NAVY EXPERIMENTAL DIVING UNIT

REPORT NO. 10-86

TEST AND EVALUATION OF TWO PROTOTYPE MODEL UNDERWATER DECOMPRESSION MONITORS

CLARK G. PRESSWOOD
EDWARD D. THALMANN
MICHAEL D. CURLEY

DECEMBER 1986

NAVY EXPERIMENTAL DIVING UNIT

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DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407-5001

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Navy Experimental Diving Unit (NEDU) performed unmanned testing and human factors evaluations on two prototype Underwater Decompression Monitors (UDMs) which were programmed with an NEDU developed decompression algorithm. Testing was designed to evaluate UDM hardware, and to recommend suitability of the UDMs tested for Approval for Navy Use (ANU) status. The approved UDM models could then be programmed with any suitable decompression algorithm. → (cont)

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The six U.S. Navy prototype ORCA UDMs tested at NEDU suffered from reliability problems as a result of water leakage into the case and failures of the pressure transducer, and several important U.S. Navy specifications were not provided on these units. As a result of these discrepancies, these units were not submitted to the full test cycle. The DIVETRONIC UDMs provided acceptable depth and profile tracking accuracy in a wide temperature spectrum, and are recommended for ANU with display modifications. Keywords: (top of)

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Abbreviations

ATA	atmospheres absolute
°F	degree fahrenheit
EDF	Experimental Diving Facility
FPM	feet per minute
FSW	feet of seawater
ft	foot
MK 15/16 RTA	MK 15/16 real time algorithm
MPTT	maximum permissible tissue tension
NAVSEA	Naval Sea Systems Command
NEDU	Navy Experimental Diving Unit
PO_2	partial pressure of oxygen
PN_2	partial pressure of nitrogen
psig	pounds per square inch gauge
SAD	safe ascent depth
UDM	underwater decompression monitor

Glossary

Algorithm	A sequence of logical steps used to obtain a mathematical result.
Decompression Obligation	The total amount of decompression stop time accrued at any time in a dive profile if ascent were begun at that instant at a specified rate.
Decompression Schedule	A listing showing required decompression stop depths and stop times for a particular bottom depth/time dive at specified ascent and descent rates.
EL-MK 15/16 Real Time Algorithm (RTA)	A computer program using the EL MK 15/16 decompression model which will compute and update a divers decompression obligation in real time. EL refers to the exponential-linear version of the MK 15/16 RTA using the VVAL18 MPTT table (see reference 3 for details).
MPTT	Maximum permissible tissue tension. The maximum tension which can be present in any tissue at a given depth such that decompression sickness will not occur (see reference 3 for complete description).
Multi-Level Dive	A dive consisting of at least two dive segments at different depths.
No Decompression Dive	A dive spent at a given depth within a time frame that would allow a diver to ascend directly to the surface at a prescribed rate without incurring an obligated decompression stop.
No Decompression Time	The maximum time that can be spent at a given depth such that ascent can be safely made directly to the surface at a prescribed rate.
SAD	The shallowest stop depth at which none of the current tissue tensions will be greater than their respective MPTT. The SAD describes the decompression status of the diver at any time, and is included on the UDM display.
Underwater Decompression Monitor (UDM)	A microprocessor controlled device which tracks depth and time and uses this information to compute decompression obligation.

Abstract

The Navy Experimental Diving Unit (NEDU) performed unmanned testing and human factors evaluations on two prototype Underwater Decompression Monitors (UDMs) which were programmed with an NEDU developed decompression algorithm. Testing was designed to evaluate UDM hardware, and to recommend suitability of the UDMs tested for Approval for Navy Use (ANU) status. The approved UDM models could then be programmed with any suitable decompression algorithm.

The six U.S. Navy prototype ORCA UDMs tested at NEDU suffered from reliability problems as a result of water leakage into the case and failures of the pressure transducer, and several important U.S. Navy specifications were not provided on these units. As a result of these discrepancies, these units were not submitted to the full test cycle. The DIVETRONIC UDMs provided acceptable depth and profile tracking accuracy in a wide temperature spectrum, and are recommended for ANU with display modifications.

KEY WORDS:

computer algorithm
constant partial pressure
EL-MK 15/16 RTA
MK 15 MOD 0 UBA
MK 16 MOD 0 UBA
multi-level diving
no-decompression dive
decompression dive
repetitive dive
SAD
warning status
underwater decompression monitor (UDM)
NEDU Test Plan 85-37

I. INTRODUCTION

Traditional U.S. Navy decompression procedures are presented in printed tables in which the maximum depth attained at any time during a dive along with the total dive time are used to choose the appropriate schedule. Procedures for giving credit for time spent at the surface breathing air are given in repetitive dive tables but no procedure was available for doing multiple level dives until the advent of the Combat Swimmer Multi-Level Dive (CSMD) procedures (reference 1). However, these procedures are not only cumbersome but also require extensive record keeping. In order to develop procedures better suited to the complicated multiple level/repetitive diving of the Naval Special Warfare Combat Swimmer, NEDU has been developing computer algorithms which can compute not only standard decompression tables but also decompression schedules in real time. The intention has been to program these algorithms into a small diver carried Underwater Decompression Monitor.

The Underwater Decompression Monitor (UDM) is a microprocessor controlled device which tracks depth and time and uses this information to compute decompression obligation. The goal of UDM development has been to provide an accurate, reliable, and maintainable instrument for use by the Naval Special Warfare Community as part of the SEAL Support System (SSS) package. Use of an approved UDM will enable long duration, multiple depth diving to be accomplished safely without the unduly restrictive decompression requirements incurred when conventional tables are used. Additionally, the UDM should prove to be much simpler to use, allow dives of unlimited multi-level complexity, and provide greater decompression profile accuracy than the CSMD procedures.

II. ALGORITHM FUNCTIONING

A. Background. The basis of a computer algorithm for doing real time decompression schedule calculation is a set of mathematical equations which compute decompression obligation based on the depth/time profile. The only external input required is actual depth and elapsed time. The U.S. Navy development has chosen to sample depth at 2 second intervals, and compute and display decompression obligation at this interval. Once developed and tested, the algorithm could be used in any computer capable of sampling depth. Also the same algorithm could be used to compute a set of standard decompression tables for standard dive profiles.

B. EL-MK 15/16 RTA. Development of computer algorithms which can be implemented into a UDM is discussed in references 2 through 4. The basis of the algorithms is given in these references. Phase I and II testing of decompression algorithms resulted in the promulgation of the first U.S. Navy approved version which was the combined result of 678 man dives. This algorithm was designed to compute real time decompression schedules for the MK 15 MOD 0 underwater breathing apparatus (UBA), or any UBA which controls to a mean PO_2 of 0.7 ATA or above, as long as it warns the diver when the PO_2 falls to 0.6 ATA or lower and uses nitrogen or air as a diluent. Because the MK 16 MOD 0 UBA functions identically to the MK 15 MOD 0 UBA in that it

electronically controls the PO_2 to a preset value independent of depth using any desired inert gas as a diluent, the real time computer algorithm is referred to as the EL-MK 15/16 Real Time Algorithm (EL-MK 15/16 RTA). EL refers to the expouential-linear version of the MK 15/16 RTA using the VVAL18 MPTT Table (reference 3). This algorithm was used to compute a set of conventional diving tables for use until a UDM was available. It was the EL-MK 15/16 RTA that was implemented into the prototype UDM models which are the subject of this report.

C. SAD. The EL-MK 15/16 RTA provides ultimate dive flexibility by constantly updating the decompression requirements and providing a decompression schedule ideally suited to a particular depth/time profile for a particular UBA. Any combination of unplanned excursions can be performed without losing track of decompression obligation. It performs this function by monitoring depth every two seconds and using this value to update the gas tensions in the nine theoretical half time tissues using a set of gas uptake and elimination equations. Updating of tissue tensions continues over the entire course of the dive, and at any given time the nine tissue tensions reflect the cumulative gas tension for the entire preceeding dive profile. The algorithm then compares these tissue tensions with the ascent criteria which are maximum permissible tissue (inert gas) tensions (MPTT) at each of the 10 FSW incremental stop depths. The algorithm determines the shallowest stop depth at which none of the current tissue tensions will be greater than their respective MPTT. This depth is displayed as the safe ascent depth (SAD).

The SAD is displayed concurrently with the divers actual depth. It is the SAD which describes the decompression status of the diver at any time. As long as the diver remains below the SAD, he is not violating any ascent criteria. To decompress from a dive involving a decompression stop obligation, the diver ascends to the displayed SAD and waits for the SAD to decrement to the next 10 FSW shallower stop. By matching his depth to the displayed SAD, the diver will eventually decompress to the surface. Once on the surface, as long as the UDM remains on, it will continue to update his tissue tensions so when he re-enters the water, all previous dives and surface intervals since the UDM was turned on are taken into account.

D. Diver on Surface. The EL-MK15/16 algorithm is designed to assume that the diver is breathing air any time his depth is 3 FSW or less, so the diver need take no action when he surfaces and begins breathing air.

E. Warning Status. Algorithm development testing was done within a certain depth/time domain and when the diver ventures outside of that domain the likelihood of decompression sickness (DCS) occurring is unknown. For instance, the maximum depth/time single dive profile which was tested initially was 150 FSW for 30 minutes. The diver should be warned if he exceeds that limit. Initially, analysis of all tested depth/time profiles showed that at the limits of the tested depth/time domain the tissue tension of the 40 FSW tissue was just 77 FSW. It was also shown that divers never went below 30 FSW during repetitive or multiple level dives as long as the 40 FSW tension was above 48 FSW. So, in the initial phases of the algorithm

development, the diver was warned he was outside of the tested depth/time domain by having the SAD display blink whenever the 40 FSW tissue tension exceeded 77 FSW. At this point the diver was to ascend to a depth of 30 FSW or shallower and remain there until the 40 FSW tissue tension fell below 48 FSW at which point the SAD stopped blinking.

These 40 minute tissue tension criteria were incorporated into the prototype UDM's because a more appropriate set of criteria had not yet been developed. The final version of the EL-MK 15/16 RTA used a different set of offgassing equations than the initial version and the 40 FSW tissue tension warning status criteria are now too conservative. This will be corrected in the final version of the algorithm which will be programmed into production models. Also, the warning status criteria will change as more experience is gained with the algorithm but the goal will be the same, to warn the diver when he is outside of the tested depth/time domain. However, it should be kept in mind when reading this report that the points in the dive where the warning status turns off will be different in the production version of the UDM. The warning status as currently implemented will require spending more time shallower than 40 FSW than required.

It must be remembered that activation of the warning s[illegible] in no way affects computation of the decompression schedule. The al[illegible] will continue to update the divers decompression status in a no[illegible] even though the warning status has activated. The safety of th[illegible] will not change suddenly once the tested limits have been exceeded, [illegible] will have a safety margin from the time the warning status is [illegible] until they are in areas which might have on increased DCS incidence. [illegible]fety margin allows the UDM to be used right up to the limits at which [illegible] status is activated; no additional safety margin is needed.

F. Hardware - Software Interaction. The testing des[illegible] is report was designed to test the UDM hardware. The UDM is a mic[illegible] with a pressure transducer input capable of being programmed w[illegible] algorithm. However, in order to properly test the hardw[illegible] must be programmed with an algorithm whose characteristics are [illegible]fined. This algorithm must test all hardware features and func[illegible]ce testing is complete, the UDM could be programmed with any algorithm [illegible] cursory testing to ensure it was properly programmed would be ne[illegible]

In the testing described in this report the UDM's we[illegible] with the EL-MK 15/16 RTA as currently implemented. This same algo[illegible]rogrammed into a Hewlett-Packard (HP) 1000 M series computer which [illegible] standard to which the UDM's were compared. In particular the follo[illegible] are functions were tested which are independent of the algori[illegible]gram the UDM.

Depth Accuracy: This is algorithm independent and [illegible] comparing the depth as displayed by the UDM to a standard of [illegible]racy.

Temperature Sensitivity: This is algorithm in[illegible] designed to see if the UDM will maintain depth [illegible]action properly over a wide range of temperatures.

Battery Duration: This is algorithm independent and designed to define battery duration under a variety of conditions.

Mud Test, Drop Test, Watertight Integrity: These are tests of ruggedness and are algorithm independent.

The set of tests described below test the functioning of the microprocessor itself. The algorithm was initially developed using the FORTRAN programming language on an HP 1000 computer. When programmed into the UDM, the logic remains the same but the programming language is different. Not only must the ability of the microprocessor to activate the various displays be tested, but the ability of the programming logic to be correctly executed in this new environment must be tested. Also the ability of the microprocessor to properly function under operational conditions must also be tested. This testing was as follows:

Profile Tracking, Decompression Dives: This simply compares the UDM profile to the HP 1000 standard. If the profile is appropriately computed for the UDM depth input then the logic of the algorithm is functioning properly. This test is performed after the UDM has been subjected to a number of environment and ruggedness tests to ensure the microprocessor will function properly under real world conditions.

Profile Tracking, Repetitive No-Decompression Dives: This not only tests the logic of the program but also the proper switching of the UDM from the 0.7 ATA constant PO_2 mode to the air mode at the surface. It also spot checks the surfacing maximum permissible tissue tensions.

Profile Tracking, Repetitive Decompression Dives: This performs the same basic function as the previous tests but under longer more extreme conditions. It additionally tests the ability of the microprocessor to accurately compute stop times and total time to surface after a surface interval.

Warning Status Test: While the above tests will activate the warning status, it was of secondary importance and warning status changes may not have been accurately recorded during the actual UDM warning status test phase. This test focuses primarily on exactly when the warning status turns on and off.

While the above tests are extensive, they cannot test all aspects of the UDM microprocessor. If all of the above tests are performed satisfactorily, one can have a high level of confidence that the gas uptake and elimination logic and warning status logic are functioning properly. However, the algorithm uses a table of some 900 maximum permissible tissue tension (MPTT) values and, using the above tests, only a small fraction of these are tested. Thus, there could be some of these MPTT values which have been improperly entered which will remain undetectable. The only way of picking up this type of problem is to have a method of actually reading the microprocessor memory. This requirement will be discussed later.

III. EQUIPMENT DESCRIPTION

A. U.S. Navy Specifications. A procurement invitation for commercial development of a diver carried underwater decompression monitor was solicited for vendors who already had "production or near production" UDM hardware. The purchasing concept was to test and evaluate commercially available UDMs which when successfully tested would be classified "Approved for Navy Use" (ANU).

The unit sought was a small, self contained unit which can be attached to the wrist or forearm of the diver by velcro fasteners, and capable of updating a divers decompression status every 2 seconds using algorithms furnished by the government. The unit must display information necessary to safely decompress the diver and also useful information for dive planning. The displays must be readable in turbid water to a distance of 2 feet. The unit should be reasonable easy to maintain. A list of hardware specifications is provided below:

1. General:

   All parts to meet specifications for acceptability aboard nuclear submarines.

2. Case:

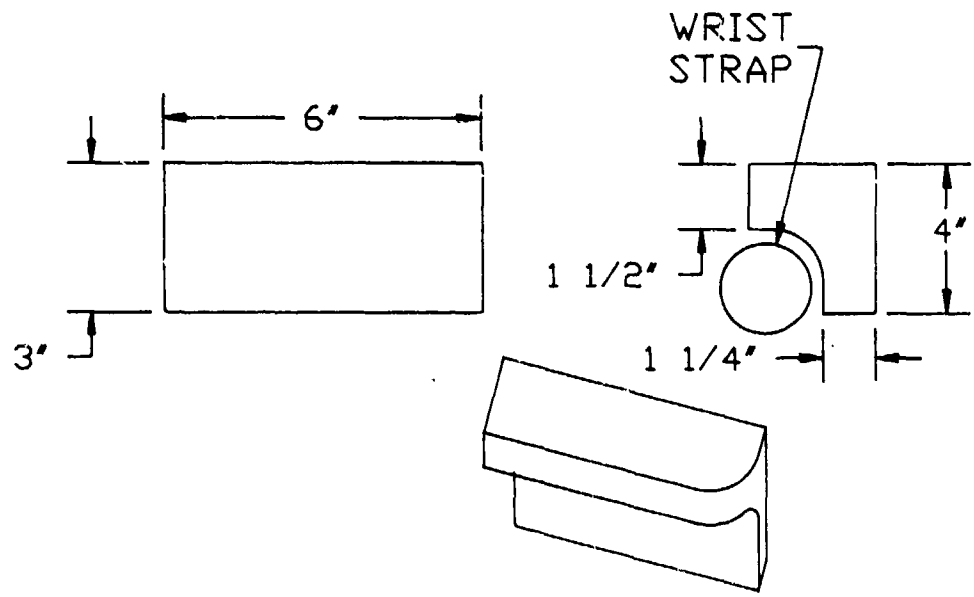
   Must be water-proof and dark colored.

   Buoyancy - at least 3 oz. negative.

   Fasteners - fastens to wrist or forearm with Velcro fasteners.

   Identification - color to differentiate between various algorithm coding, must be semi-permanent for change if unit is programmed with different algorithm.

   Size - no more than 20% larger than current prototype, as follows:



3. Accuracy, Range, and Duration:

Duration - 12 hours with all displays on and fully illuminated at 29-93°F.

Depth Range Accuracy - 0-230 FSW ± 2 FSW from 29-93°F.

Maximum Depth - 500 FSW.

4. Microprocessor:

External input - depth from pressure sensor.

Calculation Accuracy - greater than 23 bit fraction floating point.

Clock accuracy - less than 1 second deviation/hr 29-93°F.

Memory - greater than 3K (current estimate of maximum program size).

Reprogramable or replaceable ROM upon disassembly.

Display output available from edge connector on circuit board for acceptance testing and maintenance (this allows accurate monitoring of all display functions during testing without having to visually check all units).

5. Displays: All displays under program control.

6. Type: Illuminated background LCD continuously on with system on/off switch.

7. Display Readouts and Lights: LEDs or backlit LCDs.

Depth - in feet (3 digits).

Safe Ascent Depth (SAD) - 2 digits (100's, 10's) feet (hundreds and tens digits of SAD directly under hundreds and tens digits of DEPTH readout).

Total time of dive (4 digits) hours, minutes (elapsed time since first excursion below 3 FSW).

Total ascent time (4 digits) hours, minutes (total decompression time required from current depth directly to the surface).

Time at stop minutes (2 digits) (total time required at current stop depth until SAD decrements to next shallower stop).

Red light - activated if 1 FSW or more shallower than SAD.

Green light - to indicate algorithm compliance (safe to move).

Battery - voltage level indicator.

8. Maintenance Features:

- Battery pack replacement or rechargeable.
- Disassembly of electronics from case.
- Easy replacement of ROM (socketed).
- Pressure transducer threaded to accept standard fitting (for external pressurization).
- Removable plug for leak checks. (This would be connected to a standard fitting so that the interior pressure within the UDM could be monitored while pressurizing the UDM in a chamber. A pressure gauge attached to this vent line external to the chamber would register any internal UDM pressure increase, thus signifying a leak in the UDM case. This allows leak checks without the risk of flooding the UDM interior with water.)

B. Manufacturers. Procurement bids were accepted from three manufacturers, listed as follows:

ORCA Industries, Inc.
495 Bellevue Road
Diamond State Industrial Park
Newark, DE 19713

Divetronic Instruments
Aktiengesellschrafft
Postfach 159, FG 9494 Schaan
Liechtenstein

Tekna/S-Tron
101 Twin Dolphin Drive
Redwood City, CA 94065

Six prototype units were received from each manufacturer. Testing of the Tekna prototype UDMs was not complete at the time of report production. Evaluation of these units will be the subject of another report.

C. Functional Specifications Supplied by the Manufacturer

1. ORCA UDM. The ORCA Prototype UDM is a modification of a commercially available product, the ORCA "EDGE" (Electronic Dive Guide). Primary modifications involve inclusion of the U.S. Navy EL-MK 15/16 RTA, modification of the pressure transducer to monitor depth to 230 FSW, and changes in the display information and display functioning per U.S. Navy

specifications. An illustration of the ORCA Prototype UDM is provided in Figure 1. Actual specifications are provided below. A further discussion of actual specifications including an unmanned dry human factors evaluation is provided as Appendix H.

Case Size: rectangular in shape measuring 18.3 cm(L) x 7.4 cm(H) x 3.4cm(W).

Case Material: anodized, cast aluminum alloy

Case Color: silver polyurethane paint or matte black powder coat finish

Straps: Velcro® 12.1 x 40 cm. Slotted through four 1.9 cm long stainless steel pins on the bottom of the case

Display Screen Size: 5.2 cm x 4.3 cm, covered by a glass face recessed 0.4 cm below front edge of case

Display Lettering Type/Size: DOT matrix LCD, 0.8 cm(H) x 0.5 cm(W), colored black on a grey background

Display Information Available: total time of dive (hours:minutes), present depth (FSW), safe ascent depth (FSW), time at stop (hours:minutes), total time to surface (hours:minutes)

Battery: 9 volt alkaline

Low Battery Indication: blinking asterisk appearing on display changes to a blinking "B" (on for one second, off for one second)

On/Off Switch: magnetic flip-switch, plastic, 4.1(L) x 0.6(W) x 0.5 cm, small detent with nub extending out 0.1 cm from the switch providing a friction hold device

Weight: 757 grams with one battery and two wrist straps installed

The following U.S. Navy specifications were not provided on the ORCA UDM, as detailed in a letter of exception from the manufacturer:

Display output available via edge connector on circuit board.

Removable plug for leak check.

Display backlighting; manufacturer claims external lighting could be designed, or internal lighting included on a production run.

Pressure transducer threaded to accept standard fitting; manufacturer claims external fitting with o-ring seat could be designed.

Figure 1. ORCA Prototype UDM

Red light violation, green light compliance; this function performed by displaying icons on the display.

Eprom socketed for ease in changing algorithm; vacuum solderer required to execute this function.

2. Divetronic UDM. The Divetronic UDM is a modification of a commercially available product, the Divetronic Decobrain II. Primary modifications involve inclusion of the U.S. Navy EL-MK 15/16 RTA and changes in the display information and display functioning to meet U.S. Navy specifications. A backlighting switch was also supplied per U.S. Navy specifications. An illustration of the Divetronic Prototype UDM is provided in Figure 2. A comparative illustration of the Divetronic, ORCA, and Tekna UDM is provided in Figure 3. Actual specifications are provided below. A further discussion of actual specifications including an unmanned dry human factors evaluation is provided as Appendix I.

Case Size: 14.5 cm wide by 8 cm tall by 11 cm deep

Case Material: injection molded contoured black plastic

Case Color: Black; gray display face molding

Straps: Two rubber straps with steel buckles, each threaded through two stainless steel pins in the case body used to connect the unit to the arm of the user. Straps are 2.4 cm wide and 35 cm long.

Display Window: 10.5 x 6.0 cm. Total time of dive, depth, and total time to surface are three separate LCD displays, each measuring 3.9 x 1.3 cm. Safe ascent depth and time at stop are two separate LCD displays measuring 1.9 x 1.3 cm.

Display Lettering Type/Size: grey display face label containing graphics of various colors and sizes surrounding five liquid crystal display (LCD) and three light emitting diodes (LED)

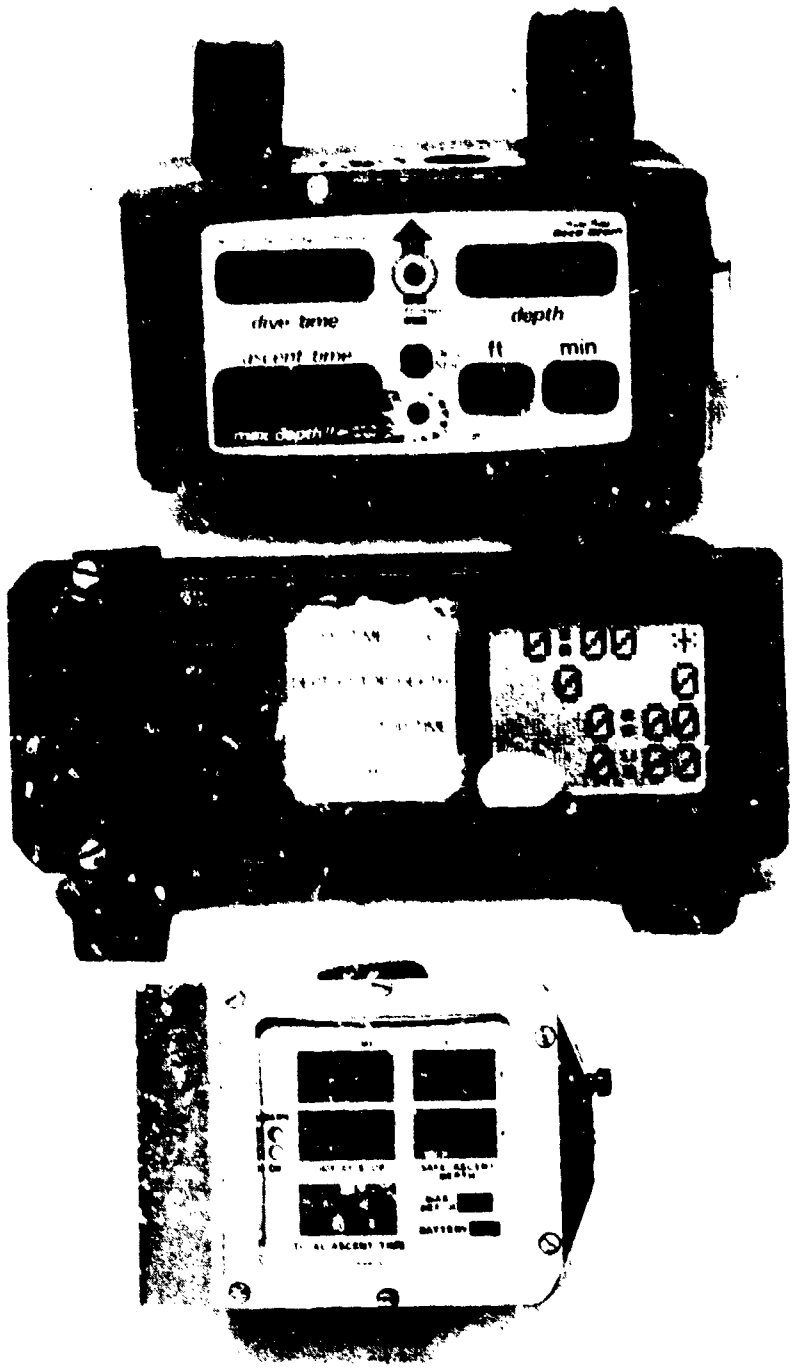
Display Information Continuously Available: total time of dive (minutes), present depth (FSW), safe ascent depth (FSW), time at stop (minutes), total time to surface (minutes)

Battery: five rechargeable NICAD batteries in a single self-contained replaceable power pack. Sliding magnetic switch activates display backlighting.

Low Battery Indication: all LCD lettering blinks on and off

On/Off Switch: pull and turn plastic power switch, beige in color, 4.1 cm in length, protrudes 1.0 → 1.2 cm from case, spring loaded positive action control

Figure 2. *DIVETRONIC* Prototype UDM



Figu. DIVETRONIC, ORCA, and TEKNA Prototype UDMs

Weight: 2 lbs. 3 ozs. (992.1 gram) in the dry with batteries and wrist straps installed.

The following U.S. Navy specifications were not provided on the Divetronic UDM:

Display output available via edge connector on circuit board.

Removable plug for leak check.

Velcro fasteners to attach unit to users forearm. Rubber straps used instead.

Battery voltage indication. Not provided when submerged.

Total time of dive, time at stop, total time to surface provided in hours and minutes. This display information provided in whole minutes only.

Prom socketed for ease in changing algorithms.

Safe ascent depth display in 2 digits (100's, 10's); display only capable of showing 2 digits (10's, 1's).

Green light compliance feature functional per U.S. Navy specifications.

Depth capability 0-230 FSW; pressure transducer "pegs out" at depths from 219 to 222 FSW.

IV. TEST PROCEDURE

UDM testing was conducted per NAVSEA Task 84-04. Figure 4 illustrates the test equipment set-up. A small Bethlehem 1000 psig unmanned test chamber was used to pressurize UDMs to depth. Each UDM was immersed in a saltwater bath in which glycol was added to prevent freeze up during cold water tests. A Hewlett Packard (HP) 1000 M-series computer was used to tabulate test data and compare UDM algorithm functioning with the EL-MK 15/16 RTA contained within its programming. The real time decompression schedule computed by the HP 1000 computer using the MK 15/16 RTA was the standard to which UDM profiles were compared. A Heise model 711a digigauge calibrated within ± 0.1% of span (1,000 FSW) was used for visual monitoring of chamber depth. A Validyne model No. CD23 digital transducer which was calibrated against the Heise digigauge was used to supply depth readings to the HP 1000 computer. UDM chamber temperature was monitored throughout the test. UDM display information was monitored either visually through the chamber port or via a video camera with remote display. During testing, UDM depth and SAD information was manually entered into the HP 1000 computer via a modified input box attached to the terminal keyboard. This led to slight inaccuracies in correctly entering all UDM status changes. This problem would be eliminated in future models by requiring an interface so UDM display information can be monitored directly by another computer.

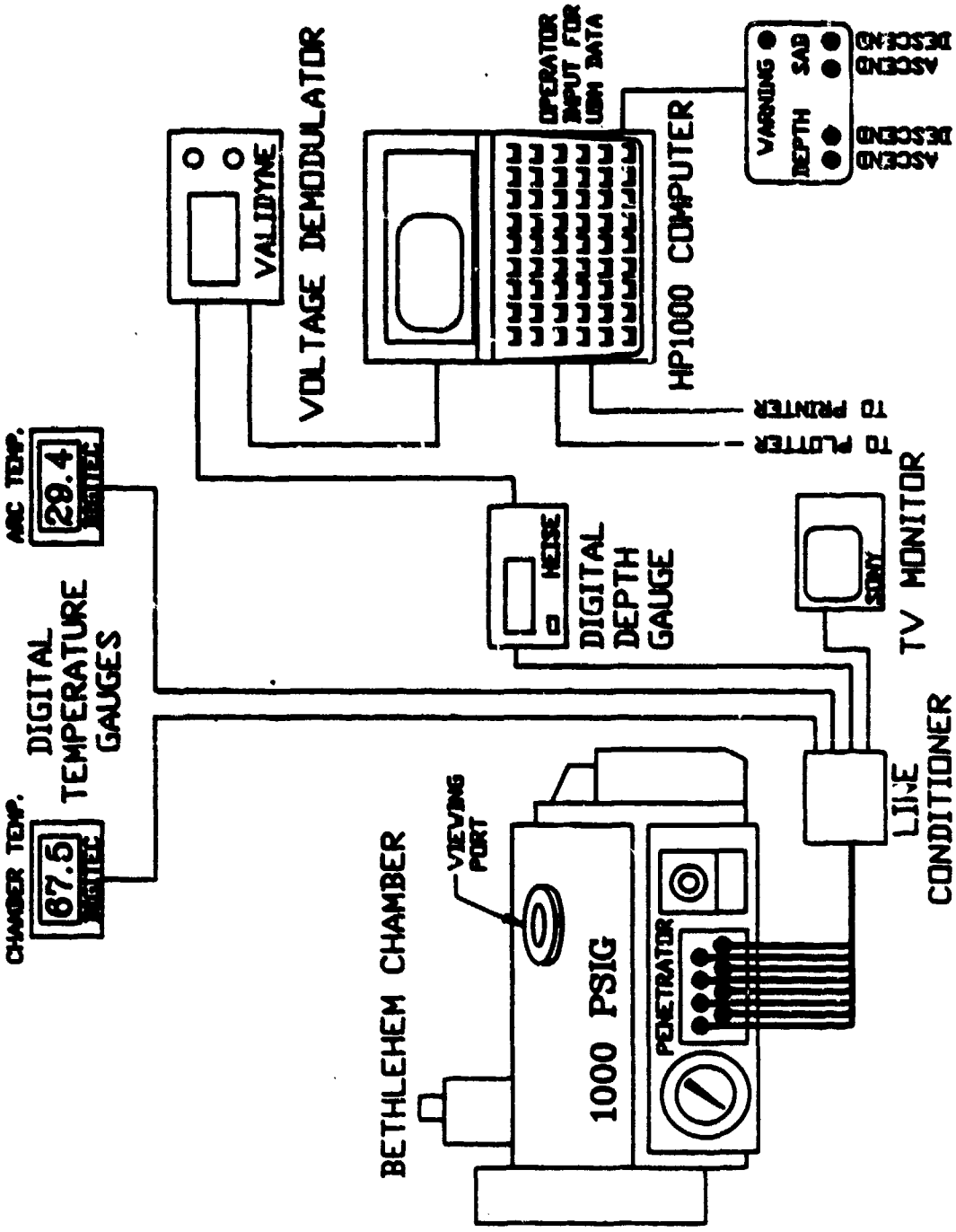


Figure 4. Test Set Up

A. Test Plan. Appendix A provides the test plan used as a guideline for the test series. UDM testing was conducted to assess pressure transducer accuracy and stability, and profile tracking per the EL-MK 15/16 RTA. A temperature sensitivity evaluation was conducted by running the pressure testing at 29° and 93°F. Watertight integrity was assessed by disassembling the units in order to check for leakage prior to and at the conclusion of a 500 FSW and 230 FSW watertight integrity test and at any time that a unit failed to function. A human factors evaluation was conducted to assess readability, display functioning, ease of operation, and buoyancy.

1. Test One: Pressure Transducer Accuracy/Temperature Sensitivity. Six units at a time were placed in the Bethlehem chamber and dove to 230 FSW, stopping at 10 FSW increments for as long as required to manually record UDM depth readings. The UDMs were immersed in a saltwater bath in which glycol was added to prevent freeze up. Each unit was tested in this manner at 93°F and 29°F water temperature. Six dives were plotted on each unit at each water temperature. UDM depth readings were compared to chamber depth to assess pressure transducer accuracy. Development of test procedures, test equipment set up, and test technician training required work up dives which resulted in more than six dives at each temperature actually being conducted. Actual number of dives and accumulated dive times are provided in the results section.

2. Test Two: Long Term Stability/Temperature Sensitivity. Six units at a time were placed in a saltwater bath in the Bethlehem chamber and dove to 230 FSW, stopping at 50 FSW increments for 30 minutes and 230 FSW for 30 minutes. UDM depth readings were recorded at the beginning and end of each 30 minute stop. Each unit was tested in this manner at 93°F and 29°F water temperature. Six dives were plotted on each unit at each water temperature. UDM depth readings were compared to chamber depth and were evaluated for stability during the 30 minute stops. Development of test procedures, test equipment set up, and training of test technicians resulted in more than six dives at each temperature actually being conducted. Actual number of dives and accumulated dive times for each unit are provided in the results section.

3. Test Three: Battery Duration. Battery duration tests were conducted at the conclusion of pressure transducer and profile tracking tests, and included an evaluation of the low battery warning function.

a. ORCA UDM. Three battery duration tests described below were conducted on four of the ORCA UDM prototypes due to disabled displays on two units prior to the battery test phase. Battery testing was conducted at 1 ATA, and included testing of both the olive drab BA-90 Eveready Mil Spec battery and standard commercially available Duracell MN1604 9 volt alkaline battery. The ORCA UDM provides a low battery warning by a blinking "B" on the upper right hand corner of the display (one second on, one second off). Low battery warning and battery depletion times were rounded off to the nearest half hour.

(1) Phase I. ORCA UDM battery duration test, Eveready BA-90 battery. Two UDMs were tested with batteries installed immediately after

removal from the freezer. Two units were tested with batteries maintained at room temperature prior to installation. Times of low battery indication and battery depletion were recorded. Battery depletion always resulted in a blank display.

(2) Phase II. ORCA UDM battery duration, test, Duracell battery. Two UDMs were tested with batteries which were installed immediately after removal from the freezer. Two units were tested with batteries maintained at room temperature prior to installation. Times of low battery indication and battery depletion were recorded.

(3) Phase III. ORCA UDM battery duration test, freezing conditions. Two units with unfrozen (room temperature) BA-90 Eveready batteries installed and two units with unfrozen Duracell batteries installed were turned on and placed in a freezer at 10°F until battery depletion occurred. Times of low battery indication and battery depletion were recorded.

b. Divetronic UDM. A single Divetronic UDM (889) suffered a SAD display failure prior to the battery duration test phase, but still provided a low battery warning and other display functioning which allowed this unit to be tested for battery duration along with the other five Divetronic prototypes. A total of five different tests as described below were conducted. Testing was conducted at 1 ATA, except for Phase II, which included an initial dive to 15 FSW for 24 hours, and Phase III, which included multiple short dives. Testing included backlighting on and backlighting off, as well as 4 hour and 5 hour charge times, and various intervals between charging and power activation. Phase V evaluated battery duration in freezing conditions. The Divetronic UDM provides a low battery warning by blinking all LCD numerals on the display. Times of low battery indication and battery depletion were rounded off to the nearest half hour.

(1) Phase I. Backlight on battery duration test, power activation 24 hours after charge. All units were drained of power and charged for 5 hours. Twenty-four hours had elapsed after charging prior to starting the test. Power and lighting were left on continuously and the units observed for low battery warning indication and power depletion. Battery packs were considered depleted upon observation of obviously incorrect display data, erratic display information, or blank display. Elapsed times to battery warning and battery depletion were recorded.

(2) Phase II. Backlight off battery duration test, power activation 24 hours after charge. All units were drained of power and charged for 5 hours. Twenty-four hours had elapsed after charging prior to starting the test. Power was turned on but backlighting was not activated, and all units were observed for low battery warning indication and power depletion. Elapsed times were recorded.

(3) Phase III. Backlight off battery duration test, power activation 72 hours after charge. All units were drained of power and charged for 5 hours. Seventy-two hours had elapsed after charging prior to starting the test. Elapsed time to low battery warning and power depletion were recorded.

(4) Phase IV. Backlight off battery durat[illegible] activation 120 hours after charge. All units were drained [illegible] charged for 4 hours. Manufacturers recommended charge tim[illegible] hours. A 4 hour charge time coupled with 120 hours elapsed time f[illegible] charge to test start up was conducted to evaluate these two worst [illegible]tions. Elapsed times to low battery warning and battery depletion [illegible]ed.

(5) Phase V. Backlight off low temperatu[illegible]ur.tion test. All units were drained of power and charged for 4 ho[illegible]ty-four hours had elapsed after charging prior to starting the test, [illegible] which all units were placed in a freezer at 10°F until power depletion [illegible] Elapsed times to low battery warning and battery depletion we[illegible]

4. Test Four: Profile Tracking. If the UDM pressure transd[illegible] monitors the same depth as the Hewlett Packard (HP) 1000 M-series compu[illegible], the UDM decompression schedule should be the same as the HP 1000 decompression schedule, provided the UDM had been programmed correctly. This test was designed to determine whether any deviations which occurred were the resul[illegible] of programming errors rather than pressure transducer depth inaccuracies.

In order to confirm that the UDM's had been correctly programmed, the UDM depth and the depth monitored by the HP 1000 computer had to be exactly the same. Since depth errors of up to 4 FSW were noted during pressure transducer accuracy testing, a modification to the test procedure had to be made so that the UDM and HP 1000 depth coincided. This was done by adjusting the Validyne pressure transducer so that the HP depth was the same as UDM depth. Since both UDM depth and SAD had to be manually entered into the HP 1000, only one UDM could be tested at any given time, simply because the technicians could not keep track of any more. The time required to complete this phase of profile tracking was therefore lengthened considerably.

