MODIS Team Member - Semi-Annual Progress Report
Marine Optical Characterization
June 1994

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NOAA/NESDIS

This reporting period has been marked by intensive work by the MOCE team which is comprised of personnel from Moss Landing Marine Laboratories (MLML) under Prof. William Broenkow, San Diego State University Center for Hydrological Optics and Remote Sensing (CHORS) under Dr. Charles Trees, and NOAA/NESDIS under Dennis Clark. Jim Brown, University of Miami, provided additional at-sea support.. Stan Hooker, SeaWiFS Project, is in charge of developing an integrated shipboard data acquisition system.

In the past six months progress has primarily been in the area of MOBY deployment and recovery cruises and testing and developing bio-optical instrumentation and measuring techniques. The operations schedule (6 months) for the MOBY system deployments and the SeaWiFS Cal/Val cruises is shown in Fig 1. The operational facility -- an 85 x 40 foot Fabric Building Structure (FBS) -- is located at the University of Hawaii's Marine Center at Snug Harbor, Honolulu, Hawaii (Fig. 2). This facility provides power, water, and space for the ship laboratories during the SeaWiFS Cal/Val cruises. Conversion of the Army Surplus container into a data acquisition laboratory was completed. A steel stacking frame with aluminum walkways and stairs was constructed to enable stacking of optical and physical laboratories. The new stacking frame between the control shelters and the new safety rails on the walkways has been installed (Fig. 3)

MOBY DEPLOYMENT

In early January all equipment was checked out to ensure all components were operational prior to shipment to Hawaii. Upon arrival at the operational facility, there were numerous items that required attention. Site preparation included waterproofing the pavement within the FBS, providing a "dust free" flooring, designing and fabricating a conventional doorway into the tent for use without unlacing entire flaps for inclement weather or during calibration periods, and sealing the surface surrounding the tent area to prevent as much dust as possible from being inadvertently tracked into the tent.

The Army Corps of Engineers granted permission to install a Marine Optical Buoy approximately ten miles off the west coast of Lanai, Hawaii, at 20°49.0' N and 157° 11.5' W. The first MOBY L2 deployment was attempted in February, 1994.

The following personnel were involved:

NOAA - Dennis Clark, Edward King, Marilyn Yuen, and Eric Stengel
MLML - William Broenkow, Mark Yarbrough, Michael Feinholz, Ed Armstrong, John Heine, Drew Gashler and Peter Von Langen
CHORS - Charles Trees and Dan Sullivan
NASA - Stanford Hooker, Bill Indest, David Herring, and Yuntao Ge
NIST - Chris Cromer and Carol Johnson
University of Miami - Jim Brown

Shore support personnel: Celso Barrientos - NOAA
Phil Hovey - NOAA
Nancy Greene - MLML
Richard Reaves - MLML
Todd Hunter - MLML
Sarma Lakkaraju - MLML

NASA MODIS Project Office: David Herring

Ship time was from February 6-10 (MOBY L2) during which time began making bench mark measurements and testing measurement procedures for upcoming validation cruises. New equipment and instrumentation were used and implemented in this procedure. This first attempt to launch MOBY was aborted after encountering serious software errors that could not be fixed aboard ship. The software designer, Richard Reaves, flew from the mainland to Honolulu to attempt to solve the problem in time to return to Lanai during the last days of our scheduled time. The major problem was found to be the overlap in timing of MOS acquisition and modem tasks and could not be resolved in time.

Another opportunity to deploy MOBY was provided by a generous offer of ship time from a University of Hawaii scientist who was conducting his own work near Lanai. MOBY-L3 was successfully launched on February 21 (Figure 4). The first data were recovered on February 22 by hard-wired connection to the buoy from a small boat. Over the next three days, operation of the data acquisition system was monitored and integration times adjusted for each of the collectors. Additional data were recovered on February 25.

During the period March 24-29, the buoy was revisited for data downloading and diver calibration tests. Heavy weather (wind speeds to 70 kts.) had occurred the previous week resulting in the buoy becoming tangled in its tether and smashing one of three solar panels. Our attempts to effect repairs were hampered by three days of high winds (40-50 kts.). Ship time was extended for two days during which repairs were made and some of the previous month’s data were downloaded. Two calibration test dives were made on successive days. The data are now being analyzed; however, initial results show good agreement (5%) on some of the collectors and poor on others (200/0 in blue). There were several probable causes for this poor agreement, and subsequent tank tests of these sources were performed by Jim Mueller at the CHORS calibration tank facility. The preliminary results indicate that the major source of error was due to a misalignment of the pin-hole aperture for the radiance calibration.

Although there have been setbacks along the way, successes and failures during this period are resulting in improvements. For example, the interval between the failed MOBY deployment and the February deployment was spent isolating the problem with the 117 real-time clock (RTC) and testing the new TT7 hardware which was to be used in the MOBY deployment. The problem with the RTC was isolated to one TT7 unit. This same unit was used in the Monterey deployment and had similar problems which could not be isolated at that time. Many of the problems (some of which have been solved and some yet to be fully understood) have been due to the limited time the whole system has been available for the software designer to test the software.

MOBY cruises L5 and L6 were scheduled primarily for in situ calibrations and due to extremely high wind and sea conditions they could not be implemented.

MOBY RECOVERY

Prior to the next cruise, instruments were recalibrated and shipped to the facility. Site modifications included installing a drainage pipe to divert water away from the tent and to keep it from running over the upper curb area. A cable trench was cut in the asphalt to protect the power cables from being crushed. The cables were run through a conduit that was buried in the trench and brought up inside the tent for hardwire connection (Fig. 5).

The MOBY-L7 recovery cruise departed Honolulu on 25 June, 1994. The following personnel were involved:

NOAA - Dennis Clark, Edward King, Phil Hovey, Eric Stengel.
MLML - William Broenkow, Mark Yarbrough, Michael Feinholz, Drew Gashler, Peter Von Langen, and Stephanie Flora
CHORS - Charles Trees and Dan Sullivan
NASA - Stanford Hooker and Yuntao Ge
University of Miami - Jim Brown
University of Hawaii - Mike Ondrusek
RDC - Larisa Koval

Shore support personnel:
NOAA - Marilyn Yuen

Ship time was from June 25-30, 1994. The primary purpose of the cruise was to perform diver-lamp calibrations, to obtain an initial bio-optical characterization of the mooring site, and to recover MOBY. After arriving on station, it was determined that the MOBY batteries were dead and that diver calibrations could not be performed. Due to rough weather, MOBY was not recovered until June 28 (Fig. 6). The divers had problems detaching MOBY from the main mooring due to urethane tape covering the shackles and the flounder plate.

Following the successful recovery of MOBY, the system was thoroughly inspected, cleaned, post calibrated, disassembled, and critical components shipped back to MLML for further evaluation and repair.

ENVIRONMENTAL IMPACT ON MOBY

MOBY's TT7 controller was still operational at the time of the recovery. MOBY collected full daily data sets until May 23, 1994, and continued to collect partial data sets from May 23 to June 25 when MOBY was shutdown for recovery. MOBY deployment data was archived on disk at the time of the recovery and are summarized in Table 1. The MOBY log shows a drop in battery capacity at about the same time the partial data files started. The fact that MOS instrument continued to operate for the last month of the deployment indicates that the MOBY batteries were receiving some charge from the solar panels though at a diminished rate. The upper MOBY battery was maintained at a level sufficient to continue data acquisition, housekeeping functions, and cell phone transceiver operation.

The fiber optics multiplexer had corroded under one of the housing seals, lifting one side of the end cap about 4 mm. Corrosion residue buildup prevented the housing from flooding with seawater. The resulting misalignment of the endcap caused jamming of the rotating mirror arm in the "home" position. The MUX controller cannot detect this locked state, and no errors were generated to indicate a problem to the TT7. The total loss of light on all collectors is the only indicator as to when the arm jammed. Since the misalignment of the MUX endcap was caused by corrosion and corrosion is a continuous process, we expect to have a period of time over which the optical throughput was being slowly degraded due to this progressive misalignment. All the subsurface optical collectors were badly corroded and the anodization was stripped from most parts (Fig. 7).

After cleaning and reassembling, the individual fibers were tested. Es, top Ed, middle Ed, and bottom Ed were still functional. Top Lu and middle Lu passed no light and bottom Lu had about 1% of normal transmission. Es was passing light but the fiber at the collector end was shattered at the tip and loose in the connector. The metal ferrule at the MUX end was made from mild steel, not stainless, and had rusted. The top Lu fiber was completely broken free from the MUX connector. The middle Lu fiber was broken free at the collector and connector (see Fig. 8). The bottom Lu fiber, which has not worked since deployment, has an unknown problem. In general, the fibers with problems seem to have an outer protective hose that has shrunk by about 4 inches relative to the internal fiber. Both remaining solar panels were found to be shattered upon recovery (Fig. 9). Tests of the panels showed that one panel was operating at 75% capacity and the other at 10%.

The seriousness of the biofouling problem was not expected since a tributyltin compound was used as an antifoulant (Fig. 10). The failure of the compound is presently being discussed with the manufacturers.

The upper buoy mast was damaged due to bashing from the surface floats during the 4 month deployment, and the divers pulled a support arm loose with the small boat during recovery. The xenon strobe battery was dead upon recovery, but the VHF was still functional.

The Minimet float lost two waterline lifting eyes. The Minimet mooring attachment point was badly worn, and the rubber bushing had worn completely through. The o-ring seal to the Minimet instrument housing was starting to corrode under the o-ring and would have eventually leaked. The powder coat on all of the upper buoy was worn away.

The stainless buoy parts below the waterline showed no signs of corrosion, except for one stainless fitting on the safety cable which had rusted away. The black powder coat on the stainless steel fittings did not hold on the most of the parts. The brushed-on epoxy appeared to be holding well to the end flanges.

DATA COLLECTION

During this 6 day recovery cruise we took 66 discrete samples for HPLC and fluorometric pigment analysis. The HPLC samples were frozen in liquid nitrogen for later analysis ashore, whereas the fluorometric samples were analyzed on the ship. DOM samples were collected and analyzed on the ship, but concentrations were so low that the DOM signal minus the water blank was at the noise level of the spectrophotometer with its 10 cm cuvette, therefore, DOM samples were not collected after the first day of sampling. Particulate absorption and reflectance measurements were made on 22 samples using the HP8452 Diode Array Spectrophotometer with integrating Sphere. Once total spectral absorption was measured, the filters were rinsed with hot methanol to remove pigmented compounds and then analyzed again. The difference between these two measurements is an estimate of the spectral absorption by pigments. A modified Turner-l O Fluorometer to measure phycoerythrin concentrations (sixteen samples) which is indicative of the presence of cyanobacteria. Initial water sample volumes were set at 2.085 liters - HPLC, 0.29 liters - Fluor, 1.14 liters - Particulate Absorption, 0.29 liters - Cyanobacteria, but these had to be increased to the following volumes because of the low concentration of the particulate (4.1 7 liters - HPLC, 1.14 liters - Fluor, 2.28 liters - Particulate Absorption, 0.58 liters - Cyanobacteria).

The newly-acquired WET Labs AC-9 attenuation and absorption meter was tested using pumped water in the along-track mode for two track lines and during two vertical profiles (100 meters). One profile using the AC-9 in stand alone configuration and another using the MOD-APS (Modular Ocean Data and Power System) allowed concurrent data logging from the Parascientific depth sensor. The receiver side of the absorption cell is sensitive to the high frequency light fluctuations (wave ripple as well as fluorescent lighting). Bubbles ruined attenuation measurements in the along track mode. The *in-situ* measurements provided relatively noise free and consistent results. We were unable to reproduce the manufacturer's air cats or "pure" water values. The two sets of shipboard air cats were more consistent than the comparisons to manufacturer data. Pure water tests require a constantly flowing source of "pure" water, and shipboard attempts to utilize the Mini-Q water system were unsuccessful. Spiking the absorption cell with concentrated chlorophyll solution produced a signal with the expected spectral characteristics but of small amplitude compared to the observed signal noise. Wetview software functioned well for acquisition but some of the display features were not supported and merged data, i.e. depth, cannot be downloaded at this time. Also, spectral plots are not possible using Wetview, so the data must be put into a spreadsheet.

An initial bio-optical characterization of the mooring site was performed. This included using the MLML CTD system to collect water samples. Twelve CTD/Rosette casts were made to quantify stratification in the upper 200 m. On June 28-29, a 24-hour CTD time series was done to quantify variability in the upper water column. On June 29, a 1500 m CTD cast was acquired just west of the MOBY site. During the cruise, a total of 66 water samples were collected for HPLC and fluorometric pigment analysis, for particle size analysis, for CTD calibration (salinity and dissolved oxygen), for total suspended material, and for particulate organic carbon and nitrogen analyses.

Daily measurements of solar transmittance were conducted during periods of clear sky conditions. Additional measurements were conducted to specifically examine short-term variability as a function of air mass in the infrared.

A new sampling method was tested for the particle counter. This method collected particulate matter from the shipboard flow-thru system. Particle matter was concentrated by passing large volumes of water through a phytoplankton net with a 5 micron mesh size. The concentrated particles were resuspended in a 3 ml solution which was then transferred to the Galai particle counter's cell. This method appeared to work well, and the results will be compared to flow cytometry results to evaluate accuracy.

The following data set is an example of along-track data compiled by the Galai laser particle counter. The data set was compiled on June 27, 1994, during the MOBY-L7 cruise about two miles off the coast of Lanai. The data were collected while the R/V Moana Wave was underway at a speed of approximately 8 knots. Three replicate observations were taken for each sample and the mean computed. The results are illustrated in Table 2. This table contains the information on cell type used, sample type, acquisition parameters, concentration, and total number of counts in the sample. For this system, a count is considered to be a focused interaction between the laser and the detector. The information specific to Table 2 is the statistics on the total sum of all three observations. It includes the mean diameter and standard deviation of seven particle size parameters. Figure 11 shows the total number distribution and a histogram of the size (microns) distribution as a percentage of particles within a given size range. Table 3 lists number of counts, size range, and percentages of cumulative counts above and below that size range. Figure 12 illustrates the variability of the three replicate observations utilized in computing the mean distribution. In the future it will be feasible to extend the lower size limit to 0.5 microns with a resolution of 0.2 microns.

CALIBRATION

Prelaunch calibrations were performed by the MLML/NOAA personnel, Carol Johnson and Chris Cromer from NIST, and Jim Mueller from CHORS. MOBY was calibrated according to NIST traceable standards and techniques. The radiance collectors were calibrated using an optronics integrating sphere and the new EG&G GAMMA 5000 systems. The irradiance collectors were calibrated using a NIST 1,000-Watt FEL and the GAMMA 5000. The NIST/NASA SXR radiometer was used to compare the various radiance sources with the NIST calibration of the SXR. The percent deviation of the SXR measurement from the radiance of the sources at the six channel wavelengths is plotted in Figure 13. NIST also studied the effectiveness of the new EG&G lamp housing and baffles on the irradiance measurements at the reference bracket using the ISA and the NIST SXR spectrophotometer. These measurements were referenced to measurements made with the entire housing and baffle system removed and NIST’s best effort at baffling with black cloth and an aperture plate painted with flat black paint. The results are shown in Figure 14. The results and recommendations were reported by NIST and forwarded to EG&G GAMMA for design modifications that are presently being implemented.

Following the MOBY-L7 recovery cruise, SIS and MOS were calibrated on July 5-7, 1994, at the MOBY operations facility. MOBY was pressure washed and the fiber optics MUX was disassembled because of serious corrosion (Fig. 15). Es, top, middle, and bottom Ed and the MOS Lu port were calibrated using the 1000 W FEL irradiance and the Optronics 420 spectral radiance sources. These calibrations were performed after the collectors had been cleaned. Finally, SIS was calibrated with the 1000 W FEL irradiance source. A linearity check on the MOS Lu port was performed utilizing the variable output of the Optronics 420. The Optronics 420 was relamped and recalibrated along with the 0L65DS current source at Optronics Laboratories prior to the MOBY-L7 cruise.

DATA PROCESSING

The work on the upgrade of the along-track data acquisition programs is continuing. All ancillary data acquisition software routines, also known as virtual instruments (V1s), have been converted from LabVIEW version 2.0 to version 3.0. The work on converting the command line interpretation library from FORTRAN to C also continues. This will be a central part of the final data processing capability as it will permit execution of all of the utilities on three different computer operating systems: Macintosh, VMS, and UNIX. The string manipulation library has been converted from FORTRAN to C (this library is a needed part of the command line interpretation library). The data processing utility that converts in situ fluorescence from raw *volts* to calibrated pigment concentration (HPLC), and the new data acquisition V1s for the AC-9 absorption meter and the water quality (laser scattering meter) monitor have been completed. Stan Hooker and Jim Brown started the VI that will facilitate fluorescence calibration by logging all of the relevant information in one file. The data processing utility that calibrates the raw fluorescence values will rely on this file for automated execution.

