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NAVY EXPERIMENTAL DIVING UNIT
WASHINGTON NAVY YARD
WASHINGTON, D.C. 20390

RESEARCH REPORT 9-70

SATURATION DIVES, WITH EXCURSIONS, FOR THE DEVELOPMENT OF A DECOMPRESSION SCHEDULE FOR USE DURING SEALAB III

23 September 1970

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ABSTRACT

Twenty-three saturation dives to depths of 200 to 850 feet were conducted at the US Navy Experimental Diving Unit to verify a decompression schedule for use at SEALAB III. Seventy-one divers completed ninety-seven man-dives and tested decompression schedules based on two different fundamental rates of ascent during the dive series. Seventy-four man-excursion dives were conducted during the series, including a record-breaking excursion to a depth of 1025 feet. A decompression schedule for use from a depth of 600 feet was developed and found to be safe for use during SEALAB III.

Eight cases of decompression illness occurred during the dive series. Details of these cases are covered in this report.

SUMMARY

Problem:

1. To verify a decompression schedule for use at SEALAB III.

Method:

1. Twenty-three dives were conducted at the Navy Experimental Diving Unit. Seventy-one divers were utilized on ninety-seven man-dives from base depths of 200 to 850 feet. Excursions to deeper depths were made on thirteen of the dives, including a record-breaking excursion dive to 1025 feet. Decompression schedules based on two different fundamental rates of ascent were tested during this sequence.

Findings:

1. A decompression table from the depth of 600 feet was developed and found to be effective and safe for use during SEALAB III.

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1. INTRODUCTION

1.1 Background

1.1.1 The concept of a pressurized work compartment to enable divers to work for extended periods of time underwater is not new. As early as 1907, in a report of studies on diving to the Admiralty submitted by J.S. Haldane, a proposal for a submersible decompression chamber was submitted by the renowned British physiologist, Dr. Leonard Hill (1,2). This chamber was eventually designed and manufactured by Sir Robert Davis of Seibe Gorman, Ltd., and after thirty years of operation, is still being used by the British Navy.

1.1.2 As the need for extended underwater work periods became more evident, a project with the code name GENESIS was conducted to determine the effect of saturation diving on man. This first series of studies began in 1957 at the Naval Medical Research Laboratory (NMRL) in New London, Connecticut, under the direction of CDR George F. Bond, MC, USN; CDR Walter F. Mazzone, MSC, USNR; and CDR R.D. Workman, MC, USN.

1.1.3 The first two of the five phases of Project GENESIS were conducted on animals under laboratory conditions, in a dry pressure-chamber environment, breathing different types of gases. The Phase A and B experiments were performed to depths of 200 feet and for a period of up to two weeks to demonstrate the feasibility of saturation diving. Larsen and Mazzone (3) effectively describe "Saturation Diving" as diving operations in which divers undergo increased pressure, either in the sea or in a pressure chamber, and remain there for a period of time longer than twenty-four hours. This principle allows all the tissues of the body to become saturated with the inert gas or gases being breathed. As Workman so clearly illustrates (4), with the use of saturation diving, divers may continue to work productively on the job without additional decompression being required following the first twenty-four hours of exposure to pressure. With the completion of Phase B of Project GENESIS, interest in hyperbaric research began to wane. Soon, however, due to the Navy's interest in manned space flight, attention was called to the need for research on helium-oxygen environments for space craft. As a result, Project GENESIS became a formal Navy program, and work progressed at flank speed(7).

1.1.4 Phases C, D, and E of GENESIS were laboratory pressure tests with human subject, and culminated in an experimental saturation dive by three men to a depth of 200 feet for twelve days in a dry chamber without suffering ill effects (5). This successful dive completed the laboratory phase of the US Navy's Man-In-The-Sea Program, which was followed by the placing of human divers on the actual sea bottom; the SEALAB I and II operations of August 1964 and October 1965, respectively. The calculations for the saturation decompressions on the SEALAB experiments were originally conceived and developed by Workman of the Experimental Diving Unit (EDU) (5, 6).

1.1.5 On 9 February 1966, the Deep Submergence Systems Project — DSSP — (which had been in existence for almost two years), was re-aligned as a separate Chief of Naval Materiel -designated organization (PM-11), and given the requirement to support a SEALAB III experiment as part of the Man-In-The-Sea Program. The impetus to this task was, in part, derived from the overwhelming success of SEALAB II, which demonstrated that divers could live and work at a depth of 205 feet for fourteen to thirty days without having to experience decompression more than once (at the conclusion of the dive). Plans were then formulated to conduct the SEALAB III experiment, in which divers would live in an underwater habitat for extended periods of time at an approximate depth of 400 feet, and perhaps conduct excursion dives to depths greater than their base depth. Consequently, DSSP was tasked with the development of a saturation-excursion dive format and decompression schedule for use during the experiment. As the testing and training program progressed at EDU, the decision was made to go for a deeper depth — 600 feet, which was the approximate depth to which the SEALAB III habitat was lowered in February of 1969.

1.2 Objectives

1.2.1 To provide a decompression schedule suitable for use during the SEALAB III experiment.

1.2.2 To conduct biomedical, diving equipment, and human-performance studies when practical.

1.2.3 To provide training in saturation-excursion diving techniques for the SEALAB aquanauts.

1.2.4 To obtain an index for the individual's physiological capability as a participant in the SEALAB III experiment.

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13. ABSTRACT

Twenty-three saturation dives to depths of 200 to 850 feet were conducted at the US Navy Experimental Diving Unit to verify a decompression schedule for use at SEALAB III. Seventy-one divers completed ninety-seven man-dives and tested decompression schedules based on two different fundamental rates of ascent during the dive series. Seventy-four man-excursion dives were conducted during the series, including a record-breaking excursion to a depth of 1025 feet. A decompression schedule for use from a depth of 600 feet was developed and found to be safe for use during SEALAB III.

Eight cases of decompression illness occurred during the dive series. Details of these cases are covered in this report.

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1.3 Scope

1.3.1 Twenty-three saturation dives to depths of 200 to 850 feet were conducted at the US Navy Experimental Diving Unit to verify a decompression schedule for use at SEALAB III. Seventy-one divers completed ninety-seven man/dives and tested decompression schedules based on two different fundamental rates of ascent. Seventy-four man-excursion dives were conducted during the series, including a record-breaking excursion to a depth of 1025 feet.

2. PROCEDURES

2.1 Experimental Subjects

2.1.1 Seventy-one qualified US Navy, foreign navy, and government civilian divers in good physical condition participated in the twenty-three saturation dives, including twenty-six divers who participated in more than one dive. A total of ninety-seven diver exposures were completed during this series. Their physical characteristics and diving qualifications are listed in Appendix C.

2.1.2 Each subject received a complete physical examination immediately before and after his dive, including audiograms and long-bone X-rays.

2.2 Dive Procedures

2.2.1 The experimental dives described in this report were conducted under controlled conditions in a diving chamber with a wet-pot. The subjects normally lived in the dry portion of the chamber complex, but would enter the wet-pot for wet experiments and excursions to depths deeper than the base saturation depth. Twenty-three dives to saturation depths of 200 to 850 feet were completed.

2.2.2 Four subjects participated in each saturation dive, except the last five dives, where five subjects per dive were used.

2.3 Chamber Atmosphere Analysis and Control

2.3.1 Oxygen analysis was accomplished using the Beckman Model F3 Oxygen Analyzer with ranges 0-5 percent, 0-15 percent, and 0-25 percent. Teledyne oxygen electrodes were also placed in the chamber for control of the oxygen make-up system at 0.3 atmospheres pO_2.

2.3.2 The oxygen in the chamber was maintained within the limits shown in Table I. Each block contains the mean and standard deviation describing the appropriate gas level for the indicated portion of the dive sequence. In general, the oxygen partial pressure was maintained near the 0.3-atmosphere level.

2.3.3 Chamber temperature and relative humidity were determined with thermistors and Luft Duratherm hygrometers. The air conditioning was set to maintain a comfortable temperature and a relative humidity of between 50-80 percent.

2.3.4 The carbon-dioxide level remained below 0.5 percent surface equivalent.

2.4 Gas Supply

2.4.1 Helium pressurization and oxygen make-up systems were installed in the chamber and igloo. Banks of cylinders containing pre-mixed helium-oxygen mixtures were available for emergency-mask breathing, treatment procedures or swimming with one of three types of underwater breathing apparatus. The gas mixture used with the different breathing apparatus was selected in such a manner as to provide a bag level of oxygen between 0.6 and 1.4 ATM during the swims/excursions.

2.5 Underwater Breathing Apparatus Used on the Dives

2.5.1 Three different types of breathing apparatus were used during the dive series: the Experimental Diving Unit Bank-Pack (which essentially consisted of a MK 6 semi-closed underwater breathing apparatus and a Garrahan Block ®), the MK 8 Mod 0, and the MK 9 semi-closed, mixed-gas, underwater breathing apparatus.

2.6 Watch Sections and Duties

2.6.1 Each twenty-four-hour watch section consisted of a Diving Officer, Chief of the Watch, a Diving Medical Officer, and a minimum of six additional personnel.

2.6.2 The Chief of the Watch supervised the operational aspects of the dive sequence assuring proper analysis and maintenance of the chamber environment and attending to the routine needs of the subjects. The Diving Officer was directly responsible for the safe conduct of all aspects of the dive, and the Diving Medical Officer was immediately available to handle any hazards or potential hazards to the subjects.

2.7 Records

2.7.1 Diving Log: An official diving log containing a chronological record of the dive procedure and significant events incident thereto was maintained throughout the dive.

2.7.2 Chamber Atmosphere Data Sheets: In addition to the official diving log, hourly readings of the chamber pressure, temperature, humidity, oxygen, and carbon dioxide were recorded on special log sheets designed for that purpose.

Table I Oxygen Partial Pressure (Atmospheres) in the Chamber

DIVE NO.	DESCENT	BOTTOM TIME	ASCENT
1	.32 ±.00	.31 ±.0	.30 ±.00
2		.31 ±.02	.30 ±.00
3		.30 ±.00	.30 ±.01
4		.31 ±.02	.34 ±.08
5	.28 ±.01	.30 ±.00	.33 ±.08
6	.28 ±.00	.30 ±.01	.30 ±.01
7	.30 ±.01	.30 ±.01	.30 ±.01
8	.30 ±.00	.29 ±.02	.30 ±.01
9	.30 ±.00	.30 ±.01	.30 ±.01
10	.30 ±.00	.31 ±.02	.30 ±.01
11	.30 ±.00	.32 ±.02	.30 ±.01
12	.29 ±.01	.31 ±.01	.30 ±.01
13	.30 ±.00	.30 ±.00	.30 ±.01
14			
15	.29 ±.00	.31 ±.02	.30 ±.01
16	.31 ±.02	.30 ±.00	.30 ±.01
17	.30 ±.01	.30 ±.00	.30 ±.01
18	.30 ±.01	.30 ±.01	.30 ±.00
19	.36 ±.03	.31 ±.03	.30 ±.01
20	.35 ±.04	.30 ±.02	.31 ±.01
21	.30 ±.01	.30 ±.01 .30 ±.00 at 825'	.30 ±.00
22	.28 ±.01	7 .30 ±.01	.31 ±.03
23	.29 ±.01	.30 ±.01	.31 ±.01

3. RESULTS

3.1 Saturation Dives with Excursions

3.1.1 The twenty-three saturation dives conducted during this series are listed by chronological order in Table II. Thirteen dives included excursions to deeper depths from the base saturation depth. The excursions were conducted from a variety of base depths, and totaled seventy-four man-excursions from the saturation depth. On three dives, excursions were conducted from each of two saturation base depths reached during the dive. The depth of the excursion, the number of team excursions (two men per team), and time at depth are listed under the column entitled "Excursions" in Table II. The critical time periods applicable to each of the twenty-three dives are summarized in Appendix A.

3.1.2 Experiments were conducted during dives, using a variety of compression rates (Appendix B). During the first four dives, the rapid rate of descent caused cases of mild compression arthralgia, and may have been a contributing factor to the cases of decompression sickness on three of the four dives. Commencing with Dive No. 5, a standard compression procedure was established and, with minor variations (Appendix B), remained the same throughout this series of saturation dives. After an initial descent was made to fourteen feet on air, compression to the final depth was accomplished, using pure helium at an average descent rate of 40 feet per hour (fph). This generally consisted of a fifteen-minute travel period and a forty-five-minute "compression" stop each hour.

3.1.3 Most of the dives were conducted with a minimum bottom time of twenty-four hours. Three dives, Numbers 1, 11, and 18, had bottom times of less than twenty-four hours (if the compression time is not counted as part of the bottom time).

3.1.4 Three saturation dives, Numbers 16, 17, and 21, involved remaining at the base depth for a minimum of twenty-four hours, conducting at least one excursion dive, and then "sliding" from the base depth to a new, deeper base depth. At least one excursion dive was then performed from the deeper base depth prior to commencing decompression. It was during dive No. 21, the third saturation dive of this "sliding" series, that a record-breaking dive was made by an excursion from the base depth of 825 feet to 1025 feet, for a bottom time of twelve minutes and thirty seconds.

Dive No.	Subjects	Date	Depth/Bottom Time	Excursions to Depth/Time (min)
1 *	4	Sep 66	200/23:34	300/60, 300/60
2	4	Nov 66	200/48	300/60, 300/62, 300/60, 300/51
3	4	Nov 66	300/26	450/60, 450/60
4	4	Nov 66	450/27:30	600/60, 600/43
5	4	Jan 67	200/30:50	None
6	4	Feb 67	450/67:12	600/60, 600/64
7	4	Feb 67	450/55:28	600/60, 600/60
8	4	Mar 67	200/28:40	None
9	4	Mar 67	450/34:55	None
10	4	Apr 67	200/28:52	None
11 *	4	Apr 67	450/13:05	None
12	4	Apr 67	200/46:48	300/60, 300/33
13	4	May 67	200/47:10	300/60, 300/60
14	4	May 67	200/28:40	None
15	4	Sep 67	450/52:46	600/60, 600/43
16	4	Sep 67	a. 200/29:25 b. 450/49:06	300/58, 300/60 600/60, 600/60
17	4	Oct 67	a. 200/27:45 b. 450/51	300/60, 300/50 600/60, 600/60
18 *	4	Oct 67	450/21:35	None
19	5	Jan 68	600/154:20	None
20	5	Jan 68	600/60:48	None
21	5	Feb 68	a. 600/44 b. 825/54:03	825/19 1025/12::30
22	5	Mar 68	600/47:30	750/60
23	5	Apr 68	600/69:43	None

Table II. Chronological listing of the SEALAB III saturation dives conducted at EDU, with a listing of excursion dives.