Manual adjustment of the Validyne digital transducer and manual programming of UDM depth and SAD information into the HP 1000 computer during dive conduct resulted in a variable level of human error which impacted on the precise accuracy of test results. Technician error was kept to a minimum by careful training and by utilizing two technicians on each dive when required, especially during long or deep dives. When noticeable human error occurred which adversely effected test data accuracy, the dive was aborted and restarted. Aborted dives also occurred during the pressure transducer test phase, and resulted in considerably more hours being logged on each UDM than the test data enclosed in this report indicates. Aborted dives increased the time required to complete testing, but resulted in an improved evaluation of UDM reliability under long term handling and repeated pressurization. The element of human error will continue to be a factor which effects the precise accuracy of UDM testing until a method of direct interrogation of UDM programming is developed. Overall, manual programming of test data as was done in this test series, while time consuming, is considered to be sufficiently accurate to document UDM performance with a reasonable degree of reliability, as indicated by the consistency and repeatability of test results. However, an accurate and reliable method of monitoring UDM display functioning will have to be provided for checking fleet issued UDM's on a periodic basis.

Dive profiles which involved decompression followed the profiles as computed by the UDM's. In many cases this required ascent to the next shallower decompression stop or to the surface sooner than would be allowed by the HP 1000 computer (EL MK 15/16 RTA) decompression schedule. As long as the algorithm is computing a decompression schedule for a constant 0.7 ATA PO_2 breathing gas, the rate of gas elimination will be independent of depth. Thus even though the HP 1000 SAD was deeper or shallower than the actual depth during decompression, the time to the next SAD decrement (stop time for the next shallower stop) would be unaffected. This meant that the standard profile to which the UDM was being compared was unaffected and remained unchanged to the surface.

Warning status was recorded during all of the profile tracking test as well as during tests which focused primarily on warning status changes. This gave a more comprehensive evaluation of warning status functioning.

The following profile tracking tests were conducted:

a. Repetitive No Decompression Dives. When a diver is using the UDM, there may be occasions when he may be at the surface breathing air for various periods of time. In order to provide for surface intervals breathing air, the algorithm assumes a PO_2 of .21 ATA whenever the depth is less than 3 FSW. If a diver should breathe his MK 15 MOD 0 UBA while on the surface, this would not be a problem because the PO_2 in the breathing gas of the UBA is higher than that being assumed by the algorithm. Once the depth increases below 3 FSW, the algorithm assumes the PO_2 is .7 ATA. The repetitive dive test is designed to evaluate the UDMs switch from PO_2 of .7 ATA to a PO_2 of .21 above 3 FSW as well as to evaluate UDM repetitive no decompression dive profile tracking accuracy. This test also provided data on single no decompression dives, therefore a separate test series on single no decompression dives was not conducted. The test profiles are as follows:

(1)	60 FSW	No Decompression
	1 Hour	Interval at 2 FSW
	120 FSW	No Decompression
(2)	60 FSW	No Decompression
	1 Hour	Interval at 5 FSW
	120 FSW	No Decompression

Each unit was tested once on each of the above profiles at 29°F water temperature. UDM depth and SAD values were manually entered into the HP 1000 computer throughout the dive for a comparison of UDM algorithm functioning to the EL MK 15/16 RTA programmed into the HP 1000 computer.

b. Decompression Dives. Each unit was tested on each of the profiles listed below at 29°F water temperature. Each unit was also tested on profile (1) at 93°F. UDM depth and SAD values, as well as warning status functioning information was manually entered into the HP 1000 computer throughout the dive for a comparison of UDM algorithm functioning to the

EL MK 15/16 RTA programmed into the HP 1000 computer. Although 175 FSW is deeper than would be dove operationally, the 175/60 profile was tested because it uses most of the MPTT values in the algorithm.

(1) 175 FSW 60 Minutes

(2) 150 FSW 30 Minutes

c. Repetitive Decompression Dives. UDM depth, SAD and warning status information is charted in the same manner as previous profile tracking tests. Each unit was tested on the following profile at 29°F water temperature.

(1) 150 FSW 30 Minutes
1 Hour Surface Interval
150 FSW 30 Minutes

d. Warning Status Test. The warning status test originally planned as described in the test protocol in Appendix A-1 proved to be unworkable. The test was modified as follows:

Descend to 150 FSW	60 minutes. Enter time UDM SAD flashes into HP 1000 computer.
Decompress to 30 FSW	Enter time SAD secures flashing on UDM into HP 1000 computer. Verify that HP 1000 computer warning status indication is off.

Descend until UDM SAD resumes flashing and HP 1000 computer warning status is activated. Do not exceed a maximum depth of 150 FSW. Enter time UDM SAD flashes and verify that HP 1000 warning status is activated.

Ascend to surface, skipping all decompression stops.

UDM depth, SAD, and warning status information is charted in the same manner as previous profile tracking tests. This test was conducted at 29°F water temperature.

5. Test Five: Mud Test. Black, sandy mud was obtained from a slough which had its outlet at the Naval Coastal Systems Center, Panama City, Florida. By ultraviolet examination, it was determined that the mud was oil-free. All six Divetronic units were completely submerged in this mud for 43 hours prior to pressuring the units to a depth of 158 FSW for 1 hour 40 minutes in order to "pack" the pressure transducer. None of the units were turned on at this time. Immediately prior to the test, the UDM displays were cleaned without affecting the condition of the pressure transducers. The units were then turned on and dove to a depth of 240 FSW at 20 foot increments to evaluate pressure transducer accuracy at ambient temperature.

6. Test Six: 500 FSW Watertight Integrity Test. Five Divetronic units and three Orca units were opened and checked for any leakage which may have occurred from previous testing. Two Divetronic units and one ORCA unit were then submerged in water and compressed in a Bethlehem chamber to a depth of 230 FSW for 24 hours. Three Divetronic units and two ORCA units were compressed to a depth of 500 FSW for 24 hours. Upon dive completion those units which continued to provide display information were dove to a depth of 220 FSW stopping at 20 FSW increments on descent and ascent to evaluate pressure transducer accuracy and display functioning. All units were then disassembled and checked for water leakage.

7. Test Seven: Four Foot Drop Test. Five Divetronic units and one Orca unit which had survived previous testing and had been opened and checked for any leakage or damage which may have occurred from the 500 FSW watertight integrity test were dropped on a concrete floor at different angles from a height of 4 feet. All units were then examined for obvious damage to the case or display, and were subjected to the following dive profile:

60 FSW No Decompression
1 Hour Surface Interval
120 FSW No Decompression

An evaluation of depth and profile tracking accuracy from the repetitive no decompression dive, as well as an internal inspection for damage or leakage, provided data on any damage which may have occurred to UDM functioning as a result of the impact.

This test was the final phase of the evaluation. One Divetronic unit (795) had previously experienced a floodout resulting from a cracked case during an operational dive following the 10°F battery duration test. Therefore only five operable Divetronic units were submitted to the four foot drop test. One of these units (889) had experienced a SAD display failure from previous testing which limited test data results, however this unit was still submitted to the test to evaluate depth and display functioning, as well as watertight integrity after having been dropped. Two ORCA units had previously experienced display failures, one ORCA unit experienced pressure transducer problems and stripped case threads during a leak check, and two units leaked during test six, watertight integrity test. All six ORCA units were dropped from a four foot height but only one was submitted to the follow-up dive to evaluate functioning.

V. TEST RESULTS

A. ORCA UDM. During Long Term Stability Testing (Test Two), UDM 1172 and 1170 failed to track depth accurately. Unit 1172 displayed 13 FSW at a depth of 40 FSW, and decayed to 4 FSW over a two hour period. Unit 1170 consistently displayed 195 FSW at a depth of 200 FSW. This occurred after approximately 40 dives on each unit at depth ranges from 0 to 250 FSW at temperatures from 29°F to 93°F. Accumulated dive time was in excess of 70 hours on each unit. These units were returned to the manufacturer for

evaluation and repair. The transducer oil had blown by the seals under the influence of high pressure. It was initially felt that this may have occurred because the initial work up dives on the ORCA UDM were conducted to a maximum depth of 250 FSW, whereas the U.S. Navy specification is 230 FSW depth range (watertight to 500 FSW). ORCA Industries, Inc. informed NEDU that a transducer oil refill may be required whenever a depth of 230 FSW is exceeded, and this is a simple operation which could be performed by U.S. Navy personnel. Although ORCA had originally indicated in writing that a test depth of 250 FSW would be satisfactory and a factory test to this depth had been conducted prior to providing these units to NEDU, a maximum test depth of 230 FSW was recommended by the manufacturer after failure of units 1172 and 1170. The manufacturer also indicated that the transducer blow by threshold could be increased on a production model so that minor over-pressurization would not cause the pressure relief feature to activate, and this would not effect the overall functioning of the unit.

Testing of the repaired units (1172 and 1170) was restarted from the beginning of the test phase, rerunning the Pressure Transducer Accuracy Test (Test One) and Long Term Stability Test (Test Two) to a maximum depth of 230 FSW. No leak problems or pronounced depth inaccuracies occurred on the repaired units when resubmitted to Test One. During Long Term Stability Testing (Test Two), Unit 1172 continued to function similarly to the units which had not previously failed and successfully completed this phase of testing. Unit 1170 was eventually to experience tracking errors of up to 6 FSW in some cases, and finally failed all together, along with units 1171 and 1173. These three units were disassembled after failure. Upon examination of the internal components it appeared that the transducer oil had leaked on all three units. Additionally, water had leaked into unit 1170, causing corrosion of the electronics. It is suspected that these leaks occurred through the pressure transducer cavity. The test results discussed in the following paragraphs discuss the performance of the two units (1172 and 1170) after being returned, repaired and resubmitted for testing from the beginning of Test One, as well as the four units which did not fail during initial testing (0107, 1171, 1173, and 1190).

1. Pressure Transducer Accuracy/Temperature Sensitivity Tests. Appendix B provides test results for pressure transducer accuracy dives at 29°F and 93°F water temperature. Each test dive required between 35 minutes to one hour 30 minutes dive time. Examination of the data indicates that the ORCA UDMs were normally accurate to within $\pm$ 2 FSW to a depth of 230 FSW, but occasionally deviated as much as $\pm$ 3 FSW. Depth readings with an error in excess of 3 FSW occurred only on unit 1170, which later went completely blank during long term stability testing.

Overall, inaccurate depth readings displayed a shallower depth slightly more often than a deeper depth. Inaccurate depth readings were somewhat more prevalent on the deeper depth ranges, but occurred throughout the depth spectrum. The UDMs were slightly more accurate on ascent than descent, and performed somewhat better at 93°F than 29°F. All UDMs read zero when on the surface.

During 29°F test units were generally within ±2 FSW. Maximum deviation was 3 FSW and deviation was usually deeper than true depth except for unit 0107 at 180 FSW and below where it was shallower (Figure B6).

During 93°F tests only two units did not fall within the ±2 FSW specification. Unit 1171 failed (read 0) on dives #2 through #5 but returned to proper functioning on dive #6. Failure on dive #2 occurred after approximately 25 dives. Accumulated dive time was in excess of 30 hours. Decay is noticeable on UDM 1170 during ascent on dive #5 and #6 after approximately 30 dives, accumulated dive time of approximately 37 hours. These two units were later found to have leaked transducer oil and water inside the case. It is apparent that when units were working depth tracking was satisfactory.

2. Long Term Stability/Temperature Sensitivity Tests. Appendix C (Figures C1-C12) provides test results for long term stability dives at 29°F and 93°F water temperature. Each table shows the depth reading at the beginning and end of each 30 minute stop at the indicated depth. Unit 1170 (during dive #1 at 93°F, Figure C7), 1171 (during dive #2 at 93°F, Figure C8), and 1173 (during dive #3 at 93°F, Figure C9) began to show signs of decay, and finally went blank during test 6 at 93°F. Unit 0107 went blank during the latter part of dive 5 at 93°F, but performed acceptably on dive 6.

Test results shown in Figures C1 through C12 provides the results of Long Term Stability Tests (Test Two) on units 1172 and 1170 after factory repair and retesting of Test One (Pressure Transducer Accuracy Testing), and test results of units 0107, 1171, 1173, and 1190 which had not previously failed except for unit 1171 which returned to acceptable functioning during Test One and was not factory repaired. Unit 1170 failed again during this test.

Examination of the data on those three units which did not fail during this test shows that depth readings did not vary more than ± 1 FSW during the 30 minute hold at each depth increment. Depth accuracy was normally within ± 2 FSW to a maximum depth of 230 FSW, but sometimes varied as much as ± 3 FSW except for unit 1190 which varied from -4 to -7 FSW on four dives at a chamber depth of 230 FSW only. Depth accuracy was generally much the same as was found in Test One. Unit 1172 read 3 FSW deeper when out of the ±2 FSW specification. Unit 0170 read 3 FSW deeper in this test (Figure C2), but 3 FSW shallower in Test One.

It is apparent that when units functioned, depth tracking accuracy was acceptable, however, multiple leaks and pressure transducer failures indicate low mechanical reliability in the present configuration, when tested to the 230 FSW depth range.

3. Profile Tracking Tests. Profile tracking tests and warning status tests were not conducted on the ORCA UDM due to failure of three units prior to these phases of testing. It was apparent that the number of failures which had occurred during the initial phase of testing, as well as the failure of the unit to meet several important U.S. Navy specifications would require

several design modifications. These modifications should be incorporated prior to the major investment in man hours and test equipment that are required to conduct the profile tracking tests. Battery duration tests, 500 FSW watertight integrity tests, and four foot drop test were conducted on the remaining units.

4. Battery Duration Evaluation

a. Phase I. BA-90 Eveready carbon-zinc Mil Spec battery. Elapsed times to low battery warning indication and battery depletion are provided below. Units 1171 and 1172 utilized batteries taken directly from the freezer. Units 0107 and 1190 utilized unfrozen batteries. Elapsed times are rounded off to the nearest half hour.

UNIT 1171		UNIT 1172		UNIT 0107		UNIT 1190	
Low Battery Warning	Battery Depletion	Low Battery Warning	Battery Depletion	Low Battery Warning	Battery Depletion	Low Battery Warning	Battery Depletion
20 hours	24.5 hours	24.5 hours	26 hours	22 hours	27.5 hours	30 hours	36 hours

The low battery warning function provided warnings from 1.5 to 6 hours prior to battery depletion, with an average from the four units tests of 4.38 hours. Battery durations ranged from 24.5 to 36 hours, with an average from the four units tested of 28.5 hours. Units utilizing batteries taken directly from the freezer experienced slightly reduced battery duration times.

The manufacturer recommends alkaline batteries for use in the ORCA UDM. BA-90 Mil Spec batteries were evaluated due to their common availability at fleet diving commands. These batteries provided substantially reduced duration times compared to the Duracell alkaline batteries.

b. Phase II. Duracell Alkaline MN 1604 battery. Elapsed times to low battery warning indication and battery depletion are provided below. Units 1171 and 1172 utilized batteries taken directly from the freezer. Units 0107 and 1190 utilized unfrozen batteries.

UNIT 1171		UNIT 1172		UNIT 0107		UNIT 1190	
Low Battery Warning	Battery Depletion	Low Battery Warning	Battery Depletion	Low Battery Warning	Battery Depletion	Low Battery Warning	Battery Depletion
80 hours	89.5 hours	62 hours	89.5 hours	62.5 hours	75.5 hours	65 hours	75.5 hours

The low battery warning function provided warnings from 9.5 to 27.5 hours prior to battery completion, with an average from the four units tested of 15.13 hours. Battery durations ranged from 75.5 to 89.5 hours, with an average from the four units tested of 82.5 hours.

c. Phase III. Duracell alkaline and Eveready Mil Spec battery duration under freezing conditions. BA-90 Eveready Mil Spec batteries were installed in units 1171 and 1172, and MN 1604 Duracell Alkaline 9 volt batteries were installed in units 0107 and 1190. Batteries and UDMs were maintained at room temperature prior to power activation, at which time they were placed in a freezer at 10°F until battery depletion. All units were checked 6 hours after being placed in the freezer and it was found that units 1171 and 1172 had failed. Units 0107 and 1190 failed after 10 hours. It is evident that the 10°F air temperature adversely affects battery output in both battery types, which might be a concern during subfreezing surface intervals between repetitive dives during which the UDM is not thermally protected, or during conditions of cold predive temperatures. All units were turned off for a 24 hour warming period at room temperature, after which unit 0107 and 1190 failed to reactivate when turned on. Unit 1172 reactivated for a period of 1 hour. Unit 1171 reactivated for a period of 2 hours.

UDM operability at 10°F temperatures is not a U.S. Navy specification, however this environmental extreme can occur during U.S. Navy operational use. Predive and surface interval temperatures in a cold climate can be even more severe than the 10°F test represents, if the UDM is not thermally protected. Discussions with Duracell, Inc. indicates cold temperatures may temporarily reduce voltage levels somewhat, but determination of the degree of voltage level drop would require testing under specific loads and temperatures.

It should be noted that a new battery can be installed in the ORCA UDM without losing the memory from preceding dives. An auxiliary battery clip is provided for this purpose. Battery changes must be conducted on the surface in a [illegible] environment.

5. 500 FSW Watertight Integrity Test. ORCA UDM 1171 was exposed to a depth of 530 FSW for a 24 hour period and units 1190 and 1172 were exposed to a depth of 500 FSW for a 24 hour period. Unit 1171 was found to be flooded upon d[illegible] surfacing. The location of the leak was not apparent. The severity of the floodout and the fact that the floodout occurred at a depth which was common to previous testing raises suspicions as to the reassembly procedures applied to the UDM after checking for leakage prior to the dive.

Disassembly of the electronics case voids the warrenty on the ORCA commercial sport diving unit, however periodic disassembly may be required for a Navy unit in order to check for leaks (a leak check plug was not provided per U.S. Navy specifications), and conceivably to change algorithms (a socketed PROM for ease in changing algorithm is also a U.S. Navy specification).

Unit 1172 was found to have suffered from slight leakage, and it is suspected that these leaks occurred through the pressure transducer cavity.

This problem was experienced on other ORCA units during previous testing. The slight leakage resulted in electronics contamination (salt water corrosion) and display failure. Even very slight leaks which result in water contacting the electronics created very rapid electronics corrosion when the unit is powered up, normally resulting in display failure. Units 1190 survived the 500 FSW dive and was then successfully tested for pressure transducer accuracy and display functioning at 20 FSW intervals during descent and ascent to a depth of 220 FSW. Test results provided below show similar functioning to the pressure transducer test series (Appendix B).

Chamber Depth (FSW)	UDM 1190 Depth (FSW)	
	Descent ↓	Ascent ↑
0	0	0
20	19	19
40	39	39
60	59	59
80	80	79
100	100	99
120	120	120
140	139	139
160	159	159
180	179	180
200	199	199
220	219	-

6. Four Foot Drop Test. The single functioning ORCA UDM (unit 1190) remaining from previous testing was dropped from a height of four feet on a concrete floor, impacting on the display face side of the unit. The unit was then submitted to a 60 FSW no decompression dive, one hour surface interval, and 120 FSW repetitive no decompression dive, and was found to function acceptably, accurately monitoring depth, no decompression time, and dive time. Display information was clear and no damage to the case or display face was found after careful examination. No leaks occurred during the dive. Profile tracking tests were not conducted on the ORCA UDM prior to this test. Unit 1190 proved to be correctly programmed during this dive, on the profile indicated above.

7. Display Functioning and External Hardware. Figure 5 provides a drawing of the ORCA UDM display layout. Appendix H provides further

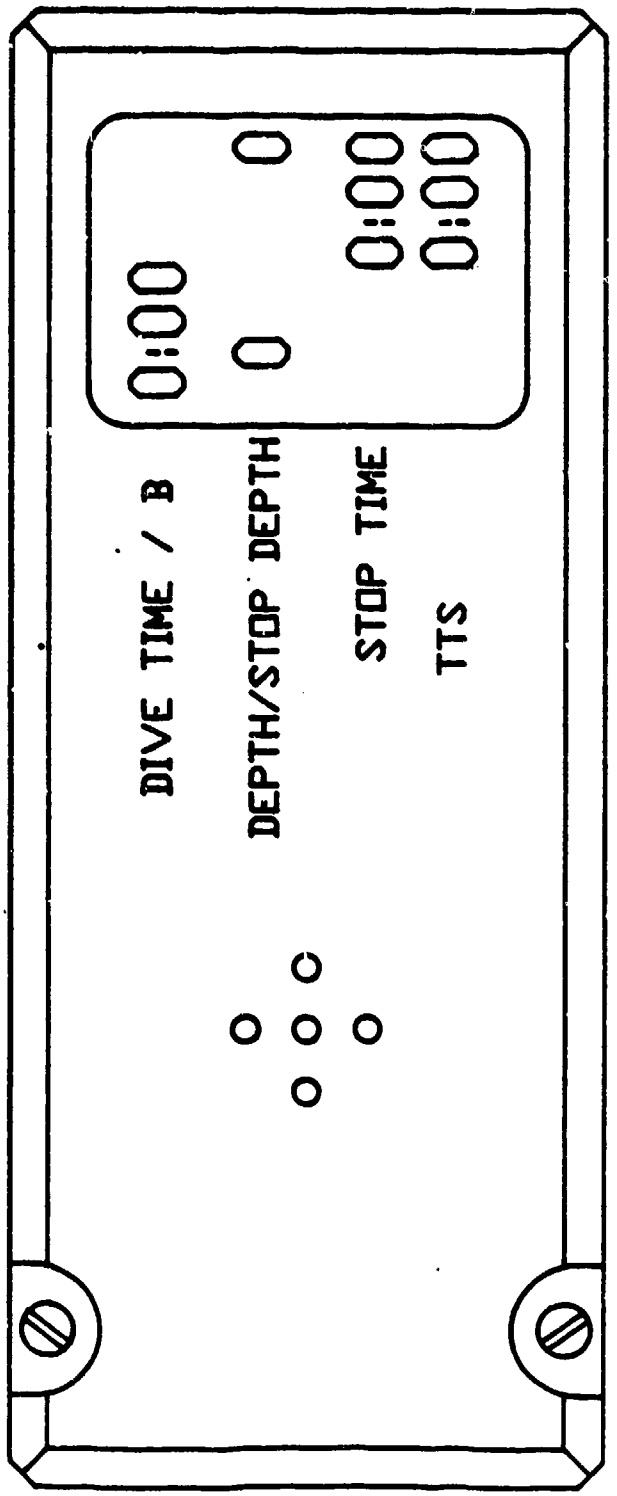


Figure 5. ORCA UDM Drawing (not to scale)

illustrations of external hardware. U.S. Navy specifications required a UDM display layout which departs from the ORCA commercial sport diving model. Graphics were eliminated except for an ORCA (killer whale) pattern which appears as soon as the unit is turned on. On the lower left hand corner the number N1 appears, signifying the Navy program designation. Several seconds after turning the unit on the display proceeds to a blinking checkerboard pattern. The UDM performs a self-check function during this time.

Display labeling is removed from under the display glass and replaced with a typed label which was epoxied to the case. During the lengthy period of testing these labels separated from the case, however the manufacturer indicated that for production run models the display labels could be printed on the case or under the display glass. Display layout is provided as follows, initiating after the checkerboard pattern and self-check function are complete:

```
Dive Time / B
Depth / Stop Depth
        Stop Time
    TTS
```

Note (1): B = battery warning (blinking asterisk which signifies proper operation changes to a flashing "B" to indicate low battery)

Note (2): TTS = total time to surface

Note (3): displays update every 2 seconds

Maximum depth, dive time/surface interval time displays provided during surface interval, remaining no decompression time, and temperature displays are provided on the ORCA commercial unit but were removed for the U.S. Navy prototype because these displays were not required by U.S. Navy specifications.

a. Stop Depth and Stop Time Display Displays. When a 10 FSW decompression stop is incurred, the "stop depth" display changes from "0" to "10" and the "stop time" display changes from "0:00" to "0:01" and begins counting up the increasing amount of time the diver must remain at the 10 FSW decompression stop in whole minutes. The "stop time" display restarts from "0:01" each time a deeper stop is incurred and continues to count upward in whole minutes. This process continues until the UDM depth decreases sufficiently to provide adequate decompression (tissue offgassing) to begin a reversal of the increasing decompression time obligation. Then the "stop time" display begins counting down, and the "stop depth" display will eventually change to the next shallower SAD stop, restarting the "stop time" countdown until sufficient decompression is achieved to continue the dive in a no-decompression status or allow surfacing. If the UDM rises shallower than the SAD the UDM "stop depth" and "stop time" displays will blink alternately, thereby providing a warning that the diver is too shallow. If this occurs, the UDM will continue to provide decompression information based on the actual depths attained for the actual time at those depths. This will result in a slower decrement of decompression stop times associated with the shallower depths attained.

During display functioning testing which involved a lengthy 230 FSW dive to initiate maximum SAD ("stop depth") activation, the "stop depth" and "stop time" display began blinking the word "ASCEND", initiating once every two seconds for one second duration. This is the "P40" warning status. The maximum "stop depth" value achieved during testing was 150 FSW. The ORCA UDM's capability to achieve deeper "stop depth" (SAD) values was not tested, and would not occur during normal operations. When the decompression "stop depth" is achieved, the blinking "ASCEND" ceases.

b. Total Time to Surface (TTS). The TTS display indicates total time to surface assuming the diver begins immediate decompression. U.S. Navy specifications requires that this display correspond to an ascent rate of 60 feet per minute (FPM) (plus stop times), however this time can be as much as 59 seconds in error because the display reads in hours and whole minutes per U.S. Navy specifications. When a depth of 1 FSW is achieved during a no-decompression dive, the TTS display reads "1" (minute). At a depth of 61 FSW on a no-decompression dive the TTS display switches to "2" (minutes), and so on. This display limitation normally results in longer (59 seconds or less) decompression times being shown than actually required. This is apparently a display limitation only, and may not reflect a limitation of the microprocessor itself.

c. Dive Time Display. This display indicates the total time of dive in hours (two digits) and minutes (two digits) per U.S. Navy specifications. This display counts up in whole minutes from zero once the UDM reaches a depth of 3 FSW on descent. The timer will "freeze" if ascent is made to 2 FSW. After 10 minutes on the surface has elapsed, the display will revert back to zero, as long as no ascent criteria has been violated, (i.e. unless decompression time still remained when diver surfaced) and any repetitive dives will be counted up from zero. If a dive is continued within 10 minutes surface interval the total time of dive provided on the display from the initial portion of the dive will continue to count up in whole minutes once a depth of 3 FSW is achieved on descent during the second portion of the dive.

d. Depth Display. This display will provide a maximum depth reading of 237 FSW. U.S. Navy specification is 230 FSW. Three digits are provided per specifications.

e. On/Off Switch. A magnetic flip switch located on the back of the case is rotated 180 degrees to activate power. This switch seats itself against the case. When the UDM is securely fastened to the divers arm it is possible, although not probable, that the UDM could be inadvertently turned off. This would occur if a protruding object came into direct contact with the switch and moved it to an approximate angle of 20 degrees from the bottom of the case, toward the divers arm. If this occurred, the UDM memory of the preceeding dive profile would be lost. Therefore installation of a switch locking device is considered appropriate. An optional "holster" is provided with this UDM which enables it to be carried on a high pressure hose or lanyard. This "holster" could be modified for use with straps, and would prevent accidental flipping of the on/off switch. Refer to Appendix H for further discussion and more detailed illustrations.

The instruction manual warns that the magnetic flip switch will affect a compass if it is held within 50 cm of the unit.

f. Battery Installation Connection. The battery clips are configured so that the battery cannot be installed with reverse polarity. An auxiliary clip is provided so that a fresh battery may be installed during a surface interval without losing the memory from dives within the previous 12 hours. The battery compartment was found to be reliably watertight during testing.

B. Divatronic UDM. During the initial phase of testing, unit 836, 215, 795, 861, and 864 failed to track depth accurately. Depth inaccuracy increased with depth, were common at all depths, and varied from true depth as much as 2 FSW at 10 FSW chamber depth, with proportionately increasing errors common as depth increased, to a maximum error of 26 FSW on two units at a depth of 230 FSW and 25 FSW on two units at a depth of 220 FSW. These inaccuracies were repeatable on each unit. Only one unit (889) proved to be accurate within specifications (except for the 230 FSW depth). The units were returned to the manufacturer for evaluation and repair. No explanation as to the cause of these discrepancies were provided by the manufacturer. The repaired units survived all test phases with acceptable depth tracking accuracy, except for units 889 and 795. Unit 889 failed to provide SAD information during the final dive of the profile tracking dive series. Unit 795 suffered a cracked case following the low temperature battery duration test.

The DIVETRONIC UDM test results provided in this text and enclosed Appendixes refer to the units returned after factory repair.

1. Pressure Transducer Accuracy/Temperature Sensitivity Tests. Appendix B (Figures B12 through B24) provides test results for pressure transducer accuracy dives at 29°F and 93°F water temperature. Examination of the data shows that the depth accuracy of the Divetronic UDMs was always within -1 FSW to +1 FSW to a depth of 220 FSW at 93°F. At 29°F the units were normally accurate to within -1 FSW to +2 FSW to a depth of 220 FSW at 29°F. Occasionally they deviated as much as +3 FSW, especially at depths below 130 FSW. Deviations of +4 FSW occurred at depths of 190 FSW and deeper, but were not common. The shallowest depth for errors outside of the ±2 FSW specification was 130 FSW. It is noteworthy that at 29°F water temperature to a maximum depth of 210 FSW, only one UDM ever provided a depth reading shallower than chamber depth, and this occurred on only one occasion at one depth (one unit read 9 FSW at an actual depth of 10 FSW on ascent only on one dive). At 93°F at a maximum depth of 220 FSW, depth readings shallower than true depth were more common, but never exceeded -1 FSW and occurred less often at shallower depths. Unit 889 was between -2 and -8 FSW in error during dives 1-5 at 29°F at a single depth of 220 FSW, but later leveled out to an accuracy which never exceeded -1 FSW deviation at this depth. The Divetronics UDMs do not track depth to 230 FSW, often displaying 222 FSW, and with a maximum error on one unit of 212 FSW. This appears to be a limitation of either the pressure transducer or the depth output circuitry.

Overall, depth readings deeper than actual depth were much more common than depth readings shallower than actual depth. Depth readings were more accurate at shallower depths. The UDMs were slightly more accurate on descent than on ascent, and were more accurate at 93°F than 29°F, although at 29°F the units displayed a deeper depth when a deviation occurred. All UDMs read zero on the surface.

The Divetronic UDM performed well down to 210 FSW. Inaccuracies below this depth did not effect shallower accuracies, suggesting a mechanical or logical limitation.

2. Long Term Stability/Temperature Sensitivity Tests. Appendix C (Figures C13 through C24) provides test results for long term stability dives at 29°F and 93°F water temperature. Examination of the data shows that depth readings did not vary more than ± 1 FSW during the 30 minute hold at each depth increment. Depth accuracy was normally within -1 FSW and +4 FSW to a depth of 200 FSW except for unit 836 on dive 4 at 93°F. Unit 836 displayed 198 FSW at a chamber depth of 200 FSW at the end of the 30 minute stop during this dive. Unit 864 on dive 3 at 93°F began to decay and finally ceased functioning at the 50 FSW ascent stop and on the surface after ascent. Unit 864 then returned to normal for the duration of all further tests. The units have a depth tracking limitation which is shallower than 230 FSW. Normally maximum depth is displayed as 222 FSW, but varies from 211 FSW to 224 FSW. All units displayed 0 at the surface, except for unit 864 on the one dive mentioned above.

Long Term Stability Tests resulted in depth tracking accuracy similar to Pressure Transducer Accuracy Tests (Test One). 200 FSW and shallower errors were all deeper at 29°F and -1 to +2 at 93°F (except for unit 864 which failed on Dive #3 at 93°F, Figure C21).

3. Repetitive No Decompression Dive Profile Tracking Tests. Appendix D shows the results of these dives for each Divetronic UDM. The top portion of each figure shows the result for the 2 FSW surface interval dive, the bottom for the 5 FSW surface interval. The surface interval depth would not affect the initial no-decompression limit. However, since the UDM would assume a 21% breathing gas for depths less than 3 FSW and a 0.7 ATA breathing gas for greater depths, the second no-decompression limit would be affected when taking a 5 FSW surface interval; the no-decompression limit for the second dive will be longer than taking a 2 FSW surface interval.

The differences between the Divetronic UDM and the HP 1000 reference for the 60 FSW no-decompression limit ranged from the Divetronic UDM having a 132 second longer to a 34 second shorter no-decompression limit. Since the depth for both the HP 1000 and UDM was only accurate to ±1 FSW, a depth difference of 1 FSW between the two would not be noticed. At 60 FSW this would result in at least a 3 minute difference in no-decompression time. Therefore the difference in no-decompression times between the HP 1000 and the UDM are well within the minimum depth accuracy limits.

The close tracking of SAD switches between the two profiles showed the switchover from 0.7 ATA to 21% O_2 at 3 FSW to be working properly. All time differences were well within limits imposed by the ±1 FSW minimum depth difference and were judged insignificant in terms of decompression stress. There was no evidence of any cumulative error.

4. Decompression Dive Profile Tracking Tests. Appendix E provides test results for decompression dives. Evaluation of the data shows that on dive profile a. (175 FSW for 60 minutes) at 29°F water temperature, UDM SAD change times at maximum dive depth (175 FSW) varied from 0 seconds to +76 seconds compared to computer SAD change times. UDM SAD change times during decompression varied from -134 seconds to +102 seconds. These changes are within the ±1 FSW depth resolution.

Dive profile a. at 93°F water temperature was the last dive conducted of the profile tracking test series, although this is not reflected in the sequence of data provided in this report. Unit 889 failed to provide SAD information during this dive, although the depth and time displays continued to operate. Failure of this unit prevented collection of test data only on the 175 FSW for 60 minute dive at 93°F, on the mud test, and on the four foot drop test. Collection of battery duration test data was still possible. Evaluation of the data from dive profile a. at 93°F on the five units which did not fail shows that UDM SAD change times at maximum dive depth varied from +2 seconds to +78 seconds compared to computer SAD change times. SAD change times during decompression varied from -100 seconds to +118 seconds.

During dive profile b. (150 FSW for 30 minutes at 29°F water temperature) UDM SAD change times at maximum dive depth varied from +2 seconds to +12 seconds. UDM SAD change times during decompression varied from -40 seconds to +18 seconds.

Overall, UDM SAD functioning was considerably more accurate at maximum dive depth than during decompression. This is consistent with [illegible] time periods required for SAD decreases to occur during decompression to the surface as compared to the more rapid SAD increases at [illegible] FSW dives resulted in greater SAD functioning accuracy than [illegible] dives. This may be due in part to the greater frequency of SAD [illegible] FSW (SAD values up to 90 FSW) and longer decompression times [illegible] this depth. These factors were also a function of the longer [illegible] 175 FSW. Although the maximum overall UDM SAD change deviations [illegible] during the 175 FSW dives was -134 seconds and +118 seconds, this [illegible] is excessively deep and long, and these time differences are [illegible] within the ±1 FSW depth resolution. The UDMs were slightly more accurate at 29°F water temperature than at 93°F water temperature.

UDM warning status data is charted along with SAD functioning data on the decompression dive profile tracking dives in order to provide a better overall evaluation of warning status functioning. An evaluation of warning status data is discussed in the warning status test result section of this report. The large discrepancies in warning status changes which occurred during testing covered in this section are attributed to observation errors on the part of test technicians.

5. Repetitive Decompression Dive Profile Tracking Tests. Appendix G provides test results for repetitive decompression dives. Twenty SAD changes occurred on each profile. The maximum SAD was 50 FSW. Evaluation of SAD functioning data indicates that the time differences observed between the HP 1000 and the UDM are within the differences expected for a 1 FSW depth difference, indicating proper algorithm functioning.

6. Warning Status Tests. Appendix H provides the results for warning status test dives. Warning status functioning data was also charted on the decompression dive data sheets (Appendix F) and repetitive decompression dive data sheets (Appendix G) in order to provide a better evaluation of warning status functioning. The warning status data collected during these dives proved to be innacurate, so Appendix H provides a more specific focus on UDM warning status functioning. Recording of warning status data on decompression dive profile b. (150 FSW for 30 minutes) and on repetitive decompression dives proved to be an advantage. It was discovered that the UDM warning status (SAD display blinking) secured at approximately the same time that the UDM 10 FSW SAD value changed to 0 FSW during decompression. During the repetitive decompression dives, the warning status resumed at approximately the same time that the UDM SAD changed from 0 FSW to 10 FSW at maximum dive depth, on the repetitive dive. Although the test data does not indicate that this is precisely the case, interviews with the test technicians who recorded the data suggests that during decompression dive profile b. and repetitive decompression dives, test technicians focused on SAD information recording during the long, up to seven hours duration, dives. Occasions occurred when warning status information was not properly recorded due to inadvertent oversite by test technicians. This is apparent in Figure F1 and Figure F11.

An additional test was conducted to confirm the suspicion that the UDM may have been designed so that the SAD display does not flash unless a SAD value is indicated (other than 0 FSW). UDM 215 was dove to a depth of 175 FSW for approximately 24 minutes (to initiate the warning status) and decompressed to 10 FSW. When the 10 FSW SAD changed to 0 FSW, flashing secured. SAD flashing resumed when the 0 FSW SAD value changed back to 10 FSW upon recompression of the UDM from the 10 FSW depth. This test was repeated on a similar profile, except the UDM was decompressed to the surface prior to recompression to depth. The same results occurred as on the previous test. It is therefore evident that a 0 FSW value on the SAD display will not flash even though the UDM may remain in the "warning status loop."

A modification should be made to the Divetronic UDM so that this will not occur on production run models.

The warning status test profile was designed so that the warning status would initiate, secure, and re-initiate on each dive. A comparison of UDM warning status initiation time and extinguishment time to computer warning status initiation and extinguishment time in seconds is provided as follows:

	UDM 889	UDM 864	UDM 861	UDM 836	UDM 795	UDM 215
Initiation	+16	+8	+14	+18	+14	+12
Secure	+82	+114	+118	+38	+108	+74
Initiation	+4	+2	0	+8	+2	+2

UDM warning status functioning always occurred after computer warning status functioning except for the re-initiation on UDM 861, which occurred at the same time as the computer. Minus 2 and +4 second time differences may be attributable to test technician time delays in programming warning status and depth change information into the computer.

7. Battery Duration Evaluation.

a. Phase I. Backlight on battery duration test, power activation 24 hours after charge. Elapsed times to low battery warning indication and power depletion are provided below. All times are rounded off to the nearest half hour.

	Unit 215	Unit 795	Unit 836	Unit 861	Unit 864	Unit 889
Low Battery Warning	14.5 hours	14.5 hours	14 hours	12 hours	11 hours	12 hours
Battery Depletion	17.5 hours	16 hours	15.5 hours	13.5 hours	11.5 hours	12.5 hours

The U.S. Navy specification for battery duration is 12 hours with fully illuminated backlighting. Unit 864 was the only UDM which did not meet this specification, suffering a battery depletion in 11.5 hours.

b. Phase II. Backlight off battery duration test, power activation 24 hours after charge. Elapsed times to low battery warning indication and power depletion are provided below.

	Unit 215	Unit 795	Unit 836	Unit 861	Unit 864	Unit 889
Low Battery Warning	80 hours	81 hours	79 hours	65 hours	84 hours	65 hours
Battery Depletion	90 hours	85 hours	81 hours	70.5 hours	85.5 hours	67 hours

c. Phase III. Backlight off battery duration test, power activation 72 hours after charge. Elapsed times to low battery warning indication and battery depletion are provided below.

	Unit 215	Unit 795	Unit 836	Unit 861	Unit 864	Unit 889
Low Battery Warning	75 hours	76 hours	68 hours	65.5 hours	80 hours	62 hours
Battery Depletion	81 hours	81 hours	74 hours	78 hours	83 hours	64 hours

d. Phase IV. Backlight off battery duration test, power activation 120 hours after charge. Elapsed times to low battery warning indication and battery depletion are provided below.

	Unit 215	Unit 795	Unit 836	Unit 861	Unit 864	Unit 889
Low Battery Warning	67.5 hours	46 hours	59.5 hours	20 hours	70 hours	72 hours
Battery Depletion	83 hours	63 hours	70 hours	48.5 hours	80 hours	83 hours

The 120 hour delay in power activation after a four hour charge did not result in pronounced reductions in battery duration during this test run, except for unit 861 which still provided acceptable times.

e. Phase V. Backlight off low temperature battery duration test. Elapsed times to low battery warning indication and battery depletion during exposure to 10°F air temperatures are provided below..