MOCE pigment data were processed and some of these results were presented by Dennis Clark at the MODIS meeting during the second week of May as well as the ATBD review and SeaWiFS meeting the following week. Initial pigment results indicated that over geographic areas, from the Equatorial Pacific to coastal areas and then to a coccolithophore bloom off Iceland, there is a predictable relationship between chlorophyll (a) and total pigment concentration (chly's a, b, c, phaeopigments and carotenoids) in the first optical depth. A paper is currently being drafted to present these findings.

Before the MOBY-L7 cruise, processing of the MOS and SIS data sets from the MOCE-2 El Puma cruise in the Gulf of California, March 29 to April 13, 1993, was completed at MLML. The SeaBird SeaCat-19 CTD data had been completely processed. The processed data set consists of 13 bio-optics stations with 13 CTD profiles and 4-replicate MOS scans generally at three depths for each station. SIS was run at 1 minute intervals during each bio-optical station. MLML personnel are working on a MOCE-2 technical report that will contain text listings and standard plots of the above data and will include 42 TMS and POC/PON analyses performed by Craig Hunter at MLML. A sample of MOCE-2 processed radiometric and CTD data for one bio-optical station is shown in Tables 4-6 and Figs. 16-18.
Collection and identification of project photographs taken since 1991 (-40 rolls of film) is now up to date. The design of a PC database program that will allow easier identification of and access to specific photographs has been initiated.

INSTRUMENT DEVELOPMENT

In April, the upgrades for the HPLC system, which included a Quaternary Gradient

Pump, Vacuum Membrane Degasser, SpectraFOCUS Programmable Absorption Detector, and new SpectraSystem Software were delivered. The new components were installed and integrated with the existing system. Cost sharing monies from the San Diego State University were used to purchase an Intel 486 to control and monitor the HPLC system and acquire the data from three absorption and fluorescence detectors. This 486 PC was also used during MOBY-L7 cruise to process radiometric data acquired by the MER profiling system. A new version of the Operating Software SPECTACLE (PC1000 Vers. 2.5) was installed on the PC. This new HPLC system with controller, although not thoroughly tested, appears to be a superb system that reduces the baseline noise by a factor of 10 for the absorption detector and by a factor of 100 for the fluorescence detector. Previously, the fluorescence signal was very noisy and provided only minimal assistance in the identification and quantification of phaeopigments. The new software speeds up processing of HPLC pigment samples because, once the system has been calibrated, all of the chromatograms can be auto-batched for unattended processing and analysis. Also included in SPECTACLE is QC/QA software that will automatically monitor the system and flag runs that do not meet certain criteria.

In order to maintain quality control on various sources of “pure” water used to baseline many of our optical systems, a laser scattering meter was designed and assembled. During the MOBY-L7 cruise, many of our pure water sources (Baxter Jackson HPLC water, Fisher scientific HPLC water, Millipore polished and RO water, and filtered sea water) were tested for concentrations of suspended particles. The system was also tested in the flow-thru mode as an indicator of the degree of bubble contamination produced in the pumping system.

Work continued on solving the problem of contamination of the water samples utilized for the total suspended matter measurement. Solution to this problem was sought by the procurement of a winch system capable of pumping water through a support cable and a paravane which is attached to the winch cable for towing off the side of the ship thus keeping the pumping system out of the ship’s wake. The paravane houses a pumping system, which collects sea water and pumps it via a hose backup to the ship to provide relatively uncontaminated water and a fluorometer for real time along- track measurements. The winch, fluorometer, and paravane system were tested during the MOBY-L6 cruise. The initial tests were very successful. The system was stable up to nine knots and all the instrumentation functioned flawlessly. Prior to MOBY-L7 some modifications were made to the towed system. The original brass pump was replaced with one of all stainless steel construction to enhance durability of the system, and the pump controller was rewired to make the setup less cumbersome. The Parascientific pressure sensor was added to the paravane to obtain underway towing depth of the instruments and the pump intake (Fig. 19). This sensor also is used in the vertical profiling mode, replacing the VLST depth signal.

The lack of level winding capability on our vertical profiling buoys has presented a constant problem at depths greater than 30 meters. The Hurst level winder bought and tested in the last at-sea experiment proved an unuseful device for our project.

The level winder allowed stacking of cable on one side of the drum and could not allow for operations deeper than 30 m. Therefore, Ed King designed a new level winder driven by a 12VDC motor to solve this problem. During the MOBY-L7 cruise this new level winder was tested. The MER 1032 Profiling System was deployed three times during the cruise (Fig. 20). During the first cast, the level-winder quit working on the up cast due to lose electrical connections. During subsequent deployments the level winder continued to malfunction. The device is now under reevaluation.

The flotation catamaran device to be used for deploying small spectroradiometer off the stern of ships to collect data (the Fastie 1/4m dual spectrometer) was completed. Deployment and retrieval techniques will be tested on future cruises (see Figure 21).

The MLML CTD (vintage 1980) will be replaced by a SeaBird 911 SeaRam. The Martek/MLML 1-m transmissometer which is part of the CTD package, is being refitted with stable electronics, collimating optics and a diode source by Sarma Lakkaraju of the SJSU Physics Department. That upgraded instrument and the MLML 3-channel fluorometer will be used during the next cruise on the SeaBird CTD. After the MLML transmissometer has been tested with a single source (540 rim), two additional spectral sources will be added, one each in the near-blue and red.

In preparation for the MOBY-L7 cruise, the chemical workstation kits for total suspended material (TSM) and particulate organic carbon and nitrogen (POC/N) filtration were built. These kits store the filtration equipment between cruises and are used aboard the ship to perform the filtrations. A top loading balance was purchased to prepare reagents used with our oxygen titration apparatus.

MARINE OPTICAL BUOY

A major activity during this reporting period was the continuation of work on system software in the prototype buoy (MOBY) and spectrograph (MOS) and the completion of a major electronics redesign of the MOS and MOBY communications systems. Personnel from MLML designed and purchased parts for a MOBY terminal port connector to allow connecting to the buoy.
During the prelaunch calibration work, MOBY software was tested both in the calibration mode and in remote data acquisition mode. Some bugs were discovered and software was repaired.

Following the software review at NASA Goddard, some time was spent making contacts with Forth developers as suggested at the Goddard review. Richard Reaves wrote a Forth editing program to input the Forth program in block-wise fashion and to send it to the TattleTale by serial interface. He has started to develop programs to acquire data from the CCD arrays using a mock-up system.

Initially, consistent cell phone contact with MOBY was maintained until early May when it began malfunctioning. There were several attempts to activate the modem but without any success. The cause of the modem malfunction remains undetermined.

MOBY data processing programs were developed to automate MOBY data reduction. MOBY data collected during the Kila cruise in March have been processed. The radiometric calibration files from the time of ML Harbor work in October 1991 to the present have been compiled and organized.

The work on the MOBY II surface float redesign to again allow usage of the Sutron DCP is continuing. This buoy work includes adding multiple instrument chambers to allow servicing of upper buoy electronic modules while deployed. Design changes include placing the upper arm collector within 1 m of the surface instead of 1.5 m, moving the middle arm to 6 m and the lower arm to 11 m, and changing the shape of upper flotation to eliminate the gap between the top of the upper arm and the bottom of the surface flotation. The changes are illustrated in Fig. 22. MLML personnel are continuing fabrication of the buoy's lower instrument bay. The mast end flanges and the mast "splice" unit have been completed. Masts will be assembled when a desired length is decided upon.

Work on the new MOS continues. The basic CCD image acquisition is functioning simultaneously from two arrays. The MUX driver circuit has been completed and is ready for software development. The prototype analog input circuitry is under construction.

Yuntao Ge's work on a Monte Carlo scheme to assist the design of irradiance collectors is in process. The finished computer-aided design program will be able to calculate the angular response of the irradiance collector designs used on the buoy. This is also a research project that can benefit the entire marine optics discipline. It will make the collector design process much faster and easier. The computer simulation program is almost completed.

DOCUMENTATION

Moss Landing Marine Laboratories Technical Publication "Oceanographic Profiling and Spectroradiometer Observations from the MOCE-1 Cruise: 28 August to 8 October 1992" issued in January. Another Publication - FORTH for NOAA/MLML Instrument - was revised in January 1994.

MLML personnel have consolidated procedures for the oceanographic methods into a technical report. They are preparing a publication giving details of the CTD/rosette vertical profiling, water sampling, and chemical analyses. This report will be issued in preliminary form before the forthcoming November cruise. Some of the CTD procedures will be updated to be specific to the SeaBird 911 Plus CTD system.

SUPPORTING GRANTS AND INTERAGENCY ACTIONS

San Diego State University Foundation and San Jose State University (MLML) grants were awarded.

A support contract with Research and Data Systems Corporation was awarded.

PERSONNEL

Initiated an interagency transfer of funds to the US. Naval Academy to provide for Dr. Yuntao Ge's full-time support to the team.

MOBY Lanai Operations

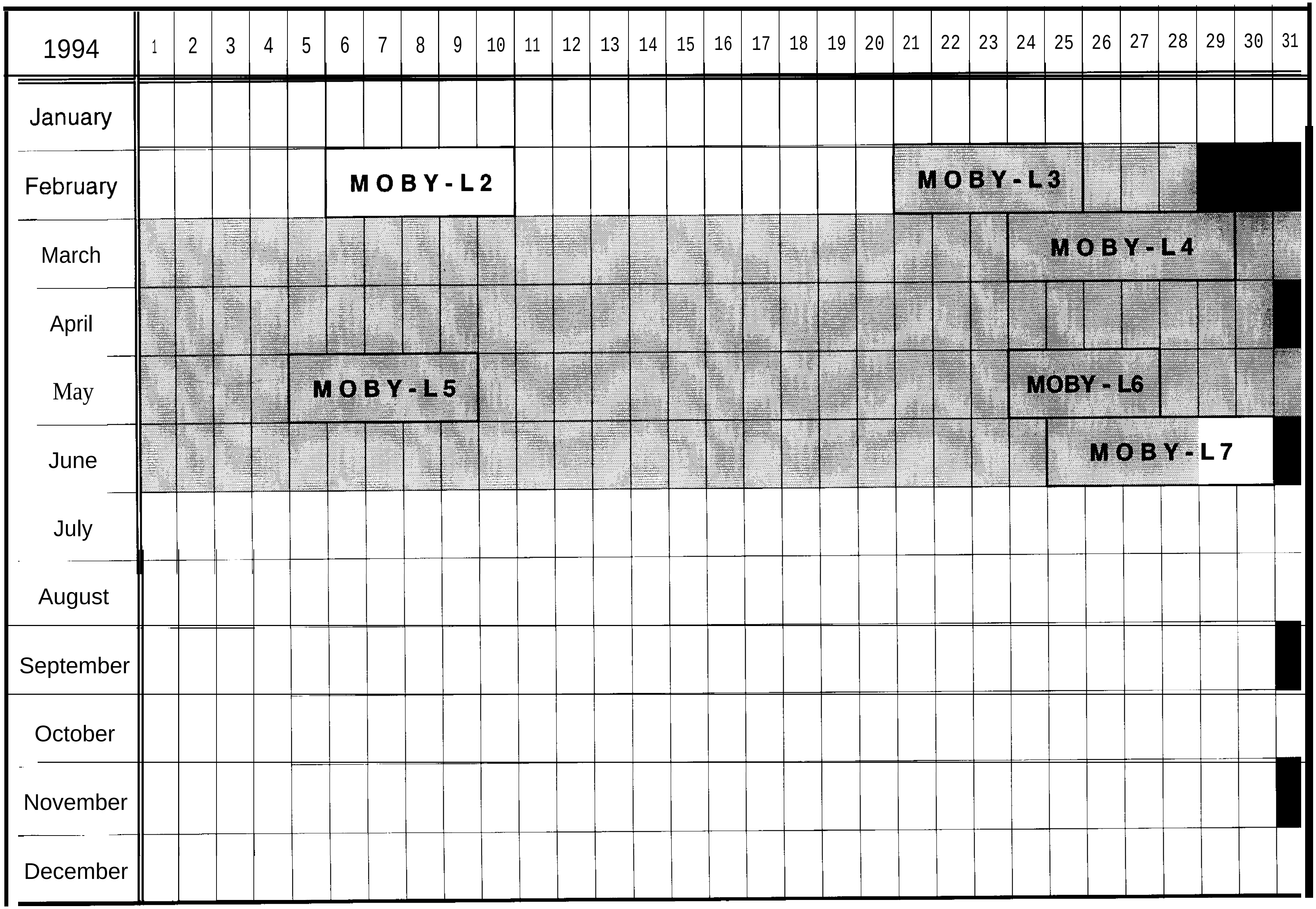
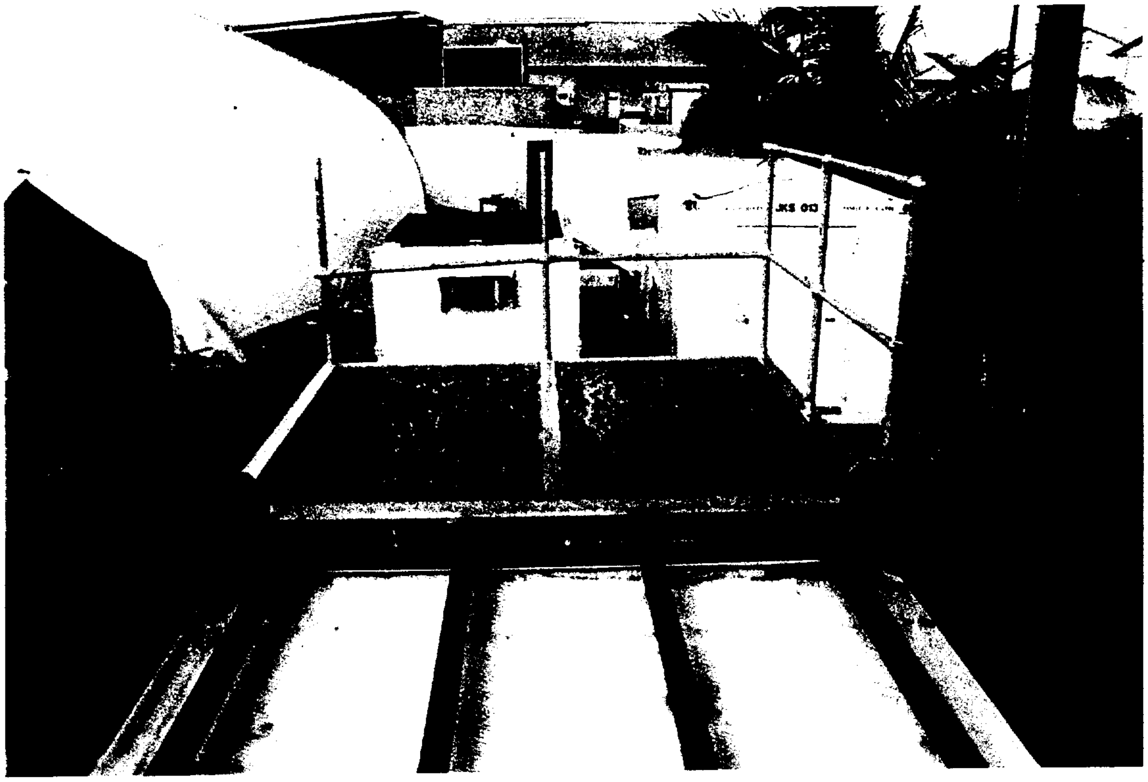


FIGURE 1

FIGURE 2.



