SECTION 9

CHAMBER CONTROL AND DIVE PROFILES

E J Towse



INTRODUCTION

Previous reports have fully described the pressure chamber facilities together with the improvements and modifications made during the extended deep diving programme (Ref 1, 2).

Between the previous dives and the two reported here certain alterations to modes of operation were incorporated and these will be described. Sample day extracts from the detailed procedure are included (Appendices 1, 2 and 3); a full detailed procedure of Dive 8 is published as a Technical Memo (3). The Dive Profiles, together with gas analysis, are presented at Pages 346 and 348, also indexed summaries of dives leading up to and including Dives 7 and 8 on Page 345. Graphical presentation of the dive parameters is shown at the end of the report.

Chamber Heating

During the course of Dive 7 the temperature control for heating the chamber vessel was brought into full automatic operation. Previous dives had relied on manual switching control using the temperature read-out and subjective comfort to determine and attempt to maintain the required temperature level. Externally the lower half of the chamber and the two ends are covered with electrically heated blankets and the whole vessel completed covered with easily removable insulation. The heating blankets are further subdivided into four staggered zones on the surface and these four zones can be individually controlled, either manually or automatically, from four sensors on the external surface of the chamber.

In practice it was found that, with the ambient air temperatures experienced during Dives 7 and 8, it was only necessary to use the heating blankets on the lower half of the vessel in order to maintain the internal temperature at the required level.

Subjects and control staff from Day 17 in Dive 7 and for all of Dive 8 found that satisfactory temperature control and comfort was more easily maintained with pre-set levels automatically controlled by the appropriate external wall sensors.

Main Lock Shower Operations

Up to and including Dive 7 shower sessions for the subjects always involved a main lock manoeuvre, that is, the main lock of the chamber had to be isolated from the main chamber and returned to the surface for draining and cleaning. Despite the expensive nature of this operation, in addition to the cleaning, the manoeuvre had two other main advantages:

1. Large experimental apparatus could be locked in or out as required by the detailed procedure; indeed, many experiments had to be planned in

conjunction with appropriate showers and therefore main lock manoeuvres once every three days in order not to clutter the living chamber with excessive equipment.

2. Each time the main lock was returned to the main chamber a complete new appropriate oxyhelium mix, amounting to approximately one-third of the total volume, was added to the whole complex. This had the advantage of reducing residual nitrogen, or any other trace gases, by up to a third of their volume percentage.

Although the main lock and shower operations continued to be a planned part of the detailed procedure, an additional hygiene requirement, to reduce possible skin infection, was that the subjects were requested to have a total body wash or shower every day using a microbicidal skin cleanser (Betadine Antiseptic). This additional shower manoeuvre would have proved expensive using the old system of returning the main lock to the surface and so a high pressure water removing drain was installed into the lock with appropriate safety shut-off valves fitted externally and internally. This system was shown to be satisfactory during Dive 8.

Chamber Humidity

Water vapour content of the gas contained in the high pressure atmosphere required careful control for these and future experiments. One problem associated with the control of water vapour was the need to accurately and meaningfully assess the quantity of vapour present in any given set of conditions. During Dive 8 a continuous study was made of comparative water vapour measurements using absolute values in terms of mass per volume as the basic standard. This work has been extensively reported elsewhere (4). In addition a simple measurement of mass of water absorbed by a standard silica-gel canister was completed. The graph of water intake of one test over a sample 12-hour period may be seen in Fig (1). The canister was housed in one of the internal atmosphere control positions (main lock) in direct replacement for the normal soda-lime canisters (of which it is an exact copy), this being the present method of water vapour removal from the chamber atmosphere.

Water taken up by the silica-gel was measured over a 20-day period by a simple weighing technique performed inside the pressure vessel.

Allowing for the mass of the container, the mass of the dried silica-gel obtained from a spring balance and at a known time later the additional mass was obtained and the difference determined the amount of water vapour taken up by the silica-gel. The results were averaged for the day and night rates and are shown in Table (1). This method was only a practical indication of the working efficiency

SAMPLE DAY WATER UPTAKE OF SILICA GEL IN CANISTER 'W' BEWEEN 0905 HOURS AND 2218 HOURS 22 FEBRUARY 1978 (22 D 12)

MAIN LOCK SCRUBBER 'C' WITH DRIVE PRESSURE OF 4.75 bar (70 psi) INITIAL MASS SILICA - 6776 grams, FINAL - 7130 GRAMS

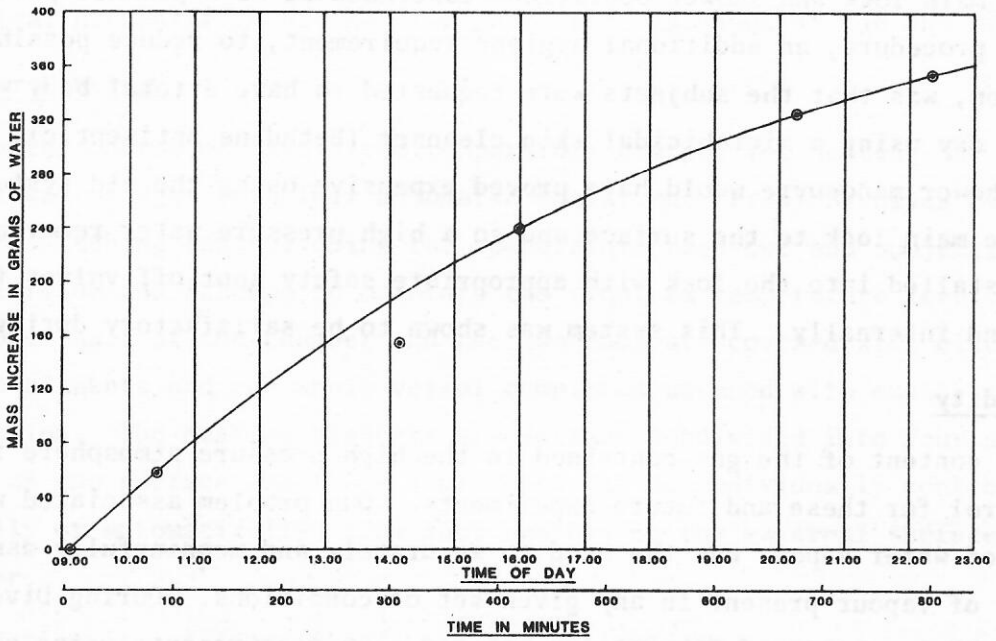


FIG 1

of the system and no attempt was made to quantify such variables as flow rate, packing and the efficiency of regeneration of the silica-gel before re-use.

DISCUSSION

1. Automatic Temperature Control

The subjective results would indicate that the precise temperature zone required by the subjects in earlier dives may not be as narrow as previously thought. The automatic temperature control brought into action half-way through Dive 7 and for all of Dive 8 seemed to suggest that temperature fluctuations were felt more that the need to hold a precise temperature. That is, although the required comfort temperature is obviously important and the zone must be defined, it is equally important, if possible, to avoid rapid temperature variations within this zone.

2. Internal Shower Operations

With the new technique the subjects were able to have an "all-over" shower every other day (more frequently, if required) without the difficulty and considerable expense of the main lock being returned to the surface on each occasion.

3. Humidity

The results of the 20-day assessment of water uptake are shown averaged in Table (1). It can be seen that the average water uptake of the canisters over both day and night periods was 35.7 g/hr although obviously from the graph in Figure (1) this is not a linear rate as the silica-gel tends to saturation over a 12-hour period of use.

From the results of the humidity measurement study(4) the method of water removal in use only just manages, when working at maximum efficiency and with at least 12-hour changes of silica-gel, to keep the water gas level within the chamber to below saturation level (26.2 mg/litre at 31 °C) of the internal atmosphere. The use of the external life-support system at depths shallower than 70 msw significantly improves water vapour removal and gives a higher level of subjective comfort during that part of the decompression that is less than 70 msw. It may also be seen from Table (1) that the maximum and minimum average water uptake of approximately 6.8 kg of silica-gel under working conditions may be double or half the expected average amount and this variation is thought to be due to regeneration efficiency and, to a lesser extent, packing and flow variations.

TABLE 1

WATER VAPOUR ABSORBED BY INTERNAL SILICA GEL CANISTER
MAXIMUM, MINIMUM RANGE AND AVERAGED AMOUNTS OVER A 20-DAY PERIOD
DEPTH RANGE: 180 msw ON COMPRESSION THROUGH 420 msw TO 55 msw ON DECOMPRESSION
4C4 TO 24D14

	DAY TIME						
	TIME OF DAY		AVERAGE OF 20 SAMPLES				
	Can In	Can Out	Time in Use (mins)	Silica Gel In (g)	Silica Gel Out (g)	Water Uptake (g)	Uptake Rate (g/h)
Minimum	0715	1913	685	6436	6889	198	15.6
Average	0834	2201	803	6759	7237	478	35.7
Maximum	0925	2325	960	6974	7570	964	72.6

	NIGHT TIME						
	TIME OF DAY		AVERAGE OF 20 SAMPLES				
	Can In	Can Out	Time in Use (mins)	Silica Gel In (g)	Silica Gel Out (g)	Water Uptake (g)	Uptake Rate (g/h)
Minimum	1913	0715	531	6435	6931	212	18.0
Average	2201	0834	637	6807	6184	377	35.7
Maximum	2325	0925	845	7017	7541	709	63.2

CONCLUSIONS

1. Subjective comfort in the chamber internal ambient temperature zone is affected by rate of change as well as set values.

