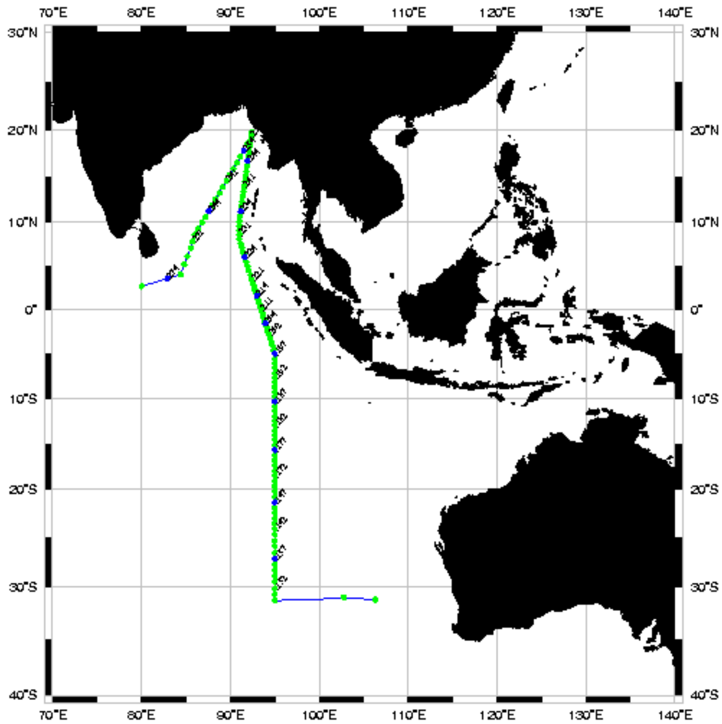
A. CRUISE REPORT: I09N

(Updated MAR 2022)



A.1. Highlights

Cruise Summary Information

Section Designation	I09N
Expedition designation (ExpoCodes)	316N145_6
Chief Scientists	Arnold L. Gordon / LDEO Donald B. Olson / MPO/RSMAS
Dates	1995 JAN 24 to 1995 MAR 05
Ship	R/V *Knorr*
Ports of call	Fremantle, Australia to Colombo, Sri Lanka
Geographic Boundaries	19.756 79.9993 106.2643 -31.2978
Stations	130
Moorings deployed or recovered	0

Contact Information:

Arnold L. Gordon
Lamont-Doherty Earth Observatory
Palisades, New York 10964-8000
Telephone: (914) 365 8325 • Telefax: (914) 365 8157
Internet: agordon@ldeo.columbia.edu

Donald B. Olson
MPO/RSMAS • University of Miami
4600 Rickenbacker Causeway • Miami, FL 33149
Telephone: (305) 361-4074 • Telefax: (305) 361-4622
Internet: don@loquat.rsmas.miami.edu

Final report assembly by Jerry Kappa, SIO/UCSD

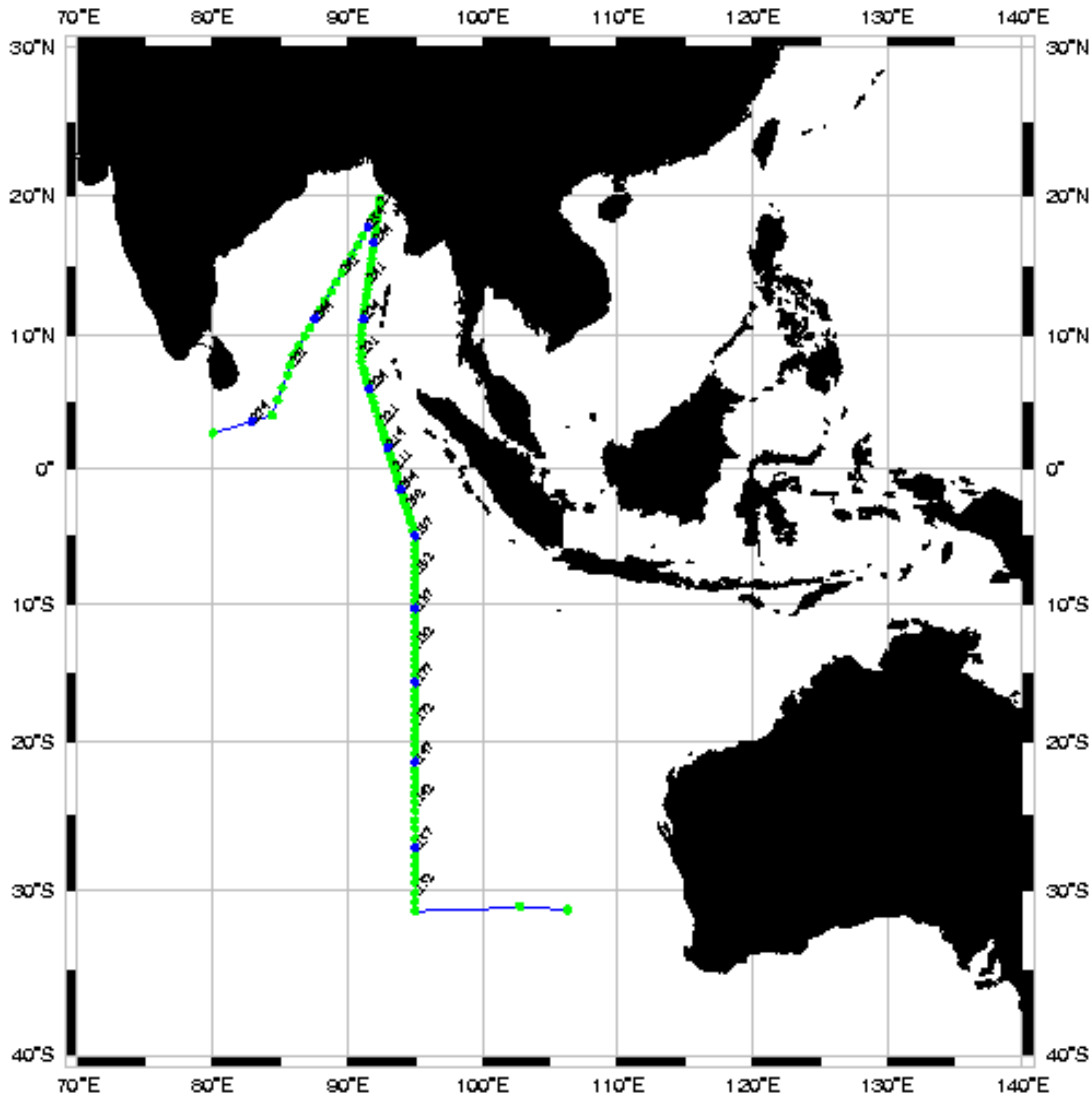
A.2. Cruise Summary Information

a. Geographic boundaries:

The RV Knorr commenced cruise 145, leg 6, WOCE WHP Indian Ocean section I9N at1620 local time on 24 January 1995 from Fremantle Australia. The 41-day cruise terminated in Colombo, Sri Lanka, 5 March 1995 at 0800 local. Figure 1 (all figures, tables not given here, and appendices are available from the WHPO) shows the station locations. Figure 2 shows an expanded view of stations within the Bay of Bengal. Station positions are tabulated in Appendix A.

b. Stations occupied:

Figure 3 shows the array of rosette bottle as a function of station number. The average station spacing along this section is 30 nm, with a minimum spacing of 20 nm from 3°S to 3°N and with a maximum spacing of 36 nm. On average the CTD station took an hour per 1400 meters of water column. There was ample time to obtain an additional section along the central axis of the Bay of Bengal at a station spacing of 46 nm.



(created by WHPO staff)

This section allows for some mapping capability within this poorly sampled embayment of the Indian Ocean. The CTD station numbering is consecutive with those of the previous (McCartney) cruise, station148 is the first station of I9N. The last station is 277 at 80°E in the same position as a planned station on the Lynne Talley I8N cruise, a total of 130stations were obtained on I9N. Stations 148, 149, 150, 152 were repeats of stations from the previous Knorr cruise along I8S and I9S. I9N connects withI8S (oddly section I9S is along 115°E, a strange mismatch of section numbering). The combined I9N and I8S sections provide a view of the entire water column from the shores of Antarctica to the northern limit of the Bay of Bengal at 100 m depth in the Myanmar EEZ.

I9N suite of measurements included: CTD with 36-bottle rosette, with water samples analysed for salinity and oxygen for calibration of the CTD sensors; nutrients; CFC; tritium/helium; carbon dioxide parameters; 14C; and hull-mounted and lowered- Acoustical Doppler Current Profiler (ADCP); underway meteorological and sea surface temperature and salinity were logged.

c. Floats and drifters deployed:
Lagrangian Instrument Launches
(Donald B. Olson)

Contact PIs:
Floats:
Russ Davis
Scripps Institution of Oceanography,
UCSD
La Jolla, CA 92093-0220
Internet: rdavis@ucsd.edu

Drifters:
Donald Olson and Peter Niiler
MPO/RSMAS
University of Miami
4600 Rickenbacker Causeway.
Miami, FL 33149
(305) 361-4074
Internet: don@loquat.rsmas.miami.edu

As part of the WOCE velocity program the R/V KNORR launched a series of mid-level floats and surface drifters along the I9N cruise track. The positions and times at which the drifters were deployed are given in Table 1. Both the floats and the drifters are part of a global network of measurements designed to cover the ice-free ocean at a density of one unit per 600ÀxÀ600 km area. At this density the Indian Ocean will have approximately ninety of each type of current-following instrument by the end of 1995. The floats and drifters both transmit information through the ARGOS system onboard the NOAA-N weather satellites. The system positions the instruments and provides a telemetry link for thermal data. The floats launched on I9N are Autonomous Lagrangian Circulation Explorer (ALACE) units (Davis, 1988). These are set to float at a depth between 800 and1000Àm. At one-month intervals they inflate a bladder in their underside with oil and ascend to the surface. Here they drift while they transmit to the satellite. The surface period is long enough to allow surface tracking and therefore an accurate tracking of the subsurface displacement of the unit. ALACEs launched in the southern subtropical gyre transmit temperature at their subsurface operating depth. The ALACEs in the equatorial zone and the monsoon forced Bay of Bengal are equipped with a temperature probe on their top that provides a vertical profile of temperature from the operation depth to the surface. This is also transmitted via ARGOS. The surface drifters are equipped to measure sea surface temperature and transmit it on a schedule that can be used in weather forecasting. The WOCE Surface Velocity Program (SVP) drifters are equipped with a holey-sock drogue centered at ten meters depth. An immersion sensor provides an indication of the status of the drogue. The design of the WOCE/TOGA drifter can be found in Niiler et al. (1990). The ALACE instruments are designed for a five-year lifetime. Currently the surface drifters are approaching lifetimes in operation of two years.

The ALACE deployments took place at the locations shown in Table 2:

d. Moorings deployed or recovered: No moorings were deployed or recovered on this cruise.

A.3. List of Principal Investigators

Principal investigators for all parameters measured on the cruise are listed in Table 3.

TABLE 3: Principal investigators for all measurements on I9N

Parameter	Principal Investigator	Institution
ADCP	E. Firing	Univ. of Hawaii
13C and 14C, 228Ra, total carbon and alkalinity	R. Key	Princeton
CTD, salinity, oxygen, nutrients	J. Swift	SIO
Chlorofluorocarbons	R. Fine	RSMAS
Barium	K. Falkner	OSU
Bathymetry		
Thermosalinograph		
ALACE floats	R. Davis	SIO
Lagrangian Drifters	D. Olson	RSMAS
	P. Niiler	SIO
Air chemistry (pCO2)	R. Weiss	SIO
Meteorology	P. Mele	LDEO

TABLE 4: WHP 19N personnel list

Individual	Responsibility	Watch
Lamont-Doherty Earth Observatory		
Arnold L. Gordon	Chief Scientist	noon - mid
Phil Mele	Physical oceanography	noon - mid
Jarvis Belinne	Physical oceanography	mid - noon
RSMAS		
Don Olson	Co-Chief Scientist	mid - noon
Amar Gandhi	Physical oceanography	mid - noon
Geoff Sammuels	Physical oceanography	mid - noon
Rebecca Gordon	Physical oceanography	noon - mid
Kevin Sullivan	CFC	mid - noon
Debbie Wiley	CFC	noon - mid
Engin Yergen	Helium/tritium	24-hour call
Princeton		
Chris Sabine	CO2 group leader	0600- 1800
Arthur Dorety	CO2	1800 -0600
Rich Rotter	14C	24-hour call
CDIAC - Oak Ridge National Laboratory		
Alex Kozyr	CO2	noon - mid
Parvadha Suntharalingam	CO2	
University of Hawaii		
Peter Hacker	ADCP	noon -mid

SIO/ODF (CTD, salinity, oxygen, and nutrients)

Carl Mattson	Watch leader/ODF TIC	noon - mid
Craig Hallman		noon - mid
Barry Nisly		noon - mid
Mary Johnson		24-hour call
John Boaz	Watch leader	mid - noon
Kristen Sanborn		mid - noon
Doug Masten		mid - noon

Myanmar Observers

Lt. Win Thein		mid - noon
Dr. San Hla Thaw		noon - mid

Ship technician (WHOI)

Ken Feldman

A.4. Scientific Programme and Methods

Figure 3 shows full depth, computer contoured sections along 95°E (nominal),the primary I9N section, from 31°S to the head of the Bay of Bengal. Salinity along I9N is shown in Figure 4 and within the Bay of Bengal in Figure 5.Potential temperature section is shown in Figure 6 and across the Bay of Bengal in Figure 7. Bottle oxygen values along I9N are displayed in Figure 8 and through the Bay of Bengal on Figure 9. Silicate values along I9N are shown in Figure 10 and through the Bay of Bengal in Figure 11. Sigma-q plots are shown for I9N in Figure 12 and for the Bay of Bengal in Station positions are given in Appendix A.

Some thoughts about the CTD data

(A. L. Gordon)

The meridional WOCE lines pass through many different climate zones. As soona s one gets some understanding of the water mass composition within any one regime, the ship passes into the next. I9N transverses four distinct regimes within the upper, thermocline layer, beginning with the subtropical gyre of the southern Indian Ocean, crossing the trans-Indian Indonesian throughflow plume; the equatorial regime; and finally the Bay of Bengal. In most cases the intermediate and deep water displayed some changes in phase with these upper layer regimes. The subtropical gyre of the southern Indian Ocean is similar to the other southern hemisphere systems, except for a strong presence of a mid-thermocline "stad-like" water mass that has been called subantarctic mode water by Mike McCartney in his seminal 1977 paper. Separating this regime from the equatorial regime is a band of water near 11°S derived from the Indonesian Seas throughflow. This band stretches across the Indian Ocean neatly dividing the subtropics from the equatorial waters. Only in the western Indian Ocean is there significant meridional exchanges within the upper layers of the ocean to breach this zonal barrier. The northern Indian Ocean is subject to strong monsoon wind forcing and buoyancy forcing unique to that region. First of all the Indian Ocean lacks a northern polar region, where tropical heat can be removed and overturning cells established. Instead we see two very different subtropical stratification regimes: the Arabian Sea is a desert with strong upwelling, the Bay of Bengal is a highly stratified estuary established by massive river outflow from Asia. The I9N data sampled only the Bay of Bengal, but revealed the interplay of water between these two extremes through the zonally constrained equatorial circulation passing south of Sri Lanka. What follows is a brief outline of some of the science issues to which the I9N data can be applied. The combination of I9N with the rest of the Indian Ocean WHP sections can be considered value-added. The combination of the water mass thermohaline and tracers fields along with the ADCP data will prove to be a powerful tool, though this discussion is based primarily on the CTD data. As a guide to the water masses encountered during the cruise the potential temperature, salinity, sigma-q, rosette oxygen, silicate full depth sections are shown in Figure 3.

1 ***Subtropical Convergence (STC):*** The contrast of water properties across STC, falling between stations 161 and 162, at 24.5°S, is evident well below the upper thermocline. Even waters of similar T/S characteristics display markedly different oxygen and CFC ages as the STC is crossed.

2 ***The Pervasive 10°C Subantarctic Mode Water (SAMW):*** The SAMW is a very dominant water mass within the subtropical gyre thermocline. It divides the South Indian thermocline into a well defined upper and lower parts. The SAMW stad is not completely homogeneous, it covers a range of temperature, from 10to 14°C from 200 to 600 meters. It marks the water column oxygen maximum and CFC-max. SAMW is a dominant feature to Indonesian plume. While present in the plume it is much weakened, becoming stronger north of plume; SAMW traces near the 12°C (300 m) layer reach into the Bay of Bengal. The return of SAMW north of the Indonesian Plume indicates that it folds around the western end of the plume, with the Somali Current, where it mixes with more saline Arabian Seawater and then spreads eastward with the South Equatorial Counter Current(SECC).

3 ***Indonesian Plume:*** The Indonesian Plume is centered at 10.8° to 12°S. The westward flow in which it is embedded may be considered as the South Equatorial Current (SEC). The Indonesian water is marked by low salinity and oxygen with high silicate, standing out in sharp contrast to the subtropical water to

the south, and to a lower level of contrast with the thermocline water to the north. The plume matching very closely the characteristics of the Timor Sea. The Timor water extends from the surface to about 360 meters, the 9 to 10°Cisotherms form the Indonesian water mass base of the plume, but the dynamical influence of the SEC seems to extend to much deeper water. Below the Indonesian(Timor Sea) water mass base of the plume there is a trace of the SAMW and the lower thermocline water of the South Indian subtropics. A very wide zone rich in fine structure exists from 19°S to 11°S, suggesting vigorous stirring of the plume water with subtropical gyre water. Just north of the Indonesian Plume there is a return to a stronger presence of south Indian thermocline and SAMW. Slightly further north (stations 195-198) a mixture of south Indian thermocline water and salty Arabian Sea water is encountered. The water characteristics north of the Indonesian Plume suggest an advected origin by the Equatorial undercurrent and SECC. As with the STC further south, though the water mass properties of the plume differ most strongly in the thermocline layer, frontal characteristics associated with the Indonesian Plume axis seem to extend into the deep water, suggesting that the plume is an effective divider of northern Indian and southern Indian Ocean stratification.

4 ***Antarctic Intermediate Water & Red Sea Water:*** The s-min of the AAIW is centered at 34.45 and 5°C at the 800 to 900 m depth. North of station 163 AAIW begins to mix water properties derived from the Red Sea. The Red Sea influence stands out as high salinity, low oxygen (to 34.65; down to nearly 3 ml/l)centered at 5°C, 27.4. The s-min of the AAIW remnant shifts to warmer temperatures, essentially disappearing by 10°S. Though north of 10°S are a few filaments of lower oxygen AAIW, e.g. near 1150 m at 7°S station 192, which may represent older AAIW trapped within the equatorial zonal flow. This feature seems to separate two s-max cores from the northern Indian Ocean, one at 400meters derived from the Arabian Sea thermocline, and a deeper s-max, near 2000m which must represent the deeper bounds of the Red Sea water mass.

5 ***Deep Water:*** In the southern subtropical Indian Ocean the deep s-max between2500 and 3000 m appears to be circumpolar deep water, though some reduced silicate suggests a lingering presence of NADW. Proceeding northward the deep s-max core abruptly increases in salinity and shallows near 10°S. The low oxygen of this northern s-max core does not support a NADW origin, but rather an influx from the Red Sea. From 4°S to 1.5°N the T/S is remarkably linear from the thermocline near 20°C to sea floor. Might the northern Indian Ocean be essentially a vertical mixed blend of Red Sea and AABW, without much circumpolar deep water or NADW input? The oxygen is low throughout this linear T/S water column, but between 9° and 15°C (150 to 700m) centered at 11°C (380dbar), there is a weak oxygen maximum, suggesting some lateral influx of what's left of the SAMW. Measurable CFC-11 to the 9°C level, even where the oxygen levels are below 1.5 ml/l, indicating rapid oxygen depletion (a condition found in the Arabian Sea, Don Olson p.c.). Continuing north, the T/S relationship remains fairly linear for temperatures colder than 10°C (400-500 m), for the warmer water above 400 m the salinity is reduced, perhaps due to some downward mixing of the very low salinity Bay of Bengal surface water. A break in the T/Oxy curve occurs near 1.15°C (about 3500 dbar) indicates the presence of more oxygenated AABW for the colder temperatures. At this T/Oxy break is also the silicate maximum, about 132 µmol/liter, consistent with AABW ventilation of the colder layer. AABW traces seem to ride-up to shallower topography of the Bay of Bengal.

6 ***Bay of Bengal:*** The stratification within the Bay of Bengal is similar to an estuary, with a very stable surface layer due low surface salinity (down to about 31). Oxygen values drop to essentially zero within the thermocline, whichis saltier than the Indonesian Plume, salt that must be derived from the Arabian Sea. A weak temperature minimum in the upper 60 to 80 meters suggest the presence of shallow overturning, perhaps a product of winter cooling along the northern fringes of the Bay. An abrupt front occurs between 224/225 (near5°N) in the upper 200 dbar, very low upper layer salinity to north. Variations of the salinity of the upper few hundred meters may be related to various deepwater gaps in the Andaman Island chain. The benthic layer within the central Bay of Bengal (the southbound section) exhibits a remarkable increase in silicate as the sea floor is approached, a reversal of the larger scale trend. This feature is most evident at station 167-171 of the central section in the Bay of Bengal, it is not observed in the eastern section. The lower three bottles within 100 m of the sea floor indicate a 10 µmol/liter increase of silicate towards the bottom with a 0.15 ml/l decrease in oxygen. A

counterclockwise bottom flow within the Bay of Bengal is suspected, with inflow along the deep water passage between the 90 Degree East Ridge and the Andaman Island chain, with outflow to the west.

Foreign Observers:

I9N obtained observations within the EEZ of Myanmar (Burma) and of the Indian Islands of Nicobar and Andaman. Myanmar observers accompanied the ship for the full cruise.

The following letter was written by A. L. Gordon to the Myanmar Foreign Minister:

I was the Chief Scientist on the US Research Vessel Knorr cruise145-6, 24 January to 5 March 1995, during which time Section # I9N, one of the primary meridional WOCE (World Ocean Circulation Experiment) oceanographic sections was obtained. Section I9N began at 31°S and followed along 95°E (slightly west of this meridian north of the Equator) ending on the outer continental shelf of Myanmar in 100 meters of water. We greatly appreciate the opportunity you have provided to obtain oceanographic data within the EEZ of Myanmar. The usefulness of the WOCE data set is greatly enhanced by extending the observations to continental boundaries. For your information, I include copies of the station map and of the contoured temperature, salinity and varied chemical parameters along the section. I provided the two Myanmar observers aboard the Knorr, Dr. San Hla Thaw and Lt. Win Thein, with copies of the full cruise preliminary data set. As the data is processed, you will be provided with final data, though the preliminary data is of high quality. I am happy to report that Dr. Thaw and Lt. Thein were very helpful to the expedition and I hope that they and ocean science research in Myanmar may benefited from their experience.

The Indian Observers joined the ship at station 226 and departed at station 242via a Knorr to Indian Naval ship transfer. Their names: Lt. ÀAnand Abhyankar and Lt. Cdr. Sreekumar. They were given preliminary copies of the data obtained during the transit within Indian EEZ and final data will be sent to New Delhi. I believe all observers departed the ship with a better understanding of our scientific program and methods.

A.5. Major Problems and Goals Not Achieved

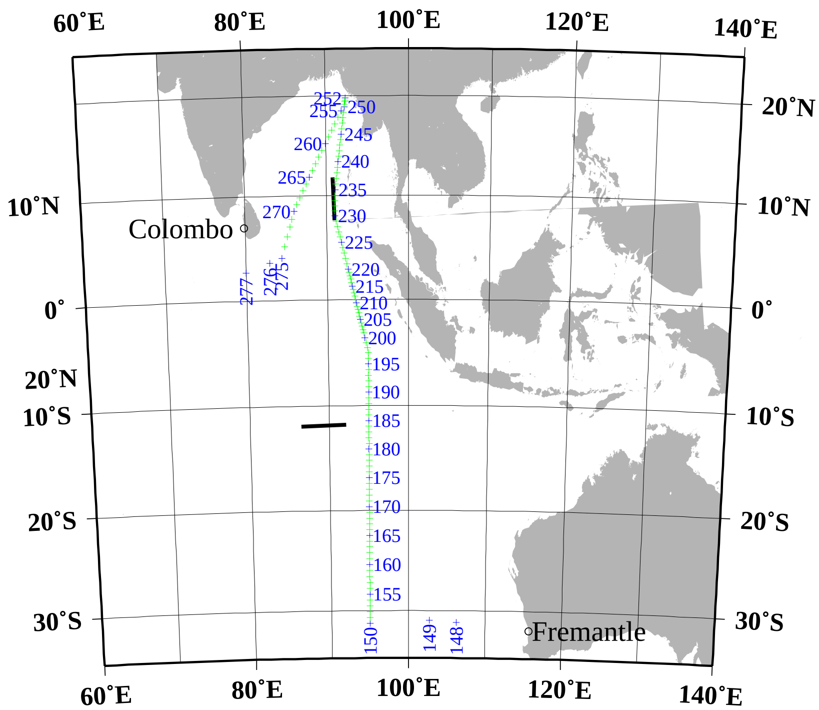
Science gear worked fine, specific problems are discussed in the individual sections above. The port winch broke, but was repaired at sea. A ship engine had major problems, which will require port work. Neither of these problems interfered with the data collect, as we temporally switched to the starboard winch and the ship did fine on the three remaining engines, though it is important that the full 4 engines be available. An annoying problem was that the bathymetry had to be manually logged at 5-minute intervals. With all of technology on the ship I am surprised to see that automation of bathymetry logging was not working.

A.6. Other Incidents of Note

None noted.

World Ocean Circulation Experiment
Indian Ocean I9N
R/V Knorr Voyage 145 Leg 6
24 January 1995 - 5 March 1995
Fremantle, Australia - Colombo, Sri Lanka
Expocode: 316N145/6

Chief Scientist: Dr. Arnold Gordon
Lamont-Doherty Earth Observatory
of Columbia University



I9N Cruise Track

Oceanographic Data Facility (ODF)
Final Cruise Report
8 August 1997

Data Submitted by:

Oceanographic Data Facility
Scripps Institution of Oceanography
La Jolla, CA 92093-0214

1. DESCRIPTION OF MEASUREMENT TECHNIQUES AND CALIBRATIONS

Basic Hydrography Program

The basic hydrography program consisted of salinity, dissolved oxygen and nutrient (nitrite, nitrate, phosphate and silicate) measurements made from bottles taken on CTD/rosette casts, plus pressure, temperature, salinity and dissolved oxygen from CTD profiles. 130 CTD/rosette casts were made, usually to within 5 meters of the bottom. One additional cast at station 204 was aborted and not reported. 4526 bottles were tripped resulting in 4515 usable bottles. No insurmountable problems were encountered during any phase of the operation. The resulting data set met and in many cases exceeded WHP specifications. The distribution of samples is illustrated in Figures 1.0.0 and 1.0.1.

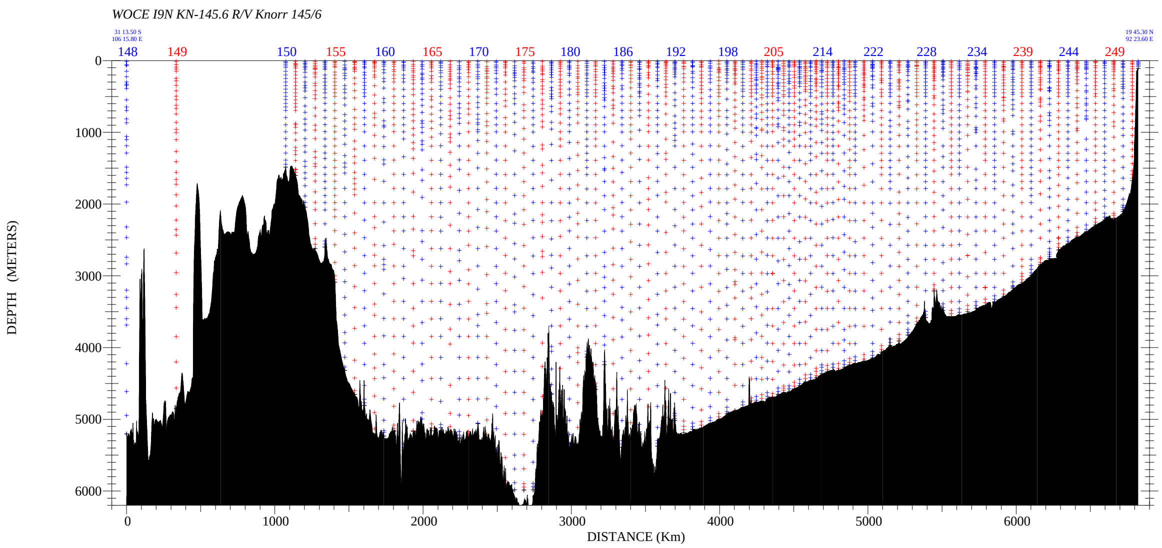


Figure 1.0.0 I9N sample distribution, stas 148-252

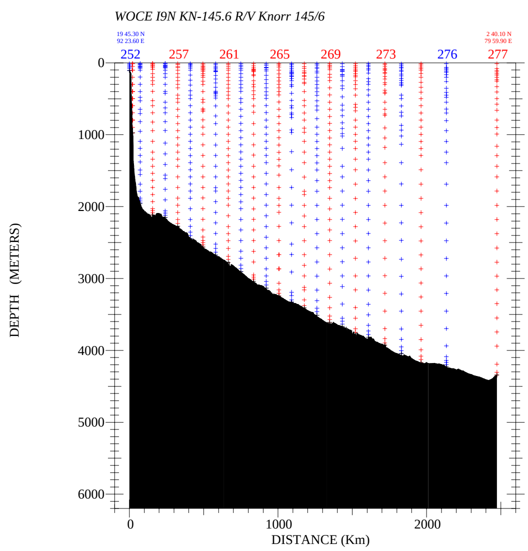


Figure 1.0.1 I9N sample distribution, stas 252-277

1.1. Water Sampling Package

Hydrographic (rosette) casts were performed with a rosette system consisting of a 36-bottle rosette frame (ODF), a 36-place pylon (General Oceanics 1016) and 36 10-liter PVC bottles (ODF). Underwater electronic components consisted of an ODF-modified NBIS Mark III CTD (ODF #1) and associated sensors, SeaTech transmissometer (TAMU #151D), RDI LADCP (UH #1246), Benthos altimeter and Benthos pinger. The CTD was mounted horizontally along the bottom of the rosette frame, with the transmissometer, a Sensormedics dissolved oxygen sensor and an FSI secondary PRT sensor deployed next to the CTD. The LADCP was vertically mounted to the frame inside the bottle rings. The altimeter provided distance-above-bottom in the CTD data stream. The pinger was monitored during a cast with a precision depth recorder (PDR) in the ship's laboratory. The rosette system was suspended from a three-conductor 0.322" electro-mechanical cable. Power to the CTD and pylon was provided through the cable from the ship. Separate conductors were used for the CTD and pylon signals. The transmissometer, dissolved oxygen, secondary temperature and altimeter were interfaced with the CTD, and their data were incorporated into the CTD data stream.

The deck watch prepared the rosette approximately 45 minutes prior to a cast. All valves, vents and lanyards were checked for proper orientation. The bottles were cocked and all hardware and connections rechecked. Upon arrival at station, time, position and bottom depth were logged and the deployment begun. The rosette was moved into position under a projecting boom from the rosette room using an air-powered cart on tracks. Two stabilizing tag lines were threaded through rings on the frame. CTD sensor covers were removed and the pinger was turned on. Once the CTD acquisition and control system in the ship's laboratory had been initiated by the console operator and the CTD and pylon had passed their diagnostics, the winch operator raised the package and extended the boom over the side of the ship. The package was then quickly lowered into the water, the tag lines removed and the console operator notified by radio that the rosette was at the surface.