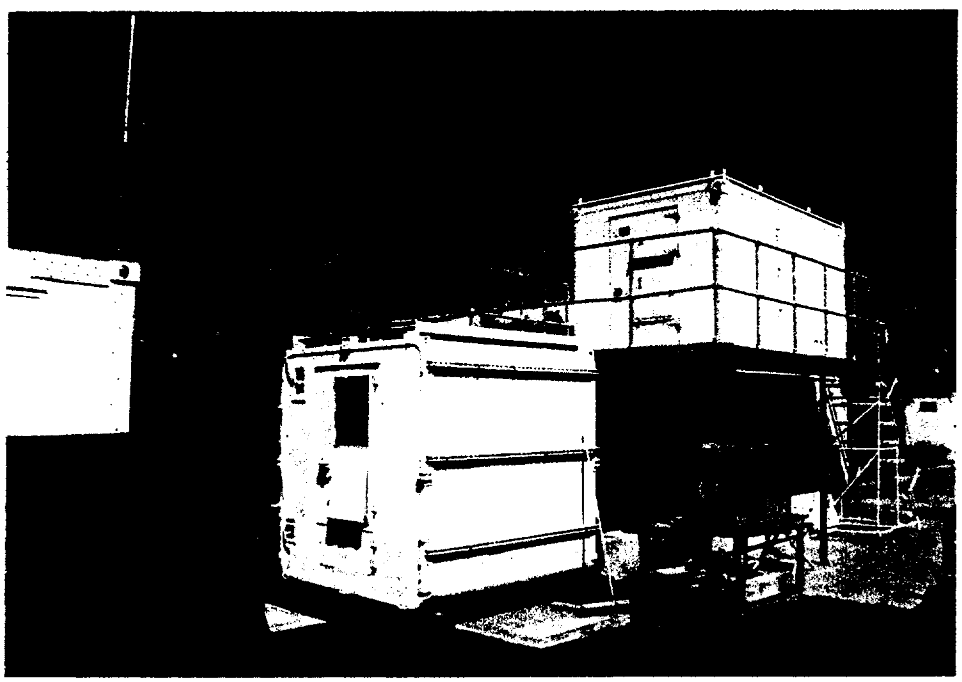


FIGURE 3.

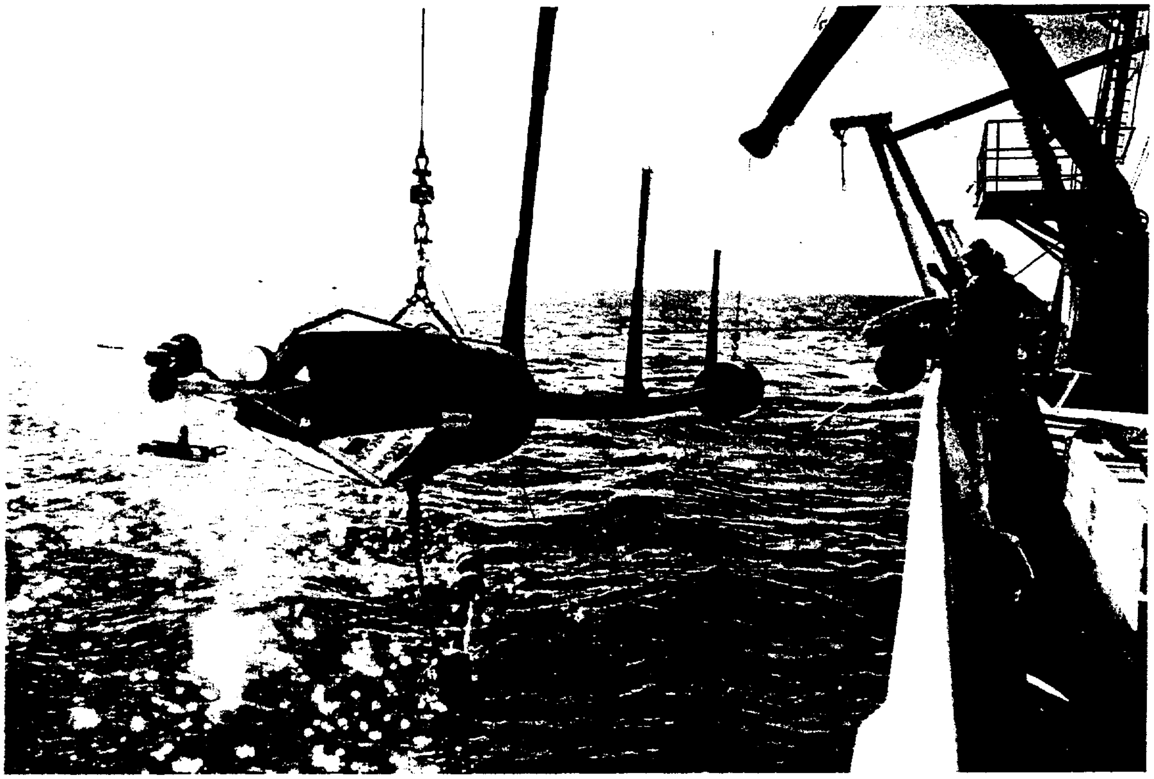


FIGURE 4.

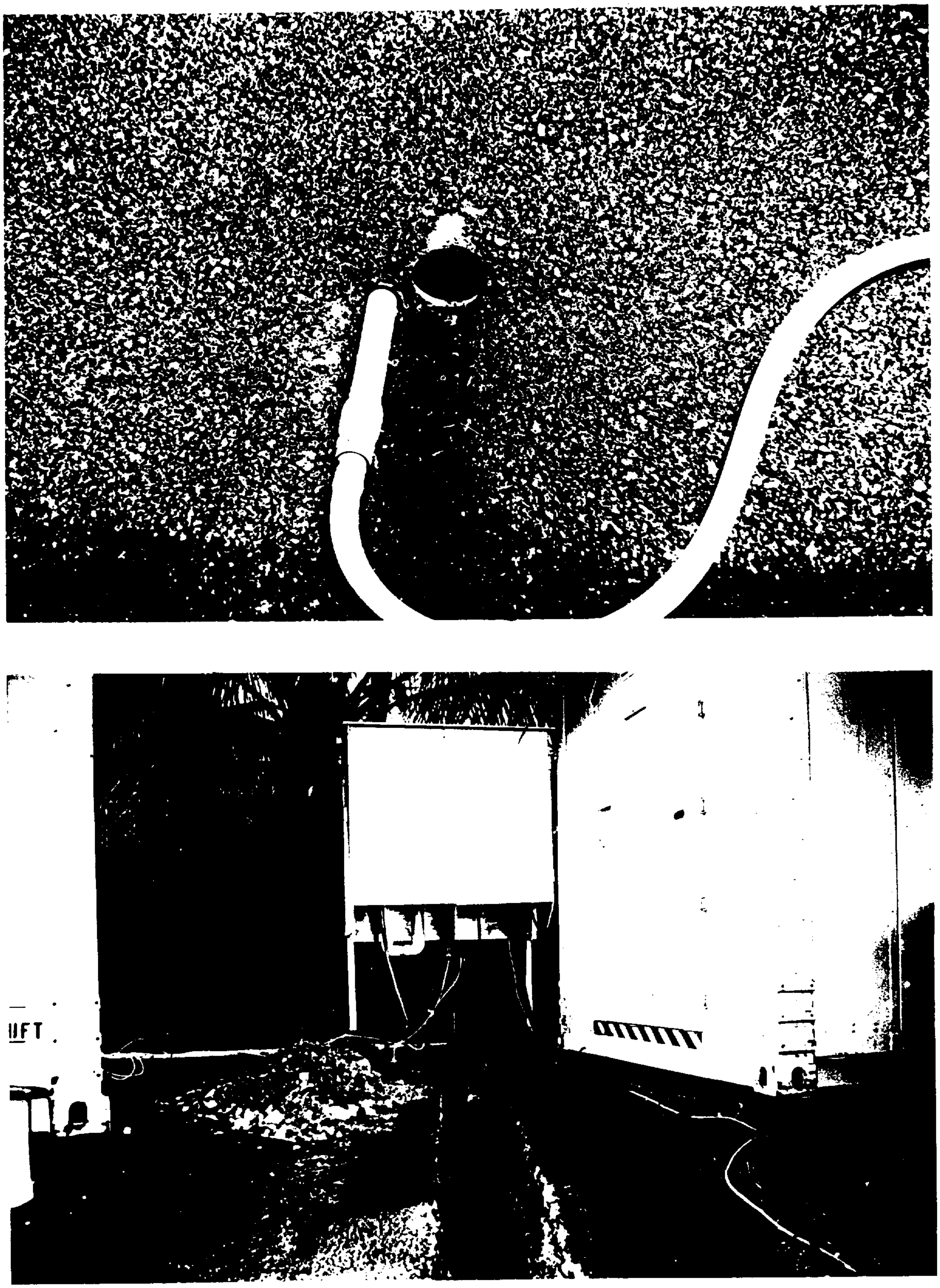
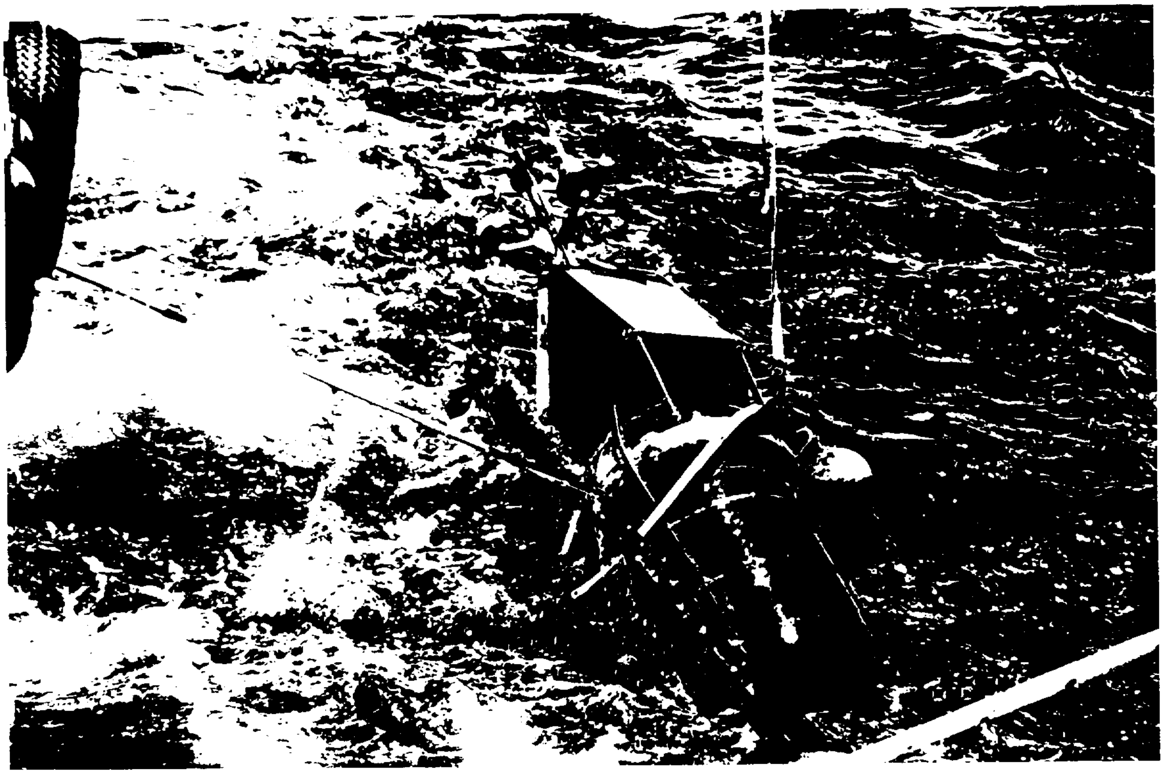


FIGURE 5.



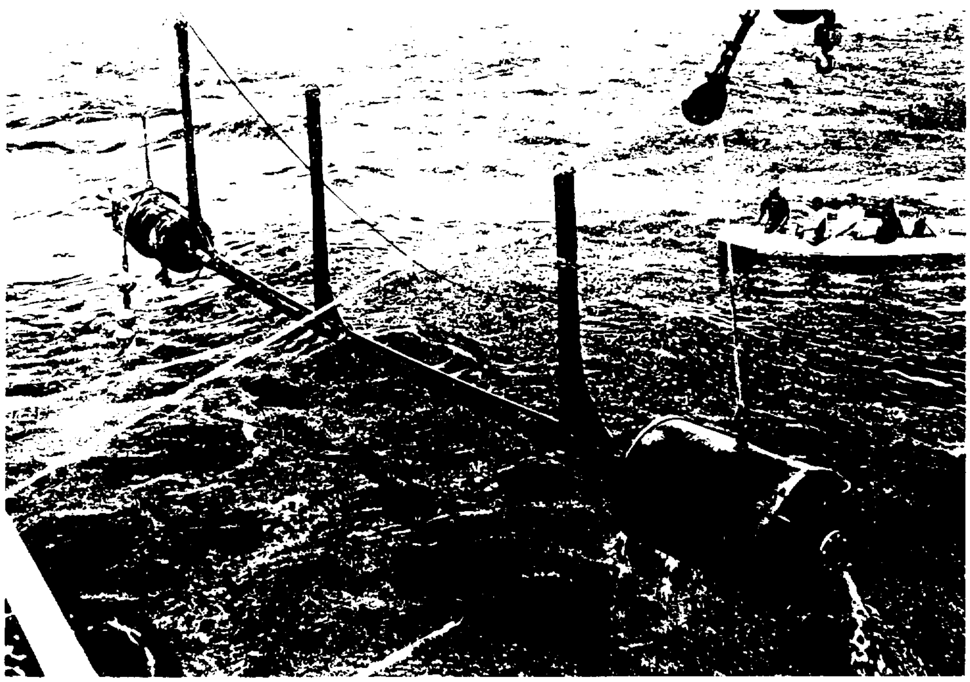


FIGURE 6.

Name	Ext	Size (bytes)	Date & Time Saved ((GMT)	File Description
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FORTH	LOG	383588	04-21-94 21:40	Moby Status information
94021905	MOB	265658	02-19-94 05:30	Prelaunch test data
94021908	MOB	265656	02-19-94 08:30	"
94021911	MOB	265656	02-19-94 11:30	"
94021914	MOB	265656	02-19-94 14:30	"
94021917	MOB	265656	02-19-94 17:30	"
94021919	CAL	38013	02-19-94 19:38	Prelaunch calibration data
94021919		0	02-19-94 19:55	Aborted calibration data
94021920	MOB	265656	02-19-94 20:30	Prelaunch test data
94021923	MOB	265656	02-19-94 23:30	"
94022002	MOB	265656	02-20-94 02:30	"
94022008	MOB	265656	02-20-94 08:30	"
94022011	MOB	285656	02-20-94 11:30	"
94022014	MOB	265656	02-20-94 14:30	"
94022017	MOB	265856	02-20-94 17:30	"
94022020	MOB	265658	02-20-94 20:30	"
94022023	MOB	265656	02-20-94 23:30	"
94022105	CAL	36013	02-21-94 05:16	Prelaunch calibration data
94022107	CAL	38013	02-21-94 07:09	"
94022108	MOB	265656	02-21-94 08:30	Prelaunch test date
94022111	MOB	265656	02-21-94 11:30	"
94022114	MOB	265656	02-21-94 14:30	"
94022117	MOB	265656	02-21-94 17:30	"
94022120	MOB	265656	02-21-94 20:30	"
				MOBY Launched
94022122	CAL	151791	02-21-94 22:13	Diver calibration data
94022200	CAL	97096	02-22-94 00:01	"
94022203	CAL	113665	02-22-94 03:08	"
94022222	MOB	265656	02-22-94 22:00	Noon MOS data set
94022322	MOB	285656	02-23-94 22:00	"
94022422	MOB	265656	02-24-94 22:00	"
94022522	MOB	265656	02-25-94 22:00	"
94022602	MOB	94902	02-26-94 02:30	Diver calibration data
94022622	MOB		02-26-94 22:00	Noon MOS data set
94022722	MOB		02-27-94 22:00	"
94022822	MOB		02-28-94 22:00	"
94030122	MOB	265656	03.01-94 22:00	"
94030222	MOB	265656	03-02-94 22:00	"
94030322	MOB	265656	03-03-94 22:00	"
94030422	MOB	265656	03-04-94 22:00	"
94030522	MOB	265656	0345-94 22;00	"
94030622	MOB	265656	03-06-94 22:00	"
94030722	MOB	265656	03-07-94 22:00	"
94030822	MOB	265656	03-08.94 22:00	"
94030922	MOB	265656	03-09-94 22:00	"
94031022	MOB	265656	03-10-94 22:00	"
94031122	MOB	264652	03-11.94 22:00	Partial data file, cause unknown
94031222	MOB	265656	03-12-94 22:00	Noon MOS data set
94031322	MOB	205656	03-13.94 22:00	"