2. Internal shower operations are proven to be totally acceptable to both subject and control staff.

3. Internal atmosphere water vapour requires a more efficient method of control over the entire working pressure range of the chamber. Additional internal scrubbing techniques would improve the situation but are not practical due to space considerations. Future measurements of water vapour (gas) in the chamber atmosphere may be more usefully quantified in terms of partial pressure when additional information is obtained using practical absolute humidity readings in oxy-helium mixtures at increasing pressures.

ACKNOWLEDGEMENTS

The expertise and dedication of the two control teams throughout every hour of the day and night during these saturation exposures is gratefully acknowledged.

Two teams of four completed alternative 24 hour watches and the teams were:

ALEC FERRIER	JOHN TOWSE
IAN LOWE	PETER PRENDERVILLE
DICKY DOSSETT (7)	MARK ENGLISH
PAUL WHITE (8)	DAVE ELNER
ADRIAN BARTHOLOMEW	

Support to the two teams and the subjects within the chamber, also various investigators, was cheerfully given by JOHN MAIDMENT on a day to day basis.

Finally, our thanks to the four subjects, PETER ATHERTON, PHIL DANIELS (Dive 7) and DAVID HARRIS, BOB McKENZIE (Dive 8) for their co-operation and tolerance during the period of these dives. (Dive 7, at 27 Days, the longest exposure ever performed in the chamber, and Dive 8 at 26 Days overall).

APPENDIX 1

DATE 6 FEBRUARY 1978 DAY MONDAY DAY CODE 6C6

TIME	DEPTH	EVENT			✓
	300				
0700	300	Reveille	Basal Metabolic Rate	(MG)	
0730	300	Wash and clear			
0800	300	BREAKFAST	Diet Control	(RC)	
0830	300		Thermic Effects of Food	(MG)	
0920			Prepare for tests		
0930	300		Psychomotor & Tracking	(BA)	
1030	300		Samples out	(RC)	
1045	300	COFFEE BREAK	Diet Control	(RC)	
1100	300		Respiratory expt	(MW) (JF)	
1200	300	Leave 300 msw			
1205	310	Arrive 310 msw			
1300	310	LUNCH	Diet Control	(RC)	
1400	310	Leave 310 msw			
1405	320	Arrive 320 msw			
1415	320		Surf Plate Cal	(PH)	
1600	320	Leave 320 msw			
1605	330	Arrive 330 msw			
1615	330	TEA BREAK	Diet Control	(RC)	
1630	330		MOR De-brief	(ZT)	
1700	330	Clean Chamber	Chamber hygiene		
1745	330	Washing operation	Subjects hygiene		
1800	330	Leave 330 msw			
1805	340	Arrive 340 msw			
1900	340	DINNER	Diet Control	(RC)	
2000	340	Leave 340 msw			
2005	350	Arrive 350 msw			
2030	350		Vestibular Tests	(ZT)	
2200	350	Leave 350 msw			
2205	360	Arrive 360 msw			
2300	360		Check 24 hr heart rate	(MG)	
2330	360	Lights down			

APPENDIX 2

DATE 9 FEBRUARY 1978 DAY THURSDAY DAY CODE 9B2

TIME	DEPTH	EVENT			✓
	420				
0700	420	Reveille; Wash and clear			
0730	420		Blood Sample	(GN)	
0800	420	BREAKFAST	Diet Control	(RC)	
0920	420		Prepare for tests		
0930	420		Psychomotor & Tracking	(BA)	
1030	420		Samples out	(RC)	
1045	420	COFFEE BREAK	Diet Control	(RC)	
1100	420		Respiratory expts	(MW) (JF)	
1300	420	LUNCH	Diet Control	(RC)	
1415	420		Respiratory expts	(MW) (JF)	
1615	420	TEA BREAK	Diet Control	(RC)	
1630	420		Sensitivities	(PH)	
1800	420	Shower Operation	Subjects hygiene		
1900	420	DINNER	Diet Control	(RC)	
2000			MOR De-brief	(ZT)	
2030	420		Helium Speech	(PA)	
2130	420		End of speech recordings		
2300	420		Check 24 hr heart rate	(MG)	
2330	420	Lights down			

APPENDIX 3

DATE 18 FEBRUARY 1978 DAY SATURDAY DAY CODE 18D8

TIME	DEPTH	EVENT			✓
	224				
0700	224	Reveille; Wash and clear			
0800	224	Leave 224 m at 4 m per hour			
	224	BREAKFAST	Diet Control	(RC)	
0900	220				
0945	217		Ultrasonics	(JW)	
1000	216	End Decompression Bleed			
1015	216		MOR De-brief	(ZT)	
1030	216		Samples out	(RC)	
1045	216	COFFEE BREAK	Diet Control	(RC)	
1100	216		Muscle fatigue	(RM)	
1300	216	LUNCH	Diet Control	(RC)	
1330	216	Leave 216 m at 4 m per hour			
1415	213		Vestibular Tests	(ZT)	
1430	212				
1515	209		MVV	(JF)	
1530	208	End Decompression Bleed			
1615	208	TEA BREAK	Diet Control	(RC)	
1630	208		Sensitivities	(PH)	
1759	208	Shower operation	Subjects hygiene		
1800	208	Leave 208 m at 4 m per hour			
1900	204	DINNER	Diet Control	(RC)	
2000	200		(Emergency gas to 2.5/97.5)		
2045	197		Ultrasonics	(JW)	
2100	196	End Decompression Bleed			
230	196	Lights down			

INDEXED SUMMARY OF DIVES LEADING UP TO AND INCLUDING DIVES 7 AND 8.

Date	Dive No	Subject	Compression Time Days: Hrs:Mins	Maximum Depth & Gas	Time at Maximum Depth Days: Hrs:Mins	Decompression Time Days: Hrs:Mins	Total Dive Time Days: Hrs:Mins
3 Sept 75 to 12 Sept 75	1	D HARRIS M TALBOT	Direct 0.5	3 msw Air	8 : 23 :49.5	Direct 0.5	8 : 23 :50.5
12 Nov 75 to 21 Nov 75	2	P ATHERTON R McKENZIE	Flush/Direct 7	3 msw O_2/He	8 : 22 :42	Direct 1	8 : 22 :50
21 Jan 76 to 30 Jan 76	3	D HARRIS M TALBOT	Flush/Direct 33	3 msw O_2/He	8 : 22 :23	Direct 1	8 : 22 :57
12 May 76 to 28 May 76	4	P ATHERTON R McKENZIE	Staged/Direct 1 : 6 :32	200 msw O_2/He	6 : 22 :48	Staged/Drops 7 : 18 :30	15 : 23 :50
22 Sept 76 to 12 Oct 76	5	D HARRIS M TALBOT	Staged/Direct 2 : 6 :25	300 msw O_2/He	7 : 13 :25	Staged/Drops 10 : 6 :25	20 : 2 :15
11 Feb 77 to 1 Mar 77	6	P ATHERTON R McKENZIE	Dir/Staged/Dir 1 : 0 :27	300 msw O_2/He	6 : 19 :15	Staged/Drops 10 : 6 : 6	18 : 1 :48
21 Sept 77 to 17 Oct 77	7	P ATHERTON P DANIELS	Staged 8 : 9 :54	420 msw O_2/He	2 : 0 :55	Staged/Drops 15 : 15 :28	26 : 2 :17
1 Feb 78 to 26 Feb 78	8	D HARRIS R McKENZIE	Staged 6 : 11 : 3	420 msw O_2/He	3 : 9 :55	Staged/Bleeds 15 : 12 :55	25 : 9 :15

DETAILED SUMMARY OF PRESSURE PROFILE AND GAS COMPOSITION (DIVE 7)

Dates: 21 September 1977 to 17 October 1977

Subjects: Peter Atherton (RED); Philip Daniels (BLUE)

Oxy-helium Dive, Oxygen Partial Pressure 0.4 bar.
(See Page 8 for Total Analysis.)