	Unit 215	Unit 795	Unit 836	Unit 861	Unit 864	Unit 889
Low Battery Warning	90 hours	47.5 hours	47.5 hours	16 hours	52 hours	58.5 hours
Battery Depletion	95 hours	75 hours	76 hours	26 hours	62 hours	70 hours

It is noteworthy that the environmental extremes provided during the test did not result in pronounced battery depletion, except for unit 861 which still survived well over the U.S. Navy specification of 12 hours minimum, although backlight illumination was not activated for this test. This unit also suffered a noticeable power drop during Phase IV. An operational dive with unit 795 two days after test completion resulted in immediate floodout when the diver entered the water. Examination of the case revealed a crack in the area surrounding the on/off switch. Whether the crack occurred as a result of the cold temperature test or as a result of an unnoticed impact is unknown. Survival of the remaining five units during the four foot drop test (paragraph 10 of this section) would seem to indicate that the temperature extremes resulted in the cracked case.

The battery warning function was found to activate prior to battery depletion on every battery test run at 1 ATA, providing warnings from 1.5 hours to 28.5 hours prior to battery failure during backlight off battery duration tests, with an averaged time of 10.7 hours prior to battery depletion. Backlight on battery duration tests resulted in battery warning function activation from 30 minutes to three hours prior to battery depletion, with an average time of 1.4 hours prior to battery completion.

Overall, battery duration times from unit to unit during backlight off tests varied from 26 hours on unit 861 during Phase V to 95 hours on unit 215 during Phase V, with an overall average battery duration average of 56 hours.

8. Mud test. A comparison of Divetronic UDM depth readings to chamber depth is provided below. The results demonstrate acceptable pressure transducer accuracy (within the ±2 FSW specification), ranging from -2 FSW to +0 FSW to a depth of 220 FSW, and "pegging out" at 222 FSW.

Chamber Depth (FSW)	UDM Depth Reading					
	Unit 215	Unit 795	Unit 836	Unit 861	Unit 864	Unit 889
20	19	19	19	19	18	19
40	39	39	39	40	39	40
60	59	59	59	59	59	59
80	80	80	80	80	80	80
100	100	100	100	100	100	100
120	119	119	119	119	119	119
140	140	140	139	140	140	140
160	159	159	159	160	159	160
180	180	180	180	180	180	180
200	200	200	200	200	200	200
220	220	220	220	220	220	220
240	222	222	222	222	222	222

9. 500 FSW Watertight Integrity Test. Divetronic UDM 215 and 836 were exposed to a depth of 230 FSW for a 24 hour period and units 861, 864, and 889 were exposed to a depth of 500 FSW for a 24 hour period. Unit 795 experienced a cracked case during previous testing. Units pressed to the same depth were found to have recorded ascent times within one minute of each other (units read in whole minutes, so precise variations are unknown) at the time of surfacing. All units were found to be operable with no obvious flooding or damage, except for unit 889 which suffered a SAD display failure during previous testing, but otherwise performed acceptably. Pressure transducer accuracy and display functioning was then successfully tested on all units at 20 FSW intervals during descent and ascent to a depth of 220 FSW. Test results provided below show functioning similar to the pressure transducer test series (Appendix B). Following the pressure transducer test dive all units were disassembled and checked for leakage. No moisture was found.

Chamber Depth (FSW)	UDM Depth Reading									
	Unit 215		Unit 836		Unit 861		Unit 864		Unit 889	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
20	20	20	20	20	20	20	19	19	19	19
40	40	40	40	40	40	40	39	39	39	39
60	60	60	60	60	60	60	59	59	59	59
80	81	81	80	80	80	81	80	80	79	79
100	100	101	100	100	101	101	100	100	99	99
120	121	121	120	120	121	121	120	120	119	120
140	141	141	140	140	140	141	140	140	139	140
160	161	162	160	160	161	161	160	160	160	160
180	182	182	180	181	182	182	181	181	180	180
200	202	202	200	201	202	202	201	201	200	200
220	222	-	220	-	222	-	221	-	220	-

↓ = Descent
↑ = Ascent

10. Four Foot Drop Test. The five functioning Divetronic UDMs remaining from previous testing were dropped from a height of four feet on a concrete floor, impacting at various angles, including display face down and on/off switch impacts. Units were then submitted to a 60 FSW no decompression dive, one hour surface interval, and 120 FSW repetitive no decompression dive. All units were found to function acceptably, accurately monitoring depth, no decompression time, and dive time, except for unit 889 which suffered a SAD display failure during previous testing. Depth and dive time functions were found to be accurate on this unit. Display information was clear on all units and no damage to the case or display face was found after careful examination. No leaks occurred during the dive.

11. Display Functioning and External Hardware. This section discusses the various functioning characteristics of the Divetronics UDM display and external hardware which were verified during testing. Display lettering is LCD (liquid crystal display), lights are LED (light emitting diode). A backlight switch is provided. Figure 6 provides a drawing of the Divetronic UDM display layout. Appendix I provides further illustrations of external hardware.

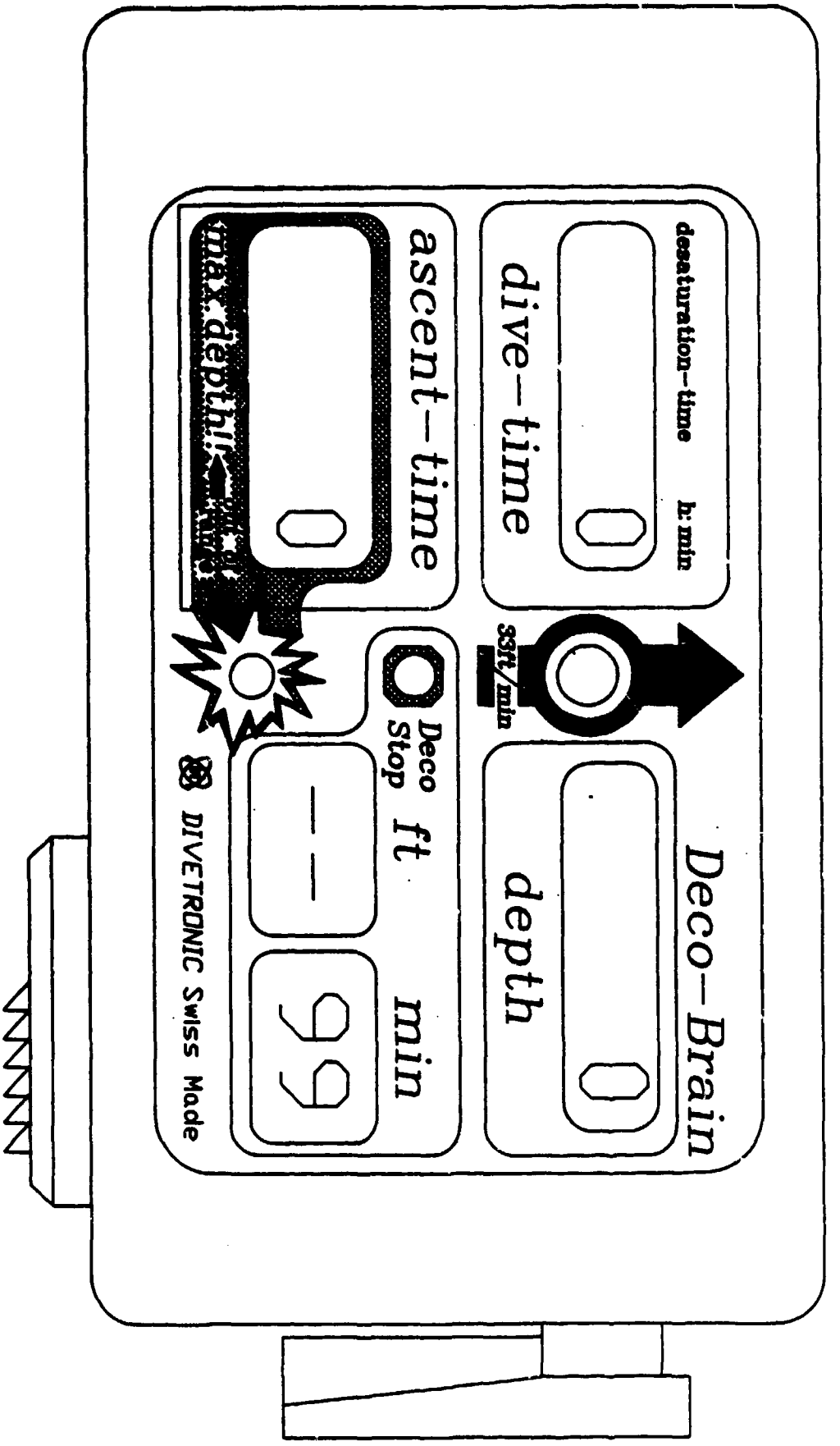


Figure 6. DIVETRONIC UDM Drawing (not to scale) .

a. **SAD display functioning.** At 1 ATA the SAD time ("min") and depth ("ft") displays scroll no decompression time limits for various depths as outlined below.

FSW	No Decompression Time (Minutes)
30	99
40	99
50	99
60	73
70	51
80	39
90	32

No decompression time limits are only provided to a depth of 90 FSW because the SAD display only provides two digits (10's, 1's). U.S. Navy specifications called for 2 digits (100's, 10's). At 30, 40, and 50 FSW the UDM scrolls a no decompression time of only 99 minutes because the SAD "min" display (time at stop) is only capable of showing two digits (10's, 1's), which is in accordance with U.S. Navy specifications. Three digit displays on SAD depth and time windows should be provided on future models. At 60 FSW the UDM scrolls 73 minutes instead of 73 minutes and 59 seconds because the time display counts whole minutes only. Regardless of the displayed no decompression time of 73 minutes, the actual UDM no decompression time would be 73 minutes and 59 seconds. When the UDM no decompression count down function reaches 0 minutes, the 10 FSW SAD activation will not occur until the given amount of additional seconds (less than one minute) expires.

The no decompression time limits are only representative as a guide for general planning purposes. The the no decompression times scrolled on the UDM display prior to the dive or during surface intervals between repetitive dives assume the entire upcoming dive will be spent at the given depth, and do not include descent times and descent depths attained during travel to the given depth. During surface intervals between repetitive dives the remaining no decompression times at depths up to 90 FSW will begin scrolling on the SAD display after a period of approximately 10 minutes on the surface. This function is not required by U.S. Navy specifications, but provides information useful to dive planning, and is only provided during a surface interval.

During a no decompression dive the UDM counts down the remaining no decompression time limit for the actual depth shown in the UDM "depth" display. This information is provided in the SAD "min" display in whole minutes. Meanwhile the SAD "ft" display shows two dashes, as illustrated below:

Depth Display →

DEPTH
60

SAD Display →

DECO STOP	FT	MIN
	—	73

The SAD "min" display counts down by whole minutes until within 5 minutes and a given number of seconds (less than 60 seconds). At this time the SAD display begins blinking as it continues to count down to zero. The blinking warns the diver that he is nearing the no decompression time limit. When the count down reaches zero it is an indication that less than one minute no decompression time remains at that depth.

Flashing of the SAD display should be eliminated for this function as it may be mistaken for a warning status. Additionally, the blinking draws the divers attention to a situation which does not normally require positive action on the part of the diver. This is discussed further in Appendix I.

Once a 10 FSW decompression stop is incurred, the SAD display stops blinking, the SAD "ft" display reads "10" and the SAD "min" display reads "1" and begins counting up the increasing amount of time the diver must remain at the 10 FSW decompression stop in whole minutes. The SAD "min" display restarts from "1" each time a deeper stop is incurred and continues to count upward in whole minutes. This process continues until the UDM depth decreases to a depth which is shallow enough to result in sufficient decompression (tissue offgassing) to begin a reversal of the increasing decompression time obligation, at which time the SAD "min" display begins counting down. If depth is maintained shallow enough to continue adequate decompression (tissue offgassing), the SAD "ft" display will eventually change to the next shallower SAD stop and the "min" display will restart the count down, until sufficient decompression is achieved to continue the dive in a no decompression status or allow surfacing. If the UDM rises shallower than the SAD the UDM will provide a warning (discussed later) but will continue to provide decompression information based on actual depths attained for the actual time during the shallow period. This will result in a slower decrement of decompression stop time associated with shallower depths attained.

b. Deco Stop light. The Deco Stop light is yellow in color and is located adjacent to the SAD "ft" and "min" displays. This light provides a steady illumination when the UDM depth matches the SAD, or is within 1 to 3 FSW deeper than the SAD. If the UDM ascends shallower than the SAD (even to the surface) the Deco Stop light will flash alternately with the out of range light, and will continue to flash until the UDM descends to the SAD or deeper.

The Deco Stop light will cease illumination when traveling between stops, or after the 10 FSW SAD expires. When the warning status is initiated, the Deco Stop light flashes when the SAD display blinks, will remain on continuously when at the SAD, and will flash while ascending to the initial SAD or ascending to the next shallower SAD as long as the UDM remains in the warning status function. During warning status functioning the Deco Stop light will go off when the 10 FSW SAD expires, or if the SAD display reaches 90 FSW and the maximum obligated time than can be acquired at the 90 FSW SAD for the given dive profile is accumulated with UDM depth still remaining deep enough to continue the accumulation of obligated decompression time.

This light should actually only illuminate when the diver is too shallow, ascending past the required decompression stop.

c. Out of range light. The out of range light is red in color and will flash alternately with the Deco Stop light if UDM depth is less than the SAD. The out of range light will flash independently if the SAD display reaches 90 FSW and the maximum obligated time that can be acquired at the 90 FSW SAD, for the given dive profile, has accumulated with UDM depth still deep enough below the SAD to continue the accumulation of decompression time. When this occurs the Deco Stop light ceases flashing and the SAD display coutinuously scrolls the decompression obligation (the decompression stop depths and times required at each decompression stop) which existed when the out of range light initially illuminated. The ascent time will also remain at the value attained when the out of range light initially illuminated. The dive time display will continue to function, as well as the depth display. If UDM depth then decreases to the SAD or shallower (even to the surface) the SAD display will continue scrolling, and will not decrease SAD values or decompression times (nor will the ascent time change or Deco Stop light function) until the UDM is turned off. Turning the UDM back on will restart all functions and the UDM will recalibrate itself for a new dive profile with no prior decompression obligation. The "out of range" labeling includes an arrow which points to a "max. depth!!" label. This light was not found to function when maximum UDM depth was achieved or exceeded.

d. Ascent time display. The ascent time display indicates the total time to surface (TTS) assuming the diver begins immediate decompression. This display is designed to correspond to an ascent travel rate of 60 feet per minute (FPM), however, this time is only precise within at least 30 seconds due to the display reading out in whole minutes. When the depth display reads between 0 and 30 FSW, the ascent time display on a no decompression dive reads "0". Between 31 FSW and 90 FSW the display reads "1" (minute). Between 91FSW and 150 FSW the display reads "2", and so on. During decompression dives the ascent time is the sum (in whole minutes) of the decompression stop times and the ascent travel time at a rate of 60 FPM from the given depth to the surface. Four digits were required on this display by U.S. Navy specifications, providing hours and minutes. This display provides ascent time in minutes only, and three digit times are the maximum that can accumulate prior to the out of range function "freezing" the display as described in the preceding section (c.).

If the UDM is left on after surfacing, the ascent time display will provide the maximum depth attained during the dive approximately every 30 seconds. This will occur within the first ten minutes of surface interval only, after which the maximum depth attained is provided by the "depth" display. The maximum depth attained will blink on and off five times for five seconds total duration, initiating every thirty seconds (approximate times).

e. Dive time display. The dive time display indicates the total time of dive in minutes (four digits). Four digits were required on this display by U.S. Navy specifications, providing hours and minutes. This display is labeled "h:min" but time is provided in minutes only. This display counts up in whole minutes from zero once the UDM reaches or exceeds a depth of 2 FSW (it is a pressure activated function). If UDM depth decreases to 0 FSW, the dive time display will "freeze" at the time indicated when

surfacing. After 10 minutes on the surface has elapsed, the display will revert back to zero (as long as no ascent criteria has been violated, i.e. decompression time still remaining), and any repetitive dives will be counted up from zero. If a dive is continued within a 10 minute surface interval, the total time of dive provided on the display, from the initial portion of the dive, will continue to count up in whole minutes once a depth of 2 FSW is achieved on descent during the second portion of the dive. After ten minutes surface interval has elapsed with the UDM left on, the dive time display will provide the total time of dive (15 seconds on, 15 seconds off).

f. Ascent rate light. The labeling provided on the ascent rate light is "33 ft/min". The commercial version is designed to flash at 2 second intervals when ascending at 33 FPM, increasing the flashing as ascent rate increases, with steady illumination if an ascent rate of 66 FPM is reached or exceeded. The actual ascent rate allowed by the UDM prior to any light illumination is approximately 66 FPM in the U.S. Navy configuration. If the light is illuminated due to the ascent rate exceeding 66 FPM, slowing down the ascent rate to the required parameters will extinguish the light. When ascending at a rate less than 66 FPM the ascent rate light will not flash at periodic intervals.

g. Depth display. The depth display is provided in three digits. Pressure transducer testing has indicated that the depth display will "peg out" at depths from 218 to 222 FSW, even though the U.S. Navy specification is 230 FSW. The depth display will not register 1 FSW. A depth of 2 FSW will activate the dive time and ascent time function. After ten minutes surface interval has elapsed with the UDM left on, the depth display will provide the maximum depth attained during the dive (15 seconds on, 15 seconds off).

h. Backlighting. The backlighting switch is located on the bottom portion of the UDM case under the SAD display. It is a magnetic, sliding switch which includes a spring that maintains the switch in the off position unless physically held in the on position. This configuration was presumably designed to save power. Section V.B.7. of this report provides the results of battery duration tests conducted with backlighting on and backlighting off, and demonstrates the substantial power drain that occurs when the lighting function is left on continuously. The backlighting switch was found to be easily accessible even with three fingered neoprene gloves. It also proved to be reliable. The bottom of the switch is serrated to provide a gripping surface for the gloved operator.

i. External Pressure Transducer Fitting. The "dive simulator" allows the operator to perform pre and post dive checks on the proper functioning of the unit, and provides an excellent training aid for unit functioning. The pressure transducer cavity must be filled with water prior to installation of the "dive simulator" in order to simulate deeper depths. Appendix I provides an illustration of the "dive simulator".

j. On/Off Switch. This switch is a biege handle, 4.1 cm in length, protruding 1.0 to 1.2 cm from the case. It uses a strong spring loaded positive action device to prevent accidental activation or deactivation of the unit. As the unit is not designed to be turned on underwater, the handle is not large enough to be pulled and turned when wearing heavy thermal protection on the hands.

k. Battery Recharger. The recharging device can be set at 110 or 220 volts AC. An optional 12 volt DC cigarette lighter charger is advertised but was not provided for evaluation. Charging can be conducted with the unit on so as to retain the memory function during surface intervals between repetitive dives. Because NiCad batteries can develop a "memory", recharging should only be conducted when the low battery warning has initiated. Overcharging should be avoided. Four to five hours is all that is required, not to exceed 12 hours by manufacturers recommendation. NiCad batteries should be stored discharged in a cool environment. Appendix I provides an illustration of the battery recharger.

VI. DISCUSSION

A. UDM Algorithm Specificity. UDM's consist of two major components, hardware and software. The hardware contains an output display, central processing unit (CPU) and memory function capable of programming with any suitable algorithm. Testing at NEDU was designed to test hardware: the ability of the unit to accurately monitor depth; long term reliability under environmental extremes; CPU computational accuracy; and suitability of case and display characteristics.

Any suitable algorithm could have been used for the conduct of the test series discussed herein. The EL MK 15/16 RTA was the first computer algorithm developed at NEDU and was implemented into the prototype UDMs because this was considered to be the first application that would be required. If another U.S. Navy algorithm had been used, it would not have had an impact on the results of this report. Reference 4 provides results of Air-N_2O_2 decompression computer algorithms development. Alternative algorithms may have future UDM application.

B. General UDM Performance. Neither UDM tested is suitable for long term USN application, however the Divetronic UDM could be modified to meet short term needs, as discussed below:

1. Depth Tracking. Both prototype models tracked depth accurately when working properly. The ORCA UDM depth transducer proved unreliable, and did not survive repeated pressurizations. The Divetronic UDM pressure transducer was not accurate below 210 FSW but was acceptable in all other regards. While not meeting the USN specification for maximum depth accuracy, 210 FSW will meet current N_2O_2 or air diving needs. This unit will not meet HeO_2 diving needs.

2. CPU Performance. The Divetronic CPU functioned satisfactorily and the units computed the correct dive profile when the depth input was

accurate. All errors could be attributable to pressure transducer inaccuracies. CPU testing on the ORCA prototype was limited, but was found to be accurate to the extent tested.

3. Displays. Of the two units tested, the Divetronic display was the most suitable. Its major shortcomings include the two digit stop time display and two digit safe ascent depth (SAD) display limitation. In current air or N_2O_2 diving, stops below 90 FSW would not be encountered within the current depth/time domain limitation. Stop times over 99 minutes, however, may be encountered. Under the current limits of the depth/time domain these long stops would not be encountered below 10 FSW, and since the total ascent time display will provide the entire time remaining at 10 FSW, this display could be used if the stop time display is pegged out at 99 minutes.

The warning lights as provided on the Divetronic model includes some auxiliary display functions which may be confusing to the diver and are not useful. The display output should be steady except when the warning status is activated. Display reprogramming will be discussed later. A means of covering the display (i.e. velcro cover or other means) is needed for Special Warfare use.

4. Warning Status. A revised warning status algorithm will be provided separately. The warning status algorithm programmed in the current units is unsuitable.

5. Battery Duration. The ORCA UDM did not provide backlighting so the battery duration with the display fully illuminated could not be tested. The Divetronic units generally met the USN specifications, however this model should incorporate a low battery indicator when submerged. Presently the low battery indication function is only provided when on the surface.

6. Display Output Interface. Neither UDM model provided a port or plug arrangement in order to read the digital display output information on a remote device. U.S. Navy specifications called for an edge connector on the circuit board so that direct computer interface between the UDM and an external monitoring device would be possible for test purposes. The absence of such a device required a modification to the test set up and test procedure which required manual programming of UDM display functioning information into the HP 1000 computer for test data production. Specifically, manual programming of UDM depth, SAD, and warning status functioning information into the HP 1000 computer for direct comparison to HP 1000 algorithm functioning on the same dive profile resulted in a variable degree of human error which effected the precise accuracy of test results. However all profile times were still within errors expected if UDM depth and actual depth differed by 1 FSW.

The lack of compliance with this specification on the part of the manufacturer may have been due to developmental, cost, or watertight integrity concerns. Although the test data provided in this report is considered sufficient to establish UDM profile tracking reliability within a reasonable degree of accuracy, future UDM development should include a digital display

output interface connector. The advantages of such an arrangement includes simple and accurate UDM testing at NEDU and fleet diving activities.

7. Leak Check Plug. The concept for use of a leak check plug is provided in Section III.A.8. of this report. This should be included in future models. The UDM would be placed in a pressure chamber with a hard pipe connected to it through the leak check port, which extends external to the chamber and is connected to a sensitive pressure transducer. The UDM is then pressurized at 50 FSW increments. Initially case compression will cause some pressure increase, but this will stop if there are no leaks. Any leaks will cause a pressure increase inside the case which will register on the pressure transducer.

C. Suitability for ANU

1. ORCA UDM. The ORCA prototype model UDMs suffered from reliability problems as a result of water leakage into the case and failures of the pressure transducer. The watertight integrity and pressure transducer problems are felt to be inter-related. The commercially available sport diving model contains a pressure transducer which is capable of a maximum depth of 160 FSW. Modification of this transducer to meet U.S. Navy specifications of depth tracking accuracy from 0 to 230 FSW proved to be unreliable, resulting in leakage of transducer oil inside the case on several occasions. This loss of oil may have also affected the watertight integrity within the pressure transducer cavity, resulting in slight water leakage which contaminated the electronics. Discussions with the manufacturer indicates that the blow by threshold of the pressure transducer may have been altered with time. When this problem was experienced commercially, shims were installed which were designed to bring the blow by threshold back into originally specified tolerances. The new shimmed transducer arrangement was not tested at NEDU and would require evaluation for reliability.

The ORCA UDM did not meet several important U.S. Navy specifications. Display backlighting is considered essential, and must be developed for an ORCA version of a U.S. Navy UDM. Red/Green light signalling functions for violation/compliance is also considered essential. Additionally, a threaded pressure transducer to accept a standard fitting is required for acceptance and periodic UDM testing by fleet diving activities.

Appendix H provides a more detailed human factors evaluation of the ORCA prototype UDM and discusses further recommended changes.

As a result of the discrepancies discussed above, profile tracking testing of the ORCA UDM was not conducted. The numerous design modifications which are required for this unit to meet U.S. Navy specifications, as well as the reliability shortfalls experienced, did not justify the major investment of man hours and test equipment required to conduct this phase of testing. The repetitive no-decompression dive conducted after the four foot drop test resulted in acceptable programming or one unit on one dive, but this was the only profile tracking test conducted on any of the ORCA UDMs. Therefore extensive dive profile testing is warranted prior to consideration of a new version of the ORCA UDM for U.S. Navy use.

2. Divetronic UDM. This model is a large, heavy UDM, but provides highly readable displays (including backlighting), ease of operation and maintenance, and acceptable depth and dive profile tracking accuracy in a wide temperature spectrum. Failure modes experienced during testing include a cracked case following a low temperature (10°F) extended duration (from 26 to 95 hours) battery duration test (although battery duration proved to be acceptable during this temperature extreme), and failure of a SAD display to function on one unit, which occurred when testing was nearing conclusion. The cracked case on unit 795 occurred after 75 hours exposure to the 10°F air temperature. This is an indication that this instrument should be protected from harsh environmental extremes above water. High temperatures (above 93°F) may also have a detrimental impact on the electronics, although this was not evaluated at NEDU. Overall reliability was proven by the extensive nature of testing, including; continued handling over a lengthy time frame, mud test, 500 FSW test, four foot drop test, and repeated pressurizations at 29°F, 93°F, and ambient salt water temperatures. Electromagnetic Interference (EMI) testing has yet to be conducted on these units.

3. Modifications for Improved Compliance with USN Specifications. The Divetronic UDM can be made suitable for air or N_2O_2 diving within a restricted depth/time domain if some modifications are made.

a. Display: Changes to display functioning are recommended for simplification in accordance with human factor and information processing guidelines. The stop time and SAD display positions should be reversed so that the 10's digit of the SAD falls directly below the 10's digit of the depth. The warning lights should be relabeled/reconfigured so that the ascent rate warning light illuminates a green LED. The three lights currently available on the Divetronic UDM display should be programmed to function as follows:

> Green Light - On if depth 2 FSW or more below the SAD. Off at all other times. This light is currently red on the Divetronic prototype UDM tested at NEDU and is used to indicate too fast of an ascent rate.
>
> Yellow Deco Stop Light - On if within 2 FSW deeper or 1 FSW shallower than the SAD. Off at all other times. The yellow and green light should never be on at the same time.
>
> Red Light - On steadily if more than 1 FSW shallower than the SAD. This mode will never be on if either the yellow or green light is on. Flashing should occur if either the SAD or depth display flashes due to activation of the warning status. This light is currently used to indicate max depth out of range on the Divetronic prototype UDM tested at NEDU.

b. Warning status: A new warning status algorithm is provided as Appendix J. Additionally, the SAD should be programmed to flash if it reaches 90 FSW.

c. Programming: All current control of display flashing and warning light functioning should be eliminated. The displays should read steady unless the warning status is activated.

The above modifications will make the Divetronic useful for N_2O_2 diving breathing a 0.7 ATA PO_2 for all dives above the limit line in the tables presented in reference 3. Additionally, these display modifications would allow dives within the depth/time domain listed below if the current air algorithm was programmed into the units:

Depth (FSW)	/	Time (MIN)
40	/	300
50	/	240
60	/	240
70	/	170
80	/	150
90	/	130
100	/	110
120	/	90
130	/	80
140	/	70
150	/	60
160	/	60
170	/	50
180	/	50
190	/	40

In all of the above dives the 20 FSW stop never exceeds 99 minutes. In some cases the 10 FSW stop does exceed 99 minutes but in this case the total ascent time display will show the entire 10 FSW stop time.

D. Specification Modification. As a result of this evaluation certain aspects of the UDM specification, as previously discussed, should be changed.

1. Depth Range. If the UDM is to be used with a nitrogen diluent the current specification is satisfactory. However, if the unit is eventually to be used for HeO_2 diving the depth range accuracy should be increased to 450 FSW.

2. Microprocessor. Rather than an edge connector for display output a true computer interface should be provided. The specifications for this are provided as Appendix K.

3. Display Readouts and Lights. Times in either minutes or hours:minutes are acceptable. The stop time display should be 3 digits.

a. Too Shallow Light: Illuminates red steadily on if 1 FSW or more shallower than the SAD, otherwise it is off as long as the warning status

has not been activated. If the warning status is activated at any time or depth during the dive (either a flashing depth or SAD display) the red light should continue flashing until the warning ceases.

b. Algorithm Compliance Light: Illuminates green steadily on if 2 FSW or more deeper than the SAD. It should flash on and off if within +2 FSW to -1 FSW of the SAD. Thus the diver will find he is at the appropriate stop depth without having to turn on the UDM backlighting. During decompression the diver will ascend until the green light changes from steady to flashing, but not so shallow so as to illuminate the red light. When the SAD decrements to the next shallower stop the green light will stop flashing and illuminate steady, indicating ascent to the next stop is possible.

c. Combined Light Indicator Functioning: The combined red light/green light function will allow a diver to know what his decompression status is at any time without having to turn on backlighting. At the beginning of the dive the green light will be steadily on. If at any time the diver ascends towards his SAD, the green light will start to flash when 2 FSW deeper than the SAD. When he ascends more than 1 FSW shallower than the SAD the green light will go out and the red light will be on steadily. When the diver descends to within 1 FSW of the SAD the red light will go out and the green light will flash and become steady as depth increases. Thus whenever the red light is steadily on, the green light is out.

If at any time or depth during the dive the warning status is activated then the red light will begin to flash (red light flashing could also signal a low battery). When the red light flashes the diver will have to turn on the UDM backlighting to see exactly what the problem is (maximum depth exceeded, maximum time at current depth exceeded, low battery). This flashing will not affect the green light, which will be steadily on or flashing as described above. However, should the diver ascent shallower than the SAD the green light will extinguish. Thus a flashing red with the green on indicates a warning but diver is within algorithm compliance. A flashing red light with no green light indicates a warning and the diver too shallow.

d. Case Identification: In addition to color coding, a semipermanent label should be attached to the face indicating the particular algorithm programmed into the unit.

VII. CONCLUSIONS

A. ORCA UDM. The ORCA UDM proved to be unreliable and cannot be recommended for ANU status without a complete reevaluation of an improved unit.

B. Pending the successful outcome of EMI testing, the Divetronic UDM is recommended for ANU status if the following modifications are made:

- Display reconfigured as discussed in the Modifications for Improved Compliance with USN Specification in the discussion section of this report (Section VI.C.3.).

- Reprogrammed with revised warning status algorithm and 40 minute tissue tension limits, provided as Appendix J.

- Future UDMs should conform to the current USN specifications modified as noted in Section D. Specification Modification in the discussion section of this report (Section VI.D.).

- A standard UDM design should be adopted which can be used to 300 FSW. For dives deeper than 300 FSW a diver carried pressure transducer connected to a topside UDM may be more appropriate for the rare instances when bounce diving to these depths are conducted. Dives to these depths might more likely be conducted in a saturation mode.

- Strong consideration should be given to providing a computer interface instead of an edge connector for display readout. Proposed specifications for this interface are provided as Appendix K.

- Careful attention should be paid to developing user level UDM test and verification procedures to ensure proper functioning on a regular basis. It is preferable to conduct these checks without a pressure chamber by using the threaded pressure transducer connector. A suitably programmed microcomputer linked to the interface should verify proper UDM functioning and accuracy with a minimum of manpower and effort.

VIII. REFERENCES

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APPENDIX A

DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407

IN REPLY REFER TO:

NAVY EXPERIMENTAL DIVING UNIT

TEST PLAN - LONG FORM

MK 15 UDC TEST AND EVALUATION

Test Number: 85-37

DECEMBER 1985

Prepared by:	Reviewed by:	Approved by:
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Distribution: Codes 00, 01, 02, 023, 025, 03, 04, 05, 051, 055
ORIGINAL TO NEDU TECHNICAL LIBRARY

1. Test Title. MK 15 UDC test and evaluation.

2. Test Number. 85-37.

3. References

(a) NAVSEA Task Assignment 84-04
(b) NEDU Test Plan 83-17
(c) NEDU Test Plan 84-04

4. Introduction. Per reference (a), the purpose of this test is to perform unmanned dives with prototype MK 15 UDCs to assess pressure transducer accuracy, temperature sensitivity, battery duration, long term stability, watertight integrity, and unit correlation with NEDU algorithm. A human factors evaluation will also be conducted, including both a bench evaluation (dry), and open water dives under conditions of darkness and turbid water.

This test plan supersedes references (b) and (c), and incorporates the experience gained from previous UDC testing in the EDF. As additional testing experience is gained, publication of a further updated test plan may be warranted, with the goal of providing a standard test to be used in all UDC tests in the future, including testing of UDCs programmed with other algorithms developed at NEDU. The UDCs presently in custody at NEDU have been programmed with the 0.7 ATA PPO_2 in N_2 Algorithm, designed for use with the MK 15 UBA. Development of a standard test procedure to be used by fleet units will also be required, which may include development of portable test equipment.

5. Program. Each UDC model will undergo a comparative evaluation under the same test conditions in accordance with this test plan. Proper functioning of the UDC display will be checked throughout the test, including monitoring of UDC timekeeping accuracy. The repetition of dives will provide a basis for a statistical evaluation of UDC profile tracking accuracy under continuous handling. Testing will consist of five unmanned phases, using the Bethlehem Chamber in the EDF, followed by a human factors evaluation. All tests are provided below:

a. TEST ONE: Pressure Transducer Accuracy/Temperature Sensitivity. Six UDC units will be stored at room temperature and placed in the Bethlehem Chamber in a saltwater bath and dove to a maximum depth of 230 FSW, stopping at 10 FSW increments for 30 seconds during both descents and ascents to record depth accuracy. The purpose of these dives is to test the depth accuracy of the UDC's pressure transducer. UDC depth readings will be compared against those of the Bethlehem Chamber digital depth gauge which had been previously calibrated. Each unit will be tested in this manner at 93° and 29°F water temperature, pressing all six units of the same model simultaneously on each dive when possible. All units will be dove six times at each water temperature. All units will have the depth accuracy manually recorded at each 10 FSW stop. A chart comparing chamber depth versus individual UDC depth readings will be compiled.

b. TEST TWO: Long Term Stability/Temperature Sensitivity. Six units will be stored at room temperature and placed in the Bethlehem Chamber in a saltwater bath and dove to a maximum depth of 230 FSW, stopping at 50 FSW

increments during both descents and ascents for 30 minutes, and 230 FSW for 30 minutes. Each unit will be tested in this manner at 93° and 29°F, pressing all six units of the same model simultaneously when possible. All units will be dove six times at each water temperature, plotting one unit during each dive, for a total of 12 dives for each unit, and two plots for each unit. Those units which are not plotted on an individual dive will have the depth accuracy manually recorded at each 50 FSW and at the 230 FSW stop.

c. TEST THREE: Battery Duration.

(1) Battery duration data will be logged during all phases of the test. Those UDCs which use nonrechargeable batteries will be operated with both commercially available alkaline batteries and lead-acid batteries available through the Navy supply system.

(2) In order to provide a more specific battery duration test for long duration functioning, all units will be maintained at a depth of 50 FSW, recording the time at which a low battery indication is given. Monitoring will continue until the unit fails. Those units which do not provide a low battery indication will be monitored until the unit fails. This test will be conducted at 29°F.

d. TEST FOUR: Profile Tracking. All units will be dove in a saltwater bath in the Bethlehem Chamber in accordance with the profiles listed in Table 1. The purpose of this test is to confirm the correlation of the units software with NEDU's decompression algorithm for a constant PPO_2 of .7 ATA in nitrogen. The standard dive profiles to which the UDCs will be compared will be generated by a Hewlett Packard 1000 M Series Computer.

e. TEST FIVE: Watertight Integrity. Watertight integrity will be monitored throughout the test. Upon completion of all testing, all units will be disassembled to check for water inside the case.

f. TEST SIX: Human Factors Evaluation.

(1) Each manufacturer's unit type will undergo a dry bench evaluation for conformance to human factors specifications as published in the Commerce Business Daily. Physical characteristics of each unit type will be assessed using standard human factors engineering procedures and guidelines, and photodocumentation of each unit will be accomplished. Wearing and use of each unit type will be evaluated from an operational perspective, including unassisted donning and doffing and operation of on-off switch when wearing thermal protective garments.

(2) During manned in-water human factor evaluations, a human factors questionnaire will be completed by each diver.

6. Preliminary Arrangements

a. NEDU has custody of six Orca UDC prototypes. The Divetronics UDC prototypes were recently returned to the manufacturer after testing per reference (c). Arrival of six Tekna UDC prototypes is anticipated in the near future. The Tekna UDCs will be tested upon receipt.

b. Unmanned testing will take place in the EDF, using the Bethlehem chamber and HP 1000 computer.

c. The EDF heating and cooling loop will be used to maintain the test temperatures in the Bethlehem chamber. A propylene glycol/water solution is to be used to achieve a temperature of 29°F.

d. All external leads will be run so that they can be operated at the Bethlehem console. A miniaturized closed circuit TV monitoring system will be installed in the Bethlehem chamber in order to monitor UDC display readout from the Bethlehem console. Information read from the UDC display via the TV monitor will be entered manually into the HP 1000 M series computer by direct interrupt control box.

7. Unmanned Test Procedure

a. Test Equipment:

(1) Bethlehem 2000 FSW chamber.

(2) Validyne pressure transducer.

(3) Javelin closed circuit TV monitoring system.

(4) Heise depth gauge and Mensor depth gauge.

(5) Hewlett Packard M series computer.

(6) Digitec digital thermometer.

(7) Monte Carlo stop watch.

b. Parameters to be controlled:

(1) Depths 0-230 FSW.

(2) Temperatures 29° and 93°F.

c. Parameters to be measured:

(1) Depth accuracy.

(2) UDC algorithm compliance.

(3) Battery duration.

(4) UDC timekeeping accuracy.

d. Data to be plotted:

(1) Depth accuracy.

(2) UDC algorithm compliance.

(3) Warning status test.

e. Test plan for pressure transducer accuracy, long term stability, battery duration, and watertight integrity testing:

(1) Establish designated temperature in UDC bath solution in Bethlehem arc.

(2) Insure proper UDC functioning in accordance with manufacturer's manual when unit is turned on.

(3) Chamber on surface.

(4) Adjust the voltage output of the Validyne transducer to coincide with the span pressure of the Heise gauge and Mensor gauge.

(5) Pressurize chamber.

(6) Manually enter UDC display depth into computer using direct interrupt control box during pressure transducer accuracy testing, warning status testing, and long term stability testing. Data will not be entered in the computer for battery duration testing, no decompression dives, or watertight integrity testing, but will be manually recorded.

(7) Bring chamber to surface.

(8) Record total battery hours for battery duration charts.

8. Post Test Arrangements. UDCs will be rinsed and dried after use.

9. Personnel

a. Number required: 4

b. Duty/names:

(1) Task Leader: LT C.G. Presswood.

(2) Test Engineer: as assigned.

(3) EDF Bethlehem Chamber Maintainer/Operator: Mr. D. Cowgill.

(4) EDF Bethlehem Chamber Operator: as assigned.

10. Safety Rules and Precautions. As specified by the EDF Operations Manual.

11. Logistic Support

a. Air supply to Bethlehem chamber.

b. Propylene glycol.

c. Salt.