* Bottom times less than twenty-four hours.

3.1.5 The length and depth of each excursion dive varied according to the saturation depth and the purpose of the excursion. All were calculated to allow a no-decompression return to the saturation depth.

3.2 Decompression Schedule Development

3.2.1 During the early portion of the saturation-excursion dive series, (dives Nos. 1-4), the length of time between completion of the last excursion and commencement of decompression from the base depth was approximately five hours (Appendix A). This time period was gradually extended to a minimum of a twenty-four-hold at the base depth. The last group of dives with excursions (dives 16, 17, 21, and 22) used this format.

3.2.2 Appendix B and Table II provide a chronological cross-reference of the decompression developments by depth and date with regard to the initial rate of ascent from the base depth, other rates of ascent or deviations in rate of ascent experienced, and any decompression stops which may have been employed with a particular decompression schedule. Figure 1 provides a graphic presentation of all of the decompression profiles.

3.2.3 The incidence of decompression sickness was eight out of ninety-seven man-dives, as summarized in Table III. Of these cases, four occurred during decompression schedules based on a 5-fph rate of ascent without stops. No cases of decompression sickness were reported on eight dives with ascents from 450 feet at 4 fph, using the same stops as the SEALAB II schedule. The other four cases occurred on deeper dives with the basic decompression rate of 4 fph. Complete Accident Reports (NAVMED 6420/1) are contained in Appendix D.

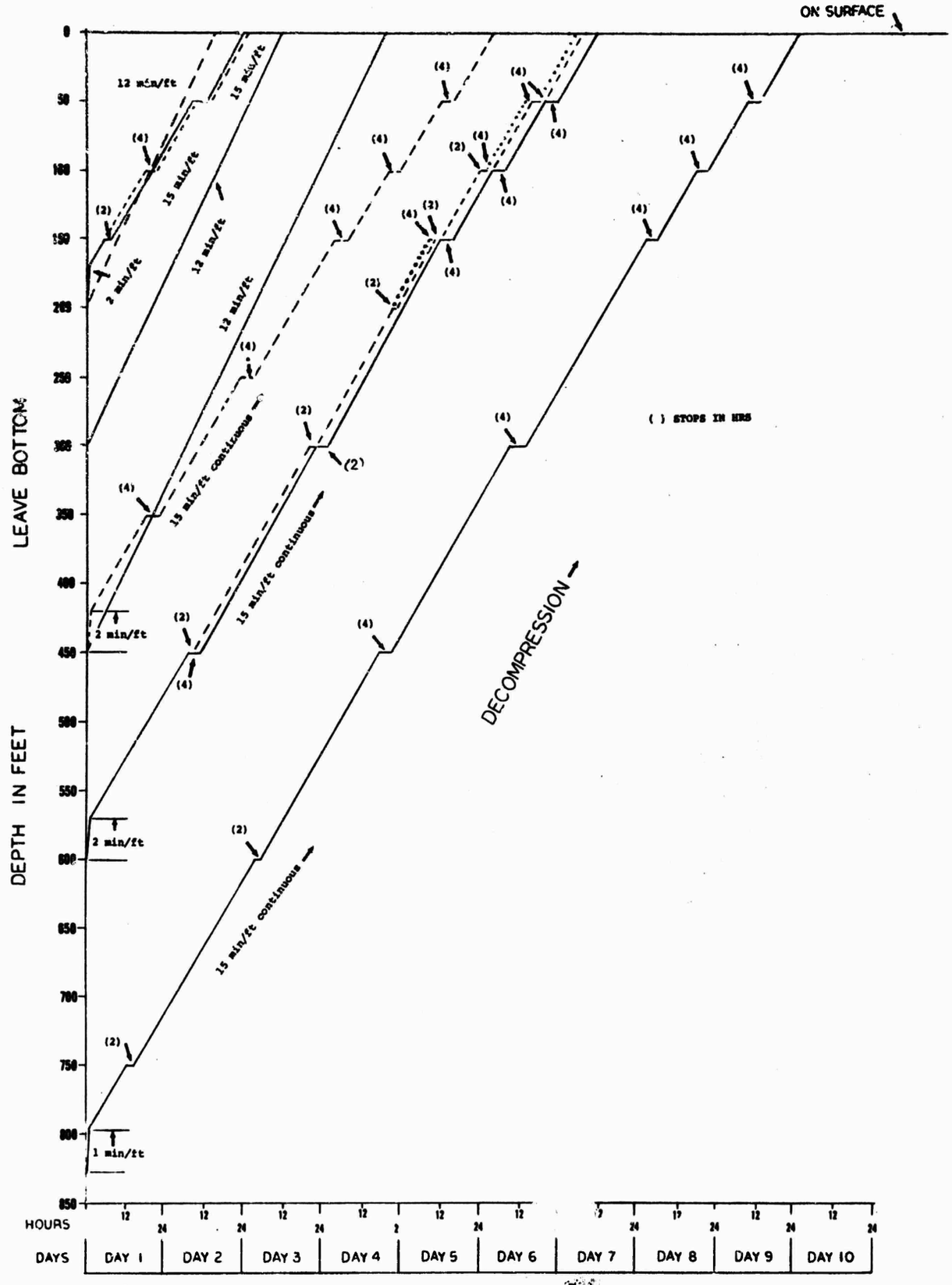

Figure 1

SEALAB III HeO2 SATURATION DIVE DECOMPRESSION PROFILES

Dive No.	Diver	Decompression Sickness
1	Blackburn	No symptoms.
	Meeks	No symptoms.
	Sundstrom	No symptoms
	Wyatt	Pain in left knee at depth of 8 feet. Dr. Bornman and LCDR Bergman accompanied R_x of Wyatt in chamber.
3	Donaldson	Pain in both knees at 50 feet. Spread to groin.
	Garrahan	No symptoms. Accompanied R_x of Donaldson.
	Mullen	Pain in left knee during Donaldson's treatment.
	Reedy	No symptoms. Accompanied R_x of Donaldson.
4	Coffman	No symptoms. Accompanied R_x of Stubbs.
	Mandible	No symptoms. Accompanied R_x of Stubbs.
	Raymond, Dr.	No symptoms. Accompanied R_x of Stubbs.
	Stubbs	Pain in right knee; reported at 122 feet (occurred at 150 feet).
20	Bird	No symptoms. Accompanied R_x of Houle.
	Bornholdt	No symptoms. Accompanied R_x of Houle.
	Houle	Pain in right knee at 77 feet and recompression back to 115 feet. Recurrence during treatment.
	Moore	No symptoms. Accompanied R_x of Houle.
	Reando	No symptoms. Accompanied R_x of Houle.
22	Bunton	No symptoms.
	Clark	Pain in left knee at 50 feet. Surface tender Reedy accompanied R_x of Clark in chamber.
	Lafferty	Pain in left knee after surfacing.
	Schmitt	No symptoms.
	Tuckfield	No symptoms.
23	Giese	Pain in thigh at 50 feet.
	Jensen	No symptoms. Accompanied R_x of Giese.
	LaFontaine	No symptoms. Accompanied R_x of Giese.
	Lukeman	No symptoms. Accompanied R_x of Giese.
	Sutton	No symptoms. Accompanied R_x of Giese.

TABLE III Summary of decompression experience applicable to saturation dives of SEALAB III.

4. DISCUSSIONS AND CONCLUSIONS

4.1 Decompression Experience

4.1.1 All ninety-seven man-saturation dives were successfully completed. In this sequence, eight cases of decompression sickness were recorded. All cases of decompression illness were successfully treated by recompression and the use of a high percentage of oxygen in the breathing medium.

4.1.2 Decompression schedules based on two primary rates of ascent were tested from various base depths in the process of evolving the schedule for use at SEALAB III. The selected schedule was more conservative than that used on the last three dives of the series to 600, 825, and 600 feet. The SEALAB III schedule was essentially that tested on eight dives to 450 feet, where no case of decompression sickness was experienced.

4.1.3 Nineteen of the saturation dives utilized a dive profile comparable to the profile which was finally selected for use with the SEALAB III experiment. In essence, they incorporated the slow compression rate, the basic four-foot-per-hour ascent rate, and a combination of decompression stops of two- or four-hour duration. The incidence of decompression sickness in this group was about 4.7 percent. Dives subsequent to this original series, but using similar dive profiles, experienced a much higher incidence of decompression sickness (9). The reasons for this difference are not entirely clear. However, the diver population utilized on the SEALAB III experiment was a highly-motivated and carefully-selected group participating in a personally-rewarding, classic voluntary program. Concern may have existed among the divers that decompression sickness would affect their participation in the final open-sea experiments. Casual interviews since the termination of the SEALAB III project suggest that at least a few cases of persistent joint pain during decompression did occur and were not reported.

4.2 SEALAB III Dive Profile

4.2.1 The final dive profile selected for use in the SEALAB III experiment is represented graphically in Figure 2. Upon descent to 14 feet on air, descent was

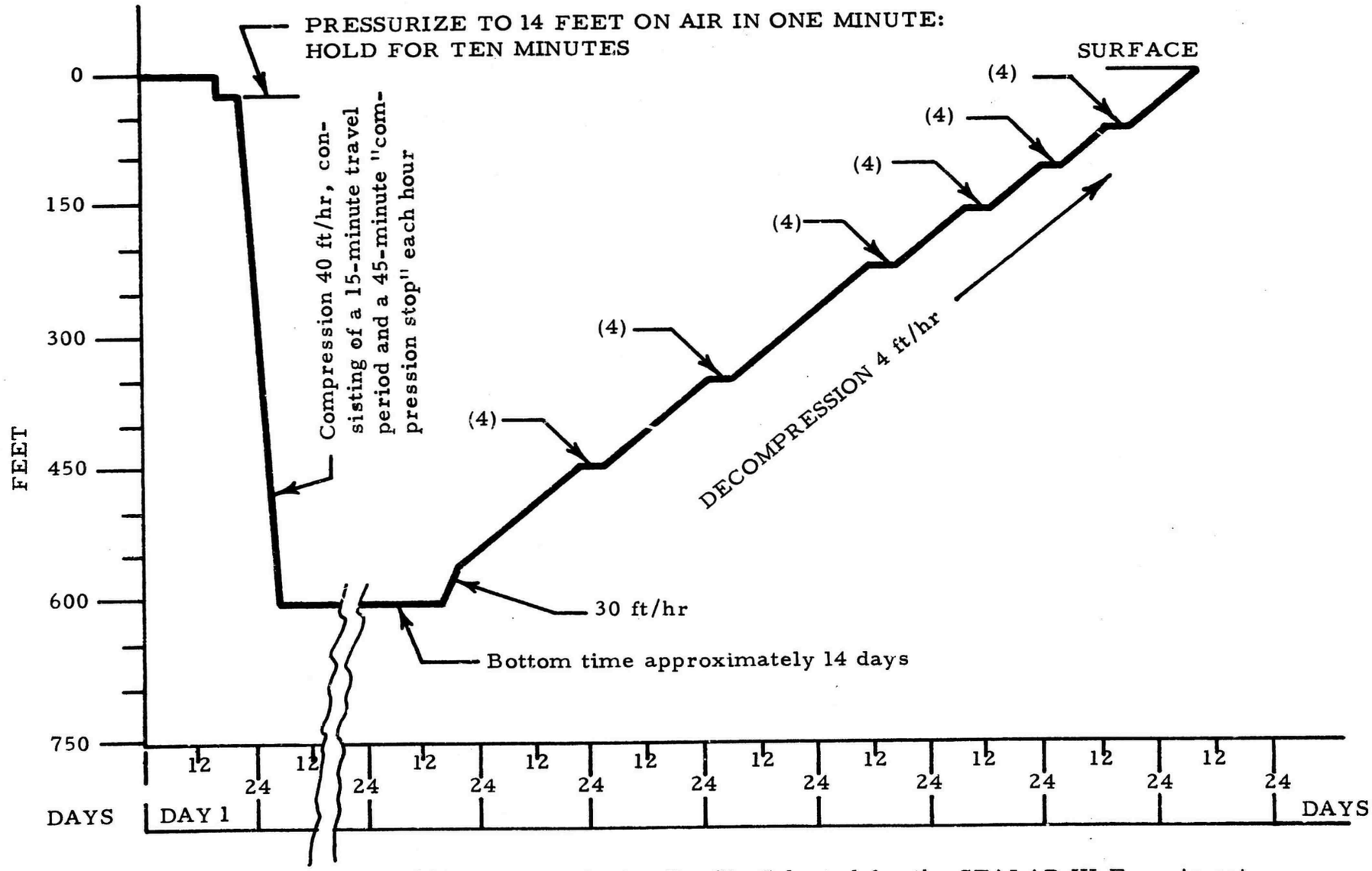

Figure 2 600-Foot Final Dive Profile Selected for the SEALAB III Experiment

made at approximately average rate of 40 fph to the base depth of 600 feet using pure helium, with 45-minute stops every 40 feet. Bottom time was to be approximately fourteen days, and maintaining a partial pressure of oxygen at 0.30 atmospheres.

The dive profile consisted of a compression phase:

- Descent to 14 feet on air
- Descent to bottom on pure helium; 14 feet to 60 feet in fifteen minutes, stop for forty-five minutes, descend 40 feet in fifteen minutes, stop for forty-five minutes until on the bottom.

Bottom Time:

- Fourteen days

Decompression:

- Ascent from 600 feet to 570 feet continuous at 30 fph
- Ascent thereafter continuous at the rate of 4 fph, except for stops of four hours each at the six stage depths of 450, 350, 250, 150, 100, and 50 feet

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Dive No. and Depth	Excursion Depth	Left Surface	Reached Bottom Elapsed Time (Hrs:Min)	Commenced Decompression Elapsed Time (Hrs:Min)	Reached Surface Elapsed Time (Hrs:Min)	Total Decompression Time (Hrs:Min)
1 200 ft	300 ft	1788 4 Sep 1966	00:26	24:00	65:16	41:16
2 200 ft	300 ft	1830 7 Nov 1966	00:20	48:00	89:17	41:17
5 200 ft	300 ft	0739 26 Jan 1967	04:50	30:50	82:20	51:30
8 200 ft	-	0900 9 Mar 1967	04:40	28:40	81:10	51:30
10 200 ft	-	1034 5 Apr 1967	04:40	28:52	80:22	51:30
12 200 ft	300 ft	1558 25 Apr 1967	10:40	46:48	98:18	51:30
13 200 ft	300 ft	1611 8 May 1967	04:40	47:10	98:40	51:30
14 200 ft	-	0837 16 May 1967	04:40	28:40	80:10	51:30

APPENDIX A
Page 1

Summary of critical time periods applicable to saturation dives of SEALAB III (at EDU) in order of depth.