COMPRESSION

Day 1:	Start: 1111. Flush lock and transfer under pressure	0 to 10 m in 36 min
	All dynamic compression rates at 2 m/min to maximum pressure.	
	Five pressure increments of 10 m at: 1400, 1600, 1800, 2000, 2200	10 to 60 m
Day 2 to Day 4:		
	Six pressure increments of 10 m at: 1100, 1300, 1500, 1700, 1900, 2100	60 to 240 m
Day 5:	One pressure increment of 10 m at: 1100	240 to 250 m
Day 6:	Hold at 250 m (Medical problem)	
Day 7:	Hold at 250 m (Medical problem)	
Day 8:	Hold at 250 m (Medical problem)	
Day 9:	Six pressure increments of 10 m at: 1100, 1300, 1500, 1700, 1900, 2100	250 to 420 m
Day 10:	Hold at 420 m	

DECOMPRESSION

	All dynamic decompression rates 1 m/min (unless otherwise stated).	
Day 11:	Leave 420 m at 2200 (1 drop of 5 m)	420 to 415 m
Day 12 to Day 14:		
	Seven drops of 5 m decrements/day at: 1000, 1200, 1400, 1600, 1800, 2000, 2200 (1 hr 55 min holds)	415 to 310 m
Day 15:	Two drops of 5 m at: 1000 and 1200	310 to 300 m
Day 16:	One drop of 5 m at: 2100 (3 hr 55 min hold)	300 to 295 m
Day 17:	Six drops of 5 m at: 0100, 0500, 0900, 1300, 1700, 2100 (3 hr 55 min holds)	295 to 265 m

Day 18:	Seven drops of 5 m at:	
	0100, 0500, 0900, 1300 (3 hr 55 min holds)	265 to 245 m
	1600, 1900, 2200 (2 hr 55 min holds)	245 to 230 m
Day 19:	Eight drops of 5 m at:	
	0100, 0400, 0700, 1000, 1300, 1600, 1900, 2200	
	(2 hr 55 min holds)	230 to 190 m
Day 20:	Seven drops of 5 m at:	
	0100, 0400, 0700, 1000 (2 hr 55 min holds)	190 to 170 m
	1400, 1800, 2200 (3 hr 55 min holds)	170 to 155 m
Day 21:	Six drops of 5 m at:	
	0200, 0600, 1000, 1400, 1800, 2200	
	(3 hr 55 min holds)	155 to 125 m
Day 22:	Six drops of 5 m at:	
	0200, 0600, 1000, 1400 (3 hr 55 min holds)	125 to 105 m
	1900, 2400 (4 hr 55 min holds)	105 to 95 m
Day 23:	Four drops of 5 m at:	
	0500, 1000, 1500, 2000 (4 hr 55 min holds)	95 to 75 m
Day 24:	Five drops of 5 m at:	
	0100, 0600, 1100, 1600, 2100 (4 hr 55 min holds)	75 to 50 m
Day 25:	Four drops of 5 m at:	
	0200, 0800, 1400, 2000 (5 hr 55 min holds)	50 to 30 m
Day 26:	Four bleeds of 5 m in 25 min at:	
	0200, 0900, 1600, 2300 (6 hr 35 min holds)	30 to 10 m
Day 27:	One bleed of 5 m in 25 min at 0600	10 to 5 m
	Both subjects on 100% oxygen (BIBS) from 1255	
	One bleed of 5 m at 1300 to 1332	
	Two holds at 1.2 m and 0.4 m	5 to 0 m

GAS ATMOSPHERE STATISTICS - DIVE 7, 420 msw, 26.1 DAYS

Oxygen (599 samples):	mean = 0.4021 bar
	SD = 0.0060 bar
Carbon dioxide (609 samples):	mean = 0.0025 bar
	SD = 0.0010 bar
Nitrogen (637 samples):	mean = 0.0143 bar
	SD = 0.0069 bar

Remainder: Helium and Water Vapour.

DETAILED SUMMARY OF PRESSURE PROFILE AND GAS COMPOSITION (DIVE 8)

Dates: 1 February 1978 to 26 February 1978

Subjects: David Harris (RED); Bob McKenzie (BLUE)

Oxy-helium Dive, Oxygen Partial Pressure 0.4 bar.
(See Page 10 for Total Analysis.)

COMPRESSION

Day 1:

Start: 1101 Flush lock and transfer under pressure	0 to 10 m in 53 min
All dynamic compression rates at 2m/min to maximum pressure	
Five pressure increments of 10 m at: 1400, 1600, 1800, 2000, 2200	10 to 60 m

Day 2 to Day 7:

Six pressure increments of 10 m at: 1200, 1400, 1600, 1800, 2000, 2200	60 to 420 m

Day 8 to Day 10:

Three days held at 420 m	420 m

DECOMPRESSION

All dynamic decompression rates at 4 m per hour (unless otherwise stated).

Day 11 to Day 23

Two "bleeds" of 8 m decrements and one of 12 m decrement per day at: 0800 to 1000, 1330 to 1530 and 1800 to 2100	420 to 56 m

Day 24

Two "bleeds" of 8 m decrements and one of 6 m decrement at: 0800 to 1000, 1330 to 1530 and 1800 to 2030	56 to 30 m

Day 25

Three "bleeds" of 5 m decrements at: 0800 to 0915, 1500 to 1615, 2200 to 2315 (5 hour 45 min holds).	30 to 15 m

Day 26

Three "bleeds" of 5 m decrements at: 0500 to 0615, 1200 to 1315, 1900 to 2015 (5 hour 45 min holds).	15 to 0 m

GAS ATMOSPHERE STATISTICS - DIVE 8, 420 msw, 25.4 DAYS

Oxygen (656 samples):	mean = 0.4040 bar SD = 0.0056 bar
Carbon Dioxide (611 samples):	mean = 0.0031 bar SD = 0.0009 bar
Nitrogen (593 samples):	mean = 0.0109 bar SD = 0.0055 bar
Remainder:	Helium and Water Vapour

REFERENCES

1. Experimental Observations on men at pressures between 4 Bars (100 ft) and 47 Bars (1500 ft).
   RNPL Report No 1-71. H V Hempleman et al.

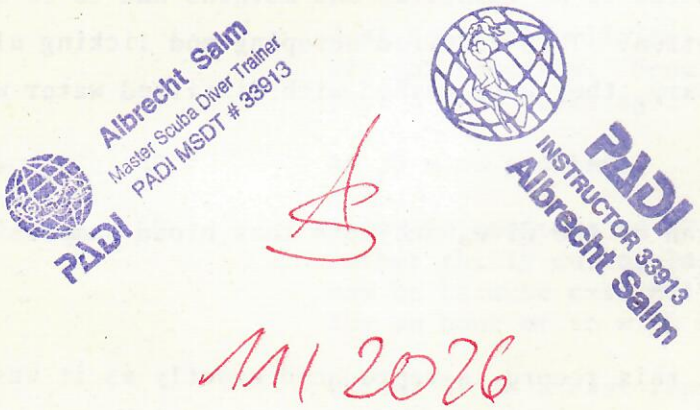
2. Observations on men at pressures of up to 300 msw (31 Bar).
   Report No AMTE(E) R78-401. H V Hempleman et al. April 1978.

3. Projected 420 msw Oxy-Helium Dive 8.
   Report No AMTE(E) TM 78-407. E J Towse. January 1978.

4. Measurement of Absolute Humidity during a 420 m Simulated Saturation Dive.
   Report No AMTE(E) TM 78-406. J T Florio and E J Towse. May 1978.

SECTION 10

PERSONAL OBSERVATIONS OF ONE DIVER ON DIVE 7 AND ONE DIVER ON DIVE 8



A PERSONAL RECORD OF A SIMULATED SATURATION DIVE TO 420 msw (21.9.77 to 17.10.77)

by

P J Atherton

INTRODUCTION

This diary is the second by the author[1], and is a record of events and personal feelings during Dive No 7 in the RNPL Saturation Dive Programme, and was of 27 days' duration.

It was the intention of this dive to completely eliminate compression problems experienced during earlier dives in this series, and to get the two subjects to 420 m free from effects and immediately capable of carrying out the scientific programme.

To achieve this end it was intended to take 7 days to complete the compression phase and 3 days at maximum pressure. In the event the compression was extended even further due to a 2-day hold (at 250 m) while the outcome of a reported sore throat by the author was awaited. The bottom time was accordingly reduced to 2 days.

As part of the metabolic studies a strict diet control was introduced for this dive.

It was necessary for the subjects to consume exactly the same food constituents each 24-hour period. In order to achieve the required accuracy the daily menu was scientifically prepared to be identical and methods had to be employed to ensure complete consumption. This required scraping and licking all plates and utensils and, if necessary, they were washed with distilled water which was then drunk.

During the total duration of the dive, subjects took blood samples from each other every other morning (25 ml).

As in previous diaries, this record is reproduced exactly as it was recorded during the dive, sometimes under considerable stress, and no attempt is made to tidy it up for fear of losing important indications of mood, etc. It is reproduced in order to preserve what may be considered trivial and insignificant events that were not recorded as part of the scientific data collection, but which may be of interest when read in conjunction with other similar records.

DIARY

DAY	TIME	DEPTH (Metres)	
-2		Surface	Started diet control. Few problems immediately obvious - does not appear as good as led to believe by the one-day trial. Not too keen on these restrictions 2 days before the start of the dive.
-1			Spent a quiet evening preparing for tomorrow, packing gear etc, bathed then relaxed watching TV. Good night's sleep.
1	1400	10	Just finished lunch. No immediate problems on controlled diet.
			Coffee very hot, hope it keeps that way.
			All flushing operations and the lock compression to 10 m went well. In fact, arrived at 10 m ahead of schedule.
			This morning was the usual rush, had a lot to do by 11 o'clock. Did not get time to prepare head EEG electrode sites.
	1405	20	At 20 m slightly warm (28.5°).
	1800	30	Pretty inactive afternoon, spent relaxing in easy chairs.
			Chest electrodes already beginning to irritate, only been on since lunchtime.
			Just been told clinical ECG will be hard-wired, try out tomorrow. Seem to remember suggesting that 3 or 4 weeks ago.
	1805	35	At 35 m no problems.
	2200	50	About to compress to 60 m. Have been feeling rather chilly during last hour (temperature 28.5° may be because external scrubber has been running for an hour or so with humidity down around 35%.
			Colour TV is a vast improvement.
	2205	60	Temperature has risen to 30° due to pressure.
			Scrubber is off, probably a comfortable temperatu for this depth.
			Slightly depressed at the moment as the discomfor of a helium atmosphere make themselves felt and o tries to imagine what 26 days is really like.