Each rosette cast was lowered to within 5-10 meters of the bottom, unless the bottom returns from both the pinger and altimeter were extremely poor or the bottom depth exceeded the range of the instrumentation. Bottles on the rosette were each identified with a unique serial number. Usually these numbers corresponded to the pylon tripping sequence, 1-36, where the first (deepest) bottle tripped was bottle #1. There were four stations where the bottles were tripped in a special sequence for freon checks. The trip sequences, deepest to shallowest, were bottles 19-36, then 1-18, at stations 166, 272 and 277; and bottles 13-36, then 1-12, at station 234.

Averages of CTD data corresponding to the time of bottle closure were associated with the bottle data during a cast. Pressure, depth, temperature, salinity and density were immediately available to facilitate examination and quality control of the bottle data as the sampling and laboratory analyses progressed.

Recovering the package at the end of deployment was essentially the reverse of the launching. Two tag lines connected to air tuggers and terminating in large snap hooks were manipulated on long poles by the deck watch to snag recovery rings on the rosette frame. The package was then lifted out of the water under tension from the tag lines, the boom retracted, and the rosette lowered onto the cart. Sensor covers were replaced, the pinger turned off and the cart with the rosette moved into the starboard-side (forward) hangar for sampling. A detailed examination of the bottles and rosette occurred before samples were taken, and any extraordinary situations or circumstances were noted on the sample log for the cast.

Routine CTD maintenance included soaking the conductivity and CTD O_2 sensors in distilled water between casts to maintain sensor stability. The rosette was stored in the rosette room between casts to insure the CTD was not exposed to direct sunlight or wind in order to maintain the internal CTD temperature near ambient air temperature.

Rosette maintenance was performed on a regular basis. O-rings were changed as necessary and bottle maintenance performed each day to insure proper closure and sealing. Valves were inspected for leaks and repaired or replaced as needed. No bottle replacements were necessary during the cruise.

The transmissometer windows were cleaned prior to deployment approximately every 20 casts. The air readings were noted in the TAMU transmissometer log book after each cleaning. Transmissometer data were monitored for potential problems during every cast.

The R/V Knorr's port-side Markey CTD winch was used during stations 148-211 and 277. The winch operator noticed a loose strand on the wire during station 172 at 4060m wire out. The strand was trimmed and the wire was taped. During stations 172-211 and 277, the winch was stopped at 4060m on both down-cast and up-cast to inspect wire integrity and to re-tape the loose strand. The port winch developed an electrical control relay problem at the start of station 212 and was repaired shortly thereafter. The starboard Almon Johnson winch and cable were used on stations 212-276.

1.2. Underwater Electronics Packages

CTD data were collected with a modified NBIS Mark III CTD (ODF #1). This instrument provided pressure, temperature, conductivity and dissolved O_2 channels, and additionally measured a second temperature (FSI temperature module/OTM) as a calibration check. An FSI pressure module/OPM was substituted in place of the secondary temperature for three casts as a check on the primary pressure sensor. Other data channels included elapsed-time, altimeter, several power supply voltages and transmissometer. The instrument supplied a 15-byte NBIS-format data stream at a data rate of 25 Hz. Modifications to the instrument included revised pressure and dissolved O_2 sensor mountings; ODF-designed sensor interfaces for O_2, FSI PRT and transmissometer; implementation of 8-bit and 16-bit multiplexer channels; an elapsed-time channel; instrument ID in the polarity byte and power supply voltages channels.

Table 1.2.0 summarizes the winches and serial numbers of instruments and sensors used during I9N.

<table>
<tr><th>Station(s)</th><th>ODF
CTD@
ID#</th><th>Sensormedics
Oxygen
Sensor</th><th>SeaTech
Transmissometer
(TAMU)</th><th>Winch</th></tr>
<tr><td>148-149,200-203</td><td>1a</td><td rowspan="2">3-03-10</td><td rowspan="8">151D</td><td>Port</td></tr>
<tr><td>150-171,173-196</td><td rowspan="2">1b</td><td>Port</td></tr>
<tr><td>172</td><td>3-11-32</td><td>Port</td></tr>
<tr><td>197-199</td><td>1c</td><td rowspan="4">3-03-10</td><td>Port</td></tr>
<tr><td>204/1-ABORTED</td><td>1d</td><td>Port</td></tr>
<tr><td>204/2-211,277</td><td rowspan="3">1b</td><td>Port</td></tr>
<tr><td>212-257,261-276</td><td>Stbd.</td></tr>
<tr><td>258-260</td><td>4-05-16</td><td>Stbd.</td></tr>
<tr><td colspan="5">NOTE: RDI LADCP #1246 (UH) deployed on all casts except:
turned off for stas 252 and 274
removed from rosette for stas 275-277</td></tr>
</table>

@ ODF CTD #1 sensor serial numbers:

<table>
<tr><th rowspan="2">ODF
CTD
ID#</th><th rowspan="2">Pressure
Paine Model
211-35-440-05
strain gage/0-8850psi</th><th colspan="2">Temperature</th><th rowspan="2">Conductivity
NBIS Model
09035-00151</th></tr>
<tr><th>PRT1
Rosemount
Model 171BJ</th><th>PRT2/(PRS2)
FSI
OTM/(OPM)</th></tr>
<tr><td>1a</td><td rowspan="4">131910</td><td rowspan="4">14304</td><td>OTM/1319T</td><td rowspan="4">5902-F117</td></tr>
<tr><td>1b</td><td>OTM/1322T</td></tr>
<tr><td>1c</td><td>(OPM/1326P)</td></tr>
<tr><td>1d</td><td>OTM/1320T</td></tr>
</table>

Table 1.2.0 I9N Instrument/Sensor Serial Numbers

The CTD pressure sensor mounting had been modified to reduce the dynamic thermal effects on pressure. The sensor was attached to a section of coiled stainless-steel tubing that was connected to the end-cap pressure port. The transducer was also insulated. The NBIS temperature compensation circuit on the pressure interface was disabled; all thermal response characteristics were modeled and corrected in software.

The O_2 sensor was deployed in a pressure-compensated holder assembly mounted separately on the rosette frame and connected to the CTD by an underwater cable. The O_2 sensor interface was designed and built by ODF using an off-the-shelf 12-bit A/D converter. The transmissometer interface was a similar design.

Although the secondary temperature sensor was located within 6 inches of the CTD conductivity sensor, it was not sufficiently close to calculate coherent salinities. It was used as a secondary temperature calibration reference rather than as a redundant sensor, with the intent of eliminating the need for mercury or electronic DSRTs as calibration checks.

The General Oceanics (GO) 1016 36-place pylon was used in conjunction with an ODF-built deck unit and external power supply instead of a GO pylon deck unit. This combination provided generally reliable operation and positive confirmation of all but 1 trip attempt, which was successful on the second try. The pylon emitted a confirmation message containing its current notion of bottle trip position, which could be useful in sorting out mis-trips. The acquisition software averaged CTD data corresponding to the rosette trip as soon as the trip was initiated until the trip confirmed, typically 2-4.5 seconds on I9N.

1.3. Navigation and Bathymetry Data Acquisition

Navigation data were acquired from the ship's Magnavox MX GPS receiver via RS-232. Data were logged automatically at one-minute intervals by one of the Sun SPARCstations. Underway bathymetry was logged manually from the 12 kHz Raytheon PDR at five-minute intervals, then merged with the navigation data to provide a time-series of underway position, course, speed and bathymetry data. These data were used for all station positions, PDR depths and bathymetry on vertical sections [Cart80].

1.4. CTD Data Acquisition, Processing and Control System

The CTD data acquisition, processing and control system consisted of a Sun SPARCstation LX computer workstation, ODF-built CTD and pylon deck units, CTD and pylon power supplies, and a VCR recorder for real-time analog backup recording of the sea-cable signal. The Sun system consisted of a color display with trackball and keyboard (the CTD console), 18 RS-232 ports, 2.5 GB disk and 8mm cartridge tape. Two other Sun SPARCstation LX systems were networked to the data acquisition system, as well as to the rest of the networked computers aboard the Knorr. These systems were available for real-time CTD data display and provided for hydrographic data management and backup. Two HP 1200C color inkjet printers provided hardcopy capability from any of the workstations.

The CTD FSK signal was demodulated and converted to a 9600 baud RS-232C binary data stream by the CTD deck unit. This data stream was fed to the Sun SPARCstation. The pylon deck unit was connected to the Sun LX through a bi-directional 300 baud serial line, allowing bottle trips to be initiated and confirmed by the data acquisition software. A bitmapped color display provided interactive graphical display and control of the CTD rosette sampling system, including real-time raw and processed CTD data, navigation, winch and rosette trip displays.

The CTD data acquisition, processing and control system was prepared by the console watch a few minutes before each deployment. A console operations log was maintained for each deployment, containing a record of every attempt to trip a bottle as well as any pertinent comments. Most CTD console control functions, including starting the data acquisition, were initiated by pointing and clicking a trackball cursor on the display at icons representing functions to perform. The system then presented the operator with short dialog prompts with automatically-generated choices that could either be accepted as defaults or overridden. The operator was instructed to turn on the CTD and pylon power supplies, then to examine a real-time CTD data display on the screen for stable voltages from the underwater unit. Once this was accomplished, the data acquisition and processing was begun and a time and position were automatically logged for the beginning of the cast. A backup analog recording of the CTD signal on a VCR tape was started at the same time as the data acquisition. A rosette trip display and pylon control window popped up, giving visual confirmation that the pylon was initializing properly. Various plots and displays were initiated. When all was ready, the console operator informed the deck watch by radio.

Once the deck watch had deployed the rosette and informed the console operator that the rosette was at the surface (also confirmed by the computer displays), the console operator or watch leader provided the winch operator with a target depth (wire-out) and maximum lowering rate, normally 60 meters/minute for this package. The package then began its descent, building up to the maximum rate during the first few hundred meters, then optimally continuing at a steady rate without any stops during the down-cast. As noted in Section 1.1, the winch was stopped around 4060m wire out on every down-cast of stations 172-211 and 277 to check the broken-strand area on the port winch wire.

The console operator examined the processed CTD data during descent via interactive plot windows on the display, which could also be run at other workstations on the network. Additionally, the operator decided where to trip bottles on the up-cast, noting this on the console log. The PDR was monitored to insure the bottom depth was known at all times.

The deck watch leader assisted the console operator by monitoring the rosette's distance to the bottom using the difference between the rosette's pinger signal and its bottom reflection displayed on the PDR. Around 200 meters above the bottom, depending on bottom conditions, the altimeter typically began signaling a bottom return on the console. The winch and altimeter displays allowed the watch leader to refine the target depth relayed to the winch operator and safely approach to within 5 meters of the bottom.

Bottles were closed on the up-cast by pointing the console trackball cursor at a graphic firing control and clicking a button. The data acquisition system responded with the CTD rosette trip data and a pylon confirmation message in a window. A bad or suspicious confirmation signal typically resulted in the console operator repositioning the pylon trip arm via software, then re-tripping the bottle, until a good confirmation was received. All tripping attempts were noted on the console log. The console operator then instructed the winch operator to the next bottle stop. The console operator was also responsible for generating the sample log for the cast.

After the last bottle was tripped, the console operator directed the deck watch to bring the rosette on deck. Once the rosette was on deck, the console operator terminated the data acquisition and turned off the CTD, pylon and VCR recording. The VCR tape was filed. Usually the console operator also brought the sample log to the rosette room and served as the *sample cop*.

1.5. CTD Data Processing

ODF CTD processing software consists of over 30 programs running under the Unix operating system. The initial CTD processing program (ctdba) is used either in real-time or with existing raw data sets to:

- Convert raw CTD scans into scaled engineering units, and assign the data to logical channels;
- Filter various channels according to specified filtering criteria;
- Apply sensor- or instrument-specific response-correction models;
- Provide periodic averages of the channels corresponding to the output time-series interval; and
- Store the output time-series in a CTD-independent format.

Once the CTD data are reduced to a standard-format time-series, they can be manipulated in various ways. Channels can be additionally filtered. The time-series can be split up into shorter time-series or pasted together to form longer time-series. A time-series can be transformed into a pressure-series, or into a larger-interval time-series. The pressure calibration corrections are applied during reduction of the data to time-series. Temperature, conductivity and oxygen corrections to the series are maintained in separate files and are applied whenever the data are accessed.

ODF data acquisition software acquired and processed the CTD data in real-time, providing calibrated, processed data for interactive plotting and reporting during a cast. The 25 Hz data from the CTD were filtered, response-corrected and averaged to a 2 Hz (0.5-second) time-series. Sensor correction and calibration models were applied to pressure, temperature, conductivity and O_2. Rosette trip data were extracted from this time-series in response to trip initiation and confirmation signals. The calibrated 2 Hz time-series data, as well as the 25 Hz raw data, were stored on disk and were available in real-time for reporting and graphical display. At the end of the cast, various consistency and calibration checks were performed, and a 2.0 db pressure-series of the down-cast was generated and subsequently used for reports and plots.

CTD plots generated automatically at the completion of deployment were checked daily for potential problems. The two PRT temperature sensors were inter-calibrated and checked for sensor drift. The CTD conductivity sensor was monitored by comparing CTD values to check-sample conductivities and by deep Theta-Salinity comparisons with adjacent stations. The CTD O_2 sensor was calibrated to check-sample data.

A few casts exhibited conductivity offsets due to biological or particulate artifacts. Some casts were subject to noise in 1 or more channels caused by sea cable or slip-ring problems. Intermittent noisy data were filtered out of the 2 Hz data using a spike-removal filter. A least-squares polynomial of specified order was fit to fixed-length segments of data. Points exceeding a specified multiple of the residual standard deviation were replaced by the polynomial value.

Density inversions can appear in high-gradient regions. Detailed examination of the raw data shows significant mixing occurring in these areas because of ship roll. In order to minimize density inversions, a ship-roll filter was applied to all casts during pressure-sequencing to disallow pressure reversals.

The first few seconds of in-water data were excluded from the pressure-series data, since the sensors were still adjusting to the going-in-water transition. However, multiple casts exhibited up to a 0.03 density drop during the top 10 db, or a sharply increasing density gradient in the top few meters of the water column. A time-series data check verified these density features were probably real: the data were consistent over many frames of data at the same pressures. Appendix C details the magnitude of the larger density drops or gradients for the casts affected.

Pressure intervals with no time-series data can optionally be filled by double-quadratic interpolation.

When the down-cast CTD data have excessive noise, gaps or offsets, the up-cast data are used instead. CTD data from down- and up-casts are not mixed together in the pressure-series data because they do not represent identical water columns (due to ship movement, wire angles, etc.). The 7 up-casts used for final I9N data are indicated in Appendix C.

There is an inherent problem in the internal digitizing circuitry of the NBIS Mark III CTD when all the bits flip at once. Raw temperature can shift 1-2 millidegrees as values cross between positive and negative, a problem avoided by offsetting the raw PRT readings by ~1.5°C. The conductivity channel also can shift by 0.001-0.002 mmho/cm as raw data values change between 32767/32768. This is typically not a problem in shallow to intermediate depths because such a small shift becomes negligible in higher gradient areas.

Raw CTD conductivity traversed 32767/32768 ~1000±200 db during the first part of I9N, and ~1700±150 db beginning about station 200. The effect on salinity is not visible until the casts near the mouth of the Bay of Bengal because of high salinity gradients. However, from station 230 until the end of I9N, a +0.001 PSU offset can be seen around 3.4°C theta and 34.81 PSU salinity, where raw conductivity values are in the right vicinity. Because the same digitizer problem has occurred on numerous other cruises, it is unlikely that this offset is real.

A deeper -0.0005 PSU inflection appears around 1.9°C theta and 34.75 PSU salinity on the same casts as the digitizer problem mentioned above. The raw conductivity is nowhere near 32768 in this area, so a CTD problem is not suspected.

As noted in Section 1.1, a loose strand was observed on the Knorr’s port winch wire during station 172. The winch was stopped from 0.5-14 minutes near 4060m wire out on both down- and up-casts from stations 172-211 and 277 to check the loose-strand area. These stops nearly always caused a problem in fitting CTD oxygen data because the raw oxygen signal shifted as oxygen became depleted in water near the stationary sensor. The drops often caused inflections and/or distorted fits over hundreds of decibars. The signal drop could usually be compensated for by applying a small constant offset to the raw oxygen current values from the stop until the bottom of the cast, then re-fitting the oxygen data to the bottles. The same solution also helped to correct oxygen shifts when the winch slowed for a bottom approach. Raw CTD O_2 offsets that resolved drops at winch stops or slowdowns are noted in Appendix C.

Appendix C contains a table of CTD casts requiring special attention; I9N CTD-related comments, problems and solutions are documented in detail.

1.6. CTD Laboratory Calibration Procedures

Pre-cruise laboratory calibrations of CTD pressure and temperature sensors were used to generate tables of corrections applied by the CTD data acquisition and processing software at sea. These laboratory calibrations were also performed post-cruise.

Pressure and temperature calibrations were performed on CTD #1 at the ODF Calibration Facility in La Jolla. The pre-cruise calibrations were done in December 1994, before five consecutive ODF WOCE legs in the Indian Ocean, and the post-cruise calibrations were done in September 1995.

The CTD pressure transducer was calibrated in a temperature-controlled water bath to a Ruska Model 2400 Piston Gage pressure reference. Calibration data were measured at -1.42/+0.01 and 30.41/31.24°C to 2 maximum loading pressures (1400/1190 and 6080 db) pre-/post-cruise. Figures 1.6.0 and 1.6.1 summarize the CTD #1 laboratory pressure calibrations performed in December 1994 and September 1995.

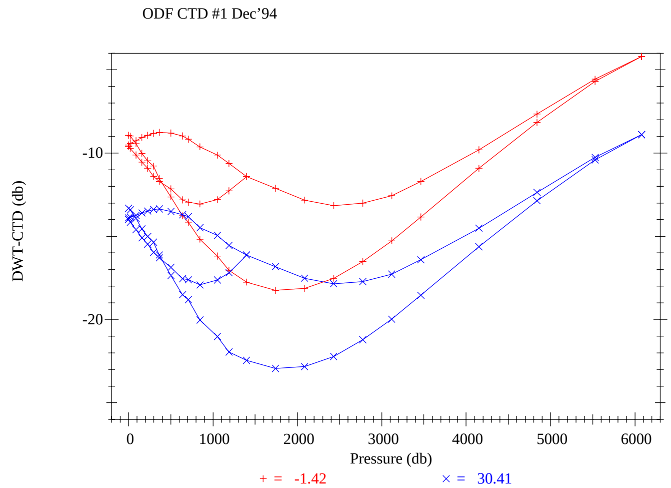


Figure 1.6.0 Pressure calibration for ODF CTD #1, December 1994.

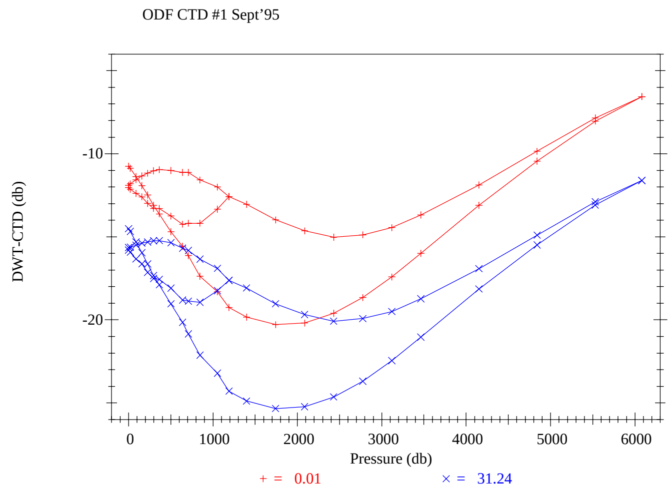


Figure 1.6.1 Pressure calibration for ODF CTD #1, September 1995.

Additionally, dynamic thermal-response step tests were conducted on the pressure transducer to calibrate dynamic thermal effects. These results were combined with the static temperature calibrations to optimally correct the CTD pressure.

CTD PRT temperatures were calibrated to an NBIS ATB-1250 resistance bridge and Rosemount standard PRT in a temperature-controlled bath. The primary and secondary CTD temperatures were offset by ~1.5°C to avoid the 0-point discontinuity inherent in the internal digitizing circuitry. Standard and PRT temperatures were measured at 9 or more different bath temperatures between -1.5 and 31.3 °C, both pre- and post-cruise. Figures 1.6.2 and 1.6.3 summarize the laboratory calibrations performed on the CTD #1 primary PRT during December 1994 and September 1995.

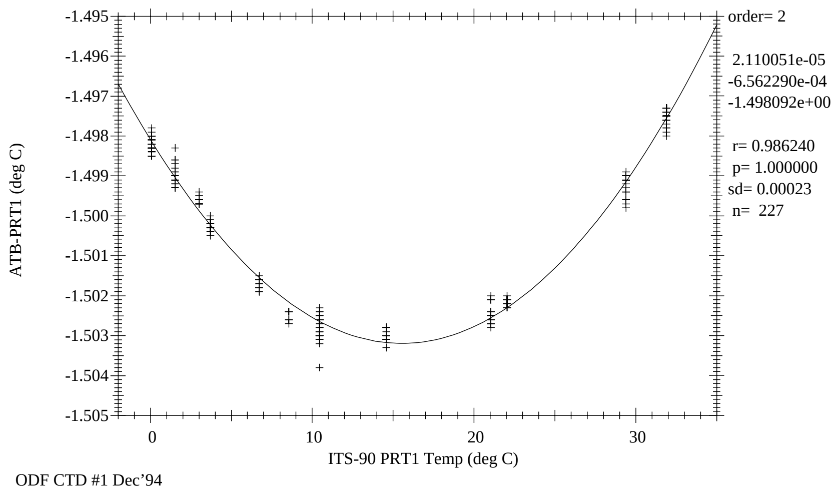


Figure 1.6.2 Primary PRT Temperature Calibration for ODF CTD #1, December 1994.

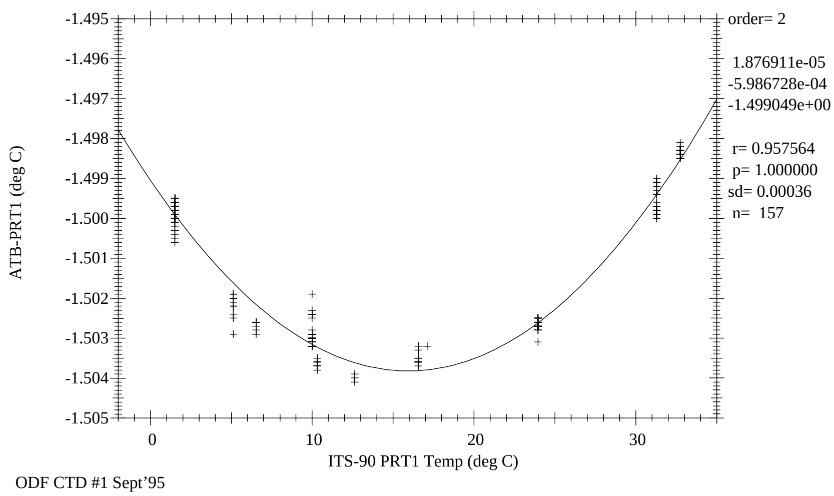


Figure 1.6.3 Primary PRT Temperature Calibration for ODF CTD #1, September 1995.

These laboratory temperature calibrations were referenced to an ITS-90 standard. Temperatures were converted to the IPTS-68 standard during processing in order to calculate other parameters, including salinity and density, which are currently defined in terms of that standard only. Final calibrated CTD temperatures were reported using the ITS-90 standard.

1.7. CTD Calibration Procedures

This cruise was the first of five consecutive Indian Ocean WOCE legs using ODF CTD #1 exclusively. A redundant PRT sensor was used as a temperature calibration check while at sea. CTD conductivity and dissolved O_2 were calibrated to *in-situ* check samples collected during each rosette cast.

Final pressure, temperature, conductivity and oxygen corrections were determined during post-cruise processing.

1.7.1. CTD #1 Pressure

An FSI pressure module was substituted in place of the FSI PRT during stations 197-199 as a check on the CTD #1 pressure calibration. The FSI pressure sensor required correction using a first-order fit of FSI pressure vs CTD #1 primary pressure minus FSI pressure difference. Once this was accomplished, the residual pressure differences for the three casts were at most ±1.5 db, indicating no significant problems with either pressure sensor.

There was a pre- to post-cruise shift of -2.4 db at shallow and deep pressures in the cold-bath laboratory calibrations for pressure. The warm-bath pressure correction shifted by -1.8 db. Half of the closure between warm/cold calibrations can be accounted for by different temperatures of the pre-/post-cruise calibrations. There were no significant slope differences between pre- and post-cruise pressure calibrations.

In order to determine when the pressure shift occurred, start-of-cast out-of-water pressure and temperature data from the 5 consecutive ODF legs were compared with similar data from the pre- and post-cruise laboratory calibrations for temperature. The pressure data from the I9N leg were essentially the same as the pre-cruise laboratory data at all temperatures, so the pre-cruise pressure calibrations, plus the dynamic thermal-response correction, were applied to CTD #1 pressures.

Down-cast surface pressures were automatically adjusted to 0 db as the CTD entered the water; any difference between this value and the calibration value was automatically adjusted during the top 50 decibars. Residual pressure offsets at the end of each up-cast (the difference between the last corrected pressure in-water and 0) averaged 0.5 db, indicating no problems with the final pressure corrections.

The entire 10-month pre- to post-cruise laboratory calibration shift for the pressure sensor on CTD #1 was less than half the magnitude of the WOCE accuracy specification of 3 db. I9N CTD pressures should be well within the desired standards.

1.7.2. CTD #1 Temperature

An FSI PRT sensor (PRT2) was deployed as a second temperature channel and compared with the primary PRT channel (PRT1) on most casts to monitor for drift. The response times of the primary and secondary PRT sensors were matched, then preliminary corrected temperatures were compared for a series of standard depths from each CTD down-cast.

There was a large drift in the PRT1-PRT2 differences during the first two casts. It was determined that the first FSI PRT flooded, and another replaced it beginning at station 150. The second FSI PRT was used for the rest of the cruise, except when the pressure sensor was substituted in its place on stations 197-199 and when the original FSI PRT was back on for testing during stations 200-203. A third FSI PRT was installed prior to the aborted cast at station 204, and was replaced by the second sensor for the remainder of the leg.

There was a slow, steady drift in the differences between the CTD #1 primary PRT and the second FSI PRT over the course of the leg. Figure 1.7.2.0 summarizes the comparison between the primary and secondary PRT temperatures.

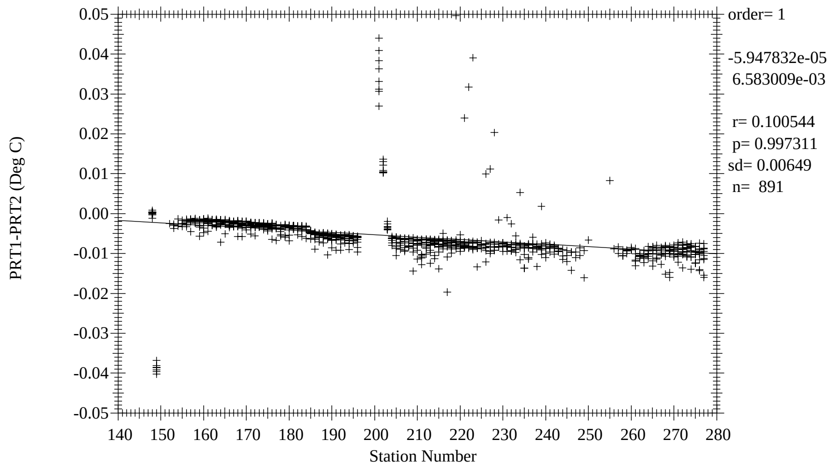


Figure 1.7.2.0 Shipboard comparison of CTD #1 primary/secondary PRT temperatures, pressure > 1800 db.

The primary temperature sensor laboratory calibrations indicated a -0.001°C shift at 0°C, -0.0006°C shift at mid-range temperatures, and a -0.0014°C shift at 32°C from pre- to post-cruise. The pre- and post-cruise temperature calibrations were equally weighted and combined to generate an average temperature correction, which was applied to all CTD casts done during the 5 legs between calibrations. Figure 1.7.2.1 summarizes the average of the pre-/post-cruise laboratory temperature calibrations for CTD #1.

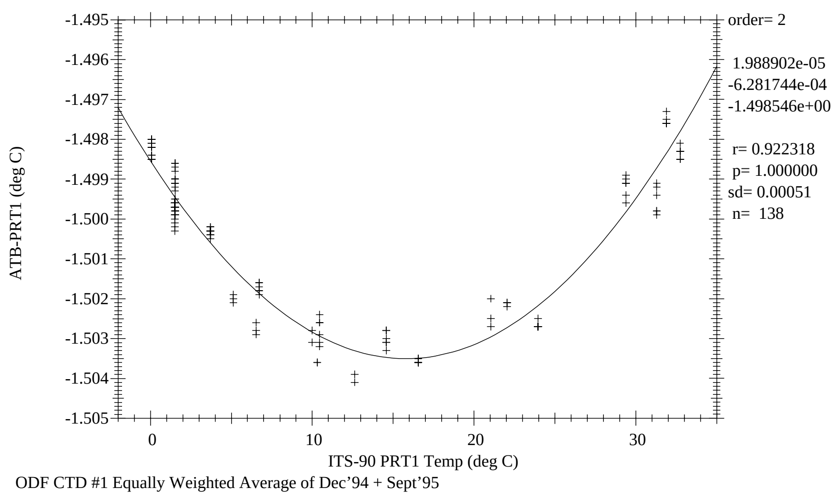


Figure 1.7.2.1 Primary temperature correction for ODF CTD #1, Dec.94/Sept.95 equally weighted average.

The 10-month pre- to post-cruise laboratory calibration shift for the primary temperature sensor on CTD #1 was less than half the magnitude of the WOCE accuracy standard of 0.002°C. Since an average of the two calibrations was applied to the data, I9N CTD temperatures should be well within the WOCE specifications.

The secondary FSI temperature sensors either failed or drifted during I9N far more than the primary sensor drifted during the 10 months between laboratory calibrations. The FSI PRT sensors seemed to monitor their own drift better than that of the primary temperature sensor mounted permanently on CTD #1. Any comparison of their pre- and post-cruise calibrations was deemed fruitless.

1.7.3. CTD #1 Conductivity

The corrected CTD rosette trip pressure and temperature were used with the bottle salinity to calculate a bottle conductivity. Differences between the bottle and CTD conductivities were then used to derive a conductivity correction. This correction is normally linear for the 3cm conductivity cell used in the Mark III CTD.

Cast-by-cast comparisons showed typical conductivity sensor drift at the start of the leg, after a long period of non-use. The differences were fairly stable, aside from a slow cast-to-cast drift, until station 203-204, where the CTD shifted ~0.002 PSU each cast. The conductivity sensor was swabbed with distilled water prior to station 205, which offset the CTD conductivity but stabilized the drift. A slow drift was evident beginning with stations in the early 220's, then the sensor displayed ±0.002 PSU salinity offsetting on the down-cast of station 253 and the up-casts of stations 254-256. The sensor was swabbed again before station 257. This again shifted the conductivity, but it remained stable except for some ±0.002 PSU salinity offsetting during the down-casts of stations 267 and 268. A third sensor swabbing did not shift the conductivity, but did clear up the offsetting problem.