Dive No. and Depth	Excursion Depth	Left Surface	Reached Bottom Elapsed Time (Hrs:Min)	Commenced Decompression Elapsed Time (Hrs:Min)	Reached Surface Elapsed Time (Hrs:Min)	Total Decompression Time (Hrs:Min)
16a 200 ft	300 ft	1402 22 Sep 1967	04:40	Compression from 200 ft to 450 ft began at elapsed time 29:25 (Hrs:Min)		
16b 450 ft	600 ft		35:40	78:31	204:31	126:00
17a 200 ft	300 ft	1347 3 Oct 1967	04:40	Compression from 200 ft to 450 ft began at elapsed time 27:45 (Hrs:Min)		
17b 450 ft	600 ft		34:00	78:45	204:45	126:00
3 300 ft	450 ft	1830 14 Nov 1966	00:28	26:00	119:05	93:05
4 450 ft	600 ft	1554 28 Nov 1966	01:26	27:30	150:37	123:07
6 450 ft	600 ft	1956 2 Feb 1967	10:56	67:12	193:12	126:00
7 450 ft	600 ft	0817 16 Feb 1967	10:55	55:28	181:28	126:00

APPENDIX A
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Summary of critical time periods applicable to saturation dives of SEALAB III (at EDU) in order of depth.

Dive No. and Depth	Excursion Depth	Left Surface	Reached Bottom Elapsed Time (Hrs:Min)	Commenced Decompression Elapsed Time (Hrs:Min)	Reached Surface Elapsed Time (Hrs:Min)	Total Decompression Time (Hrs:Min)
9 450 ft	-	0903 16 Mar 1967	10:55	34:55	160:55	126:00
11 450 ft	-	0858 11 Apr 1967	10:55	24:00	150:40	126:40
15 450 ft	600 ft	0900 12 Sep 1967	10:55	52:46	178:46	126:00
18 450 ft	-	1141 16 Oct 1967	10:55	32:30	158:30	126:00
19 600 ft	-	0854 10 Jan 1968	14:07	154:20	317:21	163:00
20 600 ft	-	0852 29 Jan 1968	14:12	60:48	232:03	171:15
21a 600 ft	825 ft	1547 16 Feb 1968	14:07	Compression from 600 ft to 825 ft began at elapsed time 44:00 (Hrs:Min)		
21b 825 ft	1025 ft		49:10	98:03	321:33	223:30

APPENDIX A
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Summary of critical time periods applicable to saturation dives of SEALAB III (at EDU) in order of depth.

Dive No. and Depth	Excursion Depth	Left Surface	Reached Bottom Elapsed Time (Hrs:Min)	Commenced Decompression Elapsed Time (Hrs:Min)	Reached Surface Elapsed Time (Hrs:Min)	Total Decompression Time (Hrs:Min)
22 600 ft	750 ft	1542 20 Mar 1968	14:08	47:30	207:00	159:30
23 600 ft	-	2224 15 Apr 1968	9:45	69:43	229:14	159:31

APPENDIX A
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Summary of critical time periods applicable to saturation dives of SEALAB III (at EDU) in order of depth.

DIVE NO. / DEPTH	DATE	COMPRESSION RATE/GAS/TO DEPTH	DECOMPRESSION RATE TO DEPTH (ASCENT FPH)	DECOMPRESSION STOPS
1 200 ft	Sep 1966	**::30/AIR/14' 7.6 fpm/He /200	5 fph to surface: continuous decompression	None
2 200 ft	Nov 1966	1::55/AIR/14' 12.1 fpm/He /200	5 fph to surface: staged decompression	2-ft increments at 25-min/stop
5 200 ft	Jan 1967	1::35/AIR/14' 40 fpm/He /200	4 fph to surface: continuous decompression, except as noted	150'/2 hrs 50'/4 hrs
8 200 ft	Mar 1967	2::00/AIR/14' 40 fph/He /200	30 fph to 170 ft; 4 fph to surface: continuous decompression, except as noted	100'/4 hrs 50'/4 hrs
10 200 ft	Apr 1967	4::00/AIR/14' 40 fph/He /200	30 fph to 170 ft: 4 fph to surface: continuous decompression, except as noted	100'/4 hrs 50'/4 hrs
12 200 ft	Apr 1967	::25/AIR/14' 40 fph/He /200	30 fph to 170 ft: 4 fph to surface: continuous decompression, except as noted	100'/4 hrs 50'/4 hrs

*Descent will be continuous unless otherwise noted. Descent rates are approximations (i.e., ±1 fph).
**The time required for compression to 14 feet on AIR will be given in minutes and seconds (0::00), instead of feet per hour.

APPENDIX B
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Description of the Compression and Decompression Profiles used on the SEALAB Saturation Dives at EDU, in order of depth.

DIVE NO. / DEPTH	DATE	COMPRESSION RATE/GAS/TO DEPTH	DECOMPRESSION RATE TO DEPTH (ASCENT FPH)	DECOMPRES-SION STOPS
13 200 ft	May 1967	1::05/AIR/14' 40 fph/He /200	30 fph to 170 ft; 4 fph to surface; decompression	100'/4 hrs 50'/4 hrs
14 200 ft	May 1967	2::00/AIR/14' 40 fph/He /200	30 fph to 170 ft; 4 fph to surface; decompression	100'/4 hrs 50'/4 hrs
16 200 ft 450 ft	Sep 1967	6::00/AIR/14' 40 fph/He /200 40 fph/He /450	30 fph to 420 ft; 4 fph to surface; staged decom-pression	350'/4 hrs 250'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
17 200 ft 450 ft	Oct 1967	2::00/AIR/14' 40 fph/He /200 40 fph/He /450	30 fph to 420 ft; 4 fph to surface; staged decom-pression	350'/4 hrs 250'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
3 300 ft	Nov 1966	1::15/AIR/14' 13.1 fpm/He /300	5 fph to 102 ft; 3 fph to 76 ft; 5 fph to surface	None
4 450 ft	Nov 1966	::32/AIR/14' 60 fpm/He /450	5 fph to surface; contin-uous	None

*Descent will be continuous unless otherwise noted. Descent rates are approximations (i.e., ±1 fph).
**The time required for compression to 14 feet on AIR will be given in minutes and seconds (0::00), instead of feet per hour.

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Description of the Compression and Decompression Profiles used on the SEALAB Saturation Dives at EDU, in order of depth.

DIVE NO. / DEPTH	DATE	COMPRESSION RATE/GAS/TO DEPTH	DECOMPRESSION RATE TO DEPTH (ASCENT FPH)	DECOMPRESSION STOPS
6 450 ft	Feb 1967	::45/AIR/14' 40 fph/He /450	30 fph to 420 ft; 4 fph to surface; staged decompression	350'/4 hrs 250'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
7 450 ft	Feb 1967	::40/AIR/14' 40 fph/He /450	30 fph to 420 ft; 4 fph to surface; staged decompression	350'/4 hrs 250'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
9 450 ft	Mar 1967	1::00/AIR/14' 40 fph/He /450	30 fph to 420 ft; 4 fph to surface; staged decompression	350'/4 hrs 250'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
11 450 ft	Apr 1967	::37 /AIR/14' 40 fph/He /450	30 fph to 420 ft; 4 fph to surface; staged decompression	350'/4 hrs 250'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
15 450 ft	Sep 1967	2::00/AIR/14' 40 fph/He /450	30 fph to 420 ft; 4 fph to surface; staged decompression	350'/4 hrs 250'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
18 450 ft	Oct 1967	6::00/AIR/14' 40 fph/He /450	30 fph to 420 ft; 4 fph to surface; staged decompression	350'/4 hrs 250'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs

*Descent will be continuous unless otherwise noted. Descent rates are approximations (i.e., ±1 fph).
**The time required for compression to 14 feet on AIR will be given in minutes and seconds (0::00), instead of feet per hour.

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Description of the Compression and Decompression Profiles used on the SEALAB Saturation Dives at EDU, in order of depth.

DIVE NO. / DEPTH	DATE	COMPRESSION RATE/GAS/TO DEPTH	DECOMPRESSION RATE TO DEPTH (ASCENT FPH)	DECOMPRESSION STOPS
19 600 ft	Jan 1968	1::00/AIR/14' 90 fph/He /60 Staged descent; 15-min travel period and 45-min compression stop each hour thereafter	30 fph to 570 ft; 4 fph to surface; staged decompression	450'/4 hrs 300'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
20 600 ft	Jan 1968	1::00/AIR/14' 40 fph/He /20' Staged descent; 15-min travel period and 45-min compression stop each hour thereafter	30 fph to 570 ft; 4 fph to 77 ft; staged decompression. Decompression illness - see Table III and NAVMED 6420/1	450'/4 hrs 300'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
21 600 ft 825 ft	Feb 1968	2::00/AIR/14' 160 fph/He /600	60 fph to 795 ft; 4 fph to surface; staged decompression	750'/2 hrs 600'/2 hrs 450'/4 hrs 300'/4 hrs 150'/4 hrs 100'/4 hrs 50'/4 hrs
22 600 ft	Mar 1968	2::00/AIR/14' 160 fph/He /600	30 fph to 570 ft; 4 fph to 50 ft; staged decompression. Decompression illness - see Table III and NAVMED 6420/1	450'/2 hrs 300'/2 hrs 200'/2 hrs 150'/2 hrs 100'/4 hrs 50'/4 hrs
23 600 ft	Apr 1968	3::00/AIR/14' 600 fph/He /220 60 fph/He /280 160 fph/He /600 Staged descent; random stops to 280 ft. Then commenced 45-min stop every 40 feet.	30 fph to 570 ft; 4 fph to surface	450'/2 hrs 300'/2 hrs 150'/4 hrs 100'/2 hrs 50'/4 hrs

*Descent will be continuous unless otherwise noted. Descent rates are approximations (i.e., ±1 fph).
**The time required for compression to 14 feet on AIR will be given in minutes and seconds (0::00), instead of feet per hour.

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Description of the Compression and Decompression Profiles used on the SEALAB Saturation Dives at EDU, in order of depth.

DIVE No.	DIVER	RANK/ RATE	AGE (YEARS)	HEIGHT (INCHES)	WEIGHT (POUNDS)	CLASS DIVER
1	Blackburn	A01	27	74	-	First
	Meeks	BM1	34	75	200	First
	Sundstrom	MMCS	34	69	-	First
	Wyatt	BMC	37	70	186	First
2	Blackburn	A01	27	74	-	First
	Coffman	TM1	37	73	200	First
	Raymond, Dr.	Lt.	31	72	-	Medical Officer
	Stubbs	SF2	29	70-1/2	-	First
3	Donaldson	HM1	-	-	-	Medical DV Tech
	Garrahan	W01	30	70	160	HeO_2 DV Officer
	Mullen	BM1	27	64	160	First
	Reedy	HM1	25	67-1/2	165	Medical DV Tech
4	Coffman	TM1	37	73	200	First
	Mandible	GMG1	32	69	170	First
	Raymond, Dr.	Lt.	31	72	-	Medical Officer
	Stubbs	SF2	29	70-1/2	-	First

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Descriptive physical data on each of the divers who participated in the saturation dives of SEALAB III (1966-1968).

DIVE No.	DIVER	RANK/ RATE	AGE (YEARS)	HEIGHT (INCHES)	WEIGHT (POUNDS)	CLASS DIVER
5	Huss	DC1	25	69	168	First
	Lazaro	EN2	39	69	154	First
	Morey	EM1	27	72	194	First
	Mulally	DC1	33	72-1/2	175	First
6	Barth	CWO	36	71	190	HeO_2 DV Officer
	Blackburn	AO1	27	74	-	First
	Mesplay	SFC	29	69	-	First
	Reedy	HM1	25	67-1/2	165	Medical DV Tech
7	Huss	DC1	25	69	168	First
	Meeks	BM1	35	75	200	First
	Morey	EM1	27	72	203	First
	Wells	MNCS	40	68-1/2	164	First
8	Cannon	Civilian	31	68-1/2	170	-
	Jenkins	Civilian	31	71-3/4	183	-
	Jones	Lt.	34	73	235	Medical DV Officer
	Waller	Civilian	33	68	152	-

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Descriptive physical data on each of the divers who participated in the saturation dives of SEALAB III (1966-1968).

DIVE No.	DIVER	RANK/ RATE	AGE (YEARS)	HEIGHT (INCHES)	WEIGHT (POUNDS)	CLASS DIVER
9	Cannon	Civilian	31	68-1/2	170	-
	Jenkins	Civilian	31	71-3/4	183	-
	Pratt	DC2	24	78	282	First
	Waller	Civilian	33	68	152	-
10	Cooper	Civilian	30	69	180	-
	Harrell	Civilian	29	68	130	-
	Pruna	Civilian	26	74	190	-
	Wyatt	BMC	38	70	186	First
11	Cooper	Civilian	30	69	180	-
	Harrell	Civilian	29	68	130	-
	Kennedy	ST1	35	72	180	First
	Pruna	Civilian	26	74	190	-
12	Bussey	Lt.	29	72	180	HeO_2 DV Officer
	Eaton	GMG1	41	68	168	First
	Mandible	GMG1	32	69	170	First
	Moynan	Lt.	29	72	170	Medical Office

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Descriptive physical data on each of the divers who participated in the saturation dives of SEALAB III (1966-1968).

DIVE No.	DIVER	RANK/ RATE	AGE (YEARS)	HEIGHT (INCHES)	WEIGHT (POUNDS)	CLASS DIVER
13	Conda	TM1	34	68-1/2	170	First
	Ramsey	PH2	33	70-1/2	150	First
	Reaves	PH1	38	71-1/2	185	First
	Rudin	BM1	34	73	150	First
14	Bunton	Civilian	33	72	180	-
	Dowling	Civilian	40	71	175	-
	Hendrey	HM1	32	66	-	First
	Stevens	Civilian	37	74	190	-
15	Bussey	Lt.	30	72	175	HeO_2 DV Officer
	Eaton	GMG1	41	68	165	First
	Ramsey	PH2	33	70-1/2	148	First
	Reaves	PH1	38	71-1/2	185	First
16	Buski	SF1	34	72	195	First
	McDole	LCDR	39	70-1/2	178	HeO_2 DV Officer
	Myers	MM1	23	68-1/2	162	First
	Vorosmarti	LCDR	31	71	160	Medical Officer

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Descriptive physical data on each of the divers who participated in the saturation dives of SEALAB III (1966-1968).