DAY	TIME	DEPTH (Metres)	
1	2355	60	Prepare apparatus for morning experiment.
2	1045	60	Waiting for tea.
			This morning's programme has been very hectic. Phil Hayes' experiment(2) went wrong from the start - transducers not working - no ventilation calibration tube - and syringe bung had shrunk due to pressure.
	1105	70	Due to above, approximately half an hour late finishing experiment. We were then not able to catch up on time-table. In fact by 1030 we were ¾ hour adrift. Will be interested to see how it works out on Friday.
			The time problem was not helped by the necessity to prepare from scratch EEG electrode sites, including hair removal and shaving. Suggest this be definitely included in the work-up programme as it is so much easier.
			Did not seem to have time for essential things, ear hygiene etc (takes ¼ hour if done properly).
			Had a really dreadful night. Read till about 1.15, felt tired, thought I would sleep but could not. Hot, sweating and noisy. No doubt will acclimatise as time goes on.
	1150	70	Comfortable. Temperature 30.0°, humidity 52%.
	1410	80	Lunch good - new type of soup, quite nice. Have now got salad cream with salad.
			External scrubber now inoperative(3).
			Just fitted in turn a silica gel canister. Humidity 67%.
			Left wrist joint beginning to tighten, very slightly. Back beginning to ache, not serious at the moment. Decided to do 5 minutes leg and back exercises. Feel better.
	2230	120	Feeling a bit chilly (30.2°), humidity 64%. Am wondering what sleeping temperature should be at this depth.
	2300	120	Requested 30.5° overnight temperature.

DAY	TIME	DEPTH (Metres)	
3	1200	130	Much better night's sleep, temperature just right. Have been busy all the morning. Blood samples this morning - not too good, Phil had two attempts at my arm and it was quite painful. He obviously had not mastered the art before coming in. Is 3 training sessions sufficient? This morning I kept a detailed time-table to demonstrate the timing of the schedule. This morning we checked out the clinical ECG system, worked OK.
	1355	140	Minor catastrophe at lunchtime - the soup had boiled over in the lock. ¾ hour delay while they produced two more soups.
	2350	170	Getting ready to turn in - Zoltan(4) has not had a very successful day. Have been suffering from indigestion this evening - a little worse than other evenings. Hope it is not for the duration of the dive. This could be another reason for earlier trials of proposed controlled diets. Felt cold earlier when temperature was 30.6°, temperature now 30.75°, feels comfortable. Request that temperature for overnight.
4	1100	180	Had a reasonable night, woke several times sweating, but not too hot. Phil(5) said he was slightly cold. This morning was my first run at BMR(2) study. Four insertion of the rectal probe very uncomfortable (brought tears to my eyes).
	1345	200	An interesting effect at lunch today. Cling film had been sealed over the salad, hence a very flat and 2-dimensional salad. They have started putting coffee in with the main meal, presumably to economise on lock manoeuvres. This means that it is cold when it is time to drink it.
	1945	230	Just finished dinner - eating meals is now becoming very routine (6 days on controlled diet). Asked Dr Carlyle(6) about indigestion. He says it may be caused by coffee. Will try milk on its own as a late drink from tomorrow.

DAY	TIME	DEPTH (Metres)	
4	1945	230	Coffee still has large, sticky deposits in the bottom of the cup. Very unpleasant to have to scrape and lick. Have asked for method of making coffee to be changed. With every drop in depth the food and coffee is getting colder quicker. It is now possible to take dishes straight from the lock without the oven cloth. All communications equipment all performing well at this depth. Tried out blood pressure machine this evening. Not too convincing. Something else that should have been tried during the test and rig period.
5	1000	240	Good night's sleep, temperature now 31.4, comfortable. Humidity 68%. Visit by Dr Leitch(7). Mentioned waking with slight sore throat (left side). Phil mentioned slight stinging in the ears which went after ear hygiene. Surprised to hear they are considering holding the compression while they treat my throat. Apparently they are concerned in case it should develop into something more serious.
	1130	250	Decision to hold for 24 hours while my throat situation is considered. Given Bradosol lozenges to take every 2 hours and Amplicillin capsules to take every 6 hours. Somewhat surprised but appreciate obvious concern. Obviously visual inspection of throat through the port is difficult but it was agreed that it looked slightly red. Getting slightly dizzy when I move, more obvious on some occasions than others, does not seem to follow any pattern.
	1530	250	Have spent the last half-hour trying to improve the performance of lock scrubber. For the moment we have to sacrifice silica gel canister in favour of CO_2 canister. Let's hope humidity problem does not get too bad.
	1800	250	Barbara(8) visited. I was feeling a little low, probably because of today's happenings. Hope it did not show.
	2330	250	Asked for temperature 31.0° overnight.

DAY	TIME	DEPTH (Metres)	
6	0940	250	Woke 2 or 3 times during the night, slightly chilly Visit by Doctors Pearson, Leitch and Shields[7]; al looked at my throat. Told them it felt better today, just a little dry on waking. What an anticlimax if we do not go on.
	1200	250	Still at 250 m. After deliberation it was decided continue the hold for a further 24 hours. Disappointed, but let's hope for tomorrow. Throat is feeling better but John Florio did not risk respiratory measurements on myself. Last night's steak was not up to scratch - very tough; Dr Carlyle could not believe it as he had seen it prepared but it was true, both of us agreed At this depth the raspberry mousse is no longer a mousse, but a milky raspberry drink. Dr Carlyle agreed to try to chill it before compression. Beginning to lose appetite, wonder whether it is the effect of the dive or just the boring repetitic of the meals, even fillet steak cooked to perfectic is no longer attractive, and that's after only 7 days. We have decided to get rid of the folding chairs on the next main lock manoeuvre as we no longer use them but tend to watch TV from the mattresses.
	1230	250	Sitting still feels a bit chilly (30.7°), humidity 70%.
	1300	250	Temperature increased to 31.1°, better but still very sticky.
	2330	250	Turning in a little earlier tonight as Phil thought overtiredness was the reason he had a job to get to sleep last night. Dr Pearson had a look at my throat at about 4.30. He said it looked fairly promising for a 'go ahead' tomorrow. Have decided, if the decision is to continue the hold tomorrow, I shall ask for decompression to start. Dr Torok inspected my throat during his de-brief and said in his opinion it was a lot better, so let's hope it's OK tomorrow Dinner tonight was tough steak again and the attempt to make the raspberry mousse travel by freezing was a disaster, it was still deep frozen on arrival. It has been suggested if we carry on compression tomorrow the bottom time will be cut by 1 day.

DAY	TIME	DEPTH (Metres)	
6	2330	250	Phil made a phone call to Portland tonight[9], slightly more successful than the last attempt. ECG transmitters are still giving trouble, so we will be without ECG monitoring tonight (possible battery faults). We are quite pleased about this as chests are getting quite sore and irritating on the electrode sites. Alternative site must be found for these electrodes. Sleeping temperature requested 30.8 to 31°. Present temperature 30.7, feels comfortable. Humidity 70%.
7	1115	260	Dive is back on the road again. My throat was inspected this morning and given the OK. Overnight temperature OK, if anything slightly cold, but not sufficient to prevent sleep. During this morning's blood sample session, Phil was a little better at it but still rather slow at putting in the needle which makes it more painful than it need be. Morning programme rather cramped, even cutting out clinical ECG session we were still a quarter-of-an-hour late for psychomotor session[10].
	2345	310	My deepest so far. A few interesting points - effects that I had previously attributed to pressure seem to be rate-dependent. On previous dives always had problem with left wrist, stiff and locking. On this dive quite free from any discomfort at the moment. Discomfort was even experienced during the 200 m dive. Also painful cracking joints are not present at all. These were present right through the bottom time of both the 200 and 300 m dive. Arrived at this depth with no problems or discomfort at all. Vestibular measurements this evening show slight imbalance with small shake when looking to extreme left. All other tests such as finger to nose quite normal. Tonight's mood seems quite jovial, surprising as we are at that depressing state of the dive, ie one week gone but with 3 weeks to go. Decision has been made to cut the bottom time at 420 m to 2 days. Request overnight temperature 31.5.