TABLE 1

94031422	MOB	265656	03-14-94 22:00	"
94031522	MOB	265656	03-15-94 22:00	"
94031622	MOB	265656	03-16-94 22:00	"
94031722	MOB	265656	03-17-94 22:00	"
94031822	MOB	265656	03-18-94 22:00	"
94031922	MOB	265656	03-19-94 22:Q0	"
94032022	MOB	265656	03-20-94 22:00	"
94032122	MOB	265656	03-21-94 22:00	"
94032222	MOB	265656	03-22-94 22:00	"
94032322	MOB	265656	03-23-94 22:00	"
94032422	MOB	265656	03-24-94 22:00	"
94032522	MOB	255034	03-25-94 22:00	Partial data file, caused by failing battery
94032622	MOB	265656	03-26-94 22:00	Noon MOS data sat
94032722	MOB	265656	03-27-94 22:00	"
94032822	MOB	120186	03-26-94 22:00	File Interrupted to service MOBY
94032902	CAL	113865	03-29-94 02:43	Diver calibration data
94032918	CAL	174	03-29-94 18:25	"
94032919	CAL	87	03-29-94 19:09	"
94032921	CAL	132828	03-29-94 21:03	"
94033022	MOB	265656	03.30-94 22;00	Noon MOS data sat
94033122	MOB	265656	03-31-94 22:00	"
94040122	MOB	265656	04-01-94 22:00	"
94040222	MOB	265656	04-02-94 22:00	"
94040322	MOB	265656	04-03-94 22:00	"
94040422	MOB	265656	04-04-94 22:00	"
94040522	MOB	265656	04-05-94 22:00	"
94040622	MOB	265656	04-06-94 22:00	"
94040722	MOB	265656	04-07-94 22:00	"
94040822	MOB	265656	04-08-94 22:00	"
9404Q922	MOB	265656	04-09-94 22:00	"
94041022	MOB	265656	04-10.94 22:00	"
94041122	MOB	265656	04-11-94 22:00	"
94041222	M0B	265656	04-12.94 22:00	"
94041322	MOB	265656	04-13-94 22:00	"
94041422	MOB	265656	04-14-94 22:00	"
94041522	MOB	265656	04.15-94 22:00	"
94041622	MOB	265656	04-16-94 22:00	"
94041722	MOB	265656	04-17-94 22:00	"
94041622	MOB	265666	04-16-94 22:00	"
94041922	MOB	265656	04-19-94 22:00	"
94042022	MOB	265656	04-20-94 22:00	"
94042122	MOB	265666	04-21-94 22:00	"
94042222	MOB	285656	04-22-94 22:00	"
94042322	MOB	285656	04-23-94 22:00	"
94042422	MOB	265656	04-24-94 22:00	"
94042522	MOB	265656	04-25-94 22:00	"
94042622	M0B	265656	04-26-94 22:00	"
94042722	MOB	265656	04-27-94 22:00	"
94043022	MOB	265656	04-30-94 22:00	"
94050122	MOB	255656	05-01-94 22:00	"
94050222	MOB	265856	05-02-94 22:00	"
94050322	MOB	265656	05-03-94 22:00	"
94050422	MOB	265656	05-04-94 22:00	"
94050522	MOB	265656	05-05-94 22:00	"
94050822	MOB	265656	05-08-94 22:00	"
94050922	MOB	265656	05-09-94 22:00	"
94051022	MOB	265656	05-10-94 22:00	"
94051122	MOB	265656	05-11-94 22:00	"

TABLE 1 CONTINUED

94051222	MOB	265656	05-12-94 22:00	
94051322	MOB	265656	05-13-94 22:00	
94051422	MOB	265656	05-14-94 22:00	
94051522	MOB	265656	05-15-94 22:00	
94051622	MOB	285656	05-16-94 22:00	
94051722	MOB	265656	05-17-94 22:00	
94051822	MOB	265656	05-18-94 22:00	
94051922	MOB	265656	05-19-94 22:00	
				Batteries start to fail
94052022	MOB	266656	05-20-94 22:00	
94052122	MOB	265656	05-21-94 22:00	
94052222	MOB	265656	05-22-94 22:00	
94052322	MOB	265656	05-23-94 22:00	
$4052422	MOB	242392	05-24-94 22:00	Partial MOS data set
94052522	MOB	156005	05-25-94 22:00	
94052622	M0B	99116	05-26-94 22:00	
94052722	MOB	109651	05-27-94 22:00	
94052822	M0B	61190	05-28-94 22:00	
94052922	MOB	99116	05-29.94 22:00	
94053022	MOB	61190	03-30-94 22:00	
94053122	MOB	128614	05-31-94 22:00	
94060122	MOB	90668	06-01-94 22:00	
94060222	MOB	52762	06-02-94 22:00	
94060322	MOB	99116	06-03-94 22:00	
94060422	MOB	109651	06-04-94 22:00	
94060522	MOB	42227	06-05-94 22:00	
94060622	MOB	61190	06-06-94 22:00	
04080722	MOB	4301	06-07-94 22:00	
94060622	MOB	71725	06-08-94 22:00	
94060922	MOB	23264	06-09-94 22:00	
94061022	MOB	52762	08-10-94 22:00	
94061122	MOB	174	06-11.94 22:00	
94081222	MOB	174	06-12-94 22:00	
94061322	MOB	174	08-13-94 22:00	
94061422	M0B	42227	06-14-94 22:00	
94061522	MOB	52762	06-15-94 22:00	
94081622	MOB	4301	06-16.94 22:00	
94061722	MOB	118079	06-17.94 22:00	
94061822	MOB	61190	08-18.94 22:00	
94061922	MOB	4301	06-19.94 22:00	
94062022	MOB	90688	06.20-94 22:00	
94062122	M0B	99116	06-21-94 22:00	
94062222	MOB	4301	06-22.94 22:00	
94062322	MOB	52762	06-23-94 22:00	
94062422	MOB	4301	06-24-94 22:00	
94062522	MOB	23264	06-25-94 22:00	

152 file(s) 31041807 bytes
53952512 bytes free

MOBY was turned off for recovery on 25 June 1994 and recovered on 28 June 1994 during the MOBY L7 cruise.

TABLE 1 CONTINUED

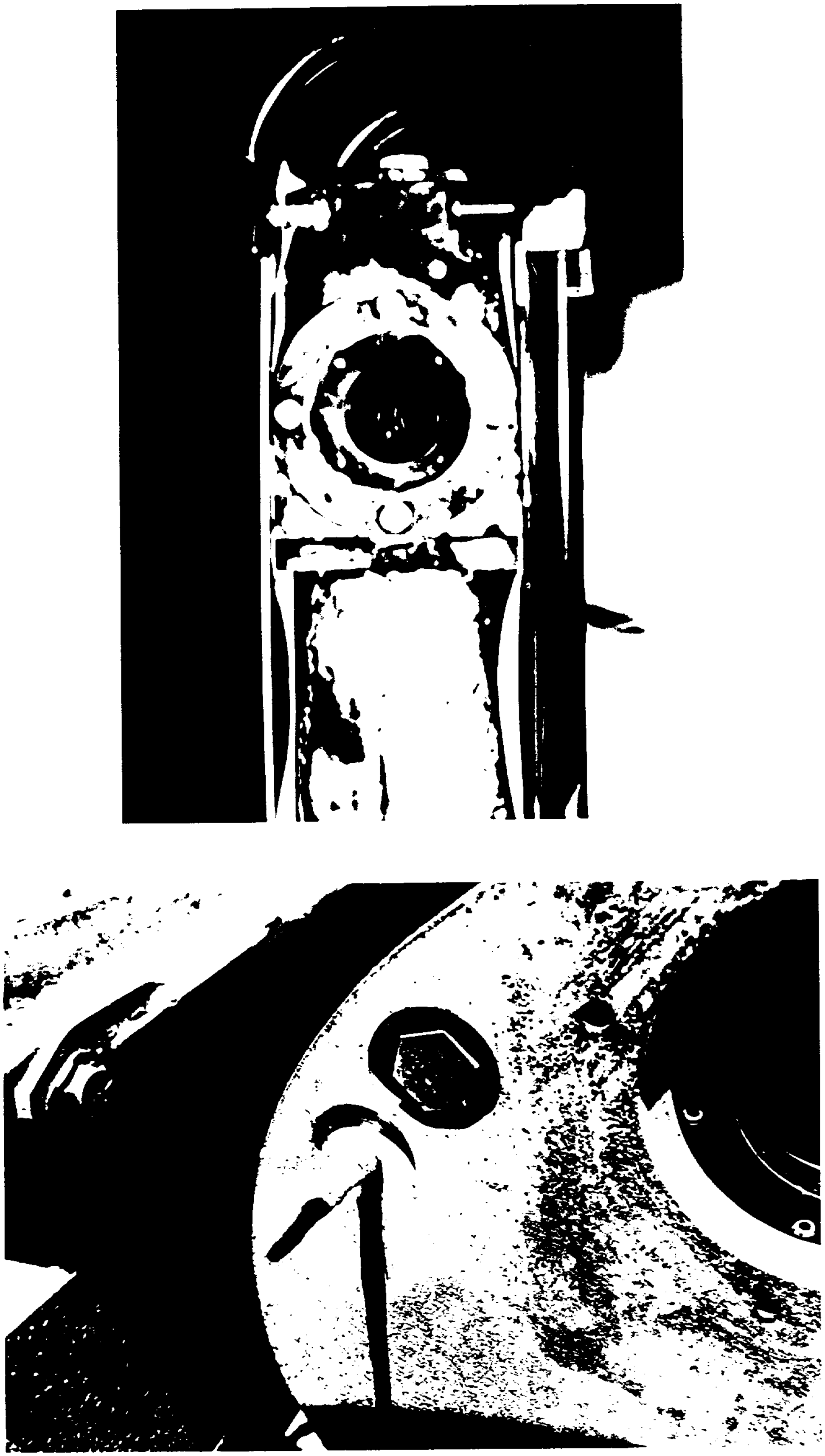


FIGURE 7.

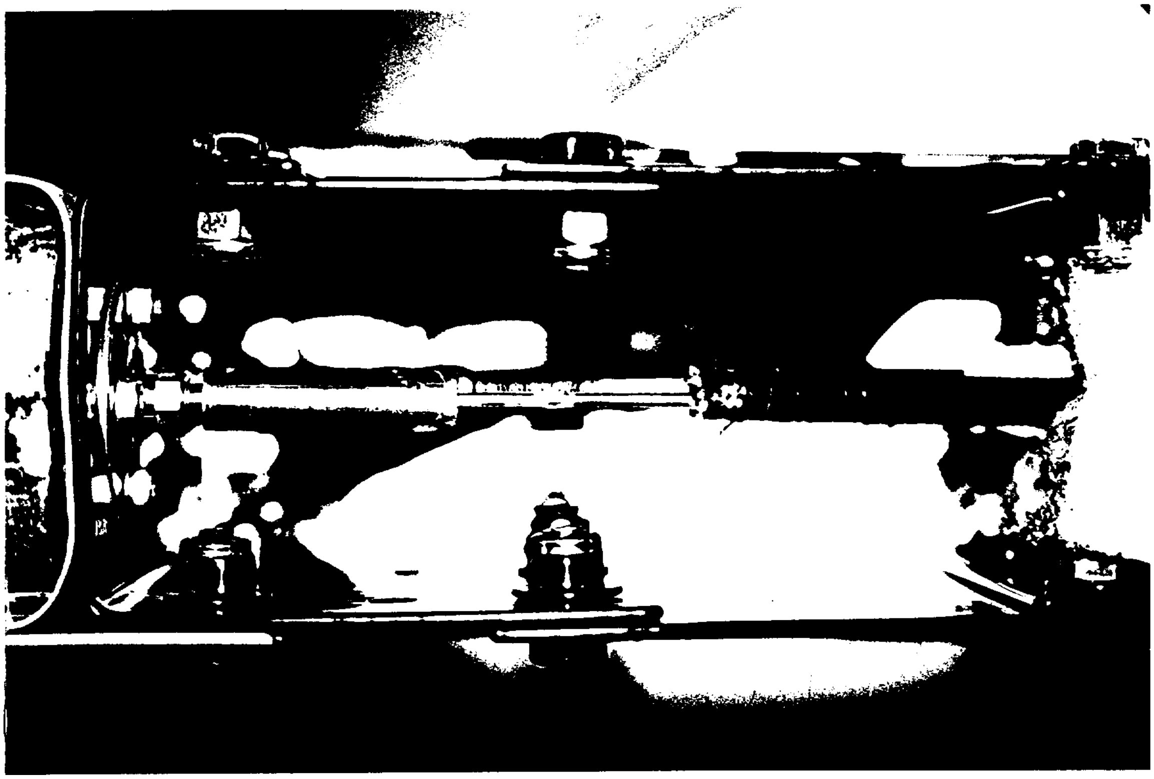


FIGURE 8.

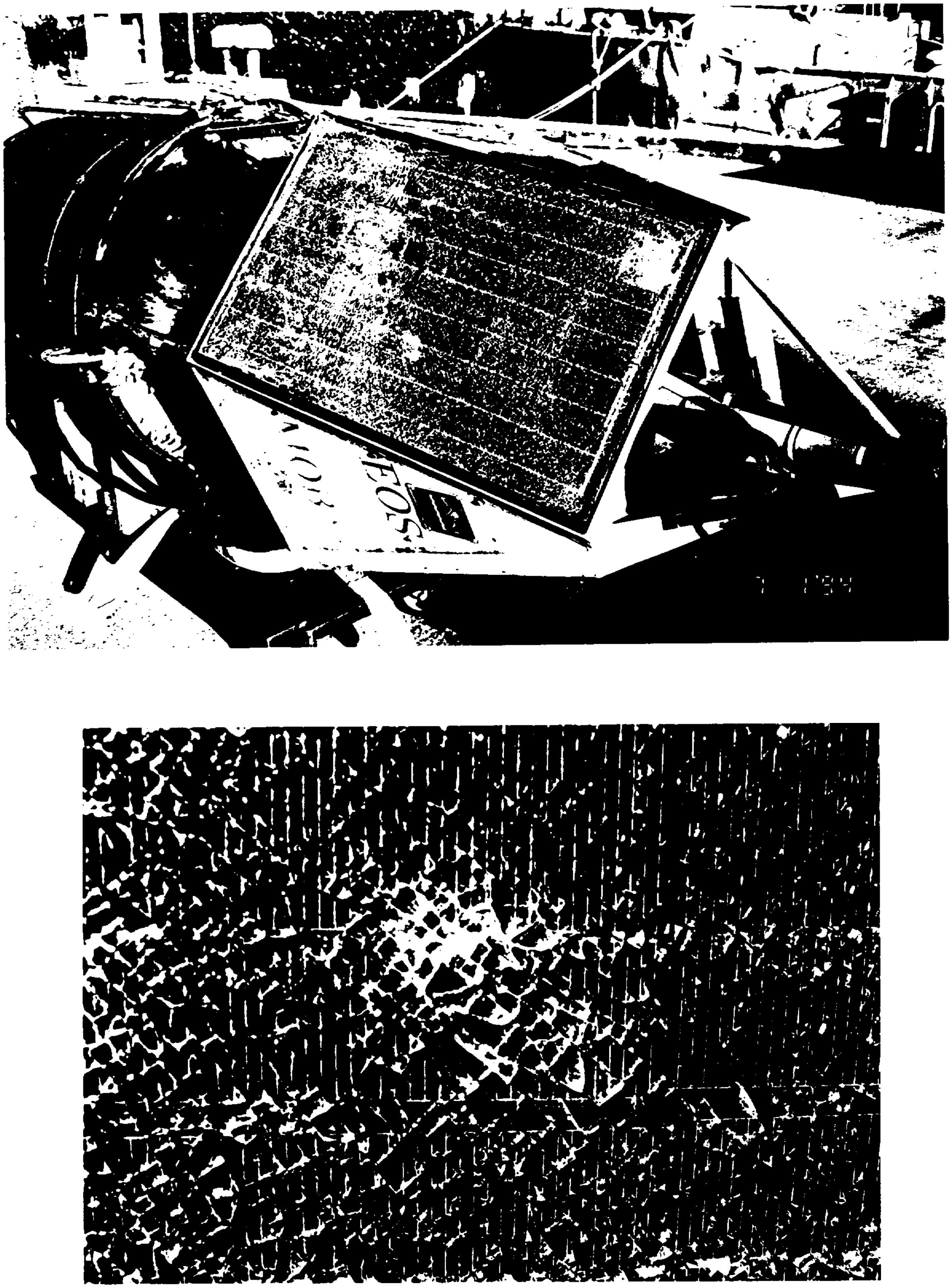


FIGURE 9.

FIGURE 10.

