scans / 31.25 scans/sec = 32750 seconds

= 9 hours
References


Distribution List for Technical Report Exchange

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**Title and Subtitle**

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

**Author(s)**

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**Performing Organization Name and Address**

Woods Hole Oceanographic Institution
Woods Hole, Massachusetts 02543

**Sponsoring Organization Name and Address**

National Science Foundation

**Abstract (Limit 200 words)**

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 data from the WHOI/Brown Mark III CTD microprofiler on a MicroVAX II computer, running the VAX/VMS operating system, version 5.3. This manual contains the instructions for operation of the AQUI89 data acquisition system version 1.0.

**Supplementary Notes**

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