12. Funding. NAVSEA 06Z.

13. Security. Nightly secure UDCs in locked storage.

14. Report Production. A written report will be forwarded from NEDU to NAVSEA (00C), with copy to NAVSEA (06Z), within 60 days of the completion of all required tests.

TABLE 1

TEST PROFILES

(NEDU TEST PLAN 85-37)

I. NO DECOMPRESSION DIVES:

a. 40 FSW

b. 60 FSW

c. 80 FSW

d. 100 FSW

e. 120 FSW

f. 140 FSW

g. 150 FSW

Each dive will be made as a single dive (no repetitive dives). No decompression time is defined as all time prior to the time at which the Safe Ascent Depth (SAD) changes from 0 to 10 FSW. The UDC no decompression time will be compared with the HP 1000 computer no decompression time. Each unit will be tested at 29°F.

II. REPETITIVE DIVES:

a. 60 Ft No Decompression

1 Hr Surface Interval at 1 Ft

120 Ft No Decompression

b. 60 Ft No Decompression

1 Hr Surface Interval at 5 Ft

120 Ft No Decompression

This test is designed to test the UDC's switch from PPO_2 of .7 to PPO_2 of .21 at 3 FSW. A comparison of the profiles will determine proper functioning. A graph will be generated on one unit during dive, which will indicate HP 1000 computer profile compared to UDC profile. Each unit will be tested at 29°F.

III. DECOMPRESSION DIVES:

a. 175 FSW 60 Min

b. 150 FSW 30 Min

The UDC decompression profile will be compared to the HP 1000 computer decompression profile. Test a. will be conducted at 93° and 29°F. Test b. will be conducted at 29°F.

IV. REPETITIVE DECOMPRESSION DIVES:

a. 150 FSW 30 Min

1 Hr Surface Interval

150 FSW 30 Min

The UDC repetitive decompression profiles will be compared to the HP 1000 computer profile. This test will be conducted at 29°F.

V. WARNING STATUS TEST:

a. 150 FSW	Until Safe Ascent Depth (SAD) flashes.
Ascend to 30 FSW	Verify that SAD secures flashing, then increase depth until SAD resumes flashing, and stay at that depth until SAD secures flashing. Record time of HP 1000 computer indication that flashing should stop, record depth.
Descent to 150 FSW	Hold depth until SAD flashes, record elapsed time, decompress to surface, record time SAD secures flashing.

All UDC profiles will be compared with HP 1000 computer. This test will be conducted at 29°F.

APPENDIX B1

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY DATA

ORCA UDM AT 29°F AND 93°F

Actual chamber depth and comparative UDM depth readings are charted at 10 FSW increments during descent and ascent as 29°F and 93°F water temperatures. Six dives are charted for each UDM at each water temperature to a maximum depth of 230 FSW.

KEY:

Figure B1 : ORCA UDM at 29°F Water Temperature, Dive #1
Figure B2 : ORCA UDM at 29°F Water Temperature, Dive #2
Figure B3 : ORCA UDM at 29°F Water Temperature, Dive #3
Figure B4 : ORCA UDM at 29°F Water Temperature, Dive #4
Figure B5 : ORCA UDM at 29°F Water Temperature, Dive #5
Figure B6 : ORCA UDM at 29°F Water Temperature, Dive #6
Figure B7 : ORCA UDM at 93°F Water Temperature, Dive #1
Figure B8 : ORCA UDM at 93°F Water Temperature, Dive #2
Figure B9 : ORCA UDM at 93°F Water Temperature, Dive #3
Figure B10: ORCA UDM at 93°F Water Temperature, Dive #4
Figure B11: ORCA UDM at 93°F Water Temperature, Dive #5
Figure B12: ORCA UDM at 93°F Water Temperature, Dive #6

Figure B1

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #1

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	11	10	11	11	10	10	9	10	10	10
20 FSW	20	20	20	20	21	21	20	20	19	20	19	19
30 FSW	30	30	32	32	31	31	30	30	30	30	29	30
40 FSW	40	39	42	41	42	42	41	41	40	40	40	40
50 FSW	50	49	53*	53*	52	52	50	50	50	50	50	50
60 FSW	60	60	62	62	62	62	60	60	60	60	60	60
70 FSW	70	69	72	72	72	72	70	70	70	70	70	70
80 FSW	80	80	82	82	82	82	80	80	80	80	80	80
90 FSW	90	89	92	92	92	92	90	90	90	90	90	90
100 FSW	100	99	102	102	102	101	100	100	100	100	100	100
110 FSW	110	110	113	112	112	112	110	110	110	110	110	110
120 FSW	120	120	122	122	122	122	120	120	120	120	120	120
130 FSW	130	129	132	132	133*	131	130	130	130	130	130	130
140 FSW	140	140	143*	142	142	142	140	140	140	140	140	140
150 FSW	150	149	152	152	152	152	150	150	150	150	150	150
160 FSW	160	160	162	162	162	162	160	160	160	160	160	160
170 FSW	170	170	172	172	173*	172	170	170	170	170	170	170
180 FSW	180	180	182	182	182	182	180	180	180	180	180	180
190 FSW	190	190	192	192	192	192	190	190	190	190	190	190
200 FSW	200	200	202	202	203*	203*	199	199	200	200	200	200
210 FSW	210	210	212	212	213*	212	208	208	210	210	210	210
220 FSW	220	220	222	222	223*	223*	218	219	220	220	220	220
230 FSW	230	-	231	-	233*	-	228	-	230	-	228	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B2

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #2

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	–	0	–	0	–	0	–	0	–	0	–
10 FSW	10	10	11	10	12	11	11	11	10	10	10	10
20 FSW	20	20	20	20	22	22	20	20	20	20	20	20
30 FSW	30	30	31	30	32	32	31	30	30	30	30	30
40 FSW	40	40	42	41	42	42	41	41	40	40	40	40
50 FSW	50	50	50	50	52	51	51	51	50	50	50	50
60 FSW	60	60	62	62	62	61	61	60	61	61	60	60
70 FSW	70	70	72	72	72	72	70	70	70	70	70	70
80 FSW	80	80	82	82	80	80	82	82	82	82	80	80
90 FSW	90	90	92	92	93*	92	91	91	92	92	90	90
100 FSW	100	100	102	101	103*	102	101	101	100	100	100	100
110 FSW	110	110	112	112	112	112	110	110	110	110	110	110
120 FSW	120	120	122	121	122	122	120	120	120	120	120	120
130 FSW	130	130	132	132	132	132	130	130	130	130	130	130
140 FSW	140	140	142	142	142	142	140	140	140	140	140	140
150 FSW	150	150	153*	152	152	152	150	150	150	150	150	150
160 FSW	160	160	163*	163*	162	161	159	159	161	160	160	160
170 FSW	170	170	173*	173*	172	171	169	169	171	171	170	170
180 FSW	180	180	183*	183*	182	182	179	179	181	181	180	180
190 FSW	190	190	192	192	192	192	189	189	191	191	190	190
200 FSW	200	200	203*	203*	202	201	199	198	200	201	200	200
210 FSW	210	210	213*	213*	212	212	209	210	211	211	210	210
220 FSW	220	220	222	222	222	222	218	218	221	222	220	220
230 FSW	230	–	232	–	232	–	229	–	232	–	226*	–

– Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B3

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #3

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	11	11	12	11	11	11	10	10	10	10
20 FSW	20	20	21	21	22	21	20	20	20	20	20	20
30 FSW	30	30	32	31	33*	32	30	30	30	30	30	30
40 FSW	41	40	42	42	42	42	40	40	40	40	40	40
50 FSW	50	51	51	50	52	52	50	50	50	50	50	50
60 FSW	60	60	60	61	63*	62	61	61	60	60	60	60
70 FSW	70	70	72	72	72	72	70	71	71	70	70	70
80 FSW	81	80	82	82	83*	82	81	81	81	80	80	80
90 FSW	90	90	92	91	93*	92	90	91	91	90	90	90
100 FSW	101	100	102	102	103*	103*	101	101	101	101	101	101
110 FSW	111	111	112	112	113*	113*	110	110	111	111	110	110
120 FSW	120	120	122	122	123*	123*	120	120	120	120	120	120
130 FSW	130	131	133*	133*	133*	133*	130	130	130	130	130	130
140 FSW	140	140	143*	143*	143*	143*	140	140	141	141	140	140
150 FSW	151	150	153*	153*	153*	152	150	150	151	151	150	150
160 FSW	160	160	163*	163*	163*	162	160	160	161	161	160	160
170 FSW	171	171	173*	173*	173*	172	169	169	170	170	170	170
180 FSW	180	180	183*	183*	182	182	179	179	180	180	180	180
190 FSW	190	190	193*	193*	193*	193*	188	189	190	190	190	190
200 FSW	200	200	202	202	202	202	199	199	201	200	200	200
210 FSW	210	210	212	211	212	211	209	210	210	210	210	210
220 FSW	218	218	222	221	222	222	218	218	220	220	220	220
230 FSW	229	-	232	-	231	-	228	-	230	-	226*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B4

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #4

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	11	11	11	11	11	11	9	10	9	9
20 FSW	20	20	20	20	21	21	20	20	19	20	19	20
30 FSW	30	30	31	31	32	32	30	30	30	30	30	30
40 FSW	40	40	41	41	42	42	40	40	40	40	40	40
50 FSW	50	50	53*	52	53*	52	51	51	50	50	50	50
60 FSW	60	60	61	62	61	61	61	61	60	60	59	60
70 FSW	70	70	71	71	72	71	71	71	70	70	70	70
80 FSW	80	80	82	82	83*	82	81	81	80	80	80	81
90 FSW	90	90	92	92	92	92	90	91	90	90	90	91
100 FSW	100	100	102	102	103*	103*	100	100	101	101	100	100
110 FSW	111	111	112	112	113*	113*	110	110	111	111	110	110
120 FSW	121	121	123*	122	123*	123*	120	120	121	121	120	120
130 FSW	131	131	133*	132	133*	133*	130	130	131	131	130	130
140 FSW	141	141	143*	142	143*	143*	140	140	141	141	140	140
150 FSW	151	150	153*	152	153*	152	150	150	150	151	150	150
160 FSW	160	160	162	162	162	162	160	160	161	161	160	160
170 FSW	171	171	173*	173*	173*	172	170	170	171	171	170	170
180 FSW	181	181	183*	183*	182	182	180	180	180	180	179	180
190 FSW	190	191	192	192	192	192	190	190	190	190	189	189
200 FSW	200	200	202	202	202	202	199	199	201	200	200	200
210 FSW	210	210	212	212	212	212	209	209	210	210	210	210
220 FSW	220	220	223*	223*	222	222	218	219	221	221	220	220
230 FSW	230	-	233*	-	232	-	229	-	230	-	227*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B5

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #5

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	11	10	11	11	9	10	9	8	9	9
20 FSW	20	20	21	21	21	21	19	20	19	19	19	19
30 FSW	30	30	31	31	31	31	29	29	29	29	29	29
40 FSW	40	40	41	41	41	41	39	39	39	39	39	39
50 FSW	50	50	51	51	51	51	49	49	49	49	49	49
60 FSW	60	60	61	61	61	61	59	59	59	59	59	59
70 FSW	70	70	71	71	71	71	69	69	69	69	69	69
80 FSW	80	80	81	81	81	81	79	79	79	79	79	79
90 FSW	90	90	91	91	92	91	89	89	89	89	89	89
100 FSW	100	100	102	102	102	102	99	99	100	99	99	99
110 FSW	110	110	112	112	112	112	109	109	110	109	109	109
120 FSW	120	120	122	122	122	122	118	119	120	119	119	119
130 FSW	130	130	132	132	132	132	128	129	130	129	129	129
140 FSW	140	140	142	142	142	142	138	139	140	140	139	139
150 FSW	150	150	152	152	152	151	148	148	150	150	149	149
160 FSW	160	160	162	162	161	161	158	158	160	159	159	159
170 FSW	169	170	172	172	171	171	168	168	170	170	169	169
180 FSW	179	179	182	182	181	181	178	178	180	179	179	179
190 FSW	189	189	192	192	191	191	187*	187*	190	189	189	189
200 FSW	199	199	202	202	202	201	197*	197*	200	199	199	199
210 FSW	209	209	212	212	211	211	207*	207*	210	210	209	209
220 FSW	219	219	222	222	220	221	217*	217*	220	220	219	219
230 FSW	229	-	233*	-	231	-	227*	-	228	-	223*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B6

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #6

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	9	10	10	11	11	9	10	9	9	9	9
20 FSW	19	19	21	20	21	21	19	20	19	19	19	19
30 FSW	30	30	31	31	31	31	29	30	29	29	29	29
40 FSW	40	40	41	41	41	41	39	39	39	39	39	39
50 FSW	49	50	51	51	51	51	49	50	49	49	50	49
60 FSW	59	59	61	61	61	61	59	60	59	59	60	59
70 FSW	69	69	71	71	71	71	69	69	69	69	70	70
80 FSW	79	79	81	81	81	81	79	79	79	79	80	80
90 FSW	89	89	91	91	91	91	89	89	89	89	90	90
100 FSW	99	99	101	101	102	102	99	99	99	99	100	100
110 FSW	109	110	111	112	111	111	109	109	109	109	110	110
120 FSW	119	120	122	122	122	121	118	118	119	119	120	120
130 FSW	130	129	132	132	132	131	128	128	129	129	130	130
140 FSW	139	140	142	142	141	141	138	138	139	139	140	140
150 FSW	149	150	151	152	151	151	148	148	149	149	150	150
160 FSW	159	160	162	162	161	161	158	158	159	159	160	160
170 FSW	169	169	172	172	171	171	168	168	170	170	170	170
180 FSW	179	179	182	182	181	181	177*	178	179	179	180	180
190 FSW	189	189	192	192	191	191	187*	187*	189	189	190	190
200 FSW	199	199	202	202	201	201	197*	197*	199	199	200	200
210 FSW	209	209	212	212	211	211	207*	207*	209	209	210	210
220 FSW	219	219	222	222	220	221	217*	217*	219	219	221	221
230 FSW	229	-	233*	-	230	-	227*	-	226*	-	230	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B7

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #1

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	9	9	9	9	9	9	10	10	9	10
20 FSW	20	20	19	19	19	18	19	19	20	20	19	19
30 FSW	30	30	29	29	30	29	29	29	30	30	29	30
40 FSW	40	39	39	39	39	39	39	40	40	40	39	39
50 FSW	50	49	50	50	50	49	49	50	50	50	49	49
60 FSW	59	60	59	59	60	60	59	59	60	60	59	59
70 FSW	69	69	69	69	70	70	69	70	70	70	69	70
80 FSW	79	79	79	79	80	80	79	79	80	80	79	79
90 FSW	89	89	89	89	90	90	89	90	90	91	89	89
100 FSW	99	99	99	99	100	100	100	99	101	100	99	99
110 FSW	110	110	109	109	110	110	109	110	110	111	109	109
120 FSW	119	119	119	119	120	120	119	120	120	120	119	119
130 FSW	130	129	130	129	130	130	129	130	131	131	129	129
140 FSW	139	140	139	139	140	140	139	139	140	141	139	139
150 FSW	150	149	149	149	150	150	150	150	151	151	149	149
160 FSW	159	159	159	159	160	160	159	160	161	160	159	159
170 FSW	169	169	169	169	170	170	170	169	170	170	169	169
180 FSW	180	179	179	179	180	180	179	179	180	181	178	179
190 FSW	189	189	189	189	190	190	1. ?	189	190	190	188	188
200 FSW	199	199	199	199	200	199	199	199	200	200	198	199
210 FSW	208	209	209	209	210	210	208	209	208	210	209	209
220 FSW	219	219	219	219	220	220	219	219	220	220	218	219
230 FSW	229	-	229	-	230	-	229	-	230	-	228	-

- Indicates no reading taken
↓ Descent
↑ Ascent

Figure B8

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #2

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	9	9	9	0	0	10	9	9	10	10	10
20 FSW	20	20	19	19	+	0	19	20	20	20	20	20
30 FSW	29	30	29	29	+	0	29	29	30	30	30	30
40 FSW	40	40	39	39	0	0	39	40	40	40	40	40
50 FSW	49	50	49	49	0	0	49	50	50	50	50	50
60 FSW	59	60	59	59	0	0	59	60	60	60	60	60
70 FSW	69	70	69	69	0	0	69	70	70	70	70	69
80 FSW	80	79	79	79	0	0	79	80	80	80	79	79
90 FSW	90	90	89	89	0	0	90	89	91	89	90	89
100 FSW	99	100	99	99	0	0	99	100	100	100	99	99
110 FSW	110	110	109	109	0	0	109	110	110	109	109	109
120 FSW	119	120	119	119	0	0	119	120	121	119	119	119
130 FSW	130	130	129	129	0	0	130	129	131	129	129	129
140 FSW	139	140	139	139	0	0	140	140	141	140	141	141
150 FSW	150	150	149	149	0	0	150	150	150	150	149	149
160 FSW	159	160	158	159	0	0	159	160	160	160	159	159
170 FSW	170	170	169	169	0	0	170	170	171	170	169	169
180 FSW	180	179	179	179	0	0	179	180	181	179	179	179
190 FSW	189	190	189	189	0	0	189	190	190	190	189	189
200 FSW	200	199	199	199	0	0	199	199	200	200	199	199
210 FSW	209	209	209	209	0	0	209	209	210	210	208	209
220 FSW	219	219	219	219	0	0	219	219	220	220	219	219
230 FSW	229	-	229	-	0	0	229	-	230	-	229	-

+ Indicates unit went blank
- Indicates no reading taken
↓ Descent
↑ Ascent

Figure B9

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #3

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	10	10	0	0	10	10	10	10	10	10
20 FSW	20	20	20	20	0	0	20	20	20	20	20	20
30 FSW	30	30	30	30	0	0	30	30	30	30	30	30
40 FSW	40	40	40	40	0	0	40	40	40	41	40	39
50 FSW	50	50	51	51	0	0	50	50	51	51	49	49
60 FSW	60	60	60	60	0	0	60	60	60	60	59	59
70 FSW	69	70	70	70	0	0	70	70	70	70	69	69
80 FSW	79	80	80	80	0	0	80	80	80	79	79	79
90 FSW	90	90	90	90	0	0	90	90	90	90	89	89
100 FSW	100	100	100	100	0	0	100	100	100	100	99	99
110 FSW	110	110	110	110	0	0	110	110	110	110	109	109
120 FSW	120	120	120	120	0	0	120	120	119	119	119	119
130 FSW	130	130	130	130	0	0	130	130	130	130	129	129
140 FSW	140	140	140	140	0	0	140	140	140	140	139	139
150 FSW	149	150	150	150	0	0	150	150	149	150	149	149
160 FSW	160	160	160	160	0	0	160	160	160	159	159	159
170 FSW	170	170	170	170	0	0	170	170	169	169	169	169
180 FSW	179	179	180	180	0	0	180	180	179	179	179	179
190 FSW	189	189	190	190	0	0	190	190	189	189	189	189
200 FSW	199	199	200	200	0	0	200	200	199	199	198	198
210 FSW	209	209	210	210	0	0	210	210	209	209	208	209
220 FSW	219	219	220	220	0	0	220	220	219	219	218	218
230 FSW	229	-	230	-	0	-	230	-	229	-	228	-

- Indicates no reading taken
↓ Descent
↑ Ascent

Figure B10

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #4

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	10	10	0	0	10	10	10	10	10	10
20 FSW	20	20	20	20	0	0	20	20	20	20	19	20
30 FSW	30	30	30	30	0	0	29	30	30	30	30	30
40 FSW	40	40	40	40	0	0	40	40	40	40	40	40
50 FSW	50	50	50	50	0	0	50	50	51	51	50	50
60 FSW	60	60	60	60	0	0	60	60	60	60	60	60
70 FSW	70	70	70	70	0	0	70	70	70	70	69	69
80 FSW	80	80	80	80	0	0	80	80	80	80	79	79
90 FSW	90	90	90	90	0	0	90	90	90	90	89	89
100 FSW	100	100	100	100	0	0	100	100	100	100	99	99
110 FSW	110	110	110	110	0	0	110	110	110	110	109	109
120 FSW	120	120	120	120	0	0	120	120	120	120	119	119
130 FSW	130	130	130	130	0	0	130	130	130	130	129	129
140 FSW	140	140	140	140	0	0	140	140	140	139	139	139
150 FSW	150	150	150	150	0	0	150	150	150	149	149	149
160 FSW	160	160	160	160	0	0	159	159	159	159	158	159
170 FSW	170	170	170	170	0	0	170	170	169	169	169	169
180 FSW	180	180	180	180	0	0	179	180	180	180	179	179
190 FSW	190	190	190	190	0	0	189	190	189	189	188	189
200 FSW	200	200	200	200	0	0	199	200	199	200	199	199
210 FSW	210	210	210	210	0	0	209	210	209	209	209	209
220 FSW	219	219	220	220	0	0	219	219	219	219	218	219
230 FSW	229	-	230	-	0	-	229	-	229	-	228	-

- Indicates no reading taken
↓ Descent
↑ Ascent

Figure B11

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #5

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	9	9	0	0	9	9	10	7*	10	10
20 FSW	19	20	19	19	0	0	19	19	20	17*	20	20
30 FSW	30	30	29	29	0	0	29	29	30	27*	29	30
40 FSW	40	39	39	39	0	0	39	39	40	37*	39	40
50 FSW	49	49	49	50	0	0	49	50	50	47*	50	50
60 FSW	60	60	59	59	0	0	59	59	60	57*	59	59
70 FSW	69	70	69	69	0	0	69	69	70	66*	69	69
80 FSW	79	79	79	79	0	0	79	80	80	77*	79	79
90 FSW	90	90	89	89	0	0	89	89	90	86*	89	89
100 FSW	99	99	99	99	0	0	99	99	100	97*	99	99
110 FSW	109	109	109	109	0	0	110	110	110	106*	109	109
120 FSW	119	119	119	119	0	0	119	120	120	116*	119	119
130 FSW	130	130	129	129	0	0	129	129	130	126*	129	129
140 FSW	139	140	139	139	0	0	139	139	140	139	139	139
150 FSW	150	150	149	149	0	0	149	150	150	149	149	149
160 FSW	160	159	159	159	0	0	159	159	160	159	159	159
170 FSW	170	169	169	169	0	0	169	169	170	167*	169	169
180 FSW	179	179	179	179	0	0	179	179	180	177*	179	179
190 FSW	189	189	189	189	0	0	189	189	190	187*	189	188
200 FSW	199	199	199	199	0	0	199	199	200	197*	199	199
210 FSW	209	209	209	209	0	0	209	209	209	207*	209	209
220 FSW	219	219	219	219	0	0	219	219	219	218	218	219
230 FSW	229	-	229	-	0	-	229	-	229	-	228	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B12

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #6

10 FSW INCREMENTS

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	10	10	10	10	10	10	10	6*	10	10
20 FSW	20	20	19	20	19	19	20	20	20	16*	20	20
30 FSW	30	30	30	30	30	30	30	30	30	26*	30	30
40 FSW	40	40	40	40	40	40	40	40	39	35*	40	39
50 FSW	50	50	50	50	50	51	50	50	49	45*	49	50
60 FSW	60	60	60	60	61	61	60	60	60	55*	60	59
70 FSW	69	70	69	70	70	71	70	70	69	65*	70	70
80 FSW	80	80	80	80	80	80	80	80	79	75*	79	79
90 FSW	89	90	90	90	91	91	89	90	90	85*	89	89
100 FSW	100	100	100	100	100	101	100	100	99	94*	99	99
110 FSW	110	110	110	110	111	111	110	110	109	104*	109	109
120 FSW	120	120	121	120	120	121	119	120	119	114*	120	119
130 FSW	130	130	130	130	131	131	130	130	129	124*	129	129
140 FSW	140	140	140	140	141	141	140	140	138	134*	149	149
150 FSW	150	150	150	150	151	151	150	150	148	144*	149	149
160 FSW	160	160	160	160	161	161	160	160	158	154*	159	159
170 FSW	169	170	170	170	171	171	170	170	168	164*	169	169
180 FSW	179	180	180	180	181	181	180	180	178	174*	179	179
190 FSW	189	189	190	190	191	191	190	190	188	185*	189	189
200 FSW	200	199	200	200	201	201	200	200	198	195*	198	199
210 FSW	210	209	210	209	211	210	209	210	208	205*	209	209
220 FSW	220	220	220	220	221	221	220	220	218	218	218	219
230 FSW	229	-	230	-	231	-	229	-	227*	-	229	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

APPENDIX B2

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY DATA

DIVETRONIC UDM AT 29°F AND 93°F

Actual chamber depth and comparative UDM depth readings are charted at 10 FSW increments during descent and ascent as 29°F and 93°F water temperatures. Six dives are charted for each UDM at each water temperature to a maximum depth of 230 FSW.

KEY:

Figure B13: Divetronic UDM at 29°F Water Temperature, Dive #1
Figure B14: Divetronic UDM at 29°F Water Temperature, Dive #2
Figure B15: Divetronic UDM at 29°F Water Temperature, Dive #3
Figure B16: Divetronic UDM at 29°F Water Temperature, Dive #4
Figure B17: Divetronic UDM at 29°F Water Temperature, Dive #5
Figure B18: Divetronic UDM at 29°F Water Temperature, Dive #6
Figure B19: Divetronic UDM at 93°F Water Temperature, Dive #1
Figure B20: Divetronic UDM at 93°F Water Temperature, Dive #2
Figure B21: Divetronic UDM at 93°F Water Temperature, Dive #3
Figure B22: Divetronic UDM at 93°F Water Temperature, Dive #4
Figure B23: Divetronic UDM at 93°F Water Temperature, Dive #5
Figure B24: Divetronic UDM at 93°F Water Temperature, Dive #6

Figure B13

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY TEST

29°F WATER TEMPERATURE, DIVE #1

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
0 FSW	0	0	0	0	0	0	0	0	0	0	0	0
10 FSW	10	11	10	10	10	10	10	10	10	10	10	10
20 FSW	21	21	20	20	20	20	21	20	20	20	20	20
30 FSW	30	31	30	30	30	30	30	30	30	30	30	31
40 FSW	40	41	40	40	40	40	40	41	40	40	41	41
50 FSW	50	51	50	50	50	50	50	51	50	50	50	51
60 FSW	61	61	60	60	60	61	60	61	60	60	61	61
70 FSW	71	71	70	70	70	71	71	71	70	70	71	71
80 FSW	81	82	80	80	81	81	81	81	80	81	81	81
90 FSW	91	92	90	90	91	91	91	91	90	91	91	92
100 FSW	101	102	100	100	101	101	101	101	100	101	102	102
110 FSW	111	112	110	110	111	111	111	111	111	111	112	112
120 FSW	122	122	120	121	121	121	122	122	121	121	122	122
130 FSW	132	132	131	131	132	132	132	132	131	131	132	132
140 FSW	142	143*	140	141	142	142	142	142	141	141	142	143*
150 FSW	152	153*	151	151	152	152	152	152	151	151	153*	153*
160 FSW	162	163*	160	161	162	162	162	162	161	161	163*	163*
170 FSW	172	173*	170	171	172	172	172	172	171	171	173*	173*
180 FSW	182	183*	180	181	182	182	182	182	181	181	183*	183*
190 FSW	193*	193*	190	190	192	192	192	192	191	192	193	193
200 FSW	203*	203*	200	200	202	203*	202	203*	201	202	203*	203*
210 FSW	213*	213*	210	210	213*	213*	213*	213*	212	212	213*	214*
220 FSW	214*	214*	220	220	220	220	222	222	222	222	222	222
230 FSW	214*	214*	222*	222*	220*	220*	222*	222*	222*	222*	222*	223*

* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B14

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY TEST

29°F WATER TEMPERATURE, DIVE #2

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
0 FSW	0	0	0	0	0	0	0	0	0	0	0	0
10 FSW	11	11	10	10	10	10	10	10	10	10	10	10
20 FSW	21	21	20	20	20	20	21	21	20	20	20	21
30 FSW	31	31	30	30	30	30	30	30	30	30	30	30
40 FSW	41	41	40	40	40	40	41	41	40	40	41	41
50 FSW	51	51	50	50	50	51	51	51	50	50	51	51
60 FSW	61	61	60	60	61	61	61	61	60	60	61	61
70 FSW	71	71	70	70	71	71	71	71	70	70	71	71
80 FSW	82	82	80	80	81	81	81	81	81	81	81	82
90 FSW	92	92	90	90	92	91	92	92	91	91	92	92
100 FSW	102	102	100	100	101	101	101	101	101	101	102	102
110 FSW	112	112	110	110	111	112	112	111	111	111	112	112
120 FSW	122	122	120	121	122	122	122	122	121	121	122	122
130 FSW	132	132	130	131	132	132	132	132	131	131	132	132
140 FSW	143*	143*	140	141	142	142	142	142	141	141	142	143*
150 FSW	153*	153*	151	150	152	152	152	153*	151	152	153*	153*
160 FSW	163*	163*	161	160	162	162	162	162	161	162	163*	163*
170 FSW	173*	173*	170	170	172	172	172	172	171	172	173*	173*
180 FSW	183*	183*	180	180	182	182	182	182	181	182	183*	183*
190 FSW	193*	193*	190	190	192	193*	193*	193*	192	192	193*	193*
200 FSW	203*	203*	200	200	203*	203*	203*	203*	202	202	203*	203*
210 FSW	213*	213*	210	210	213*	213*	213*	213*	212	212	213*	213*
220 FSW	213*	213*	220	220	219	219	222	222	222	222	222	222
230 FSW	213*	213*	222*	222*	219*	219*	222*	222*	222*	222*	222*	222*

* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B15

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY TEST

29°F WATER TEMPERATURE, DIVE #3

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑		↑	↓	↑	↓	↑	↓	↑
0 FSW	0		0	0	0	0	0	0	0	0	0	0
10 FSW	10	10	10	10	11	11	10	10	10	10	10	10
20 FSW	20	21	20	20	21	21	20	20	20	21	20	20
30 FSW	30	30	30	31	31	31	30	30	31	31	30	30
40 FSW	40	41	40	40	41	41	40	40	41	41	40	40
50 FSW	50	51	51	50	51	51	50	50	51	51	50	50
60 FSW	61	61	61	61	61	61	60	60	61	61	60	61
70 FSW	71	71	71	71	71	71	70	71	71	71	71	71
80 FSW	81	81	81	81	81	82	81	81	81	81	81	81
90 FSW	91	92	91	91	92	92	91	91	91	92	91	92
100 FSW	101	101	101	101	101	102	101	101	101	101	101	101
110 FSW	111	112	111	111	112	112	111	111	111	111	111	112
120 FSW	122	122	121	121	122	122	121	121	122	122	122	122
130 FSW	132	132	131	131	132	132	131	132	132	132	132	132
140 FSW	142	142	141	141	142	143*	142	142	142	142	142	142
150 FSW	152	152	151	151	152	153*	152	152	152	152	152	152
160 FSW	162	162	161	161	163*	163*	162	162	162	162	162	162
170 FSW	172	172	171	171	173*	173*	172	172	172	172	172	172
180 FSW	182	182	181	181	183*	183*	182	182	182	182	182	183*
190 FSW	192	192	191	191	193*	193*	192	192	192	192	193*	193*
200 FSW	202	203*	201	201	203*	203*	202	202	202	202	203*	203*
210 FSW	213*	213*	211	211	213*	214*	212	213*	212	213*	213*	213*
220 FSW	214*	214*	221	221	221*	221*	222	222	223*	223*	222	222
230 FSW	214*	214*	223*	223*	221*	221*	223*	223*	223*	223*	222*	222*

* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B16

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY TEST

29°F WATER TEMPERATURE, DIVE #4

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
0 FSW	0	0	0	0	0	0	0	0	0	0	0	0
10 FSW	10	10	11	11	10	10	10	10	10	10	10	10
20 FSW	20	20	21	21	21	20	21	21	20	20	21	21
30 FSW	30	30	31	31	31	31	30	30	30	30	31	31
40 FSW	40	40	41	41	41	41	41	41	40	40	41	41
50 FSW	50	50	51	51	51	51	51	51	50	50	51	51
60 FSW	60	60	61	61	61	61	61	61	60	60	61	61
70 FSW	70	71	71	71	71	71	71	71	70	70	71	71
80 FSW	81	81	81	81	81	81	81	82	81	81	82	82
90 FSW	91	91	91	91	92	92	92	92	91	91	92	92
100 FSW	101	101	101	101	101	101	102	102	101	101	102	102
110 FSW	111	110	111	110	112	111	112	112	111	111	112	112
120 FSW	121	121	121	122	122	123*	122	122	121	121	122	122
130 FSW	132	132	132	132	132	133*	132	133*	131	132	133*	133*
140 FSW	142	142	142	142	142	142	143*	143*	142	142	143*	143*
150 FSW	152	152	152	152	153*	153*	153*	153*	152	152	153*	153*
160 FSW	162	162	161	161	162	162	163*	163*	162	162	163*	163*
170 FSW	172	172	171	172	173*	173*	173*	173*	172	172	173*	173*
180 FSW	182	182	181	181	183*	183*	183*	183*	182	182	183*	183*
190 FSW	192	192	191	191	193*	193*	193*	193*	192	192	194*	194*
200 FSW	202	203*	201	201	203*	203*	203*	203*	202	202	204*	204*
210 FSW	212	212	211	211	213*	214*	213*	214*	212	212	214*	214*
220 FSW	212	212	222	221	222	219	212	222	221	222	219	222
230 FSW	212*	-	223*	-	219*	-	222*	-	222*	-	222*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B17

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY TEST

29°F WATER TEMPERATURE, DIVE #5

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
0 FSW	0	0	0	0	0	0	0	0	0	0	0	0
10 FSW	10	10	10	10	10	10	10	9	10	10	10	10
20 FSW	21	20	20	20	21	20	20	20	21	21	20	20
30 FSW	31	30	30	30	31	30	30	30	31	30	30	30
40 FSW	41	41	40	40	41	40	40	40	41	41	40	40
50 FSW	51	51	50	50	51	50	50	51	51	51	50	50
60 FSW	61	61	60	60	51	61	60	60	61	61	60	60
70 FSW	70	71	70	70	71	71	70	70	71	71	71	70
80 FSW	82	81	80	80	82	81	81	80	82	81	81	81
90 FSW	92	92	90	90	92	91	91	91	92	92	91	91
100 FSW	102	102	101	100	102	101	101	101	102	101	101	101
110 FSW	112	112	111	111	112	111	111	111	112	112	111	111
120 FSW	122	122	121	121	122	121	121	121	122	122	121	121
130 FSW	133*	132	131	131	132	132	132	131	132	132	132	131
140 FSW	143*	143*	141	141	142	142	142	142	143*	143*	142	142
150 FSW	153*	153*	151	151	153*	152	152	152	153*	153*	152	152
160 FSW	163*	163*	161	161	162	162	162	161	163*	162	162	161
170 FSW	173*	173*	171	171	173*	172	172	172	173*	173*	172	172
180 FSW	183*	183*	181	181	183*	182	182	182	183*	183*	182	182
190 FSW	194*	193*	191	190	193*	193*	192	192	193*	193*	192	192
200 FSW	203*	203*	201	201	203*	203*	202	202	203*	203*	202	202
210 FSW	214*	214*	211	211	213*	213*	212	212	213*	213*	212	212
220 FSW	222	222	220	220	219	219	212	212	222	222	222	222
230 FSW	222*	-	222*	-	219*	-	212*	-	222*	-	222*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B18

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY TEST

29°F WATER TEMPERATURE, DIVE #6

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
0 FSW	0	0	0	0	0	0	0	0	0	0	0	0
10 FSW	10	10	10	10	11	11	10	10	10	11	10	10
20 FSW	20	20	20	20	21	21	20	20	21	21	21	21
30 FSW	30	30	30	30	31	31	30	30	30	31	30	31
40 FSW	40	40	40	40	41	41	40	40	41	41	41	41
50 FSW	50	50	50	50	51	51	50	50	51	51	51	51
60 FSW	61	60	60	60	61	61	60	60	61	61	61	61
70 FSW	71	71	70	70	71	72	70	70	71	71	71	72
80 FSW	81	81	80	80	81	82	80	81	81	82	81	82
90 FSW	91	91	90	91	92	92	91	91	91	92	91	92
100 FSW	101	101	101	101	102	102	101	101	101	102	102	102
110 FSW	111	111	111	111	112	112	111	111	111	112	112	112
120 FSW	121	122	120	121	122	122	121	121	122	122	122	123*
130 FSW	131	131	131	130	132	132	131	131	132	132	132	132
140 FSW	142	142	141	141	143*	142	141	141	142	142	143*	142
150 FSW	152	152	151	151	152	153*	151	151	152	152	152	153*
160 FSW	162	162	161	161	162	163*	161	161	162	162	163*	163*
170 FSW	172	172	171	171	172	173*	171	171	172	172	173*	173*
180 FSW	182	182	181	181	183*	183*	181	181	182	182	183*	183*
190 FSW	192	192	190	190	193*	193*	191	192	192	193*	193*	193*
200 FSW	202	202	200	201	203*	203*	202	202	202	203*	203*	203*
210 FSW	212	212	210	210	213*	213*	212	212	212	213*	213*	214*
220 FSW	220	220	220	220	214*	219	222	222	222	222	222	222
230 FSW	220*	-	222*	-	219*	-	222*	-	222*	-	222*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B19

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #1

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	–	0	–	0	–	0	–	0	–	0	–
10 FSW	10	10	10	10	10	10	10	10	10	10	10	10
20 FSW	20	20	20	20	20	20	21	20	20	20	20	20
30 FSW	30	30	30	30	30	30	30	30	30	30	30	30
40 FSW	40	40	40	40	40	39	40	40	40	40	40	40
50 FSW	50	50	50	50	50	49	50	50	50	50	50	50
60 FSW	60	60	60	60	60	59	60	60	60	60	60	60
70 FSW	70	70	70	70	70	69	70	70	70	70	70	70
80 FSW	80	80	80	80	80	79	80	80	80	80	80	80
90 FSW	90	90	91	91	90	89	90	90	90	90	90	90
100 FSW	100	100	101	101	100	99	100	100	100	100	100	100
110 FSW	110	110	111	111	109	109	110	110	110	110	110	110
120 FSW	120	120	121	121	119	119	120	120	120	120	120	120
130 FSW	130	130	131	131	129	129	130	130	130	130	130	130
140 FSW	140	140	141	141	139	139	140	140	140	140	140	140
150 FSW	150	150	151	151	149	150	150	150	150	150	150	150
160 FSW	160	160	161	161	159	159	160	160	160	160	160	160
170 FSW	170	170	171	171	169	169	170	170	170	170	170	170
180 FSW	179	180	181	181	179	179	180	180	180	180	180	180
190 FSW	189	190	190	191	189	189	190	190	190	190	190	190
200 FSW	199	199	201	201	199	199	200	200	200	200	200	200
210 FSW	209	209	211	211	209	209	210	210	210	210	210	210
220 FSW	219	219	221	221	219	219	220	220	220	220	220	220
230 FSW	222*	–	222*	–	222*	–	222*	–	222*	–	222*	–

– Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B20

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #2

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	10	10	10	10	10	11	10	10	10	10
20 FSW	20	20	20	21	20	19	21	21	20	20	20	20
30 FSW	30	30	30	30	30	29	30	30	30	30	30	30
40 FSW	40	40	40	41	39	39	40	41	40	40	40	40
50 FSW	50	50	50	51	49	49	50	50	50	50	50	50
60 FSW	60	59	60	61	59	59	60	60	60	60	60	60
70 FSW	70	70	70	71	69	69	70	70	70	70	70	70
80 FSW	80	79	81	81	79	79	80	80	80	80	80	80
90 FSW	90	90	91	91	89	89	91	91	90	90	90	91
100 FSW	100	99	101	101	99	99	100	100	100	100	100	101
110 FSW	110	109	111	111	109	109	110	110	110	110	110	110
120 FSW	120	120	121	121	119	119	120	120	120	120	120	120
130 FSW	130	129	131	131	129	129	130	130	130	130	130	130
140 FSW	140	139	141	141	139	139	140	141	140	140	140	140
150 FSW	150	150	151	151	149	149	151	150	151	150	151	150
160 FSW	160	159	161	161	159	159	160	160	161	160	160	160
170 FSW	170	169	171	171	169	169	170	170	170	170	170	170
180 FSW	180	179	181	181	179	179	180	180	180	180	180	180
190 FSW	190	189	191	191	189	189	190	190	190	190	190	190
200 FSW	200	199	201	201	199	199	200	200	200	200	200	200
210 FSW	210	209	211	211	209	209	210	210	210	210	211	210
220 FSW	220	220	221	221	219	219	220	220	220	220	220	220
230 FSW	222*	-	222*	-	222*	-	222*	-	222*	-	222*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B21