DIVE No.	DIVER	RANK/ RATE	AGE (YEARS)	HEIGHT (INCHES)	WEIGHT (POUNDS)	CLASS DIVER
17	Armstrong	HM1	25	70	150	First
	Eggar	Lt.	41	70	175	HeO_2 DV Officer
	Melder	EQCM	33	68	175	First
	Schleigh	BUC	32	69	162	First
18	Dowling	Civilian	40	71	165	-
	Hallanger	Civilian	28	73	165	-
	Osborn	LCDR	29	70	180	HeO_2 DV Officer
	Robinson	Civilian	26	72	160	-
19	Bradley	Lt.	31	-	-	Medical Officer
	Garrahan	WO1	30	70	160	HeO_2 DV Officer
	Morey	EM1	28	72	203	First
	Shipp	Lt.		-	-	HeO_2 DV Officer
	Wells	MNCS	41	68-1/2	164	First
20	Bird	EN1	30	71	205	First
	Bornholdt	Lt.	30	-	-	HeO_2 DV Officer
	Houle	BM1		-	-	First
	Moore	MM2	26	74-1/2	205	First
	Reando	MR1	31	71	174	First

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Descriptive physical data on each of the divers who participated in the saturation dives of SEALAB III (1966-1968).

DIVE No.	DIVER	RANK/ RATE	AGE (YEARS)	HEIGHT (INCHES)	WEIGHT (POUNDS)	CLASS DIVER
21	Conda	TM1	34	68-1/2	170	First
	Kleckner	HM1	26	72	155	-
	Lugo	MM1	26	67	170	First
	Risk	MM2	31	69	155	First
	Winters	EN1	-	-	-	First
22	Bunton	Civilian	33	72	180	-
	Clark	PO1	34	70	165	Royal Navy (British)
	Lafferty	Lt.	30	69	170	Royal Navy (British)
	Schmitt	MMC	29	70	150	First
	Tuckfield	ENCS	46	-	-	First
23	Giess	LCDR	31	-	-	HeO_2 DV Officer
	Jensen	EN1	24	-	-	First
	LaFontaine	LCDR	34	69	180	Canadian Navy
	Lukeman	LSCD	28	68	175	Canadian Navy
	Sutton	Lt.	28	-	-	Australian Navy

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Descriptive physical data on each of the divers who participated in the saturation dives of SEALAB III (1966-1968).

APPENDIX D

NAVMED 6420/1 REPORTS

(Reports of Decompression Sickness
and all Diving Accidents)

0003475

REPORT OF DECOMPRESSION SICKNESS AND ALL DIVING ACCIDENTS

BAMED-816 (REV. 2-56)

ORIGINAL - TO BUMED, WASHINGTON, D. C.
COPY - TO EXP. DIVING UNIT, NAVAL GUN FACTORY, WASH., D. C.

REPORTS SYMBOL: MED-882C-1

NAME AND ADDRESS OF REPORTING STATION: U. S. NAVY EXPERIMENTAL DIVING UNIT, WASHINGTON NAVY YARD, WASHINGTON, D. C. 20390

DATE: 14 Nov 1966

NAME OF PATIENT (Surname first): WYATT, Frank McClain BM1 (DV) USN

IDENTIFICATION NUMBER: 787 73 57

AGE	WEIGHT	HEIGHT	BUILD (Check one)					DIVING QUALIFICATIONS (Check one)									
			SLENDER	MED.	HEAVY	OBESE	MAST	1/C	SAL.	D.S.	2/C	UOT	EOD	UWS	STU	(OTHER)	
38 YRS.	175 LBS.	INS.		X				X									

RECORD OF ALL DIVES MADE DURING THE TWELVE HOURS PRECEDING THE ACCIDENT
(If more than three dives were made, record additional under "REMARKS" on reverse.)

FIRST DIVE 4 Sep 1966 included (

TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME
WET	DRY X	200 feet	24 hrs

TYPE OF EQUIPMENT: CLOSED CIRCUIT SCUBA — CHAMBER

TYPE OF WORK: MILD X

BREATHING MEDIUM: HELIUM % 96, OXYGEN % 4

SOURCE OF BREATHING MEDIUM: HELIUM-OXYGEN BANKS — AUTOMATIC MIXING OF HE & O_2

DECOMPRESSION SCHEDULE: STANDARD; SURFACE USING AIR / OXYGEN; HE. DECOMPR. SATURATION P.P. MIN.; TABLE USED

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
1748	1814	FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

SECOND DIVE 5 Sep 1966

TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME
WET X	DRY	300 feet	60 min.

TYPE OF EQUIPMENT: OPEN CIRCUIT SCUBA — MARK VI BACK PACK

TYPE OF WORK: MODERATE X

BREATHING MEDIUM: HELIUM % 90, OXYGEN % 10

SOURCE OF BREATHING MEDIUM: HELIUM-OXYGEN BANKS X

DECOMPRESSION SCHEDULE: STANDARD; SURFACE USING AIR / OXYGEN; HE. DECOMPR. NO DECOMPRESSION P.P. MIN.; TABLE USED

TIME LEFT ~~SURFACE~~ 200	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED ~~SURFACE~~ 200
1147	1149	60 FT/MIN	1248

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

THIRD DIVE

TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME
WET	DRY	feet	min.

TYPE OF EQUIPMENT

TYPE OF WORK

BREATHING MEDIUM

SOURCE OF BREATHING MEDIUM

DECOMPRESSION SCHEDULE: STANDARD; SURFACE USING AIR / OXYGEN; HE. DECOMPR. P.P. MIN.; TABLE USED

TIME LEFT ~~SURFACE~~	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

SND-PAPO

SIGNS AND SYMPTOMS BEFORE TREATMENT				
	ONSET		ANATOMICAL LOCATION	INTENSITY (MILD, MOD., SEVERE)
	DATE	TIME		
LOCALIZED PAIN	7 Sep	0643	Right knee	mild
RASH				
MUSCULAR WEAKNESS				
NUMBNESS				
DIZZINESS				
VISUAL DISTURBANCES				
PARALYSIS				
UNCONSCIOUSNESS				
DYSPNEA (CHOKES)				
NAUSEA OR VOMITING				
MUSCULAR TWITCHING				
RESTLESSNESS				
CONVULSIONS				
ACOUSTIC AURA				
PARESTHESIA				

REMARKS: *(other signs and symptoms before, during and following treatment)*

Bend under pressure while undergoing decompression from saturation:excursion dive. "Stiff" knee from known trauma at 0643 and 22 feet. Definite pain at 0926 and 8 feet. Treatment started from 8 feet gauge.

TREATMENT SCHEDULE					RECURRENCE TREATMENT SCHEDULE				
LEFT [redacted] 8 feet		RELIEF		TIME REACHED BOTTOM	LEFT SURFACE		RELIEF		TIME REACHED BOTTOM.
DATE	TIME	TIME	DEPTH		DATE	TIME	TIME	DEPTH	
7 Sep	0946	0954	40 ft.	60 Ft- 0956					
TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED	TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED
		DATE	TIME				DATE	TIME	
MIN.		7 Sep	1211	Short oxygen	MIN.				

DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)		DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)	
FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM	FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM
165	73.4			165	73.4		
140	62.3			140	62.3		
120	53.4			120	53.4		
100	44.5			100	44.5		
80	35.6			80	35.6		
60	26.7			60	26.7		
50	22.3			50	22.3		
40	17.8			40	17.8		
30	13.4			30	13.4		
20	8.9			20	8.9		
10	4.5			10	4.5		
TO SURFACE				TO SURFACE			

REMARKS: *(Include sequence of events preceding the accident and subsequent result of treatment, noting any unusual contributing factors - Use continuation sheet if needed)*

SEE ATTACHED SHEET

R. C. Bornmann

R. C. BORNMANN, CDR, MC, USN
SENIOR MEDICAL OFFICER

SIGNATURE OF MEDICAL DEPARTMENT REPRESENTATIVE

This 38 year old Diver First Class was one of four divers participating in the first developmental dive with chamber saturation for 24 hours at 200 feet on helium-oxygen and excursions to 300 feet in the wet pot. Decompression from 200 feet was at the rate of 2 feet every 25 minutes with a planned total of 41 hours. On the evening of the second day of decompression, with the chamber at approximately 60 feet, WYATT bumped his right knee climbing into a hammock. Awakened at 0630 the next morning (24 feet) he reported that the knee was "stiff". Two hours and 43 minutes later, when the chamber was 8 feet, the knee was definitely aching. The other three divers were without symptoms and were transferred to the Igloo where the original schedule was followed without incident to the surface. WYATT was kept in the chamber. The atmosphere was flushed with air and he began to breathe oxygen. He was taken to 60 feet. Relief was complete as the chamber went past 40 feet. Pressure schedule followed profile of short Oxygen Treatment Schedule to surface, which was reached at 1211 on Wednesday 7 September, one hour and seven minutes later than the other three divers.

COMMENT: Appearance of bends at this site is felt to be directly related to the trauma mentioned and to the abnormal tissue condition which was produced. Diver's age is also noted, although this is not felt to be unusually significant. No change in decompression schedule for these saturation dives is contemplated as the result of this accident. Incident was valuable exercise in treating bends during saturation decompression, but was also quite simple as a result of the fact that pain occurred so close to the surface. Other three divers were able to complete last 75 minutes in Igloo. This would not have been possible, due to lack of complete life support and comfort facilities there, if decompression were to extend much longer.

R. C. BORNMANN
Commander, Medical Corps
U. S. Navy

NOT REPRODUCIBLE

REPORT OF DECOMPRESSION SICKNESS AND ALL DIVING ACCIDENTS

NAVMED 6420/1 (REV. 3-67)
S/N 0105-214-1050

REPORTS SYMBOL: MED-6420-1

ORIGINAL - BUMED, WASHINGTON, D. C.
COPY - NAVY EXP. DIVING UNIT, WASHINGTON NAVY YARD, WASHINGTON, D. C.
COPY - NAVAL SUB. MED. CENTER, NAVAL SUB. BASE NEW LONDON, GROTON, CONN.

NAME AND ADDRESS OF REPORTING STATION: Navy Experimental Diving Unit, Bldg. 214, WNY, Washington, D.C.

DATE: 19 NOV 1966

NAME OF PATIENT (Surname first)	GRADE/RATE	IDENTIFICATION NO.	TYPE OF DIVING ACCIDENT
MULLEN James E.	BM(1)	494 95 62	Poss. Decompression Sickne

AGE	WEIGHT	HEIGHT	BUILD (Check one)				DIVING QUALIFICATIONS (Check one)									
			SLENDER	MED.	HEAVY	OBESE	MAST	I/C	SAL.	D.S.	Z/C	UDT	E	UWS	STU	(OTHER)
27 YRS.	160 LBS.	64 INS.		X				X								

RECORD OF ALL DIVES MADE DURING THE TWELVE HOURS PRECEDING THE ACCIDENT
(If more than three dives were made, record additional under "REMARKS" on reverse.)

FIRST DIVE

TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME
WET	DRY		
X	X	300 feet	1551 min.

TYPE OF EQUIPMENT

DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER
					CHAMBER

TYPE OF WORK

NONE	MILD	MODERATE	HEAVY
		X	

BREATHING MEDIUM

AIR	HELIUM % OXYGEN %	OXYGEN	OTHER (Specify)
85.9% He, 11.1% N2, 3% O2			

SOURCE OF BREATHING MEDIUM

AIR BANKS	HELIUM-OXYGEN BANKS	GASOLINE COMPRESSOR	OTHER
	X		

DECOMPRESSION SCHEDULE

STANDARD	SURFACE USING		HE. DECOMPR.	TABLE USED
	AIR	OXYGEN		
	SATURATION		P.P.	MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
14 NOV 1830	14 NOV 1858	See addendum FT/MIN	19 NOV 1726

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER		CHAMBER	
	MINUTES AT STOP	BREATHING MEDIUM	MINUTES AT STOP	BREATHING MEDIUM
210				
200				
190	SEE ADDENDUM			
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

SECOND DIVE

TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME
WET	DRY		
		feet	min.

TYPE OF EQUIPMENT

DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER

TYPE OF WORK

NONE	MILD	MODERATE	HEAVY

BREATHING MEDIUM

AIR	HELIUM % OXYGEN %	OXYGEN	OTHER (Specify)

SOURCE OF BREATHING MEDIUM

AIR BANKS	HELIUM-OXYGEN BANKS	GASOLINE COMPRESSOR	OTHER

DECOMPRESSION SCHEDULE

STANDARD	SURFACE USING		HE. DECOMPR.	TABLE USED
	AIR	OXYGEN		
			P.P.	MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER		CHAMBER	
	MINUTES AT STOP	BREATHING MEDIUM	MINUTES AT STOP	BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

THIRD DIVE

TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME
WET	DRY		
		feet	min.

TYPE OF EQUIPMENT

DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER

TYPE OF WORK

NONE	MILD	MODERATE	HEAVY

BREATHING MEDIUM

AIR	HELIUM % OXYGEN %	OXYGEN	OTHER (Specify)

SOURCE OF BREATHING MEDIUM

AIR BANKS	HELIUM-OXYGEN BANKS	GASOLINE COMPRESSOR	OTHER

DECOMPRESSION SCHEDULE

STANDARD	SURFACE USING		HE. DECOMPR.	TABLE USED
	AIR	OXYGEN		
			P.P.	MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER		CHAMBER	
	MINUTES AT STOP	BREATHING MEDIUM	MINUTES AT STOP	BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

(over)

SIGNS AND SYMPTONS BEFORE TREATMENT				
	ONSET		ANATOMICAL LOCATION	INTENSITY (MILD, MOD., SEVERE)
	DATE	TIME		
LOCALIZED PAIN	18 NOV 66	1021	left knee	mild
RASH				
MUSCULAR WEAKNESS				
NUMBNESS				
DIZZINESS				
VISUAL DISTURBANCES				
PARALYSIS				
UNCONSCIOUSNESS				
DYSPNEA (CHOKES)				
NAUSEA OR VOMITING				
MUSCULAR TWITCHING				
RESTLESSNESS				
CONVULSIONS				
ACOUSTIC AURA				
PARESTHESIA				

REMARKS: *(other signs and symptoms before, during and following treatment)*

SEE ADDENDUM

TREATMENT SCHEDULE					RECURRENCE TREATMENT SCHEDULE				
LEFT SURFACE		RELIEF		TIME REACHED BOTTOM	LEFT SURFACE		RELIEF		TIME REACHED BOTTOM
DATE	TIME	TIME	DEPTH		DATE	TIME	TIME	DEPTH	
SEE ADDENDUM									
TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED	TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED
		DATE	TIME				DATE	TIME	
SEE ADDENDUM					MIN.				

DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)		DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)	
FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM	FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM
165	73.4			165	73.4		
140	62.3			140	62.3		
120	53.4			120	53.4		
100	44.5			100	44.5		
80	35.6			80	35.6		
60	26.7			60	26.7		
50	22.3			50	22.3		
40	17.8			40	17.8		
30	13.4			30	13.4		
20	8.9			20	8.9		
10	4.5			10	4.5		
TO SURFACE				TO SURFACE			

REMARKS: *(Include sequence of events preceding the accident and subsequent result of treatment, noting any unusual contributing factors - Use continuation sheet if needed)*

SEE ADDENDUM

J. K. Summitt

J. K. SUMMITT, CDR, MC, USN

SIGNATURE OF MEDICAL DEPARTMENT REPRESENTATIVE

NAVMED 6420/1 (BACK)

MULLEN was one of 4 divers making a saturation dive to 300 feet with an excursion dive to 450 feet for one hour. The dive began at 14 NOV 66. Decompression was carried out in 2 foot steps, spending 25 minutes at each stop. The chamber atmosphere at 300 feet consisted of 3% Oxygen, 11.1% Nitrogen, and 85.9% Helium. During decompression the oxygen level was maintained at 0.3 atmospheres.

One of the other divers experienced a pain only bend at the 50 foot level and MULLEN accompanied the recompression treatment back to 108'. Decompression from this level was at 20 MPF. At 90 feet, MULLEN reported a tense sensation in the left knee and was treated with two 30 minute periods of breathing 60-40 helium-oxygen mixture by mask while continuing decompression. Subjectively, he reported slight improvement following these periods. Decompression was continued to the surface without any change in his symptoms.

IMPRESSION: Possible mild decompression sickness.

0003494 92B

REPORT OF DECOMPRESSION SICKNESS AND ALL DIVING ACCIDENTS

NAVMED-816 (REV. 2-56)

ORIGINAL - TO BUMED, WASHINGTON, D. C.
COPY - TO EXP. DIVING UNIT, NAVAL GUN FACTORY, WASH., D. C.

REPORTS SYMBOL: MED-6020-1

NAME AND ADDRESS OF REPORTING STATION: U.S. NAVY EXPERIMENTAL DIVING UNIT, WASHINGTON NAVY YARD, WASHINGTON, D. C. 20390

DATE: 8 Dec ~~28 Nov~~ 1966

NAME OF PATIENT (Surname first): DONALDSON, Gene Boyce, LT1(DV)

IDENTIFICATION NUMBER: 253 37 35

AGE	WEIGHT	HEIGHT	BUILD (Check one) SLENDER	MED.	HEAVY	OBESE	MAST	J/C	SAL.	D.S.	2/C	UOT	EOD	UWS	STU	(OTHER)
36 YRS.	185 LBS.	72 INS.		X				X								

DIVING QUALIFICATIONS (Check one)

RECORD OF ALL DIVES MADE DURING THE TWELVE HOURS PRECEDING THE ACCIDENT
(If more than three dives were made, record additional under "REMARKS" on reverse.)

	FIRST DIVE	SECOND DIVE	THIRD DIVE
TYPE OF DIVE	WET X, DRY X	WET, DRY	WET, DRY
DEPTH OF DIVE	300'/450' feet	feet	feet
BOTTOM TIME	25:51:20 min.	min.	min.
TYPE OF EQUIPMENT	DEEP SEA, DEEP SEA HELIUM, OPEN CIRCUIT SCUBA, CLOSED CIRCUIT SCUBA, SHALLOW WATER MASK, OTHER CHAMBER	DEEP SEA, DEEP SEA HELIUM, OPEN CIRCUIT SCUBA, CLOSED CIRCUIT SCUBA, SHALLOW WATER MASK, OTHER	DEEP SEA, DEEP SEA HELIUM, OPEN CIRCUIT SCUBA, CLOSED CIRCUIT SCUBA, SHALLOW WATER MASK, OTHER
TYPE OF WORK	NONE, MILD, MODERATE X, HEAVY	NONE, MILD, MODERATE, HEAVY	NONE, MILD, MODERATE, HEAVY
BREATHING MEDIUM	AIR, HELIUM % OXYGEN %, OXYGEN, OTHER (Specify) SEE ADDENDUM	AIR, HELIUM % OXYGEN %, OXYGEN, OTHER (Specify)	AIR, HELIUM % OXYGEN %, OXYGEN, OTHER (Specify)
SOURCE OF BREATHING MEDIUM	AIR BANKS, HELIUM-OXYGEN BANKS X, GASOLINE COMPRESSOR, OTHER	AIR BANKS, HELIUM-OXYGEN BANKS, GASOLINE COMPRESSOR, OTHER	AIR BANKS, HELIUM-OXYGEN BANKS, GASOLINE COMPRESSOR, OTHER
DECOMPRESSION SCHEDULE	STANDARD, SURFACE USING AIR / OXYGEN, HE. DECOMPR. P.P., TABLE USED MIN.	STANDARD, SURFACE USING AIR / OXYGEN, HE. DECOMPR. P.P., TABLE USED MIN.	STANDARD, SURFACE USING AIR / OXYGEN, HE. DECOMPR. P.P., TABLE USED MIN.
	SEE ADDENDUM		
TIME LEFT SURFACE / TIME REACHED BOTTOM / RATE OF ASCENT TO FIRST STOP FT/MIN / TIME REACHED SURFACE	SEE ADDENDUM		
If surface decompression used, time from last water stop to 1st chamber stop. MIN.			

DEPTH OF STOP (feet)	WATER MINUTES AT STOP	WATER BREATHING MEDIUM	CHAMBER MINUTES AT STOP	CHAMBER BREATHING MEDIUM	DEPTH OF STOP (feet)	WATER MINUTES AT STOP	WATER BREATHING MEDIUM	CHAMBER MINUTES AT STOP	CHAMBER BREATHING MEDIUM	DEPTH OF STOP (feet)	WATER MINUTES AT STOP	WATER BREATHING MEDIUM	CHAMBER MINUTES AT STOP	CHAMBER BREATHING MEDIUM
210					210					210				
200	SEE ADDENDUM				200					200				
190					190					190				
180					180					180				
170					170					170				
160					160					160				
150					150					150				
140					140					140				
130					130					130				
120					120					120				
110					110					110				
100					100					100				
90					90					90				
80					80					80				
70					70					70				
60					60					60				
50					50					50				
40					40					40				
30					30					30				
20					20					20				
10					10					10				

OIC ✓ AOIC ✓ PO ✓
STO ✓ AMO ✓ MEDEPT ✓
ED ENG ✓ ASTENG ✓ APO ✓
MASTDIVER ✓ YEOMAN ✓

2ND-PAPO

(over)

SIGNS AND SYMPTOMS BEFORE TREATMENT

	ONSET DATE	ONSET TIME	ANATOMICAL LOCATION	INTENSITY (MILD, MOD., SEVERE)
LOCALIZED PAIN	17 NOV '66	52:02:30	BOTH KNEES	MODERATE
RASH				
MUSCULAR WEAKNESS				
NUMBNESS				
DIZZINESS				
VISUAL DISTURBANCES				
PARALYSIS				
UNCONSCIOUSNESS				
DYSPNEA (CHOKES)				
NAUSEA OR VOMITING				
MUSCULAR TWITCHING				
RESTLESSNESS				
CONVULSIONS				
ACOUSTIC AURA				
PARESTHESIA				

REMARKS: *(other signs and symptoms before, during and following treatment)*

SEE ADDENDUM

TREATMENT SCHEDULE

LEFT SURFACE DATE	LEFT SURFACE TIME	RELIEF TIME	RELIEF DEPTH	TIME REACHED BOTTOM
	SEE ADDENDUM			

TIME ON BOTTOM	REACHED SURFACE DATE	REACHED SURFACE TIME	TREATMENT TABLE USED
MIN.			

DEPTH OF STOP FEET	DEPTH OF STOP LBS	CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered) MINUTES AT STOP	BREATHING MEDIUM
165	73.4		
140	62.3	SEE ADDENDUM	
120	53.4		
100	44.5		
80	35.6		
60	26.7		
50	22.3		
40	17.8		
30	13.4		
20	8.9		
10	4.5		
TO SURFACE			

RECURRENCE TREATMENT SCHEDULE

LEFT SURFACE DATE	LEFT SURFACE TIME	RELIEF TIME	RELIEF DEPTH	TIME REACHED BOTTOM

TIME ON BOTTOM	REACHED SURFACE DATE	REACHED SURFACE TIME	TREATMENT TABLE USED
MIN.			

DEPTH OF STOP FEET	DEPTH OF STOP LBS	CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered) MINUTES AT STOP	BREATHING MEDIUM
165	73.4		
140	62.3		
120	53.4		
100	44.5		
80	35.6		
60	26.7		
50	22.3		
40	17.8		
30	13.4		
20	8.9		
10	4.5		
TO SURFACE			

REMARKS: *(Include sequence of events preceding the accident and subsequent result of treatment, noting any unusual contributing factors – Use continuation sheet if needed)*

C. J. Rubenstein

C. J. RUBENSTEIN, LT, MC, USNR

SIGNATURE OF MEDICAL DEPARTMENT REPRESENTATIVE

APPENDIX I

DONALDSON was one of four divers making a saturation dive to 300' with an excursion dive to 450' for 1 hour. The dive began on 14 November 1966. Decompression was carried out in 2 foot steps, spending 25 minutes at each stop. The chamber atmosphere at 300' consisted of 3.0% oxygen, 11.1% nitrogen, and 85.9% helium. During the decompression the oxygen level was maintained at 0.3 atmosphere, the pressure being maintained, as needed, with 100% helium. CO_2 was not allowed to exceed .05%. The gas mixture for the 450' excursion was 8% oxygen/92% helium.

The pre-dive physical examination was unremarkable. DONALDSON had been treated for left knee pain during a dive to 400 feet for 1 hour on 6 October, and for right knee pain during a dive to 450 feet for 1/2 hour on 11 October. On 25 October he made a 100 foot saturation dive, with a 200' excursion, without incident.

At 52:02::30 from the start of decompression, at 50', DONALDSON reported moderate pain behind the patellae of both knees. The pain had begun minimally at 54', and had increased in intensity after the progression to 52' and to 50'. Physical examination by REEDY, HM1(DV), a member of the 4-man team, under the direction of the medical officer, was unremarkable. Recompression was begun, with the patient breathing 20% O_2, 80% He by mask. At 60' the pain was slightly decreased. At 70' the retro-patellar pain was nearly gone, but he began having pain in the right calf and right popliteal fossa. The patellar pain disappeared at 80', but the right calf pain increased in intensity and extended down the leg. Re-examination at 80', again under the direct supervision of the attending M.D., revealed slight weakness of the right leg. The pain was increased by neck flexion. Sensation was intact, deep tendon reflexes equal bilaterally, plantar responses normal, and the femoral and pedal pulses were intact and equal bilaterally. The pain increased transitorily as the recompression was continued to 90', with the addition of some pain in the right groin.

The transition to 100' was not accompanied by additional pain. At this depth the pain became intermittent, primarily involving the right calf, popliteal fossa, and groin areas. Re-examination was normal except for minimal weakness of the right leg. (The apparent weakness may have been due to pain). He spent two 30 minute periods breathing 80%/20% HeO_2 by mask, with 10 minute intervals breathing chamber atmosphere. At the end of this time the pain was present in the right knee and occasionally in the left knee. The physical examination was normal, and he had only minimal subjective knee weakness after doing 5 deep knee bends. He then spent two 30 minute periods breathing 60% He/40% O_2 by mask, with 10 minute intervals breathing chamber atmosphere. Very slight pain and stiffness were present in the right knee at the end of this time, and occasional slight pain in the left knee.

NOT REPRODUCIBLE

It was decided to proceed to 110' to achieve more nearly complete relief. The pain increased in intensity as the pressure was increased, however, with pain returning in the right groin. The recompression was stopped at 106' because of the pain. Physical examination revealed no neurological deficit. After 30 minutes breathing chamber atmosphere, he was put on 60% helium, 40% oxygen by mask for two 30 minute periods, with an interval period of 30 minutes off the mask. There was no pain at the end of this time. The pressure was increased to 108' as a pain-provocative test. Since the increased pressure did not result in pain this time, the decompression was restarted from 108', spending 40 minutes at each 2' step.

At 38' DONALDSON reported very slight pain in the right knee and occasional twitching of the left hip. The symptoms disappeared during the course of two 30 minute periods breathing 50% helium, 50% oxygen. Subsequently mild vague right knee pain recurred with each depth change, and disappeared during the 40 minute stop. At each stop he spent 20 minutes breathing chamber atmosphere and 20 minutes breathing 50/50 HeO_2 by mask and was not recompressed. (See 2nd treatment schedule).

From 30' to 12' he experienced no pain. At the end of the 12' stop he reported pain in the left leg below the knee. His three team mates were locked into the igloo portion of the chamber complex to finish their decompression on the original schedule of 25 minutes/2 foot stop. A fresh tender was locked in to join DONALDSON who then was put on 100% O_2 and recompressed to 30'. The chamber atmosphere was switched to air. The recompression was slow because the pain shifted to the right knee and groin, and increased with the increased pressure. (See 3rd treatment schedule). One of the medical officers locked in at 30', and a thorough physical examination was unremarkable. Thirty minutes after the pain was gone completely the decompression was continued as per the 3rd treatment schedule, and the surface was reached without further incident.

There were no post-dive sequellae. Physical examination, routine laboratory values, and multiple x-rays of both knees were all normal.

DONALDSON's repeated susceptibility to decompression sickness in the same anatomical location during deep dives has led to his disqualification from the Man-in-the-Sea program. This does not necessarily mean, however, that he can not participate in standard Navy diving. The decompression schedules continue to undergo evaluation at the Experimental Diving Unit.