Conductivity differences above and below the thermocline were fit to CTD conductivity for all 5 legs together to determine the conductivity slope. The conductivity slope gradually increased from stations 148 to 800 (I7N), after which the conductivity sensor was swabbed with alcohol. Figure 1.7.3.0 shows the individual preliminary conductivity slopes for stations 148-800.

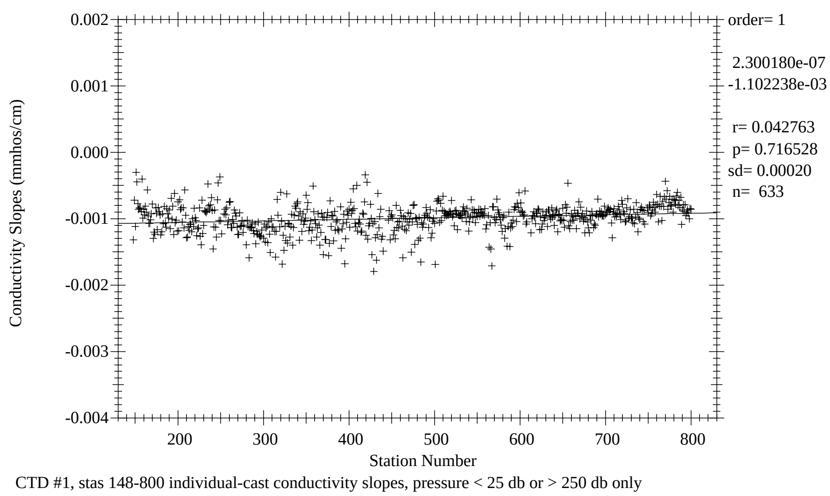


Figure 1.7.3.0 CTD #1 prelim. conductivity slopes for stations 148(I9N) through 800(I7N).

The conductivity slopes for stations 148-800 were fit to station number, with outlying values (4,2 standard deviations) rejected. Conductivity slopes were calculated from the first-order fit and applied to each I9N cast.

Once the conductivity slopes were applied, residual CTD conductivity offset values were calculated for each cast using bottle conductivities deeper than 1400 db. Figure 1.7.3.1 illustrates the I9N preliminary conductivity offset residual values.

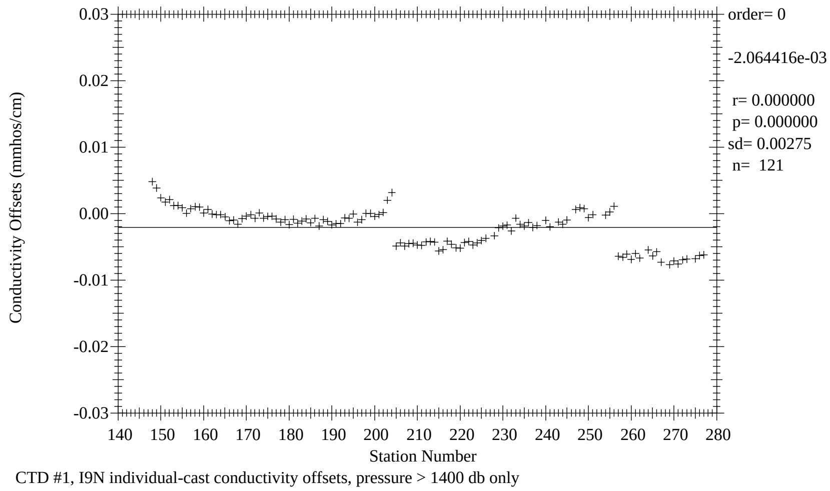


Figure 1.7.3.1 CTD #1 preliminary conductivity offsets by station number for I9N.

Casts were grouped together based on drift and/or known CTD conductivity shifts to determine average offsets. This also smoothed the effect of any cast-to-cast bottle salinity variation, typically on the order of ±0.001 PSU. Nine casts were omitted from the groups because of known bottle or CTD salinity problems, or because they were shallower than 1400 db. Smoothed offsets were applied to each cast, then some offsets were manually adjusted to account for discontinuous shifts in the conductivity transducer response or bottle salinities, or to maintain deep theta-salinity consistency from cast to cast.

After applying the conductivity slopes and offsets to each cast, it was determined that surface salinity differences were ~0.008 PSU high compared to intermediate and deep differences. After the offset adjustments were made, a mean second-order conductivity correction was calculated for stations 148-800. Figure 1.7.3.2 shows the residual conductivity differences used for determining this correction.

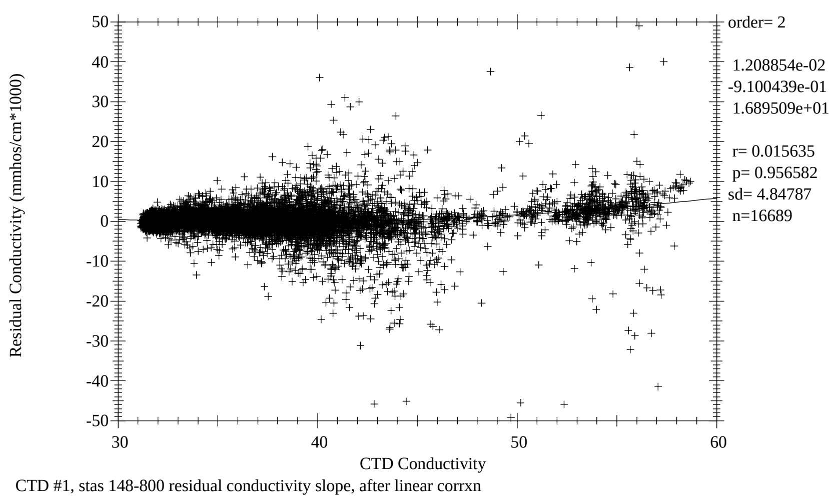


Figure 1.7.3.2 CTD #1 residual non-linear conductivity slope.

A 4,2-standard deviation rejection of the second-order fit was performed on the differences, then the remaining values were fit to conductivity. This non-linear correction, added to the linear corrections for each cast, effectively pulled in surface differences while having minimal effect on differences below the thermocline/halocline.

The final I9N conductivity slopes, a combination of the linear coefficients from the preliminary and second-order fits, are summarized in Figure 1.7.3.3. Figure 1.7.3.4 summarizes the final combined conductivity offsets by station number.

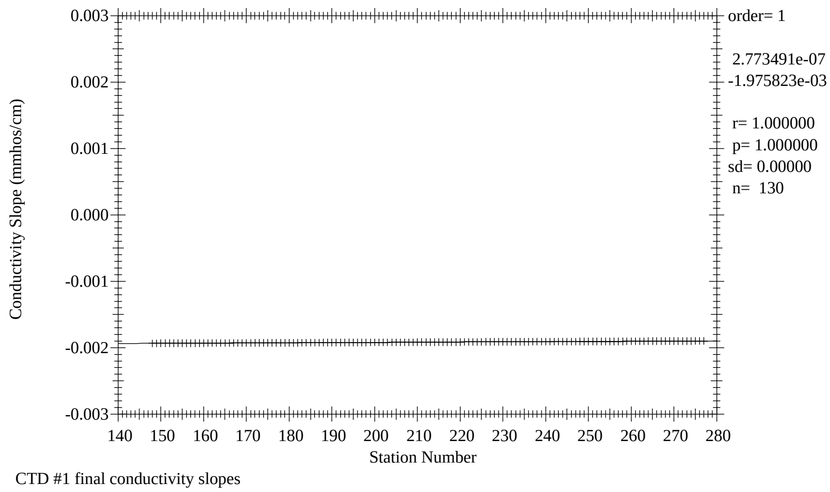


Figure 1.7.3.3 CTD #1 conductivity slope corrections by station number.

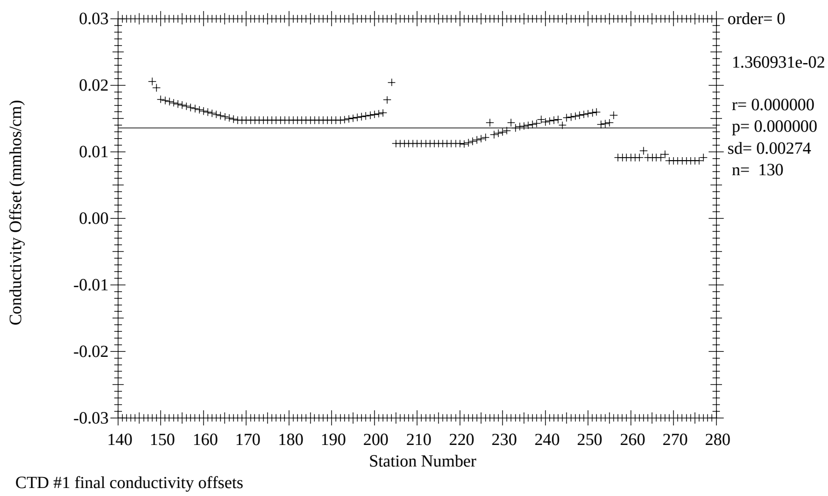


Figure 1.7.3.4 CTD #1 conductivity offsets by station number.

I9N temperature and conductivity correction coefficients are also tabulated in Appendix A.

Summary of Residual Salinity Differences

Figures 1.7.3.5, 1.7.3.6 and 1.7.3.7 summarize the residual differences between bottle and CTD salinities after applying the conductivity corrections.

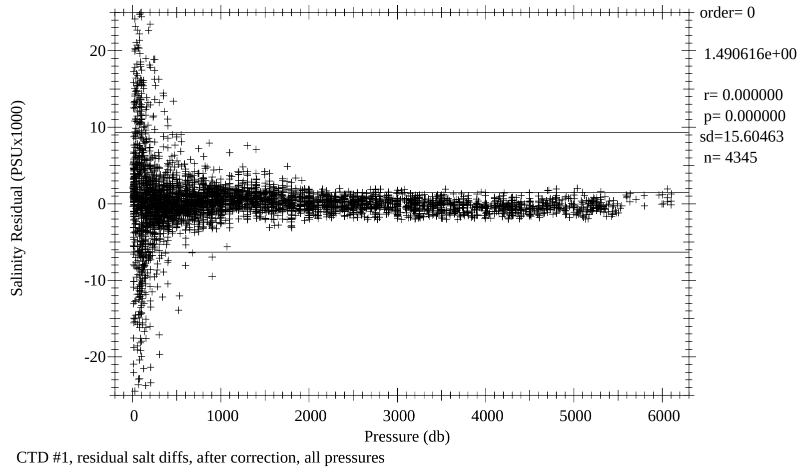


Figure 1.7.3.5 Salinity residual differences vs pressure (after correction).

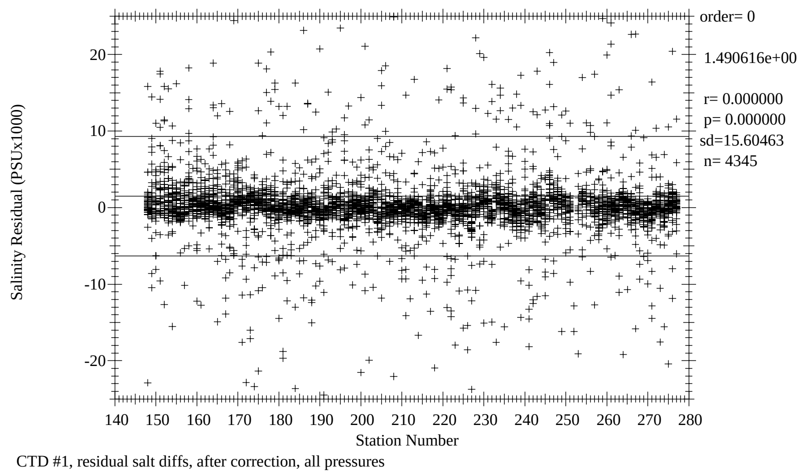


Figure 1.7.3.6 Salinity residual differences vs station # (after correction).

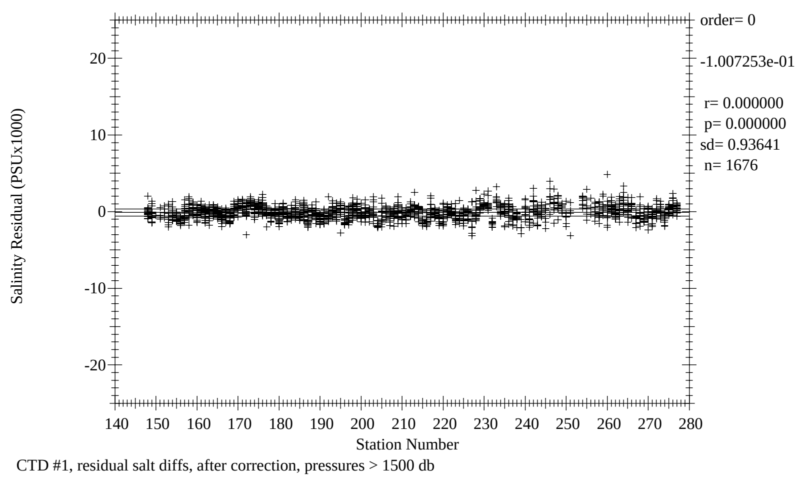


Figure 1.7.3.7 Deep salinity residual differences vs station # (after correction).

The CTD conductivity calibration represents a best estimate of the conductivity field throughout the water column. 3σ from the mean residual in Figures 1.7.3.6 and 1.7.3.7, or ±0.0234 PSU for all salinities and ±0.0014 PSU for deep salinities, represents the limit of repeatability of the bottle salinities (Autosal, rosette, operators and samplers). This limit agrees with station overlays of deep Theta-Salinity. Within a cast (a single salinometer run), the precision of bottle salinities appears to exceed 0.001 PSU. The precision of the CTD salinities appears to exceed 0.0005 PSU.

Final calibrated CTD data from WOCE95 I3 and I8N/I5E legs were compared with I9N data. Deep Theta-Salinity comparisons for casts at four positions where the WOCE lines crossed showed less than 0.001 PSU difference for each group of casts. Tw o stations from GEOSECS were also compared with I9N casts at the same positions. The GEOSECS data were 0.0005-0.0015 PSU higher than I9N data. This difference becomes less than ±0.001 PSU if GEOSECS salinity values are corrected for standard seawater batch differences [Mant87]. The standard seawater batch from the five consecutive ODF legs has not been compared to other batches. A cross-calibration is planned for Fall 1997; however, recent batches from OSI have been quite reliable, requiring, at worst, a ±0.001 PSU correction [Mant97].

1.7.4. CTD Dissolved Oxygen

There are a number of problems with the response characteristics of the Sensormedics O_2 sensor used in the NBIS Mark III CTD, the major ones being a secondary thermal response and a sensitivity to profiling velocity. Stopping the rosette for as little as half a minute, or slowing down for a bottom approach, can cause shifts in the CTD O_2 profile. All winch stops or slow-downs that affected CTD oxygen data are documented in Appendix C. As noted in Section 1.1, the winch was stopped around 4060m wire out on every down- and up-cast from station 172 through 211, and on station 277. There was frequently a noticeable effect on the CTD O_2 profiles, which could often be corrected by offsetting the raw oxygen data from the stop to the bottom of the cast. The offset sections are also documented in Appendix C.

Because of these same stop/slow-down problems, up-cast CTD rosette trip data cannot be optimally calibrated to O_2 check samples. Instead, down-cast CTD O_2 data are derived by matching the up-cast rosette trips along isopycnal surfaces. When down-casts were deemed to be unusable (see Appendix C), up-cast CTD O_2 data were processed despite the signal drop-offs typically seen at bottle stops. The differences between CTD O_2 data modeled from these derived values and check samples are then minimized using a non-linear least-squares fitting procedure.

The same oxygen sensor was used on all but 4 of the I9N CTD casts. Figures 1.7.4.0 and 1.7.4.1 show the residual differences between the corrected CTD O_2 and the bottle O_2 (ml/l) for each station.

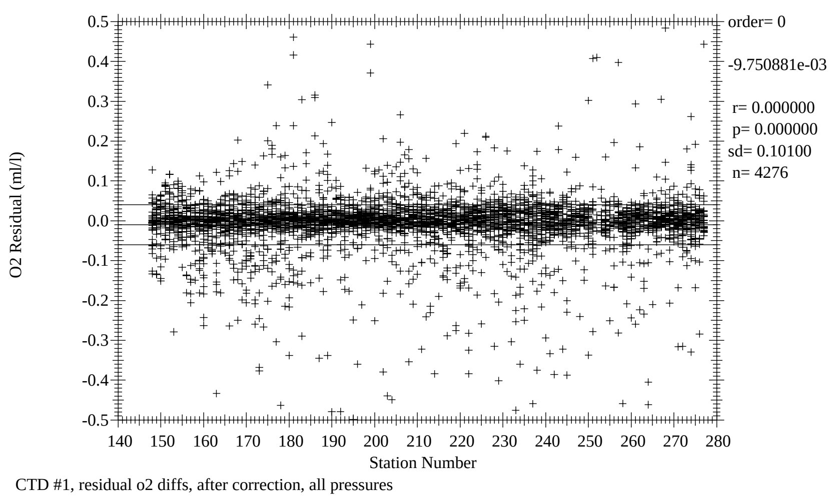


Figure 1.7.4.0 O_2 residual differences vs station # (after correction).

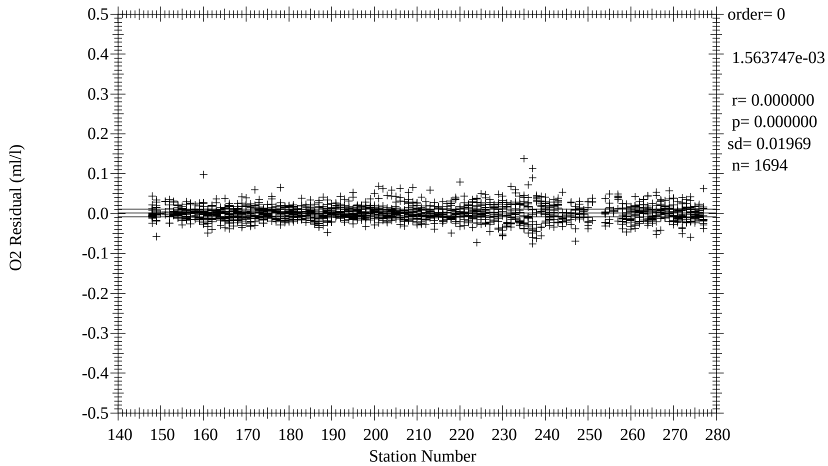


Figure 1.7.4.1 Deep O_2 residual differences vs station # (after correction).

The standard deviations of 0.10 ml/l for all oxygens and 0.02 ml/l for deep oxygens are only intended as metrics of the goodness of the fits. ODF makes no claims regarding the precision or accuracy of CTD dissolved O_2 data.

The general form of the ODF O_2 conversion equation follows Brown and Morrison [Brow78] and Millard [Mill82], [Owen85]. ODF does not use a digitized O_2 sensor temperature to model the secondary thermal response but instead models membrane and sensor temperatures by low-pass filtering the PRT temperature. *In-situ* pressure and temperature are filtered to match the sensor response. Time-constants for the pressure response τ_p, and two temperature responses τ_{Ts} and τ_{Tf} are fitting parameters. The sensor current, or O_c, gradient is approximated by low-pass filtering 1st-order O_c differences. This term attempts to correct for reduction of species other than O_2 at the cathode. The time-constant for this filter, τ_{og}, is a fitting parameter. Oxygen partial-pressure is then calculated:

$$O_{pp} = [c_1 O_c + c_2] \cdot f_{sat}(S,T,P) \cdot e^{(c_3 P_l + c_4 T_f + c_5 T_s + c_6 \frac{dO_c}{dt})} \qquad (1.7.4.0)$$

where:

O_{pp}	= Dissolved O_2 partial-pressure in atmospheres (atm);
O_c	= Sensor current (μamps);
$f_{sat}(S,T,P)$	= O_2 saturation partial-pressure at S,T,P (atm);
S	= Salinity at O_2 response-time (PSUs);
T	= Temperature at O_2 response-time (°C);
P	= Pressure at O_2 response-time (decibars);
P_l	= Low-pass filtered pressure (decibars);
T_f	= Fast low-pass filtered temperature (°C);
T_s	= Slow low-pass filtered temperature (°C);
$\frac{dO_c}{dt}$	= Sensor current gradient (μamps/secs).

I9N CTD O_2 correction coefficients (c_1 through c_6) are tabulated in Appendix B.

1.8. Bottle Sampling

At the end of each rosette deployment water samples were drawn from the bottles in the following order:

- CFCs;
- ^{3}He;
- O_2;
- Total CO_2;
- Alkalinity;
- AMS ^{14}C;
- Tritium;
- Nutrients;
- Salinity;
- Barium.

The correspondence between individual sample containers and the rosette bottle from which the sample was drawn was recorded on the sample log for the cast. This log also included any comments or anomalous conditions noted about the rosette and bottles. One member of the sampling team was designated the *sample cop*, whose sole responsibility was to maintain this log and insure that sampling progressed in the proper drawing order.

Normal sampling practice included opening the drain valve before opening the air vent on the bottle, indicating an air leak if water escaped. This observation together with other diagnostic comments (e.g., "lanyard caught in lid", "valve left open") that might later prove useful in determining sample integrity were routinely noted on the sample log.

Drawing oxygen samples also involved taking the sample draw temperature from the bottle. The temperature was noted on the sample log and was sometimes useful in determining leaking or mis-tripped bottles.

Once individual samples had been drawn and properly prepared, they were distributed to their respective laboratories for analysis. Oxygen, nutrients and salinity analyses were performed on computer-assisted (PC) analytical equipment networked to Sun SPARCstations for centralized data analysis. The analysts for each specific property were responsible for insuring that their results were updated into the cruise database.

1.9. Bottle Data Processing

The first stage of bottle data processing consisted of verifying and validating individual samples, and checking the sample log (the sample inventory) for consistency. At this stage, bottle tripping problems were usually resolved, sometimes resulting in changes to the pressure, temperature and other CTD properties associated with the bottle. Note that the rosette bottle number was the primary identification for all samples taken from the bottle, as well as for the CTD data associated with the bottle. All CTD trips were retained (whether confirmed or not), so resolving bottle tripping problems simply consisted of assigning the right rosette bottle number to the right CTD trip level.

Diagnostic comments from the sample log were entered into the computer as part of the quality control procedure. Every potential problem indicated in these computer files was investigated. The data were coded with the results of the investigation.

The second stage of processing began once all the samples for a cast had been accounted for. Oxygen flask numbers were verified, as each flask is volumetrically calibrated and significantly affects the calculated O_2 concentration. All samples for bottles suspected of leaking were checked to see if the properties were consistent with the profile for the cast, with adjacent stations, and, where applicable, with the CTD data. All comments from the analysts were examined and turned into appropriate WHP water sample codes.

The third stage of processing continued throughout the cruise and until the data set was considered "final". Various property-property plots and vertical sections were examined for both consistency within a cast and consistency with adjacent stations. In conjunction with this process, the analysts reviewed and sometimes revised their data as additional calibration or diagnostic results became available. Assignment of a WHP water sample code to an anomalous sample value was typically achieved through consensus between analysts and one of the chief scientists.

WHP water bottle quality flags were assigned as defined in the WOCE Operations Manual [Joyc94] with the following additional interpretations:

2	No problems noted.
3	Leaking. *An air leak large enough to produce an observable effect on a sample is identified by a code of 3 on the bottle and a code of 4 on the oxygen. (Small air leaks may have no observable effect, or may only affect gas samples.)*
4	Did not trip correctly. *Bottles tripped at other than the intended depth were assigned a code of 4. There may be no problems with the associated water sample data.*
5	Not reported. *No water sample data reported. This is a representative level derived from the CTD data for reporting purposes. The sample number should be in the range of 80-99.*
9	The samples were not drawn from this bottle.

WHP water sample quality flags were assigned using the following criteria:

1	The sample for this measurement was drawn from the water bottle, but the results of the analysis were not *(yet)* received.
2	Acceptable measurement.
3	Questionable measurement. *The data did not fit the station profile or adjacent station comparisons (or possibly CTD data comparisons). No notes from the analyst indicated a problem. The data could be acceptable, but are open to interpretation.*
4	Bad measurement. *The data did not fit the station profile, adjacent stations or CTD data. There were analytical notes indicating a problem, but data values were reported. Sampling and analytical errors were also coded as 4.*
5	Not reported. *There should always be a reason associated with a code of 5, usually that the sample was lost, contaminated or rendered unusable.*
9	The sample for this measurement was not drawn.

WHP water sample quality flags were assigned to the CTDSAL (CTD salinity) parameter as follows:

2	Acceptable measurement.
3	Questionable measurement. *The data did not fit the bottle data, or there was a CTD conductivity calibration shift during the up-cast.*
4	Bad measurement. *The CTD up-cast data were determined to be unusable for calculating a salinity.*
7	Despiked. *The CTD data have been filtered to eliminate a spike or offset.*

WHP water sample quality flags were assigned to the CTDOXY (CTD O_2) parameter as follows:

2	Acceptable measurement.
3	Questionable measurement.
4	Bad measurement. *The CTD data were determined to be unusable for calculating a dissolved oxygen concentration.*
5	Not reported. *The CTD data could not be reported, typically when CTD salinity is coded 3 or 4.*
7	Despiked. *The CTD data have been filtered to eliminate a spike or offset.*
9	Not sampled. *No operational CTD O_2 sensor was present on this cast.*

Note that all CTDOXY values were derived from the down-cast pressure-series CTD data. CTD data were matched to the up-cast bottle data along isopycnal surfaces. If the CTD salinity was footnoted as bad or questionable, the CTD O_2 was not reported.

Table 1.9.0 shows the number of samples drawn and the number of times each WHP sample quality flag was assigned for each basic hydrographic property:

Rosette Samples Stations 148-277								
	Reported levels	WHP Quality Codes						
		1	2	3	4	5	7	9
Bottle	4526	0	4511	13	1	0	0	1
CTD Salt	4526	0	4464	21	25	0	16	0
CTD Oxy	4480	0	4314	120	14	46	32	0
Salinity	4515	0	4391	103	21	1	0	10
Oxygen	4500	0	4454	28	18	7	0	19
Silicate	4502	0	4484	6	12	3	0	21
Nitrate	4504	0	4484	8	12	1	0	21
Nitrite	4504	0	4491	1	12	1	0	21
Phosphate	4504	0	4476	16	12	1	0	21

Table 1.9.0 Frequency of WHP quality flag assignments.

Additionally, all WHP water bottle/sample quality code comments are presented in Appendix D.

During shipboard data quality evaluation, the data were compared with the GEOSECS Indian Ocean data.

1.10. Pressure and Temperatures

All pressures and temperatures for the bottle data tabulations on the rosette casts were obtained by averaging CTD data for a brief interval at the time the bottle was closed on the rosette, then correcting the data based on CTD laboratory calibrations.

The temperatures are reported using the International Temperature Scale of 1990.

1.11. Salinity Analysis

Equipment and Techniques

Two Guildline Autosal Model 8400A salinometers were used to measure salinities. Autosal #57-396 was used on stations 148-233, and stations 242-277. Autosal #55-654 was used for stations 234-241. These were located in a temperature controlled laboratory. The salinometers were modified by ODF and contained interfaces for computer-aided measurement. A computer (PC) prompted the analyst for control functions (changing sample, flushing) while it made continuous measurements and logged results. The salinometers were standardized for each group of analysis (typically one cast, usually 36 samples) using at least one fresh vial of standard per cast. The salinity analyses were performed when samples had equilibrated to laboratory temperature, usually within 8-20 hours after collection. The salinometer cell was flushed until successive readings met software criteria for consistency, then two successive measurements were made and averaged for a final result.

Sampling and Data Processing

Salinity samples were drawn into 200 ml Kimax high alumina borosilicate bottles, which were rinsed three times with sample prior to filling. The bottles were sealed with custom-made plastic insert thimbles and Nalgene screw caps. This assembly provides very low container dissolution and sample evaporation. Prior to collecting each sample, inserts were inspected for proper fit and loose inserts were replaced to insure an airtight seal. During the first week of the expedition, the salinity samples may not have been analyzed up to 36 hours after collection. This did not appear to have an adverse effect on the data. The draw time, equilibration time, per-sample analysis time, and laboratory temperature were logged for all samples.

The data were added to the cruise database. PSS-78 salinity [UNES81] was then calculated for each sample from the measured conductivity ratios. 4515 salinity measurements were made and 316 vials of standard water were used. The estimated accuracy of bottle salinities run at sea is usually better than 0.002 PSU relative to the particular Standard Seawater batch used.

Laboratory Temperature

The temperature stability in the salinometer laboratory was fair, with the lab temperature generally 1-2°C lower than the Autosal bath temperature.

Standards

IAPSO Standard Seawater (SSW) Batch P-126, was used to standardize the salinometers.

1.12. Oxygen Analysis

Equipment and Techniques

Dissolved oxygen analyses were performed with an ODF-designed automated oxygen titrator using photometric end-point detection based on the absorption of 365nm wavelength ultra-violet light. The samples were titrated and the data logged by the PC control software. Thiosulfate was dispensed by a Dosimat 665 buret driver fitted with a 1.0 ml buret. ODF used a whole-bottle modified-Winkler titration following the technique of Carpenter [Carp65] with modifications by Culberson *et al.* [Culb91], but with higher concentrations of potassium iodate standard (approximately 0.012N) and thiosulfate solution (50 gm/l). Standard solutions prepared from pre-weighed potassium iodate crystals were run at the beginning of each session of analyses, which typically included from 1 to 3 stations. Several standards were made up during the cruise and compared to assure that the results were reproducible, and to preclude the possibility of a weighing error. Reagent/distilled water blanks were determined to account for presence of oxidizing or reducing materials.

Sampling and Data Processing

Samples were collected for dissolved oxygen analyses soon after the rosette sampler was brought on board and after CFC and helium were drawn. Nominal 125ml volume-calibrated iodine flasks were rinsed twice with minimal agitation, then filled via a drawing tube, and allowed to overflow for at least 3 flask volumes. The sample temperature was measured with a small platinum resistance thermometer embedded in the drawing tube. Reagents were added to fix the oxygen before stoppering. The flasks were shaken twice to assure thorough dispersion of the precipitate, once immediately after drawing, and then again after 20 minutes. The samples were analyzed within 4 hours of collection and the data were then merged with the cruise database.

Thiosulfate normalities were calculated from each standardization and corrected to 20°C. The 20°C normalities and the blanks were plotted versus time and were reviewed for possible problems. New thiosulfate normalities were recalculated after the blanks had been smoothed. These normalities were then smoothed, and the oxygen data were recalculated.

Oxygens were converted from milliliters per liter to micromoles per kilogram using the *in-situ* temperature. Ideally, for whole-bottle titrations, the conversion temperature should be the temperature of the water issuing from the bottle spigot. The sample temperatures were measured at the time the samples were drawn from the bottle, but were not used in the conversion from milliliters per liter to micromoles per kilogram because the software for this calculation was not available. Aberrant drawing temperatures provided an additional flag indicating that a bottle may not have tripped properly.

4500 oxygen measurements were made. No major problems were encountered with the analyses. The auto-titrator generally performed very well.

Calibration

Oxygen flasks were calibrated gravimetrically with degassed deionized water (DIW) to determine flask volumes at ODF's chemistry laboratory. This is done once before using flasks for the first time and periodically thereafter when a suspect bottle volume is detected. All volumetric glassware used in preparing standards were calibrated, as was the 10 ml Dosimat buret used to dispense standard iodate solution.