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #3

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	10	10	10	10	10	11	10	10	10	10
20 FSW	20	20	20	21	20	20	21	21	20	20	19	20
30 FSW	30	30	30	30	30	30	30	31	30	30	29	30
40 FSW	40	40	40	41	40	39	40	40	40	40	39	39
50 FSW	50	50	50	51	50	50	50	50	50	50	49	50
60 FSW	60	60	60	61	60	59	60	60	60	60	59	59
70 FSW	70	70	71	71	70	69	71	70	70	70	70	69
80 FSW	80	80	81	81	80	79	81	81	80	80	79	80
90 FSW	90	90	91	91	90	90	91	91	90	90	90	90
100 FSW	100	100	101	101	100	99	101	101	100	100	100	100
110 FSW	110	110	111	111	110	110	110	111	110	110	109	110
120 FSW	120	120	121	121	120	119	120	120	120	120	120	120
130 FSW	130	130	131	131	130	130	131	131	130	130	130	130
140 FSW	140	140	141	141	140	140	141	141	140	140	139	140
150 FSW	150	150	151	151	150	150	151	151	150	150	150	150
160 FSW	160	160	161	161	160	159	160	160	160	160	160	159
170 FSW	170	170	171	171	170	169	171	170	170	170	170	169
180 FSW	180	180	179	179	180	180	181	181	180	180	180	179
190 FSW	190	190	190	191	189	189	190	190	190	190	190	189
200 FSW	200	200	201	201	199	199	200	200	200	200	199	199
210 FSW	210	210	211	211	209	209	210	210	210	210	209	209
220 FSW	220	220	220	220	219	219	220	220	220	220	219	219
230 FSW	222*	-	222*	-	222*	-	222*	-	222*	-	221*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B22

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #4

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	10	10	10	10	10	10	9	9	10	10
20 FSW	20	20	20	20	20	20	20	20	19	19	20	20
30 FSW	30	30	30	30	30	30	30	30	29	29	30	30
40 FSW	40	40	40	40	40	40	40	40	39	39	40	40
50 FSW	50	50	50	50	50	50	50	50	49	49	50	50
60 FSW	60	60	60	60	60	59	60	60	59	59	60	60
70 FSW	70	70	70	70	70	69	70	70	69	69	70	70
80 FSW	80	80	80	80	80	79	80	80	79	79	80	80
90 FSW	90	90	90	90	90	90	90	90	89	89	90	90
100 FSW	100	100	100	100	99	99	100	100	99	99	100	100
110 FSW	110	110	110	110	109	109	110	110	109	109	110	110
120 FSW	120	120	120	120	119	119	120	120	119	119	120	120
130 FSW	130	130	130	130	129	129	130	130	129	130	130	130
140 FSW	140	140	140	140	139	139	140	140	139	139	140	140
150 FSW	150	150	150	150	149	149	150	150	149	150	150	150
160 FSW	160	160	160	160	159	159	159	159	159	159	160	159
170 FSW	170	170	170	170	169	169	169	169	169	169	170	169
180 FSW	180	180	180	180	179	179	179	179	179	179	179	179
190 FSW	190	190	190	190	189	189	189	189	189	189	189	189
200 FSW	200	200	2(	200	199	199	199	199	199	199	199	199
210 FSW	210	210	210	210	209	209	209	209	209	209	209	209
220 FSW	220	220	220	220	219	219	219	219	219	219	219	219
230 FSW	222*	-	222*	-	222*	-	222*	-	222*	-	222*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B23

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #5

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	10	10	10	10	10	10	10	10	10	10
20 FSW	20	20	20	20	20	20	20	20	20	20	20	20
30 FSW	30	30	30	30	30	30	30	30	30	30	30	30
40 FSW	40	40	40	40	40	39	40	40	40	40	40	40
50 FSW	50	50	50	50	49	49	50	50	50	50	49	50
60 FSW	60	60	60	60	59	59	60	60	59	60	59	60
70 FSW	70	70	70	70	69	69	70	70	70	70	69	70
80 FSW	80	80	80	80	79	79	79	80	80	80	79	80
90 FSW	90	90	90	90	89	89	90	90	90	90	89	90
100 FSW	100	100	100	100	99	99	99	100	100	100	99	100
110 FSW	110	110	110	110	109	109	110	110	110	110	110	110
120 FSW	120	120	120	121	119	119	120	120	120	120	119	120
130 FSW	130	130	130	131	129	129	130	130	130	130	130	130
140 FSW	140	140	140	140	139	139	140	140	140	140	139	139
150 FSW	150	150	150	150	149	149	150	150	150	150	149	149
160 FSW	160	160	160	160	159	159	159	159	160	160	159	159
170 FSW	170	170	170	170	169	169	169	169	170	170	169	169
180 FSW	180	180	180	180	179	179	179	179	180	180	179	179
190 FSW	190	190	190	190	189	189	189	189	190	190	189	189
200 FSW	200	200	200	200	199	199	199	199	200	200	199	199
210 FSW	210	210	210	210	209	209	209	209	210	210	209	209
220 FSW	220	220	220	220	219	219	219	219	220	220	219	219
230 FSW	222*	-	222*	-	222*	-	222*	-	222*	-	222*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

Figure B24

PRESSURE TRANSDUCER ACCURACY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #6

10 FSW INCREMENTS

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑	↓	↑
	0	-	0	-	0	-	0	-	0	-	0	-
10 FSW	10	10	10	10	10	10	10	10	9	10	10	10
20 FSW	20	20	20	20	20	20	20	20	19	20	20	20
30 FSW	30	30	30	30	30	30	30	30	29	30	30	30
40 FSW	40	40	40	40	39	39	40	40	39	39	40	40
50 FSW	50	50	50	50	49	49	50	50	49	49	50	50
60 FSW	60	60	60	60	59	59	60	60	59	59	60	60
70 FSW	70	70	70	70	69	69	70	70	70	69	70	70
80 FSW	80	80	80	80	79	79	80	80	80	79	80	80
90 FSW	90	90	90	91	89	89	90	90	89	89	90	90
100 FSW	100	99	100	100	99	99	100	100	99	99	100	100
110 FSW	110	110	110	111	109	109	110	110	110	109	110	110
120 FSW	120	119	120	121	119	119	120	120	119	119	120	120
130 FSW	130	129	130	131	129	129	130	129	130	130	130	129
140 FSW	140	140	140	141	139	139	140	139	140	139	140	139
150 FSW	150	150	150	151	149	149	150	150	150	150	150	150
160 FSW	160	159	160	161	159	159	160	160	160	159	160	159
170 FSW	169	169	170	170	169	169	169	169	169	169	170	169
180 FSW	179	179	180	180	179	179	179	179	179	179	180	179
190 FSW	189	189	190	190	189	189	189	189	189	189	189	189
200 FSW	199	199	200	200	199	199	199	199	199	199	199	199
210 FSW	209	209	210	210	209	209	209	209	209	209	209	209
220 FSW	219	219	220	220	219	219	219	219	219	219	219	219
230 FSW	222*	-	222*	-	222*	-	222*	-	222*	-	222*	-

- Indicates no reading taken
* Readings outside of ±2 FSW specification
↓ Descent
↑ Ascent

APPENDIX C1

LONG TERM STABILITY/TEMPERATURE SENSITIVITY DATA

ORCA UDM AT 29°F AND 93°F

Actual chamber depth and comparative UDM depth readings are charted at 50 FSW increments and at 230 FSW, recording UDM depth readings at the beginning and end of each 30 minute stop at each depth increment during descent and ascent as 29°F and 93°F water temperatures. Six dives are charted for each UDM at each water temperature to a maximum depth of 230 FSW.

KEY:

Figure C1 : ORCA UDM at 29°F Water Temperature, Dive #1
Figure C2 : ORCA UDM at 29°F Water Temperature, Dive #2
Figure C3 : ORCA UDM at 29°F Water Temperature, Dive #3
Figure C4 : ORCA UDM at 29°F Water Temperature, Dive #4
Figure C5 : ORCA UDM at 29°F Water Temperature, Dive #5
Figure C6 : ORCA UDM at 29°F Water Temperature, Dive #6
Figure C7 : ORCA UDM at 93°F Water Temperature, Dive #1
Figure C8 : ORCA UDM at 93°F Water Temperature, Dive #2
Figure C9 : ORCA UDM at 93°F Water Temperature, Dive #3
Figure C10: ORCA UDM at 93°F Water Temperature, Dive #4
Figure C11: ORCA UDM at 93°F Water Temperature, Dive #5
Figure C12: ORCA UDM at 93°F Water Temperature, Dive #6

Figure C1

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #1

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	53*	53*	51	51	50	50	50	50	49	49
100 FSW	100	100	102	102	102	102	100	100	101	101	99	99
150 FSW	150	149	153*	153*	152	151	150	150	151	151	149	149
200 FSW	199	199	203*	203*	201	201	200	200	201	201	199	199
230 FSW	229	229	233*	233*	231	231	226*	226*	230	230	223*	223*
200 FSW	199	199	203*	203*	201	201	200	200	200	200	199	199
150 FSW	150	150	153*	153*	151	151	150	150	151	151	149	149
100 FSW	100	100	102	102	102	102	100	100	101	101	99	99
50 FSW	50	50	53*	53*	51	51	50	50	50	50	49	49
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C2

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #2

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	52	52	50	50	53*	53*	50	50	51	51
100 FSW	100	100	102	102	101	101	102	102	101	101	102	102
150 FSW	150	150	152	152	151	151	153*	153*	151	151	153*	153*
200 FSW	200	200	202	202	201	201	203*	203*	200	200	203*	203*
230 FSW	226*	226*	231	231	230	230	233*	233*	230	230	232	232
200 FSW	200	200	201	201	200	200	203*	203*	200	200	203*	203*
150 FSW	150	150	152	152	151	151	153*	153*	151	151	153*	153*
100 FSW	100	100	102	102	101	101	102	102	101	101	102	102
50 FSW	50	50	52	52	50	50	53*	53*	50	50	51	51
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C3

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #3

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	51	50	50	50	50	50	52	52	50	50
100 FSW	100	100	100	100	101	101	100	100	102	102	100	100
150 FSW	149	149	150	150	151	151	150	150	152	152	150	150
200 FSW	200	200	200	200	201	201	200	200	202	202	200	200
230 FSW	227*	227*	229	229	230	230	229	229	231	231	226*	226*
200 FSW	200	200	200	200	200	200	200	200	201	201	200	200
150 FSW	149	149	150	150	151	151	150	150	152	152	150	150
100 FSW	100	100	100	100	101	101	100	100	102	102	100	100
50 FSW	50	50	50	50	50	50	50	50	52	52	50	50
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C4

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #4

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	50	50	51	51	50	50	52	51	50	50
100 FSW	101	101	100	100	102	102	100	100	101	101	100	99
150 FSW	150	150	150	150	151	151	150	150	151	151	149	149
200 FSW	201	201	200	200	201	201	200	200	201	201	199	199
230 FSW	223*	223*	232	232	231	231	226*	226*	230	230	223*	223*
200 FSW	201	201	200	200	201	201	200	200	201	201	199	199
150 FSW	150	150	150	150	151	151	150	151	150	151	149	150
100 FSW	101	101	100	100	102	102	100	100	101	101	99	99
50 FSW	50	50	50	50	51	51	50	50	52	52	50	51
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C5

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #5

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	51	51	50	50	52	52	50	50	49	49
100 FSW	100	100	102	102	100	100	102	102	101	101	99	99
150 FSW	150	150	151	151	151	150	152	152	151	151	149	149
200 FSW	200	200	201	201	200	200	203*	203*	201	201	199	199
230 FSW	226*	226*	232	231	230	231	233*	233*	230	230	224*	224*
200 FSW	200	200	201	201	200	200	202	203*	200	200	199	199
150 FSW	150	150	150	151	150	150	152	152	151	151	149	149
100 FSW	100	100	102	102	100	100	102	102	101	101	99	99
50 FSW	50	50	51	51	50	51	52	52	50	50	49	49
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C6

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #6

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	52	52	51	51	50	50	50	50	50	50
100 FSW	100	100	102	102	101	101	100	100	101	101	100	100
150 FSW	149	150	152	152	151	151	150	150	151	151	149	149
200 FSW	199	200	202	202	201	201	200	200	200	201	200	200
230 FSW	229	229	232	232	231	231	226*	226*	230	230	224*	224*
200 FSW	200	200	202	202	201	201	200	200	200	200	200	200
150 FSW	150	150	152	152	151	150	150	150	151	151	149	149
100 FSW	100	100	102	102	101	100	100	100	100	100	100	100
50 FSW	50	50	52	52	51	51	50	50	50	50	50	50
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C7

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #1

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	50	50	50	50	51	51	49*	49*	50	50
100 FSW	100	100	100	100	100	100	101	101	95*	95*	99	100
150 FSW	150	150	150	149	151	150	151	151	144*	144*	149	149
200 FSW	199	200	199	199	200	200	201	201	193*	193*	199	199
230 FSW	229	221*	229	229	230	230	231	231	219*	211*	228	229
200 FSW	187*	177*	199	199	200	200	201	201	180*	173*	199	199
150 FSW	123*	122*	150	150	151	151	151	151	118*	116*	149	149
100 FSW	73*	67*	99	99	100	100	101	101	99	61*	99	100
50 FSW	16*	51	50	49	50	49	51	51	12*	48*	50	50
0 FSW	-	0	-	0	-	0	-	0	-	0	-	0

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C8

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #2

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	11*	4*	49	49	49	49	50	50	13*	5*	50	50
100 FSW	13*	6*	99	100	100	100	100	100	18*	8*	99	100
150 FSW	19*	19*	149	149	150	150	149	150	29*	24*	149	149
200 FSW	45*	30*	199	199	200	199	199	199	66*	62*	199	199
230 FSW	58*	55*	229	229	229	228	229	229	91*	87*	229	229
200 FSW	59*	79*	199	199	198	198	200	199	85*	101*	199	199
150 FSW	33*	17*	149	149	150	150	150	149	53*	41*	149	149
100 FSW	0*	0*	99	99	98	98	100	100	0*	0*	99	99
50 FSW	0*	0*	49	50	49	49	50	50	0*	3*	50	50
0 FSW	-	0	-	0	-	0	-	0	-	0	-	0

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C9

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #3

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	8*	3*	49	49	49	49	49	50	6*	3*	50	50
100 FSW	9*	4*	99	99	99	99	99	100	9*	6*	99	99
150 FSW	14*	6*	150	150	150	150	149	149	13*	9*	149	149
200 FSW	14*	17*	200	199	198	198	199	199	20*	38*	199	199
230 FSW	35*	27*	229	229	227*	226*	229	229	75*	88*	229	229
200 FSW	6*	27*	200	199	197*	196*	199	199	63*	61*	199	199
150 FSW	0*	0*	150	150	147*	146*	149	149	20*	17*	149	149
100 FSW	0*	5*	99	99	97*	97*	99	99	4*	6*	100	99
50 FSW	0*	3*	49	49	47*	47*	50	50	0*	3*	50	50
0 FSW	-	0	-	0	-	0	-	0	-	0	-	0

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C10

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #4

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	9*	8*	50	50	48	48	49	49	6*	4*	49	50
100 FSW	16*	11*	100	100	97*	97*	99	99	11*	8*	100	100
150 FSW	22*	17*	150	150	147*	146*	148	148	15*	11*	150	149
200 FSW	32*	38*	200	199	196*	195*	197*	198	53*	69*	199	199
230 FSW	54*	46*	229	229	225*	224*	228	228	104*	114*	229	229
200 FSW	21*	17*	199	199	194*	194*	198	197*	88*	89*	199	199
150 FSW	5*	7*	150	149	144*	144*	149	148	42*	41*	149	149
100 FSW	0*	3*	99	99	95*	94*	98	99	5*	7*	99	99
50 FSW	1*	2*	49	49	45*	45*	49	49	4*	6*	50	50
0 FSW	-	0	-	0	-	0	-	0	-	0	-	0

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C11

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #5

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	15*	10*	49	49	50	50	50	49	14*	10*	50	49
100 FSW	17*	12*	99	99	99	99	99	99	16*	13*	99	99
150 FSW	23*	14*	149	149	149	149	149	149	21*	17*	149	149
200 FSW	30*	17*	199	199	198	197*	198	198	73*	10*	198	198
230 FSW	27*	21*	230	230	227*	225*	228	+	28*	44*	229	228
200 FSW	11*	12*	200	199	196*	192*	+	+	43*	42*	198	199
150 FSW	1*	7*	149	149	144*	142*	+	+	40*	41*	149	149
100 FSW	0*	2*	100	100	94*	92*	+	+	167*	165*	100	99
50 FSW	0*	1*	50	49	44*	42*	+	+	176*	247*	50	50
0 FSW	0	-	0	-	0	-	+	+	247*	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

+ Indicates unit went blank

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C12

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #6

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

ORCA UDM

Chamber Depth	UDM Depth Reading											
	Unit 1173		Unit 1172		Unit 1171		Unit 0107		Unit 1170		Unit 1190	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	13*	7*	49	50	+	+	49	49	+	+	50	49
100 FSW	13*	8*	99	100	+	+	99	99	+	+	99	99
150 FSW	16*	+	149	149	+	+	148	149	+	+	149	150
200 FSW	+	+	200	200	+	+	198	199	+	+	199	199
230 FSW	+	+	231	230	+	+	228	228	+	+	229	229
200 FSW	+	+	201	200	+	+	199	198	+	+	200	199
150 FSW	+	+	149	149	+	+	149	149	+	+	150	150
100 FSW	+	+	100	100	+	+	100	99	+	+	100	100
50 FSW	+	+	50	50	+	+	50	50	+	+	50	50
0 FSW	+	+	0	-	+	+	0	-	+	+	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

+ Indicates unit went blank

- Indicates no reading taken

* Readings outside of ±2 FSW specification

APPENDIX C2

LONG TERM STABILITY/TEMPERATURE SENSITIVITY DATA

DIVETRONIC UDM AT 29°F AND 93°F

Actual chamber depth and comparative UDM depth readings are charted at 50 FSW increments and at 230 FSW, recording UDM depth readings at the beginning and end of each 30 minute stop at each depth increment during descent and ascent as 29°F and 93°F water temperatures. Six dives are charted for each UDM at each water temperature to a maximum depth of 230 FSW.

KEY:

Figure C13: Divetronic UDM at 29°F Water Temperature, Dive #1
Figure C14: Divetronic UDM at 29°F Water Temperature, Dive #2
Figure C15: Divetronic UDM at 29°F Water Temperature, Dive #3
Figure C16: Divetronic UDM at 29°F Water Temperature, Dive #4
Figure C17: Divetronic UDM at 29°F Water Temperature, Dive #5
Figure C18: Divetronic UDM at 29°F Water Temperature, Dive #6
Figure C19: Divetronic UDM at 93°F Water Temperature, Dive #1
Figure C20: Divetronic UDM at 93°F Water Temperature, Dive #2
Figure C21: Divetronic UDM at 93°F Water Temperature, Dive #3
Figure C22: Divetronic UDM at 93°F Water Temperature, Dive #4
Figure C23: Divetronic UDM at 93°F Water Temperature, Dive #5
Figure C24: Divetronic UDM at 93°F Water Temperature, Dive #6

Figure C13

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #1

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	51	51	50	50	50	51	50	51	50	50	51	51
100 FSW	102	102	100	100	101	101	101	102	101	101	102	102
150 FSW	153*	153*	151	151	152	152	153*	153*	152	152	153*	153*
200 FSW	203*	203*	200	200	203*	203*	203*	203*	202	202	203*	203*
230 FSW	213*	213*	222*	222*	219*	219*	222*	222*	222*	222*	222*	222*
200 FSW	203*	203*	200	200	203*	203*	203*	203*	202	202	203*	203*
150 FSW	153*	153*	151	151	152	152	153*	153*	152	152	153*	153*
100 FSW	102	102	100	100	101	101	102	102	101	101	102	102
50 FSW	51	51	50	50	51	51	51	51	50	50	51	51
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C1A

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #2

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	51	51	50	50	51	51	51	51	50	50	50	50
100 FSW	101	102	101	101	102	102	102	102	100	100	101	101
150 FSW	152	152	151	151	153*	153*	152	152	150	150	152	152
200 FSW	203*	203*	202	202	203*	203*	203*	203*	200	200	202	202
230 FSW	222*	222*	222*	222*	222*	222*	213*	213*	222*	222*	219*	219*
200 FSW	203*	203*	201	201	203*	203*	202	202	200	200	202	202
150 FSW	152	152	151	151	152	152	152	152	150	150	152	152
100 FSW	101	101	100	100	102	102	101	101	100	100	101	101
50 FSW	51	51	50	50	51	51	50	51	50	50	50	50
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Errors outside of ±2 FSW specification

Figure C15

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29 °F WATER TEMPERATURE, DIVE #5

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	51	51	50	50	51	51	51	51	50	50	51	51
100 FSW	102	102	100	100	102	102	102	102	101	101	102	102
150 FSW	153*	153*	151	151	153*	153*	153*	153*	152	152	153*	153*
200 FSW	204*	204*	200	200	203*	203*	203*	203*	202	202	204*	204*
230 FSW	212*	212*	222*	222*	218*	218*	222*	222*	222*	222*	222*	222*
200 FSW	204*	204*	200	200	203*	203*	203*	203*	202	202	204*	203*
150 FSW	153*	153*	151	151	153*	153*	153*	153*	152	152	153*	153*
100 FSW	102	102	100	100	102	102	102	102	101	101	102	102
50 FSW	51	51	50	50	51	51	51	51	50	50	51	51
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C16

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #4

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 851	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	51	51	51	50	51	50	51	50	50	51	51
100 FSW	102	102	101	101	102	102	102	102	101	101	102	102
150 FSW	153*	153*	152	152	153*	153*	153*	153*	152	152	153*	153*
200 FSW	203*	203*	201	201	203*	203*	203*	203*	202*	202*	204*	204*
230 FSW	212*	212*	223*	223*	218*	218*	222*	222*	222*	222*	222*	222*
200 FSW	203*	203*	201	201	203*	203*	203*	203*	202	202	204*	204*
150 FSW	152	153*	152	152	153*	153*	152	153*	152	152	153*	153*
100 FSW	102	102	101	102	102	102	102	102	101	101	102	102
50 FSW	51	51	51	51	51	51	51	51	51	50	51	51
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C17

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #5

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	51	50	50	50	51	49	50	50	50	50	50
100 FSW	102	102	100	100	102	102	101	101	101	101	101	101
150 FSW	153*	153*	151	151	153*	153*	152	152	152	152	152	152
200 FSW	203*	203*	200	200	203*	203*	202	202	202	202	203*	203*
230 FSW	212*	212*	222*	222*	218*	218*	221*	221*	222*	222*	222*	221*
200 FSW	203*	203*	200	200	203*	203*	202	202	202	202	203*	203*
150 FSW	153*	153*	151	151	153*	153*	152	152	152	152	152	152
100 FSW	103*	103*	100	100	102	102	101	101	101	101	101	101
50 FSW	51	51	50	50	51	51	51	50	50	50	50	50
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C18

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

29°F WATER TEMPERATURE, DIVE #6

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	51	50	50	50	51	51	51	50	50	51	51
100 FSW	102	102	100	100	102	102	102	102	101	101	102	102
150 FSW	153*	153*	151	151	153*	153*	153*	153*	152	152	154*	154*
200 FSW	204*	203*	200	200	204*	204*	204*	203*	202	202	204*	204*
230 FSW	211*	211*	222*	222*	217*	218*	222*	222*	222*	222*	222*	222*
200 FSW	204*	204*	200	201*	204*	204*	203*	203*	202	202	204*	204*
150 FSW	153*	153*	151	151	153*	153*	153*	153*	152	152	153*	153*
100 FSW	102	102	100	100	102	102	102	102	101	101	102	102
50 FSW	51	51	50	50	51	51	51	51	50	50	51	51
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C-19

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #1

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	49	51	51	50	49	50	50	50	50	50	50
100 FSW	99	100	101	101	99	99	100	100	100	100	100	100
150 FSW	150	150	151	151	149	149	151	151	151	151	151	151
200 FSW	199	199	201	201	199	199	200	200	200	200	200	200
230 FSW	223*	223*	222*	222*	222*	222*	222*	222*	222*	222*	222*	222*
200 FSW	199	199	201	201	199	199	200	200	200	200	200	200
150 FSW	150	150	152	151	149	149	151	151	151	151	151	151
100 FSW	100	100	101	101	99	99	100	100	100	100	100	100
50 FSW	49	49	50	50	49	49	50	50	50	50	50	50
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C-20

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #2

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	49	49	50	51	50	50	50	50	50	50	50	50
100 FSW	99	99	101	101	99	99	100	100	100	100	100	101
150 FSW	150	150	151	151	150	149	151	151	151	151	151	151
200 FSW	199	199	201	201	199	199	200	200	200	200	200	200
230 FSW	223*	223*	222*	222*	222*	222*	222*	222*	222*	222*	222*	222*
200 FSW	199	199	201	201	199	199	200	200	200	200	200	200
150 FSW	150	150	152	151	150	149	151	150	150	150	151	151
100 FSW	99	99	101	101	99	99	100	100	100	100	100	100
50 FSW	49	49	51	51	49	49	50	50	50	50	50	50
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Readings outside of ±2 FSW specification

Figure C-21

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #3

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	50	51	50	49	50	50	50	50	49	49
100 FSW	99	99	101	102	99	99	100	101	100	100	100	100
150 FSW	149	149	152	152	149	149	151	151	150	150	150	150
200 FSW	199	199	202	202	199	199	200	200	200	190	199	199
230 FSW	222*	223*	222*	222*	222*	222*	222*	222*	190*	187*	221*	221*
200 FSW	199	199	201	201	199	199	200	200	187*	187*	200	200
150 FSW	149	149	152	152	149	149	151	151	149	149	150	150
100 FSW	99	99	101	101	99	99	100	100	99	99	100	100
50 FSW	49	49	51	51	49	49	50	50	-	-	50	49
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Errors outside of ±2 FSW specification

Figure C-22

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #4

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	50	51	49	49	50	50	50	50	50	50
100 FSW	100	99	101	101	99	99	100	100	100	100	100	100
150 FSW	150	150	152	152	149	149	151	151	151	151	151	151
200 FSW	199	199	202	202	199	198	200	200	200	200	200	200
230 FSW	224*	224*	222*	222*	222*	222*	222*	222*	222*	222*	222*	222*
200 FSW	199	199	202	202	199	199	200	200	200	200	200	200
150 FSW	150	150	152	152	149	149	151	151	151	151	150	150
100 FSW	99	99	101	101	99	99	100	100	100	100	100	100
50 FSW	49	49	51	51	49	49	50	50	50	50	50	50
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Errors outside of ±2 FSW specification

Figure C-23

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #5

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	50	50	49	49	50	50	50	50	50	50
100 FSW	100	100	101	101	99	99	100	101	101	100	100	100
150 FSW	150	150	151	151	149	149	150	150	151	151	150	150
200 FSW	199	200	200	201	199	199	199	199	201	201	199	199
230 FSW	224*	224*	221*	221*	222*	222*	221*	221*	222*	222*	221*	221*
200 FSW	200	200	201	201	199	199	199	199	201	200	200	199
150 FSW	150	150	151	151	149	149	150	150	151	151	150	150
100 FSW	99	100	100	100	99	99	100	99	100	100	100	100
50 FSW	50	50	50	50	49	49	49	49	50	50	49	49
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Errors outside of ±2 FSW specification

Figure C-24

LONG TERM STABILITY/TEMPERATURE SENSITIVITY

93°F WATER TEMPERATURE, DIVE #6

30 MINUTE STOPS AT 50 FSW INCREMENTS AND AT 230 FSW

DIVETRONIC UDM

Chamber Depth	UDM Depth Reading											
	Unit 889		Unit 215		Unit 836		Unit 795		Unit 864		Unit 861	
	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End	Begin	End
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-
50 FSW	50	50	51	51	50	50	50	50	50	51	51	51
100 FSW	100	99	102	102	99	99	100	100	101	101	101	101
150 FSW	150	150	152	152	149	149	150	150	151	151	151	151
200 FSW	199	199	202	202	199	199	200	200	201	201	201	201
230 FSW	224*	224*	222*	222*	222*	222*	221*	221*	222*	222*	222*	222*
200 FSW	200	200	202	202	199	199	200	200	201	201	201	201
150 FSW	150	150	152	152	150	150	150	150	151	151	151	151
100 FSW	100	100	101	101	99	99	100	100	101	101	101	101
50 FSW	50	49	51	51	49	49	50	50	51	50	51	51
0 FSW	0	-	0	-	0	-	0	-	0	-	0	-

Begin = UDM Depth Reading at Beginning of 30 Minute Depth Stop

End = UDM Depth Reading at End of 30 Minute Stop

- Indicates no reading taken

* Errors outside of ±2 FSW specification

APPENDIX D

REPETITIVE NO DECOMPRESSION DIVE PROFILE TRACKING DATA

UDM dive profiles are charted as compared to HP 1000 computer programming. Two separate repetitive dives are charted with surface interval depths of 2 FSW and 5 FSW, respectively. The following dive profiles were executed:

a. 60 FSW No Decompression
   1 Hour Interval at 2 FSW
   120 FSW No Decompression

b. 60 FSW No decompression
   1 Hour Interval at 5 FSW
   120 FSW No Decompression

A comparison of profiles provides an evaluation of the UDM's switch from PPO_2 of .7 to PPO_2 of .21 at 3 FSW. All dives were conducted at 29°F water temperature.

KEY:

Figure D1: Divetronic Unit 889
Figure D2: Divetronic Unit 864
Figure D3: Divetronic Unit 861
Figure D4: Divetronic Unit 836
Figure D5: Divetronic Unit 795
Figure D6: Divetronic Unit 215

Figure D1

REPETITIVE NO DECOMPRESSION DIVE PROFILE TRACKING DATA

29°F WATER TEMPERATURE

DIVETRONIC UDM #889

Dive Profile a. 60 FSW No Decompression

1 Hour Surface Interval at 2 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4430	60	60	10	0	-
4446	60	60	10	10	+16
4500	24	26	10	0	-
4502	23	24	0	0	-2
8440	120	120	0	10	-
8452	120	120	10	10	-12
8680	10	10	0	10	-
8730	10	10	0	0	+50

Dive Profile b. 60 FSW No Decompression

1 Hour Surface Interval at 5 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4380	60	60	10	0	-
4460	60	60	10	10	+80
4520	20	20	10	0	-
4556	5	5	0	0	-36
9164	120	120	10	0	-
9178	120	120	10	10	+14
9448	10	10	10	0	-
9474	10	10	0	0	-26

- Indicates awaiting next SAD change on UDM or computer for SAD change times comparison

NOTE: Slight differences in computer depth and UDM depth during SAD change times are occasionally evident, particularly when SAD changes occurred during depth travel. This is a result of slight delays in manually programming computer depth to reflect UDM depth changes.

Figure D2

REPETITIVE NO DECOMPRESSION DIVE PROFILE TRACKING DATA

29°F WATER TEMPERATURE

DIVETRONIC UDM #864

Dive Profile a. 60 FSW No Decompression

1 Hour Surface Interval at 2 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4410	60	59	10	0	-
4464	49	50	10	10	+54
4496	27	27	10	0	-
4506	22	21	0	0	-10
8528	120	120	0	10	-
8568	80	78	10	10	-40
8658	19	17	0	10	-
8780	10	10	0	0	+122

Dive Profile b. 60 FSW No Decompression

1 Hour Surface Interval at 5 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4356	60	60	10	0	-
4456	60	60	10	10	+100
4496	28	29	10	0	-
4550	6	5	0	0	-54
9140	120	120	10	0	-
9154	120	120	10	10	+14
9378	10	10	10	0	-
9452	1	0	0	0	-74

- Indicates awaiting next SAD change on UDM or computer for SAD change times comparison

NOTE: Slight differences in computer depth and UDM depth during SAD change times are occasionally evident, particularly when SAD changes occurred during depth travel. This is a result of slight delays in manually programming computer depth to reflect UDM depth changes.

Figure D3

REPETITIVE NO DECOMPRESSION DIVE PROFILE TRACKING DATA

29°F WATER TEMPERATURE

DIVETRONIC UDM #861

Dive Profile a. 60 FSW No Decompression

1 Hour Surface Interval at 2 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4428	60	60	10	0	-
4474	60	60	10	10	+26
4516	28	30	10	0	-
4538	15	15	0	0	-22
8514	120	120	0	10	-
8524	120	120	10	10	-10
8750	10	10	0	10	-
8822	10	10	0	0	+72

Dive Profile b. 60 FSW No Decompression

1 Hour Surface Interval at 5 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4430	60	60	10	0	-
4444	60	60	10	10	+14
4510	23	13	0	10	-
4520	18	12	0	0	+10
8982	120	120	10	10	0
9226	10	10	0	10	-
9238	10	10	0	0	+12

- Indicates awaiting next SAD change on UDM or computer for SAD change times comparison

NOTE: Slight differences in computer depth and UDM depth during SAD change times are occasionally evident, particularly when SAD changes occurred during depth travel. This is a result of slight delays in manually programming computer depth to reflect UDM depth changes.

Figure D4

REPETITIVE NO DECOMPRESSION DIVE PROFILE TRACKING DATA

29°F WATER TEMPERATURE

DIVETRONIC UDM #836

Dive Profile a. 60 FSW No Decompression

1 Hour Surface Interval at 2 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4428	60	60	0	10	-
4462	60	60	10	10	-34
4510	29	28	0	10	-
4536	13	12	0	0	+26
8506	120	120	0	10	-
8524	120	120	10	10	-18
8846	10	10	0	10	-
8944	10	10	0	0	+98

Dive Profile b. 60 FSW No Decompression

1 Hour Surface Interval at 5 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4442	60	60	0	10	-
4448	60	60	10	10	-6
4498	26	25	0	10	-
4504	21	21	0	0	+6
9128	120	120	10	10	0
9468	10	10	0	10	-
9478	10	10	0	0	+10

- Indicates awaiting next SAD change on UDM or computer for SAD change times comparison

NOTE: Slight differences in computer depth and UDM depth during SAD change times are occasionally evident, particularly when SAD changes occurred during depth travel. This is a result of slight delays in manually programming computer depth to reflect UDM depth changes.

Figure D5

REPETITIVE NO DECOMPRESSION DIVE PROFILE TRACKING DATA

29°F WATER TEMPERATURE

DIVETRONIC UDM #795

Dive Profile a. 60 FSW No Decompression

1 Hour Surface Interval at 2 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4488	60	60	10	0	-
4490	60	60	10	10	+2
4548	27	27	0	10	-
4574	14	10	0	0	+26
8588	120	120	0	10	-
8608	120	120	10	10	+20
8828	10	10	0	10	-
8910	10	10	0	0	+82

Dive Profile b. 60 FSW No Decompression

1 Hour Surface Interval at 5 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4328	60	60	10	0	-
4460	60	60	10	10	+132
4538	14	16	10	0	-
4608	10	10	0	0	-70
9262	120	120	10	0	-
9288	120	120	10	10	+26
9544	10	10	10	0	-
9616	10	10	0	0	-72

- Indicates awaiting next SAD change on UDM or computer for SAD change times comparison

NOTE: Slight differences in computer depth and UDM depth during SAD change times are occasionally evident, particularly when SAD changes occurred during depth travel. This is a result of slight delays in manually programming computer depth to reflect UDM depth changes.

Figure D6

REPETITIVE NO DECOMPRESSION DIVE PROFILE TRACKING DATA

29°F WATER TEMPERATURE

DIVETRONIC UDM #215

Dive Profile a. 60 FSW No Decompression

1 Hour Surface Interval at 2 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4424	60	60	10	0	-
4446	60	60	10	10	+22
4490	30	31	10	0	-
4496	26	27	0	0	-6
8480	120	120	10	0	-
8490	120	120	10	10	+10
8672	10	10	10	0	-
8684	0	0	10	0	-

Dive Profile b. 60 FSW No Decompression

1 Hour Surface Interval at 5 FSW

120 FSW No Decompression

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)
4410	60	60	10	0	-
4466	60	60	10	10	+56
4510	27	28	10	0	-
4538	10	10	0	0	-28
9110	120	120	10	0	-
9112	120	120	10	10	+2
9412	10	10	0	10	-
9418	9	10	0	0	+6

- Indicates awaiting next SAD change on UDM or computer for SAD change times comparison

NOTE: Slight differences in computer depth and UDM depth during SAD change times are occasionally evident, particularly when SAD changes occurred during depth travel. This is a result of slight delays in manually programming computer depth to reflect UDM depth changes.

APPENDIX E

DECOMPRESSION DIVE PROFILE TRACKING DATA

UDM dive profiles are charted as compared to HP 1000 computer programming. Two separate dive profiles were conducted on each UDM on the following schedule:

a. 175 FSW 60 Minutes
b. 150 FSW 30 Minutes

Dive schedule a. is conducted at 29°F and 93°F water temperatures. Dive schedule b. is conducted at 29° water temperature.

KEY:

Figure E1 : Dive Profile a. at 29°F Water Temperature, Divetronic UDM 889
Figure E2 : Dive Profile a. at 29°F Water Temperature, Divetronic UDM 864
Figure E3 : Dive Profile a. at 29°F Water Temperature, Divetronic UDM 861
Figure E4 : Dive Profile a. at 29°F Water Temperature, Divetronic UDM 836
Figure E5 : Dive Profile a. at 29°F Water Temperature, Divetronic UDM 795
Figure E6 : Dive Profile a. at 29°F Water Temperature, Divetronic UDM 215
Figure E7 : Dive Profile a. at 93°F Water Temperature, Divetronic UDM 889
Figure E8 : Dive Profile a. at 93°F Water Temperature, Divetronic UDM 864
Figure E9 : Dive Profile a. at 93°F Water Temperature, Divetronic UDM 861
Figure E10: Dive Profile a. at 93°F Water Temperature, Divetronic UDM 836
Figure E11: Dive Profile a. at 93°F Water Temperature, Divetronic UDM 795
Figure E12: Dive Profile a. at 93°F Water Temperature, Divetronic UDM 215
Figure E13: Dive Profile b., Divetronic UDM 889
Figure E14: Dive Profile b., Divetronic UDM 864
Figure E15: Dive Profile b., Divetronic UDM 861
Figure E16: Dive Profile b., Divetronic UDM 836
Figure E17: Dive Profile b., Divetronic UDM 795
Figure E18: Dive Profile b., Divetronic UDM 215

FIGURE E1

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #889

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
492	175	175	10	0	-	-	-	-
502	176	175	10	10	+10	-	-	-
566	175	175	20	10	-	-	-	-
576	175	175	20	20	+10	-	-	-
656	175	175	30	20	-	-	-	-
666	175	175	30	30	+10	-	-	-
768	175	175	40	30	-	-	-	-
780	175	175	40	40	+12	-	-	-
920	175	175	50	40	-	-	-	-
934	175	175	50	50	+14	-	-	-
1160	175	175	60	50	-	-	-	-
1178	175	175	60	60	+18	-	-	-
1482	175	175	60	60	-	FLASHING	-	-
1520	175	175	60	60	-	FLASHING	FLASHING	+38
1678	175	175	70	60	-	FLASHING	FLASHING	-
1700	175	175	70	70	+22	FLASHING	FLASHING	-
2114	175	175	80	70	-	FLASHING	FLASHING	-
2132	175	175	80	80	+18	FLASHING	FLASHING	-
3020	175	175	90	80	-	FLASHING	FLASHING	-
3044	175	175	90	90	+24	FLASHING	FLASHING	-
4284	90	90	90	80	-	FLASHING	FLASHING	-
4302	80	80	80	80	-18	FLASHING	FLASHING	-
5144	80	80	80	70	-	FLASHING	FLASHING	-
5156	74	75	70	70	-12	FLASHING	FLASHING	-
6006	70	70	70	60	-	FLASHING	FLASHING	-
6010	67	68	50	60	-4	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E1

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7600	60	60	60	50	-	FLASHING	FLASHING	-
7640	50	50	50	50	-40	FLASHING	FLASHING	-
9314	50	50	50	40	-	FLASHING	FLASHING	-
9346	40	40	40	40	-32	FLASHING	FLASHING	-
11040	39	40	40	30	-	FLASHING	FLASHING	-
11052	29	31	30	30	-12	FLASHING	FLASHING	-
13140	30	30	20	30	-	FLASHING	FLASHING	-
13160	30	30	20	20	+20	FLASHING	FLASHING	-
17490	20	20	10	20	-	FLASHING	FLASHING	-
17532	19	20	10	10	+42	FLASHING	FLASHING	-
17538	16	17	10	10	-	-	FLASHING	-
19172	10	10	10	10	-	-	-	+1634*
23566	10	10	0	10	-	-	-	-
23658	10	10	0	0	+92	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison
* Technician error in plotting data.