DAY	TIME	DEPTH (metres)	
8	1700	360	Reasonable night last night, except woken twice by slipping scrubbers. Temperature reasonable, slightly cold. Today's compressions have all gone well. No problems to either. Major discomforts still not present, ie locking joints or painfully cracking joints. Atmosphere really feels thick now, to breathe in and out. Wonder what heavy exercise will be like at the bottom. Noted that the 1 litre calibration syringe requires noticeably more effort to pump. It is suggested if the steak is as bad tonight then the meat might be used for a stew or something similar, this will make a change. No sugar in my tea this morning. This highlights the disadvantage of controlled diet. This sugar will have to be made up during the day. Barbara visited at tea-time for 10 minutes.
	2345	370	Shower this evening. What a therapy that is. Scalp had been itching terribly during the day. Head is again the most uncomfortable part of my body. Complained of itchy scrotum, calomine lotion locked in, seemed to work straight away. Left wrist now beginning to tighten slightly. After the main lock manoeuvre we are now really topped up with equipment. New drawers and trays are a vast improvement, especially now that we have so much auxiliary bits and pieces. Request 31.5 overnight temperature.
9	1900	410	Busiest day so far, even EEG worked. Cambridge psychology tests as boring as ever. For this afternoon's work programme it took $1\frac{1}{4}$ hours just to rig the ergometer, hence only time to do a 50 W run on Phil and MVV on myself. During the day we were asked what our subjective feelings would be if asked to extend the depth of the dive at this stage. After some discussion both agreed that all things considered we would refuse. This point highlighted how difficult it is to hold an extended serious discussion under these oxy-helium conditions.

DAY	TIME	DEPTH (Metres)	
9	2359	420	At last, arrived on the bottom. Very much an anticlimax. First reflections on 420 m - feel fine, except slightly tired. Still free from aches or painful cracking joints. Both getting really fed up with the food. Neither of us fancy carrying on with the controlled diet. There appears to be some misunderstanding between us and the outside staff as to what was agreed on about the controlled diet. I was under the impression that we were only supposed to do 3 days either side of the bottom time, and including the bottom time, but we are supposed to have agreed to attempt the whole dive. Ballbearing tests down to 20. Request temperature 31.5 overnight.
10	2000	420	First day on the bottom. It is becoming difficult to find a comfortable temperature, especially this evening which is around 31.5°. This still feels chilly. It seems to depend very much on body activity. Hope to do a short helium speech recording while at this depth. Did not sleep too well last night, felt cold and on several occasions had shivering spells. Phil reported being too hot. This is the first time we had differed on comfort temperature. Had 2 or 3 muscle spasms or twitches during the night. Now very aware of tremor, especially when doing something requiring effort, for example when getting up from a crouching position, legs shake violently. Cannot eat any more of the bread. Either it's rotten bread or something disastrous happens to it while travelling through the lock manoeuvre. It has been agreed to toast the bread in future. Turned in early, 2330. Request 31.5 overnight temperature.
11	0900	420	Best night so far, only woke twice during the night, and both of those times were to urinate.

DAY	TIME	DEPTH (Metres)	
11	0900	420	While reading in bed last night, had several rather large muscle jerks. Tried telephone link again last night, still no better. This is a very difficult problem to solve as it can only be tried during a deep sat dive and no time is available during the dive for experimentation. Had another painful blood session today. Have now got 2 of my 4 useful veins severely bruised - make point even louder about practice before the dive. Present situation severely aggravated by considerable tremor. This tremor is not immediately obvious when measuring postural tremor, but very noticeable when doing a task requiring varying degrees of muscle tension, for example taking blood. The steady pull required to pull out the plunger slowly caused tremor sufficient for the needle to be pulled out completely and back into the vein. This not only made the operation messy, but also painful, causing a haematoma. Do tremors increase linearly with depth? If so, what is the practical limit for taking experimental blood samples every other day?
	1800	420	Work study experiment - I could not finish 150 W workload - was into about minute 4 or 5, had just completed the rebreathe manoeuvre when overcome by violent shaking of body like a coarse high amplitude tremor. Phil says my pupils were dilating at the same frequency. Soon recovered. Clinical ECG was normal immediately afterwards. Phil had no problems and completed the 150 W workload. After discussion it was agreed to repeat the study next Wednesday when we will be at 300 m. Dr Torok says there is a possibility that I held my breath at one stage when Phil handed a rebreathe bag without the mass spec sample probe and there was a slight delay while this was inserted.
	2210	415	Have just left the bottom and completed first decompression.
12	1630	395	Nice to experience chamber Sunday routine. Funny how a thing like being called one hour later makes a difference. We both feel a break in the routine at this stage has been quite important. Very relaxing day. Note on Rolex Seadweller watches - we had been assured by the manufacturers that it was in order to release the winder valve in order to change the date while at pressure - what they neglected to tell us was that at this pressure it would be impossible

DAY	TIME	DEPTH (Metres)	
12	1630	395	to release the winder seal - had to lock out watches for date to be reset.
	2200	380	Have completed shower - that extra day had made us both feel really grotty, especially the hair which after a couple of days gets extremely greasy and wet. When lock was returned it was discovered the drain plug was leaking. On investigation the 'O' ring was found to be missing. NO SPARE. Temporary repair carried out with rubber gasket. ECG transmitters are still a problem, fault appears to be that PP3 batteries do not like being compressed, 80% failure rate on being locked in.
13	0900	380	Now on our way back. What a long haul - 2 weeks. Most welcome shower last night, 4 days is getting to the limit. After discussion, it has been decided to give us a break from the controlled diet. We will carry on until Wednesday and then break for one week. It was suggested that when we go back on the diet we stay on the controlled diet after coming out of the chamber. Neither of us was keen on this idea. We both felt that after 27 days one needs to relax completely when coming out of the chamber and we certainly did not feel like coming into the Laboratory for every bit of food and drink. It was then suggested that if we stayed on the diet just for the day that we came out of the chamber, we would then be prepared to do a 3-day post-dive period a week or so after the dive. All parties agreed on this procedure. Will be interested to see if scientific data shows marked tremor as we are now very aware of tremor problems, particularly with blood samples. I knocked over a blood container this morning, completely due to tremor. Also affecting tasks such as plugging and unplugging electrical connectors. Will be interested to see if at scientific wash-up the report is as last time, ie "no significant tremor". If this is the case then the method of measuring must be suspect.
	1245	370	There are still a few vulnerable points giving nasty head knocks in the chamber. Could anything possibly be done about the nuts and studs on the overhead chamber port, ie perhaps padding. Also, the lever for the fire hose.

DAY	TIME	DEPTH (Metres)	
13	2359	345	Turning in for the night. John[8] is trying out th auto-temperature control. Hope they get it right, would certainly rather feel too hot than too cold. Phil has complained of sore throat. He was suppose to have had a swab taken but it did not come about. He has also been a bit shivery and has been sneezin a lot today. Barbara visited tonight. I think we were both a bi miserable. It should be better after tomorrow as we will then be over half-way.
14	1035	340	This morning tried out DTU-type headset. Gives slight improvement in quality from microphone, but do not think it is suitable as microphone is not noise-cancelling. On the whole, communications have been very good so far. Have already ordered toothpaste for Thursday. Really looking forward to cleaning teeth for the first time for 15 days[12].
	1900	320	Fairly quiet day today. Saving ourselves for tomorrow's exercise study. There is a possibility that Phil will be required to do 200 W. This afternoon my knees have begun to get "stiff". Feel as if they are complaining of lack of use. Barbara came in tonight. We were both in a better mood. Ordered a chocolate cake for Thursday.
	2330	310	John Williams turned up tonight to do a run on ultrasonics. Apparently everybody else had modifi-cations to the programme but we had not been given a copy. Discomfort in legs has spread to thighs. Scrubber B has started squeaking loudly, hope it does not keep me awake.
15	2345	300	Very busy day, hence no time to write diary until now. Blood session this morning, very much improved Still a little affected by tremor. I feel I was more affected by tremor on the 300 m dive than I am now having returned to 300 m from 420 m. I wonder if that means anything? Repeated the exercise study today. Once again I had to stop, this time due to an overpowering feeling of not being able to get enough "air", no matter how hard I tried. Remembered thinking 'Is this what it's like to drown'.

DAY	TIME	DEPTH (Metres)	
15	2345	300	During the discussion afterwards, I was told I was moving about 98 litres which they tell me is my maximum voluntary ventilation, so according to Dr Torok I was quite right to stop. Phil tried 200 W but could not make it. Leg ache and lack of breath. Off diet control tomorrow. Have ordered just cornflakes, toast and marmalade for breakfast. What a treat. We are beginning to realise from odd snippets of information that we have caused a rumpus over the diet control and we are being severely criticised. I only hope it comes up at the wash-up meeting when our case can be put.
16	0730	300	Cleaned teeth - LUXURY.
	2000	295	When Barbara visited tonight she asked if I had enjoyed the cake. WHAT CAKE. She was quite upset to think she had spent considerable time making it and bringing it in and they hadn't bothered to tell me that it was there. Feeling very tired today - must try to get a little more sleep. Leg aches have disappeared today, maybe yesterday's exercise did them good. Tremor very much reduced. Bread with today's meals was superb, ie controlled diet bread was unsuitable.
17	1030	280	Best night's sleep of the dive, only woke once. Blood sample session went very smoothly. Very little effect from tremor. Had painful experience with cornflakes this morning. Tongue and cheeks were being sucked into vacuum pockets as they snapped, crackled and popped. Sugar rationing is in force.
	2300	265	Another pretty quiet day - the big YAWN period is setting in. Have still been tired today.