G A L A I - C I S - 1 0 0

Computerized Inspection System

STATISTICS

SAMPLE NAME : TOW1.SUM
FILE NAME : TOW1.SUM

DATE : 27/06/1994	ACQ. RANGE : 2-100	COUNTS : 109367
TIME : 10:58	ACQ. MODE : SAMPLE	S.N.F. : 0.78
CONFIG. : 2 (2 B)	ACQ. TIME : 232 SEC	S.D.U. : 1187
CELL TYPE : MAGNETIC (2)	SAMPLE SIZE : REP. SUM	CONCENTR. : 1.6E+05 #/ml
SAMPLE TYPE : REGULAR	REQ. CONF. : None	SOLIDS : REP. SUM

SPECIFIC AREA : 7.7E-01 cm^2/ml

	MEAN Diameter	S.D.
Number, Length :	6.00 µm	5.55 µm
Number, Area :	8.17 µm	5.95 µm
Number, Volume :	10.62 µm	7.22 µm
Length, Area :	11.13 µm	8.72 µm
Length, Volume :	14.13 µm	9.22 µm
Area, Volume :	17.96 µm	12.48 µm
Volume, Moment :	26.63 µm	17.94 µm

	MEDIAN Diameter	MODE	CONFIDENCE
Number	3.40 µm	2.50 µm	100.00%
Area	15.63 µm	15.49 µm	94.26%
Volume	20.00 µm	15.49 µm	92.16%

TABLE **2**

SAMPLE NAME : TOW1.SUM
FILE NAME : TOW1.SUM

DATE	: 27/06/1994	ACQ. RANGE	: 2-100	COUNTS	: 109367
TIME	: 10:58	ACQ. MODE	: SAMPLE	S.N.F.	: 0.78
CONFIG.	: 2 (2 B)	ACQ. TIME	: 232 SEC	S.D.U.	: 1187
CELL TYPE	: MAGNETIC (2)	SAMPLE SIZE	: REP. SUM	CONCENTR.	: 1.6E+05 #/ml
SAMPLE TYPE	: REGULAR	REQ. CONF.	: None	SOLIDS	: REP. SUM

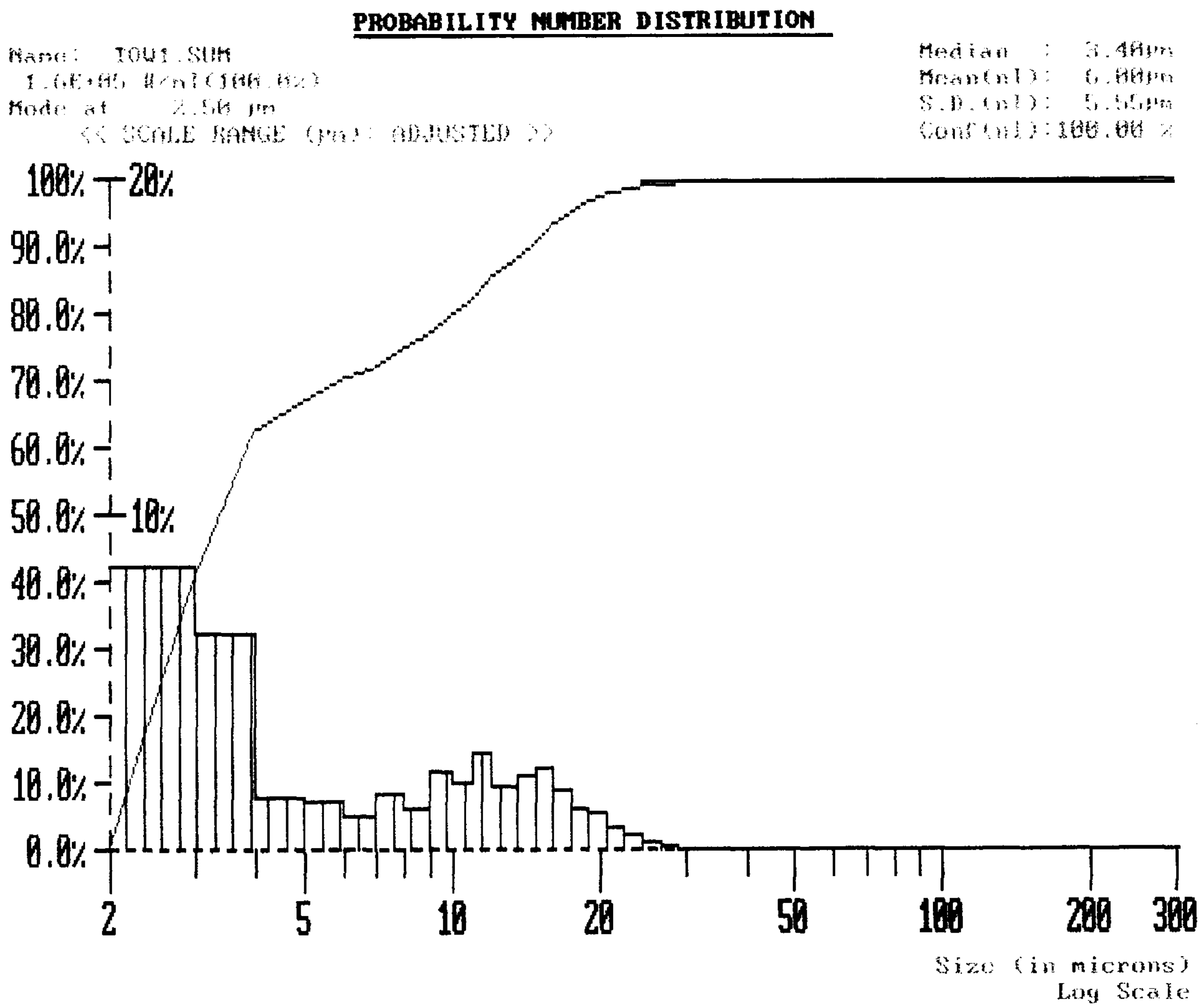


FIGURE 11.

NUMBER DISTRIBUTION TABLE [RANGES)

SAMPLE NAME : TOW1.SUM
FILE NAME : TOW1.SUM

DATE : 27/06/1994	ACQ. RANGE : 2-100	COUNTS : 109367
TIME : 10:58	ACQ. MODE : SAMPLE	S.N.F. : 0.78
CONFIG. : 2 (2 B)	ACQ. TIME : 232 SEC	S.D.U. : 1187
CELL TYPE : MAGNETIC (2)	SAMPLE SIZE : REP. SUM	CONCENTR. : 1.6E+05 #/ml
SAMPLE TYPE : REGULAR	REQ. CONF. : None	SOLIDS : REP. SUM

RANGE (microns)	LOCAL (#/ml)	UNDER(#/ml)	OVER(#/ml)
2.0 - 3.0	64753	64753	92978
3.0 - 4.0	35052	99805	57926
4.0 - 5.0	6632	106438	51293
5.0 - 6.0	5221	111660	46071
6.0 - 8.0	7478	119139	38592
8.0 - 10.0	7506	126646	31085
10.0 - 11.0	3765	130411	27320
11.0 - 12.0	4813	135225	22506
12.0 - 13.0	2740	137965	19766
13.0 - 14.0	3010	140976	16755
14.0 - 15.0	3066	144043	13688
15.0 - 17.0	5679	149723	8008
17.0 - 20.0	3962	153685	4046
20.0 - 30.0	3470	157155	576
30.0 - 40.0	335	157490	241
40.0 - 50.0	145	157636	95
50.0 - 60.0	64	157700	31
60.0 - 70.0	6	157707	24
70.0 - 80.0	21	157729	2
80.0 - 90.0	2	157731	0

TABLE 3

G A L A I - C I S - 1 0 0

Computerized Inspection System

SAMPLE NAME : TOW1.001
FILE NAME : TOW1.001

DATE : 27/06/1994	ACQ. RANGE : 2-100	COUNTS : 59593
TIME : 10:58	ACQ. MODE : SAMPLE	S.N.F. : 0.93
CONFIG. : 2 (2 B)	ACQ. TIME : 121 SEC	S.D.U. : 1306
CELL TYPE : MAGNETIC (2)	SAMPLE SIZE : 2	CONCENTR. : 7.5E+04 #/ml
SAMPLE TYPE : REGULAR	REQ. CONF. : None	SOLIDS : 7.3E-03 %

SAMPLE NAME : TOW1.002
FILE NAME : TOW1.002

DATE : 27/06/1994	ACQ. RANGE : 2-100	COUNTS : 31442
TIME : 11:00	ACQ. MODE : SAMPLE	S.N.F. : 0.78
CONFIG. : 2 (2 B)	ACQ. TIME : 72 SEC	S.D.U. : 1209
CELL TYPE : MAGNETIC (2)	SAMPLE SIZE : 2	CONCENTR. : 1.4E+05 #/ml
SAMPLE TYPE : REGULAR	REQ. CONF. : None	SOLIDS : 7.6E-03 %

SAMPLE NAME : TOW1.003
FILE NAME : TOW1.003

DATE : 27/06/1994	ACQ. RANGE : 2-100	COUNTS : 18332
TIME : 11:01	ACQ. MODE : SAMPLE	S.N.F. : 0.62
CONFIG. : 2 (2 B)	ACQ. TIME : 39 SEC	S.D.U. : 1046
CELL TYPE : MAGNETIC (2)	SAMPLE SIZE : 2	CONCENTR. : 2.6E+05 #/ml
SAMPLE TYPE : REGULAR	REQ. CONF. : None	SOLIDS : 8.9E-03 %

PROBABILITY NUMBER DISTRIBUTION

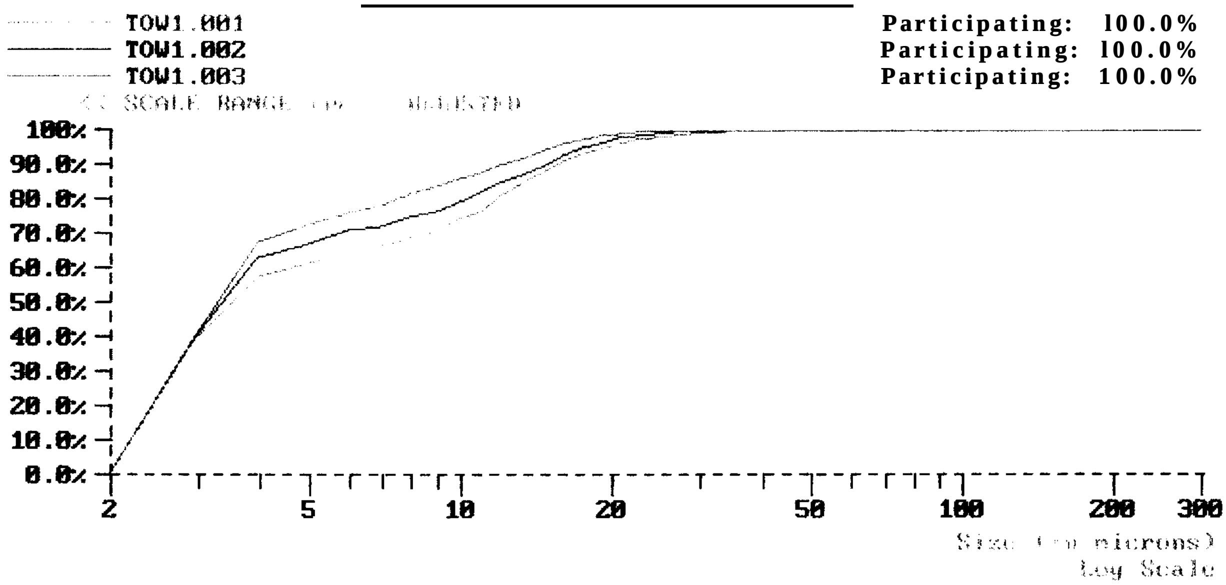
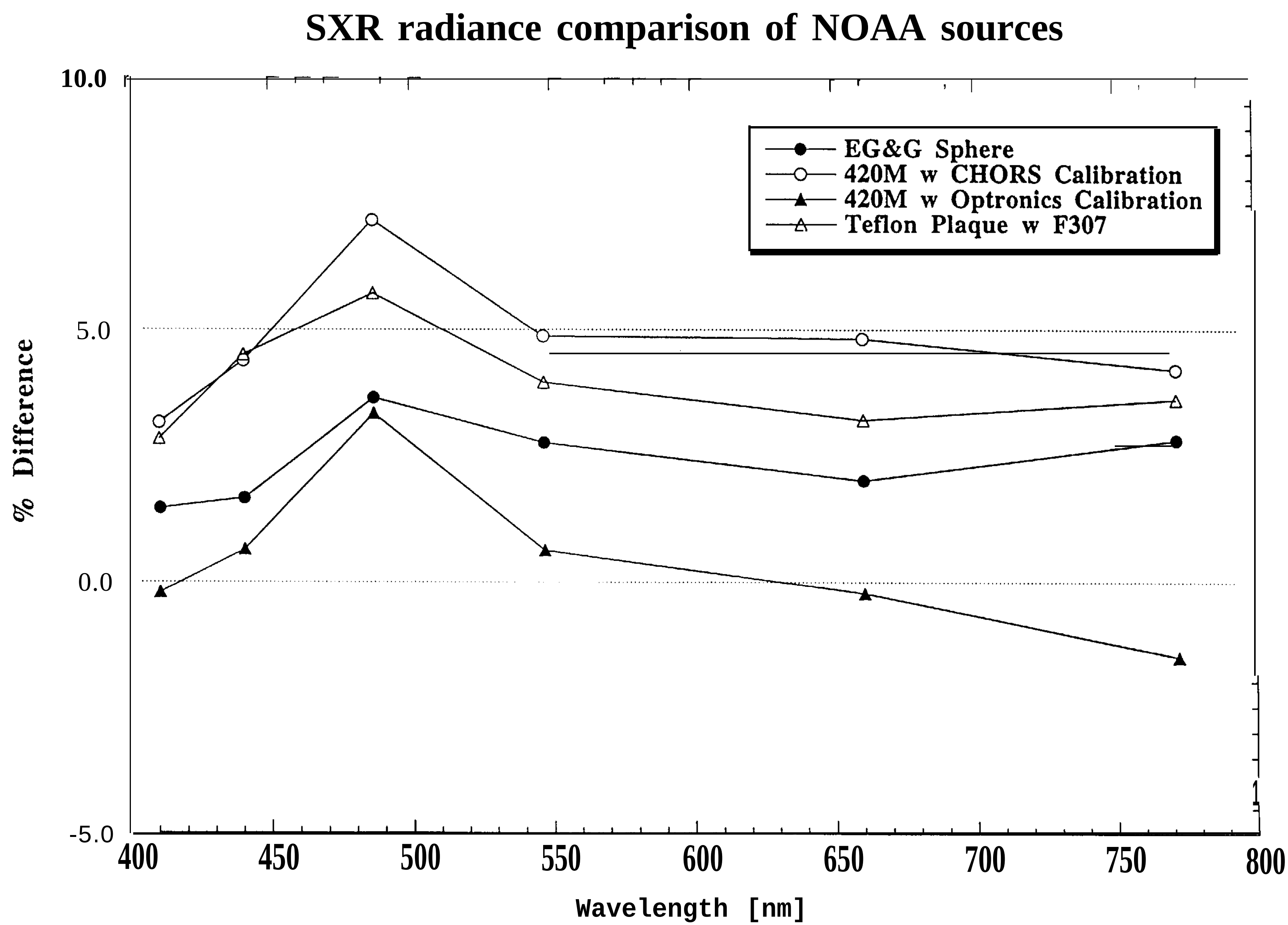


FIGURE 12.



SXR radiance comparison of NOAA sources
EG&G Sphere
420M w CHORS Calibration
420M w Optronics Calibration
Teflon Plaque w F307
10.0
5.0
0.0
-5.0
% Difference
400
450
500
550
600
650
700
750
800
Wavelength [nm]

FIGURE 13.