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E2

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #864

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
500	175	175	10	0	-	-	-	-
508	175	175	10	10	+8	-	-	-
574	175	175	20	10	-	-	-	-
582	175	175	20	20	+8	-	-	-
664	175	175	30	20	-	-	-	-
674	175	175	30	30	+10	-	-	-
778	175	175	40	30	-	-	-	-
788	175	175	40	40	+10	-	-	-
932	175	175	50	40	-	-	-	-
944	175	175	50	50	+12	-	-	-
1174	175	175	60	50	-	-	-	-
1188	175	175	60	60	+14	-	-	-
1490	175	175	60	60	-	FLASHING	-	-
1504	175	175	60	60	-	FLASHING	FLASHING	+14
1692	175	175	70	60	-	FLASHING	FLASHING	-
1700	175	175	70	70	+8	FLASHING	FLASHING	-
2130	175	175	80	70	-	FLASHING	FLASHING	-
2132	175	175	80	80	+2	FLASHING	FLASHING	-
3046	175	175	80	90	-	FLASHING	FLASHING	-
3062	175	175	90	90	-16	FLASHING	FLASHING	-
4352	90	90	90	80	-	FLASHING	FLASHING	-
4370	80	81	80	80	-18	FLASHING	FLASHING	-
5214	80	80	80	70	-	FLASHING	FLASHING	-
5224	75	76	70	70	-10	FLASHING	FLASHING	-
6076	70	70	60	60	0	FLASHING	FLASHING	-
7746	60	60	60	50	-	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E2

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7780	50	50	50	50	-34	FLASHING	FLASHING	-
9468	50	50	50	40	-	FLASHING	FLASHING	-
9486	42	41	40	40	-18	FLASHING	FLASHING	-
11194	40	40	30	30	0	FLASHING	FLASHING	-
13370	30	30	30	20	-	FLASHING	FLASHING	-
13374	30	30	20	20	-4	FLASHING	FLASHING	-
17682	20	20	20	20	-	-	FLASHING	-
17758	20	20	20	20	-	-	-	+76
17822	20	20	10	20	-	-	-	-
17824	20	20	10	10	+2	-	-	-
23980	10	10	0	10	-	-	-	-
24022	10	10	0	0	+42	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E3

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #861

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
494	175	175	10	0	-	-	-	-
502	175	175	10	10	+8	-	-	-
570	175	175	20	10	-	-	-	-
576	175	175	20	20	+6	-	-	-
660	175	175	30	20	-	-	-	-
664	174	175	30	30	+4	-	-	-
774	175	175	40	30	-	-	-	-
778	175	175	40	40	+4	-	-	-
930	175	175	50	40	-	-	-	-
932	175	175	50	50	+2	-	-	-
1178	175	175	60	60	0	-	-	-
1486	175	175	60	60	-	FLASHING	-	-
1496	175	175	60	60	-	FLASHING	FLASHING	+10
1690	175	175	70	60	-	FLASHING	FLASHING	-
1696	175	175	70	70	+6	FLASHING	FLASHING	-
2126	175	175	80	70	-	FLASHING	FLASHING	-
2132	175	175	80	80	+6	FLASHING	FLASHING	-
3060	175	175	90	80	-	FLASHING	FLASHING	-
3062	175	175	90	90	+2	FLASHING	FLASHING	-
4302	90	90	80	90	-	FLASHING	FLASHING	-
4304	90	90	80	80	+2	FLASHING	FLASHING	-
5154	80	80	70	80	-	FLASHING	FLASHING	-
5164	80	80	70	70	+10	FLASHING	FLASHING	-
6008	70	70	60	70	-	FLASHING	FLASHING	-
6028	70	70	60	60	+20	FLASHING	FLASHING	-
7652	60	60	50	50	0	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E3

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
9360	50	50	40	50	-	FLASHING	FLASHING	-
9448	45	50	40	40	+88	FLASHING	FLASHING	-
11066	40	40	30	40	-	FLASHING	FLASHING	-
11102	40	40	30	30	+36	FLASHING	FLASHING	-
13246	30	30	20	30	-	FLASHING	FLASHING	-
13284	30	30	20	20	+38	FLASHING	FLASHING	-
17556	20	20	20	20	-	-	FLASHING	-
17660	20	20	10	20	-	-	FLASHING	-
17670	20	20	10	20	-	-	-	+114
17712	20	20	10	10	+52	-	-	-
23780	10	10	0	10	-	-	-	-
23882	10	10	0	0	+102	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E4

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #836

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
490	175	175	10	0	-	-	-	-
498	175	175	10	10	+8	-	-	-
564	175	175	20	10	-	-	-	-
572	175	175	20	20	+8	-	-	-
652	175	175	30	20	-	-	-	-
666	175	175	30	30	+14	-	-	-
764	175	175	40	30	-	-	-	-
778	175	175	40	40	+14	-	-	-
916	175	175	50	40	-	-	-	-
934	175	175	50	50	+18	-	-	-
1154	175	175	60	50	-	-	-	-
1188	175	175	60	60	+26	-	-	-
1478	175	175	60	60	-	FLASHING	-	-
1496	175	175	60	60	-	FLASHING	FLASHING	+18
1670	175	175	70	60	-	FLASHING	FLASHING	-
1700	175	175	70	70	+30	FLASHING	FLASHING	-
2094	175	175	80	70	-	FLASHING	FLASHING	-
2138	175	175	80	80	+44	FLASHING	FLASHING	-
2984	175	175	90	80	-	FLASHING	FLASHING	-
3060	175	175	90	90	+76	FLASHING	FLASHING	-
4323	90	90	80	90	-	FLASHING	FLASHING	-
4325	90	90	80	80	+2	FLASHING	FLASHING	-
5153	80	80	80	70	-	FLASHING	FLASHING	-
5178	70	70	70	70	-25	FLASHING	FLASHING	-
6016	69	70	70	60	-	FLASHING	FLASHING	-
6030	60	59	60	60	-14	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E4

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7666	59	60	60	50	-	FLASHING	FLASHING	-
7693	50	50	50	50	-27	FLASHING	FLASHING	-
9343	50	50	50	40	-	FLASHING	FLASHING	-
9399	40	40	40	40	-56	FLASHING	FLASHING	-
11087	39	40	40	30	-	FLASHING	FLASHING	-
11107	30	30	30	30	-20	FLASHING	FLASHING	-
13231	30	30	30	20	-	FLASHING	FLASHING	-
13255	22	22	20	20	-24	FLASHING	FLASHING	-
17597	20	20	20	20	-	-	FLASHING	-
17651	20	20	20	10	-	-	FLASHING	-
17657	16	17	10	10	-6	-	FLASHING	-
17699	10	10	10	10	-	-	-	+102
23765	10	10	10	0	-	-	-	-
23802	0	0	0	0	-37	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E5

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #795

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
490	175	175	10	0	-	-	-	-
494	175	175	10	10	+4	-	-	-
566	174	175	20	10	-	-	-	-
568	174	175	20	20	+2	-	-	-
656	175	175	30	30	-	-	-	-
770	175	175	40	30	-	-	-	-
772	175	175	40	40	+2	-	-	-
926	175	175	50	40	-	-	-	-
932	175	175	50	50	+6	-	-	-
1172	175	175	60	50	-	-	-	-
1178	175	175	60	60	+6	-	-	-
1484	175	175	60	60	-	FLASHING	-	-
1494	175	175	60	60	-	FLASHING	FLASHING	+10
1688	175	175	70	60	-	FLASHING	FLASHING	-
1692	175	175	70	70	+4	FLASHING	FLASHING	-
2124	175	175	80	70	-	FLASHING	FLASHING	-
2128	175	175	80	80	+4	FLASHING	FLASHING	-
3012	175	175	90	80	-	FLASHING	FLASHING	-
3028	175	175	90	90	+16	FLASHING	FLASHING	-
4364	90	90	90	80	-	FLASHING	FLASHING	-
4380	80	81	80	80	-16	FLASHING	FLASHING	-
5234	80	80	70	80	-	FLASHING	FLASHING	-
5260	78	80	70	70	+26	FLASHING	FLASHING	-
6086	70	70	60	70	-	FLASHING	FLASHING	-
6090	69	70	60	60	+4	FLASHING	FLASHING	-
7756	60	60	60	50	-	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E5

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7790	50	50	50	50	+34	FLASHING	FLASHING	-
9480	50	50	50	40	-	FLASHING	FLASHING	-
9496	41	41	40	40	-16	FLASHING	FLASHING	-
11204	40	40	30	40	-	FLASHING	FLASHING	-
11206	40	40	30	30	+2	FLASHING	FLASHING	-
13406	30	30	30	20	-	FLASHING	FLASHING	-
13412	27	27	20	20	-6	FLASHING	FLASHING	-
17690	20	20	20	20	-	-	FLASHING	-
17764	20	20	20	20	-	-	-	+74
17866	20	20	20	10	-	-	-	-
17876	16	17	10	10	-10	-	-	-
24052	10	10	0	10	-	-	-	-
24076	10	10	0	0	+24	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E6

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #215

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
492	175	175	10	0	-	-	-	-
498	175	175	10	10	+6	-	-	-
566	175	175	20	10	-	-	-	-
572	175	175	20	20	+6	-	-	-
656	175	175	30	20	-	-	-	-
662	175	175	30	30	+6	-	-	-
770	175	175	40	30	-	-	-	-
778	175	175	40	40	+8	-	-	-
924	175	175	50	40	-	-	-	-
934	175	175	50	50	+10	-	-	-
1168	175	175	60	50	-	-	-	-
1178	175	175	60	60	+10	-	-	-
1484	175	175	60	60	-	FLASHING	-	-
1496	175	175	60	60	-	FLASHING	FLASHING	+12
1684	175	175	70	60	-	FLASHING	FLASHING	-
1698	175	175	70	70	+14	FLASHING	FLASHING	-
2118	175	175	80	70	-	FLASHING	FLASHING	-
2138	175	175	80	80	+20	FLASHING	FLASHING	-
3014	175	175	90	80	-	FLASHING	FLASHING	-
3024	175	175	90	90	+10	FLASHING	FLASHING	-
4236	90	90	80	90	-	FLASHING	FLASHING	-
4296	90	90	80	80	+60	FLASHING	FLASHING	-
5068	80	80	80	70	-	FLASHING	FLASHING	-
5088	71	70	70	70	-20	FLASHING	FLASHING	-
5930	70	70	70	60	-	FLASHING	FLASHING	-
5942	65	65	60	60	-12	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E6

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7510	61	60	60	50	-	FLASHING	FLASHING	-
7536	50	50	50	50	-26	FLASHING	FLASHING	-
9202	50	50	50	40	-	FLASHING	FLASHING	-
9244	41	39	40	40	-42	FLASHING	FLASHING	-
10930	40	40	40	30	-	FLASHING	FLASHING	-
10950	31	30	30	30	-20	FLASHING	FLASHING	-
13026	30	30	30	20	-	FLASHING	FLASHING	-
13096	21	20	20	20	-70	FLASHING	FLASHING	-
17346	21	20	20	10	-	FLASHING	FLASHING	-
17414	10	10	10	10	-68	FLASHING	FLASHING	-
17438	10	10	10	10	-	-	FLASHING	-
17552	10	10	10	10	-	-	-	+114
23436	10	10	10	0	-	-	-	-
23570	0	0	0	0	-134	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE 57

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
93°F WATER TEMPERATURE
DIVETRONIC UDM #889

UNIT FAILED TO PROVIDE SAD INFORMATION

FIGURE E8

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
93°F WATER TEMPERATURE
DIVETRONIC UDM #864

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
556	175	175	10	0	-	-	-	-
564	175	175	10	10	+8	-	-	-
630	175	175	20	10	-	-	-	-
636	175	175	20	20	+8	-	-	-
720	175	175	30	20	-	-	-	-
728	175	175	30	30	+8	-	-	-
832	175	175	40	30	-	-	-	-
842	175	175	40	40	+10	-	-	-
986	175	175	50	40	-	-	-	-
995	175	175	50	50	+10	-	-	-
1224	175	175	60	50	-	-	-	-
1242	175	175	60	60	+18	-	-	-
1546	175	175	60	60	-	FLASHING	-	-
1560	175	175	60	60	-	FLASHING	FLASHING	+14
1740	175	175	70	60	-	FLASHING	FLASHING	-
1764	175	175	70	70	+24	FLASHING	FLASHING	-
2162	176	175	80	70	-	FLASHING	FLASHING	-
2202	175	175	80	80	+40	FLASHING	FLASHING	-
3044	175	175	90	80	-	FLASHING	FLASHING	-
3122	175	175	90	90	+78	FLASHING	FLASHING	-
4822	90	90	90	80	-	FLASHING	FLASHING	-
4860	80	80	80	80	-38	FLASHING	FLASHING	-
5676	80	80	80	70	-	FLASHING	FLASHING	-
5714	70	70	70	70	-38	FLASHING	FLASHING	-
6850	70	70	70	60	-	FLASHING	FLASHING	-
6950	60	60	60	60	-100	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E8

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
8578	60	60	60	50	-	FLASHING	FLASHING	-
8656	50	50	50	50	-78	FLASHING	FLASHING	-
10302	50	50	50	40	-	FLASHING	FLASHING	-
10364	40	40	40	40	-62	FLASHING	FLASHING	-
12028	40	40	40	30	-	FLASHING	FLASHING	-
12070	30	30	30	30	-42	FLASHING	FLASHING	-
14620	30	30	30	20	-	FLASHING	FLASHING	-
14632	21	22	20	20	-12	FLASHING	FLASHING	-
18556	20	20	20	20	-	-	FLASHING	-
18598	20	20	20	20	-	-	-	+42
19456	20	20	10	20	-	-	-	-
19464	20	20	10	10	+8	-	-	-
26018	10	10	0	10	-	-	-	-
26136	10	10	0	0	+118	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E9

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
93°F WATER TEMPERATURE
DIVETRONIC UDM #861

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
494	175	175	10	0	-	-	-	-
498	175	175	10	10	+4	-	-	-
568	175	175	20	10	-	-	-	-
572	175	175	20	20	+4	-	-	-
658	175	175	30	20	-	-	-	-
662	175	175	30	30	+4	-	-	-
772	175	175	40	30	-	-	-	-
778	175	175	40	40	+6	-	-	-
926	175	175	50	40	-	-	-	-
934	175	175	50	50	+8	-	-	-
1166	175	175	60	50	-	-	-	-
1178	175	175	60	60	+12	-	-	-
1482	175	175	60	60	-	FLASHING	-	-
1496	175	175	60	60	-	FLASHING	FLASHING	+14
1678	175	175	70	60	-	FLASHING	FLASHING	-
1700	175	175	70	70	+22	FLASHING	FLASHING	-
2110	175	175	80	70	-	FLASHING	FLASHING	-
2138	175	175	80	80	+28	FLASHING	FLASHING	-
2994	175	175	90	80	-	FLASHING	FLASHING	-
3060	175	175	90	90	+66	FLASHING	FLASHING	-
4360	90	90	90	80	-	FLASHING	FLASHING	-
4378	80	80	80	80	-18	FLASHING	FLASHING	-
5218	80	80	80	70	-	FLASHING	FLASHING	-
5232	69	69	70	70	-14	FLASHING	FLASHING	-
6060	70	70	70	60	-	FLASHING	FLASHING	-
6084	60	60	60	60	-24	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E9

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7772	60	60	60	50	-	FLASHING	FLASHING	-
7780	51	51	50	50	-8	FLASHING	FLASHING	-
9442	50	50	50	40	-	FLASHING	FLASHING	-
9486	40	40	40	40	-44	FLASHING	FLASHING	-
11194	40	40	30	40	-	FLASHING	FLASHING	-
11200	40	40	30	30	+6	FLASHING	FLASHING	-
13344	30	30	30	20	-	FLASHING	FLASHING	-
13348	27	30	20	20	-4	FLASHING	FLASHING	-
17680	20	20	20	20	-	-	FLASHING	-
17756	20	20	20	20	-	-	-	+76
17776	20	20	10	20	-	-	-	-
17796	20	20	10	10	+20	-	-	-
23926	10	10	0	10	-	-	-	-
23990	10	10	0	0	+64	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E10

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
93°F WATER TEMPERATURE
DIVETRONIC UDM #836

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
496	175	175	10	0	-	-	-	-
502	175	175	10	10	+6	-	-	-
572	175	175	20	10	-	-	-	-
578	175	175	20	20	+6	-	-	-
662	175	175	30	20	-	-	-	-
668	175	175	30	30	+6	-	-	-
776	175	175	40	30	-	-	-	-
782	175	175	40	40	+6	-	-	-
932	175	175	50	40	-	-	-	-
936	175	175	50	50	+4	-	-	-
1178	175	175	60	50	-	-	-	-
1182	175	175	60	60	+4	-	-	-
1488	175	175	60	60	-	FLASHING	-	-
1498	175	175	60	60	-	FLASHING	FLASHING	+10
1686	175	175	70	60	-	FLASHING	FLASHING	-
170[illegible]	175	175	70	70	+14	FLASHING	FLASHING	-
2114	175	175	80	70	-	FLASHING	FLASHING	-
2138	175	175	80	80	+24	FLASHING	FLASHING	-
3020	175	175	90	80	-	FLASHING	FLASHING	-
3060	175	175	90	90	+40	FLASHING	FLASHING	-
4346	90	90	90	80	-	FLASHING	FLASHING	-
4370	80	80	80	80	-24	FLASHING	FLASHING	-
[illegible]	[illegible]	80	80	70	-	FLASHING	FLASHING	-
5224	70	70	70	70	-16	FLASHING	FLASHING	-
6070	70	70	70	60	-	FLASHING	FLASHING	-
6078	59	[illegible]0	60	60	-8	FLASHING	FLASHING	-

- Indicates await next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E10

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7736	60	60	60	50	-	FLASHING	FLASHING	-
7778	50	50	50	50	-42	FLASHING	FLASHING	-
9452	50	50	50	40	-	FLASHING	FLASHING	-
9486	40	40	40	40	-34	FLASHING	FLASHING	-
11180	40	40	40	30	-	FLASHING	FLASHING	-
11192	29	30	30	30	-12	FLASHING	FLASHING	-
13346	30	30	30	20	-	FLASHING	FLASHING	-
13352	25	26	20	20	-6	FLASHING	FLASHING	-
17678	20	20	20	20	-	-	FLASHING	-
17746	20	20	20	20	-	-	-	+68
17792	20	20	20	10	-	-	-	-
17802	15	16	10	10	-10	-	-	-
23936	10	10	0	10	-	-	-	-
23978	10	10	0	0	+42	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E11

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
93°F WATER TEMPERATURE
DIVETRONIC UDM #795

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
502	175	175	10	0	-	-	-	-
508	175	175	10	10	+6	-	-	-
576	175	175	20	10	-	-	-	-
582	175	175	20	20	+6	-	-	-
666	175	175	30	20	-	-	-	-
674	175	175	30	30	+8	-	-	-
778	175	175	40	30	-	-	-	-
788	175	175	40	40	+10	-	-	-
930	176	175	50	40	-	-	-	-
944	176	175	50	50	+14	-	-	-
1166	175	175	60	50	-	-	-	-
1188	175	175	60	60	+22	-	-	-
1490	175	175	60	60	-	FLASHING	-	-
1680	176	175	70	60	-	FLASHING	-	-
1712	176	175	70	70	+32	FLASHING	-	-
1736	176	175	70	70	-	FLASHING	FLASHING	+246
2102	176	175	80	70	-	FLASHING	FLASHING	-
2148	176	175	80	80	+46	FLASHING	FLASHING	-
2946	176	175	90	80	-	FLASHING	FLASHING	-
3064	176	175	90	90	+18	FLASHING	FLASHING	-
4428	90	90	80	80	0	FLASHING	FLASHING	-
5228	80	80	80	70	-	FLASHING	FLASHING	-
5280	70	70	70	70	-52	FLASHING	FLASHING	-
6106	70	70	70	60	-	FLASHING	FLASHING	-
6154	60	60	60	60	-48	FLASHING	FLASHING	-
7756	60	60	60	50	-	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E11

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7860	50	50	50	50	-104	FLASHING	FLASHING	-
9462	50	50	50	40	-	FLASHING	FLASHING	-
9566	40	40	40	40	-104	FLASHING	FLASHING	-
11192	40	40	40	30	-	FLASHING	FLASHING	-
11274	30	30	30	30	-82	FLASHING	FLASHING	-
13396	30	30	30	20	-	FLASHING	FLASHING	-
13482	20	20	20	20	-86	FLASHING	FLASHING	-
17756	20	20	20	20	-	FLASHING	-	-
17760	20	20	20	20	-	-	-	-4
17842	20	20	20	10	-	-	-	-
17920	10	10	10	10	-78	-	-	-
24042	10	10	10	0	-	-	-	-
24056	5	5	0	0	-14	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E12

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE A. 175 FSW 60 MINUTES, DECOMPRESS TO SURFACE
93°F WATER TEMPERATURE
DIVETRONIC UDM #215

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
530	175	175	10	0	-	-	-	-
532	175	175	10	10	+2	-	-	-
604	175	175	20	10	-	-	-	-
608	175	175	20	20	+4	-	-	-
694	175	175	30	20	-	-	-	-
700	175	175	30	30	+6	-	-	-
808	175	175	40	30	-	-	-	-
814	175	175	40	40	+6	-	-	-
964	175	175	50	40	-	-	-	-
968	175	175	50	50	+4	-	-	-
1206	175	175	60	50	-	-	-	-
1212	175	175	60	60	+6	-	-	-
1520	175	175	60	60	-	FLASHING	-	-
1530	175	175	60	60	-	FLASHING	FLASHING	+10
1722	175	175	70	60	-	FLASHING	FLASHING	-
1734	175	175	70	70	+12	FLASHING	FLASHING	-
2154	175	175	80	70	-	FLASHING	FLASHING	-
2168	175	175	80	80	+14	FLASHING	FLASHING	-
3072	175	175	90	80	-	FLASHING	FLASHING	-
3088	175	175	90	90	+16	FLASHING	FLASHING	-
4326	88	90	90	80	-	FLASHING	FLASHING	-
4330	84	90	80	80	-4	FLASHING	FLASHING	-
5172	80	80	80	70	-	FLASHING	FLASHING	-
5184	70	70	70	70	-12	FLASHING	FLASHING	-
6034	70	70	70	60	-	FLASHING	FLASHING	-
6038	69	70	60	60	-4	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E12

(Continued)

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
7642	60	60	60	50	-	FLASHING	FLASHING	-
7670	50	50	50	50	-28	FLASHING	FLASHING	-
9356	50	50	50	40	-	FLASHING	FLASHING	-
9376	40	40	40	40	-20	FLASHING	FLASHING	-
11076	40	40	40	30	-	FLASHING	FLASHING	-
11082	36	37	30	30	-6	FLASHING	FLASHING	-
13182	30	30	20	30	-	FLASHING	FLASHING	-
13194	30	30	20	20	+12	FLASHING	FLASHING	-
17532	20	20	10	20	-	FLASHING	FLASHING	-
17568	20	20	10	20	-	-	FLASHING	-
17570	20	20	10	10	+38	-	FLASHING	-
17964	10	10	10	10	-	-	-	+396
23616	10	10	0	10	-	-	-	-
23708	10	10	0	0	+92	-	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E13

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE 8. 150 FSW 30 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #889

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
626	150	150	10	0	-	-	-	-
630	150	150	10	10	+4	-	-	-
758	150	150	20	10	-	-	-	-
762	150	150	20	20	+4	-	-	-
942	151	150	30	20	-	-	-	-
950	151	150	30	30	+8	-	-	-
1276	150	150	40	30	-	-	-	-
1288	150	150	40	40	+12	-	-	-
1712	150	150	50	40	-	-	-	-
1726	150	150	50	50	+14	-	-	-
1808	150	150	50	50	-	FLASHING	-	-
1820	150	150	50	50	-	FLASHING	FLASHING	+12
2280	50	50	40	50	-	FLASHING	FLASHING	-
2282	50	50	40	40	+2	FLASHING	FLASHING	-
2706	40	40	30	40	-	FLASHING	FLASHING	-
2712	40	40	30	30	+6	FLASHING	FLASHING	-
3478	30	30	30	20	-	FLASHING	FLASHING	-
3484	30	30	20	20	-6	FLASHING	FLASHING	-
4860	20	20	20	10	-	FLASHING	FLASHING	-
4880	11	11	10	10	-20	FLASHING	FLASHING	-
6586	10	10	0	10	-	FLASHING	-	-
6588	10	10	0	0	+2	FLASHING	-	-
6624	0	0	0	0	-	FLASHING	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E14

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE B. 150 FSW 30 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #864

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
620	150	150	10	0	-	-	-	-
632	150	150	10	10	+12	-	-	-
750	150	150	20	10	-	-	-	-
762	150	150	20	20	+12	-	-	-
936	150	150	30	20	-	-	-	-
952	150	150	30	30	+16	-	-	-
1268	150	150	40	30	-	-	-	-
1288	150	150	40	40	+20	-	-	-
1702	150	150	50	40	-	-	-	-
1720	150	150	50	50	+18	-	-	-
1802	150	150	50	50	-	FLASHING	-	-
1818	150	150	50	50	-	FLASHING	FLASHING	+16
2170	51	50	50	40	-	FLASHING	FLASHING	-
2176	47	47	40	40	-6	FLASHING	FLASHING	-
2600	40	40	40	30	-	FLASHING	FLASHING	-
2602	40	40	30	30	-2	FLASHING	FLASHING	-
3298	30	30	30	20	-	FLASHING	FLASHING	-
3302	29	29	20	20	-4	FLASHING	FLASHING	-
4576	20	20	20	10	-	FLASHING	FLASHING	-
4616	10	10	10	10	-40	FLASHING	FLASHING	-
6302	10	10	10	0	-	FLASHING	FLASHING	-
6306	10	10	10	0	-	FLASHING	-	-
6324	0	0	10	0	-	FLASHING	-	-
6338	0	0	0	0	-36	FLASHING	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E15

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE B. 150 FSW 30 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #861

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
646	150	150	10	0	-	-	-	-
654	150	150	10	10	+8	-	-	-
776	150	150	20	10	-	-	-	-
786	150	150	20	20	+10	-	-	-
964	150	150	30	20	-	-	-	-
978	150	150	30	30	+14	-	-	-
1298	150	150	40	30	-	-	-	-
1304	150	150	40	40	+6	-	-	-
1310	150	150	40	30	-	-	-	-
1320	150	150	40	40	+10	-	-	-
1730	150	150	50	40	-	-	-	-
1752	150	150	50	50	+22	-	-	-
1828	150	150	50	50	-	FLASHING	-	-
1932	150	150	50	50	-	FLASHING	FLASHING	+4
2196	50	50	40	50	-	FLASHING	FLASHING	-
2198	50	50	40	40	+2	FLASHING	FLASHING	-
2624	40	40	30	40	-	FLASHING	FLASHING	-
2638	40	40	30	30	+14	FLASHING	FLASHING	-
3300	30	30	30	20	-	FLASHING	FLASHING	-
3330	30	30	20	20	-30	FLASHING	FLASHING	-
4662	20	20	10	20	-	FLASHING	FLASHING	-
4672	20	20	10	10	+10	FLASHING	FLASHING	-
6368	10	10	0	10	-	FLASHING	FLASHING	-
6380	10	10	0	0	+12	FLASHING	FLASHING	-
6410	0	0	0	0	-	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E16

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE B. 150 FSW 30 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #836

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
624	150	150	10	0	-	-	-	-
630	150	150	10	10	+6	-	-	-
754	150	150	20	10	-	-	-	-
764	150	150	20	20	+10	-	-	-
942	150	150	30	20	-	-	-	-
952	150	150	30	30	+10	-	-	-
1290	150	150	40	30	-	-	-	-
1292	150	150	40	40	+2	-	-	-
1710	150	150	50	40	-	-	-	-
1728	150	150	50	50	+18	-	-	-
1806	150	150	50	50	-	FLASHING	-	-
1824	150	150	50	50	-	FLASHING	FLASHING	+18
2204	50	50	40	50	-	FLASHING	FLASHING	-
2206	50	50	40	40	+2	FLASHING	FLASHING	-
2628	40	40	40	30	-	FLASHING	FLASHING	-
2632	40	40	30	30	-4	FLASHING	FLASHING	-
3364	30	30	20	30	-	FLASHING	FLASHING	-
3380	30	30	20	20	+16	FLASHING	FLASHING	-
4680	20	20	20	10	-	FLASHING	FLASHING	-
4716	20	20	10	10	-36	FLASHING	FLASHING	-
6398	10	10	10	0	-	FLASHING	FLASHING	-
6402	10	10	10	0	-	FLASHING	-	-
6422	10	10	0	0	-24	FLASHING	-	-
6466	0	0	0	0	0	FLASHING	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E17

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE B. 150 FSW 30 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #795

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
636	150	150	10	0	-	-	-	-
644	150	150	10	10	+8	-	-	-
766	150	150	20	10	-	-	-	-
778	150	150	20	20	+12	-	-	-
954	150	150	30	20	-	-	-	-
974	150	150	30	30	+20	-	-	-
1292	150	150	40	40	0	-	-	-
1724	150	150	50	40	-	-	-	-
1742	150	150	50	50	+18	-	-	-
1818	150	150	50	50	-	FLASHING	-	-
1836	150	150	50	50	-	FLASHING	FLASHING	+18
2180	50	50	50	40	-	FLASHING	FLASHING	-
2182	50	50	40	40	-2	FLASHING	FLASHING	-
2608	40	40	30	30	0	FLASHING	FLASHING	-
3296	30	30	30	20	-	FLASHING	FLASHING	-
3302	30	30	20	20	-6	FLASHING	FLASHING	-
4588	20	20	20	10	-	FLASHING	FLASHING	-
4616	20	20	10	10	-28	FLASHING	FLASHING	-
6302	10	10	10	0	-	FLASHING	FLASHING	-
6322	10	10	0	0	-20	FLASHING	FLASHING	-
6328	9	10	0	0	-	FLASHING	-	-
6366	0	0	0	0	-	FLASHING	-	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

FIGURE E18

DECOMPRESSION DIVE PROFILE TRACKING DATA
DIVE PROFILE B. 150 FSW 30 MINUTES, DECOMPRESS TO SURFACE
29°F WATER TEMPERATURE
DIVETRONIC UDM #215

ELAPSED DIVE TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
630	150	150	10	0	-	-	-	-
634	150	150	10	10	+4	-	-	-
762	150	150	20	10	-	-	-	-
764	150	150	20	20	+2	-	-	-
952	150	150	30	20	-	-	-	-
954	150	150	30	30	+2	-	-	-
1298	150	150	30	40	-	-	-	-
1300	150	150	40	40	-2	-	-	-
1724	150	150	50	40	-	-	-	-
1732	150	150	50	50	+8	-	-	-
1814	150	150	50	50	-	FLASHING	-	-
1826	150	150	50	50	-	FLASHING	FLASHING	+12
1974	50	50	40	40	0	FLASHING	FLASHING	-
2400	40	40	30	40	-	FLASHING	FLASHING	-
2402	40	40	30	30	+2	FLASHING	FLASHING	-
2926	29	30	30	20	-	FLASHING	FLASHING	-
2934	25	25	20	20	-8	FLASHING	FLASHING	-
4040	20	20	20	10	-	FLASHING	FLASHING	-
4058	12	11	10	10	-18	FLASHING	FLASHING	-
5764	10	10	0	10	-	FLASHING	FLASHING	-
5768	9	10	0	0	+2	FLASHING	FLASHING	-

- Indicates awaiting next change in SAD or warning status on computer or UDM for change time comparison

NOTE: Slight differences in computer depth and UDM depth are occasionally evident, particularly during depth travel, as a result of slight delays in manually programming computer depth to reflect UDM depth changes.

APPENDIX F

REPETITIVE DECOMPRESSION DIVE PROFILE TRACKING DATA

UDM dive profiles are charted as compared to HP 1000 computer programming. One dive profile is conducted on each UDM at 29°F water temperature on the following schedule:

a. 150 FSW 30 Minutes
   1 Hour Surface Interval
   150 FSW 30 Minutes

KEY:

Figure F1: Divetronic UDM 889
Figure F2: Divetronic UDM 864
Figure F3: Divetronic UDM 861
Figure F4: Divetronic UDM 836
Figure F5: Divetronic UDM 795
Figure F6: Divetronic UDM 215

FIGURE F1

REPETITIVE DECOMPRESSION DIVE PROFILE TRACKING DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #889

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
626	150	150	10	0	-	-	-	-
634	150	150	10	10	+8	-	-	-
758	150	150	20	10	-	-	-	-
766	150	150	20	20	+8	-	-	-
946	150	150	30	20	-	-	-	-
956	150	150	30	30	+10	-	-	-
1282	150	150	40	30	-	-	-	-
1296	150	150	40	40	+14	-	-	-
1708	150	150	50	40	-	-	-	-
1730	150	150	50	50	+22	-	-	-
1806	150	150	50	50	-	FLASHING	-	-
1824	150	150	50	50	-	FLASHING	FLASHING	+18
2186	50	50	50	40	-	FLASHING	FLASHING	-
2202	41	42	40	40	-16	FLASHING	FLASHING	-
2616	40	40	40	30	-	FLASHING	FLASHING	-
2628	32	32	30	30	-12	FLASHING	FLASHING	-
3306	30	30	30	20	-	FLASHING	FLASHING	-
3336	20	20	20	20	-30	FLASHING	FLASHING	-
4626	20	20	20	10	-	FLASHING	FLASHING	-
4658	10	10	10	10	-32	FLASHING	FLASHING	-
6338	10	10	10	0	-	FLASHING	FLASHING	-
6368	2	0	0	0	-30	FLASHING	FLASHING	-
6394	0	0	0	0	-	FLASHING	-	-
10396	150	150	10	0	-	FLASHING	-	-
10402	150	150	10	10	+6	FLASHING	-	-
10452	150	150	10	10	-	FLASHING	FLASHING	-4058
10752	150	150	20	10	-	FLASHING	FLASHING	-

FIGURE F1

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
10764	150	150	20	20	+12	FLASHING	FLASHING	-
11084	150	150	30	20	-	FLASHING	FLASHING	-
11098	150	150	30	30	+14	FLASHING	FLASHING	-
11422	150	150	40	30	-	FLASHING	FLASHING	-
11442	150	150	40	40	+20	FLASHING	FLASHING	-
11846	150	150	50	40	-	FLASHING	FLASHING	-
11868	150	150	50	50	+22	FLASHING	FLASHING	-
12564	50	50	50	40	-	FLASHING	FLASHING	-
12592	40	40	40	40	-28	FLASHING	FLASHING	-
13956	40	40	40	30	-	FLASHING	FLASHING	-
14016	30	30	30	30	-60	FLASHING	FLASHING	-
15684	30	30	30	20	-	FLASHING	FLASHING	-
15722	20	20	20	20	-38	FLASHING	FLASHING	-
17408	20	20	20	10	-	FLASHING	FLASHING	-
17430	10	10	10	10	-22	FLASHING	FLASHING	-
20502	10	10	10	10	-	-	FLASHING	-
20518	10	10	10	10	-	-	-	+16
20736	10	10	10	0	-	-	-	-
20864	0	0	0	0	-128	-	-	-

FIGURE F2

REFETITIVE DECOMPRESSION DIVE PROFILE TRACKING DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #864

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
632	150	150	10	0	-	-	-	-
638	150	150	10	10	+6	-	-	-
764	150	150	20	10	-	-	-	-
770	150	150	20	20	+6	-	-	-
952	150	150	30	20	-	-	-	-
960	150	150	30	30	+8	-	-	-
1294	150	150	40	30	-	-	-	-
1302	150	150	40	40	+8	-	-	-
1724	150	150	50	40	-	-	-	-
1736	150	150	50	50	+12	-	-	-
1816	150	150	50	50	-	FLASHING	-	-
1838	150	150	50	50	-	FLASHING	FLASHING	+20
2184	50	50	50	40	-	FLASHING	FLASHING	-
2188	50	50	40	40	-4	FLASHING	FLASHING	-
2614	40	40	30	30	0	FLASHING	FLASHING	-
3306	30	30	30	20	-	FLASHING	FLASHING	-
3322	30	30	20	20	-16	FLASHING	FLASHING	-
4606	20	20	20	10	-	FLASHING	FLASHING	-
4638	20	20	10	10	-32	FLASHING	FLASHING	-
6342	10	10	0	10	-	FLASHING	FLASHING	-
6350	10	10	0	0	+8	FLASHING	FLASHING	-
7374	0	0	0	0	-	FLASHING	-	-
10296	150	150	10	0	-	FLASHING	-	-
10304	150	150	10	10	+8	FLASHING	-	-
10650	150	150	20	10	-	FLASHING	-	-
10656	150	150	20	20	+6	FLASHING	-	-
10662	150	150	20	20	-	FLASHING	FLASHING	-3288

FIGURE F2

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
10978	150	150	30	20	-	FLASHING	FLASHING	-
10990	150	150	30	30	+12	FLASHING	FLASHING	-
11312	150	150	40	30	-	FLASHING	FLASHING	-
11336	150	150	40	40	+24	FLASHING	FLASHING	-
11738	150	150	50	40	-	FLASHING	FLASHING	-
11756	150	150	50	50	+18	FLASHING	FLASHING	-
12956	50	50	40	50	-	FLASHING	FLASHING	-
12962	50	50	40	40	-6	FLASHING	FLASHING	-
14582	40	40	40	30	-	FLASHING	FLASHING	-
14612	40	40	30	30	-30	FLASHING	FLASHING	-
16304	30	30	30	20	-	FLASHING	FLASHING	-
16318	30	30	20	20	-14	FLASHING	FLASHING	-
18024	20	20	10	20	-	FLASHING	FLASHING	-
18026	20	20	10	10	-2	FLASHING	FLASHING	-
21098	10	10	10	10	-	-	FLASHING	-
21348	10	10	10	10	-	-	-	+250
21890	10	10	10	0	-	-	-	-
21896	10	10	0	0	-6	-	-	-