DAY	TIME	DEPTH (Metres)	
18	0930	250	Good night's sleep. John T has been experimenting again with auto-temperature control. Seems to be quite successful. Problems with scrotum due to humidity. Calomine treatment does not seem to be doing much good. I wonder whether calomine works as it should in a humid helium atmosphere as it seems to stay wet. For some reason this morning's usual tests have been cancelled - must be Saturday. That means we get a morning off from putting on electrodes that nobody uses.
	2359	230	Not a very active day but still felt very tired. In fact, as soon as I became inactive, was tending to drop off to sleep. Scrotum very sore, does not seem to be responding to calomine treatment. Also area between toes is rotting quite rapidly. That also does not seem to be responding to either Canesten or calomine. A cut on the forefinger caused by a slipping screw-driver is taking a long time to heal. Looking forward to late call tomorrow, 0830.
19	1200	210	Virtual day off today except for blood samples which went without a hitch. Automatic temperature control seems to be working well. Very comfortable. I have now exceeded the longest time I have previously spent in the chamber.
	2330	190	End of a very lazy day. Very nice not to have to do anything but it makes the day seem long. Called in medical officer this evening as scrotum is a lot worse and beginning to weep. Very painful to wash and dry. Dr Shields came in and said there was nothing here but would get something from Haslar tomorrow (Monday). Sent in Tineafax for feet. Have also got ulcers in mouth and a rash on upper leg. Received full match report of RNPL game against DAEDALUS. Apparently they were very unlucky to lose 9-2.

DAY	TIME	DEPTH (Metres)	
20	0900	175	Another comfortable night. Temperature control system seems to be working well. Have been much aware last 2 days of even temperature rather than cycling. Vast improvement in condition of feet after only 2 applications of Tineafax powder.
	1000	175	Crutch inspected by Dr Pearson. Told to try Tineafax there as well. All signs of tremor have now disappeared. Now that all the effects have gone, even more conscious of how we were affected by tremor. We did wonder at the time whether tremor could have been caused by the cramped conditions but now that they have gone this was obviously not the case, and they were caused by helium tremors.
	2330	155	On reflection it appears that tremor is more noticeable when muscle effort is changing, ie increasing or decreasing. Scrotum still very sore, hard to tell at this stage whether Tineafax treatment is working. Beginning to notice humidity again at this depth. Chamber walls beginning to get wet.
21	0830	145	Good start to the day - failure after 3 attempts to take my blood.
	1330	140	Cambridge tests this morning - never ceases to amaze me how anybody can make anything from these tests. Psychomotor tests - with the cramped programme for the early morning session it has been a constant aggravation point that we have to waste valuable time putting on electrodes that nobody uses. Why can't we just drop them in a pot of saline.
	1930	130	Shower and dinner completed. Humidity now very high. Dr Pearson advises change of treatment from powder to Betnovate ointment. Applied first application after shower. This problem is really making me feel miserable and depressed. Rash appearing on inside of upper thighs. Suggested possible cause, blocked hair follicles.

DAY	TIME	DEPTH (Metres)	
22	1030	110	Humidity now getting noticeably worse during the day. Silica gel can has to be fitted into least efficient scrubber unit which is in the main lock. Medical problem seems improved this morning after application of Betnovate ointment. Dr Pearson agreed it looked better.
	1930	100	Nothing too much has happened today, medical problem seems to be responding slowly to treatment. Have just noticed we are able to hold a conversation with a little difficulty.
23	1045	85	Blood samples complete success this morning. Both first time in fact, best session so far. Kept awake some of the night by crutch discomfort, feeling depressed about the whole thing as it does not seem to be responding to any sort of treatment. Have spent the morning so far manufacturing home-made birthday cards for Martin Garrard.
	1700	80	Have now yet another treatment for lower regions - Setavlex cream. Condition now very nasty. Whole area of inner thighs, scrotum and, now, penis very red and continually weeping. Extremely uncomfortabl to wear any sort of clothing adjacent to affected parts. When clothing is worn it has to be changed every hour. Hoping tomorrow night might bring some relief as external scrubbers are brought into operation. Have been told that fungus may thrive on high oxygen level. Therefore probably can expect no relief until we come out. Phil also suffering from the same complaint to a lesser degree. "Special" film show tonight. Under the circumstances wonder whether that's a good thing.
24	0815	65	Had a bit of trouble getting to sleep last night as external scrubbers came into operation on reaching 70 m at 0105. Will no doubt get used to the noise. Switched off diver-to-diver communications as we can now converse without too much difficulty. Must investigate possibility of muting entertainment speaker by chamber control switch.
	0845	65	Breakfast came in burnt. Both agreed impossible to lick plates clean as normally required.

DAY	TIME	DEPTH (Metres)	
24	0930	65	Mid-morning tea-break. Biscuits forgotten. That means extra biscuits to be consumed during the day. Obviously somebody is having problems getting back into food routine - must remember to keep low profile and not to complain.
	1245	60	Problems with muscle fatigue experiment. Phil beginning to get worried about similar symptoms. Detected slight feeling in knee joints during and for a few minutes after drop from 65 to 60 m.
	2245	50	Decided to turn in early. Felt definite, very slight, twinges in both knees during drop to 50 m. This was reported and instruction is to extend next drop (0200 hours) to 25 minutes duration. Evening meal is again causing indigestion and repetition (unpleasant).
25	0845	40	Just completed second 25 minute drop. No sign of knee niggles. Woke at 0220 this morning at end of decompression drop but think it was probably caused by oxygen injection noise. Blood samples were again taken with complete success. Have got sore backside - probably caused by continual sitting on hard seats. If dives get any longer serious thought will have to go into seat redesign.
	2320	30	Preparing to turn in. Both feeling as if we are "feeling the pinch". Everything seems to be building up - all ailments seem major, medication does not seem to be making any noticeable improvements. Rash on upper legs has now taken over as major discomfort spot. Very red and lumpy. Area affected perhaps 6 square inches, each side. Feel that medication is making it more uncomfortable. Walking after the dive will be a painful exercise. Whole posterior area very sore - quite understandable considering that now for nearly one month body weight has been taken on this one point, on hard seating.

DAY	TIME	DEPTH (Metres)	
25	2320	30	I remember answering a diving questionnaire not long ago. In answer to question "What did I consider the maximum time that should be spent in a pressure chamber" my answer was 30 days. I now think I was absolutely right, especially in a chamber such as this, with its crude facilities. Felt slight twinges in left knee during the drop 40-35 m (last 5 minutes). Also knee twinges during 35-30 m drop, again last 5 minutes.
26	1520	20	Poor night's sleep last night, mostly kept awake by crutch discomfort. Awake for 0200 decompression, no problems. Breakfast burnt again. Have now finished experimental programme except for Dave Harris's knee jerks tomorrow (13). Will wait and see how my knees are feeling tomorrow before I decide whether to do that experiment or not.
27	1030	5	Last morning. Mood rather frivolous. Still very uncomfortable. Dr Pearson promises relief by soaking in a warm bath. Was already awake at 0600 for decompression. Slight ache in both knees during last half-metre. It appears that last drop to the surface will be by a slow bleed while on oxygen.
	1340		Leave chamber. Pain in both knees during very last stages of final decompression drop. No idea at what depth as we could not communicate due to ultrasonics monitoring and being on BIBS (probably last metre). Felt very unsteady on legs - hardly surprising. To DTU for post-dive medical - very uncomfortable walking, will not be able to wear normal clothing for some time. Skin scrapings taken for culture - medication prescribed. Phil won the beard-growing competition by a hair's breadth. Have now completed longest dive undertaken in RNPL pressure chambers.

COMMENTS

The object of this dive in the series was successfully achieved. Both subject arrived at 420 m completely fit, apart from minor HPNS symptoms, and capable of carrying out all tasks required of them (with the exception of the author's inability to complete the experiment involving the heavy workload - which should be covered in the relevant report).

For the author two things spoilt what would have been a very smooth and successful dive:

a. The hold in compression at 250 m, which upset the routine;

b. The skin problem experienced during the last half of the dive, which understandably affected my morale.

It was interesting to note that the problem of stiff wrists and cracking shoulder joints experienced on previous dives to depths of 200 and 300 m, employing more normal compression rates, did not manifest themselves at any stage during this dive.

The dietary studies were not very popular with both subjects, especially when it became obvious to them that there was some confusion about the experimental diet period intended. Reluctantly we were allowed a short break but both realised that we were unpopular with the investigators. The problems caused by diet control had a considerable effect on morale, especially during periods of appetite loss.

It is suggested that for future dives a method of serving the same food constituents, but in varied form, be investigated.

Finally, a few post-dive observations.

The skin fungus problem took several weeks to clear. During the first week medicated baths were taken several times a day and it was impossible to wear any other clothing than a loose-fitting tracksuit.

Two or three weeks after the dive the skin on both hands peeled completely over a period of about one week. Could this have been an effect of long exposure to high humidity?

Once again, the indentations appeared on the fingernails, corresponding to the dive, and remained until they grew out several months later.

Although blood was taken every other day, successfully for the major part of the dive, it did prove difficult at 420 m due to tremors.

Post-dive fatigue lethargy was experienced by both divers, manifesting itself by lack of enthusiasm and inability to concentrate. This condition lasted for about one week after completion of the dive.