Laboratory Temperature

The temperature stability of the laboratory used for the analyses was poor, varying from 22 to 28°C over short time scales. Portable fans were used to assist in maintaining some temperature stability.

Standards

Iodate standards were pre-weighed in ODF's chemistry laboratory to a nominal weight of 0.44xx grams. The exact normality was calculated at sea after the volumetric flask volume and dilution temperature were known. Potassium iodate was obtained from Johnson Matthey Chemical Co. and was reported by the supplier to be >99.4% pure. All other reagents are "reagent grade" and are tested for levels of oxidizing and reducing impurities prior to use.

1.13. Nutrient Analysis

Equipment and Techniques

Nutrient analyses (phosphate, silicate, nitrate and nitrite) were performed on an ODF-modified 4-channel Technicon AutoAnalyzer II, generally within one hour after sample collection. Occasionally some samples were refrigerated at 2 to 6°C for a maximum of 4 hours. The methods used are described by Gordon *et al.* [Gord92], Hager *et al.* [Hage72], Atlas *et al.* [Atla71]. The analog outputs from each of the four channels were digitized and logged automatically by computer (PC). The raw file was then processed to produce another file of absorbances, response factors and baseline values.

Silicate was analyzed using the technique of Armstrong *et al.* [Arms67]. An acidic solution of ammonium molybdate was added to a seawater sample to produce silicomolybdic acid which was then reduced to silicomolybdous acid (a blue compound) following the addition of stannous chloride. Tartaric acid was also added to impede PO_4 color development. The sample was passed through a 15mm flowcell and the absorbance measured at 820nm. ODF's methodology is known to be non-linear at high silicate concentrations (>120 μM); a correction for this non-linearity is applied through ODF's software.

A modification of the Armstrong *et al.* [Arms67] procedure was used for the analysis of nitrate and nitrite. For the nitrate analysis, the seawater sample was passed through a cadmium reduction column where nitrate was quantitively reduced to nitrite. Sulfanilamide was introduced to the sample stream followed by N-(1-naphthyl)ethylenediamine dihydrochloride which coupled to form a red azo dye. The stream was then passed through a 15mm flowcell and the absorbance measured at 540nm. The same technique was employed for nitrite analysis, except the cadmium column was not present, and a 50mm flowcell was used for measurement.

Phosphate was analyzed using a modification of the Bernhardt and Wilhelms [Bern67] technique. An acidic solution of ammonium molybdate was added to the sample to produce phosphomolybdic acid, then reduced to phosphomolybdous acid (a blue compound) following the addition of dihydrazine sulfate. The reaction product was heated to ~55°C to enhance color development, then passed through a 50mm flowcell and the absorbance measured at 820m.

Sampling and Data Processing

Nutrient samples were drawn into 45ml polypropylene, narrow mouth, screw-capped centrifuge tubes. The tubes were cleaned with 10% HCl and rinsed with sample three times before filling. Standardizations were performed at the beginning and end of each group of analyses (typically one cast, usually 36 samples) with an intermediate concentration mixed nutrient standard prepared prior to each run from a secondary standard in a low-nutrient seawater matrix. The secondary standards were prepared aboard ship by dilution from dry, pre-weighed primary standards. Sets of 5-6 different standard concentrations were analyzed periodically to determine the deviation from linearity as a function of concentration for each nutrient.

4504 nutrient samples were analyzed. Each computer absorbance reading was checked for accuracy against a strip chart recorded value. The data were then added to the cruise database. No major problems were encountered with the measurements. The pump tubing was changed once. An aliquot of stored, large volume deep seawater was run with each set of samples as a substandard. The efficiency of the cadmium column used for nitrate reduction was monitored throughout the cruise and ranged from 99.8-100.0%.

Nutrients, reported in micromoles per kilogram, were converted from micromoles per liter by dividing by sample density calculated at 1 atm pressure, *in-situ* salinity, and an assumed laboratory temperature of 25°C.

Laboratory Temperature

The temperature stability of the laboratory used for the analyses was poor, varying from 22 to 28°C over short time scales. Portable fans were used to assist in maintaining some temperature stability.

Standards

Na_2SiF_6, the silicate primary standard, was obtained from Fluka Chemical Company and Fisher Scientific and was reported by the suppliers to be >98% pure. Primary standards for nitrate (KNO_3), nitrite ($NaNO_2$), and phosphate (KH_2PO_4) were obtained from Johnson Matthey Chemical Co. and the supplier reported purities of 99.999%, 97%, and 99.999%, respectively.

References

Arms67.

Armstrong, F. A. J., Stearns, C. R., and Strickland, J. D. H., “The measurement of upwelling and subsequent biological processes by means of the Technicon Autoanalyzer and associated equipment,” *Deep-Sea Research,* 14, pp. 381-389 (1967).

Atla71.

Atlas, E. L., Hager, S. W., Gordon, L. I., and Park, P. K., “A Practical Manual for Use of the Technicon AutoAnalyzer® in Seawater Nutrient Analyses Revised,” Technical Report 215, Reference 71-22, p. 49, Oregon State University, Department of Oceanography (1971).

Bern67.

Bernhardt, H. and Wilhelms, A., “The continuous determination of low level iron, soluble phosphate and total phosphate with the AutoAnalyzer,” *Technicon Symposia,* I, pp. 385-389 (1967).

Brow78.

Brown, N. L. and Morrison, G. K., “WHOI/Brown conductivity, temperature and depth microprofiler,” Technical Report No. 78-23, Woods Hole Oceanographic Institution (1978).

Carp65.

Carpenter, J. H., “The Chesapeake Bay Institute technique for the Winkler dissolved oxygen method,” *Limnology and Oceanography,* 10, pp. 141-143 (1965).

Cart80.

Carter, D. J. T., “Computerised Version of Echo-sounding Correction Tables (Third Edition),” Marine Information and Advisory Service, Institute of Oceanographic Sciences, Wormley, Godalming, Surrey. GU8 5UB. U.K. (1980).

Culb91.

Culberson, C. H., Knapp, G., Stalcup, M., Williams, R. T., and Zemlyak, F., “A comparison of methods for the determination of dissolved oxygen in seawater,” Report WHPO 91-2, WOCE Hydrographic Programme Office (Aug 1991).

Gord92.

Gordon, L. I., Jennings, J. C., Jr., Ross, A. A., and Krest, J. M., “A suggested Protocol for Continuous Flow Automated Analysis of Seawater Nutrients in the WOCE Hydrographic Program and the Joint Global Ocean Fluxes Study,” Grp. Tech Rpt 92-1, OSU College of Oceanography Descr. Chem Oc. (1992).

Hage72.

Hager, S. W., Atlas, E. L., Gordon, L. D., Mantyla, A. W., and Park, P. K., “A comparison at sea of manual and autoanalyzer analyses of phosphate, nitrate, and silicate,” *Limnology and Oceanography,* 17, pp. 931-937 (1972).

Joyc94.

Joyce, T., ed. and Corry, C., ed., “Requirements for WOCE Hydrographic Programme Data Reporting,” Report WHPO 90-1, WOCE Report No. 67/91, pp. 52-55, WOCE Hydrographic Programme Office, Woods Hole, MA, USA (May 1994, Rev. 2). UNPUBLISHED MANUSCRIPT.

Mant87.

Mantyla, A. W., “Standard Seawater Comparisons Updated,” *Journal of Physical Oceanography,* 17.4, p. 547 (1987).

Mant97.

Mantyla, A. W. (1997). Private communication.

Mill82.

Millard, R. C., Jr., “CTD calibration and data processing techniques at WHOI using the practical salinity scale,” Proc. Int. STD Conference and Workshop, p. 19, Mar. Tech. Soc., La Jolla, Ca. (1982).

Owen85.
Owens, W. B. and Millard, R. C., Jr., “A new algorithm for CTD oxygen calibration,” *Journ. of Am. Meteorological Soc.*, 15, p. 621 (1985).

UNES81.
UNESCO, “Background papers and supporting data on the Practical Salinity Scale, 1978,” UNESCO Technical Papers in Marine Science, No. 37, p. 144 (1981).

Appendix A

WOCE95-I9N: CTD Temperature and Conductivity Corrections Summary

Sta/ Cast	PRT Response Time (secs)	ITS-90 Temperature Coefficients $corT = t2*T^2 + t1*T + t0$			Conductivity Coefficients $corC = c2*C^2 + c1*C + c0$		
		t2	t1	t0	c2	c1	c0
148/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93477e-03	0.02058
149/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93450e-03	0.01962
150/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93422e-03	0.01790
151/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93394e-03	0.01772
152/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93366e-03	0.01755
153/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93339e-03	0.01737
154/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93311e-03	0.01719
155/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93283e-03	0.01702
156/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93255e-03	0.01684
157/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93228e-03	0.01667
158/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93200e-03	0.01649
159/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93172e-03	0.01632
160/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93144e-03	0.01614
161/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93117e-03	0.01596
162/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93089e-03	0.01579
163/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93061e-03	0.01561
164/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93033e-03	0.01544
165/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.93006e-03	0.01526
166/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92978e-03	0.01508
167/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92950e-03	0.01491
168/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92923e-03	0.01475
169/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92895e-03	0.01475
170/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92867e-03	0.01475
171/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92839e-03	0.01475
172/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92812e-03	0.01475
173/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92784e-03	0.01475
174/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92756e-03	0.01475
175/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92728e-03	0.01475
176/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92701e-03	0.01475
177/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92673e-03	0.01475
178/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92645e-03	0.01475
179/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92617e-03	0.01475
180/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92590e-03	0.01475
181/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92562e-03	0.01475
182/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92534e-03	0.01475
183/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92507e-03	0.01475
184/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92479e-03	0.01475
185/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92451e-03	0.01475
186/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92423e-03	0.01475

Sta/ Cast	PRT Response Time (secs)	ITS-90 Temperature Coefficients corT = t2∗T² + t1∗T + t0 t2	t1	t0	Conductivity Coefficients corC = c2∗C² + c1∗C + c0 c2	c1	c0
187/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92396e-03	0.01475
188/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92368e-03	0.01475
189/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92340e-03	0.01475
190/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92312e-03	0.01475
191/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92285e-03	0.01475
192/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92257e-03	0.01475
193/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92229e-03	0.01483
194/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92201e-03	0.01494
195/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92174e-03	0.01505
196/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92146e-03	0.01516
197/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92118e-03	0.01528
198/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92090e-03	0.01539
199/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92063e-03	0.01550
200/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92035e-03	0.01561
201/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.92007e-03	0.01573
202/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91980e-03	0.01584
203/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91952e-03	0.01780
204/02	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91924e-03	0.02043
205/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91896e-03	0.01124
206/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91869e-03	0.01124
207/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91841e-03	0.01124
208/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91813e-03	0.01124
209/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91785e-03	0.01124
210/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91758e-03	0.01124
211/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91730e-03	0.01124
212/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91702e-03	0.01124
213/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91674e-03	0.01124
214/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91647e-03	0.01124
215/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91619e-03	0.01124
216/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91591e-03	0.01124
217/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91564e-03	0.01124
218/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91536e-03	0.01124
219/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91508e-03	0.01124
220/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91480e-03	0.01124
221/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91453e-03	0.01117
222/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91425e-03	0.01137
223/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91397e-03	0.01158
224/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91369e-03	0.01178
225/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91342e-03	0.01198
226/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91314e-03	0.01218
227/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91286e-03	0.01438

Sta/ Cast	PRT Response Time (secs)	ITS-90 Temperature Coefficients corT = t2∗T² + t1∗T + t0 t2	t1	t0	Conductivity Coefficients corC = c2∗C² + c1∗C + c0 c2	c1	c0
228/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91258e-03	0.01258
229/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91231e-03	0.01278
230/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91203e-03	0.01298
231/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91175e-03	0.01318
232/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91147e-03	0.01438
233/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91120e-03	0.01358
234/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91092e-03	0.01378
235/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91064e-03	0.01387
236/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91037e-03	0.01400
237/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.91009e-03	0.01412
238/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90981e-03	0.01425
239/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90953e-03	0.01487
240/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90926e-03	0.01449
241/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90898e-03	0.01462
242/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90870e-03	0.01474
243/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90842e-03	0.01487
244/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90815e-03	0.01399
245/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90787e-03	0.01512
246/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90759e-03	0.01524
247/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90731e-03	0.01537
248/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90704e-03	0.01549
249/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90676e-03	0.01561
250/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90648e-03	0.01574
251/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90621e-03	0.01586
252/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90593e-03	0.01599
253/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90565e-03	0.01411
254/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90537e-03	0.01424
255/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90510e-03	0.01436
256/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90482e-03	0.01548
257/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90454e-03	0.00914
258/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90426e-03	0.00914
259/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90399e-03	0.00914
260/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90371e-03	0.00914
261/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90343e-03	0.00914
262/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90315e-03	0.00914
263/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90288e-03	0.01014
264/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90260e-03	0.00914
265/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90232e-03	0.00914
266/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90205e-03	0.00914
267/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90177e-03	0.00914
268/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90149e-03	0.00964
269/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90121e-03	0.00864

Sta/ Cast	PRT Response Time (secs)	ITS-90 Temperature Coefficients corT = t2∗T² + t1∗T + t0 t2	t1	t0	Conductivity Coefficients corC = c2∗C² + c1∗C + c0 c2	c1	c0
270/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90094e-03	0.00864
271/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90066e-03	0.00864
272/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90038e-03	0.00864
273/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.90010e-03	0.00864
274/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.89983e-03	0.00864
275/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.89955e-03	0.00864
276/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.89927e-03	0.00864
277/01	.34	1.9889e-05	-6.2817e-04	-1.4986	1.14690e-05	-1.89899e-03	0.00914

Appendix B

Summary of WOCE95-I9N CTD Oxygen Time Constants

Temperature		Pressure	O_2 Gradient
Fast(τ_{Tf})	Slow(τ_{Ts})	(τ_p)	(τ_{og})
1.0	400.0	24.0	16.0

WOCE95-I9N: Conversion Equation Coefficients for CTD Oxygen

(refer to Equation 1.7.4.0)

Sta/ Cast	O_cSlope (c_1)	Offset (c_2)	$P_l$coeff (c_3)	$T_f$coeff (c_4)	$T_s$coeff (c_5)	$\frac{dO_c}{dt}$coeff (c_6)
148/01	9.11927e-04	-2.29801e-02	1.74632e-04	-1.73012e-02	-1.96968e-02	1.46147e-06
149/01	9.14971e-04	-4.10864e-02	1.81432e-04	3.97696e-03	-3.29264e-02	1.33144e-06
150/01	9.31326e-04	7.84748e-02	4.40621e-06	5.61992e-03	-3.51088e-02	5.41869e-06
151/01	9.82442e-04	1.70562e-02	7.55370e-05	5.67720e-03	-3.62848e-02	2.72207e-06
152/01	8.25653e-04	-8.95170e-04	1.86894e-04	8.95990e-03	-2.96020e-02	-1.30375e-06
153/01	8.77644e-04	-1.48898e-02	1.77272e-04	-1.52134e-03	-2.53956e-02	2.27805e-06
154/01	1.00876e-03	-4.44606e-02	1.57094e-04	7.56508e-04	-3.45085e-02	-4.89802e-07
155/01	8.86435e-04	1.04957e-03	1.57043e-04	5.22326e-03	-3.04964e-02	-5.85379e-06
156/01	9.54253e-04	-2.40973e-02	1.58948e-04	1.08534e-02	-3.78468e-02	2.57903e-07
157/01	9.65631e-04	-3.05481e-02	1.61577e-04	1.01513e-02	-3.81012e-02	1.41220e-05
158/01	1.01502e-03	-5.01214e-02	1.65359e-04	6.28942e-04	-3.29887e-02	-4.56159e-06
159/01	9.85583e-04	-4.05060e-02	1.64952e-04	7.08611e-03	-3.48243e-02	-5.28758e-06
160/01	1.02508e-03	-6.10405e-02	1.71143e-04	6.92323e-03	-3.57833e-02	1.79262e-06
161/01	1.00427e-03	-4.85086e-02	1.66905e-04	1.49469e-03	-3.34657e-02	3.89649e-06
162/01	1.02495e-03	-5.87221e-02	1.69616e-04	2.66756e-03	-3.43776e-02	1.65349e-05
163/01	9.74985e-04	-4.06807e-02	1.67933e-04	5.47630e-03	-3.35926e-02	5.36352e-06
164/01	9.71015e-04	-3.19969e-02	1.63043e-04	4.00451e-03	-3.37972e-02	7.17177e-06
165/01	1.00133e-03	-3.71054e-02	1.60704e-04	-1.65595e-03	-3.12106e-02	2.51145e-06
166/01	1.00310e-03	-4.38049e-02	1.65159e-04	5.29592e-03	-3.56105e-02	4.41627e-06
167/01	1.00030e-03	-3.82241e-02	1.61175e-04	5.44130e-03	-3.62760e-02	8.96206e-06
168/01	1.00356e-03	-4.21551e-02	1.64253e-04	-8.37898e-04	-3.24203e-02	4.88850e-06
169/01	9.98877e-04	-3.70284e-02	1.62065e-04	2.83782e-04	-3.25476e-02	4.20027e-06
170/01	9.75204e-04	-2.55356e-02	1.59683e-04	6.27141e-04	-3.15567e-02	1.66673e-06
171/01	1.03873e-03	-5.26545e-02	1.64913e-04	1.38367e-03	-3.39052e-02	2.64451e-05
172/01	7.54675e-04	3.83187e-03	1.42202e-04	-1.30953e-03	-2.70321e-02	1.11838e-06
173/01	1.04301e-03	-4.18971e-02	1.69179e-04	2.21551e-03	-3.38035e-02	5.99304e-06
174/01	1.04413e-03	-2.85285e-02	1.62383e-04	2.23293e-03	-3.37458e-02	1.25718e-06
175/01	1.03981e-03	-2.91757e-02	1.63173e-04	6.74148e-04	-3.28478e-02	1.94933e-06
176/01	1.18079e-03	-4.11970e-02	1.53387e-04	-2.53017e-02	-6.55027e-03	9.55288e-06
177/01	1.04807e-03	-3.98070e-02	1.70223e-04	6.03697e-04	-3.15304e-02	-4.86822e-06

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
178/01	1.04234e-03	-3.67141e-02	1.68788e-04	3.12692e-03	-3.33993e-02	-1.31013e-06
179/01	1.07074e-03	-4.26865e-02	1.67713e-04	7.11905e-04	-3.23038e-02	7.74533e-06
180/01	1.02076e-03	-3.02578e-02	1.68483e-04	4.73099e-03	-3.29774e-02	5.61431e-06
181/01	1.03946e-03	-2.88064e-02	1.62030e-04	8.48158e-03	-3.80914e-02	6.18320e-06
182/01	1.01651e-03	-2.98643e-02	1.68640e-04	3.94705e-03	-3.36690e-02	-9.33069e-08
183/01	1.05060e-03	-4.11047e-02	1.69995e-04	4.20607e-03	-3.35601e-02	3.94007e-06
184/01	1.02665e-03	-3.23132e-02	1.70516e-04	6.84539e-03	-3.59400e-02	-3.88571e-07
185/01	1.05493e-03	-3.89554e-02	1.66930e-04	4.40536e-03	-3.59642e-02	1.99306e-06
186/01	1.23898e-03	-5.90217e-02	1.52015e-04	-2.78889e-02	-3.82630e-03	-5.92409e-06
187/01	1.12733e-03	-6.64861e-02	1.72108e-04	5.43706e-03	-3.77949e-02	-1.82576e-06
188/01	1.08873e-03	-5.45471e-02	1.72722e-04	6.24703e-03	-3.72235e-02	6.02920e-08
189/01	1.11425e-03	-5.74752e-02	1.67226e-04	1.40528e-03	-3.56748e-02	-6.14964e-07
190/01	1.12279e-03	-6.32736e-02	1.70180e-04	5.91147e-03	-3.76891e-02	-1.16006e-08
191/01	1.09347e-03	-4.83485e-02	1.66397e-04	7.62956e-03	-3.80097e-02	2.31591e-06
192/01	1.12512e-03	-6.57668e-02	1.73029e-04	4.52347e-03	-3.89392e-02	2.54742e-06
193/01	1.11488e-03	-6.00329e-02	1.70162e-04	6.58714e-03	-3.83562e-02	5.51537e-06
194/01	1.11077e-03	-5.81479e-02	1.68982e-04	8.17683e-03	-3.95103e-02	6.95073e-06
195/01	1.13599e-03	-6.90844e-02	1.73294e-04	7.44809e-03	-3.93478e-02	5.83111e-06
196/01	1.15490e-03	-6.79764e-02	1.65596e-04	7.23546e-03	-4.04938e-02	5.70367e-06
197/01	1.13808e-03	-7.03255e-02	1.72513e-04	4.96848e-03	-3.72943e-02	3.78347e-06
198/01	1.11404e-03	-5.59720e-02	1.66507e-04	6.86731e-03	-3.75738e-02	2.22356e-07
199/01	1.19614e-03	-4.25689e-02	1.43545e-04	-2.10805e-02	-9.04812e-03	6.85343e-07
200/01	1.11256e-03	-5.94718e-02	1.66610e-04	1.02933e-02	-4.24163e-02	-2.41055e-06
201/01	1.12757e-03	-5.96878e-02	1.66154e-04	1.09562e-02	-4.41700e-02	7.38849e-06
202/01	1.12012e-03	-6.10543e-02	1.68954e-04	8.22240e-03	-3.96908e-02	3.85397e-06
203/01	1.11378e-03	-5.05605e-02	1.61461e-04	8.36294e-03	-4.11262e-02	5.28902e-06
204/02	1.13583e-03	-5.60195e-02	1.59011e-04	6.18453e-03	-4.17247e-02	2.44356e-06
205/01	1.17123e-03	-7.53169e-02	1.64243e-04	9.44316e-03	-4.19921e-02	1.73306e-06
206/01	1.12517e-03	-5.12890e-02	1.57257e-04	1.47761e-02	-4.64835e-02	1.00308e-06
207/01	1.12691e-03	-4.90149e-02	1.55313e-04	9.48101e-03	-4.30508e-02	4.53840e-06
208/01	1.12856e-03	-5.92388e-02	1.61206e-04	1.22106e-02	-4.47617e-02	3.45736e-06
209/01	1.11046e-03	-5.15810e-02	1.63035e-04	1.13360e-02	-4.12041e-02	-1.30658e-06
210/01	1.13539e-03	-6.09584e-02	1.62175e-04	9.00149e-03	-4.10287e-02	-1.01782e-06
211/01	1.13403e-03	-5.71487e-02	1.59529e-04	1.07880e-02	-4.50508e-02	4.44817e-06
212/01	1.09586e-03	-4.49403e-02	1.58859e-04	5.60466e-03	-4.15870e-02	5.22007e-06
213/01	1.10378e-03	-5.92408e-02	1.66803e-04	7.77119e-03	-3.95080e-02	1.39849e-06
214/01	1.15637e-03	-6.55840e-02	1.59297e-04	1.31523e-02	-4.64082e-02	-1.98152e-06
215/01	1.09057e-03	-5.85376e-02	1.70329e-04	1.08678e-02	-4.35382e-02	2.69826e-06
216/01	1.15913e-03	-7.86671e-02	1.67341e-04	9.69318e-03	-4.21259e-02	5.59094e-06
217/01	1.11966e-03	-6.39118e-02	1.67005e-04	1.21232e-02	-4.21036e-02	5.45694e-06
218/01	1.18082e-03	-7.69866e-02	1.61370e-04	1.45467e-02	-4.80539e-02	5.96037e-06
219/01	1.16278e-03	-8.08468e-02	1.67760e-04	8.90886e-03	-4.34292e-02	3.77903e-06
220/01	1.16991e-03	-8.16460e-02	1.67251e-04	7.44303e-03	-4.14253e-02	7.33262e-06

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
221/01	1.18909e-03	-7.98790e-02	1.60772e-04	1.59671e-02	-4.97064e-02	-3.18768e-08
222/01	1.11989e-03	-6.36719e-02	1.65851e-04	1.29836e-02	-4.38072e-02	7.02874e-06
223/01	1.17801e-03	-7.44735e-02	1.57001e-04	2.12787e-02	-5.51366e-02	2.61576e-07
224/01	1.19732e-03	-6.89931e-02	1.51132e-04	2.61351e-02	-6.03310e-02	-3.61869e-07
225/01	1.08992e-03	-3.99263e-02	1.54668e-04	2.70161e-02	-5.86768e-02	1.31277e-06
226/01	9.80895e-04	6.50799e-04	1.52395e-04	1.63486e-02	-5.42531e-02	2.27881e-06
227/01	9.60978e-04	1.77470e-02	1.39465e-04	5.18611e-02	-8.14877e-02	-4.63994e-06
228/01	1.20108e-03	-6.79837e-02	1.47989e-04	2.62835e-02	-6.05943e-02	-3.78054e-06
229/01	1.21351e-03	-4.44798e-02	1.25118e-04	3.51147e-02	-7.15140e-02	1.93690e-05
230/01	1.26431e-03	-6.17236e-02	1.27961e-04	2.69368e-02	-6.54635e-02	7.01517e-06
231/01	1.09407e-03	-2.02147e-02	1.38746e-04	3.22331e-02	-6.67539e-02	-3.97057e-06
232/01	1.25143e-03	-8.01240e-02	1.46147e-04	2.60653e-02	-6.18513e-02	-8.17608e-07
233/01	1.14728e-03	-5.58187e-02	1.55097e-04	1.04884e-02	-4.46040e-02	1.00201e-05
234/01	1.14633e-03	-3.07909e-02	1.33049e-04	3.95393e-02	-7.35765e-02	4.61224e-07
235/01	1.33793e-03	-6.52307e-02	1.13150e-04	3.94267e-02	-7.97038e-02	-6.17618e-07
236/01	1.47325e-03	-1.33860e-01	1.27499e-04	-6.35725e-03	-3.60316e-02	-3.79508e-06
237/01	1.51650e-03	-1.12170e-01	1.00099e-04	2.03178e-02	-6.27645e-02	-6.11803e-06
238/01	1.46798e-03	-9.87122e-02	9.92411e-05	2.20199e-02	-6.58427e-02	-5.87529e-06
239/01	1.40826e-03	-1.38310e-01	1.52501e-04	-1.92276e-02	-2.26522e-02	-2.00872e-06
240/01	1.33410e-03	-7.00623e-02	1.12733e-04	3.19900e-02	-7.24993e-02	-2.91428e-06
241/01	1.43050e-03	-6.58762e-02	8.26797e-05	3.97921e-02	-8.15176e-02	-4.91760e-06
242/01	1.62225e-03	-6.27955e-02	3.42768e-05	6.59420e-02	-1.13825e-01	1.94743e-06
243/01	1.67350e-03	-7.27344e-02	2.06158e-05	6.66049e-02	-1.15481e-01	-6.89181e-06
244/01	2.42991e-03	-2.15267e-02	-1.34557e-04	1.27791e-01	-1.89175e-01	-3.09449e-06
245/01	2.89870e-03	8.73026e-02	-2.28647e-04	1.82876e-01	-2.52912e-01	1.00322e-05
246/01	3.18644e-03	8.59013e-02	-2.64003e-04	1.80488e-01	-2.54513e-01	-2.90732e-05
247/01	2.84515e-03	-1.56906e-02	-2.02210e-04	1.52873e-01	-2.21291e-01	-2.65303e-05
248/01	1.36483e-03	-5.03892e-02	7.96459e-05	3.29244e-02	-7.31493e-02	-3.52012e-06
249/01	2.77584e-03	-9.36310e-02	-1.67331e-04	1.02756e-01	-1.73308e-01	4.37860e-06
250/01	3.16439e-03	-1.30999e-01	-2.19085e-04	6.25052e-02	-1.45979e-01	-7.57190e-06
251/01	5.22379e-03	-3.49163e-01	-4.29213e-04	8.93951e-02	-1.82264e-01	-1.69492e-06
252/01	7.62959e-01	-7.58400e+01	1.02146e-03	1.80341e-01	-4.71492e-01	2.65426e-05
253/01	3.19453e-01	-2.41377e+01	-2.80398e-03	1.00382e-01	-3.55446e-01	-1.27580e-05
254/01	2.53122e-03	-1.45154e-01	-1.28248e-04	6.40622e-02	-1.28582e-01	-8.39041e-07
255/01	4.43544e-03	-1.71322e-01	-3.32683e-04	1.38992e-01	-2.28814e-01	-4.13344e-06
256/01	3.43816e-03	-1.76727e-01	-2.24257e-04	1.12250e-01	-1.88690e-01	-2.83180e-05
257/01	1.25041e-03	-4.23225e-02	6.89444e-05	-1.78069e-02	-1.67584e-02	4.52048e-06
258/01	1.24596e-03	-2.87982e-02	7.91915e-05	1.11819e-02	-4.59493e-02	3.28441e-06
259/01	1.05038e-03	-1.32314e-02	1.35675e-04	-1.24511e-03	-2.68571e-02	4.41027e-06
260/01	9.22738e-04	4.04005e-03	1.70339e-04	4.65571e-03	-2.87634e-02	4.49780e-06
261/01	1.53675e-03	9.26790e-02	-3.79330e-05	1.37195e-01	-1.85546e-01	-2.38595e-06
262/01	1.27093e-03	-4.57900e-02	1.11467e-04	4.09678e-02	-7.92960e-02	1.54199e-06
263/01	1.06703e-03	-5.68502e-02	1.82442e-04	4.32508e-03	-3.42475e-02	1.79214e-06

Sta/ Cast	O_c Slope (c_1)	Offset (c_2)	P_l coeff (c_3)	T_f coeff (c_4)	T_s coeff (c_5)	$\frac{dO_c}{dt}$ coeff (c_6)
264/01	1.18450e-03	-2.28613e-02	1.13405e-04	5.49000e-02	-9.09836e-02	-1.53481e-06
265/01	1.21233e-03	-7.15279e-02	1.49795e-04	1.62039e-02	-5.26190e-02	2.12134e-06
266/01	1.03962e-03	2.58721e-02	1.13630e-04	7.55418e-02	-1.04952e-01	-2.84792e-06
267/01	1.11729e-03	-2.37735e-02	1.32728e-04	-1.84067e-02	-1.23646e-02	-1.03646e-06
268/01	1.13193e-03	-2.98568e-02	1.34374e-04	-2.87702e-02	-2.36112e-03	-2.94637e-06
269/01	1.15537e-03	5.35162e-03	1.00391e-04	6.83713e-02	-1.03836e-01	-5.36562e-06
270/01	1.10045e-03	1.67994e-03	1.17593e-04	5.60380e-02	-9.07081e-02	3.68581e-06
271/01	1.15355e-03	-3.67320e-02	1.38269e-04	3.68645e-02	-7.23864e-02	4.94594e-07
272/01	1.18648e-03	-3.65884e-02	1.28310e-04	3.98807e-02	-7.65746e-02	7.50245e-07
273/01	1.12880e-03	-4.03006e-02	1.46722e-04	3.16299e-02	-6.67467e-02	-2.18445e-06
274/01	1.03750e-03	1.28896e-02	1.24413e-04	6.20629e-02	-9.58904e-02	1.65100e-06
275/01	1.11239e-03	-3.98972e-02	1.52066e-04	1.78523e-02	-5.15647e-02	6.15196e-07
276/01	1.12549e-03	-6.44362e-02	1.68704e-04	1.04945e-02	-4.34376e-02	-3.08353e-06
277/01	1.16682e-03	-3.82597e-02	1.39517e-04	-2.05211e-02	-8.27572e-03	-4.12373e-06