FIGURE F3

REPETITIVE DECOMPRESSION DIVE PROFILE TRACKING DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #861

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
622	150	150	10	0	-	-	-	-
628	150	150	10	10	+6	-	-	-
750	150	150	20	10	-	-	-	-
760	150	150	20	20	+10	-	-	-
936	150	150	30	20	-	-	-	-
950	150	150	30	30	+14	-	-	-
1274	150	150	40	30	-	-	-	-
1290	150	150	40	40	+16	-	-	-
1712	150	150	50	40	-	-	-	-
1728	150	150	50	50	+16	-	-	-
1804	146	149	50	50	-	FLASHING	-	-
1824	126	129	50	50	-	FLASHING	FLASHING	+20
1920	50	50	40	50	-	FLASHING	FLASHING	-
1950	40	40	40	40	+30	FLASHING	FLASHING	-
2346	40	40	30	40	-	FLASHING	FLASHING	-
2360	40	40	30	30	+14	FLASHING	FLASHING	-
2824	30	30	30	20	-	FLASHING	FLASHING	-
2846	20	20	20	20	-22	FLASHING	FLASHING	-
3928	20	20	20	10	-	FLASHING	FLASHING	-
3944	12	11	10	10	-16	FLASHING	FLASHING	-
5636	10	10	10	0	-	FLASHING	FLASHING	-
5662	0	0	0	0	-26	FLASHING	FLASHING	-
5670	0	0	0	0	-	FLASHING	-	-
9464	150	150	10	0	-	FLASHING	-	-
9470	150	150	10	10	+6	FLASHING	-	-
9474	150	150	10	10	-	FLASHING	FLASHING	-3804
9820	150	150	20	10	-	FLASHING	FLASHING	-

FIGURE F3

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
9828	150	150	20	20	+8	FLASHING	FLASHING	-
10160	150	150	30	20	-	FLASHING	FLASHING	-
10174	150	150	30	30	+14	FLASHING	FLASHING	-
10496	150	150	40	30	-	FLASHING	FLASHING	-
10516	150	150	40	40	+20	FLASHING	FLASHING	-
10874	150	150	50	40	-	FLASHING	FLASHING	-
10890	150	150	50	50	+16	FLASHING	FLASHING	-
11836	50	50	50	40	-	FLASHING	FLASHING	-
11856	40	40	40	40	-20	FLASHING	FLASHING	-
13198	40	40	40	30	-	FLASHING	FLASHING	-
13244	30	30	30	30	-46	FLASHING	FLASHING	-
14920	30	30	30	20	-	FLASHING	FLASHING	-
14950	21	20	20	20	-30	FLASHING	FLASHING	-
16642	20	20	20	10	-	FLASHING	FLASHING	-
16656	14	12	10	10	-14	FLASHING	FLASHING	-
19730	10	10	10	10	-	-	FLASHING	-
19750	10	10	10	10	-	-	-	+20
19828	10	10	10	0	-	-	-	-
20010	0	0	0	0	-182	-	-	-

FIGURE F4

REPETITIVE DECOMPRESSION DIVE PROFILE TRACKING DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #836

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
626	150	150	10	0	-	-	-	-
632	150	150	10	10	+6	-	-	-
756	150	150	20	10	-	-	-	-
764	150	150	20	20	+8	-	-	-
946	150	150	30	20	-	-	-	-
954	150	150	30	30	+8	-	-	-
1290	150	150	40	30	-	-	-	-
1296	150	150	40	40	+6	-	-	-
1718	150	150	50	40	-	-	-	-
1730	150	150	50	50	+12	-	-	-
1808	150	150	50	50	-	FLASHING	-	-
1824	150	150	50	50	-	FLASHING	FLASHING	+16
2182	50	50	40	50	-	FLASHING	FLASHING	-
2186	50	50	40	40	+4	FLASHING	FLASHING	-
2606	40	40	40	30	-	FLASHING	FLASHING	-
2608	40	40	30	30	-2	FLASHING	FLASHING	-
3308	30	30	30	20	-	FLASHING	FLASHING	-
3318	28	26	20	20	-10	FLASHING	FLASHING	-
4636	20	20	20	10	-	FLASHING	FLASHING	-
4664	20	20	10	10	-28	FLASHING	FLASHING	-
6360	10	10	10	10	-	FLASHING	-	-
6362	10	10	10	0	-	FLASHING	-	-
6370	7	6	0	0	-8	FLASHING	-	-
10288	150	150	10	0	-	FLASHING	-	-
10290	150	150	10	10	+2	FLASHING	-	-
10310	150	150	10	10	-	FLASHING	FLASHING	-3950
10642	150	150	20	10	-	FLASHING	FLASHING	-

FIGURE F4

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
10650	150	150	20	20	+8	FLASHING	FLASHING	-
10974	150	150	30	20	-	FLASHING	FLASHING	-
10986	150	150	30	30	+12	FLASHING	FLASHING	-
11306	150	150	40	30	-	FLASHING	FLASHING	-
11330	150	150	40	40	+24	FLASHING	FLASHING	-
11732	150	150	50	40	-	FLASHING	FLASHING	-
11758	150	150	50	50	+26	FLASHING	FLASHING	-
12460	50	50	40	50	-	FLASHING	FLASHING	-
12470	50	50	40	40	+10	FLASHING	FLASHING	-
13824	40	40	40	30	-	FLASHING	FLASHING	-
13878	30	30	30	30	-54	FLASHING	FLASHING	-
15548	30	30	30	20	-	FLASHING	FLASHING	-
15586	20	20	20	20	-38	FLASHING	FLASHING	-
17276	20	20	20	10	-	FLASHING	FLASHING	-
17292	12	12	10	10	-16	FLASHING	FLASHING	-
20364	10	10	10	10	-	-	FLASHING	-
20410	10	10	10	10	-	-	-	+46
20616	10	10	10	0	-	-	-	-
20678	0	0	0	0	-62	-	-	-

FIGURE F5

REPETITIVE DECOMPRESSION DIVE PROFILE TRACKING DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #795

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
620	150	150	10	0	-	-	-	-
632	150	150	10	10	+12	-	-	-
750	150	150	20	10	-	-	-	-
764	150	150	20	20	+14	-	-	-
940	150	150	30	20	-	-	-	-
958	149	150	30	30	+18	-	-	-
1292	150	150	40	30	-	-	-	-
1296	150	150	40	40	+4	-	-	-
1714	150	150	50	40	-	-	-	-
1728	150	150	50	50	+14	-	-	-
1804	150	150	50	50	-	FLASHING	-	-
1822	150	150	50	50	-	FLASHING	FLASHING	+18
2146	50	50	40	40	0	FLASHING	FLASHING	-
2566	40	40	40	30	-	FLASHING	FLASHING	-
2572	40	40	30	30	-6	FLASHING	FLASHING	-
3216	30	30	30	20	-	FLASHING	FLASHING	-
3242	30	30	20	20	-16	FLASHING	FLASHING	-
4476	20	20	20	10	-	FLASHING	FLASHING	-
4516	20	20	10	10	-40	FLASHING	FLASHING	-
6196	10	10	10	0	-	FLASHING	FLASHING	-
6200	10	10	10	0	-	FLASHING	-	-
6222	10	10	0	0	-26	FLASHING	-	-
9998	94	96	0	0	-	FLASHING	FLASHING	-3798
10156	150	150	10	0	-	FLASHING	FLASHING	-
10162	150	150	10	10	+6	FLASHING	FLASHING	-
10512	150	150	20	10	-	FLASHING	FLASHING	-
10522	150	150	20	20	+10	FLASHING	FLASHING	-

FIGUPE F5

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
10850	150	150	30	20	-	FLASHING	FLASHING	-
10856	150	150	30	30	+6	FLASHING	FLASHING	-
11196	150	150	40	30	-	FLASHING	FLASHING	-
11200	150	150	40	40	+4	FLASHING	FLASHING	-
11614	150	150	50	40	-	FLASHING	FLASHING	-
11620	150	150	50	50	+6	FLASHING	FLASHING	-
12178	50	50	40	50	-	FLASHING	FLASHING	-
12180	50	50	40	40	+2	FLASHING	FLASHING	-
13474	40	40	40	30	-	FLASHING	FLASHING	-
13482	40	40	30	30	-8	FLASHING	FLASHING	-
15182	30	30	30	20	-	FLASHING	FLASHING	-
15188	30	30	20	20	-6	FLASHING	FLASHING	-
16896	20	20	10	20	-	FLASHING	FLASHING	-
16908	20	20	10	10	+12	FLASHING	FLASHING	-
19968	10	10	0	10	-	-	FLASHING	-
20022	10	10	0	10	-	-	-	+54
20026	10	10	0	0	+58	-	-	-

FIGURE F6

REPETITIVE DECOMPRESSION DIVE PROFILE TRACKING DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #215

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
626	150	150	10	0	-	-	-	-
636	150	150	10	10	+10	-	-	-
756	150	150	20	10	-	-	-	-
766	150	150	20	20	+10	-	-	-
944	150	150	30	20	-	-	-	-
956	150	150	30	30	+12	-	-	-
1282	150	150	40	30	-	-	-	-
1300	150	150	40	40	+18	-	-	-
1710	150	150	50	40	-	-	-	-
1732	150	150	50	50	+22	-	-	-
1806	150	150	50	50	-	FLASHING	-	-
1866	150	150	50	50	-	FLASHING	FLASHING	+60
2198	50	50	50	40	-	FLASHING	FLASHING	-
2206	45	46	40	40	-8	FLASHING	FLASHING	-
2632	40	40	30	40	-	FLASHING	FLASHING	-
2638	40	40	30	30	+6	FLASHING	FLASHING	-
3354	30	30	30	20	-	FLASHING	FLASHING	-
3370	21	30	20	20	-16	FLASHING	FLASHING	-
4676	20	20	20	10	-	FLASHING	FLASHING	-
4724	10	10	10	10	-48	FLASHING	FLASHING	-
6428	10	10	0	10	-	FLASHING	FLASHING	-
6430	10	10	0	10	-	FLASHING	-	-
6432	10	10	0	0	+4	FLASHING	-	-
10294	150	150	10	0	-	FLASHING	-	-
10302	150	150	10	10	+8	FLASHING	-	-
10306	150	150	10	10	-	FLASHING	FLASHING	-3876
10648	150	150	20	10	-	FLASHING	FLASHING	-

FIGURE 56

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
10662	150	150	20	20	+14	FLASHING	FLASHING	-
10986	150	150	30	20	-	FLASHING	FLASHING	-
11000	150	150	30	30	+14	FLASHING	FLASHING	-
11318	150	150	40	30	-	FLASHING	FLASHING	-
11344	150	150	40	40	+26	FLASHING	FLASHING	-
11746	150	150	50	40	-	FLASHING	FLASHING	-
11774	150	150	50	50	+28	FLASHING	FLASHING	-
12512	50	50	50	40	-	FLASHING	FLASHING	-
12546	40	40	40	40	-34	FLASHING	FLASHING	-
13934	39	40	40	30	-	FLASHING	FLASHING	-
13994	30	30	30	30	-60	FLASHING	FLASHING	-
15652	30	30	30	20	-	FLASHING	FLASHING	-
15700	20	20	20	20	-48	FLASHING	FLASHING	-
17378	20	20	20	10	-	FLASHING	FLASHING	-
17406	9	10	10	10	-28	FLASHING	FLASHING	-
20478	10	10	10	10	-	-	FLASHING	-
20666	10	10	10	10	-	-	-	+188
20736	10	10	0	10	-	-	-	-
20742	10	9	0	0	+6	-	-	-

APPENDIX G

WARNING STATUS TEST DATA

UDM safe ascent depth (SAD) information is verified for accuracy by conducting the following schedule at 29°F water temperature:

a. 150 FSW 60 minutes Decompress to 30 FSW	Verify that UDM SAD secures flashing and HP 1000 computer warning status secures, then increase depth until UDM SAD resumes flashing. Do not exceed depth of 150 FSW. Hold depth until computer and UDM warning status is initiated. Surface, skipping all decompression stops. Confirm UDM out of range light activation. Monitor UDM ascent time, and compare to computer "Total Time to Surface (TTS)."

KEY:

Figure G1 : Divetronic UDM 889
Figure G2 : Divetronic UDM 864
Figure G3 : Divetronic UDM 861
Figure G4 : Divetronic UDM 836
Figure G5 : Divetronic UDM 795
Figure G6 : Divetronic UDM 215

FIGURE G1

WARNING STATUS TEST DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #889

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
644	150	150	10	0	-	-	-	-
652	150	150	10	10	+8	-	-	-
774	150	150	20	10	-	-	-	-
782	150	150	20	20	+8	-	-	-
962	150	150	30	20	-	-	-	-
972	150	150	30	30	+10	-	-	-
1304	150	150	40	30	-	-	-	-
1318	150	150	40	40	+14	-	-	-
1734	150	150	50	40	-	-	-	-
1750	150	150	50	50	+16	-	-	-
1826	150	150	50	50	-	FLASHING	-	-
1842	150	150	50	50	-	FLASHING	FLASHING	+16
2324	150	150	60	50	-	FLASHING	FLASHING	-
2340	150	150	60	60	+16	FLASHING	FLASHING	-
3374	150	150	70	60	-	FLASHING	FLASHING	-
3394	150	150	70	70	+20	FLASHING	FLASHING	-
4152	70	70	70	60	-	FLASHING	FLASHING	-
4154	70	70	60	60	-2	FLASHING	FLASHING	-
5008	60	60	50	60	-	FLASHING	FLASHING	-
5010	60	60	50	50	+2	FLASHING	FLASHING	-
6600	50	50	50	40	-	FLASHING	FLASHING	-
6608	44	44	40	40	-8	FLASHING	FLASHING	-
8306	40	40	40	30	-	FLASHING	FLASHING	-
8316	32	33	30	30	-10	FLASHING	FLASHING	-
10022	30	30	20	30	-	FLASHING	FLASHING	-
10030	30	30	20	20	+8	FLASHING	FLASHING	-
12094	30	30	10	20	-	FLASHING	FLASHING	-

FIGURE G1

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
12096	30	30	10	10	+2	FLASHING	FLASHING	-
15548	30	30	10	10	-	-	FLASHING	-
15630	30	30	10	10	-	-	-	+82
16230	150	150	20	10	-	-	-	-
16242	150	150	20	20	+12	-	-	-
16518	150	150	30	20	-	-	-	-
16526	150	150	30	30	+8	-	-	-
16774	150	150	30	30	-	FLASHING	-	-
16778	150	150	30	30	-	FLASHING	FLASHING	+4

FIGURE G2

WARNING STATUS TEST DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #864

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
634	150	150	10	0	-	-	-	-
638	150	150	10	10	+4	-	-	-
766	150	150	20	10	-	-	-	-
768	150	150	20	20	+2	-	-	-
956	150	150	30	20	-	-	-	-
958	150	150	30	30	+2	-	-	-
1298	150	150	30	40	-	-	-	-
1304	150	150	40	40	-6	-	-	-
1730	150	150	50	40	-	-	-	-
1732	150	150	50	50	+2	-	-	-
1820	150	150	50	50	-	FLASHING	-	-
1828	150	150	50	50	-	FLASHING	FLASHING	+8
2318	150	150	50	60	-	FLASHING	FLASHING	-
2330	150	150	60	60	-12	FLASHING	FLASHING	-
3376	149	150	70	70	0	FLASHING	FLASHING	-
4148	70	70	60	70	-	FLASHING	FLASHING	-
4158	70	70	60	60	+10	FLASHING	FLASHING	-
5000	60	60	50	60	-	FLASHING	FLASHING	-
5020	60	60	50	50	+20	FLASHING	FLASHING	-
6600	50	50	50	40	-	FLASHING	FLASHING	-
6602	50	50	40	40	-2	FLASHING	FLASHING	-
8308	41	40	30	40	-	FLASHING	FLASHING	-
8326	41	40	30	30	+18	FLASHING	FLASHING	-
10014	30	30	20	30	-	FLASHING	FLASHING	-
10050	30	30	20	20	+36	FLASHING	FLASHING	-
12108	30	30	10	20	-	FLASHING	FLASHING	-
12110	30	30	10	10	+2	FLASHING	FLASHING	-

FIGURE G2

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
15534	30	30	10	10	-	-	FLASHING	-
15648	30	30	10	10	-	-	-	+114
16242	150	150	20	10	-	-	-	-
16254	150	150	20	20	+12	-	-	-
16528	150	150	30	20	-	-	-	-
16542	150	150	30	30	+14	-	-	-
16790	150	150	30	30	-	FLASHING	-	-
16792	150	150	30	30	-	FLASHING	FLASHING	+2

FIGURE G3

WARNING STATUS TEST DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #861

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
644	150	150	10	0	-	-	-	-
648	150	150	10	10	+4	-	-	-
774	150	150	20	10	-	-	-	-
780	150	150	20	20	+6	-	-	-
964	150	150	30	20	-	-	-	-
970	150	150	30	30	+6	-	-	-
1306	150	150	40	30	-	-	-	-
1308	150	150	40	40	+2	-	-	-
1736	150	150	50	40	-	-	-	-
1744	150	150	50	50	+8	-	-	-
1826	150	150	50	50	-	FLASHING	-	-
1840	150	150	50	50	-	FLASHING	FLASHING	+14
2330	150	150	60	50	-	FLASHING	FLASHING	-
2334	150	150	60	60	+4	FLASHING	FLASHING	-
3376	150	150	70	60	-	FLASHING	FLASHING	-
3390	150	150	70	70	+14	FLASHING	FLASHING	-
4138	70	70	70	60	-	FLASHING	FLASHING	-
4140	70	70	60	60	-2	FLASHING	FLASHING	-
4992	60	60	50	60	-	FLASHING	FLASHING	-
5002	60	60	50	50	+10	FLASHING	FLASHING	-
6554	50	50	50	40	-	FLASHING	FLASHING	-
6572	42	42	40	40	-18	FLASHING	FLASHING	-
8278	40	40	30	30	0	FLASHING	FLASHING	-
9984	30	30	20	30	-	FLASHING	FLASHING	-
10002	30	30	20	20	+18	FLASHING	FLASHING	-
12018	30	30	10	20	-	FLASHING	FLASHING	-
12022	30	30	10	10	+4	FLASHING	FLASHING	-

FIGURE G3

(Continuod)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
15490	30	30	10	10	-	-	FLASHING	-
15608	30	30	10	10	-	-	-	+118
16240	150	150	20	10	-	-	-	-
16244	150	150	20	20	+4	-	-	-
16518	150	150	30	20	-	-	-	-
16526	150	150	30	30	+8	-	-	-
16780	150	150	30	30	-	FLASHING	FLASHING	0

FIGURE G4

WARNING STATUS TEST DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #836

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
632	150	150	10	0	-	-	-	-
640	150	150	10	10	+8	-	-	-
762	150	150	20	10	-	-	-	-
772	150	150	20	20	+10	-	-	-
950	150	150	30	20	-	-	-	-
962	150	150	30	30	+12	-	-	-
1290	150	150	40	30	-	-	-	-
1306	150	150	40	40	+16	-	-	-
1720	150	150	50	40	-	-	-	-
1740	150	150	50	50	+20	-	-	-
1814	150	150	50	50	-	FLASHING	-	-
1832	150	150	50	50	-	FLASHING	FLASHING	+18
2300	150	150	60	50	-	FLASHING	FLASHING	-
2334	150	150	60	60	+34	FLASHING	FLASHING	-
3342	150	150	70	60	-	FLASHING	FLASHING	-
3382	150	150	70	70	+40	FLASHING	FLASHING	-
4162	70	70	70	60	-	FLASHING	FLASHING	-
4190	60	60	60	60	-28	FLASHING	FLASHING	-
5022	60	60	60	50	-	FLASHING	FLASHING	-
5042	50	50	50	50	-20	FLASHING	FLASHING	-
6626	50	50	50	40	-	FLASHING	FLASHING	-
6644	40	40	40	40	-18	FLASHING	FLASHING	-
8352	40	40	30	30	0	FLASHING	FLASHING	-
10070	30	30	20	20	0	FLASHING	FLASHING	-
12088	30	30	20	10	-	FLASHING	FLASHING	-
12144	30	30	10	10	-56	FLASHING	FLASHING	-
15598	30	30	10	10	-	-	FLASHING	-

FIGURE G4

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
15636	30	30	10	10	-	-	-	+38
16252	150	150	20	10	-	-	-	-
16266	150	150	20	20	+14	-	-	-
16548	150	150	30	20	-	-	-	-
16558	150	150	30	30	+10	-	-	-
16802	150	150	30	30	-	FLASHING	-	-
16810	150	150	30	30	-	FLASHING	FLASHING	+8

FIGURE G5

WARNING STATUS TEST DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #795

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
628	150	150	10	0	-	-	-	-
632	150	150	10	10	+4	-	-	-
760	150	150	20	10	-	-	-	-
764	150	150	20	20	+4	-	-	-
950	150	150	30	20	-	-	-	-
954	150	150	30	30	+4	-	-	-
1296	150	150	40	40	0	-	-	-
1722	150	150	50	40	-	-	-	-
1730	150	150	50	50	+8	-	-	-
1810	150	150	50	50	-	FLASHING	-	-
1824	150	150	50	50	-	FLASHING	FLASHING	+14
2300	150	150	60	50	-	FLASHING	FLASHING	-
2310	150	150	60	60	+10	FLASHING	FLASHING	-
3342	150	150	70	60	-	FLASHING	FLASHING	-
3376	150	150	70	70	+34	FLASHING	FLASHING	-
4168	70	70	70	60	-	FLASHING	FLASHING	-
4186	70	70	60	60	-18	FLASHING	FLASHING	-
5028	60	60	60	50	-	FLASHING	FLASHING	-
5040	51	50	50	50	-12	FLASHING	FLASHING	-
6646	50	50	50	40	-	FLASHING	FLASHING	-
6666	40	40	40	40	-20	FLASHING	FLASHING	-
8344	40	40	40	30	-	FLASHING	FLASHING	-
8372	30	30	30	30	-28	FLASHING	FLASHING	-
10078	30	30	20	30	-	FLASHING	FLASHING	-
10080	30	30	20	20	+2	FLASHING	FLASHING	-
12164	30	30	10	20	-	FLASHING	FLASHING	-
12166	30	30	10	10	+2	FLASHING	FLASHING	-

FIGURE G5

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
15574	30	30	10	10	-	-	FLASHING	-
15682	30	30	10	10	-	-	-	+108
16286	150	150	20	10	-	-	-	-
16292	150	150	20	20	+6	-	-	-
16	150	150	30	20	-	-	-	-
16586	150	150	30	30	+12	-	-	-
16834	150	150	30	30	-	FLASHING	-	-
16836	150	150	30	30	-	FLASHING	FLASHING	+2

FIGURE G6

WARNING STATUS TEST DATA
29°F WATER TEMPERATURE
DIVETRONIC UDM #215

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
630	150	150	10	0	-	-	-	-
636	150	150	10	10	+6	-	-	-
762	149	150	20	10	-	-	-	-
766	150	150	20	20	+4	-	-	-
954	150	150	30	20	-	-	-	-
956	150	150	30	30	+2	-	-	-
1300	150	150	30	40	-	-	-	-
1302	150	150	40	40	-2	-	-	-
1726	150	150	50	40	-	-	-	-
1732	150	150	50	50	+6	-	-	-
1814	150	150	50	50	-	FLASHING	-	-
1826	150	150	50	50	-	FLASHING	FLASHING	+12
2322	150	150	60	60	0	FLASHING	FLASHING	-
3360	150	150	70	60	-	FLASHING	FLASHING	-
3378	150	150	70	70	+18	FLASHING	FLASHING	-
4160	70	70	70	60	-	FLASHING	FLASHING	-
4164	65	68	60	60	-4	FLASHING	FLASHING	-
5018	60	60	50	60	-	FLASHING	FLASHING	-
5024	60	60	50	50	-6	FLASHING	FLASHING	-
6606	50	50	50	40	-	FLASHING	FLASHING	-
6626	40	40	40	40	-20	FLASHING	FLASHING	-
8328	40	40	40	30	-	FLASHING	FLASHING	-
8334	37	38	30	30	-6	FLASHING	FLASHING	-
10040	30	30	20	20	0	FLASHING	FLASHING	-
12116	30	30	10	10	0	FLASHING	FLASHING	-
15576	30	30	10	10	-	-	FLASHING	-
15650	30	30	10	10	-	-	--	+74

FIGURE G6

(Continued)

TIME (SECONDS)	COMPUTER DEPTH (FSW)	UDM DEPTH (FSW)	COMPUTER SAD (FSW)	UDM SAD (FSW)	UDM SAD CHANGE TIME COMPARED TO COMPUTER SAD CHANGE TIME (SECONDS)	COMPUTER WARNING STATUS	UDM WARNING STATUS	UDM WARNING STATUS CHANGE TIME COMPARED TO COMPUTER WARNING STATUS CHANGE TIME (SECONDS)
16262	150	150	10	20	-	-	-	-
16264	150	150	20	20	-2	-	-	-
16548	150	150	30	20	-	-	-	-
16552	150	150	30	30	+4	-	-	-
16802	150	150	30	30	-	FLASHING	-	-
16804	150	150	30	30	-	FLASHING	FLASHING	+2

APPENDIX H

December 22, 1986

TECHNICAL MEMORANDUM NO. TM86-14

From: NEDU Code 025 (Author: CURLEY)
To: NEDU Code 00
Via: (1) NEDU Code 02
(2) NEDU Code 031
(3) NEDU Code 01

Subj: UNMANNED DRY HUMAN FACTORS EVALUATION OF THE ORCA INDUSTRIES PROTOTYPE MODEL "N1 UDC" UNDERWATER DECOMPRESSION MONITOR (UDM)

Distribution A: Approved for public release; distribution unlimited.

Ref: (a) Navy Experimental Diving Unit Test Plan No. 85-37 of DEC 85
(b) MIL-STD-1472B, Human Engineering Design Criteria for Military Systems, Equipment and Facilities, 31 DEC 1974 with 1976, 1978 Revisions.
(c) Commerce Business Daily, Issue No. PSA-8546 of 19 March 1984

Encl: (1) Figures 1 - 3 (All photographs by B. Campoli, NCSC)

Key Words: ORCA, UDC, UDM, Human Factors, Underwater, Decompression, Computer, N1

1. Introduction

One prototype wrist-worn (or holstered) underwater decompression computer/meter manufactured by ORCA Industries was received for a preliminary human factors evaluation as outlined in reference (a). The unit was numbered 1190 on the bottom of the battery compartment, and was accompanied by a two-page instruction sheet titled "Manual for the Navy Mark 15 Underwater Decompression Computer, copyright January 1985 ORCA Industries". This manual referred to the prototype UDM as the "N1 UDC". A manual for the ORCA EDGE UDC was also provided, as the manufacturer indicated that the hardware for both the EDGE and the prototype N1 are essentially identical.

2. General Characteristics

The N1 UDC prototype (Figure 1) was rectangular in shape and measured 18.3 cm (L) x 7.4 cm (H) x 3.4 cm (W). It weighed 757 grams with one battery and two wrist straps installed. The case was cast aluminum alloy with a glass display window (from EDGE manual), and was colored blue. One unit sent to NEDU had a matte black finish. Two velcro bands (2.1 x 40 cm) with plastic buckles were slotted through four 1.9 cm long stainless steel pins on the bottom of the case (Figure 2). The pin holders were off-set, presumably to provide a contoured form for wearing the unit on the arm. The bands were easily threaded through the pins.

Pressure transducer ports are located on the front of the unit to the left of the display (Figure 1). Access to the battery compartment on the underside of the unit was via two slotted screws, which are operable by a coin. The screws have stops to prevent their coming out of the case and subsequent loss. A common 9v alkaline battery powers the unit. Two battery connectors are provided so that a low battery can be replaced without interruption of power and loss of repetitive dive information.

Also on the underside of the unit is the on-off switch (Figure 3). The switch is termed a magnetic flip switch by the manufacturer, appears to be made of plastic, and measured 4.1 (L) x 0.6 (W) x 0.5 cm. A small detent with nub extending out 0.1 cm from the switch provided a friction holding device. This device can wear rapidly, leading to the inadvertent dislodging of the switch from the designated position. The switch also appears to be subject to breakage, as it protrudes from the case when being moved. There was no problem in operating this switch with three-fingered neoprene gloves.

3. Display Characteristics

The liquid crystal display (LCD) face measured 5.2 cm x 4.3 cm, and was covered by a glass face recessed 0.4 cm below the front edge of the case. This feature should help prevent damage to the display. When the on/off switch was turned to the "on" position, the display activated with a picture of a whale and the label N1 (rotated 90° to the left) in the lower left hand corner of the display. A blinking checkerboard display then appeared, followed by the standard display of zeros and a blinking asterisk (Figure 1).

The LCD numbers were large [0.8 cm (H) x 0.5 cm (W)], colored black on a grey background, and easy to discriminate when viewed from directly above in office fluorescent light illumination. However, a rapid and substantial decrease in LCD legibility occurred as the unit was rotated away from a position directly in front of the viewer. At ~ 30° offset in either direction, the display became illegible; i.e. the numbers disappeared.

LCD displays are included for dive time, depth, stop depth, stop time, and total time to surface. All convey essential information, and are grouped acceptably. The display times are identified by the colon between hours:minutes. To signal that the unit is functioning properly, a large asterisk blinks in the upper right hand corner of the display. This is inappropriate by human engineering standards [reference (b)], where the use of blinking and flashing lights and displays should be relegated to conditions alerting the operator to a condition which requires his attention and action. A recommended change is to eliminate the blinking asterisk during normal functioning. As the display is already designated to switch from the asterisk to a "B" when battery duration is expected to be less than 4 hours, one could have the "B" present in a steady state. When battery life becomes short, the "B" could start blinking, alerting the operator to a condition requiring his attention.

The use of alternating blinking displays when a diver ascends too shallow is an appropriate warning device. The P40 warning device is also a distinct and clear warning device appropriately programmed. As far as labeling of the display, the prototype unit was furnished with a piece of white paper, on which was lettered in black the labels shown in Figure 1. The paper was secured to the unit with a covering of epoxy, which was peeling away from the unit at the time of this test. Further, the epoxy was off-colored and contained bubbles, rendering the lettering underneath hazy. The labels are not in close proximity to their LCD readout, although the linear spatial relationship between label and LCD is appropriate if one uses the convention of reading from left to right, down one line, and starting over. There appears to be room adjacent to the "TTS" and "Stop Time" LCDs for labels. If the asterisk (or "B") was made smaller and the "dive time" display moved left on the same line, there would be room for the label. The "depth/stop depth" LCDs require some ingenuity to provide a label in close proximity. The rationale for moving the labels closer to the LCDs is to reduce the probability of operator error/confusion in reading the displays, especially with the three time function LCDs being identical in appearance.

4. Conformance With Specifications

A review of the specifications outlined in reference (c) with the prototype ORCA "N1 UDC" revealed the following discrepancies:

*no illuminated background LCD; no on-off switch for LCD illumination.

*no red/green light signaling for violation/compliance.

*no removable plug for leak check and pressure transducer to accept standard fitting.

5. Recommendations

a. Ensure compliance with published specifications; internal illumination is essential, as are signaling functions.

b. Install locking/securing device for on-off switch so it cannot be dislodged inadvertently.

c. Incorporate LCD labels into display window.

d. Re-design LCDs so that numbers can be read when unit is turned at an angle at least to 45° away from head-on.

e. Eliminate blinking asterisk; replace with a steady state alpha-numeric, or better yet a steady green LED.

f. Replace "paste on" display label with integrated labels in display in close proximity to respective LCD.

g. Reduce size and weight of UDM.

6. Summary

The ORCA "N1 UDC" is a large, bulky and heavy UDM, yet offers several advantages in simplicity of design, large numerical LCDs, and ease of operation and maintenance. It is essential, however, that the specifications for illumination and signaling be met before the unit is considered for Navy use. A re-evaluation of a revised prototype incorporating changes outlined in section 5 above would be appropriate.

M. D. Curley

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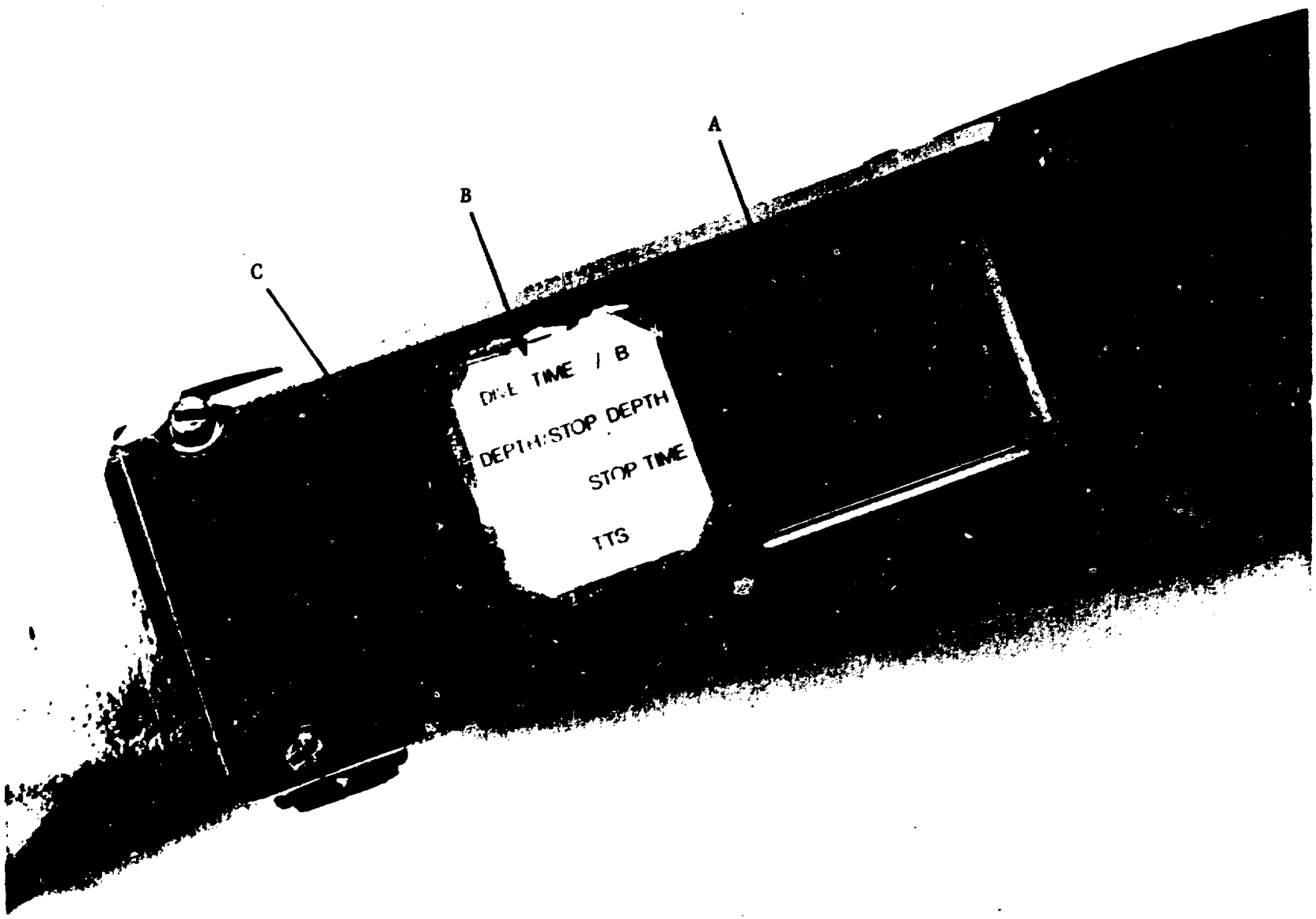

FIGURE 1. N1 UDC showing display window (A), display labels (B), and pressure transducer ports (C).

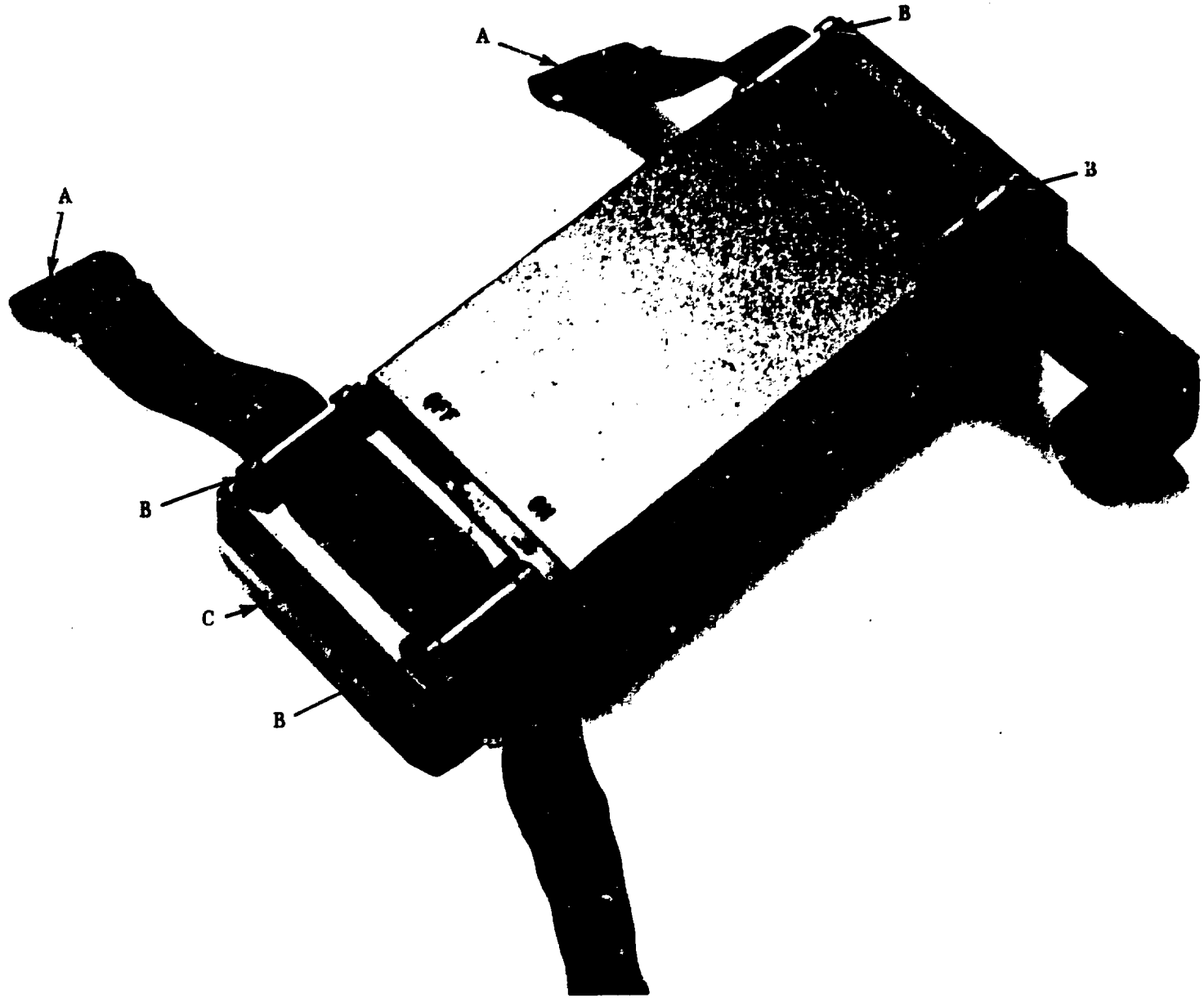

FIGURE 2. Underside view of N1 UDC showing wrist straps (A), steel retaining pins (B), and battery compartment (C).

FIGURE 3. On-off switch of N1 UDC.

APPENDIX I

December 22, 1986

TECHNICAL MEMORANDUM NO. TM86-13

From: NEDU Code 025 (Author: CURLEY)
To: NEDU Code 00
Via: (1) NEDU Code 02
(2) NEDU Code 031
(3) NEDU Code 01

Subj: UNMANNED DRY HUMAN FACTORS EVALUATION OF THE DIVETRONIC PROTOTYPE U.S. NAVY MODEL UNDERWATER DECOMPRESSION MONITOR (UDM)

Distribution A: Approved for public release; distribution unlimited.