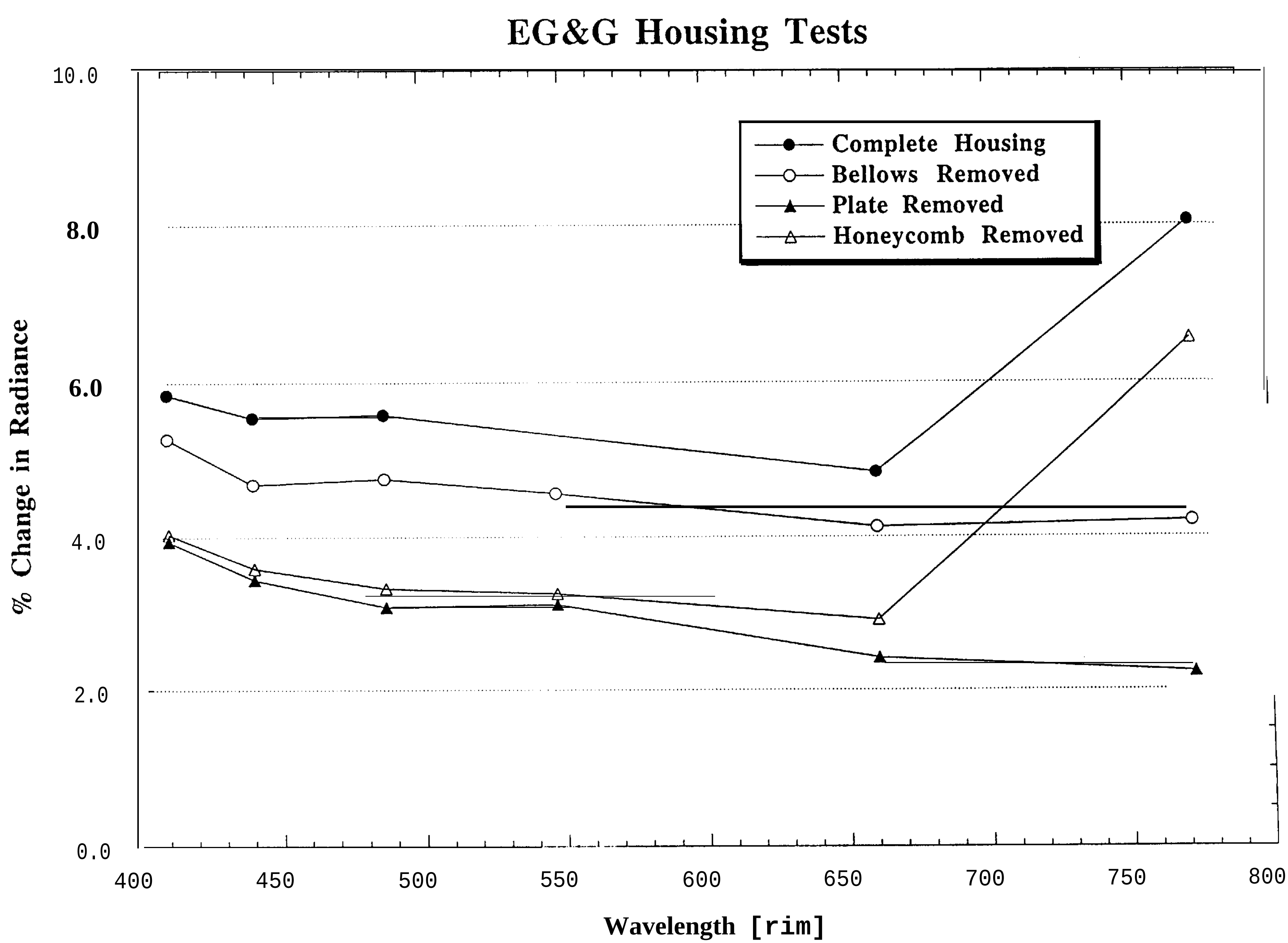

EG&G Housing Tests
Complete Housing
Bellows Removed
Plate Removed
Honeycomb Removed
% Change in Radiance
10.0
8.0
6.0
4.0
2.0
0.0
400
450
500
550
600
650
700
750
800
Wavelength [rim]

FIGURE 4.

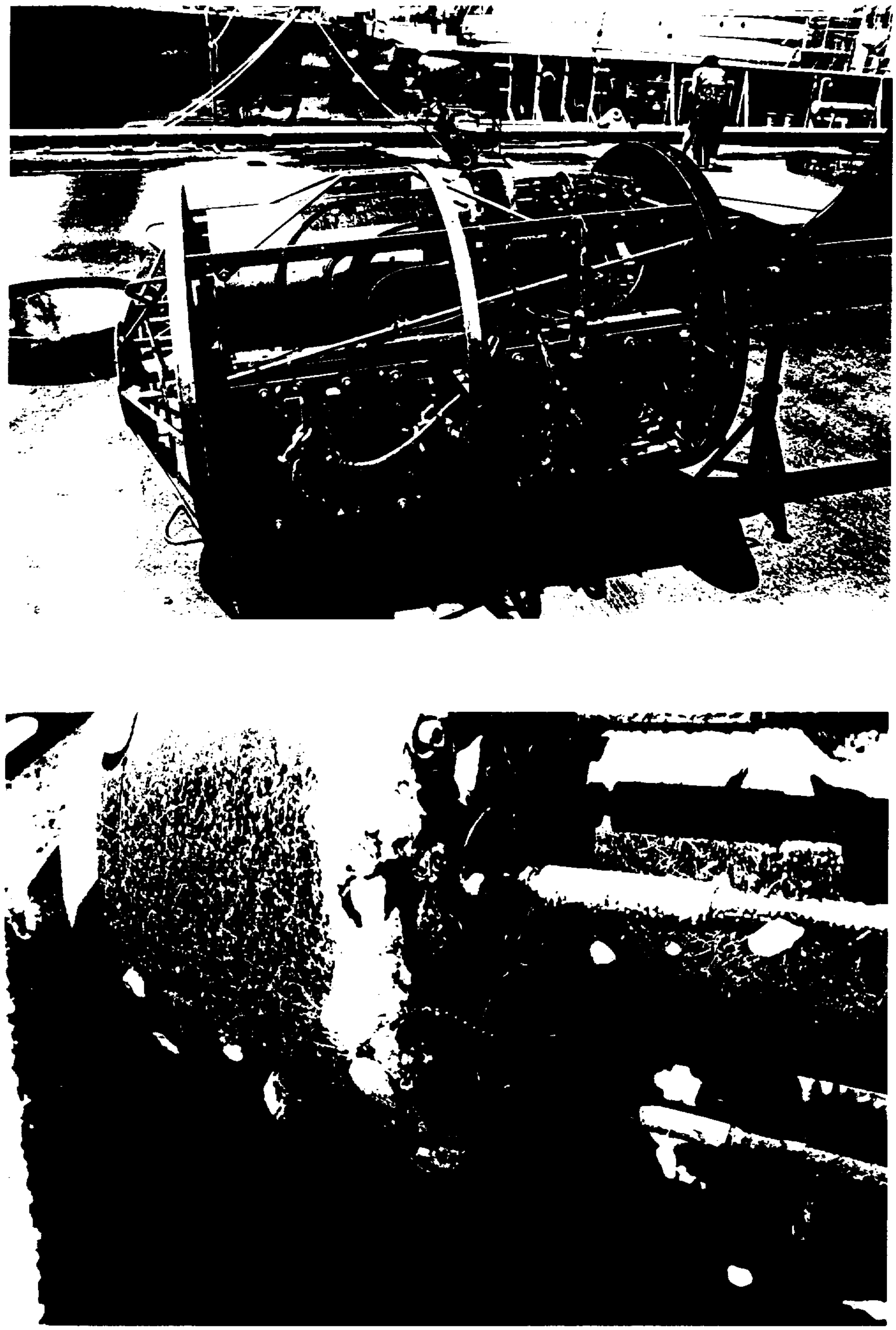


FIGURE 15.

File: DATA$DEV: [DATA.NOAA.MOCE_2.MOS.PRC]S TN02_PRC-MLDAT; 1

MODIS Marine Optical Characterization Experiment NOAA/MLML

CRUISE: MOCE-2 SHIP: El Puma STATION: 02 - Isla Santa Cruz
DATE: 21:27 (GMT) 31 Mar 1993 POSITION: 25°13.0 N 110°43.5 W

SeaWiFS-weighted water-leaving radiance:

Wavelength (m):	412	443	490	510	555	670	765	865
Lw' (uW/cm^2/sr):	7.02E+0	8.26E+0	1.01E+1	8.65E+0	4.38E+0	3.50E-1	1.50E-1	7.68E-2

	Top		Top		Mid		Mid		Bot		Bot	
Depth (m)	0.6		1.2		5.7		6.3		10.7		11.1	
Time (GMT)	22:13		22:09		21:40		21:25		20:40		20:30	
Lambda	Ed_1	Es_1	Lu_1	Es_1	Ed_2	Es_2	Lu_2	Es_2	Ed_3	Es_3	Lu_3	Es_3
400	5.75E+1	5.53E+1	5.17E-1	5.99E+1	3.88E+1	6.63E+1	3.59E-1	6.92E+1	2.83E+1	7.66E+1	2.05E-1	7.82E+1
410	6.81E+1	7.05E+1	5.79E-1	7.64E+1	4.67E+1	8.44E+1	4.14E-1	8.79E+1	3.51E+1	9.72E+1	2.40E-1	9.92E+1
420	7.25E+1	7.65E+1	6.10E-1	8.30E+1	5.11E+1	9.16E+1	4.52E-1	9.53E+1	3.99E+1	1.05E+2	2.67E-1	1.07E+2
430	6.74E+1	7.76E+1	5.72E-1	8.44E+1	4.91E+1	9.30E+1	4.38E-1	9.67E+1	3.98E+1	1.07E+2	2.65E-1	1.09E+2
440	8.17E+1	9.02E+1	6.81E-1	9.82E+1	6.08E+1	1.08E+2	5.37E-1	1.12E+2	5.08E+1	1.24E+2	3.31E-1	1.26E+2
450	9.29E+1	1.03E+2	7.89E-l	1.13E+2	7.10E+1	1.24E+2	6.42E-1	1.29E+2	6.12E+1	1.42E+2	4.06E-1	1.45E+2
460	9.58E+1	1.09E+2	8.22E-1	1.19E+2	7.47E+1	1.31E+2	6.84E-1	1.36E+2	6.59E+1	1.50E+2	4.41E-1	1.53E+2
470	9.48E+1	1.10E+2	8.39E-1	1.20E+2	7.56E+1	1.32E+2	7.18E-1	1.37E+2	6.86E+1	1.51E+2	4.69E-1	1.54E+2
480	9.81E+1	1.13E+2	8.81E-1	1.24E+2	7.99E+1	1.36E+2	7.72E-l	1.41E+2	7.42E+1	1.55E+2	5.19E-1	1.58E+2
490	9.46E+1	1.10E+2	8.35E-l	1.21E+2	7.77E+1	1.33E+2	7.41E-1	1.38E+2	7.31E+1	1.51E+2	5.10E-1	1.54E+2
500	9.34E+1	1.13E+2	7.73E-1	1.23E+2	7.62E+1	1.36E+2	6.86E-1	1.41E+2	7.15E+1	1.54E+2	4.76E-1	1.57E+2
510	9.35E+1	1.12E+2	6.38E-1	1.22E+2	7.27E+1	1.34E+2	5.48E-1	1.39E+2	6.56E+1	1.53E+2	3.74E-1	1.55E+2
520	8.96E+1	1.07E+2	5.50E-1	1.17E+2	6.83E+1	1.29E+2	4.65E-1	1.34E+2	6.07E+1	1.47E+2	3.16E-1	1.49E+2
530	9.37E+1	1.11E+2	5.46E-1	1.21E+2	7.12E+1	1.33E+2	4.62E-1	1.38E+2	6.35E+1	1.52E+2	3.16E-1	1.54E+2
540	9.14E+1	1.12E+2	4.86E-l	1.23E+2	6.82E+1	1.35E+2	4.07E-1	1.40E+2	6.00E+1	1.54E+2	2.78E-1	1.56E+2
550	9.16E+1	1.12E+2	4.19E-1	1.22E+2	6.57E+1	1.35E+2	3.42E-1	1.40E+2	5.61E+1	1.53E+2	2.31E-1	1.56E+2
560	8.84E+1	1.10E+2	3.62E-1	1.21E+2	6.18E+1	1.33E+2	2.91E-1	1.38E+2	5.17E+1	1.51E+2	1.96E-1	1.54E+2
570	8.69E+1	1.08E+2	3.02E-1	1.19E+2	5.78E+1	1.31E+2	2.35E-l	1.36E+2	4.65E+1	1.49E+2	1.55E-1	1.51E+2
580	8.65E+1	1.07E+2	2.09E-1	1.18E+2	4.93E+1	1.30E+2	1.43E-1	1.35E+2	3.49E+1	1.48E+2	8.84E-2	1.51E+2
590	8.05E+1	1.07E+2	1.15E-1	1.18E+2	3.38E+1	1.30E+2	6.32E-2	1.35E+2	1.85E+1	1.48E+2	3.51E-2	1.50E+2
600	7.45E+1	1.05E+2	5.46E-2	1.15E+2	1.83E+1	1.27E+2	2.16E-2	1.32E+2	6.25E+0	1.45E+2	1.18E-2	1.47E+2
610	6.99E+1	1.02E+2	4.14E-2	1.13E+2	1.47E+1	1.24E+2	1.49E-2	1.29E+2	4.10E+0	1.41E+2	9.16E-3	1.43E+2
620	6.67E+1	1.01E+2	3.54E-2	1.12E+2	1.36E+1	1.23E+2	1.25E-2	1.28E+2	3.40E+0	1.40E+2	7.10E-3	1.42E+2
630	6.55E+1	9.94E+1	3.10E-2	1.09E+2	1.24E+1	1.21E+2	1.03E-2	1.25E+2	2.89E+0	1.37E+2	5.67E-3	1.39E+2
640	6.62E+1	9.97E+1	2.87E-2	1.10E+2	1.15E+1	1.21E+2	8.95E-3	1.25E+2	2.50E+0	1.37E+2	4.93E-3	1.39E+2
650	6.35E+1	9.81E+1	2.51E-2	1.08E+2	9.80E+0	1.19E+2	7.36E-3	1.23E+2	1.93E+0	1.35E+2	4.26E-3	1.37E+2
660	5.88E+1	9.63E+1	1.93E-2	1.06E+2	6.84E+0	1.16E+2	5.55E-3	1.21E+2	1.06E+0	1.32E+2	3.97E-3	1.34E+2
670	6.05E+1	9.82E+1	2.14E-2	1.08E+2	5.81E+0	1.19E+2	8.71E-3	1.23E+2	7.70E-1	1.34E+2	8.18E-3	1.36E+2
680	5.88E+1	9.59E+1	2.84E-2	1.06E+2	5.08E+0	1.16E+2	1.63E-2	1.20E+2	6.37E-1	1.31E+2	1.66E-2	1.32E+2
690	4.84E+1	8.91E+1	2.03E-2	9.81E+1	3.51E+0	1.08E+2	1.13E-2	1.12E+2	3.82E-1	1.22E+2	1.16E-2	1.24E+2
700	5.0IE+1	8.75E+1	1.12E-2	9.63E+1	2.26E+0	1.06E+2	4.35E-3	1.10E+2	1.61E-1	1.20E+2	4.61E-3	1.22E+2

(16Jun94 MF)

File: DATA$DEV: [DATA.NOAA.MOCE_2.MOS.PRC] STN02_PRC.MLDAT; 1

MODIS Marine Optical Characterization Experiment NOAA/MLML

CRUISE: MOCE-2 SHIP: El Puma
DATE: 21:27 (GMT) 31 Mar 1993

STATION: 02 - Isla Santa Cruz
POSITION: 25°13.0 N 110°43.5 W

SeaWiFS-weighted normalized water- leaving radiance:

Wavelength (nm):	412	443	490	510	555	670	765	865
Lwn' (uW/cm^2/sr):	1.07E+1	1.20E+1	1.40E+1	1.20E+1	6.07E+0	4.64E-1	1.92E-1	1.07E-1