Appendix C

WOCE95-I9N: CTD Shipboard and Processing Comments

Key to Problem/Comment Abbreviations	
CO	conductivity offset
DG	density gradient in top 10db, data consistent/smooth in time-series CTD; possibly real
DI	density inversion in top 10db, data consistent/smooth in time-series CTD; possibly real
OB	bottom ctdoxy signal drop coincides with slowdown for bottom approach
OD	up-cast, deep/bottom ctdoxy drifts high, won't fit correctly
OH	ctdoxy fit high near surface: high raw ctdoxy signal
OL	ctdoxy fit low near surface: either slow cast start or low ctdoxy signal
OM	ctdoxy fits high in minimum o2 area
ON	ctdoxy signal unusually noisy
OS	raw ctdoxy signal shifts
SS	probable sea slime on conductivity sensor
WS	winch stopped to check possible winch problem; potential shift in ctdoxy signal
XD	transmissometer signal drop/nephels layer at bottom, may correspond with ctdoxy feature
Key to Solution/Action Abbreviations	
DO	despiked raw ctdoxy, despiked data ok unless otherwise indicated
DS	despiked salinity, changed temperature and/or conductivity - see .ctd file codes
NA	no action taken, used default quality code 2
NR	cast not processed, not reported with final data
O3	quality code 3 oxygen in .ctd file for pressures specified
O4	quality code 4 oxygen in .ctd file for pressures specified
RO	offset raw ctdoxy data to account for signal drop caused by slowdown/stop/yoyo; usually DO in transition area above offset
UP	used up-cast data for final pressure-series data

Cast	Problem/Comment	Solution/Action
148/01	OB	RO +2 5070-5226db; RO +5 5228-5302db/btm
149/01	OB	RO +2 4808-4938db/btm
	PRT1-PRT2 = -0.04, PRT2/FSI-1319 flooded	switch to PRT2/FSI-1322 after cast
150/01	DI/-0.015 0-6db; OB	NA; RO +3 1458-1502db/btm
151/01	WS/1 min. at 1594db	NA
152/01	DI/-0.021 0-6db	NA
156/01	deepest 4 bottle oxys disagree, 3848-4390db	ctdoxy ok, see bottle codes
157/01	starting this cast, increase speed through down-cast thermocline to decrease shiproll effects	
158/01	DI/-0.025 0-6db	NA
159/01	DI/-0.021 0-6db	NA
160/01	OB	RO +1 5250-5328db/btm
161/01	DI/-0.020 0-6db	NA
162/01	OL	DO/O3 0-14db
163/01	OB	RO +1 5088-5258db/btm
164/01	OB	RO +1 5158-5166db/btm

Cast	Problem/Comment	Solution/Action
165/01	WS/3+ mins. at 2056db to change deck units; frame-synch errors; OS	Re-digitize/re-average data after cast; DO 2054-2148db
166/01	OB	RO +1 5232-5256db/btm
167/01	OB	RO +1 5174-5266db/btm
169/01	low ctdoxy feature 976-1054db	NA/also on up-cast
	ON/signal spikes+cutouts	DO 2000-2020db
170/01	ON/signal spikes+cutouts	DO 1644-2242db
171/01	OL; OB	DO/O3 0-20db; RO +1 5312-5448db/btm
172/01	change to ctdoxy sensor 3-11-32	repair 3-3-10, bubbles in sensor housing oil?
	raw ctdoxy segment shifts up, not seen on up-cast	O3 1094-1174db
	WS/14.5 mins. at 4118db to inspect broken strand on wire; yoyo 4118-4102db; raw ctdoxy signal goes crazy thru end of down-cast; up-cast ctdoxy noisy/unusable	O4 4108-5634db; replace o2 sensor after cast
173/01	back to orig. ctdoxy sensor 3-3-10	
	WS/2 mins. at 4106db	NA
174/01	WS/1 min. at 4094db	NA
175/01	WS/4 mins. at 4096db	NA
176/01	SS/CO 5820db down-cast until 5m above bottom	UP
	WS/1 min. at 4050db; OD	NA; O3 5402-5700db, O4 5702-6100db
177/01	WS/0.5 min. at 4093db	NA
178/01	WS/3.5 mins. at 4092db	NA
179/01	WS/1.5 mins. at 4108db	NA
180/01	DG/+0.24 0-10db	NA
	WS/1 min. at 4106db; OB	NA; RO +1 5386-5506db/btm
181/01	SS/CO -0.035 PSU drop in salinity	DS 2922-2936db
	WS/6 mins. at 4097db, OS; OB	RO +3 4094-5348db; RO +4 5350-5450db/btm
182/01	WS/4.5 mins. at 4094db, OS	RO +2 4088-4196db/btm
183/01	WS/1.5 mins. at 4086db	NA
	OB?	O3 4518-4660db/may be slowdown drop, may be real
184/01	WS/1 min. at 4090db, OS	RO +2 4088-4304db/btm
185/01	WS/1.5 mins. at 4071db, OS; OB	RO +1 4066-5274db; RO +2 5276-5368db/btm
186/01	SS/3180-3300db down-cast; yoyo cleared off foreign matter	UP/SS segment too long to despike
	WS/1.5 min. at 4106db; OD	NA; O3 4800-5098db, O4 5100-5484db
187/01	WS/6.5 mins. at 4083db, OS	RO +2 4082-5176db
	OB; ctdoxy fits low ˜5300db-bottom	RO +3 5178-5368db/btm; O3 5294-5368db
188/01	DI/-0.015 0-8db	NA
	WS/0.5 min. at 4096db; OB	NA; RO +2 5140-5296db/btm
189/01	WS/4 mins. at 4094db, OS	RO +2 4090-5332db/btm
190/01	WS/7.5 mins. at 4086db, OS; OB	RO +2 4082-5372db; RO +3 5374-5470db/btm
191/01	DI/-0.017 0-4db	NA
	WS/1.5 mins. at 4092db; OB	NA; RO +1.5 5074-5202db/btm
	ctdoxy drops near bottom	DO/ok-within .02 ml/l 5146-5202db
192/01	WS/5 mins. at 4086db	RO +3 4082-4100db
	OB/yoyo 4948-4922db, winch went wrong way 200m above bottom	RO +3 4936-5102db/btm; small ctdoxy discontinuity remains
193/01	DG/+0.40 0-10db; WS/1 min. at 4092db	NA; DO

Cast	Problem/Comment	Solution/Action
194/01	DG/+0.29 0-10db; WS/0.5 min. at 4065db	NA; DO
195/01	DG/+0.21 0-10db	NA
	WS/1.5 mins. at 4096db; OB	NA; RO +1.5 5088-5210db/btm
196/01	DG/+0.29 0-10db; WS/5 mins. at 4090db, OS	NA; RO +2 4088-5142db/btm
197/01	FSI-OPM#1326 replaces PRT2 prior to cast	
	WS/0.5 mins. at 4095db; OB	NA; RO +1 5080-5086db/btm
198/01	WS/4.5 mins. at 4096db ,OS	RO +2 4080-5004db/btm
199/01	SS/CO 3150-3930db down-cast	UP
	OD/WS	O3 3106-3364db
	WS/4.5 mins. at 4086db; OD	DO; O3 4596-4958db
200/01	FSI-1319 replaces PRT2 prior to cast	
	DI/-0.016 0-6db; WS/6 mins. at 4090db, OS	NA; RO +2 4086-4914db/btm
201/01	OL; WS/1 min. at 4087db	DO/O3 0-22db; DO
202/01	WS/2 mins. at 4094db	RO +1 4094-4116db
203/01	yoyo 204-2.5db/just under surface, console never initiated correctly	start pressure-sequencing from top of yoyo/2db
	WS/1 min. at 4085db; OB	DO; RO +2 4740-4824db/btm
204/01	FSI-1320 replaces PRT2 prior to cast; CTD signal died, voltage dropped 20 units as pkg entered water	NR/ABORT cast, find/fix problem
204/02	FSI-1322 replaces PRT2 prior to cast; signal ok now	NA
	WS/1.5 mins. at 4094db, OS	RO +2 4094-4794db/btm
205/01	deep/small jumps in CTD salinity in last 2 casts	swabbed cond. sensor w/dist.water prior to cast
	WS/4.5 mins. at 4071db, OS	RO +2 4046-4068db, RO +3 4070-4774db/btm
206/01	WS/5.5 mins. at 4096db, OS; OB	RO +2 4096-4628db; RO +4 4630-4728db/btm
207/01	WS/1.5 mins. at 4044db, OS	RO +2 4040-4588db, DO/O3 4006-4072db
	OB	RO +4 4590-4698db/btm
208/01	DG/+0.12 0-10db; DI/-0.08 2-6db, DI/-0.033 12db	only 2-6db inversion despiked: PI says possible contamination from ship
	ON/small-scale noise	DO intermittent time-series levels 1900-4688db
	WS/4 mins. at 4094db, OS	RO +2 4092-4688db/btm
209/01	DI/-0.033 0-6db; WS/1 min. at 4093db	NA; DO/O3 4088-4132db
210/01	WS/2 mins. at 4094db, OS; OB	RO +1 4092-4540db; RO +3 4542-4604db/btm
211/01	CTD Temperature pegs out at up-cast surface	NA/does not affect bottle trip data
	WS/4 mins. at 4030db, OS	RO +3 4028-4054db, RO +2 4056-4372db
	OB	RO +4 4374-4544db/btm
212/01	abort first launch attempt, rosette suspended above deck	change to starboard winch
	DG/+0.28 0-10db	NA
213/01	OB?/4426-4490db	NA/may be slowdown drop, may be real
214/01	DI/-0.017 0-6db	NA
	ctdoxy does not match btls/nearby casts	O3 3802-4432db
215/01	DG/+0.16 0-10db	NA
	surface bottle oxy high compared to nearby casts	used average value from 4 nearby casts for surface ctdoxy fit
	odd ctdoxy shape	O3 3936-4404db/may be real, matches bottles
	CTD Temperature pegs out at up-cast surface	NA/does not affect bottle trip data
216/01	DG/+0.28 0-10db	NA

Cast	Problem/Comment	Solution/Action
217/01	OB	RO +2 4308-4382db/btm
218/01	odd ctdoxy shape	O3 4156-4286db/may be real, matches bottles
	OB	RO +2 4240-4340db/btm
219/01	DG/+0.16 0-10db	NA
	CTD Temperature pegs out at up-cast surface	NA/does not affect bottle trip data
220/01	DG/+0.40 0-10db	NA
221/01	OB	RO +3 4184-4250db/btm
222/01	OB	RO +3 4102-4206db/btm
223/01	DG/+0.41 0-10db	NA
225/01	OB; odd drop near bottom, 3940-3964db	RO +2 3870-3964db/btm; DO/ok-within .02 ml/l
226/01	OB	RO +3 3782-3796db, RO +4 3798-3880db/btm
227/01	OM; ctdoxy fits low at bottom; XD	O3 400-700db; O3 3570-3724db; NA
	CTD salinity offsets, bottom to ˜2140db up; shifts back to meet downtrace most bottle stops	despike up-cast for bottle files only, down-cast ok
228/01	OB	RO +1.5 3622-3632db/btm
	ctdoxy fits low near bottom, 3584-3632db	DO/ok-within .02 ml/l
229/01	DI/-0.018 0-4db; OB	NA; RO +2 3194-3252db/btm
230/01	DG/+0.47 0-10db; OB	NA; RO +2 3444-3526db/btm
231/01	DG/+0.10 0-10db	NA
	XD, ctdoxy fits low near bottom	O3 3522-3616db
232/01	surface bottle oxy high compared to nearby casts	used average value from 4 nearby casts for surface ctdoxy fit
	ctdoxy fit off compared to bottles 0-100db; XD	NA/CTD salinity also odd compared to bottles
233/01	DI/-0.020 0-6db; OM; XD	NA; O3 130-440db; NA
	SS/CO -0.09+ PSU drop in salinity, WS/1.5 mins. at 362db cleared contamination	DS 330-362db
234/01	XD, OB	RO +4 3420-3498db/btm
235/01	DG/+0.46 0-10db; XD	NA
236/01	XD	NA
237/01	DI/-0.017 0-6db; XD, OB	NA; RO +4 3320-3326db/btm
238/01	OB	RO +3 3148-3160db; RO +6 3162-3210db/btm
239/01	XD, ctdoxy fits high at bottom	O3 3100-3134db
240/01	DI/-0.015 0-4db	NA
	XD corresponds with ctdoxy feature	NA
241/01	OB	RO +3 2782-2876db/btm
242/01	ctdoxy feature corresponds with TS feature	NA 30-40db
	OB	RO +2 2702-2792db/btm
243/01	OM; XD	O3 200-550db; NA
244/01	ctdoxy spike after fitting; OB	O3 74db; RO +3 2572-2582db/btm
	XD, ctdoxy fits low compared to bottom bottles	O3 2540-2582db/may be real
245/01	DI/-0.015 0-4db	NA
	odd ctdoxy shape compared to bottles 0-70db	ok/ctdoxy corresponds with TS feature
	XD, OB - ctdoxy fits low compared to bottom bottles	O3 2422-2486db/part-all may be real
246/01	OH compared to bottles, nearby casts	O3 0-2db
	DG/+0.21 0-10db; XD, OB?/OS	NA; RO +2 2340-2352db
247/01	DG/+0.42 0-10db; XD	NA
	OH compared to bottles, nearby casts	O3 0-8db
248/01	DI/-0.017 0-4db; OM; XD	NA; O3 60-200db; NA

Cast	Problem/Comment	Solution/Action
249/01	XD, OB - odd ctdoxy shape near bottom	O3 2184-2238db/part-all may be real
250/01	OM; XD, OB	O3 80-200db; RO +2 2048-2126db/btm
251/01	DG/+0.19 0-10db	NA
	OB; ctdoxy spikes at bottom after fitting	RO +2 1654-1690db/btm; O3 1690db
252/01	DI/-0.020 0-6db; XD, OB - ctdoxy drop at bottom	NA; O3 106-108db/part-all may be real
253/01	DG/+0.16 0-10db; DI/-0.016 4db	NA
	SS/CO until near bottom	offset cond. +0.0045 mmho/cm 226-968db
254/01	DG/+0.15 0-10db	NA
	XD, OB; ctdoxy spikes at bottom after fitting	RO +2 1900-1978db/btm; O3 1978db
255/01	DG/+0.15 0-10db; XD	NA
256/01	DG/+0.24 0-10db; XD	NA
257/01	deep/small jumps in CTD salinity last 3 casts	swabbed cond. sensor w/dist.water prior to cast
	ctdoxy signal crazy 1545db down until bottom, ok on up except 2 small sections	UP
	DG/+0.22 0-10db; XD	NA
	WS/sharp gradient, ON/ctdoxy spikes/cutouts	O3 24-28db, DO 1146-1170db
258/01	change to ctdoxy sensor #4-05-16 (new)	
	XD, OB	RO +5 2464-2470db/btm
259/01	DI/-0.018 0-6db; OB; XD	NA; RO +3 2532-2592db/btm; NA
260/01	DG/+0.10 0-10db; XD	NA
	ON/small-scale noise, increasing with pressure	DO intermittent time-series levels 1000-2704db
261/01	back to orig. ctdoxy sensor 3-3-10 prior to cast	
	OM; XD	O3 130-480db; NA
262/01	OM	O3 120-340db
263/01	OM	O3 120-550db
264/01	OM	O3 150-750db
265/01	OM	O3 140-600db
266/01	ctdoxy fit off compared to bottles, surface to o2 minimum	O3 0-310db
	DI/-0.020 0-6db; OB; XD	NA; RO +2 3320-3370db/btm; NA
267/01	sm-scale deep offsetting down-cast salinity; XD	UP; NA
268/01	sm-scale deep offsetting down-cast salinity; XD	UP; NA
269/01	salinity offsetting last 2 casts	swabbed cond. sensor w/dist.water prior to cast
	ctdoxy fits high compared to bottles; XD, OB	O3 2200-3120db; RO +1 3656-3660db/btm
270/01	DI/-0.019 0-6db	NA
271/01	DI/-0.019 0-6db; OB; XD	NA; RO +1 3830-3842db/btm; NA
272/01	ON/small-scale noise	DO intermittent time-series levels 2250-3872db
275/01	WS 25/52/160mwo, shiproll test: lower at 25m/min. srfc to 160mwo; ctdoxy spikes	O3 24-28db
	OB	RO +2 4232-4236db/btm
276/01	DG/+0.18 0-10db; OB; XD	NA; RO +2 4208-4292db/btm; NA
277/01	back to port winch to check broken-strand section	
	oxy signal spiky/bad most of 1860-3500db down, only 2 bad sections on up-cast	UP
	ON/signal spikes/cutouts	DO/O3 810-970db; DO/O3 1132-1200db
	WS/3.5 mins. at 4090db; OD	DO; O3 4226-4410db

Appendix D

WOCE95-I9N: Bottle Quality Comments

Remarks for deleted samples, missing samples, PI data comments, and WOCE codes other than 2 from WOCE I9N KN-145.6. Investigation of data may include comparison of bottle salinity and oxygen data with CTD data, review of data plots of the station profile and adjoining stations, and rereading of charts (i.e., nutrients). Comments from the Sample Logs and the results of ODF's investigations are included in this report. Units stated in these comments are degrees Celsius for temperature, Practical Salinity Units for salinity, and unless otherwise noted, milliliters per liter for oxygen and micromoles per liter for Silicate, Nitrate, Nitrite, and Phosphate. The first number before the comment is the cast number (CASTNO) times 100 plus the bottle number (BTLNBR).

Station 148

129	Sample Log: "Leak from spigot-not seated all the way." Samples are acceptable.
114	Nutrients: "Silicate had an air bubble that was not caught until after run was complete. Could not rerun samples." Footnote silicate bad. PI says data appears to be okay compared with GEOSECS data. Silicate is acceptable.
113	Delta-S at 2348db is 0.0021. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. Out of WOCE spec of measurement. Footnote salinity questionable.
111	PI: Suspect sil high, need to compare to next station." Silicate is acceptable.
109	Sample Log: "Drip from bottom cap, questionable." Samples were affected, salinity and oxygen are high, phosphate is low. Footnote bottle leaking, samples bad.
105	PI: Suspect O2 high, need to compare to next station." Oxygen is acceptable. See 104-108 nutrient comment.
104-108	Nutrients: "Silicate had an air bubble that was not caught until after run was complete. Could not rerun samples." PI said samples were okay.

Station 149

135	Delta-S at 55db is -0.0258. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. Out of WOCE spec of measurement. Footnote salinity questionable.
117	Oxygen: "Forgot acid." Footnote sample lost.
113	Sample log: "Free flows when drain cock pushed in. Rotating end cap fixes it." PO4, NO3, and O2 appear slightly high, salinity agrees with CTD data, but SIL appears slightly low. PI says data appears to be okay.
104	Delta-S at 3907db is -0.0063. Salinity does not agree with Station 148. Duplicate samples were drawn for salinity, the duplicate value agrees with the CTD. Footnote salinity bad, not within WOCE specifications. Other samples appear to be okay.

Station 150

Cast 1	Sample Log: "Tritium may have been drawn last on the first 14 bottles. Midnight to noon watch on relieving the other watch discovered the error in sampling order."
112	Sample log: "Nutrients and salinity drawn before tritium." Delta-S at 601db is -0.0104, salinity is 34.592. Salinity agrees with overlay of previous stations. Salinity agreement with CTD is -0.0081, a little high but acceptable.
110	Sample log: "Out of water, partial bottle on tritium."
108	Oxygen drawer: "Possible air bubble from NaOH dispenser." Oxygen is slightly high, footnote questionable, it is usable.

107 Oxygen drawer: "Possible air bubble from NaOH dispenser." Oxygen is slightly high, footnote questionable, it is usable.

106 PI: "O2 high, check vs. CTDO." Oxygen drawer: "Possible air bubble from NaOH dispenser." PI rechecked the data, footnote oxygen bad, evidently there was a problem with the data.

Station 151

110 PI: "O2 slightly high-but again agrees with trend."

109 Sample log: "Lanyard hung." No samples.

105 Oxygen appears high, however, CTD trace also shows a max. PI: "Follows property trend okay." PI: "High in O2/SiO3. Somewhat high near inflections in SiO3/O2 and Sigma theta/O2 curves. Also high compared to Sigma Theta/O2 in 148-149. O2 ˜0.1 high. Footnote oxygen questionable."

Station 152

129 Sample log: "Water drains until top cap pushed." Oxygen ˜0.15 low compared to adjoining stations. Other samples appear to be okay. PI: "Close to 148 and 149, data acceptable. PI did thermal effect, difference in temperature (day vs night temperatures on 153)."

113 Sample log: "Vent cock not tight." Data appears to be okay.

Station 153

131 Sample log: "Flows freely before venting." Data appears to be okay.

129 Sample log: "Flows freely before venting." Data appears to be okay.

127 See 128 PO4 comments, footnote PO4 questionable.

128 PI: "PO4 high vs 154, footnote questionable." Nutrient analyst rechecked data, found the peaks to be a little noisy.

121 Sample log: "Lanyard caught in top." Salinity and oxygen high, nutrients low. Footnote bottle leaking, samples bad. PI agrees samples bad. Delta-S at 421db is 0.0585.

105 See 104 PO4 comment. Footnote PO4 questionable.

104 PI: "PO4 high, footnote questionable." Nutrient analyst rechecked data, made minor corrections, found the peaks to be a little noisy. PO4 still high even after minor correction.

Station 154

127 Sample log: "Leaks from bottom rim after venting." Samples appear to be okay.

104-110 PO4 low, can’t find any obvious analytical reason or 153 high. PI: "These samples are okay, Station 153 somewhat high."

Station 155

136 Sample log: "Alkalinity out of order after nuts."

135 Delta-S at 26db is -0.0265. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

120 CTD Processor: "Bottle O2 high compared with CTD Oxygen." O2 does appear high, but "fits" Station 154 profile. CTD up profile shows a higher oxygen. Bottle O2 is acceptable.

113 Sample log: "Flows on valve opening prior to vent-stiff vent probably not closed." PI: "Oxygen and nutrients are okay."

109 Sample log: "Leak on end cap after vent." PI: "Oxygen, nuts okay. O2 0.05 too high?" Data appears to be okay. Oxygen within WOCE specs of 1%.

105 Sample log: "Flows freely before venting." Samples appear to be okay.

Station 156

134 CTDO Processor: "Bottle O2 low compared with CTD." O2 appears low compared with adjoining stations. A low oxygen is difficult to explain what went wrong. Salinity appears high compared with adjoining stations, but agrees with CTD. Other parameters also appear acceptable.

121 PI: "Low O2 check with later stations." No complaint from CTDO fitting, suspect data okay.

120 PI: "Low O2 check with later stations." No complaint from CTDO fitting, suspect data okay.

114 Oxygen high, does not agree with station profile, adjoining stations or CTDO. No analytical problems noted. Footnote oxygen bad.

109 Delta-S at 2949db is -0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

104 Delta-S at 3995db is -0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. Oxygen appears slightly high on station profile and compared with CTDO. PI: "Follows 148, but check with later stations." CTDO Processor: "Bottle O2 high compared with CTD." Footnote O2 questionable.

103 Delta-S at 4199db is -0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. CTDO Processor: "Bottle O2 low or 102 and 104 high. CTDO fits through bottle even when it's excluded from fit." O2 is acceptable, 102 and 104 are high.

102 CTDO Processor: "Bottle O2 high or 103 low compared with CTD." O2 could be high by 0.019 which is within WOCE specs. O2 is acceptable.

101 Oxygen: "Sample lost to program glitch on PC."

Station 157

135 Sample log: "Free flows before venting." Salinity, Oxygen and nutrients fit station profile and adjoining stations, salinity agrees with CTD.

126 Sample log: "Free flows before venting." Salinity, Oxygen and nutrients fit station profile and adjoining stations, salinity agrees with CTD.

117 Oxygen high, nutrients low, salinity low, Delta-S -.1211; appears to be a tripping problem. Autosal diagnostics do not indicate a problem. Footnote samples bad, bottle leaking. PI agrees, Redfield bad.

108 Salinity is high on the press vs salinity plot. Agreement with the CTD is good. Leave data as is (no footnote). Autosal took 3 readings before getting good agreement.

Station 158

119 Delta-S at 1000db is 0.0063. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. PI: "PO4 high by 0.03." This is within the accuracy of the measurement. Will leave as is, do not code data.

113 Sample log: "Free flow before venting." Salinity agrees with CTD and adjoining stations, oxygen and nutrients agree with adjoining stations.

107 Delta-S at 3751db is 0.0034. Autosal took 3 readings to get two ratios to agree. There must have been some slight contamination in the sample. Salinity: "Insert came off in cap." Footnote salinity questionable.

Station 159

134 Delta-S at 30db is -0.0284. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

122	Sample log: "Redraw on O2, reagent problem." Oxygen appears to be okay.
120	Sample log: "Barium only partial sample, bottle empty, duplicate pCO2 and TCO2." Samples are acceptable.
113	Sample log: "Leaking top end cap-also tight vent." Samples are acceptable.
110	PO4 0.01 high. Other samples are acceptable. Leave as is, do not code, this is within the accuracy of the measurement.
109	Sample log: "Leaking from bottom end cap after vent." Samples are acceptable.
101	Delta-S at 5321db is -0.0026. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. Sample log: "Redraw on O2, reagent problem." Oxygen is acceptable.

Station 160

Cast 1	No comments from the sample log.

Station 161

Cast 1	No comment on sample log.
123	PI: "O2/SiO3 low O2 or sil; checked vs Station 162 and all okay."
115	PI: "O2/SiO3 low O2 or high sil; checked vs Station 162 and all okay."

Station 162

135	CTDO Processor: "Bottle O2 low compared with CTDO, looks like duplicate draw." O2 draw temperature does not indicate a duplicate draw. O2 agrees with Stations 163 and 164. O2 is acceptable.
121	Sample log: "Lanyard caught in top (leaking)?." Salinity high, oxygen high, PO4 and NO3 low. Delta-S at 1001db is 0.129. Footnote bottle leaking, samples bad.

Station 163

136	Sample log: "Top cap not seated-small leak on vent." Data appears to be okay.
132	PI: "Nutrients high, checked vs. later stations okay with Station 166, okay on sil.
111	Oxygen appears slightly high. PI: "Oxygen okay, breaks back to trend in SiO3/O2-Falls in line of future stations 164,165."
109	PI: "Low NO3/PO4 similar to Sta 162, PO4 0.03 high, footnote PO4 questionable." Nutrient analyst rechecked data, found 108 higher than 109, no apparent reason.
108	PO4 slightly high. PI: "Low NO3/PO4 similar to Sta 162, within spec, data are acceptable." Nutrient analyst rechecked data, found 108 higher than 109, no apparent reason.

Station 164

132	Sample log: "Vent open on recovery." All bottle parameters plot okay.
129	Salinity: "Bottle not sampled." Evidently a sample was supposed to be drawn, but salinity analyst indicated there was no water in the bottle. Footnote salinity lost.
126	Sample log: "Vent open on recovery." All bottle parameters plot okay.
102-103	See 101 PO4 comment. Footnote questionable.
101	Phosphate values higher than adjacent stations. Peaks and calcs okay. Flag as questionable as per nutrient analyst. PI:"These values are high by 0.1 - flag. Check with Equator and Bay of Bengal NO3 denitrification."

Station 165

135	Sample log: "Flows freely before venting." All samples look okay on plotting.

130 Sample log: "Leaking from bottom." Oxygen appears a little high on plots. Oxygen within accuracy of the measurement, leave for PI decision whether or not the bottle had an air leak. PI: "Okay on SiO3/O2."

128 Sample log: "Top not closed right." All samples look okay on plotting.

Station 166

Cast 1 Sample Log: "Bottles fired starting at 19 (deepest)-36, 1-18 (shallowest) for freon blank test."

117 Sample Log: "Lanyard caught in top NB17.-vented" Salinity, Oxygen and nutrients look okay on plot. PI: "SiO3/O2 okay."

101 Sample Log: "Bottle 1 leaking on vent from bottom endcap". Salinity, Oxygen and nutrients look okay on plot. PI: "SiO3/O2 okay."

Station 167

134 Sample Log: "Hooked recover hook - top cap open on landing. -Hard slam" Salinity, oxygen and nutrients appear to be okay.

126 PI: "SiO3 slightly high 1.0 um/l, within WOCE specs." Leave as is, this is within the accuracy of the measurement.

113 Sample Log: "leaking from bottom - stopped during oxy draw." Oxygen appears to be okay.

107 PI: "SiO3 slightly high 1.0 um/L, within WOCE specs." Leave as is, this is within the accuracy of the measurement.

Station 168

Cast 1 No comments from Sample Log.

120 See 119 PO4 PI comment.

119 PI: "High PO4 compared to nearest GEOSECS station, +0.05 um/l, also +0.025 above WOCE deep trend." Nutrient analyst rechecked data, peaks, calcs okay. Can't see any analytical problems.

Station 169

Cast 1 No comments in Sample Log.

116 CTDO Processor: "CTDO signal unusually noisy, despiked raw CTDO, data okay unless otherwise indicated. Code CTDO despiked."

Station 170

128 Sample Log: "Flask 1165 broke, may be confusion on NB28. O2 flask off, resampled." Analyst appears to have straightened this out.

120 Delta-S at 894 db is 0.0056. Can find no obvious analytical problem. Footnote salinity questionable.

119 Delta-S at 968db is 0.0057. Can find no obvious analytical problem. Footnote salinity questionable per PI.

118 Delta-S at 1001db is 0.0075. There was trouble with getting the first two reading to agree. Gradient area, okay as is. Footnote salinity questionable per PI.

115 Delta-S at 1510db is 0.0066. Gradient area, okay as is. Footnote salinity questionable per PI.

114 Delta-S at 1797db is 0.0045. Can find no obvious analytical problem. Footnote salinity questionable per PI. CTDO Processor: "CTDO signal unusually noisy, signal spikes/cutouts. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO despiked."

113 Delta-S at 2097db is 0.0029. Gradient area, okay as is. Out of WOCE specs. Footnote salinity questionable. CTDO Processor: "CTDO signal unusually noisy, signal spikes/cutouts. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO despiked."

110	Oxygen appears low, no analytical notes. Oxygen value plotted vs potential temp. Looks OK.
102	Found oxygen flask broken in case; footnote oxygen lost.

Station 171

Cast 1	No comments from sample log.
136	Oxygen: "Bubble." Oxygen is acceptable. CTDO Processor: "CTDO fit low near surface; either slow cast start or low CTDO signal. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO questionable."
132-133	PI: "Fall above Redfield line (NO3-PO4), low PO4 -0.05 or high NO3 +0.4 - Pacific Water. These are more in line with GEOSECS Station 440. Peak in both PO4 and NO3 vs. Sigma Theta. Similar to Pacific Water Intrusion in Stations 174-180." Nutrient analyst checked and found no reading or calculation errors. PI decided these are acceptable within specs of measurements.
110	Delta-S at 3021db is 0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. Salinity is slightly high on press. vs salinity plot. No indication there was a problem with autosal readings.

Station 172

134	Delta-S at 61db is 0.073. Salinity and other parameters are acceptable. PI agrees, fine structure.
133	Delta-S at 80db is -0.0271. Salinity and other parameters are acceptable. PI agrees, fine structure.
130	Delta-S at 176db is 0.0273. Salinity and other parameters are acceptable. PI agrees, fine structure.
128	PI: "Low PO4/NO3. As compared with Station 171 this appears to be a denitrification." Nutrient analyst check and found not reading or calculation errors. PI found after comparison with later stations that these were okay.
127	PI: "High, PO4/NO3, data are acceptable." Nutrient analyst checked and found no reading or calculation errors.
126	Sample log: "Cap Loose." Not certain if comment refers to salinity bottle or sample bottle, however all data are acceptable.
123	PI: "High PO4/NO3." Nutrient analyst checked and found no reading or calculation errors. PI: "Sigma Theta approximately 27.2, Arabian Sea/Red Sea influence. Data are acceptable."
117	Delta-S at 1795db is 0.0030. No analytical problem noted. Gradient area, salinity is acceptable.
109	Delta-S at 3700db is 0.0042. The autosal took 5 tries to read the conductivity ratios. Footnote salinity bad, all other data are acceptable. PI suggests coding this as 3, questionable.
101-107	CTDO Processor: "Winch stopped to check possible problem. Yoyo 4118-4102db; rawoxy signal goes crazy thru end of down-cast. Code CTDO bad."