C. J. Rubenstein

C. J. RUBENSTEIN
LT, MC, USNR

NOT REPRODUCIBLE

1st TREATMENT SCHEDULE

DEPTH	INSPIRED GAS	TIME
50'	Chamber atmosphere	(Reported pain)
60'	80/20 He/O_2	27 minutes
70'	" " "	3 minutes
80'	" " "	2 minutes
90'	" " "	7 minutes
100'	" " "	30 minutes
	Chamber atmosphere	10 minutes
	80/20 HeO_2	30 minutes
	Chamber	10 minutes
	60/40 HeO_2	30 minutes
	Chamber	10 minutes
	60/40 HeO_2	30 minutes
	Chamber	10 minutes
106'	Chamber	22 minutes
	60/40 HeO_2	30 minutes
	Chamber	30 minutes
	60/40 HeO_2	30 minutes
	Chamber	12::30
108'	Chamber	No pain -

219 HeO_2

RE-START DECOMPRESSION

2nd TREATMENT SCHEDULE

38'	50/50 HeO_2	30 minutes
	Chamber	10 minutes
	50/50 HeO_2	30 minutes
36'	Chamber	20 minutes
	50/50 HeO_2	20 minutes
34'	Chamber	20 minutes
	50/50 HeO_2	20 minutes
32'	Chamber	20 minutes
	50/50 HeO_2	20 minutes
30'	Chamber	20 minutes
	50/50 HeO_2	20 minutes
	Chamber	20 minutes

220 HeO_2

No pain - proceeded with 2 foot decompression stops, spending 20 minutes on 50/50 HeO_2 and 20 minutes on Chamber gas at each stop.

NOT REPRODUCIBLE

3rd TREATMENT SCHEDULE

DEPTH	INSPIRED GAS	TIME
30'	100% O_2	30 minutes
	Air	30 minutes
	100% O_2	30 minutes
	Air	30 minutes
	100% O_2	30 minutes
	Pain gone	
	Air	30 minutes
20'	100% O_2	30 minutes including 20 minutes travel time.
	Air	20 minutes
10'	100%	30 minutes including 20 minutes travel time.
	Air	20 minutes
8'	100% O_2	30 minutes
6'	Air	30 minutes
4'	100% O_2	30 minutes
2'	Air	30 minutes
SURFACE		

153 02

NOT REPRODUCIBLE

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REPORT OF DECOMPRESSION SICKNESS AND ALL DIVING ACCIDENTS
NAVMED-816 (REV. 2-56)

ORIGINAL - TO BUMED, WASHINGTON, D. C.
COPY - TO EXP. DIVING UNIT, NAVAL GUN FACTORY, WASH., D. C.

REPORTS SYMBOL: MED-6020-1

NAME AND ADDRESS OF REPORTING STATION: U.S. NAVY EXPERIMENTAL DIVING UNIT, WASHINGTON NAVY YARD, WASHINGTON, D. C. 20390

DATE: 14 DEC 1966

NAME OF PATIENT (Surname first): STUBBS, Joe Pete SFM2 (DV)

IDENTIFICATION NUMBER: 965 52 77

AGE	WEIGHT	HEIGHT	BUILD (Check one)					DIVING QUALIFICATIONS (Check one)									
29 YRS.	216 LBS.	70½ INS.	SLENDER	MED.	HEAVY X	OBESE	MAST	1/C X	SAL.	U.S.	2/C	UOT	EOO	UWS	STU	(OTHER)

RECORD OF ALL DIVES MADE DURING THE TWELVE HOURS PRECEDING THE ACCIDENT
(If more than three dives were made, record additional under "REMARKS" on reverse.)

FIRST DIVE								
TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME					
WET X	DRY X	150'/600' feet	27:31::15					
TYPE OF EQUIPMENT								
DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER			
SEE ADDENDUM								
TYPE OF WORK								
NONE	MILD	MODERATE X	HEAVY					
BREATHING MEDIUM								
AIR	HELIUM % OXYGEN %	OXYGEN	OTHER (Specify)					
SEE ADDENDUM								
SOURCE OF BREATHING MEDIUM								
AIR BANKS	HELIUM-OXYGEN BANKS X	GASOLINE COMPRESSOR	OTHER					
DECOMPRESSION SCHEDULE								
STANDARD	SURFACE USING		HE. DECOMPR.	TABLE USED				
	AIR	OXYGEN						
	SEE ADDENDUM			MIN.				
TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE					
SEE ADDENDUM		FT/MIN						
If surface decompression used, time from last water stop to 1st chamber stop. MIN.								

DEPTH OF STOP (feet)	WATER		CHAMBER	
	MINUTES AT STOP	BREATHING MEDIUM	MINUTES AT STOP	BREATHING MEDIUM
210				
200				
190				
180	SEE ADDENDUM			
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

SECOND DIVE								
TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME					
WET	DRY	feet	min.					
TYPE OF EQUIPMENT								
DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER			
TYPE OF WORK								
NONE	MILD	MODERATE	HEAVY					
BREATHING MEDIUM								
AIR	HELIUM % OXYGEN %	OXYGEN	OTHER (Specify)					
SOURCE OF BREATHING MEDIUM								
AIR BANKS	HELIUM-OXYGEN BANKS	GASOLINE COMPRESSOR	OTHER					
DECOMPRESSION SCHEDULE								
STANDARD	SURFACE USING		HE. DECOMPR.	TABLE USED				
	AIR	OXYGEN	P.P.	MIN.				
TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE					
		FT/MIN						
If surface decompression used, time from last water stop to 1st chamber stop. MIN.								

DEPTH OF STOP (feet)	WATER		CHAMBER	
	MINUTES AT STOP	BREATHING MEDIUM	MINUTES AT STOP	BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

THIRD DIVE								
TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME					
WET	DRY	feet	min.					
TYPE OF EQUIPMENT								
DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER			
TYPE OF WORK								
NONE	MILD	MODERATE	HEAVY					
BREATHING MEDIUM								
AIR	HELIUM % OXYGEN %	OXYGEN	OTHER (Specify)					
SOURCE OF BREATHING MEDIUM								
AIR BANKS	HELIUM-OXYGEN BANKS	GASOLINE COMPRESSOR	OTHER					
DECOMPRESSION SCHEDULE								
STANDARD	SURFACE USING		HE. DECOMPR.	TABLE USED				
	AIR	OXYGEN	P.P.	MIN.				
TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE					
		FT/MIN						
If surface decompression used, time from last water stop to 1st chamber stop. MIN.								

DEPTH OF STOP (feet)	WATER		CHAMBER	
	MINUTES AT STOP	BREATHING MEDIUM	MINUTES AT STOP	BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

CIC ---- AOIC ---- FO
EMO ---- AMO ---- MEDEPT
EO ENG ---- AST ENG ---- APO
MASTDIVER ---- SK ---- YEOMAN

15 DEC 1966

3MD-P&PO

SIGNS AND SYMPTOMS BEFORE TREATMENT

	ONSET DATE	ONSET TIME	ANATOMICAL LOCATION	INTENSITY (MILD, MOD., SEVERE)
LOCALIZED PAIN	29 NOV 1966		RIGHT KNEE	MILD-MODERATE
RASH				
MUSCULAR WEAKNESS				
NUMBNESS				
DIZZINESS				
VISUAL DISTURBANCES				
PARALYSIS				
UNCONSCIOUSNESS				
DYSPNEA (CHOKES)				
NAUSEA OR VOMITING				
MUSCULAR TWITCHING				
RESTLESSNESS				
CONVULSIONS				
ACOUSTIC AURA				
PARESTHESIA				

REMARKS: *(other signs and symptoms before, during and following treatment)*

TREATMENT SCHEDULE

LEFT SURFACE DATE	LEFT SURFACE TIME	RELIEF TIME	RELIEF DEPTH	TIME REACHED BOTTOM
SEE ADDENDUM				

TIME ON BOTTOM	REACHED SURFACE DATE	REACHED SURFACE TIME	TREATMENT TABLE USED
MIN.			

DEPTH OF STOP FEET	DEPTH OF STOP LBS	CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered) MINUTES AT STOP	BREATHING MEDIUM
165	73.4		
140	62.3		
120	53.4		
100	44.5		
80	35.6		
60	26.7		
50	22.3		
40	17.8		
30	13.4		
20	8.9		
10	4.5		
TO SURFACE			

RECURRENCE TREATMENT SCHEDULE

LEFT SURFACE DATE	LEFT SURFACE TIME	RELIEF TIME	RELIEF DEPTH	TIME REACHED BOTTOM

TIME ON BOTTOM	REACHED SURFACE DATE	REACHED SURFACE TIME	TREATMENT TABLE USED
MIN.			

DEPTH OF STOP FEET	DEPTH OF STOP LBS	CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered) MINUTES AT STOP	BREATHING MEDIUM
165	73.4		
140	62.3		
120	53.4		
100	44.5		
80	35.6		
60	26.7		
50	22.3		
40	17.8		
30	13.4		
20	8.9		
10	4.5		
TO SURFACE			

REMARKS: *(Include sequence of events preceding the accident and subsequent result of treatment, noting any unusual contributing factors - Use continuation sheet if needed)*

C. J. Rubenstein

C. J. RUBENSTEIN, LT, MC, USNR

SIGNATURE OF MEDICAL DEPARTMENT REPRESENTATIVE

NOT REPRODUCIBLE

ADDENDUM

STUBBS was one of 4 divers making a simulated saturation dive to 450', with an excursion to 600' for 1 hour. The dive was carried out in a wet-dry chamber complex at the Experimental Diving Unit. The chamber atmosphere was maintained at 0.3 ATA of oxygen. Pressurization was accomplished and maintained with 100% helium. The planned decompression schedule consisted of a 25 minute stop at each 2 foot decrement.

At 124', after 67:35:00 of decompression, STUBBS reported moderate right knee pain. The pain had been present since about 150', and had not increased as the depth was decreased. Physical examination by Dr. Raymond (one of the four divers) was normal. He was treated with 80% helium/20% oxygen by mask for 20 minutes, and then with 32% HeO_2 for two 30 minute periods. Intervening were 10 minute periods breathing chamber atmosphere. The pain was not relieved completely, so the chamber was pressurized to 165' where he was treated with five 30 minute periods breathing 32% HeO_2. These periods were alternated with 30 minute periods breathing chamber atmosphere. Pain relief was complete after the 3rd period. Thirty minute after the last period on 32% HeO_2 the decompression was re-started at the original rate.

At 28', after 105:34:50 of decompression, STUBBS again reported right knee pain. HM1 (DV) REEDY was locked in, and he and STUBBS were isolated from the 3 other divers who continued their ascent to the surface. STUBBS and REEDY were recompressed slowly on air, with STUBBS breathing 100% oxygen. Complete relief was obtained at 32', but repressurization was continued to 60'. After 25 minutes on oxygen he reported right calf pain. There were no significant physical findings. He then spent 10 minutes on air, 20 minutes on O_2, 10 minutes on air, and 20 minutes on O_2. After another 10 minutes on air the ascent was restarted at 1 FPM with STUBBS breathing 100% O_2. The pain recurred at 40'. He was re-pressurized to 50' with slight relief. A blood pressure cuff was placed around the affected calf and inflated. At 80 mm.Hg. the pain was markedly decreased. At 100 mm.Hg. the pain increased again. The cuff was released, and the pain vanished, never to return again. The ascent was resumed at 25 min./2' decrement up to 30', then 40 minutes/2' decrement to the surface. The post-dive physical examination was normal.

Impression - decompression sickness.

This developmental decompression schedule is being revised in hopes of avoiding further decompression problems.

C. J. Rubenstein

C. J. RUBENSTEIN
LT, MC, USNR

0003806

REPORT OF DECOMPRESSION SICKNESS AND ALL DIVING ACCIDENTS

NAVMED-816 (REV. 2-56)

ORIGINAL - TO BUMED, WASHINGTON, D. C.
COPY - TO EXP. DIVING UNIT, NAVAL GUN FACTORY, WASH., D. C.

REPORTS SYMBOL: MED-6020-1

NAME AND ADDRESS OF REPORTING STATION: Experimental Diving Unit, Washington Navy Yard, Washington, D.C.

DATE: 2-16-68

NAME OF PATIENT (Surname first): HOULE, Howard Vernon

IDENTIFICATION NUMBER: 903 68 21

AGE	WEIGHT	HEIGHT	BUILD (Check one)				DIVING QUALIFICATIONS (Check one)									
			SLENDER	MED.	HEAVY	OBESE	MAST	I/C	SAL.	D.S.	2/C	UDT	EOD	UWS	STU	(OTHER)
23 YRS.	152 LBS.	71 INS.		X				X								SEALAB

RECORD OF ALL DIVES MADE DURING THE TWELVE HOURS PRECEDING THE ACCIDENT
(If more than three dives were made, record additional under "REMARKS" on reverse.)

FIRST DIVE							SECOND DIVE							THIRD DIVE						
TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME				TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME				TYPE OF DIVE		DEPTH OF DIVE	BOTTOM TIME			
WET X	DRY	feet	min.				WET	DRY	feet	min.				WET	DRY	feet	min.			
TYPE OF EQUIPMENT							TYPE OF EQUIPMENT							TYPE OF EQUIPMENT						
DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER Plan VII		DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER		DEEP SEA	DEEP SEA HELIUM	OPEN CIRCUIT SCUBA	CLOSED CIRCUIT SCUBA	SHALLOW WATER MASK	OTHER	
TYPE OF WORK							TYPE OF WORK							TYPE OF WORK						
NONE	MILD	MODERATE X	HEAVY				NONE	MILD	MODERATE	HEAVY				NONE	MILD	MODERATE	HEAVY			
BREATHING MEDIUM							BREATHING MEDIUM							BREATHING MEDIUM						
AIR	HELIUM % OXYGEN % 92 8	OXYGEN	OTHER (Specify) OAT CB				AIR	HELIUM % OXYGEN % OIC	OXYGEN AOIC	OTHER (Specify) PO				AIR	HELIUM % OXYGEN %	OXYGEN	OTHER (Specify)			
SOURCE OF BREATHING MEDIUM							SOURCE OF BREATHING MEDIUM							SOURCE OF BREATHING MEDIUM						
AIR BANKS	HELIUM-OXYGEN BANKS X	GASOLINE COMPRESSOR	OTHER				AIR BANKS	HELIUM-OXYGEN BANKS	GASOLINE COMPRESSOR	OTHER				AIR BANKS	HELIUM-OXYGEN BANKS	GASOLINE COMPRESSOR	OTHER			
DECOMPRESSION SCHEDULE							DECOMPRESSION SCHEDULE							DECOMPRESSION SCHEDULE						
STANDARD	SURFACE USING AIR	SURFACE USING OXYGEN SATURATION	HE. DECOMPR.	TABLE USED	MIN.		STANDARD	SURFACE USING AIR	SURFACE USING OXYGEN	HE. DECOMPR. P.P.	TABLE USED	MIN.		STANDARD	SURFACE USING AIR	SURFACE USING OXYGEN	HE. DECOMPR. P.P.	TABLE USED	MIN.	
TIME LEFT SURFACE 0352 29 Jan 69	TIME REACHED BOTTOM 0303 29 Jan 69	RATE OF ASCENT TO FIRST STOP FT/MIN	TIME REACHED SURFACE 0910 8 Feb 6				TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP FT/MIN	TIME REACHED SURFACE				TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP FT/MIN	TIME REACHED SURFACE			
If surface decompression used, time from last water stop to 1st chamber stop. MIN.							*If surface decompression used, time from last water stop to 1st chamber stop.* MIN.							*If surface decompression used, time from last water stop to 1st chamber stop.* MIN.						