APPENDIX

1. RNPL Technical Memorandum 1/77 - P J Atherton.

2. Mr P Hayes/Mr M Garrard - Experiment to measure basal metabolic rate.

3. External scrubber not capable of operating below this depth.

4. Dr Z Torok, scientific co-ordinator for this dive, also experiments to measure eye movement.

5. Mr Philip Daniels - Diving partner.

6. Dr R Carlyle - Experiments on dietary studies.

7. Dive medical cover as provided by Senior Medical Officer Underwater.

8. Author's wife.

9. Experimental link through chamber communications/helium speech processor/ GPO Telephones.

10. Daily experiment to measure formal EEG - Manual dexterity - tremor - mental arithmetic.

11. Mr E Towse - Chamber supervisor.

12. Restrictions due to diet control.

13. Dr D Harris - Experiments on the knee-jerk reflex.

SUBJECTIVE OBSERVATIONS DURING A 420 msw O_2He DIVE (1.2.78 to 26.2.78)

by

D J Harris

INTRODUCTION

This report contains extracts from a personal log made by the author during a 420 metre experimental saturation dive. The comments appear as they were written at the time and have not been altered except to remove ambiguity etc. The notes below and the Appendix (referred to by superscripted numbers in the text of the log) are for the further information of those not familiar with the AMTE (PL) dive series.

Dive Profile. Dive 8 was a 26-day saturation dive to 420 m with 3 days exposure to maximum pressure. The compression rate, designed to be as slow as conveniently possible was effectively 60 m/day. Compression took place for 10 minutes (rate = 1 metre/min) every 2 hours over a 12-hour period and was followed by 12-hour overnight holds. Decompression lasted 16 days and used an experimental profile developed by Dr T R Hennessy, AMTE (PL).

Diet. The diet formed part of an extensive metabolic study in which the same exact amounts of constituent foods were offered in the form of six menus. It was vital to the success of the experiment that every scrap of food and no more be eaten so that the regulated dietary intake remained balanced and identical from day to day.

Clothing. In the chamber, the subjects wore T-shirts, shorts and if necessary track suits.

Skin Cleansing. As a result of the development of an unpleasant and persistent skin infection in the previous experimental dive, a daily routine of thorough skin cleansing was introduced into this dive. This involved either a whole body wash or a shower using the proprietary agent Betadine (see Appendix). Aural hygiene was carried out twice a day.

Day 1
1.2.78
0-60 m

I began to feel warm and humid before lunch. The external scrubber was switched on during the afternoon session and the temperature and humidity rapidly dropped. We asked for an increase in temperature and 1 °C was given but this was not enough.

Obviously no compression-related problems at this time, apart from some joint pains in the wrist and shoulder. We turned in at 2340 - not a bad start for us.

Day 2
2.2.78
60-120 m

Last night was a good start considering I haven't slept in a chamber for 16 months. I woke up a couple of times but had no problem in getting back to sleep. I thought I might feel cold in the night but this was not the case. The day has gone very smoothly apart from equipment breakdowns.

I'm still enjoying the food although the quantity feels only just sufficient. My right thumb is cracking at the last joint - not a problem yet. We had a relaxed evening watching TV, and were early to bed (2310).

Day 3
3.2.78
120-180 m

Reasonable night but woke a few times - mainly due to noise and feeling a little bit hot.

During the ball-bearing test I felt a very mild kind of excitement which had some effect on my performance. I think Bob[1] did too, and he also scored low - although the different table height/illumination may be partly responsible. The electrodes are sticking very well despite other technical hitches with psychomotor tests. This morning I had a suggestion of very minor giddiness when rising, probably postural hypotension (?). However, since reaching 180 m one has this feeling of something just beginning to happen, but it's very slight. A feeling in my head akin to that after a couple of whiskies but without the merriment and lack of inhibition etc. A touch of imperfect balance now and again - but who is to say if we could stand up, that we wouldn't be perfectly OK?

Day 4
4.2.78
180-240 m

Not a particularly good night. I was hot and sweaty again and the scrubber at my end was intermittently noisy.

Zoltan[2] had an extended session this morning and again this evening. In the ball-bearings I noticed the same increased excitement, raised heart rate and slight fumbling intention movements which were very familiar to me on my last 300 m dive[3]. I get this same excitement etc during the maths test but as long as I can write fast enough, however jerkily, it will not affect the outcome (completed 49 again).

What is fascinating is that this is developing over the same time course as the previous dive as well as being related to depth (Pete Atherton also noticed intention tremor at this depth on his 420 m dive[4]).

My wrists hurt quite a lot when I bend them although my shoulders don't feel too bad. I have a very small area of red spots on my glans - I'll keep a careful eye on these. My eyes feel tired and I have to blink a lot. Zoltan is picking up nystagmus in the right eye and some in the left. Occasionally I can feel a slight lurch or swaying, not really unsteadiness but a "clumsiness". However, I'm fairly certain it's the same vertiginous symptom. Our spirits are very good, we're trying not to think too hard into the future and keeping our sights on just a couple of days ahead. The food is excellent but the drinks are not enjoyable.

Day 5
5.2.78
240-300 m

Sunday morning. An excellent night's sleep (low scrubber noise). A very quiet and pleasant day. Had a reassuring letter from Sarah.

My tendon reflexes feel quiet and the muscle fatigue experiment went OK. I apparently have nystagmus in both eyes but they feel better in terms of the blinking than they did yesterday. Other symptoms have not significantly worsened today. They are no worse really than two days ago.

Comparing the state of my mind and body at 300 m on this dive, and after the 5-hour compression to 300 m on Dive 5, the difference in well-being is unbelievable. This is certainly a better way to arrive at 300 m.

Day 6
6.2.78
300-360 m

A terrible night - very unsettled. Dreamt about weird basal metabolic rate experiment and had a nightmarish dream involving the family.

Symptoms. The movement tremor (ball-bearings and finger-to-nose test) had worsened slightly. It seems to be a final precision error in motor control. There is some definite unsteadiness but I don't need any support. No visual lag effect or other static problems. Very slight butterflies in the early part of the day and no reflex twitches.

I have just tested my tendon reflexes. Subjectively the knee-jerk reflexes seemed extremely sharp, the ankle jerk less so. The next reflex session is at 420 m.

I'm rapidly losing my appetite and accordingly the diet seems to be very excessive. I requested that the amount of food be reduced in some way but the request was denied.

Day 7
7.2.78
360-420 m

Very large jitters. Intention tremor.

Sick feeling developing.

Complete loss of appetite.

Attacks of butterflies and trembling. Hands shaking.

Postscript written on Day 9.

If four scrawled lines (see above) can represent a miserable day, then these do it very well. It was completely unexpected that we would feel quite so bad, and the resultant disappointment was probably an important factor in the drop in morale.

The "nerves", butterflies and intention tremor are the same as I remember from the 300 m dive, and my previous experience was a help. Dizziness has not been a problem (very, very mild) this time and neither has delayed or swinging vision.

The intestinal/abdominal problem is what has bothered me most - is it pressure-related or is it a 'bug'? It lasted two days when it came, although the strange (go and defecate) messages from my abdomen the previous few days should have been a sign that all was not well.

Day 7 (contd)

Throughout the day, symptoms mentioned above developed, especially the butterflies and trembling. In fact I felt so rough and cold that night that I slept with my track suit on in the sleeping bag. I refused dinner that night because I felt I would have vomited had I eaten anything.

The blood sample[6] in the morning was a very shaky operation - I missed the vein altogether the first time. The rhythmical tremor in the arms and fingers is what causes the problem. Had several periods of feeling cold throughout the day.

Day 8
8.2.78
420 m

Written on Day 9.

A steady deterioration throughout the day, with the sick feeling predominating - coupled with long periods of shivering, or trembling.

Started the day with Bob doing basal metabolic rate[5] (I couldn't eat my breakfast and therefore was unable to be the subject). Felt a bit faint after sitting up whilst calibrating - and had to lie down (I occasionally have this in outside life, perhaps once a year). Neither Bob nor I ate lunch. During the afternoon Bob had to spend most of his time lying down, complaining of feeling sick. It was a very tiring and busy day, marked with periods of tremor, trembling, shivering,'butterflies' and insecurity, very sensitive reflexes. My stomach was unsettled although this was not too bad in the evening.

Day 9
9.2.78
420 m

Largely a day of recovery towards normality. Began with a successful but extremely trembly and nervous blood sample. This was followed by a very light breakfast.

I am beginning to notice twitches in single muscles.

Exercise studies: MVVs - easier than I expected with no hiccoughs.
50 W - no problem but the last rebreathing gas was unpleasant.
150 W - from a workload point of view, again not too much of a problem. The feeling of

Day 9 (contd)

impending respiratory insufficiency did not bother me although it was present. But, the last rebreathing gas felt utterly poisonous. I felt myself blacking out by 5 seconds and came off at 7 seconds all fading fast and stopped pedalling. I soon recovered but the MO says I overdid it.

Felt greatly improved by the evening and had a full meal which I enjoyed very much.

Day 10
10.2.78
420 m

A very liquid motion but I ate all my breakfast and feel OK.

Psychomotor tests: As expected, the shaking is beginning to maximise now, and the ball-bearings were very difficult. I even dropped the forceps once. The shaking was also so bad it affected my maths test slightly, the writing was very jerky and laboured.