Depth(m)	1-6	1-6	1-11	1-11	6-11	6-11	Top	Top	Mid	Bot	Lw_1
R_Es	0.828	0.873	0.728	0.785	0.879	0.898	Kl_1	Kl_2	Kl_1	Kl_2	
Lambda	Ke_1	Kl_1	Ke_2	Kl_2	Ke_3	Kl_3	Lw_1	Lw_2	Lw_3	Lw_4	Lwn
400	1.14E-1	9.94E-2	1.02E-1	1.19E-1	8.97E-2	1.39E-1	3.18E-1	3.25E-1	3.64E-1	4.15E-1	4.98E-1
410	1.11E-1	9.33E-2	9.74E-2	1.14E-1	8.35E-2	1.36E-1	3.53E-1	3.62E-1	4.04E-1	4.61E-1	5.42E-1
420	1.05E-l	8.60E-2	9.08E-2	1.08E-1	7.61E-2	1.32E-1	3.69E-1	3.79E-1	4.22E-1	4.83E-1	5.55E-1
430	9.85E-2	7.99E-2	8.39E-2	1.03E-1	6.88E-2	1.26E-1	3.43E-1	3.53E-1	3.93E-1	4.50E-1	5.08E-1
440	9.49E-2	7.36E-2	7.89E-2	9.77E-2	6.23E-2	1.23E-1	4.05E-1	4.17E-1	4.63E-1	5.31E-1	5.91E-1
450	8.94E-2	6.74E-2	7.31E-2	9.19E-2	5.62E-2	1.18E-1	4.66E-1	4.80E-1	5.33E-1	6.11E-1	6.71E-1
460	8.54E-2	6.31E-2	6.87E-2	8.77E-2	5.14E-2	1.14E-1	4.83E-1	4.98E-1	5.52E-1	6.34E-1	6.89E-1
470	8.10E-2	5.76E-2	6.38E-2	8.36E-2	4.59E-2	1.11E-1	4.89E-1	5.05E-1	5.60E-1	6.43E-1	6.91E-1
480	7.70E-2	5.28E-2	5.93E-2	7.83E-2	4.10E-2	1.05E-1	5.11E-1	5.27E-1	5.84E-1	6.71E-1	7.17E-1
490	7.56E-2	5.03E-2	5.73E-2	7.46E-2	3.83E-2	1.00E-1	4.83E-1	4.97E-1	5.52E-1	6.33E-1	6.72E-l
500	7.67E-2	5.03E-2	5.82E-2	7.38E-2	3.91E-2	9.85E-2	4.47E-1	4.60E-1	5.11E-1	5.86E-1	6.20E-1
510	8.61E-2	5.70E-2	6.68E-2	7.88E-2	4.68E-2	1.02E-1	3.72E-1	3.82E-1	4.26E-1	4.87E-1	5.15E-1
520	9.01E-2	6.00E-2	7.02E-2	8.08E-2	4.97E-2	1.03E-1	3.22E-1	3.30E-1	3.68E-1	4.21E-1	4.44E-1
530	9.06E-2	5.97E-2	7.03E-2	7.99E-2	4.93E-2	1.01E-1	3.19E-1	3.27E-1	3.65E-1	4.17E-1	4.42E-1
540	9.40E-2	6.20E-2	7.33E-2	8.12E-2	5.19E-2	1.01E-1	2.85E-1	2.92E-1	3.26E-1	3.72E-1	3.94E-1
550	1.02E-1	6.72E-2	8.03E-2	8.50E-2	5.80E-2	1.04E-1	2.47E-1	2.53E-1	2.83E-1	3.22E-1	3.42E-l
560	1.07E-1	6.98E-2	8.49E-2	8.68E-2	6.21E-2	1.05E-1	2.14E-1	2.19E-1	2.45E-1	2.79E-1	2.97E-1
570	1.17E-1	7.68E-2	9.38E-2	9.22E-2	7.02E-2	1.08E-1	1.80E-1	1.84E-1	2.06E-1	2.34E-1	2.51E-1
580	1.47E-1	1.01E-1	1.22E-1	1.12E-1	9.62E-2	1.23E-1	1.28E-1	1.30E-1	1.47E-1	1.66E-1	1.78E-1
590	2.07E-1	1.46E-1	1.78E-1	1.45E-1	1.49E-1	1.45E-1	7.46E-2	7.45E-2	8.53E-2	9.50E-2	1.03E-1
600	3.12E-1	2.11E-1	2.78E-1	1.80E-1	2.44E-1	1.48E-1	3.85E-2	3.71E-2	4.40E-2	4.72E-2	5.32E-2
610	3.41E-1	2.29E-1	3.14E-1	1.78E-1	2.86E-1	1.24E-1	2.98E-2	2.80E-2	3.41E-2	3.56E-2	4.10E-2
620	3.47E-1	2.34E-1	3.28E-1	1.88E-1	3.07E-1	1.39E-1	2.57E-2	2.43E-2	2.94E-2	3.09E-2	3.50E-2
630	3.62E-l	2.45E-1	3.42E-1	1.97E-1	3.21E-1	1.47E-1	2.28E-2	2.15E-2	2.61E-2	2.74E-2	3.09E-2
640	3.79E-1	2.58E-1	3.57E-1	2.03E-1	3.35E-1	1.46E-1	2.15E-2	2.01E-2	2.45E-2	2.55E-2	2.88E-2
650	4.02E-1	2.70E-1	3.79E-1	2.05E-1	3.55E-1	1.36E-1	1.91E-2	1.76E-2	2.18E-2	2.24E-2	2.54E-2
660	4.57E-1	2.74E-1	4.31E-1	1.85E-1	4.03E-1	9.19E-2	1.48E-2	1.32E-2	1.69E-2	1.68E-2	1.95E-2
670	4.95E-1	2.05E-1	4.66E-1	1.23E-1	4.35E-1	3.56E-2	1.50E-2	1.35E-2	1.71E-2	1.72E-2	1.97E-2
680	5.15E-1	1.37E-1	4.82E-l	7.93E-2	4.47E-1	1.86E-2	1.83E-2	1.70E-2	2.09E-2	2.17E-2	2.39E-2
690	5.50E-1	1.43E-1	5.13E-1	8.15E-2	4.75E-1	1.64E-2	1.32E-2	1.22E-2	1.51E-2	1.55E-2	1.72E-2
700	6.43E-1	2.15E-1	6.03E-1	1.15E-1	5.61E-1	1.01E-2	7.95E-3	7.02E-3	9.09E-3	8.95E-3	1.03E-2

(16Jun94 MF)

MODIS Marine Optical Characterization Experiment - II NOAA/MLML

CRUISE: MOCE-2 SHIP: El Puma
STATION: 02 Isla Santa Cruz
DATE: 20:40 (GMT) 31 Mar 1993
POSITION: 25° 14.7′ N 110°42.7′ W

CTD #21031033

Secchi: 17m Munsell: 10G 7/6

Press db	Temp °C	Theta °C	Salin PSU	Sigma-0 g/l	c(625) l/m	Fluor (680)
0	21.33					0.16
5	21.25	21.25	35.07	24.48	0.164	0.61
10	21.20	21.20	35.07	24.50	0.166	0.75
15	21.10	21.10	35.07	24.53	0.165	0.93
20	21.08	21.08	35.07	24.53	0.164	1.28
25	20.99	20.99	35.06	24.54	0.166	1.49
30	20.30	20.30	35.03	24.71	0.159	2.27
35	19.19	19.18	35.06	25.02	0.132	2.10
40	19.10	19.09	35.02	25.02	0.129	1.88
45	18.31	18.30	35.08	25.26	0.124	1.46
50	18.07	18.06	35.02	25.27	0.123	1.27
55	17.71	17.70	35.03	25.37	0.116	1.02
60	17.44	17.43	34.98	25.40	0.114	0.82
65	17.00	16.99	34.99	25.51	0.111	0.68
70	16.44	16.43	34.97	25.63	0.106	0.50
75	15.65	15.64	35.16	25.96	0.107	0.34
80	15.51	15.50	34.95	25.83	0.107	0.29
85	15.18	15.16	34.95	25.90	0.105	0.26
90	14.86	14.84	34.92	25.94	0.104	0.23
95	14.65	14.64	34.91	25.98	0.104	0.21
100	14.15	14.13	34.91	26.09	0.102	0.22
105	13.93	13.92	34.92	26.14	0.102	0.21
110	13.88	13.86	34.87	26.12	0.102	0.21
115	13.80	13.78	34.88	26.14	0.102	0.22
120	13.58	13.56	34.88	26.19	0.102	0.21
125	13.40	13.38	34.85	26.20	0.102	0.22
130	13.27	13.25	34.85	26.23	0.102	0.22
135	13.09	13.07	34.84	26.26	0.103	0.22
140	13.03	13.01	34.83	26.26	0.103	0.23
143	12.99	12.97	34.83	26.27	0.102	0.22

TABLE 6

MODIS Marine Optical Characterization Experiment - 2 NOAA/MLML

CRUISE: MOCE-2 SHIP: El Puma
STATION: 02- Isla Santa Cruz

Top = lm
Mid = 6m
Bot = llm

POSITION: 25013.0 N 110043,5 W
DATE: 21:27 (GMT) 31 Mar 1993

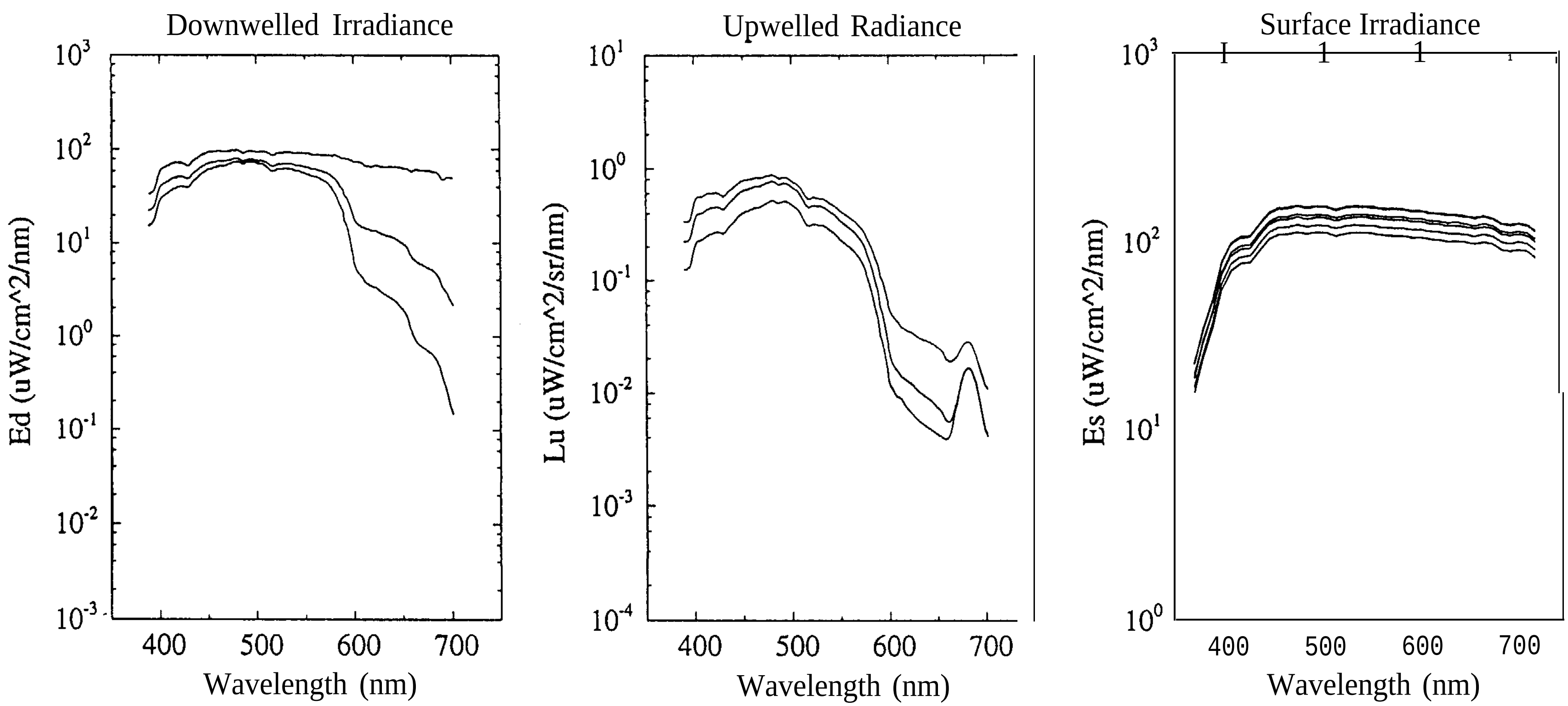


FIGURE 16.

MODIS Marine Optical Characterization Experiment -2 NOAA/MLML

CRUISE: MOCE-2 SHIP: El Puma
STATION: 02- Isla Santa Cruz

Top = l to 6m
Mid = l to llm
Bot = 6 to llm

POSITION: 25°13.0 N 110°43.5 W
DATE: 21:27 (GMT) 31 Mar 1993

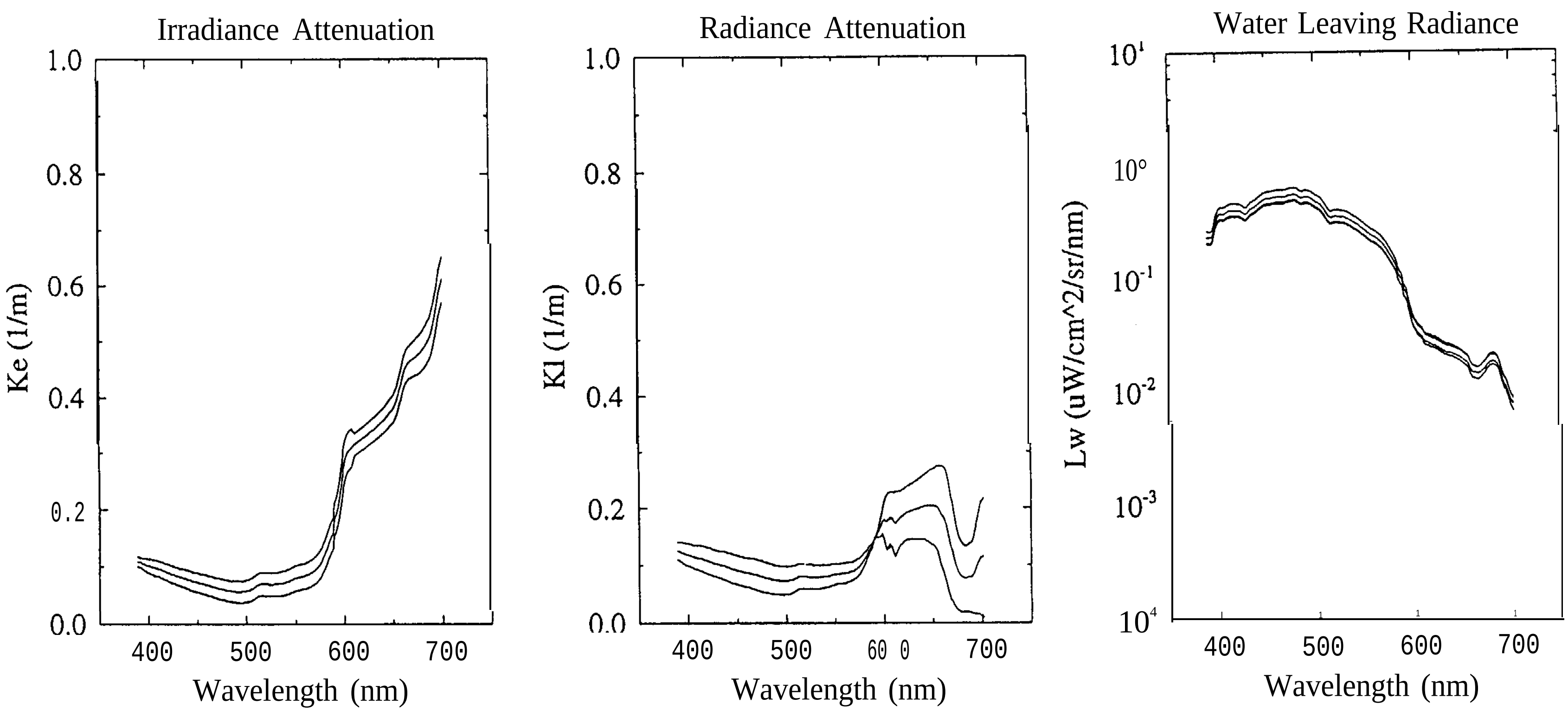


FIGURE 17.

MODIS Marine Optical Characterization Experiment - II NOAA/MLML

CRUISE: MOCE-2 SHIP: El Puma

CTD # 21031033

STATION: 02 Isla Santa Cruz

DATE: 20:40 (GMT) 31 Mar 1993

Secchi: 17 m Munsell: 10G 7/6

POSITION: 25”14.7’ N 110°42.7’ W

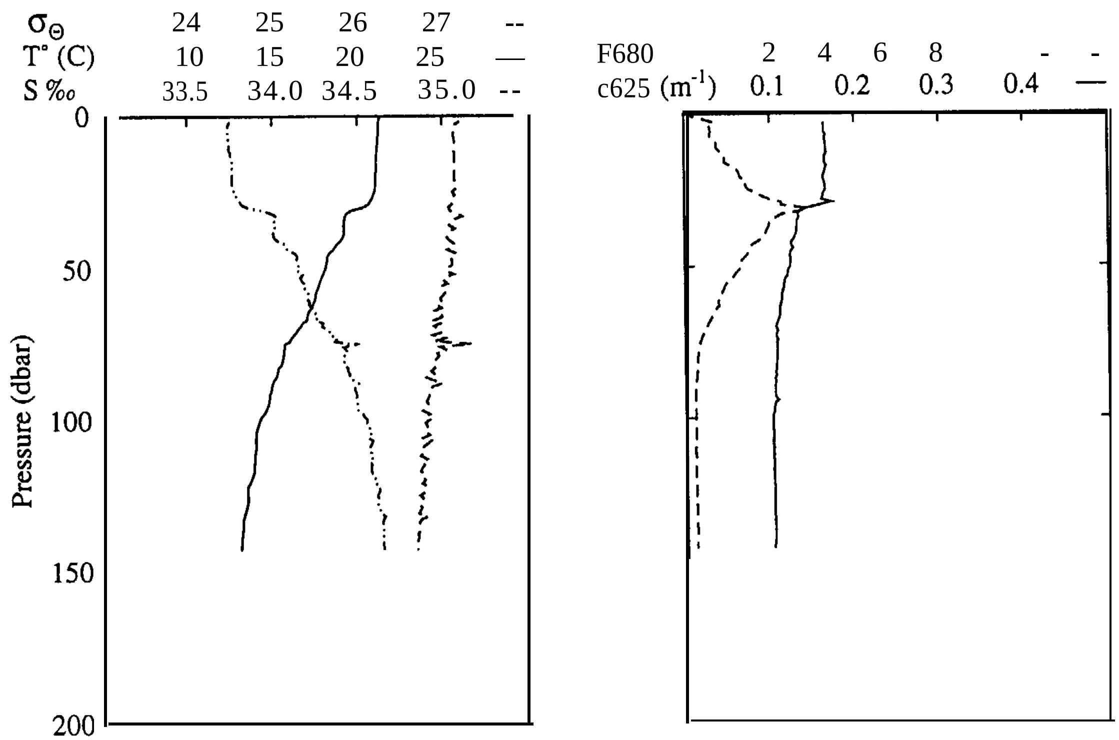


FIGURE 18.