Ref: (a) Navy Experimental Diving Unit Test Plan No. 85-37 of December 1985.
(b) MIL-STD-1472B, Human Engineering Design Criteria for Military Systems, Equipment and Facilities, 31 DEC 1974 with 1976, 1978 Revisions.
(c) Commerce Business Daily, Issue No. PSA-8546 of 19 March 1984

Encl: (1) Figures 1 - 5 (All photographs by B. Campoli, NCSC)

Key Words: Divetronics, UDC, UDM, Deco-Brain, Human Factors, Decompression, Computer

1. Introduction

A prototype wrist-worn underwater decompression monitor/computer (UDM/UDC) manufactured by Divetronic-Instruments AG (Postfach, FL-9494 Schaan, Furstentum, Leichtenstein) was received at NEDU and forwarded for a preliminary human factors evaluation IAW reference (a). The unit was inscribed by NEDU personnel for test purposes with the number 861 on the front of the case (Figure 1). An instructional manual of the HANS HASS Deco-Brain II accompanied the unit; the manual was annotated in pencil "rough draft.....new manual....P2-2" (Figure 2). Two sets of serial numbers were on the UDM casing: 02861 was stamped under the case (Figure 3) and 08-83-01 on the rear edge of the case (Figure 3). A "dive-simulator" tool was also provided which fits over the unit's pressure transducer (Figure 4).

2. General Characteristics

The Deco-Brain II UDC uses a molded contoured black plastic case, measuring roughly 14.5 cm wide by 8 cm tall by 11 cm deep. It weighed approximately 2 lbs 3 ounces (992.1 g) in the dry with batteries and wrist straps installed. The face of the case incorporates a 10.5 x 6.0 cm display window to present various information. The label on the display face was grey, and contained graphics of varying colors and sizes surrounding five (5) liquid crystal displays (LCD) and three (3) light emitting diodes (LED). On the bottom of the unit a sliding magnetic switch activated the display

backlighting (Figure 5). Two rubber straps with steel buckles were each threaded through two stainless steel pins and the case body, and are used to attach the unit to the arm of the user. The straps are 2.4 cm wide and 35 cm long (Figure 5).

3. Instruction Manual Review

The instruction manual (Figure 2) accompanying the UDC was written in a language appropriate for the user. Some material could be rearranged for clarity. For example, at the bottom of page 4 there is a note stating that the Deco-Brain must be turned on before entering the water, but it is not until the bottom of page 5 that a simple explanation of the rationale is presented. A primary source of confusion and frustration to the reader is that the text refers to items on the UDM by number, yet the numbers are not found in any of the drawings in the text except on page 24, figure 10. This figure is not referred to in the text. Other specific areas of concern found during the reading of the manual include:

* p. 4 Why will "8888"s not look like figure 1?
* p. 6 Is the UDM accuracy really ± 1.6 ft water, regardless of depth or specific gravity of water (i.e. fresh versus salt water)?
* p. 7 The stated ascent rate of 33 FPM not in accord with USN rate of 60 FPM.
* p. 9 The use of flashing displays when within 6 minutes of incurring a decompression obligation may be inappropriate for Navy use. The present countdown feature is appropriate and adequate without flashing.
* p.10 As presently programmed, the LED for rate of ascent flashes when within a normal rate of ascent, and then stops flashing when the rate is exceeded. This is inappropriate. According to human factors engineering criteria [ref (b)], "the use of flashing lights shall be minimized. Flashing lights may be used only when it is necessary to call the operator's attention to some condition requiring action. The flash rate shall be within 3 to 5 flashes per second..." Further, the use of a red LED is not acceptable for this function in accordance with reference (b). A steady green or yellow light should be used if the rate of ascent is within specifications. A flashing red LED is appropriate only if the ascent rate becomes too rapid.
* p.10 The Deco-Stop LED is flashing when the diver is at an appropriate stop; again, the use of flashing signals should be relegated to a warning status IAW reference (b). A constant green light should be used to indicate all conditions are satisfactory.
* p.10 Why does ascending faster than 33 FPM (or 60 FPM) cause a no-decompression time to switch to a decompression time? An explanation is desirable in the text for the reader.
* p.11 The yellow LED for DECO-STOP flashes when diver is at his required decompression stop. Again, this is inappropriate by Mil Spec human engineering standards [reference (b)].
* p.12 Two LEDs flash if a diver ascends past the required decompression stop. A single flashing red LED would be sufficient.

* p.13 The time to flight value is mentioned but not explained in the manual. This feature is not required for U.S. Navy use.
* p.18 Why cannot the UDM recharger be plugged directly into line voltage? How does the manual define line voltage?
* p.21 Multiple data presentation, including non-operator controlled non-essential information, can lead to operator confusion in state of stress or presence of heavy information processing load.

* No information is provided on how to replace batteries.

* No addresses, telephone numbers, or point of contacts were listed in manual.

* Activation of the UDM on the surface with the dive simulator revealed that not all specifications function as described in the manual. For example, maximum depth is only displayed at the surface, not while in the water. Ascent rate LED functioning is also affected by low battery voltage, though this is not mentioned in the text.

4. Display Characteristics

The display face consists of five liquid crystal displays (LCDs), three of which measure 3.9 x 1.3 cm, and two which measure 1.9 x 1.3 cm. Three warning lights are incorporated into the display, and are light emitting diodes (LEDs). Lettering for the display information consists of eight different size/type/font combinations, colored blue, red and grey. The display face cover is grey. The display is laid out with LCDs for time (dive-time and ascent-time; 4 digits each) grouped on the left side of the display, and LCDs for depth (depth and stops) grouped on the right side. The three LEDs which serve as indicators are grouped vertically in the center.

Comments:

* The LCD numbers are easy to read under normal office fluorescent lighting levels and are not angle dependent; that is, the contrast between figure and ground is sufficient to ensure legibility even when the UDM is rotated up to 45° away from head on. The limiting factor is the edge of the display cutout, and not the contrast of the figure-ground relationship.

* The wide assortment of lettering colors and types is uneven and may inhibit the ease of information processing. The lettering for "dive-time", "ascent-time", "depth", "ft" and "min" is clear, large enough, and grouped appropriately with their respective LCDs. The display's cluttering surrounds the LEDs and the use of color and expletives in the "max-depth" lettering. The use of the present graphics turns the eye towards the middle column of LEDs and the "max depth" sign, despite the fact that this information is not normally attended to during the majority of the dive. The removal of the bold arrow and red circle around the ascent LED, the red starburst pattern around the out of range LED, and the blue coloration and exclamation points from the maximum depth graphic would greatly harmonize the display and ease in eye focusing on relevant information.

* The LEDs are bright enough to be seen easily underwater. However, the multiple lighting and flashing of those LEDs as presently programmed is distracting, inappropriate as reviewed above, and can lead to sensory overload.

* As described in the manual, the maximum depth indicator is flashed for 2.5 seconds each 30 sec; this approach removes control of information access from the operator, and may interfere substantially with his access to information he desires, e.g. ascent time. Access to desired but not essential (i.e. critical) information should be on demand at the operator's discretion. Maximum depth displays appear appropriate for a recall feature only. The unit tested only displayed this function at the surface. If this information is not displayed at depth, it should be so noted in the manual.

* The backlighting function appears to provide an even level of illumination to the LCD displays. The magnetic light switch requires little force to operate and can be operated easily when the operator wears three fingered neoprene gloves. The bottom of the switch (Figure 5) is serrated to provide a gripping surface for the gloved operator.

5. Conformance With Specifications

This unit does not meet the following specifications in reference (c):

* Velcro fasteners not used to attach unit to arm.
* No green light compliance feature.
* No battery voltage indication available while submerged.

6. Case Comments

* The dive simulator is a welcome function which allows the operator to perform pre- and post-dive checks on the proper functioning of the unit (Figure 4).

* The battery degassing screw is not identified by marking or configuration on the unit proper (Figure 3).

* Slotted screws are used for all case fasteners; this feature aids in minimizing tools needed for access to the UDM for maintenance (Figure 3).

* The on-off handle is beige in color, 4.1 cm in length, protrudes 1.0-1.2 cm from the case, and uses a strong spring loaded positive-action device to prevent accidental activation or deactivation of the unit. As the unit is not designed to be turned on underwater, the handle is not large enough to be pulled and turned when wearing thermal protection on the hands (Figure 1).

* The battery recharger is simple, appears rugged, and is appropriately labeled. An adapter is provided to use on 120v versus 220v circuits (Figure 1).

7. Recommendations for Re-Design for Use by U.S. Navy

a. Eliminate flashing display function when within 6 min of no-decompression obligation being incurred.

b. Eliminate rate of ascent signaling except for a flashing (3-5 cps) red LED when rate is EXCEEDED. LED will go out when rate falls within 0-60 fps.

c. Use rate of ascent flashing red LED to also signal when diver is TOO SHALLOW, ascending past the required decompression stop. Red LED will go out and be replaced by steady green LED when diver is at designated stop.

d. Change Deco-Stop LED to a steady green LED.

e. Eliminate out of range LED.

f. Ensure compliance of display IAW reference (b).

g. Reconfigure display graphics to reduce clutter IAW Section 4 comments above; use proper Navy terminology (e.g. 60 ft/min vice 33 ft/min).

h. Rewrite instruction manual, including in revision the information noted omitted previously in section 3 and ensure it accurately reflects the present UDM features and programming.

i. Incorporate a low battery indicator function when unit is submerged; this function is critical for use on long missions.

j. Reduce size and weight of UDM.

k. Identify battery degassing screw on case.

l. Eliminate time to flight function.

8. Summary

The Divetronics Deco-Brain II is a fairly large, heavy, and bulky unit which uses the manufacturer's commercially marketed product as the basis for this prototype. It shows promise for use by the U.S. Navy providing the display programming is reconfigured IAW military specifications, the commercial bid specifications are met, and the presentation of the information is simplified IAW human factor and information processing guidelines. It is strongly recommended that these criteria be met before approval is considered for U.S. Navy use.

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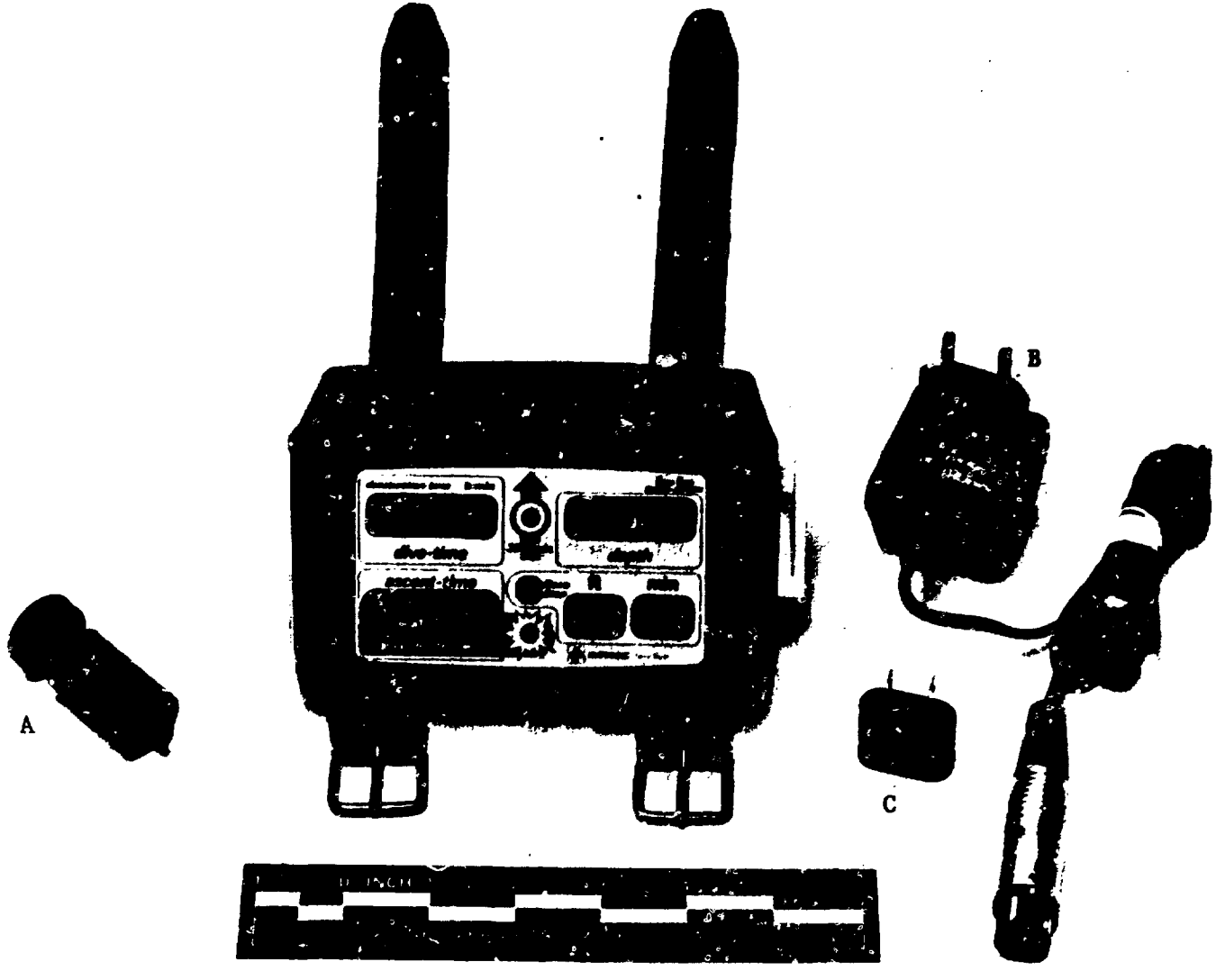


FIGURE 1. Prototype U.S. Navy UDM with dive simulator (A), battery recharger (B), and line voltage adapter (C).

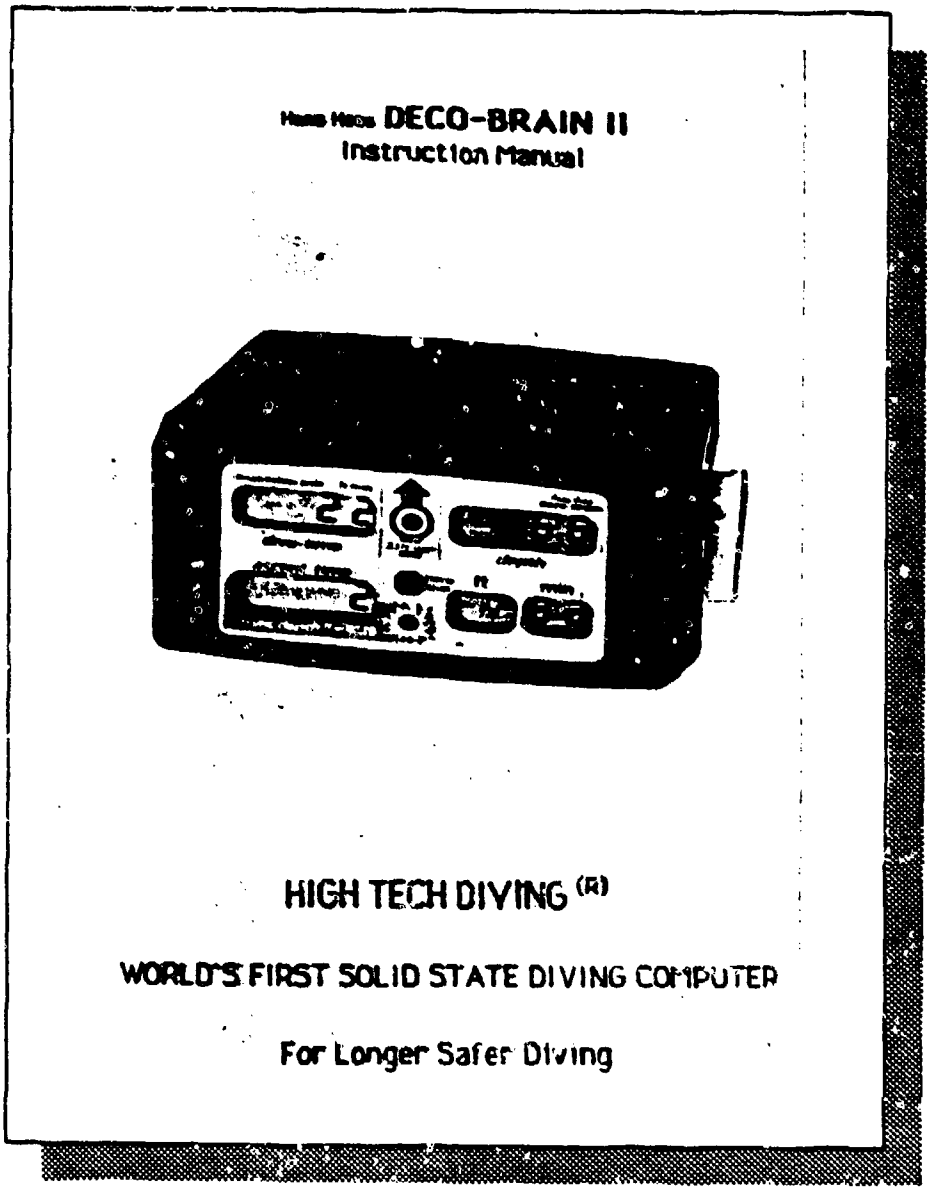


FIGURE 2. Cover of accompanying instruction manual for UDM.

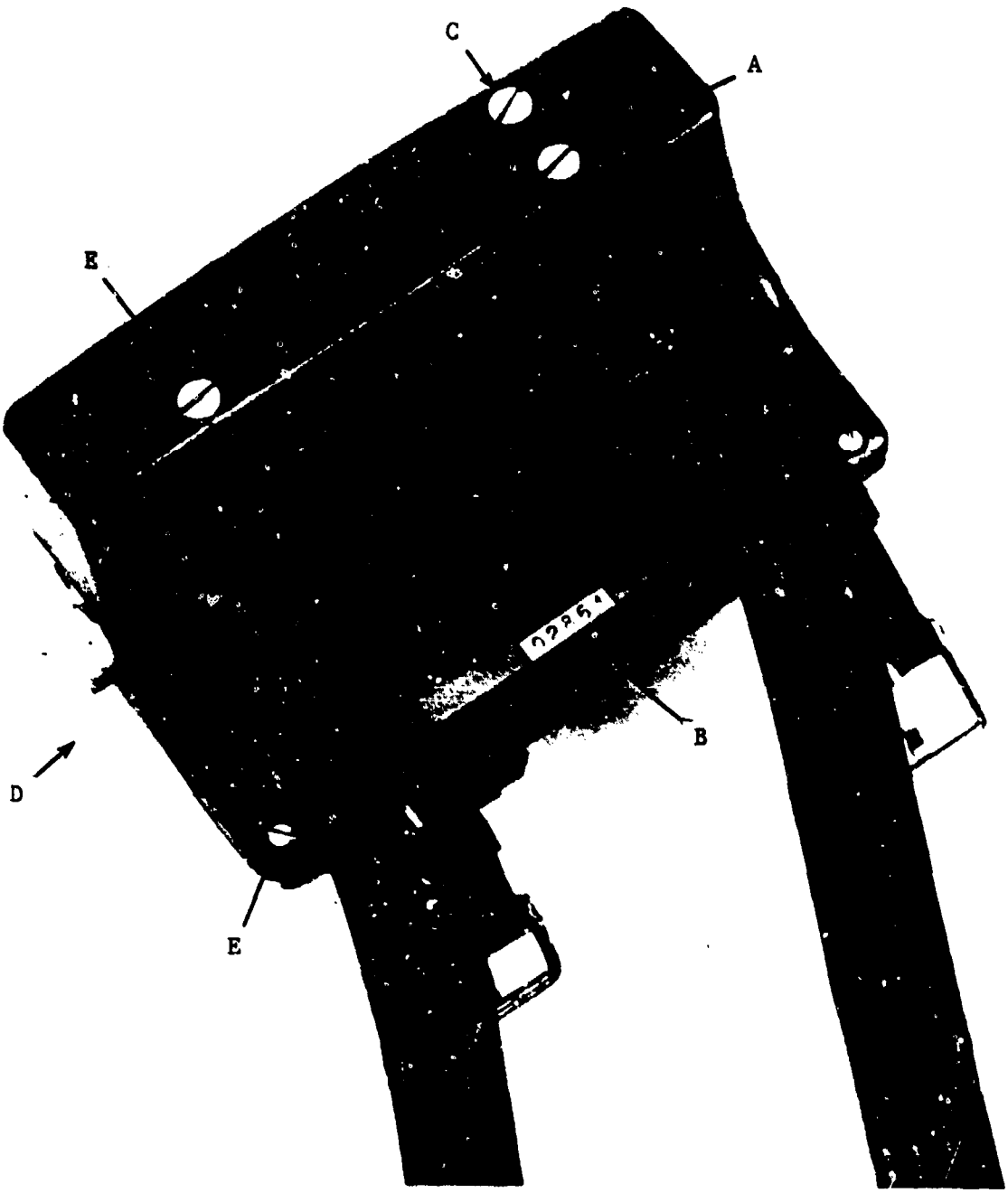


FIGURE 3. Back of UDM showing identifying numbers (A, B), battery degassing screw (C), on-off switch (D), and use of slotted screws (E).

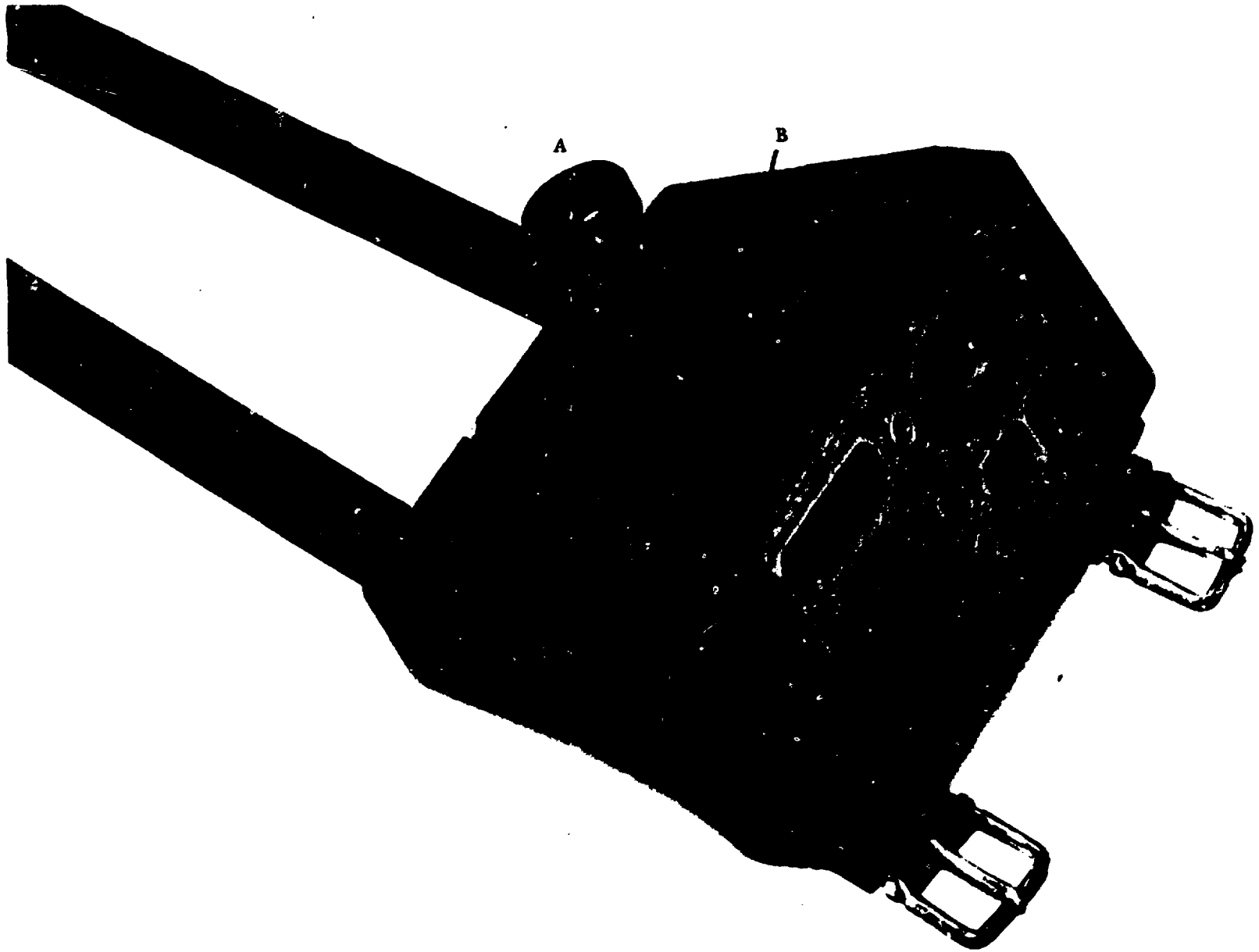


FIGURE 4. UDM with dive simulator inserted into pressure transducer port (A) adjacent to r·charging socket (B).

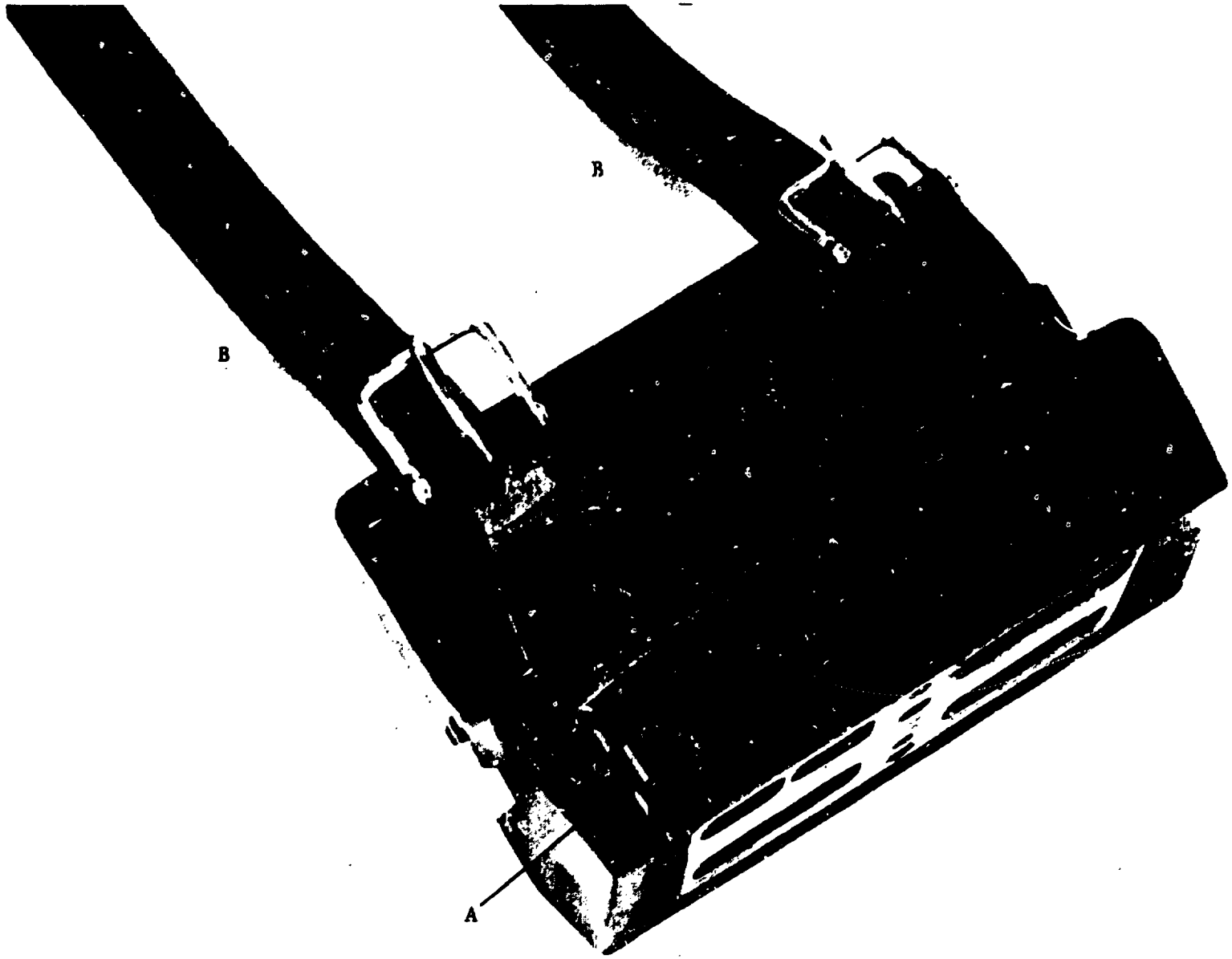


FIGURE 5. Bottom view of unit showing serratted on-off lighting switch (A) and straps (B).

APPENDIX J

WARNING STATUS LIMITS AND ALGORITHM REVISION

The initial Warning Status Limits for the EL MK 15/16 RTA were based on the tissue tension of the 40 min. tissue. If it exceeded 77 FSW the maximum depth/time domain boundary had been exceeded. The diver then had to decompress to a depth shallower than 30 FSW and wait until this tissue tension fell below 48 FSW before descending. The 77 FSW "turn on" limit would have limited the times for bounce diving to those in Table 1. These limits would have proved restrictive for some profiles which were tested during Phase I 0.7 ATA constant PO_2 in N_2 testing (NEDU Report 11-80) which were felt to be very safe. Test profile 4 included three successive dives to 120 FSW for 30 minutes with 30 minute intervals at 10 FSW between each dive. The original Warning Status Limits would have restricted the subsequent times at 125 FSW to 22 minutes instead of 30 minutes.

When the algorithm was revised for Phase II testing (NEDU Report 1-84) it allowed some dives to be dove which had previously been unsafe. The 100 FSW for 60 minute profile was decompression sickness (DCS) free in 10 man dives where the shorter Phase I schedule produced one case of DCS in the same number of man dives. During testing of the Air/N_2O_2 algorithm (NEDU Report 8-85) the 100/60 schedule was dove on a constant 0.7 ATA PO_2 in N_2 on 27 man dives without DCS with a total decompression time about the same as in Phase I testing (51 minutes) but with a shallower first stop. Since the original Warning Status Limit of 77 FSW was based on the 100/60 Phase I profile it appeared this limit could now be relaxed. Test Profile 4 mentioned above had the 40 minute tissue tension at 87 FSW for the two repetitive 125/30 minute exposures. If this limit is applied, the maximum time allowed at 100 FSW increases to 75 minutes, and the maximum time allowed at 150 FSW increases the 35 minutes. However, during the Air/N_2O_2 algorithm testing the 19 DCS free dives were on a schedule some 30 minutes shorter than the current VVAL 18 schedule. Therefore extending the limit line 5 minutes at this depth is not unreasonable. When a 150/40 minute schedule was tested during the Air/N_2O_2 algorithm testing there was one DCS in 10 man dives but the schedule was 15 minutes shorter than the VVAL 18 schedule. This, therefore, does not speak too strongly against extending the limit line at 150 FSW. Therefore the Warning Status "turn on" tissue tension will be increased to 87 FSW. The increase in allowed bottom times are shown in Table 1.

The original "Turn Off" limit was 48 FSW. Looking at the tissue tensions for repetitive dives conducted during Phase II testing, the 40 minute tissue tension had fallen to 50 FSW on both the 150/30 repetitive dive (Profile 24A) and the 100/60 repetitive dive (Profile 25A) where the surface interval was on air. There was a single case of Type I DCS on the 150 FSW profile in 10 man dives while none occurred on the 100 FSW profile in the same number. Based on these considerations, the 30 minute increase in required surface interval

which would have been required by requiring another 2 FSW of offgassing would only serve to reduce the probability of DCS. So the Warning Status "Turn Off" limit should remain at 48 FSW.

A revised Warning status algorithm is found in Figure 1. The current values for P_{max}, P_{min}, D_1, and D_2 are given. These values may change with increased experience using the UDM.

TABLE 1

Depth of Dive (FSW)	Maximum Bottom Times P_{40} = 77 FSW	P_{40} = 87 FSW
150	25	35
140	30	40
130	35	45
120	40	50
110	45	60
100	55	75
90	70	100
80	100	220
70*	210	
60*		

* Dives shallower than 60 FSW will never result in the 40 minute tissue tension exceeding 77 FSW and at 70 FSW the 40 minute tissue tension will not exceed 87 FSW.

FIGURE 1

WARNING STATUS PROCEDURE

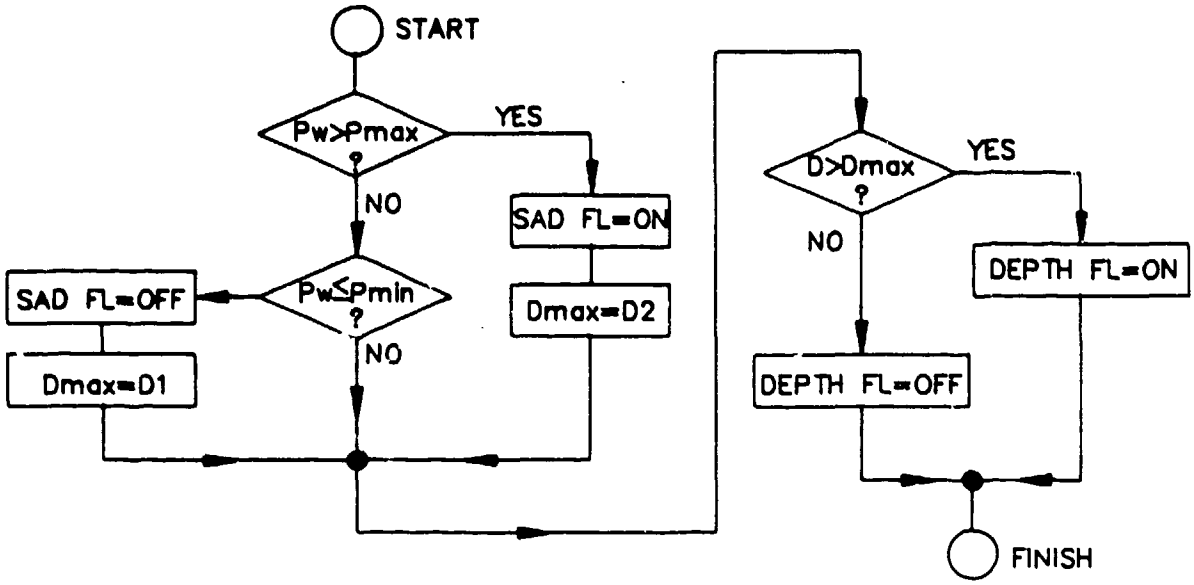
Two Warnings:	ON	OFF
SAD FL	SAD display flashes red light flashes	SAD steady
DEPTH FL	Depth display flashes red light flashes	Depth steady

Initialization: both warnings off on initial turn on.

Procedure Execution: after all tissue updates and SAD computation concluded.

Parameters:

Pw – actual tissue tension in specified tissue (currently 40 minute tissue)
Pmax – maximum tissue tension allowed in specified tissue (currently 87 FSW in 40 minute tissue)
Pmin – maximum tissue tension required in specified tissue (currently 48 FSW in 40 minute tissue)
D – actual depth
D_1 – maximum depth of model (currently 150FSW)
D_2 – maximum shallow interval depth (currently 30 FSW)



NOTE: Red warning light should flash if either SAD FL or DEPTH FL is on. (See section on Combined Light Interaction Functioning in discussion section of NEDU Report 10–86.)

APPENDIX K

PROPOSED UDM COMPUTER INTERFACE SPECIFICATION

The experience of testing two prototype UDMs discussed in NEDU Report 10-86 showed the necessity of directly inputing display information into a host computer. This would suffice for minimum maintenance requirements but a formal computer interface would be more desirable. Additionally, a method of recording and outputing the depth time profile would be useful. A proposed functional specification for these refinements is provided below.

Computer Interface

1. Plugs into UDM replacing battery and supplying power while maintaining watertight integrity to UDM maximum test depth.

2. Interfaces to host computer through standard serial I/O microcomputer port (serial terminal port, RS-232 or IEE 488).

3. All commands to and readouts from the UDM should be ASCII commands executable through standard higher level language (FORTRAN, BASIC) I/O instructions.

4. Interface should be compatible with current IBM compatible disc operating systems for execution on the widest range of computers.

5. The following functions should be available for UDM diagnostic and maintenance procedures.

Read Display: Transmits values of all display readouts to host computer. Numerical displays are transmitted as ASCII integers, lights as logical values (1 = ON, 0 = OFF). Data is read one time only.

Read Display Continuous: Transmits values continuously in same format as above but a frequency of flashing warning indicators. This would allow detection of flashing warning lights or displays. This mode is stopped by executing a read display command. Output must be buffered.

Read Algorithm: Causes the entire algorithm within the UDM to be dumped to an ASCII disc file. File name should be user specified. This file should be such that it could be printed directly without further manipulation.

Read Parameters: Causes the program variables and parameters (e.g. maximum permissible tissue tension value) to be output to an ASCII disc file.

External Depth: Disconnects depth register from UDM pressure transducer and accepts a depth from the host computer using the Send Depth command. The depth register remains disconnected until an Internal Depth command is issued. Thus by executing a Set Depth, the host computer can send depth values to the UDM without the need for pressurization, which would be useful for diagnostic purposes. Disconnecting the UDM from the external interface automatically reconnects the UDM depth register to the UDM pressure transducer output.

Send Depth: Transmits a depth value as on ASCII integer to the UDM. Interface will only accept this data if an External Depth command has been previously executed.

Internal Depth: Cause any further depths to be input to the UDM depth register from the UDM pressure transducer output.

Start: Turns UDM on in same manner as if ON/OFF switch manually turned on.

Stop: Turns UDM off in same manner as if ON/OFF switch manually turned off.

Sleep: Halts algorithm after current completion cycle. All displays remain intact and can be read. Algorithm remains in sleep state until run issued.

Run: Starts algorithm again after having been temporarily halted by a sleep command.

Profile Recording

If this provision is provided then what is recorded depends on the amount of memory available. If sufficient memory is available then depth and water temperature (°C) (if profile recording is implemented then a temperature sensor should be provided to record temperature to an accuracy of ±1°C) should be recorded every time the SAD is updated by the algorithm. Provision should be made to record profiles up to 12 hours long. Alternative: a recording could be made every time there is a depth change greater than or equal to 4 FSW. However, in this instance the time (in number of 4 second increments since unit was turned on) must be recorded along with the depth and temperature. If 32 bits were available for each record then the following information could be recorded.

Time (# 4 sec increments)	14 bits	0 - 18 hrs
Depth (FSW)	9 bits	0 - 512 FSW
Temp (°C)	5 bits	-23°C - +40°C
Warning Status Light #1	2 bits	on, off, flashing
Warning Status Light #2	2 bits	on, off, flashing

A more efficient packing mechanism might be possible but the minimum and maximum values should be retained. The total number of records which would need to be recorded would depend on the number of excursions. The worst case would be 4 FSW changes every 4 seconds and this would require 16,384 records. However, it would be highly unlikely that excursions would occur at that rate, more likely long periods of time would be spent at a constant depth. If one assumes 32 excursions from 0 to 256 FSW during an 18 hour dive then each excursion would require 128 records and 4,096 total records would be needed to record the profile. This is more likely to be the worst case scenario so storing 4,096 records should be the initial goal.

If records are recorded this would need to be recorded in an ASCII file, each record consisting of:

Time (sec), depth (FSW), temp °C, Warning starts #1, #2

A suitable command to be given to the UDM through the above computer interface would cause the profile to be stored in a user specified ASCII disc file. An internal power source would be needed by the UDM to retain recorded dive information during the time the main power supply is off while connecting the computer interface. A maximum change over time of 5 minutes should be sufficient although ideally the dive profile memory should have a completely independent power supply able to retain memory values almost indefinitely, so information for accident investigation would be available even if the main power supply became exhausted.

Provision should be made so that the stored profile can only be erased after it has been correctly read and verified, or by actuation of a separate reset switch accessible only by removal of some sort of protective device to prevent inadvertent erasure of a recorded profile.