Muscle twitches. For about two days I've had regular random twitches of skeletal muscles, usually monolateral but sometimes bilateral. These twitches seem very reflex in nature and are amusing rather than annoying. So far I have had no multiple twitches or whole-body spasms (that weren't associated with shivering/trembling periods).

Applied psychology tests: I became very excited during these and had to cope with a shaky hand which was worse when I was trying to write quickly.

There is still plenty of random machine noise which sounds like music, conversations etc.

We start the decompression tomorrow. Bob says he's disappointed and is feeling a sense of anticlimax etc. Personally I'm glad that the programme has worked out well and that all experiments have been completed as far as possible. After all, we had no other aims.

Day 11
11.2.78
420-392 m

Hand shaking during blood sampling is still uncontrollable and the needle flew out with the syringe only half full. Plenty of shaking during the ball-bearings too. This time we measured it with the postural tremor device attached to the forceps-holding finger.

Very quiet day all through, we watched TV at night and enjoyed an extremely hot bath.

Day 12
12.2.78
392-364 m

A good, long night. I awoke happy and remained so all day, particularly with the visit of the family.

There were no experiments today, we played scrabble and watched TV most of the time. Bob occasionally has reaction to food, but I feel fine. I haven't noticed the tremor so much today - perhaps it only matters when it (the task) is "important". I am still twinging and twitching reflexly but perhaps not quite as much as yesterday. All unsteadiness in the postural field has gone; only the clumsy stumbling (tremor in legs etc) remains in climbing into the main lock etc. I have an ulcer in the back of my upper left gum and this is quite sore. Apart from some cracking thumbs and awkward shoulders and tender wrists, and a bit of athletes' foot, there are no other problems.

Day 13
13.2.78
364-336 m

Although the blood sample was shaky it has definitely steadied since last time, and I never lost control (I'm glad for Bob). The ball-bearings, which were done in the afternoon, were also a little better.

The shoulder still pulls at times.

The thumb is still cracking.

No disorientation, unsteadiness at all.

Skin is very clear of all infection.

Morale is very high and I'm in a good state of mind.

Day 14
14.2.78
336-308 m

Good BMR/DIT[5] run this morning. Thoroughly enjoyed my big breakfast including the egg. Feel my appetite has fully returned.

We were asked to do an extra session of psychomotor tests this morning and I was surprised how reluctant I was to smile and co-operate. We complied, of course, but my performance was definitely unsettled. Some problems with the headsets added to the general confusion this evening. This is the first time that there has been any tension at all and thankfully it soon passed. It has been a good night and peace reigns.

There was little tremor during the ball-bearings and the intention tremor was very steady. Eyes feel OK.

Day 15 & 16
15/16.2.78
308-242 m

Feeling very normal. I am sleepy or sleepyish, and lethargic but in a very contented way. There is still a long way to go, so no slipping into contented lethargy yet.

Interesting points are that (1) the diet is no problem in terms of bulk. This I find surprising, I was certainly in error here; (2) joint pain and cracking has stopped (cf 300 m dive); (3) my writing has returned to normal - will see what happens to the blood sampling in the morning.

Most of my spare thoughts concern the question of whether I would dive again; what would be gained, what would be lost, and whether I would be a useful subject? For example, would tremor prevent my being able to take blood samples at greater depth?

Day 17 & 18
17/18.2.78
242-196 m

All signs of HPNS now gone (by Day 17). There was no shaking at all when taking the blood sample. I feel happy, co-operative and enthusiastic but also very sleepy and drowsy. This is strange because I've been sleeping very well. I have my full appetite back and get hungry before meals.

Day 17 & 18 (contd)

Now we are more than half-way back, I can start looking forward to coming out. Bob has been down a bit today (Day 18) and yesterday. This happens in bursts but I think he's pulling out of it now.

Day 19
19.2.78
196-168 m

Straightforward, perfectly steady blood sample.

MVVs: The first two were OK but the third was broken up by coughing. I think it's because I'm taking gas down my throat.

No other symptoms. Skin clear, ears OK, no tremor. I feel sleepy but not tired. It's a physical inertia (not apathy) but I am OK once I get started on something.

Day 20
20.2.78
168-140 m

The day started very well with a slick BMR. Then John Towse began talking about next Monday. They want to organise a subjects' debrief at 1000 hours. I suspected as much so I was prepared. Bob didn't know anything about it and it was his turn to become irate. A long chat with Zoltan sorted most things out. Bob let off steam and Zoltan promised to organise the debrief properly. Right thumb still cracks. Otherwise no symptoms, a very good day. Pleasant evening.

Day 21-23
21-23.2.78
140-56 m

We are now much better-humoured during these lazy, lethargic days. There are large gaps in the day's programme so we have done a lot of reading. I do seem to be waking up at night though.

Blood sampling is perfect from my point of view and there are no other problems at all.

Day 24
24.2.78
56-30 m

I woke up after the worst night for quite some time. The external scrubber was switched off and I was very warm and sweaty. In fact I

Day 24 (contd)

woke up pouring sweat several times. When the scrubber was switched back on in the morning it dried me out very quickly.

During the afternoon reflex session we both shaved our legs enthusiastically and received painful stimulations as a result. The electrode jelly also stung. The session went OK even though it was interrupted by a power cut.

Dinner, which was intended to be a lovely fillet steak, was ruined by overheating. Same with the drinks.

Symptoms: There are no ENT problems except an occasionally itchy ear. The thumbs are barely cracking. There is a suggestion of a tweaking pain in the knees (especially the right) when I stand on them. This happened after arrival at 30 m - but it is only a suggestion of a pain.

I feel very fit. The skin is extremely clear, probably due to the antiseptic/antibacterial Betadine[8] we have been using. I do have a couple of inflamed axillary lymph nodes (each armpit). I have had these for a few days.

Day 25
25.2.78
30-15 m

No comments.

Day 26
26.2.78
15-0 m

Passed by quickly enough as we attacked all the crosswords we could find and played scrabble.

At the 10-5 m decompression drop I noted the merest hint of something in my knees but this is only appreciable on a bended knee. I have to mention it because it probably wouldn't be there if we weren't decompressing. But it is no hindrance to walking, no problem at all.

5-0 m drop: We were able to stand up and step out of the chamber with no marked discomfort in either knee, quite a contrast to my previous 300 m experience. Once outside the chamber and the post-dive medical over (at which we were pronounced very fit), I suffered from immediate restlessness. I felt compelled to stand up and walk

Day 26 (contd)

about for the entire bend-watch period. After the bend-watch I found my way to bed at home and had a long luxurious sleep.

Day 27 onwards
27.2.78

Post-dive. As a result of all the walking around on emerging from the chamber last night, the hip muscles which move the thighs forward and my calf muscles feel extremely stiff, presumably because this is the first time they have been fully stretched and used properly for nearly four weeks.

Over the next couple of days some large, quite painful, spots on my thighs developed which were probably due to the trousers having an irritating or abrasive effect on the hair follicles. These spots disappeared within a week or two.

Post-dive fatigue appeared as expected, manifesting itself as slow and slightly confused thinking. This also lasted for at least a week but I felt perfectly normal after a fortnight.

COMMENTS

In terms of the day to day running of the dive, the completion of experiments and general morale, this was a very smooth, successful and satisfying operation. The lack of skin or ear infections and latterly the absence of any decompression discomfort contributed greatly to the relative enjoyment of the experience.

The surprising (and disappointing) thing for the subjects was the apparent severity of the symptoms experienced during and after the final day's compression to 420 m. This subject at least will never be sure whether the sick feeling and loss of appetite were part of the general HPNS (tremor, trembling, "butterflies") or the result of some quite different cause (eg alimentary disorder). It is interesting that while there was no nausea or gross vertigo, and only mild unsteadiness, the intention movement tremor in the limbs was nonetheless still quite marked and maximised on the third day of maximum pressure. The periods of spontaneous nervous/ "butterfly" sensations described at pressure are very similar to the nerves most people experience before participating in an important event (eg a concert, interview or sporting contest) and probably result from the same increased adrenalin output.

In spite of the slow compression, symptoms (slight tremor, increased excitement/ nervy feeling) first occurred at around 180-200 metres during compression and disappeared by 240 m during decompression.

Finally, it is worth recording that in the opinion of both subjects, they would have been capable of performing any tasks required at any time during the dive apart from a period of a few hours after compression. Certainly on days 9 and 10, wet diving would not have been a problem.

APPENDIX

(1) Mr R McKenzie, Scientific Officer, AMTE(PL) - Diving Partner.

(2) Dr Z Torok, MO(R), AMTE(PL) - Scientific Co-ordinator.

(3) RNPL Tech Memo 4/76 - D J Harris.

(4) RNPL Tech Memo 1/77 - P J Atherton.

(5) BMR/DIT, Basal metabolic rate/Dietary induced thermogenesis.

(6) Blood Sample - 20-25 ml from cubital vein, alternate days.

(7) Mr J Towse, Higher Scientific Officer, AMTE(PL) - Chamber Supervisor for Dive 8.

(8) Betadine - polyvinyl pyrrolidone, NAPP Laboratories.