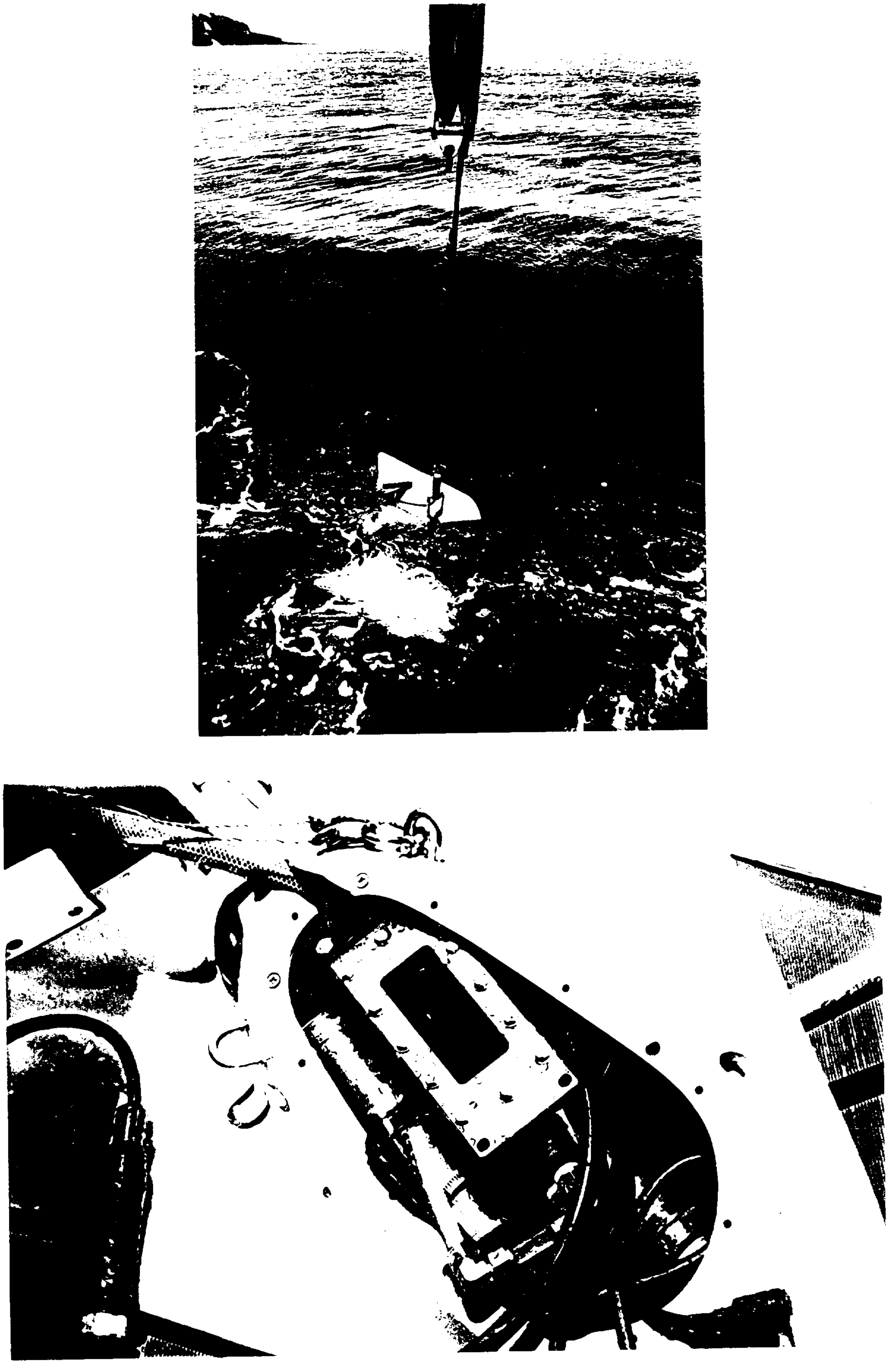


FIGURE 19.

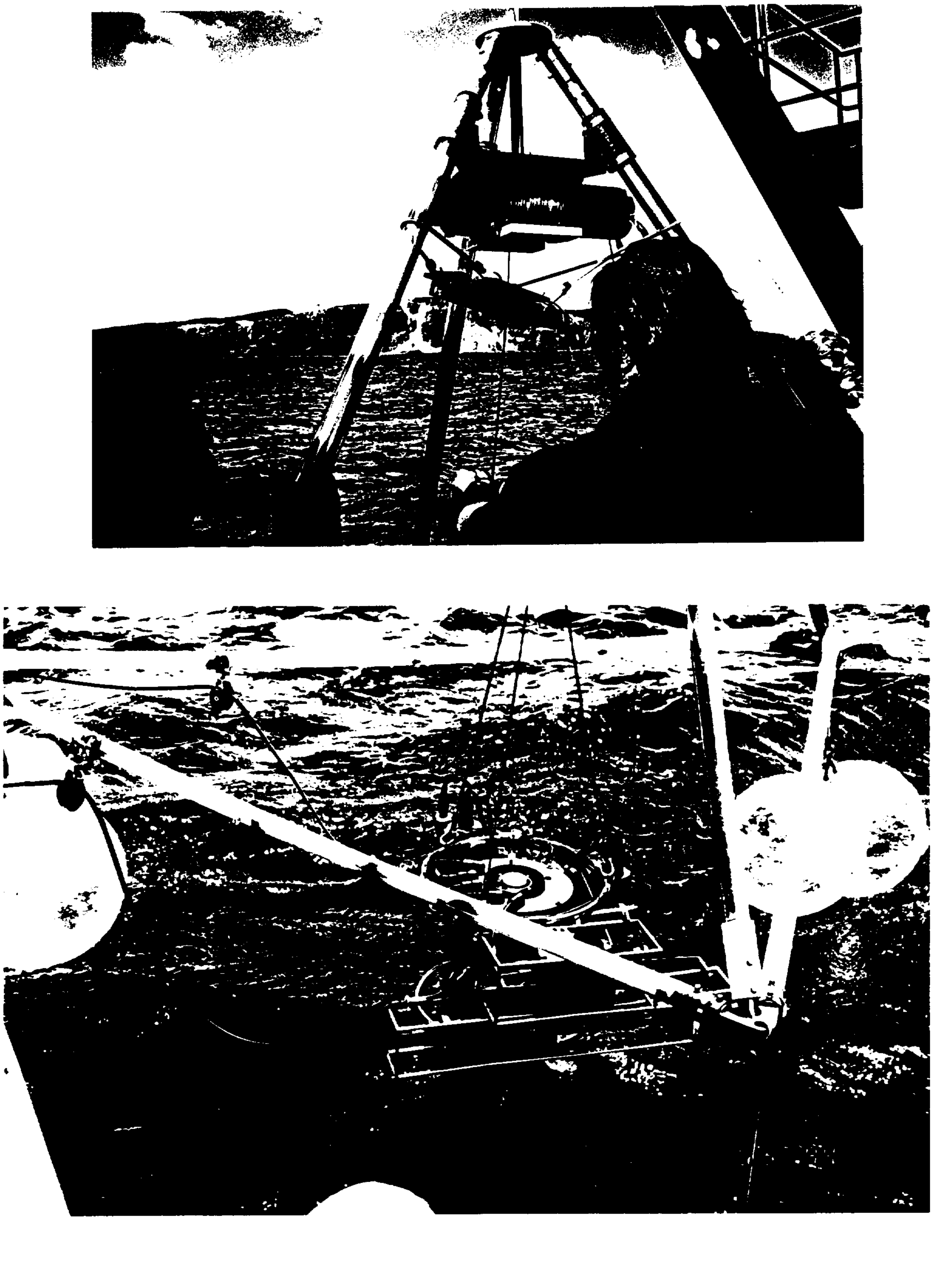
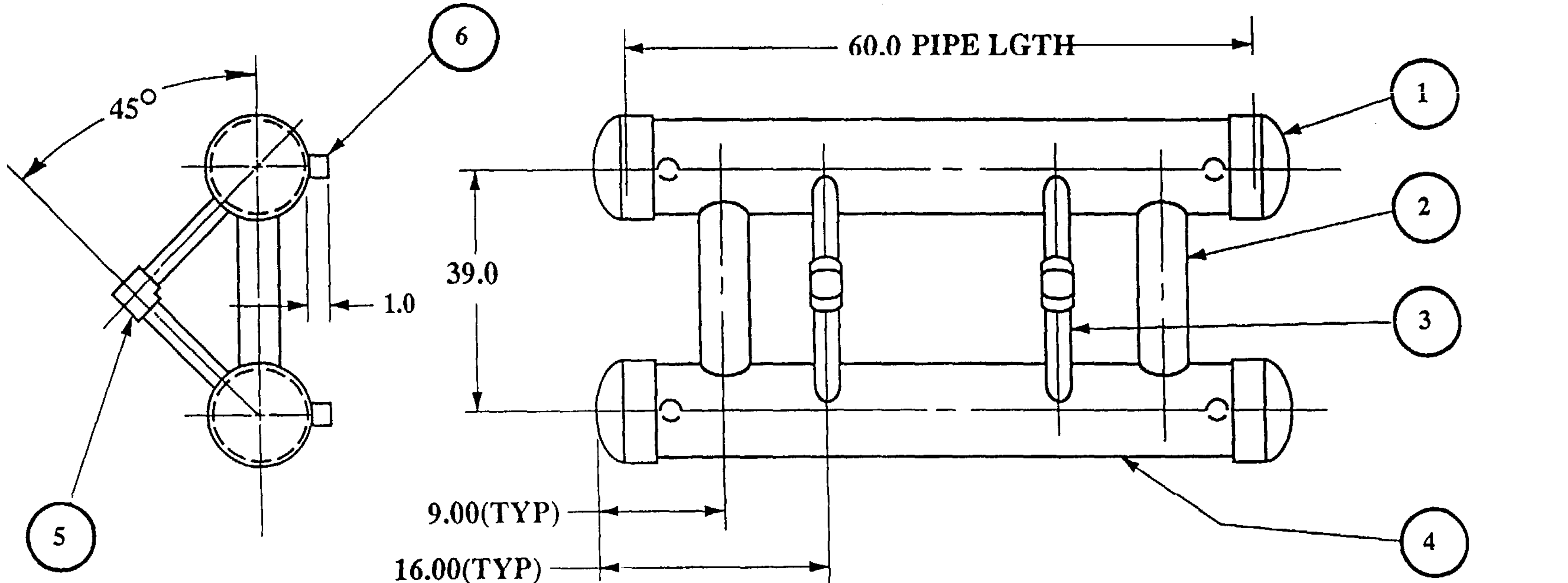


FIGURE 20.

FIGURE 21.



ITEM	DESCRIPTION	SPECS	QTY
6	1.00” DIA x 1.0” PVC CLEAR	FURN.	2
5	2.00” DIA ELBO PVC CLEAR	FURN.	2
4	6.00” DIA X 60” PVC CLEAR	FURN.	2
3	2.00” DIA X 20” PVC CLEAR	FURN.	4
2	4.00” DIA X 30” PVC CLEAR	FURN.	2
1	6.00” DIA CAP PVC GRAY	FURN.	4

MATERIALS LIST

DRAWN BY:E. KING | DATE 01/94

APPROVED D.CLARK | DATE 01/94

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
FRACTIONS ±1/64
DECIMALS XX ±.01
DECIMALS XXX ±.005

DO NOT SCALE DRAWING

National Oceanic & Atmospheric Admin.
NESDIS-ORA-SAL-MAB
WWB CAMP SPRINGS MD.

CATAMARAN FLOAT ASSEMBLY

SIZE A | CODE IDENT. | DWG. NO. 10011-423

SCALE HALF I | SHEET

MOBY II

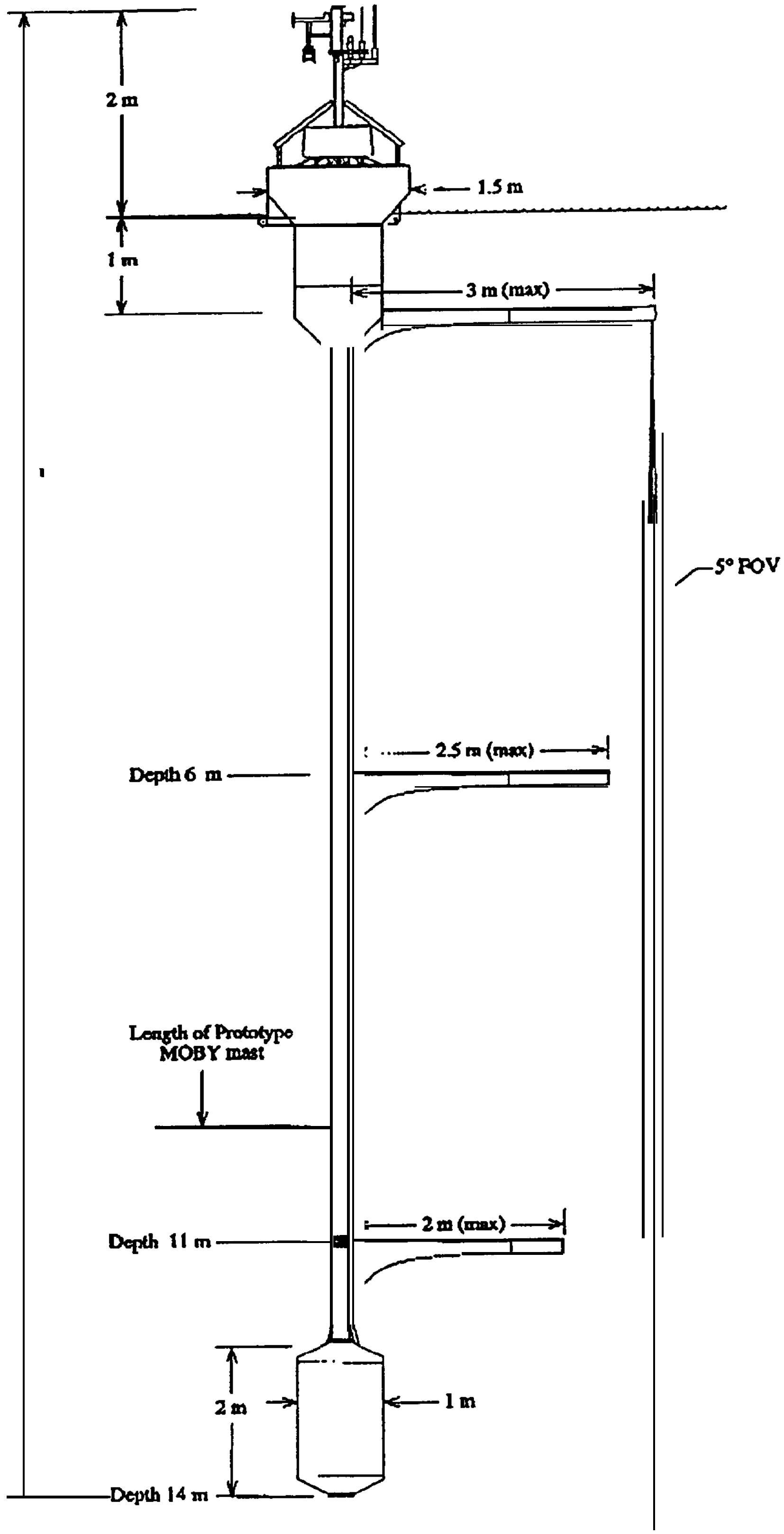


FIGURE 22.