Station 173

Cast 1	No comments on sample log.
113	NO3 ˜0.2 high, within precision of measurement. Peak and calc looks okay. PI: "NO3/PO4 good. Well within scatter at this horizon."
106	NO3 slightly low, within precision of measurement. Peak and calc looks okay. PI: "Data acceptable, fits with later data."
102	Delta-S at 6021db is 0.0025. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 174

Cast 1	No comment on sample log.
131	Delta-S at 181db is 0.0419. Salinity as well as other parameters appear to be okay. PI: "Agree, local structure?"
130	PI: "Oxygen/Salinity min." Delta-S at 208db is -0.0234. Salinity and other parameters appear to be okay. PI: "Agree, local structure?"
123	PI: "High PO4/NO3, Delta-S 0.0039, O2-SiO3 good." PI: "Sigma Theta approximately 27.2, Arabian Sea/Red Sea influence."
118	Delta-S at 1897db is 0.0021. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. Out of WOCE specs, footnote salinity questionable.
107	Delta-S at 4698db is 0.008. Bottle salinity is too high, not sure what happened no problem noted on salinity data sheet. Footnote salinity bad. PI wants coded as 3, questionable.

Station 175

136	Delta-S at 14db is 0.1009. Bottle salinity and other parameters appear to be okay. PI: "Okay, local structure." CTD salinity is okay.
135	Sample Log: "Lanyard caught in top." Samples appear to be okay. Footnote bottle and samples acceptable. PI: "Mixed layer, samples okay."
129	PI: "High PO4/NO3 similar to Stas 172-174, real structure? data are acceptable." Nutrient analyst could not find any analytical or calculation errors. Peak low on chart also and okay.
125	PI: "High PO4/NO3 similar to Stas 172-174, real structure? data are acceptable." Nutrient analyst could not find any analytical or calculation errors.

Station 176

135	Sample log:"NB35 lanyard caught in bottle top." Potential Temp. vs Oxygen plots with adjacent stations show oxygen may be 0.02 ml/L too high. Need to check other parameters. Nutrients are inconclusive. Salinity agrees with CTD and adjoining stations. Leave data as is (bottle code 2, okay). PI: "O2 sat 0.4% different, data okay."
125	PI: "High PO4/NO3; Delta-S 0.0030." Nutrient analyst could not find any analytical or calculation error. Same as 175 and okay, nutricline. PI: "Sigma Theta approximately 27.2, Arabian Sea/Red Sea influence, data are acceptable."
124	PI: "High PO4/NO3; Delta-S 0.0034." PI: "Sigma Theta approximately 27.3, Arabian Sea/Red Sea influence, data are acceptable."
104-105	CTDO Processor: "Used up-cast data for final pressure-series data. CTDO fit high. Code CTDO questionable."
101-103	CTDO Processor: "Used up-cast data for final pressure-series data. CTDO drifts high. Code CTDO bad."

Station 177

135	Sample Log: "Lanyard caught in top". Oxygen and other samples appear to be okay.
128	Sample Log: "Lanyard caught in top". Oxygen is higher than next stations and lower than previous stations, but agrees with station trend and CTDO. Other samples also appear to be okay.
122	PI: "PO4/NO3 high; Delta-S -0.0064." Nutrient analyst could not find any analytical or calculation errors. Same as 175,176, okay. PI: "Sigma Theta approximately 27.2, Arabian Sea/Red Sea influence, data are acceptable."

Station 178

135	Sample Log: "Lanyard in top." Data are acceptable.

131	Delta-S at 129db is 0.0385. Spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
124	NO3, PO4, Sil appears low O2 high, salinity agrees with profile, CTD and adjoining stations. Data are acceptable. PI: "Lots of fine structure, checked with log and CTDO, NO3/PO4 check good."
121	PI: "PO4/NO3 within specs, data are acceptable - consistent with Stas 173-177- denitrification?." Nutrient analyst found no analytical or calculation errors. All okay. PI: "Sigma Theta approximately 27.2, Arabian Sea/Red Sea influence, data are acceptable."

Station 179

Cast 1	No comments on Sample Log.
132	Delta-S at 107db is 0.0682. Data, salinity and other parameters are acceptable. PI agrees.
128	See 122 PI comment.
123	PI: "PO4/NO3 high, PO4 0.025 high or low NO3." See 122 PI comment.
122	PI: "PO4/NO3 high." Nutrient analyst could find no analytical or calculation errors. Okay. PI: "Data are acceptable."
103-106	PI: "PO4/NO3 high." Nutrient analyst could find no analytical or calculation errors. Okay. PI: "Water off crest of seamount? - No analytical or draw problem. Footnote NO3 and PO4 questionable."

Station 180

Cast 1	CTD Processor: "Salts are routinely 0.001 low compared to nearby cast." This is within the accuracy of the measurement.
132	Delta-S at 101db is -0.0364. Data, salinity and other parameters are acceptable. PI: "Surface profiles up vs. down changing." PI agrees data okay.
131	Delta-S at 124db is -0.0484. Data, salinity and other parameters are acceptable. PI: "Surface profiles up vs. down changing." PI agrees data okay.
130	Delta-S at 177db is 0.0332. Data, salinity and other parameters are acceptable. PI: "Surface profiles up vs. down changing." PI agrees data okay.
113	Delta-S at 2647db is 0.0028. Salinity slightly high, all other parameters okay. Footnote salinity questionable. PI agrees code salinity 3, but in line with later stations 186-187.
101	Sample Log: "Slow drip from bottom end cap after opening." Samples appear to be okay. PI: "O2/SiO3 okay."

Station 181

Cast 1	No comments on the Sample Log sheet.
131	Delta-S at 225db is 0.0549. Difference between down and up CTD trace, data, salinity and other parameters okay. PI agrees, surface salinity.
130	Delta-S at 249db is -0.0396. Difference between down and up CTD trace, data, salinity and other parameters okay. PI agrees, surface salinity.
114	Nutrient analyst found that sample was not drawn. Footnote nutrients lost. PI suggests that these be coded 9, not drawn.

Station 182

Cast 1	No comments on the Sample Log sheet.
130	PI: "PO4/NO3 high; upper cast has slightly higher PO4 than surrounding casts or NO3 low? Theta/NO3 curves." Nutrient analyst could not find any analytical or calculation error. PI: "Okay with later stations, data are acceptable, within specs."

128	PI: "PO4/NO3 high; upper cast has slightly higher PO4 than surrounding casts or NO3 low? Theta/NO3 curves." Nutrient analyst could not find any analytical or calculation error. PI: "Okay with later stations, data are acceptable, within specs."
109	Oxygen: "Technician error, sample lost."
Station 183	
Cast 1	No comments on the Sample Log sheet.
133	PI: "High PO4/NO3 ratio similar to 174, no others in this range, not O2 min ?." PI: "Data are acceptable, agrees with Station 186-190."
123	PI: "High PO4/NO3 ratio. Near O2 min and other stations with high ratios. Okay."
113	Delta-S at 2002db is 0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
103	Delta-S at 4565db is 0.0021. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. Out of WOCE spec of measurement. PI: "Delta-S 0.0019 off theta/S for region, footnote questionable." CTDO Processor: "Bottom CTDO signal drop coincides with slowdown for bottom approach. May be slowdown drop, may be real. Code CTDO questionable." Footnote salinity questionable.
101-102	CTDO Processor: "Bottom CTDO signal drop coincides with slowdown for bottom approach. May be slowdown drop, may be real. Code CTDO questionable."
Station 184	
Cast 1	No comments on Sample Log.
124	PI: "High PO4/NO3 check with earlier stations." Nutrient analyst could not find any analytical or calculation error. PI: "Data compares well with earlier stations."
123	PI: "High PO4/NO3 check with earlier stations, okay code 2, data acceptable."
109	Oxygen: "Overtitrated, but still bad." No apparent affect. Oxygen plots look good. PI: "Plots fine on sigma theta/O2 and SiO3/O2, data acceptable."
Station 185	
Cast 1	No comments on Sample Log.
132	PI: "Low O2 - nuts look fine, but O2 low by 0.2?" PI: "CTD trace shows low O2 of ˜0.7-0.9 ml/l compared to bottle 31. Bottle diff is 0.799. Oxygen is okay, similar feature in Stations 191-192."
131	PI: "High PO4/NO3, okay."
109	Delta-S at 3096db is 0.0023. PI: "Code salinity as questionable."
108	Delta-S at 3297db is 0.0025. Salinity slightly out of WOCE specs. PI: "Code salinity as questionable."
107	Delta-S at 3628db is 0.0025. Salinity slightly out of WOCE specs. PI: "Code salinity as questionable."
Station 186	
Cast 1	No comments on Sample Log.
134	Delta-S at 56db is 0.0264. Autosal diagnostics do not indicate a problem. Gradient area, leave as is, do not code.
126	PI: "Spur too high PO4 on ratio. Consistent for earlier stations, okay." Nutrient analyst could not find any analytical or calculation error. PI: "Western basin influence."
101-104	CTDO Processor: "Used up-cast data for final pressure-series data. CTDO drifts high. Code CTDO bad."

Station 187

Cast 1	CTD Processor: "Salts are routinely 0.001 low compared to nearby cast." This is within the accuracy of the measurement. So will leave as is. No analytical problem found.
135	Delta-S at 26db is -0.036. Spike in the CTD up trace, footnote CTD salinity bad. Bottle data agrees with adjoining stations. PI: "Okay." No CTDO is calculated because the CTD Salinity is coded bad.
121	Sample Log: "Lanyard in bottle top-leaks on venting." Oxygen values are consistent with adjoining stations. Delta-S at 1001db is 0.0117. Salinity high, nutrients low. Footnote bottle leaking and samples bad. PI: "O2 okay in O2 vs sigma 2. NO3, PO4, and SiO3 low, code 4 all samples."
102	Sample Log: "Small leak before venting. Leak stopped when pushed on spigot before venting. Oxygen values are consistent with adjoining stations. Salinity and nutrients also appear to be okay.
101-102	CTDO Processor: "Bottom CTDO signal drop coincides with slowdown for bottom approach. No obvious offset, CTDO fit low. Code CTDO questionable."

Station 188

128	Sample Log: "Top cap not sealed-leaker." Data appears to be okay.

Station 189

133	Delta-S at 66db is 0.0274. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
129	Sample Log: "Free flow before venting." Samples agree with adjoining stations. Delta-S is -.0096, salinity agree with CTD profile. CTD salinity is acceptable.
105	Oxygen ˜0.04 high. No analytical notes noting a problem. Other parameters do not show a difference. Possible, but off on sigma 4/O2 to all closer stations. Footnote oxygen questionable."

Station 190

136	Delta-S at 12db is 0.0613. Salinity appears to be okay, mixed layer, agrees with adjoining stations for shallow water.
133	Delta-S at 81db is -0.0319. Spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
125	Sample Log: "Out of water after helium draw." No nutrients or salinity samples.
120	CFC technician reports very high value, suspects contamination. Oxygen value on plots looks okay. PI: "O2 okay, right on Station 189."
111	Oxygen vs depth plots: Oxy value looks 0.02 too low. Nutrients appear high on station profile, and agree with next station. PI: "Code 2 for O2, NO3/PO4 fine, NO3 checks with Station 189, SiO3 high, but in line with later stations. O2 in line with changes between stations in sigma 4/O2 plot."

Station 191

134	Delta-S at 34db is -0.0379. Spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
104	NO3 a little low ˜0.2, silicate 0.2 low, analyst could find no problems in peak or calculation. These are within the precision of the measurement, okay as is.
102	Sample Log: "A few drops from valve when closed". Oxygen plots look good. Data okay. PI: "NO3/PO4 okay."

Station 192

Cast 1	No comments on Sample Log.
113	Delta-S at 2327db is 0.004. The salinity bottle's insert came off with the screw top lid. There were a few other bottles that had loose inserts, the data appears to be okay for the other samples, and even this bottle is not a bad agreement with CTD. Footnote salinity bad.
101	Delta-S at 5101db is -0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. PI: "Low SiO3 by 0.2-0.3 within specs, data acceptable."

Station 193

Cast 1	Nitrate high on entire station profile, cadmium column changed. Adjusted F1s-looks better, but still may be off a bit. PI: "Have NO3 = 0.0 in surface and agrees with NO3/PO4 over most of column. Within data specifications with corrections. NO3 higher than 192 deep, but on 193 curve."
128	Sample Log: "Free flow before venting." Samples appear to be okay, salinity and oxygen agree with CTD.
117	Delta-S at 1802db is -0.0286. Salinity, Oxygen, and silicate low, phosphate and nitrate high. Bottle mistripped. Footnote bottle leaking and samples bad. ODF recommends deletion of all water samples.

Station 194

136	Delta-S at 12db is -0.079. Spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
132	Delta-S at 88db is -0.0475 Changing area, spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
131	Delta-S at 150 is -0.03. Changing area, spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
127	PI: "Off PO4/NO3 by 0.05 in PO4 or high 0.5 to 1.0 in NO3, Check later stations." Nutrient analyst found no analytical or calculation errors. Analyst changed PO4 absorbences, PO4/NO3 are now in agreement. PI: "Stations 194, 195 and 198 agree."
109	Sample Log: "Vent found open must have been open during cast." Salinity high, oxygen low, phosphate high, silicate okay. All parameters are within WOCE specs, but a slight leak. Footnote bottle leaking, samples bad.

Station 195

133	Delta-S at 77db is 0.0388. Salinity agrees with adjoining stations. Spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
125-131	PI: "Low PO4/NO3; similar to Sta 194, low oxygens; water mass change.
115	Sample Log: "Valve pushed in during cast." Oxygen and other parameters appear to be okay.
112	Delta-S at 2601db is 0.0026. Salinity and other samples agree with adjoining stations. Salinity is out of WOCE specs. Footnote salinity questionable.
101	Sample Log: "Dripping slowing from bottom endcap, reseated after O2 draw then okay." Oxygen and other parameters agree with adjoining stations.

Station 196

Cast 1	No comments on Sample Log.
121	Delta-S at 1001db is 0.0052. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. Out of WOCE spec of measurement. Footnote salinity questionable.

117	Delta-S at 1797db is 0.0027. Autosal diagnostics indicate 4 tries to get a good reading, indicating a problem with the samples. There is a gradient here. Footnote salinity questionable.
103	Delta-S at 5061db is -0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
Station 197	
133	Delta-S at 117db is -0.0443. Spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
117	Sample Log: "Free flow before venting (from bottom cap?)." Oxygen value compares well with adjoining stations and CTDO. Other parameters also agree with adjoining stations.
Station 198	
133	Delta-S at 76db is 0.0189. Spike in the CTD up trace, footnote CTD salinity bad. Bottle salinity agrees with adjoining stations. No CTDO is calculated because the CTD Salinity is coded bad.
125-129	PI: "High NO3/PO4 similar to stations 194-195, fall on overall curve, data are acceptable."
112	Delta-S at 2752db is 0.0022. Salinometer took three tries to get two readings to agree. Footnote salinity questionable.
101	Sample Log: "Leaky bottom end cap-constant stream flowing out-okay after reseating-done after helium before oxygen draw." Oxygen value compares well with adjoining stations and CTD oxygen values. Other properties also are acceptable.
Station 199	
107-109	CTDO Processor: "Used up-cast data for final pressure-series data. Winch stopped to check possible problem. CTDO fit low. Code CTDO questionable."
101	Sample Log: "No leak, fix worked."
101-102	CTDO Processor: "Used up-cast data for final pressure-series data. CTDO fit high. Code CTDO questionable."
Station 200	
121	Sample Log: "Lanyard caught in top." Oxygen and Salinity plots look okay compared to CTD values and adjoining stations. Other parameters also look okay.
120	PI: "PO4/NO3 high, footnote PO4 questionable." Analyst could not find any problem in the data.
109	Delta-S at 3253db is 0.0017. Salinity value high compared to CTD value. Other hydro parameters okay. Autosal output okay. PI: "Sigma2/O2 suggest high Salt or low O2, O2 is okay." Salinity is within WOCE specs, leave as is. CTDO Processor: "Bottle O2 low compared to CTDO, Station 202 indicates bottle leaked." O2 draw temperature does appear slightly high. Freon and helium were not drawn on this bottle. Final data review, after the expedition, revealed that this bottle may have leaked on Stations 200-202. ODF has footnoted the bottle as leaking and samples bad for this range of stations.
Station 201	
Cast 1	No comments on Sample Log.
136	CTDO Processor: "CTDO fit low near surface; either slow cast start or low CTDO signal. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO questionable."
113	Delta-S at 2246db is -0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
109	CTDO Processor: "Bottle O2 low compared to CTDO, Station 202 indicates bottle leaked." O2 draw temperature does appear slightly high. Salinity value high compared to CTD value. Freon was not draw but helium was drawn on this bottle. Final data review, after the expedition, revealed that this bottle may have leaked on Stations 200-202. ODF has footnoted the bottle as

	leaking and samples bad for this range of stations.
106	Delta-S at 3946db is 0.0015. Slightly high, other parameters appear to be okay. Within WOCE specs, salinity is acceptable. Nutrient analyst rechecked data for NO3, made correction and data looks good. PI: "Sigma 2/O2 comparison fine."
Station 202	
119	Nutrients: "No 19." Sample log indicates nutrients were to to be drawn, but analyst found no water in the sample tube. Footnote nutrients lost because of sampling error.
117	Sample Log: "Top cap not seated, seated by freon before freon draw." Samples appear to be okay.
114	Sample Log: "Top cap not seated, seated by freon before freon draw." Samples appear to be okay. PI: "Okay on sigma 2/O2 plot."
113	PI: "High O2 on sigma2/O2 plot." O2 acceptable. Salinity looks low on station profile and compared to adjoining stations, however it agrees with the CTD data.
111	Sample Log: "Vent on top seemed tight, free flowing before vented, freon sampler reseated top end cap." Samples appear to be okay. PI: "Okay on sigma 2/O2 plot."
109	Delta-S at 2799db is 0.005. NO3 high, O2 0.1 low, PO4 slightly high, sil okay. Appears that bottle leaked. Footnote bottle leaking, samples bad.
108	Oxygen slightly high, ˜0.03. No analytical problems noted. Footnote oxygen questionable.
106	Sample Log: "Leak noticed before O2 draw bottom end cap." Samples appear to be okay. PI: "O2 fine on sigma 2/O2 plot."
101	Sample Log: "Bottom endcap leaking when opened spigot before venting." Samples appear to be okay.
Station 203	
133	Delta-S at 86db is 0.0261. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
106	Sample Log: "Leaks from bottom after venting." Samples all appear to be okay.
105	N:P ratio appears a little low, nutrient analyst checked peaks and calculations and found no problems. PI: "SiO3 low by ˜1.0, Okay, data within specs of data."
104	Delta-S at 4510db is -0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. N:P ratio appears a little low, nutrient analyst checked peaks and calculations and found no problems. PI: "SiO3 low by ˜1.0, Okay, data within specs of data."
Station 204	
Cast 1	Cast 1 aborted.
228	Sample Log: "Bottom cap loose". Plots of oxygen and nutrient values are consistent with adjoining stations. Footnote bottle data okay.
209	Delta-S at 3264db is -0.0029. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
207	Delta-S at 3740db is -0.0054. No analytical reason for difference with CTD. PI: "Sigma 2/O2 on target, data acceptable." Adjoining stations were not sampled on this density level. After reviewing the data, it appears the salinity is high. Will code salinity as bad.
204	Delta-S at 4499db is -0.0027. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. Redfield ratio appears high, nutrient analyst looked at values and all appears to be okay. PI: "These fell nicely on curve-lower than next few stations, in specs, all acceptable."

203	Delta-S at 4701db is -0.0026. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
202	Delta-S at 4752db is -0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
201	Delta-S at 4792db is -0.0029. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 205

120	Sample Log: "Free flowing, top cap not seated." Plots of oxygen and nutrients are consistent with adjoining stations. Footnote bottle data are acceptable.
109	Oxygen and nutrient plots demonstrate NB09 mistrip. Delta-S at 3252db is 0.0053, salinity is 34.732. Oxygen and silicate are low, salinity, phosphate and nitrate slightly high. Changed tripping information to agree with bottle 10. All data except oxygen which are different from each other by 0.016 indicates that the bottle tripped one level up. Suggest bottle did not trip as scheduled, and oxygen 3. Data appears much better after changing trip information. PI: "Target depth 3252db, plot suggests bottle fired with 10. O2 slightly off, but within specs for this scenario."
106	Delta-S at 3998db is 0.0029. Salinity slightly high, other data appears to be okay. The autosal took 3 tries to get two readings to agree, which is an indication that there is a problem with the sample. Footnote salinity 3 (questionable) since the value is not that far out of spec. Next station (207) that this salinity bottle was used also had a poor agreement with the CTD will take box L out of circulation. PI: "Agree with coding, sigma 2/O2 plot shows sigma 2 high; SiO3/O2 fine."

Station 206

132	Delta-S at 111db is 0.0272. Salinity agrees with adjoining stations. Spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
128	Sample Log: "Bottom end cap leaking, stopped after rotating end cap after venting." Data appears to be okay.

Station 207

Cast 1	No comments on Sample Log.
133	Delta-S at 85db is -0.0439. Spike in the CTD up trace, footnote CTD salinity bad. No CTDO is calculated because the CTD Salinity is coded bad.
106	Delta-S at 4005db is 0.0082. Analyst took 3 readings to come up with this. Suspect there was some contamination in the salinity sample. Using the first reading still does not give a good agreement with the CTD or adjoining station data. Delta-S at 4005db is 0.0034, salinity is 34.717. Other data appears to be okay, seems that this is the salinity box L that is giving us a problem. PI: "Sigma 2/O2 off, too dense. SiO3/O2 is right on, SiO3/O2 good." Footnote salinity bad.
103	Delta-S at 4635db is 0.0028. Salinity is slightly high compared with adjoining stations, other samples are acceptable. Footnote salinity questionable.

Station 208

Cast 1	No comments on Sample Log.
101-113	CTDO Processor: "CTDO signal unusually noisy, small-scale noise. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO despiked."

Station 209

119	PI: "NO3 slightly high ?, within spec." NO3 is acceptable.

112 CTDO Processor: "Bottle O2 high compared with CTD." O2 also high compared with adjacent stations vs. Sigma 4, but with specs. Oxygen is acceptable.

106 PI: "O2 low by 0.02 within spec, or low SiO3, see Station 211?" Oxygen is acceptable.

Station 210

132 Delta-S at 91db is -0.046. Spike in the CTD up trace, footnote CTD salinity bad. Salinity agrees with adjoining stations, other parameters also okay. No CTDO is calculated because the CTD Salinity is coded bad.

131 Delta-S at 108db is -0.0361. Spike in the CTD up trace, footnote CTD salinity bad. Salinity agrees with adjoining stations, other parameters also okay. No CTDO is calculated because the CTD Salinity is coded bad.

129 Sample Log: "Drain cock pushed in before freon sampling." All samples appear to be okay.

121 Sample Log: "Dripping after venting-bottom end cap reseated. Oxygen first to draw from bottle." All samples appear to be okay.

110-112 PI: "NO3 high." 0.2 high on sigma 2 surface compared to Station 209. within WOCE Standard."

Station 211

Cast 1 No comments on sample log.

115-117 PI: "NO3 0.3 low for density horizon. Could be denitrification in lower O2 minimum." Footnote Nitrate questionable.

108 Bottle appears to have mistripped. Delta-S at 3107db is 0.2308. Bottle appears to have tripped between 900 and 1000 db. Footnote bottle leaking and samples bad. Phosphate, nitrate high, and silicate and oxygen low.

101-107 PI: "Lower SiO3 bottom water?" Nutrient analyst made corrections to standards, silicate fits station profile and adjoining stations.

Station 212

131 Delta-S at 143db is -0.0293. Spike in the CTD up trace, footnote CTD salinity bad. Other data also agree with adjoining stations. No CTDO is calculated because the CTD Salinity is coded bad.

120 Sample Log: "Free flow before venting-air from bottom." Data appears to be okay, agrees with adjoining stations.

Station 213

113 Sample Log: "Leaking from bottom end cap." Samples appear to be acceptable.

111 Sample Log: "Dribbling from valve until top cap seated." Samples appear to be acceptable.

101 CTDO Processor: "Bottle O2 low compared to nearby casts." Salinity higher than adjacent stations and agrees with CTD and is acceptable. Nutrients do not show this feature and are acceptable. Station 216 also shows the feature with a lower oxygen and a higher salinity and agreed with CTDO (no comment from CTDO Processor.) The O2 draw temp is higher than next bottle (shallower), and the higher draw temp is also seen in Station 216 and 215. Station 215 O2 is also acceptable. O2 is acceptable.

Station 214

129 Sample Log: "Top end cap no good, free flow before venting." Samples appear to be okay.

107-108 PI: "NO3 0.2 high on sigma 2 surface PO4 fine, within WOCE specs."

101-105 CTDO Processor: "CTDO does not match bottles, nearby casts. Code CTDO questionable."

Station 215

136 Delta-S at 16db is -0.2032. Gradient area, down and up trace differ, therefore, salinity is different than CTD trace. Salinity and other parameters agree with adjoining stations, data are acceptable. CTDO Processor: "Bottle O2 high compared with CTD." O2 appears 0.1 high compared with adjacent stations. Footnote O2 questionable.

130 Sample Log: "Oxygen taken before helium."

126 Sample Log: "Low on water-salts may have trouble." Salinity as well as other samples are acceptable.

125 Sample Log: "Low on water-2/3 bottle of salts, barium okay." Suspect this note means barium was drawn. Salinity as well as other samples are acceptable.

113 PI: "O2 0.05 low ? or trend to low O2 high SiO3, data are acceptable."

110 Autosalt took 5 tries to get a good reading, the first reading appears to be correct. After change Delta-S is 0.0001, much better. All other samples are acceptable. PI: "O2 0.02 low (?) within specs, data are acceptable."

105 Delta-S at 3800db is -0.0022. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

104 Delta-S at 4102db is -0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Oxygen: "Forgot stir bar, went to launch rosette, sample lost." See 101-104 CTDO comment. Footnote CTDO questionable, salinity questionable and oxygen lost.

101-104 CTDO Processor: "Odd CTDO shape; may be real, matches bottles. Code CTDO questionable."

Station 216

121 Sample Log: "Leaks from bottom-a little." Samples appear to be okay.

104 Delta-S at 3997db is -0.0031. Salinity and other samples appear to be okay. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

102 Delta-S at 4342db is -0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 217

131 Delta-S at 100db is -0.0288. Gradient area, spike in the CTD up trace, footnote CTD salinity bad. Other samples appear to be okay. No CTDO is calculated because the CTD Salinity is coded bad.

111-112 PI: "Low O2, okay with later stations."

105 Sample Log: "Free flowing-top vent open." Sample are acceptable.

101-107 PI: "Low SiO3, within specs, values are acceptable."

Station 218

134 Sample Log: "Bottom end cap leaking after venting-stopped after reseating." Samples are acceptable.

120 Sample Log: "Had to reseat top end cap." Samples are acceptable.

103 CTDO Processor: "Odd CTDO shape; may be real, matches bottles. Code CTDO questionable."

Station 219

Cast 1 No comments on Sample Log.

118 PI: "O2 high by 0.12 on sigma2/O2 plot, footnote questionable. Compares to bottle 18 on Station 220, both plot high." NO3 and PO4 lower on station profile, but agrees with Station 220. Will code oxygen questionable as suggested by PI.

104 Delta-S at 4000db is -0.0024. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

102 Salinity is slightly low compared with adjoining stations. Delta-S is -.0025, temperature is also lower than previous and next bottle, but not sure what that means. Salinity and other samples appear to be okay. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 220

Cast 1 No comments on Sample Log.

131 PI: "NO3/Sigma theta off, Delta-S 0.0198, theta/salinity anomaly. Footnote salinity questionable."

118 PI: "O2 high ?, see comments on Station 219. Footnote oxygen questionable."

105-106 PI: "SiO3 low by 2.5, to Station 221, close to 222 (1.0) value acceptable."

104 Delta-S at 4002db is -0.0026. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

102 Delta-S at 4242db is -0.003. Previous station is also a little high in salinity. No analytical problem noted in salinity. Out of WOCE spec of measurement. Footnote salinity questionable.

102-103 PI: "SiO3 low by 0.5, value acceptable."

Station 221

117 NO3 low, PO4 low, O2 appears a little high compared to adjoining stations. Nutrient analyst found no analytical problem, suggests mistrip or bad draw. Salinity and silicate agrees with adjoining stations. PI: "O2 high ˜0.05 on SiO3/O2-SiO3 on sigma 2/SiO3 curve." Silicate is acceptable, footnote oxygen questionable."

108 Oxygen appears slightly high compared with adjoining stations, however, it agrees with CTD trace. Oxygen and other samples are acceptable. PI: "Falls back to 220 O2/SiO3 curve. Oxygen is acceptable."

101 Sample Log: "Small leak on bottom end cap-reseating stopped leak." Samples are acceptable.

Station 222

135 Delta-S at 27db is 0.1254. Large gradient, salinity and other samples appear to be okay for shallow water.

111 Sample Log: " Leaking from bottom after O2 draw-stopped after reseating." Silicate is a little low < 1.0 compared to adjoining stations, but all other data are acceptable. PI: "Transitioned on SiO3/O2 between Stas. 220 & 224, data are acceptable."

102-103 CTDO Processor: "Bottle O2s could be dup draw; (too small to tell/could be real)." O2 draw temperature are the same and both are lower than 101 and 104. O2 is acceptable, within WOCE specs.

Station 223

128 Sample Log: "Lanyard caught in top." Oxygen and salinity are low, nutrients are high. Suspect this bottle was contaminated, footnote bottle leaking and samples bad. PI: "Lowest O2 on cast, SiO3/O2 curve okay. Large Delta-S; theta/S compares with Station 225. Will code these as questionable."

127 Delta-S at 311db is -0.0868. Silicate extremely high, but similar feature in all properties. Suspect this tripped lower in the water column. Footnote bottle leaking, samples bad. 28 had the lanyard from 27 caught in it. Oxygen draw temperature is 2 degrees lower than should be.

120 Oxygen appears ˜0.1 low. PI: "Okay vs. later stations, oxygen is acceptable."

104 Delta-S at 3798db is -0.0025. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 224

113	Sample Log: "Dripping on bottom after pushing spigot in, stopped after reseating." Samples are acceptable.

Station 225

Cast 1	No comments on Sample Log.
101-107	PI: "Low SiO3 or O2, compares to 220 that was also low. Sigma2/O2 compares to Station 217,220. Data are acceptable." Nutrient analyst rechecked data, made correction to standards, data now fits adjoining station comparison.

Station 226

127	Sample Log: "Leak from bottom." Samples are acceptable.
113	PI: "High SiO3/O2, O2 low 0.025, footnote oxygen questionable."
101	CTDO Processor: "Bottle O2 may be high compared to CTDO." O2 gradient, agrees with Station 225. O2 draw temperature reasonable. Other parameters are acceptable. SiO3 also ˜2.0 high. Rechecked nutrient raw data and peak is higher. O2 is acceptable. Footnote SiO3 questionable.