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM	DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM	DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210	CONSULT ADMIRAL				210					210				
200	FROM 170 TO				200					200				
190	DEPTH OF SUBMERSION				190					190				
180	AT 10 min/ft				180					180				
170					170					170				
160					160					160				
150					150					150				
140					140					140				
130					130					130				
120					120					120				
110					110					110				
100					100					100				
90					90					90				
80					80					80				
70					70					70				
60					60					60				
50					50					50				
40					40					40				
30					30					30				
20					20					20				
10					10					10				

3ND-P&PO

SIGNS AND SYMPTOMS BEFORE TREATMENT				
	ONSET		ANATOMICAL LOCATION	INTENSITY (MILD, MOD., SEVERE)
	DATE	TIME		
LIZED PAIN	[illegible]	[illegible]	[illegible]	MILD
RASH				
MUSCULAR WEAKNESS				
NUMBNESS				
DIZZINESS				
VISUAL DISTURBANCES				
PARALYSIS				
UNCONSCIOUSNESS				
DYSPNEA (CHOKES)				
NAUSEA OR VOMITING				
MUSCULAR TWITCHING				
RESTLESSNESS				
CONVULSIONS				
ACOUSTIC AURA				
PARESTHESIA				

REMARKS: *(other signs and symptoms before, during and following treatment)*

PT noted stiffness slight pain RT knee at 170 relieved on 4 HR STOP at 150, returned at 110, relieved at 100 (4 HR stop). slight Sensation returned at 85', increased in intensity to 77' where 1st reported. no other signs or symptoms could be elicited at that time or at any other point in the treatment.

NOT REPRODUCIBLE

TREATMENT SCHEDULE					RECURRENCE TREATMENT SCHEDULE				
LEFT SURFACE		RELIEF		TIME REACHED BOTTOM	LEFT SURFACE		RELIEF		TIME REACHED BOTTOM
	TIME	TIME	DEPTH		DATE	TIME	TIME	DEPTH	
SEE ATTACHED PROFILE FOR									
TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED	TIME ON BOTTOM		REACHED SURFACE		TREATMEN TABLE USED
TREATMENT MIN.		DATE	TIME		MIN.		DATE	TIME	

DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)		DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)	
FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM	FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM
165	73.4			165	73.4		
140	62.3			140	62.3		
120	53.4			120	53.4		
100	44.5			100	44.5		
80	35.6			80	35.6		
60	26.7			60	26.7		
50	22.3			50	22.3		
40	17.8			40	17.8		
30	13.4			30	13.4		
20	8.9			20	8.9		
10	4.5			10	4.5		
TO SURFACE				TO SURFACE			

REMARKS: *(Include sequence of events preceding the accident and subsequent result of treatment, noting any unusual contributing factors - Use continuation sheet if needed)*

SEE ATTACHED SHEET

James S Kelley

SIGNATURE OF MEDICAL DEPARTMENT REPRESENTATIVE

Prior to this dive the patient, Houle gives a history of injury to the involved extremity, occurring in a motorcycle accident approximately one year ago, causing severe contusions and abrasions in the general area of the present symptoms. In addition, he has had two previous cases of the bends, both within the last three months while working with the ADS IV Project in England. These bends manifested the same symptoms as those in the present case.

The dive was a 600 foot saturation run, descent in 14:35 44 hours on the bottom during which the Mark VIII semi-closed scuba rigs were swimtested in the wetpot. No excursion was attempted.

Ascent began at a rate of 2 minutes a foot to 570 where the rate of ascent was changed to 15 minutes per foot. This rate was held constant except for stops of four hours duration at 450', 300', 150' and 100'. Constant .3ATM O_2 + H_e was maintained.

In retrospect, according to his own log, the first signs had appeared at 170: with a mild pain in the right knee which cleared at the 150' stop. It returned at 110 but was better after the four hour hold at 100 and gone at 96'. At 35' the sensation returned, involving the right knee and hip, gradually increasing in intensity until, on prompting by fellow diver it was reported at 77' after 140: 15:00 hours decompression. (All times will refer to log times, indicating in this case time after leaving bottom).

Treatment was begun according to the protocol devised for treatment of cases occuring in saturation dives:

(Letters refer to enclosed garph)

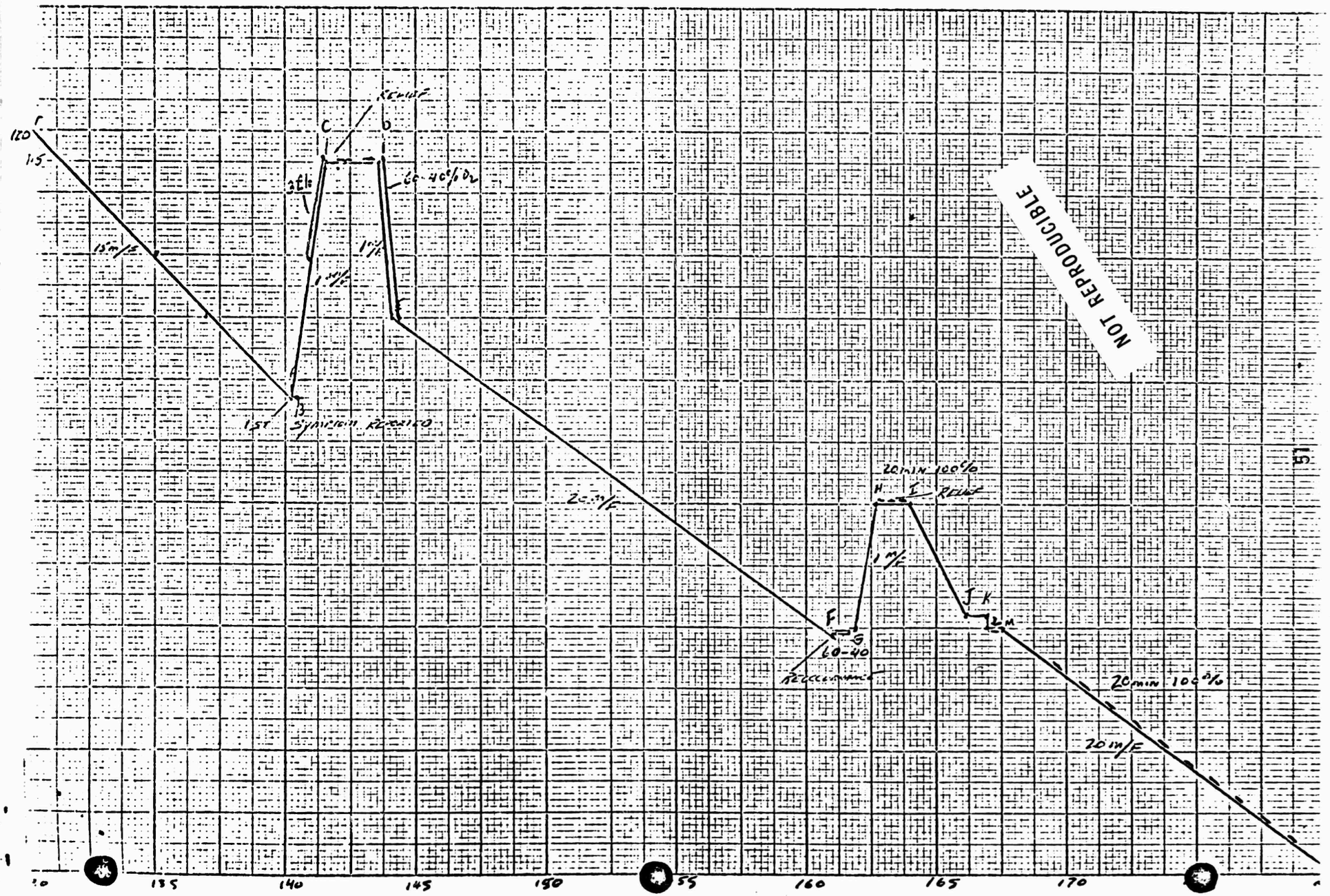
A.	140:15	Pain in right knee and hip reported, no further signs or symptoms elicited.
B.	140:47	During recompression toward depth of relief Houle placed on He-32%O2 mix by mask.
	141:32	Off Mask
C.	141:32	Depth of Relief 115 feet. No pain, no loss of strength or sensation
	142:03	On Mask He-32%O2
	142:28	On Mask He-40%O2
	142:37	Off Mask
	142:58	On Mask (40%)
	143:28	Off Mask
D.	143:36	On Mask (40%). Began Ascent to 90 feet according to treatment protocol, at rate of 1fpm.
E.	144:03	Reached 90' changed rate of ascent to 20 Min/ft.
	144:08	Off Mask
F.	161:01	Houle reports onset of mild ache medial aspect of right knee and right anterior thigh, occurred after reaching 39'. Again no other signs or symptoms.
	161:09	On 60-40 mix by mask
	161:39	Off Mask
	161:43	Other divers separated, tender sent from surface to join Houle in chamber, chamber taken down one foot to make seal

NOT REPRODUCIBLE

		on hatch.
G.	161:51	Began descent toward sixty feet at 1 fpm. No change in symptoms. Pain was almost completely relieved at 50'
H.	162.38	Further improvement on reaching sixty feet. Began cycles of twenty minutes 100% 02 by mask.
	162:58	Off Mask
	163:09	On Mask during this period all symptoms had cleared.
	163:27	Off Mask
	163:37	On Mask
	163:57	Off Mask
I.	163:59	Ascent to 50 feet at 1 fpm. No symptoms.
K.	166:50	Ascent to the surface at the rate of 20 minutes/foot, (actual travel 2ft at 1 fpm, then 38 minute holds). Each hour twenty minutes of 02 administered by mask.
N.	180:32	Surface

There were no residual symptoms, x-ray of the involved extremity was negative. The four other divers never manifested any signs or symptoms of decompression sickness.

NOT REPRODUCIBLE



NOT REPRODUCIBLE

000 5317

REPORT OF DECOMPRESSION SICKNESS AND ALL DIVING ACCIDENTS

NAVMED 6420/1 (REV. 3-67)
S/N 0105-214-1650

REPORTS SYMBOL: MED-6420-1

ORIGINAL - BUMED, WASHINGTON, D. C.
COPY - NAVY EXP. DIVING UNIT, WASHINGTON NAVY YARD, WASHINGTON, D. C.
COPY - NAVAL SUB. MED. CENTER, NAVAL SUB. BASE NEW LONDON, GROTON, CONN.

NAME AND ADDRESS OF REPORTING STATION: S. Navy Experimental Diving Unit, Wash. Navy Yard, Washington, D. C.

DATE: 28 Mar 1968

NAME OF PATIENT (Surname first)	GRADE/RATE	IDENTIFICATION NO.	TYPE OF DIVING ACCIDENT
CLARK, Dorck J.	PO-CD1	RN P/JX889156	Bends

AGE	WEIGHT	HEIGHT	BUILD (Check one)				DIVING QUALIFICATIONS (Check one)									
			SLENDER	MED.	HEAVY	OBESE	MAST	I/C	SAL.	D.S.	2/C	UDT	EOD	UWS	STU	(OTHER)
33 YRS.	170 LBS.	70 INS.		X				X								Royal Navy

RECORD OF ALL DIVES MADE DURING THE TWELVE HOURS PRECEDING THE ACCIDENT
(If more than three dives were made, record additional under "REMARKS" on reverse.)

FIRST DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
	X	600 feet	Saturation

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER: Cham

TYPE OF WORK: NONE | MILD: X | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN %: 92.4 He, 6.0 N, | OXYGEN | OTHER (Specify): 1.6 O

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS: X | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
1542 20 Mar	14:07	1 fpm FT/MIN	02:30 30 Mar

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200	SEE ATTACHED SHEET			
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

SECOND DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
		feet	min.

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER

TYPE OF WORK: NONE | MILD | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN % | OXYGEN | OTHER (Specify)

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

THIRD DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
		feet	min.

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER

TYPE OF WORK: NONE | MILD | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN % | OXYGEN | OTHER (Specify)

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

(over)

D-30480

SIGNS AND SYMPTONS BEFORE TREATMENT

	ONSET DATE	ONSET TIME	ANATOMICAL LOCATION	INTENSITY (MILD, MOD., SEVERE)
LOCALIZED PAIN	23 Mar 68	1500	Left Knee	Mod.
RASH				
MUSCULAR WEAKNESS				
NUMBNESS				
DIZZINESS				
VISUAL DISTURBANCES				
PARALYSIS				
UNCONSCIOUSNESS				
DYSPNEA (CHOKES)				
NAUSEA OR VOMITING				
MUSCULAR TWITCHING				
RESTLESSNESS				
CONVULSIONS				
ACOUSTIC AURA				
PARESTHESIA				

REMARKS: *(other signs and symptoms before, during and following treatment)*

No other signs or symptoms

TREATMENT SCHEDULE					RECURRENCE TREATMENT SCHEDULE				
LEFT SURFACE		RELIEF		TIME REACHED BOTTOM	LEFT SURFACE		RELIEF		TIME REACHED BOTTOM
DATE	TIME	TIME	DEPTH		DATE	TIME	TIME	DEPTH	
SEE ATTACHED SHEET TREATED ON									
TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED	TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED
MIN.		DATE	TIME	protocol	MIN.		DATE	TIME	

DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)		DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)	
FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM	FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM
165	73.4			165	73.4		
140	62.3			140	62.3		
120	53.4			120	53.4		
100	44.5			100	44.5		
80	35.6			80	35.6		
60	26.7			60	26.7		
50	22.3			50	22.3		
40	17.8			40	17.8		
30	13.4			30	13.4		
20	8.9			20	8.9		
10	4.5			10	4.5		
TO SURFACE				TO SURFACE			

REMARKS: *(Include sequence of events preceding the accident and subsequent result of treatment, noting any unusual contributing factors - Use continuation sheet if needed)*

SIGNATURE OF MEDICAL DEPARTMENT REPRESENTATIVE

NAVMED 6320/1 (BACK)

Decompression

Ascended from 600 to 570 at rate of 1 fpm, chamber O_2 had been raised slightly prior to ascent. Held constant ascent rate of 15 minutes per foot except for four hour stops at 450, 300, 150, 100 feet. Decompression was uneventful until 51 feet.