Station 227

132	Sample Log: "Sampled by salts only."
133	Sample Log: "Sampled by salts only."
127	Sample Log: "Leaks from bottom." Oxygen appears 0.1 low compared with Stas. 226 and 228, but is close to Sta 225. All samples are acceptable. PI: "O2 okay on SiO3/O2, O2 is acceptable."
121-124	CTDO Processor: "CTDO fit high at base of minimum. Code CTDO questionable."
109-110	PI: "High on theta/S plot. Code 9 & 10 salinity as bad." Not sure what happened to salts. See 101-116 CTD salinity comments. Footnote CTD salinity despiked. Footnote salinity bad.
107	PI: "Low O2 on sigma2/O2, but compares to later stations, okay." See 101-116 CTD salinity comments. See 107-108 salinity comment. Footnote CTD salinity despiked. Footnote salinity questionable.
107-108	PI: "High on theta/S plot. Footnote 7 & 8 salinity as questionable." Not sure what happened to salts. See 101-116 CTD salinity comments. Footnote CTD salinity despiked. Footnote salinity questionable.
106	Sample Log: "Salinity drawing test, only salts drawn, no other samples." See 101-116 CTD salinity comments. Footnote CTD salinity despiked, oxygen and nutrients not drawn.
105	Oxygen appears low, so does 7, but it agrees with Station 228. Leave for PI decision. PI: "O2 okay, follows later trend." See 101-116 CTD salinity comments. Footnote CTD salinity despiked.
102	Delta-S is -0.0021. Autosal diagnostics do not indicate a problem. Agrees with adjoining stations. Could be a little low as compared with adjoining stations vs. pressure, but not as much as CTD indicates. Same as 101 vs. potential temperature. Salinity is acceptable. See 101-116 CTD salinity comments. See 101-103 CTD oxygen comments. Code CTD salinity questionable. Code CTD oxygen questionable.
101-103	CTDO Processor: "CTDO fit low at bottom. See 101-116 CTD salinity comments. Code CTD salinity questionable. Code CTDO questionable."
101-116	CTD Processor: "CTD salinity data were despiked."

Station 228

129	Sample Log: "Free flow before venting-from bottom." Samples are acceptable.

121 PI: O2 low on sigma2/O2 and on SiO3/O2, footnote oxygen questionable."

101 Sample Log: "Leaks from bottom." Delta-S at 3632db is 0.0002. Samples are acceptable.

Station 229

129 Sample Log: "Drain valve flowed until top cap reseated." Samples are acceptable.

128 CTD Processor: "Bottle O2 looks high compared to CTD." Oxygen is high compared with adjacent stations. No analytical reason could be found. However, could be a drawing problem. Footnote O2 bad.

116 PI: "High O2/low SiO3, ˜0.1 in O2. Sigma2/O2 oxygen okay, footnote silicate questionable." Nutrient analyst rechecked data and could find no analytical problems.

113-114 PI: "High O2/low SiO3, footnote silicate questionable." Nutrient analyst rechecked data and could find no analytical problems.

112 Delta-S at 1552db is 0.0059. Salinity appears slightly high for station profile. Footnote salinity questionable.

107 O2 0.1 high, SiO3 1.0 low, PO4 0.02, NO3 0.2 low, compared with station profile and adjoining stations. Salinity does not show this feature. PI: "High on SiO3/O2, O2 is fine, SiO3 low. Footnote silicate questionable."

Station 230

123 Sample Log: "Dripping from bottom cap when drain pushed in, bad bottom o-ring." Samples are acceptable.

Station 231

132 Delta-S at 101db is 0.0521. Salinity and other samples are acceptable for shallow samples. Nutrients: "Silicate had a problem, not enough water to rerun." Footnote silicate lost.

131 Nutrients: "Silicate had a problem, not enough water to rerun." Footnote silicate lost.

108 Delta-S at 2601db is -0.0063. Salinity is low compared with station profile and adjoining stations, other samples are acceptable No problems notes on autosal run. Footnote salinity bad, just too far out.

106 Delta-S at 3001db is 0.0025. No problems notes on autosal run. Salinity just barely acceptable and other samples are acceptable. PI: "Footnote salinity questionable."

101 Sample Log: "Dripping from bottom." Delta-S at 3614db is 0.0019. No problems notes on autosal run. Salinity just barely acceptable and other samples are acceptable. PI: "Footnote salinity questionable."

101-103 CTDO Processor: "CTDO fit low at bottom. Code CTDO questionable."

Station 232

136 CTDO Processor: "Bottle O2 high compared with CTD." O2 is 0.2 high compared with adjacent stations. Footnote O2 bad.

130 Oxygen: "Sample lost, forgot stirrer bar."

109 Delta-S at 2398db is -0.0022. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

107 Delta-S at 2798db is -0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

104 Delta-S at 3400db is -0.0024. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

103 Delta-S at 3506db is -0.0032. Salinity is lower than previous station, next station is not as deep. Other data are also acceptable. Out of WOCE spec of measurement. Footnote salinity

questionable.

101 Sample Log: "Leaks from bottom after venting." Oxygen as well as other data are acceptable.

Station 233

120-129 CTDO Processor: "CTDO fits high in minimum O2 area. Code CTDO questionable."

119 PI: "Low NO3/PO4 okay, footnote acceptable. Feature appears in 233, 235, 236 denitrification at sigma theta =27.2."

113 Oxygen appear ˜0.1 higher than adjoining stations. PI: "Footnote questionable."

106 Delta-S at 2749db is 0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. Salinity is 0.001 higher than other two bottles tripped at this pressure. 3 bottles tripped @˜2750db, this oxygen is 0.04 higher than the other two. No analytical problem found. Could be a drawing problem. Footnote oxygen questionable.

105 Delta-S at 3050db is 0.0024. Salinity does appear slightly high compared to adjoining stations. Other data are acceptable. Out of WOCE specs. Footnote salinity questionable.

Station 234

Cast 1 Sample Log: "Bottle blank cast. Deep bottle 13." Bottles fired starting at 13 (deepest)-36, 1-12 (shallowest) for freon blank test.

106 Oxygen: "No stir bar, sample lost." Oxygen analyst could not recover sample. Delta-S at 109db is -0.0319. Spike in the CTD up trace, footnote CTD salinity bad. Bottle salinity as well as other data are acceptable. No CTDO is calculated because the CTD Salinity is coded bad.

131 PI: "SiO3/O2 appears low, footnote oxygen questionable."

129 PI: "SiO3/O2 appears low, but they are acceptable." CTD Processor found the bottle O2 was high compared with the CTDO. The O2 draw temperature is slightly low. This usually indicates a bottle leaking or tripping problem. Salinity is a little high, but within the accuracy of the measurement. Footnote oxygen questionable.

Station 235

127 Sample Log: "Leaking from bottom after venting." Oxygen as well as other samples are acceptable.

126 Sample Log: "Free Flow before venting." Oxygen could be low. NO3/PO4 high. Nutrient analyst rechecked peaks and calculations, no changes were made. PI decided to footnote oxygen questionable.

124-126 PI: "O2/sigma theta, O2 is high, footnote questionable."

123-125 PI: "High O2 or low SiO3, SiO3 is acceptable." Footnote O2 questionable.

122-125 PI: "Low NO3, see similar feature Station 236. Feature appears in 233, 235, 236 denitrification at sigma theta =27.2." NO3 is acceptable.

121 Oxygen 0.1 low. Could possibly be a drawing error, but double checked draw temperature on 22 and that is not the case, or difficulty titrating low oxygen. CTD processor had difficulty fitting with CTDO. PI decided to code oxygen acceptable.

105-107 Sample Log: "Salinity drawing test, only salinity drawn, no nutrients or oxygen."

102 Delta-S at 3418db is -0.0023. Salinity appears 0.001 lower than previous station, but next station also has lower bottom salinities. Other data are also acceptable. Salinity is out of WOCE specs. Footnote salinity questionable.

101 Delta-S at 3457db is 0.0023. Salinity agrees with adjoining stations. Other data are also acceptable. Salinity is out of WOCE specs. Footnote salinity questionable.

Station 236

123 NO3/PO4 low. Nutrient analyst rechecked peaks and calculations, and found no problems. PI: "Feature appears in 233, 235, 236 denitrification at sigma theta =27.2. Low NO3 on sigma theta/NO3 123-121, see feature in Station 235. NO3/PO4 are acceptable."

111 Sample Log: "Flows before venting." Oxygen as well as other data are acceptable.

110 Salinity @2000db is 0.001 low, O2 0.15 high, NO3 0.2 low. PO4 and silicate are acceptable. PI: "O2 0.08 high on sigma2/O2, footnote oxygen questionable. NO3 in spec, NO3 is acceptable. SiO3/O2 low for profile but on 235 line."

106 Delta-S at 2800db is 0.0024. NO3 appears 0.1 high compared with adjoining stations. Salinity as well as other data are acceptable. Autosal diagnostics do not indicate a problem. Out of WOCE specs, footnote salinity questionable.

104-107 Silicate appears higher than previous station, but agrees with next station. PI: "SiO3/O2 shows high, SiO3 compared to Station 235, data are acceptable."

101 Sample Log: "Leaks from bottom after venting." Oxygen as well as other data are acceptable. PI: "O2 perhaps high on SiO3/O2 plot okay on theta/O2 plots."

Station 237

132 Delta-S at 86db is 0.0292. Spike in the CTD up trace, footnote CTD salinity bad. Salinity and other data are acceptable. No CTDO is calculated because the CTD Salinity is coded bad.

127 Sample Log: "Leaked from bottom end cap after venting, reseated okay." Samples are acceptable. Oxygen is acceptable.

123 Oxygen may be 0.1 ml/l too high compared to previous station, however, it agrees with the CTDO and next station. PI: "Falls in SiO3/O2, for surrounding stations, data are acceptable."

Station 238

Cast 1 No comments on Sample Log.

106 Silicate appears low, NO3 low on station profile, but agrees with Sta. 237, O2 and PO4 high on station profile, but agree with Sta. 237. Nutrient analyst rechecked data, no analytical problems. PI: "High O2, at level in 233. NO3/PO4 okay. SiO3/O2 falls near Station 237, footnote oxygen questionable all other data are acceptable."

Station 239

Cast 1 No comments from Sample Log.

130 Nutrient analyst rechecked data and made corrections to NO3. PI: "PO4 still high, code questionable."

129 PI: "High PO4/NO3, high NO3 on NO3/sigma theta, but 130 has large delta-S." Nutrient analyst rechecked data and found no analytical problems, but made correction to 130. PI: "PO4 still high on sigma theta/PO4, code questionable."

128 PI: "PO4 high on sigma theta/PO4, within spec, data are acceptable."

110 Delta-S at 2000db is -0.0028. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

109 Delta-S at 2200db is -0.0025. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. Out of WOCE spec of measurement. Footnote salinity questionable.

108 Delta-S at 2400db is -0.0033. Salinity as well as other data are acceptable. Out of WOCE spec of measurement. Footnote salinity questionable.

107 Delta-S at 2600db is -0.0027. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. NO3 0.1 higher than adjoining stations and

	within spec.
106	Delta-S at 2803db is -0.0022. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
105	Delta-S at 2904db is -0.0027. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
104	Delta-S at 3003db is -0.0031. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
103	Delta-S at 3042db is -0.0043. Salinity appears high compared to adjoining stations, however, it agrees with Station 241 and density is appropriate. PI: "101-111 low on theta/S compared to all surrounding stations; consistent with CTD offset. Station 241 more saline. Footnote salinity questionable."
102	Delta-S at 3042db is -0.0057. Salinity appears high compared to adjoining stations, however, it agrees with Station 241 and density is appropriate. See PI comments on 103, footnote salinity questionable.
101	Delta-S at 3134db is -0.003. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable. CTDO Processor: "CTDO fit high at bottom. Code CTDO questionable."
Station 240	
131	PI: "Low SiO3/O2; O2 high also high O2 on sigma theta/O2, check with Station 241 indicates higher SiO3/O2 through much of mid-range."
121	Sample Log: "Leaking from bottom." Oxygen and other data are acceptable.
113	Sample Log: "Leaking from bottom." Oxygen and other data are acceptable.
112	Delta-S at 1701db is -0.0149. Suspect drawing error on salinity, same value as 11. All other data are acceptable. Footnote salinity bad.
Station 241	
Cast 1	No comments on Sample Log.
106	CTDO Processor: "Bottle O2 low compared to CTDO, next station also the same bottle lower than CTDO." O2 gradient, slightly higher than 242, 243 and 244 well within specs of the measurement. Other parameters do not indicate a problem with this bottle. Different O2 flasks used for these two stations and O2 draw temperature appears reasonable. O2 is acceptable.
102	Delta-S at 2845db is -0.0025. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
Station 242	
120	NO3/PO4 low. Nutrient analyst rechecked data, made minor change to PO4. NO3 is higher, could be questionable. PI: "Looks okay on NO3/PO4 and sigma theta/NO3 within specs, data are acceptable."
106	Delta-S at 2550db is 0.0014. Salinity as well as other samples are acceptable. CTDO Processor: "Bottle O2 low compared with CTDO." O2 agrees with Station 244. O2 draw temperature is reasonable. O2 is acceptable.
101	Sample Log: "Bottom end cap leaked-ok when reseated." Delta-S at 2791db is 0.0014. Oxygen as well as other samples are acceptable.
Station 243	
Cast 1	No comments on Sample Log.
129	CTDO Processor: "Bottle O2 high compared with CTDO." O2 agrees with previous stations, 242 and 241. O2 is higher than next station 244. O2 is acceptable.

123-128	CTDO Processor: "CTDO fits high in minimum O2 area. Code CTDO questionable."
114	CTDO Processor: "Bottle O2 low compared with CTDO." O2 agrees with adjacent stations. O2 is acceptable.
104	Delta-S at 2500db is -0.0022. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
105-106	Sample Log: "Salinity drawing test, no oxygen or nutrients."
101	PO4 appears high on press vs. po4 plot. Nutrient analyst made correction to data, value much better. PI: "NO3/PO4 look okay, data are acceptable."

Station 244

113	Sample Log: "Small leak bottom end cap."
103	CTDO Processor: "Bottle O2 high compared to CTDO and nearby casts." O2 does appear higher than adjacent stations vs. pressure. However, appears to be okay comparing adjacent stations SiO3 vs. O2. Also Sigma 4 vs. O2 appears acceptable. O2 is acceptable.
101-102	CTDO Processor: "Transmissometer signal drop-nephels layer at bottom, may correspond with CTDO feature. CTDO fit low compared to bottom bottles; may be real. Code CTDO questionable."

Station 245

127	Sample Log: "Bottom cap dripping after venting." Salinity and other samples are acceptable.
126	Delta-S at 102db is 0.0294. Gradient, spike in the CTD up trace, footnote CTD salinity bad. Salinity and other samples are acceptable. No CTDO is calculated because the CTD Salinity is coded bad.
103	Delta-S at 2420db is -0.0022. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
101-102	CTDO Processor: "Bottom CTDO signal drop coincides with slowdown for bottom approach. Transmissometer signal drop-nephels layer at bottom, may correspond with CTDO feature. CTDO fit low compared to bottom bottles; part-all may be real. Code CTDO questionable."

Station 246

Cast 1	No comments on Sample Log.
103	Delta-S at 2420db is -0.0022. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 247

Cast 1	No comments on Sample Log.

Station 248

124-127	CTDO Processor: "CTDO fits high in minimum O2 area. Code CTDO questionable."
113	Sample Log: "Leaking from bottom." Delta-S at 1100db is 0.0066. Salinity and other data are acceptable. PI: "Sigma theta/O2 fine, code 2, acceptable."
101-105	NO3, PO4 and Salinity lower than adjoining stations, O2 and Sil higher. PI: "Theta/S tight except for 102; 102 similar to Station 247. Sigma2/O2 within 0.02 within spec, code 2, acceptable, for S, O2. NO3/PO4 within specs, code 2, acceptable, low by ˜0.1-0.2 and 0.01-0.02, respectively."

Station 249

Cast 1	No comments on Sample Log.
123	PI: "O2 high compared to other stations within specs code 2, acceptable."
122	PI: "O2 high compared to other stations within specs code 2, acceptable."

101	Delta-S at 2238db is 0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
101-102	CTDO Processor: "Bottom CTDO signal drop coincides with slowdown for bottom approach. Transmissometer signal drop-nephels layer at bottom, may correspond with CTDO feature. Odd CTDO shape near bottom; part-all may be real. Code CTDO questionable."
Station 250	
124-126	CTDO Processor: "CTDO fits high in minimum O2 area. Code CTDO questionable."
115	PI: "High PO4/NO3 compared to Stas. 246-247, within specs, data are acceptable."
106	Sample Log: "Bottom end cap dripping-okay when reseated." Oxygen as well as other samples are acceptable.
105-106	PI: "High PO4/NO3 compared to Stas. 246-247, within specs, data are acceptable."
101	Delta-S at 2126db is -0.0024. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
Station 251	
Cast 1	No comments on Sample Log.
122	Oxygen: "Overtitrate." Oxygen is acceptable. PI: "O2 0.1 high, footnote questionable."
106	Oxygen: "Overtitrate, no stirrer bar." Oxygen does not fit station profile, adjoining station comparison or CTDO. Other samples appear to be okay. Footnote oxygen bad.
Station 252	
Cast 1	No comments on Sample Log.
101	CTDO Processor: "Bottom CTDO signal drop coincides with slowdown for bottom approach. Transmissometer signal drop-nephels layer at bottom, may correspond with CTDO feature. CTDO drop at bottom; part-all may be real. Code CTDO questionable."
Station 253	
Cast 1	No comments on Sample Log. Helium/Tritium samples incorrectly taken without Salinity or oxygen. Bottle integrity unknown for these samples.
135	Helium and tritium only samples drawn. No other samples drawn. Samplers were informed that at least salinity should be drawn.
129	Helium and tritium only samples drawn. No other samples drawn. Samplers were informed that at least salinity should be drawn.
123	Helium and tritium only samples drawn. No other samples drawn. Samplers were informed that at least salinity should be drawn.
120	Helium and tritium only samples drawn. No other samples drawn. Samplers were informed that at least salinity should be drawn.
117	Helium and tritium only samples drawn. No other samples drawn. Samplers were informed that at least salinity should be drawn.
114	Helium and tritium only samples drawn. No other samples drawn. Samplers were informed that at least salinity should be drawn.
108	Helium and tritium only samples drawn. No other samples drawn. Samplers were informed that at least salinity should be drawn.
102	Helium and tritium only samples drawn. No other samples drawn. Samplers were informed that at least salinity should be drawn.

Station 254

Cast 1 No comments on Sample Log.

Station 255

125 Delta-S at 65db is -0.027. Spike in the CTD up trace, footnote CTD salinity bad. Salinity as well as other samples are acceptable. No CTDO is calculated because the CTD Salinity is coded bad.

120 Oxygen appears ˜0.1 high. Footnote oxygen questionable. PI: "Compares with 248, 250 that are neighbors on line. On sigma theta/oxygen, oxygen is high, footnote questionable."

116 Sample Log: "Detritus on draincock." Samples are acceptable.

108-119 CTD Processor: "Upcast salinity offset -0.003 psu; not despiked. CTD salinity profile usually "jumped" back to correct value at bottle trip, however, not on these bottles. Code CTD salinity questionable." No CTDO is calculated because the CTD Salinity is coded questionable.

104 Delta-S at 2048db is 0.0037. Autosal diagnostics indicate 3 tries to get a good reading, frequently indicating a problem with the samples. Salinity is 0.001 higher than adjacent stations. This is within the specs of the measurement. Salinity is acceptable. CTD Processor: "Upcast salinity offset -0.003 psu; not despiked. CTD salinity profile usually "jumped" back to correct value at bottle trip, however, not on these bottles. Code CTD salinity questionable." No CTDO is calculated because the CTD Salinity is coded bad.

Station 256

117 Sample Log: "Free flowing before venting-bottom cap loose." Oxygen as well as other samples are acceptable.

117-120 PI: "Low NO3/PO4, low compared to all surrounding stations." PI: "PO4 high by ˜0.01 within specs, data are acceptable." Nutrient analyst rechecked data and made correction to NO3.

112 CTD Processor: "Upcast salinity offset -0.003 psu; not despiked. CTD salinity profile usually "jumped" back to correct value at bottle trip, however, not on these bottles. Code CTD salinity questionable." No CTDO is calculated because the CTD Salinity is coded questionable.

107-108 NO3 either low on 108 or high on 107. Nutrient analyst rechecked data and could not find any analytical problems. PI: "Looks like denitrification step in reverse?."

107-110 CTD Processor: "Upcast salinity offset -0.003 psu; not despiked. CTD salinity profile usually "jumped" back to correct value at bottle trip, however, not on these bottles. Code CTD salinity questionable." No CTDO is calculated because the CTD Salinity is coded questionable.

101-102 PO4 appears a little high, nutrient analyst rechecked data made minor changes to 101, 102, and 103. Data much better on the comparison with adjoining stations. PI: "Similar curvature to other stations, falls in envelope, data are acceptable."

101-103 CTD Processor: "Upcast salinity offset -0.003 psu; not despiked. CTD salinity profile usually "jumped" back to correct value at bottle trip, however, not on these bottles. Code CTD salinity questionable." No CTDO is calculated because the CTD Salinity is coded questionable.

Station 257

Cast 1 No comments on Sample Log.

129 Delta-S at 26db is -0.031. Salinity as well as other data are acceptable. CTDO Processor: "Used up-cast data for final pressure-series data. Winch stopped to check possible problem. Sharp gradient, CTDO spikes. Code CTDO questionable."

124-125 PI: "NO3/PO4 high." Nutrient analyst rechecked data and could find no analytical problem.

119 Oxygen appears a little high compared with adjoining stations, O2 high compared with silicate. Silicate, phosphate nitrate slightly low on station profile. Salinity does not show this feature, suspect data acceptable. PI: "O2 high by 0.06, misdraw? footnote questionable same as 18.

Temperature change on draw too large to make that possible." Oxygen draw temperature 0.3 different between bottle 18 and this bottle.

112 CTDO Processor: "CTDO signal unusually noisy, signal spikes/cutouts. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO despiked."

Station 258

Cast 1 No comments on Sample Log.

112 Delta-S at 1400db is 0.0115. Salinity high compared with adjoining stations; other data are acceptable. PI: "High on theta/salinity plot, footnote questionable."

108 See 107 NO3 PI comment. NO3 is acceptable.

107 NO3 appears high compared with adjoining stations. Nutrient analyst rechecked data and found no analytical problems. PI: "High by 0.1 to 0.2 on Sigma2/NO3 within specs, data are acceptable."

Station 259

Cast 1 No comments on Sample Log.

133 Delta-S at 61db is 0.1185. Spike in the CTD up trace, footnote CTD salinity bad. Gradient area. Salinity and other data acceptable. No CTDO is calculated because the CTD Salinity is coded bad.

Station 260

Cast 1 No comments on Sample Log.

104-108 PO4 may be high. Nutrient analyst recheck data found peaks slightly noisy, but okay. PI: "Difference 0.01 to 0.02 in sigma 2/PO4, data are acceptable."

101-115 CTDO Processor: "CTDO signal unusually noisy, small-scale noise. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO despiked."

Station 261

Cast 1 No comments on Sample Log.

125-131 CTDO Processor: "CTDO fits high in minimum O2 area. Code CTDO questionable."

112 NO3 may be low on station profile, but agrees with Station 259. Nutrient analyst rechecked data and made minor corrections. Data looks much better. PI: "Low by 0.2 compared to Station 258 in sigma 2/NO3 within specs, data are acceptable."

105 NO3 may be low on station profile, but agrees with Station 259. Nutrient analyst rechecked data and found no analytical problems. PI: "NO3 higher by 0.2, 0.1 than Station 258 and 262 on sigma 2/NO3, within specs, data are acceptable."

Station 262

128-131 CTDO Processor: "CTDO fits high in minimum O2 area." Code CTDO questionable."

126 PI: "NO3/PO4 high, within specs, data are acceptable."

121 Sample Log: "Drips from bottom cap when vented." Oxygen as well as other data are acceptable.

106 Nutrient analyst rechecked and corrected value, still low but within specs. PI: "NO3 low by 0.1 on sigma 2/NO3 compared to Station 261, within specs, data are acceptable."

Station 263

Cast 1 No comments on Sample Log. PI: "This station similar to 230-235, fresh high O2 signal in bottles 131-132 unique. No analytical problems, data are acceptable."

132 Delta-S at 96db is 0.0624. Spike in the CTD uptrace, footnote CTD salinity bad. Salinity as well as other data are acceptable. No CTDO is calculated because the CTD Salinity is coded bad.

126 PI: Delta-S is 0.0045 @250db, okay for high gradient zone, data is acceptable." Salinity bottle had a loose thimble, Autosal took a couple readings before getting two to agree. Change to first reading. Salinity was 35.032 now 35.029 and Delta-S 0.00017.

121-129 CTDO Processor: "CTDO fits high in minimum O2 area." Code CTDO questionable."

116 PI: "Delta-S is 0.0059 @1149db, footnote salinity uncertain." Salinity bottle had a loose thimble, Autosal took a couple readings before getting two to agree. Change to first reading. Salinity was 34.911 now 34.905 and Delta-S -0.0002. Salinity is acceptable.

113 PI: Delta-S is 0.0035 @1600db, footnote salinity uncertain." Autosal took a couple readings before getting two to agree. Change to first reading. Salinity was 34.834 now 34.832 and Delta-S -0.0011. Salinity is acceptable.

112 PI: "High on theta/S, footnote salinity questionable." Salinity analyst had many problems with this run, got multiple readings, use the first reading. Salinity Autosal took a couple readings before getting two to agree. Change to first reading. Salinity was 34.810 now 34.809 and Delta-S -0.0006. Salinity is acceptable.

108 PI: "Off neighboring theta/S points, CTD/Bottle compare, within specs, data are acceptable."

103 Delta-S at 3016db is 0.0037. Salinity is slightly higher compared with adjoining stations, but so is O2, NO3 and Sil are lower. PI: "Significantly off theta/S curve, footnote salinity questionable."

Station 264

122-130 CTDO Processor: "CTDO fits high in minimum O2 area." Code CTDO questionable."

121 Sample Log: "Leaking from bottom." Oxygen as well as other data are acceptable.

110 Delta-S at 2150db is 0.0022. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

101-108 Nutrient analyst found that silicate came out higher on this station and 265. Could not find any analytical problems. High nutrient seawater came out higher which was the indication that silicate may be high. PI: "SiO3/O2 relationship fits as intermediate to later stations in bottom water, tight curve in mid-depths, data are acceptable."

Station 265

125-132 CTDO Processor: "CTDO fits high in minimum O2 area." Code CTDO questionable."

113 Sample Log: "Leaking from bottom." Oxygen and other data are acceptable.

109 See 101-105 Silicate comment and PI comment.

108 Sample Log: "Salinity drawing test, no oxygen or nutrients."

107 See 101-105 Silicate comment and PI comment.

106 Sample Log: "Salinity drawing test, no oxygen or nutrients."

101-105 Nutrient analyst found that silicate came out higher on this station and 264. Could not find any analytical problems. High nutrient seawater came out higher which was the indication that silicate may be high. However, Oxygen appears lower than adjoining stations. PI: "SiO3/O2 relationship fits as intermediate to later stations in bottom water, tight curve in mid-depths, data are acceptable."

Station 266

132-136 CTDO Processor: "CTDO fit off compared to bottles, surface to O2 minimum. Code CTDO questionable."

131 Delta-S at 122db is -0.0319. Spike in the CTD up trace, footnote CTD salinity bad. Salinity as well as other data are acceptable. No CTDO is calculated because the CTD Salinity is coded bad.

130 CTDO Processor: "CTDO fit off compared to bottles, surface to O2 minimum. Code CTDO questionable."

129 Delta-S at 144db is -0.0746. Spikes in the CTD up trace, footnote CTD salinity bad. Salinity as well as other data are acceptable. No CTDO is calculated because the CTD Salinity is coded bad.

128 Delta-S at 156db is 0.0325. Salinity is low, oxygen high compared on station profile and adjoining stations. However, CTD also shows the salinity feature. Spike in the CTD up trace, footnote CTD salinity bad. Other data are acceptable. PI: "Low salinity point in theta/S, appears at no other stations. High gradient firing on feature, data are acceptable." CTDO fit off compared to bottles, surface to O2 minimum. No CTDO is calculated because the CTD Salinity is coded bad.

121 Sample Log: "Slow drip from bottom cap when vented." Oxygen and other data are acceptable.

107 Nutrient analyst rechecked data and made corrections before giving to PI. PI: "NO3 & PO4 high compared to surrounding stations, 0.3 and 0.03, respectively, on Sigma 4 compared to Station 269, within spec, data are acceptable."

104 Nutrient analyst rechecked data and made corrections before giving to PI. PI: "High PO4 tied to transition in bottom boundary layer. Fits on shallower trend and water mass to east. Nutrient minimum below correlates with high O2. Water mass change in boundary layer. NO3/PO4 ratio okay, data are acceptable."

103 PI: "High Salinity on theta/S compared to 267 on. Delta-S is 0.0011. Fits over theta/S for Station 265, within specs, salinity is acceptable."

Station 267

121 Sample Log: "Leaking from bottom." Oxygen as well as other data are acceptable.

114 Sample Log: "Dripping from bottom." Oxygen as well as other data are acceptable.

111 PI: "Salinity off on theta/S, Delta-S is -0.0027, footnote salinity questionable."

104 PI: "Low nutrient water associated with O2 max layer and topographic effect. Fits to general curves. NO3/PO4 okay. Data are acceptable."

102 Delta-S at 3421db is -0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

101 Delta-S at 3452db is -0.0032. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 268

Cast 1 No comments on Sample Log.

Station 269

Cast 1 No comments on Sample Log.

123 PI: "Oxygen high on SiO3 and Sigma Theta plots. Footnote oxygen questionable."

106-111 CTDO fit high compared to bottles Code CTDO questionable."

103 Delta-S at 3570db is -0.0026. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

102 Delta-S at 3618db is -0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 270

Cast 1 No comments on Sample Log.

132 Oxygen appears low on station profile and with previous stations. However, value agrees with CTDO profile, but low compared with 271 and 269. PI: "Agrees with low O2 feature on Station 266 and Stations 237-240 on eastern line, O2 is acceptable."

118 Oxygen: "Lost some reagent." Oxygen appears low on station profile and with adjoining stations, however, it agrees with CTDO and agrees with 271. PI: "Close to surrounding stations in Sigma Theta/O2 (+0.001 to +0.03), O2 is acceptable."

107 Oxygen: "Draw temperature out of sequence, 6.2 between 4.9 (for 6) and 5.5 (for 8). Oxygen appears high on station profile and with adjoining stations, however, it agrees with CTDO and agrees with 271. PI: "Fits in range on Sigma 4/O2 plot, doesn't look high. Other draws, He drawn, but also drawn on neighboring bottles."

106 Autosal took several readings before agreement between two were obtained. Salinity analyst did not write down the first reading and the others are too high. Footnote salinity bad. Delta-S at 3149db is 0.0026. PI: "Way off on theta/S, footnote bad."

Station 271

126 Sample Log: "Free flow before venting." Oxygen as well as other data are acceptable. PI: "O2 consistent with O2 feature in other stations, O2 is acceptable."

118 PO4 high. Nutrient analyst rechecked data and made minor corrections. PI: "The NO3-PO4 maximum compares with Stations 225-235 range on eastern line, data are acceptable."

116 PO4 high. Nutrient analyst rechecked data and made minor corrections. PI: "The NO3-PO4 maximum compares with Stations 225-235 range on eastern line, data are acceptable."

115 NO3 high. Nutrient analyst rechecked data and made minor corrections. PI: "The NO3-PO4 maximum compares with Stations 225-235 range on eastern line, nitrate is acceptable. O2 lower on SiO3/O2 and Sigma 2/O2 plots by 0.1 and 0.05, respectively, compared to surrounding stations. Footnote oxygen questionable."

107 NO3/PO4 low, silicate, oxygen and salinity are okay. Nutrient analyst rechecked data, made corrections and values agree with adjoining stations. This had an odd looking peak. PI: "-0.02 delta PO4 with Station 271, +0.2 delta NO3 with Station 273 on Sigma 2/Nutrient, within specs, data are acceptable."

104 Delta-S at 3598db is -0.004. Salinity is low compared to adjoining stations and station profile. Footnote salinity questionable. Other data are acceptable. PI: "Off on theta/S curve, footnote salinity questionable."

Station 272

Cast 1 Sample Log: "Blank test bottle 19 is the deepest bottle." Bottles fired starting at 19 (deepest)-36, 1-18 (shallowest) for bottle freon test.

128 Oxygen appears 0.1 high, but CTDO has a feature that indicates oxygen is okay. Oxygen agrees with Station 273. PI: "Agrees with later stations, oxygen is acceptable. Higher O2's comparable to Stas 227-233 at same latitude to cast-connections across 90E Ridge?"

126 Sample Log: "Leaking from bottom." Oxygen appears to be okay. Oxygen agrees with CTDO. Oxygen agrees with Station 273. Delta-S at 3000db is -0.0058. Salinity is high compared to adjoining stations and station profile. Footnote salinity questionable. PI: "Salinity well off theta/S, footnote questionable."

120 CTDO Processor: "Bottle O2 high compared to CTDO." O2 could be 0.01 high, but this is within WOCE specs. O2 draw temperature is reasonable. O2 is acceptable.

Station 273

Cast 1 No comments on Sample Log.

110 PI: "Low SiO3 on SiO3/O2 (O2 fine on Sigma2/O2) agrees with Station 274." Nutrient analyst rechecked data and found no analytical problems.

104 Oxygen high but agrees with CTDO, same feature is in Station 274, and same feature is in other properties. PO4, NO3 and Sil lower on stations profile. PI: "Oxygen in line with 274 on O2/SiO3

	plot, but higher and at lower SiO3. Sigma 4/O2 fits into earlier stations - but this is deep, footnote all data questionable." Nutrient analyst rechecked data and found no analytical problems in PO4, NO3, made minor change in SiO3. PI: "Agrees with Stations 275-276, data are acceptable."
102	CTDO Processor: "Bottle O2 high compared with CTDO." O2 does appear 0.01 high when compared with adjacent stations vs. pressure. However, O2 draw temperature is reasonable, and O2 appears acceptable vs. SiO3. O2 is acceptable.

Station 274

126-127	Oxygen high compared with adjoining stations, and station profile, nutrients low indicating the same feature. There is a 0.4 difference in the draw temperature with 26. Oxygen is acceptable. PI: "This fits with Stations 216-221 on eastern line, samples are acceptable." CTD Processor also identified a difference between the down up profiles of oxygen.
125	Sample Log: "Leaking from bottom." Oxygen as well as other data are acceptable.
121	Sample Log: "Leaking from bottom." Oxygen as well as other data are acceptable.
116	PI: "O2 high on Sigma2/O2 and SiO3/O2 curves, agrees with Station 275, O2 is acceptable."
112	Delta-S at 2001db is -0.0023. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
107	Oxygen low compared with adjoining stations, nutrients high indicating same feature. Oxygen and nutrients agree with 272. PI: "This fits on earlier curves. Widely spread stations make intercomparisons hard here, samples are acceptable. SiO3/O2 curve close to Stations 271,272."
104	Delta-S at 3900db is -0.003. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
101	Delta-S at 4102db is -0.0021. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 275

128	Sample Log: "Free flow before venting." Oxygen as well as other data are acceptable.
123	Sample Log: "Leaking from bottom." Oxygen as well as other data are acceptable.
108	Delta-S at 3298db is 0.0031. Salinity is high compared with adjoining stations. Autosal took three tries before having two readings agree. Analyst did not write down the first number, suspect salt crystal caused the higher salinity. Footnote salinity questionable. PI: "Salinity high on theta/S, salinity is questionable."

Station 276

Cast 1	No comments on the Sample Log.
124	PI: "NO3/PO4 relation fine. Points in NO3 and PO4 high vs. Sigma Theta, very variable region, data are acceptable."
123	PO4/NO3 low. Nutrient analyst rechecked data and found no analytical problems. Silicate and oxygen and CTDO also show this feature. Salinity agrees with CTD trace. Data are acceptable.
122	PI: "Delta-S is -0.0035, theta/S on station curves, suspect CTD Salinity is questionable, footnote questionable." Autosal diagnostics do not indicate a problem with salinity. CTD Processor: "CTD salinity is acceptable." Do not code as questionable.
116	Delta-S at 1401db is 0.0048. No analytical problem, but salinity is higher compared with adjoining stations. Footnote salinity uncertain.
113	Delta-S at 2251db is 0.0029. Autosal diagnostics indicate 3 tries to get a good reading, indicating a problem with the samples. Out of WOCE spec of measurement. Footnote salinity questionable.

Station 277

Cast 1	No comments from Sample Log. Bottles fired starting at 19 (deepest)-36, 1-18 (shallowest) for freon blank test.
112	Delta-S at 202db is 0.03. Autosal diagnostics do not indicate a problem. Out of WOCE spec of measurement. Footnote salinity questionable.
102	Oxygen: "Spilled some sample." Oxygen too low, footnote bad. PI: "Way off SiO3/O2 and way off density plots, agree with footnote bad."
101	CTDO Processor: "CTDO signal unusually noisy, signal spikes/cutouts. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO questionable."
129	PI: "Low SiO3?" Footnote questionable. Nutrient analyst rechecked data and found no analytical problems, low on trace.
125	Delta-S at 3393db is 0.0025. Salinity high compared to adjoining stations. Autosal took 3 readings to get two to agree. Suspect first reading was correct, but analyst did not record that number. Footnote salinity uncertain.
122	CTDO Processor: "CTDO signal unusually noisy, signal spikes/cutouts. Despiked raw CTDO, data okay unless otherwise indicated. Code CTDO questionable."
121	CTD Processor: "Bottle O2 is high compared with CTD." Further data investigation found that the O2 draw temperature is a little low. PO4 also appears a little low and SiO3 appears a little high. Salinity agrees with previous station. Oxygen is slightly high compared with next leg (I8N), Station 293, but is acceptable.
119-121	CTDO Processor: "Used up-cast data for final pressure-series data. CTDO fit high. Code CTDO questionable."

CCHDO Data History

- **File Online** **Andrew Barna**

316N145_6_ctd.nc (download) #a8d10
Date: 2021-08-26
Current Status: dataset
Notes
```
CCHDO-1.0 CF netCDF files converted from ctd exchange file
```

- **File Update** **CCHDO System**

i09ndo.pdf (download) #b91a8
Date: 2015-04-23
Current Status: dataset
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09n_316N145_6trk.jpg (download) #ae892
Date: 2015-04-23
Current Status: merged
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09n_nc_hyd.zip (download) #7458a
Date: 2015-04-23
Current Status: dataset
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09n_hy1.csv (download) #6f3fa
Date: 2015-04-23
Current Status: dataset
Notes

```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09n_nc_ctd.zip (download) #befaa
Date: 2015-04-23
Current Status: dataset
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09ndo.txt (download) #4daf4
Date: 2015-04-23
Current Status: dataset
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09nct.zip (download) #d00e4
Date: 2015-04-23
Current Status: dataset
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09nhy.txt (download) #a5ba4
Date: 2015-04-23
Current Status: dataset
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09nsu.txt (download) #97520
Date: 2015-04-23

Current Status: dataset
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09n_ct1.zip (download) #31a07
Date: 2015-04-23
Current Status: dataset
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **File Update** **CCHDO System**

i09n_316N145_6trk.gif (download) #480e1
Date: 2015-04-23
Current Status: merged
Notes
```
There is not enough information to know where this file should go in the
timeline.
```

- **correct data value online** **Sarilee Anderson**

Date: 2005-07-25
Data Type: NO2+NO3
Action: Website Updated:
Note:
```
I09N event log by Sarilee Anderson (132.239.114.244 / xebec.ucsd.edu)
Expocode: 316N145_6
Bottle: (nitrat, nitrit)
Made changes to NO3 and NO2 on sta. 157, samp. 16 re email from Kristin and
Lynne. Made new exchange and netcdf files.
```

- **Kristin Sanborn**

Date: 2005-07-21
Data Type: NO2+NO3
Action: Data value corrected
Note:

```
Susan checked the data and:
EXPOCODE 316N145_6   WHP-ID  I09N     CRUISE DATES 012495 TO 030595
   STNNBR  CASTNO  SAMPNO  NITRAT  NITRIT
WAS:
     157        1      16   34.17     0.14
SHOULD BE:
     157        1       16   34.31    0.00
```

- **covers 9 Indian Ocean cruises, 1/94-1/96 Robert Key**

Date: 2005-01-10
Data Type: DELC14
Action: Report Submitted
Note:

The U.S. WOCE Indian Ocean Survey consisted of 9 cruises covering the period December 1,1994 to January 22,1996.All of the cruises used the R/V Knorr operated by the Woods Hole Oceanographic Institute. A total of 1244 hydrographic stations were occupied with radiocarbon sampling on 366 stations.

- **Decimal-1 data replaced with decimal-2 data Dave Muus**

Date: 2003-03-14
Data Type: DELC13
Action: Website Updated:
Note:

Replaced DELC13 decimal-1-data with decimal-2-data from same original data files.

```
Notes on I09N        Mar 14, 2003      D. Muus

1. Replaced 1-decimal-place DELC13 in i09nhy.txt (20020809WHPOSIOSA)
   with 2-decimal-place DELC13 from:

   /usr/export/html-public/data/onetime/indian/i09/i09n/original
    20020401.102200_GERLACH_I09N/20020401.102200_GERLACH_I09N_whpo_i09n.txt

2. Both QUALT1 and QUALT2 set to QC value given in original data file.

3. Made new exchange file for Bottle data.

4. Checked new bottle file with Java Ocean Atlas.
```

- **CTD NetCDF, Exchange and inventory files created** **Danie Bartolacci**

Date: 2002-08-12
Data Type: CTD
Action: Website Updated:
Note:
```
I have rezipped the ODF corrected CTD files, created exchange and NetCDF CTD
files. Zipped all and replaced current online files with the updated ones.
Inventory txt file that was created during NetCDF conversion was also
replaced.
```

- **Data Online** **Sarilee Anderson**

Date: 2002-08-09
Data Type: CTDTMP
Action: Website Updated:
Note:
```
*See CFCs entry.
```

- **Data Online** **Sarilee Anderson**

Date: 2002-08-09
Data Type: THETA
Action: Website Updated:
Note:
```
*See CFCs entry.
```

- **Data Online** **Sarilee Anderson**

Date: 2002-08-09
Data Type: CFCs
Action: Website Updated:
Note:
```
Merged the corrected ODF temperature and theta into the online bottle file.
Created QUALT2 flags by copying the Qualt1 flags. Remerged the CFC from
Wisegarver in order to make sure the correct Q2 flag was present. Created new
exchange file.

Notes on I09N:

Merged the corrected ODF CTDTMP and THETA from file i9nhyd.tar.gz found in
/usr/export/html-
public/data/onetime/indian/i10/original/2001_ODF_TEMP_UPDATE.

Added the QUALT2 word, remerged CFC11 and CFC12 from file 20010918.171840_
WISEGARVER_I09N_i09n_CFC_DQE.dat found in /usr/export/html-public/data/
```

onetime/indian/i10/original/2001.09.18_I09N_CFC_DQE_WISEGARVER to make sure the correct QUALT2 flag associated with the CFC's was in the file.

- **Data Online Sarilee Anderson**

Date: 2002-07-29
Data Type: CFCs
Action: Website Updated:
Note:
*See ALKALI entry.

- **Data Online Sarilee Anderson**

Date: 2002-07-29
Data Type: DELC14
Action: Website Updated:
Note:
*See ALKALI entry.

- **Data Online Sarilee Anderson**

Date: 2002-07-29
Data Type: DELC13
Action: Website Updated:
Note:
*See ALKALI entry.

- **Data Online Sarilee Anderson**

Date: 2002-07-29
Data Type: TCARBN
Action: Website Updated:
Note:
*See ALKALI entry.

- **Data Online** **Sarilee Anderson**

Date: 2002-07-29
Data Type: ALKALI
Action: Website Updated:
Note:
Merged the new CFCs sent by Wisegarver, DELC14 and C14ERR sent by Key, DELC13 sent by GERLACH, and TCARBN and ALKALI sent by Kozyr. Made new exchange file.

Notes on i09n merging:

Merged the new CFC data file 20010918.171740_WISEGARVER_I09N_i09n_CFC_DQE.dat found in /usr/export/html-public/data/onetime/indian/i09/i09n/original/2001.09.18_I09N_CFC_DQE_WISEGARVER into the online file 20001023WHPOSIOSRA.

Merged the DELC14 and C14ERR data from file I09.C14 found in /usr/export/html-public/data/onetime/indian/i09/i09n/original/20020410_KEY_I9N_C14 into the online file 20001023WHPOSIOSRA.

Merged DELC13 from file 20020401102200_GERLACH_I09N_wqhpo_i09n.txt found in /usr/export/html-public/data/onetime/indina/i09/i09n/original/20020401.102200_GERLACH_I09N into online file 20001023WHPOSIOSRA.

Remerged TCARBN and ALKALI from file 2000.02.14_CO2_KOZYR_i9ndat.txt found in /usr/export/html-public/data/onetime/indian/i09/original/MOVED_FROM_ftp-incoming .2000.02.14 into online file 20001023WHPOSIOSRA.

Changed TRITIUM to TRITUM in the second header of the online file 20001023WHPOSIOSRA.

- **Header added** **Heidi Buck**

Date: 2002-04-12
Data Type: C14
Action: Data moved from incoming
Note:
Moved I9N.C14 data from /usr/export/ftp-incoming to i09/i09n/original/20020410_KEY_I9N_C14 . Data is a CSV file with C14 data. Added this line to the header # I09N, 316N145_6, Key

- **Submitted Robert Key**

Date: 2002-04-10
Data Type: C14
Action: Submitted
Note:
The file: I1.C14 - 87908 bytes has been saved as: 20020410.072032_KEY_ALL†INDIAN†OCEAN_I1.C14 in the directory: 20020410.072032_KEY_ALL†INDIAN†OCEAN

The data disposition is: Public

The bottle file has the following parameters: STATION, CAST, BOTTLE, DELC14, C14ERR, C14F

The file format is: Plain Text (ASCII)

The archive type is: NONE - Individual File

The data type(s) is: Bottle Data (hyd)

The file contains these water sample identifiers: Cast Number (CASTNO), Station Number (STATNO), Bottle Number (BTLNBR)

KEY, ROBERT would like the following action(s) taken on the data: Merge Data, Place Data Online, Update Parameters

Any additional notes are: I've included the C14 from the French occupation of I6S. All files are same format. Tool does not accept mput syntax

- **See Note: Heidi Buck**

Date: 2002-04-01
Data Type: DELC13
Action: Data moved from incoming
Note:
Moved data from /usr/export/html-public/cgi/SUBMIT/INCOMING/20020401.102200_GERLACH_I09N to /usr/export/html-public/data/onetime/indian/i09/i09n/original/20020401.102200_GERLACH_I09N. Directory contains a readme file from teh data submission website and a data file containing DECL13.

- **Dana Gerlach**

Date: 2002-04-01
Data Type: DELC13
Action: Submitted
Note:

```
Date:   Mon, 1 Apr 2002 10:22:00 -0800 (PST)
From:   WHPO Website &lt;http@odf.ucsd.edu&gt;
To:             dgerlach@whoi.edu, jrweir@whpo.ucsd.edu, whpo@ucsd.edu
Subject:        WHPO DATA I09N: OTHER from GERLACH
This is information regarding line:   I09N
ExpoCode:       316N145/6
Cruise Date:    995/01/24 - 1995/03/06
From:           GERLACH, DANA
Email address:  dgerlach@whoi.edu
Institution:            WHOI
Country:                USA

The file:  C:\My Documents\C13-project\whpo_indian_march02\whpo_i09n.txt -
7404 bytes
has been saved as:  20020401.102200_GERLACH_I09N_whpo_i09n.txt
in the directory:  20020401.102200_GERLACH_I09N
The data disposition is:      Public
The file format is:           Plain Text (ASCII)
The archive type is:          NONE - Individual File
The data type(s) is:          Other: flagged 13C data
The file contains these water sample identifiers:
                                      Cast Number (CASTNO)
                                      Station Number (STATNO)
                                      Bottle Number (BTLNBR)
GERLACH, DANA would like the following action(s) taken on the data:
                                      Merge Data
                                      Place Data Online
Any additional notes are:
                                      If there are questions, concerns, or
problems, please contact:
                                              Dana Gerlach (dgerlach@whoi.edu)
or
                                              Ann McNichol
(amcnichol@whoi.edu)
```

- **Data ready to be merged** **Danie Bartolacci**

Date: 2002-03-04
Data Type: CFC's
Action: DQE'd data submitted
Note:
```
I have placed the DQEd CFC data sent by D. Wisegarver in the appropriate I09N
original directory
.../indian/i09/i09n/original/2001.09.18_I09N_CFC_DQE_WISEGARVER

Included in the directory are website submission README file and data file
containing CFC11/12 and quality flags. Data are in need of merging at this
time.
```

- **See Note:** **Adel Hajrasuliha**

Date: 2002-01-03
Data Type: CTD
Action: Internal DQE completed
Note:
```
created *check.txt file. Created .ps files for the curise.
```

- **Exchange file online** **Karla Uribe**

Date: 2001-12-24
Data Type: CTD
Action: Website Updated:
Note:
```
CTD has been converted to exchange using the new code and put online.
```

- **Status Changed to Public** **Zafer Top**

Date: 2001-08-29
Data Type: NEON
Action: Website Updated:
Note:
```
Zafer - Is it safe to assume that all WOCE One-Time Survey neon data from you
are now public?  Jim

Yes they are. Zafer
```

- **Exchange file online** **Karla Uribe**

Date: 2001-06-21
Data Type: CTD/BTL
Action: Website Updated:
Note:
CTD and bottle exchange files were put online.

- **Processing error corrected, revised data available by ftp** **Mary Johnson**

Date: 2001-06-20
Data Type: CTD
Action: Data Update:
Note:
ODF has discovered a small error in the algorithm used to convert ITS90 temperature calibration data to IPTS68. This error affects reported Mark III CTD temperature data for most cruises that occurred in 1992-1999. A complete list of affected data sets appears below.

ODF temperature calibrations are reported on the ITS90 temperature scale. ODF internally maintains these calibrations for CTD data processing on the IPTS68 scale. The error involved converting ITS90 calibrations to IPTS68. The amount of error is close to linear with temperature: approximately -0.00024 degC/degC, with a -0.00036 degC offset at 0 degC. Previously reported data were low by 0.00756 degC at 30 degC, decreasing to 0.00036 degC low at 0 degC. Data reported as ITS90 were also affected by a similar amount. CTD conductivity calibrations have been recalculated to account for the temperature change. Reported CTD salinity and oxygen data were not significantly affected.

Revised final data sets have been prepared and will be available soon from ODF (ftp://odf.ucsd.edu/pub/HydroData). The data will eventually be updated on the whpo.ucsd.edu website as well.

IPTS68 temperatures are reported for PCM11 and Antarktis X/5, as originally submitted to their chief scientists. ITS90 temperatures are reported for all other cruises.

Changes in the final data vs. previous release (other than temperature and negligible differences in salinity/oxygen):

S04P: 694/03 CTD data were not reported, but CTD values were reported with the bottle data. No conductivity correction was applied to these values in the original .sea file. This release uses the same conductivity correction as the two nearest casts to correct salinity.

AO94: Eight CTD casts were fit for ctdoxy (previously uncalibrated) and resubmitted to the P.I. since the original release. The WHP-format bottle file was not regenerated. The CTDOXY for the following stations should be significantly different than the original .sea file values:

009/01 013/02 017/01 018/01 026/04 033/01 036/01 036/02

I09N: The 243/01 original CTD data file was not rewritten after updating the ctdoxy fit. This release uses the correct ctdoxy data for the .ctd file. The original .sea file was written after the update occurred, so the ctdoxy values reported with bottle data should be minimally different.

==

DATA SETS AFFECTED:

WOCE Final Data - NEW RELEASE AVAILABLE:

WOCE Section ID	P.I.	Cruise Dates
S04P	(Koshlyakov/Richman)	Feb.-Apr. 1992
P14C	(Roemmich)	Sept. 1992
PCM11	(Rudnick)	Sept. 1992
P16A/P17A (JUNO1)	(Reid)	Oct.-Nov. 1992
P17E/P19S (JUNO2)	(Swift)	Dec. 1992 - Jan. 1993
P19C	(Talley)	Feb.-Apr. 1993
P17N	(Musgrave)	May-June 1993
P14N	(Roden)	July-Aug. 1993
P31	(Roemmich)	Jan.-Feb. 1994
A15/AR15	(Smethie)	Apr.-May 1994
I09N	(Gordon)	Jan.-Mar. 1995
I08N/I05E	(Talley)	Mar.-Apr. 1995
I03	(Nowlin)	Apr.-June 1995
I04/I05W/I07C	(Toole)	June-July 1995
I07N	(Olson)	July-Aug. 1995
I10	(Bray/Sprintall)	Nov. 1995
ICM03	(Whitworth)	Jan.-Feb. 1997

non-WOCE Final Data - NEW RELEASE AVAILABLE:

Cruise Name	P.I.	Cruise Dates
Antarktis X/5	(Peterson)	Aug.-Sept. 1992
Arctic Ocean 94	(Swift)	July-Sept. 1994

Preliminary Data - WILL BE CORRECTED FOR FINAL RELEASE ONLY/NOT YET AVAILABLE:

Cruise Name	P.I.	Cruise Dates
WOCE-S04I	(Whitworth)	May-July 1996
Arctic Ocean 97	(Swift)	Sept.-Oct. 1997
HNRO7	(Talley)	June-July 1999
KH36	(Talley)	July-Sept. 1999

"Final" Data from cruise dates prior to 1992, or cruises which did not use NBIS CTDs, are NOT AFFECTED.

post-1991 Preliminary Data NOT AFFECTED:

Cruise Name	P.I.	Cruise Dates
Arctic Ocean 96	(Swift)	July-Sept. 1996
WOCE-A24 (ACCE)	(Talley)	May-July 1997
XP99	(Talley)	Aug.-Sept. 1999
KH38	(Talley)	Feb.-Mar. 2000

- **See Note:** **James Swift**

Date: 2001-06-19
Data Type: CTDTMP
Action: Update Needed
Note:
An oceanographically insignificant error in CTDTMP data for this cruise has been found (ca. -0.00024*T - 0.00036 degC). A data update is forthcoming. In the interim the corrected data files can be obtained from:
ftp://odf.ucsd.edu/pub/HydroData/woce/crs

- **Arnold Mantyla**

Date: 2001-02-07
Data Type: NUTs/S/O
Action: DQE Begun
Note:
Hi Jim,
Sure, I would be glad to look over the Indian Ocean data for you. Sarilee has started plotting up I01 for me to start on. - Arnold

- **found in 'sum file' directory** **Karla Uribe**

Date: 2000-11-21
Data Type: Cruise Report
Action: Submitted
Note:
2000.11.21 DMB
File contained here is CRUISE SUMMARIES and NOT sumfiles. Files listed below should be considered WHP DOC files. Documentation already contained online.

2000.10.11 KJU
Files were found in incoming directory under whp_reports. This directory was zipped, files were separated and placed under proper cruise. All of them are sumfiles.
Received 1997 August 15th.

- **Data merged into BTL file** **Stacey Anfuso**

Date: 2000-10-23
Data Type: He/Tr/Ne
Action: Website Updated:
Note:

```
Merged TRITIUM, TRITER, HELIUM, HELIER, DELHE3, DELHER, NEON, NEONER from Z.
Top into hyd file. Updated hyd file is on-line. Merging notes in original
subdir 1998.12.18.I09N_HE_ZAFER_TOP.

There were no cast #'s in data submitted by PI, had to add cast "1" to data
prior to merging.

Missing data were blank fields.  Edited data, replaced missing data with -9.

No data flags were submitted with data.  Contacted PI, advised all data
submitted are
considered acceptable, and was ok to code data as 2 (see correspondence
below).

Two data values were submitted incorrectly by PI.  Stas 190 (#11) and 253
(#14) had data values reversed for HELIUM and NEON.  Contacted PI to verify
error and correction  (see correspondence below).

Split data file (i9he.txt) into smaller files during reformat for review and
merging. Merged data files are in MERGED_DATA subdir: i9trt.dat,
i9helium.dat, i9delhe.dat, i9neon.dat.
```

- **pdf, txt versions online** **Linda Huynh**

Date: 2000-09-29
Data Type: Cruise Report
Action: Website Updated:

- **Jerry Kappa**

Date: 2000-09-28
Data Type: Cruise Report
Action: PDF & ASCII Versions Updated

- **new data online** **Stephen C. Diggs**

Date: 2000-07-26
Data Type: CTD
Action: Website Updated:
Note:
```
Replaced i09nct.zip with new version (same name) on website and CD2.0 site.
New version is from Johnson @ ODF. Headers have expocodes switched to new
version (""). Rezipped and replaced.
```

- **updated hyd file online** **Stephen C. Diggs**

Date: 2000-07-25
Data Type: BTL
Action: Website Updated:
Note:
```
Updated hyd (sea) file on website and CD2.0 site. All tables and files have
been updated as well.
- took the ODF final data (final as of 4/1997, submitted 9/1997) and merged
with existing TCARBN, ALKALI, CFC-11, and CFC-12.
```

- **DQE Complete** **Alexander Kozyr**

Date: 2000-02-14
Data Type: TCARBN/ALKALI
Action: Final Data Submitted
Note:
```
I've just put a total of 13 files [carbon data measured in Indian (6 files)
and Atlantic (7 files) oceans] to the WHPO ftp area. Please let me know if
you get data okay.
```

- **See note:** **Debbie Willey**

Date: 1999-10-20
Data Type: CFCs
Action: Data are Public
Note:
```
This is a follow-up to last month's message requesting that all of our
Pacific and Indian Ocean CFCs be made accessible to the public.  Our cruises
are; (Pacific) P17C, P1716S, P06E, P19C, P17N, P21E, and (Indian) I09N,
I05W/I04, I07N, I10.
```

- **See note: Kelly Falkner**

Date: 1999-09-29
Data Type: BA
Action: Data Update:
Note:

The quality of the Ba data from most WOCE legs in the Indian Ocean turned out to be quite poor; far worse than attainable analytical precision (+/-20% as opposed to 2%). We recorded many vials which came back with loose caps and evaporation associated with that seems to be the primary problem. The only hope I have of producing a decent data set is to run both Ba and a conservative element simultaneously and then relating that to the original salinity of the sample. We will be taking delivery on a high resolution ICPMS here at OSU sometime this winter which would make the project analytically feasible and economical. I do not presently have the funds in hand to do this and so have archived the samples for the time being. I don't think the WHPO would derive any benefit from the present data set.
KKF

- **See note: Zafer Top**

Date: 1999-05-27
Data Type: He/Tr
Action: Data are Public
Note:

My helium-tritium data from IO legs I1-I7N and I9N may now be made public. It should be kept in mind though that we are working on the synthesis; some modifications may occur. Also, there are some papers are in progress; interested parties should check with the tracer group (Schlosser, Jenkins, Lupton, Top)

- **Status changed to Public Rana A. Fine**

Date: 1999-04-01
Data Type: CFCs
Action: Website Updated:
Note:

Rana Fine gave the word that CFC values for I09N are final and public. Therefore I09N is fully public.

All tables and file updated accordingly.

- **final numbers not OnLine** **Alexander Kozyr**

Date: 1999-04-01
Data Type: TCARBN/ALKALI
Action: Update Needed
Note:
I looked at the I9N hydro file you just made public and discovered that all TCO2 and ALKI numbers are different from my final numbers. I think you've got these row (not corrected) numbers from A. Gordon's ship file. I've just put the final CO2 measurements file into WHPO ftp area. Please replace all TCO2, ALKI, and flags in your data file.

- **see note:** **Stephen C. Diggs**

Date: 1999-03-24
Data Type: SUM
Action: Website Updated:
Note:
I have put the updated and reformatted SUMFILE for I09N (Gordon) online. Dave Muus reformatted/corrected it so that it is in the revised WHP format.

- **can cfc's be made public?** **Rana A. Fine**

Date: 1999-03-24
Data Type: CFCs
Action: Data Requested by sdiggs
Note:
Dear Dr. Fine,

We would like to know if the CFC dataset for I09N (Gordon) should be made public at this time. I just spoke to Debbie Willey and she referred me to you.

Thanks for your time.

-Steve Diggs

- **Status Changed to Public** **Arnold L. Gordon**

Date: 1999-03-24
Data Type: CTD/BTL
Action: Website Updated:
Note:
I have received your email by way of Jim Swift and Mattias Tomczak. I09N is now public (BOTTLE (Salts, O2, Nuts) and CTD). CFC values have been removed from the bottle file pending word from Rana Fine.

- **ready to be merged into HYD file Stephen C. Diggs**

Date: 1999-01-26
Data Type: He/Tr
Action: Submitted

- **Dave Muus**

Date: 1999-01-15
Data Type: SUM
Action: Data Update:

- **Preliminary, not for DQE Ashwanth Srinivasan**

Date: 1998-12-22
Data Type: He/Tr Deep
Action: Submitted
Note:

```
This is Ashwanth Srinivasan from Noble Gas Isotope Lab , RSMAS, Univ of
Miami. We have submitted four files, i7he.txt, i9he.txt and i1he.txt and
readme.he to the incoming directory at your ftp site. These files contain
tritium, helium and neon data from WOCE I7N, I9N and I1 cruises. These data
are preliminary and proprietary and the format is explained in the readme.he
file.  In case of problems or questions please email to one of the following
addresses.

Zafer Top : ztop@rsmas.miami.edu
Ashwanth Srinivasan : asrinivasan@rsmas.miami.edu
```

- **Debbie Willey**

Date: 1998-10-26
Data Type: CFCs
Action: Submitted for DQE

- **Mary Johnson**

Date: 1998-07-29
Data Type: CTD
Action: Data Updated & sent back to PI

- **New SEA file w/ CFCs merged in Debbie Willey**

Date: 1998-06-04
Data Type: CFCs
Action: Submitted for DQE

- **Status changed to Public Arnold L. Gordon**

Date: 1998-06-01
Data Type: CTD/S/O/NUT
Action: Website Updated:
Note:
```
CTD, S, O2, and nutrient
```

- **data are on their public ftp site Phil Mele**

Date: 1998-04-15
Data Type: CTD/BTL/SUM
Action:
Note:
```
I am confused by Debbie Willey's request for the I9N data.  on Dec 18, 1997 E
e-mailed all the I9N participants informing them that I had the final I9N
data and that it was on our public ftp site.  Rana Fine and Kevin Sullivan
where on the list.  I will email Debbie with the instructions.
```

- **Updates will follow Phil Mele**

Date: 1998-01-20
Data Type: CTD/HYD
Action: Submitted