Bend

28 March
1500 At fiftyone,-two feet CLARK noted pain in the prepatellar area left knee, worse with exercise, no other symptoms

Evaluation

History: no previous bends, rugby injuries to both legs 5-10 years previously. No other trouble during this dive, no trauma recently. Now at fifty feet has sensation in both knees.
Physical: vital signs normal, no rash, chest clear [50 foot stop] to P and A. No crepitus in joints or tendons, no changes in the fundus. Nervous system intact, no parasthesias in the affected area. Pain relieved during exam.

Treatment

NOT REPRODUCIBLE

28 March
1615 Pain recurred at fifty foot stop, during meal, after short rest,
1633 put on 100% O_2
1653 Off O_2 Some improvement
1710 Worse in both knees
1711 On 100% O_2 preparing to split complex
1731 Off O_2 (50 feet) Ready sent down as tender Chamber pressurized
1747 Much better at sixty feet, going on 60-40 mix
1750 Pain worse spreading to thigh pressurizing chamber
1820 Some improvement, giving trial of 60-40 mix at this depth
1840 Off mix, knee clear, thigh mild ache, encouraging hydration. Return depth according to protocol - 66.8 ft.
1858 On mix
1920 Off mix no residual symptoms
1940 On mix no residual symptoms
2000 Off mix no residual symptoms
2030 Walking in chamber, no symptoms, rate of ascent switched to twenty minutes/foot (at 75 feet)

29 March
0200 Holding for four hours at fifty feet. No change.
0700 Continuing ascent at 20 fpm. No change.
0815 Added 100% O_2 for 40 minutes every 10 feet to regimen. No symptoms

30 March
0150 CLARK on surface, no symptoms, no signs on physical.

REPORT OF DECOMPRESSION SICKNESS AND ALL DIVING ACCIDENTS

NAVMED 6420/1 (REV. 3-67)
S/N-0105-214-1650

REPORTS SYMBOL: MED-6420-1

ORIGINAL - BUMED, WASHINGTON, D. C.
COPY - NAVY EXP. DIVING UNIT, WASHINGTON NAVY YARD, WASHINGTON, D. C.
COPY - NAVAL SUB. MED. CENTER, NAVAL SUB. BASE NEW LONDON, GROTON, CONN.

NAME AND ADDRESS OF REPORTING STATION: Navy Experimental Diving Unit, Bldg. 214, WNY, Washington, D.C.

DATE: 28 MAR 68

NAME OF PATIENT (Surname first)	GRADE/RATE	IDENTIFICATION NO.	TYPE OF DIVING ACCIDENT
LAFFERTY, C. F.	LT	UNKNOWN	Decompression Sickness

AGE	WEIGHT	HEIGHT	BUILD (Check one)				DIVING QUALIFICATIONS (Check one)									
			LINEAR	MED.	HEAVY	OBESE	MAST	I/C	SAT.	D.S.	J/C	DDT	EOD	UWS	SHO	OTHER
30 YRS.	170 LBS.	90 INS.		X				X								Diving Officer (RN)

RECORD OF ALL DIVES MADE DURING THE TWELVE HOURS PRECEDING THE ACCIDENT
(If more than three dives were made, record additional under "REMARKS" on reverse.)

FIRST DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
	X	600 feet	2848 min.

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER: CHAMBER

TYPE OF WORK: NONE | MILD: X | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN % | OXYGEN | OTHER (Specify): 92.4% He, 6.0% N2, 1.6% O2

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS: X | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN: SATURATION | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
1542 20 MAR	+ 14:07	1 FT/MIN	0730 29 MAR

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180				
170	SEE ATTACHED SHEET			
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

SECOND DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
		feet	min.

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER

TYPE OF WORK: NONE | MILD | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN % | OXYGEN | OTHER (Specify)

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

THIRD DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
		feet	min.

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER

TYPE OF WORK: NONE | MILD | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN % | OXYGEN | OTHER (Specify)

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180				
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

(over)

SIGNS AND SYMPTONS BEFORE TREATMENT

	ONSET DATE	ONSET TIME	ANATOMICAL LOCATION	INTENSITY (MILD, MOD., SEVERE)
LOCALIZED PAIN	29 MAR 68	0750	left knee	mod.
RASH				
MUSCULAR WEAKNESS				
NUMBNESS				
DIZZINESS				
VISUAL DISTURBANCES				
PARALYSIS				
UNCONSCIOUSNESS				
DYSPNEA (CHOKES)				
NAUSEA OR VOMITING				
MUSCULAR TWITCHING				
RESTLESSNESS				
CONVULSIONS				
ACOUSTIC AURA				
PARESTHESIA				

REMARKS: *(other signs and syeptoms before, during and following treatment)*

SEE ATTACHED SHEET

TREATMENT SCHEDULE					RECURRENCE TREATMENT SCHEDULE				
LEFT SURFACE		RELIEF		TIME REACHED BOTTOM	LEFT SURFACE		RELIEF		TIME REACHED BOTTOM
DATE	TIME	TIME	DEPTH	see attached sheet	DATE	TIME	TIME	DEPTH	
29MAR 68	0808	UNK	10'						
TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED	TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED
see attached sheet MIN.		DATE 28 MAR	TIME 1018	other	MIN.		DATE	TIME	

DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)		DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)	
FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM	FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM
165	73.4			165	73.4		
140	62.3			140	62.3		
120	53.4	SEE ATTACHED SHEET		120	53.4		
100	44.5			100	44.5		
80	35.6			80	35.6		
60	26.7			60	26.7		
50	22.3			50	22.3		
40	17.8			40	17.8		
30	13.4			30	13.4		
20	8.9			20	8.9		
10	4.5			10	4.5		
TO SURFACE				TO SURFACE			

REMARKS: *(Include sequence of events preceding the accident and subsequent result of treatment, noting any unusual contributing factors - Use continuation sheet if needed)*

SEE ATTACHED SHEET

J K Summitt

J K SUMMITT, CDR, MC, USN

SIGNATURE OF MEDICAL DEPARTMENT REPRESENTATIVE

NAVMED 6420/1 (BACK)

Ascent from 600 to 570 feet at 1 FPM, Chamber O2 had been raised slightly prior to ascent. Hold constant rate of ascent of 15 MPF except for 4 hour stops at 450, 300, 150, 100 and 50 feet.

20 minutes after surfacing the patient began complaining of left knee pain. He was placed on 100% O2 by mask and recompressed over a ten minute period to 30 feet. The patient complained of marked increase in pain coincident with compression and it was decided to return to a shallower depth. Considerable improvement was noted upon reaching 10 feet, so the patient was held for one hour of O2 breathing at that depth. He was then surfaced, still breathing O2, at a rate of 5 minutes per foot. He surfaced asymptomatic and experienced no further difficulty.

TREATMENT SCHEDULE

Left surface	0808	Breathing 100% oxygen by mask
Reach 30'	0819	
Leave 30'	0823	
Reach 10'	0828	
Leave 10'	0928	
Reach Surface	1018	

REPORT OF DECOMPRESSION SICKNESS AND ALL DIVING ACCIDENTS

NAVMED 6420/1 (REV. 3-67)
S/N.0105-214-1650

REPORTS SYMBOL: MED-6420-1

ORIGINAL - BUMED, WASHINGTON, D. C.
COPY - NAVY EXP. DIVING UNIT, WASHINGTON NAVY YARD, WASHINGTON, D. C.
COPY - NAVAL SUB. MED. CENTER, NAVAL SUB. BASE, NEW LONDON, GROTON, CONN.

NAME AND ADDRESS OF REPORTING STATION: Navy Experimental Diving Unit, Bldg. 214, WNY, Washington, D.C.

DATE: 25 APR 1968

NAME OF PATIENT (Surname first)	GRADE/RATE	IDENTIFICATION NO.	TYPE OF DIVING ACCIDENT
GIESS	LCDR	UNKNOWN	Decompression Sickness

AGE	WEIGHT	HEIGHT	BUILD (Check one)				DIVING QUALIFICATIONS (Check one)									
			SLENDER	MLD.	HEAVY	OBESE	MAST	I/C	SAL.	D.S.	2/C	UDT	EOD	DWS	STU	(OTHER)
31 YRS.	UNK LBS.	UNK INS.		X												Diving Officer

RECORD OF ALL DIVES MADE DURING THE TWELVE HOURS PRECEDING THE ACCIDENT
(If more than three dives were made, record additional under "REMARKS" on reverse.)

FIRST DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
	X	600 feet	4192 min.

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER: CHAMBER

TYPE OF WORK: NONE | MILD: X | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN %: 92.4% He, 6% N2, 1.6% O2 | OXYGEN | OTHER (Specify)

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS: X | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN: SATURATION | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
15 APR 2214	+ 09:45	1 FT/MIN	1130 25 APR

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
200				
190				
180	SEE ATTACHED SHEET			
170				
160				
150				
140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

SECOND DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
		feet	min.

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER

TYPE OF WORK: NONE | MILD | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN % | OXYGEN | OTHER (Specify)

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
210				
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190				
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170				
160				
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THIRD DIVE

TYPE OF DIVE: WET	DRY	DEPTH OF DIVE	BOTTOM TIME
		feet	min.

TYPE OF EQUIPMENT: DEEP SEA | DEEP SEA HELIUM | OPEN CIRCUIT SCUBA | CLOSED CIRCUIT SCUBA | SHALLOW WATER MASK | OTHER

TYPE OF WORK: NONE | MILD | MODERATE | HEAVY

BREATHING MEDIUM: AIR | HELIUM % OXYGEN % | OXYGEN | OTHER (Specify)

SOURCE OF BREATHING MEDIUM: AIR BANKS | HELIUM-OXYGEN BANKS | GASOLINE COMPRESSOR | OTHER

DECOMPRESSION SCHEDULE: STANDARD | SURFACE USING: AIR | OXYGEN | HE. DECOMPR. P.P. | TABLE USED MIN.

TIME LEFT SURFACE	TIME REACHED BOTTOM	RATE OF ASCENT TO FIRST STOP	TIME REACHED SURFACE
		FT/MIN	

If surface decompression used, time from last water stop to 1st chamber stop. MIN.

DEPTH OF STOP (feet)	WATER: MINUTES AT STOP	WATER: BREATHING MEDIUM	CHAMBER: MINUTES AT STOP	CHAMBER: BREATHING MEDIUM
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140				
130				
120				
110				
100				
90				
80				
70				
60				
50				
40				
30				
20				
10				

(over)

B-28420

SIGNS AND SYMPTONS BEFORE TREATMENT				
	ONSET		ANATOMICAL LOCATION	INTENSITY (MILD, MOD., SEVERE)
	DATE	TIME		
LOCALIZED PAIN	24 APR 68	2305	Right thigh	Mild
RASH				
MUSCULAR WEAKNESS				
NUMBNESS				
DIZZINESS				
VISUAL DISTURBANCES				
PARALYSIS				
UNCONSCIOUSNESS				
DYSPNEA (CHOKES)				
NAUSEA OR VOMITING				
MUSCULAR TWITCHING				
RESTLESSNESS				
CONVULSIONS				
ACOUSTIC AURA				
PARESTHESIA				

REMARKS: *(other signs and symptoms before, during and following treatment)*

SEE ATTACHED SHEET

TREATMENT SCHEDULE					RECURRENCE TREATMENT SCHEDULE				
LEFT SURFACE		RELIEF		TIME REACHED BOTTOM	LEFT SURFACE		RELIEF		TIME REACHED BOTTOM
DATE	TIME	TIME	DEPTH		DATE	TIME	TIME	DEPTH	
NA	NA	0510 25 APR	25'	NA					
TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED	TIME ON BOTTOM		REACHED SURFACE		TREATMENT TABLE USED
		DATE	TIME				DATE	TIME	
NA MIN.		25 APR	1130	O2 breathing during decompression	MIN.				

DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)		DEPTH OF STOP		CHAMBER (Stops filled in only when treatment table 3 or 4 is used or when other treatment tables are altered)	
FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM	FEET	LBS	MINUTES AT STOP	BREATHING MEDIUM
165	73.4			165	73.4		
140	62.3			140	62.3		
120	53.4	SEE ATTACHED SHEET		120	53.4		
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20	8.9			20	8.9		
10	4.5			10	4.5		
TO SURFACE				TO SURFACE			

REMARKS: *(Include sequence of events preceding the accident and subsequent result of treatment, noting any unusual contributing factors - Use continuation sheet if needed)*

SEE ATTACHED SHEET

J. K. Summitt

J. K. SUMMITT, CDR, MC, USN

SIGNATURE OF MEDICAL DEPARTMENT REPRESENTATIVE

NAVMED 6420/1 (BACK)

Ascent from 600 to 570 feet a 1 FPM. Used constant rate of ascent thereafter of 15 MPF except for 4 hour stops at 450, 300, 150, 100 and 50 feet.

Shortly after leaving the 50 foot stop the subject reported mild pain lower right thigh. It has been intermittent over the previous 3 days of decompression. Since the symptoms were mild, it was decided to treat with periods of oxygen by mask and continue decompression.

2305	24 APR	Symptoms reported.
2305-2325	"	100% oxygen, significant relief.
0400-0420	25 APR	100% oxygen
0425-0445	"	100% oxygen
0450-0510	"	100% oxygen - complete relief
0900-0920	"	100% oxygen
0925-0945	"	100% oxygen
0950-1010	"	100% oxygen
1130	"	Surface