

Radioactive

Conf. file

714742

Report
for
Dr. John H. Lawrence.

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GROUP IV: Downgraded at
3 Year Intervals
Declassify after 12 Years

Rate of absorption of radioactive krypton measured
in deep sea divers at the Experimental Diving Unit,
Navy Yard, Washington, D.C. by Drs. J. G. Hamilton
and H. B. Jones.

Analysis
of
Data



Lieutenant Commander, (MC), USN.,
and,
Lieutenant, H-V(S), U.S.N.R.

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SUMMARY

Twenty men the majority of whom were deep sea divers inhaled radioactive krypton to determine whether or not the rate of saturation of the tissues in the lower forearm and hand could be used as an index of susceptibility to decompression sickness.

Although the tests were conducted with meticulous care, the test conditions were severe in that the divers were selected at random, without reference to previous amount of exercise, food ingested, time of day, or physical condition.

The divers themselves represent men, who because of repeated decompression trauma, may exhibit the variable of localized areas of impaired blood flow. Thus, while gas transport to the tissues of the body as a whole may be efficient, a traumatized, circumscribed area may render an individual unduly susceptible to "bends".

With these statements in mind it can be concluded --

(a) That no close correlation exists between a high saturation index and resistance to decompression sickness. A trend, however, is discernible. In the upper group of 10 men graded according to rate of gaseous saturation, 4 men were resistant to "bends", while in the lower group of 10 men, only one man was resistant. On the other hand, the upper group included 5 highly susceptible men or the same number present in the lower group.

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(2) The technique affords a precise method of measuring gas transport and absorption in the extremities. The constancy of results in repeated tests and the ease in making measurements stand in contrast with the difficulties involved in the determination of nitrogen elimination.

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(3) In healthy men the procedure appears to be a means of determining effective blood flow to an extremity.

In summary, and without reference to results obtained elsewhere the procedure does not appear promising as a specific test to determine susceptibility to aeroembolism. It may be of value in studies relative to the formation of gas bubbles during rapid decompression. With reference to gaseous absorption in the lungs, gaseous transport and distribution to peripheral tissue, the technic constitutes a precise, basic physiologic procedure. Under controlled conditions a quantitative method of estimating physical fitness may be evolved.

PRESENTATION OF DATA

Table No. 1.

The subjects are deep sea divers with the exception of [REDACTED], [REDACTED], [REDACTED], [REDACTED], and [REDACTED].

The index showing rate of absorption of radioactive krypton can be expressed according to Lawrence and Hamilton as a ratio of Geiger counts taken at 7 and at 28 minutes from

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the start of inhalation of the activated gas.

Susceptibility to decompression sickness, was graded according to the scale 0, +, ++, +++, and +++. In evaluating degree of susceptibility, we based our score mainly on the results of repeated exposures to low pressures, see enclosure (A), and partly on diving experience.

The variable presented by tissue injury is illustrated by the case of [REDACTED] who in 1941 was resistant to "bends", but who in 1942, following an injury to the thigh muscles of the right leg, became highly susceptible, page 10, enclosure (A).

Of the men severely incapacitated at times by wide spread embolism incident to actual or experimental deep sea diving, [REDACTED], [REDACTED], [REDACTED], and [REDACTED] serve as examples.

The pain experienced by [REDACTED] was sharply limited to the area between the first and second metacarpal bones of the right hand, an area representing the site of old fractures.

With the exception of [REDACTED] who was tested only on two occasions, the resistant men have been notably free from decompression symptoms in the following order, [REDACTED], [REDACTED] and [REDACTED].

Specific gravity of the entire body as measured by the method of water displacement (1). High values for specific gravity denote leanness, while low values signify obes-

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ity.

The thickness of the abdominal fat layer was measured in the umbilical and lumbar regions by means of Consolazio-Draeger calipers.

Tissue analysis of forearm was made from measurements according to the technique of Weinboch employing soft tissue roentgenograms.

Table No. 2.

Average "k" value, 0' - 10' "k" value, 10' - 20'
"k" value. Gaseous nitrogen absorption or elimination by the body as a whole follows a curve which can be conveniently expressed by one or more exponential equations of the form, (1) $Y = A (1 - e^{-kt})$ which states that the nitrogen is eliminated at a rate which is a constant percentage of the amount present at any given time (2).

In the equation Y represents the value for nitrogen eliminated during the time interval, t; A, the total nitrogen; k, the rate of change in the slope of the curve, and e, the natural base of logarithms. The expression, $1 - e^{-kt}$, gives the percentage decrease of the total nitrogen during the time interval t.

The value of A in terms of Y can be expressed as
(2) $A = \frac{(Y_1)^2}{2 Y_1 - Y_2}$ providing that the time interval t_2 , corresponding to the value of Y_2 is twice that of t_1 , corresponding to the value for Y_1 .

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In terms of k, equation (1) becomes --

$$(3) k = \log_e \frac{A}{A-Y} \cdot \frac{1}{t}$$

With reference to the absorption of radioactive krypton in the tissue of the forearm and hand, it is to be expected that equation (1) will apply even more rigidly provided that the values for k are computed individually for successive time periods of 10 minutes or less.

This limitation, applicable also to the nitrogen absorption or elimination curves, can be ascribed to the unequal distribution of blood flow to the various parts of the forearm and hand. Values for k therefore tend to decrease progressively during saturation or desaturation. For intervals of 10 minutes, however, the same value of k will apply with sufficient accuracy to points on the experimental curve.

For example, the Geiger counts recorded for Shahan at 5 and 10 minutes from the start of inhalation of krypton, were 49 and 74 respectively. Substituting these values in equation (2), A can be computed as 100. From these values and with t expressed in minutes, k can be computed from equation (3) as 0.138 representing a rate of change in the slope of the saturation curve as 13.8 per cent per minute.

Substituting the A and k values in equation (1) the amount of gaseous absorption can be computed for each minute of the 10-minute interval. The computation for the 3rd minute, for example, gives a value for the Geiger count of 33. The recorded experimental value was 34.

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We regard the value of k which represents the average rate of change in the slope of the absorption curve for the ten-minute time intervals, as a more accurate index of rate of absorption than the arbitrary 7/28 minute ratio, I.

Further, the ratio of the two k values for 0 to 10 and 10 to 20 minutes serves to check the accuracy of the experimental procedure.

In table 2, column 1, the k value is the average of the values for k from 0 to 10 minutes, and from 10 to 20 minutes. Zero time represents the start of inhalation of radioactive gas.

For comparison, k values for nitrogen elimination from the entire body are given in column 4 and are applicable to the 10 to 20 minute interval following the initial 3-minute lung rinsing period required to remove nitrogen present in pulmonary air. These values are generally lower than the corresponding values for krypton and do not show either an intrinsic or correlative relationship.

Table No. 3.

The data in columns 1, 2, and 3, demonstrate a remarkable agreement in duplicate tests. To obtain the figures recorded for k the analytic technique must be precise since any error will in the course of computation be raised to the second power.

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With respect to nitrogen elimination from the body, as a whole, comparable experimental technique may be expected to yield values for k as recorded in column 4. Subjects "A", "B", and "C" were divers on whom measurements were made in 1933.

Graph 1.

The exponential equation (1) $Y = A(1 - e^{-kt})$ can be reduced to the linear function $\log_e (A - Y) = A k t$.

In this manner the experimental data can be plotted linearly; the slope of the lines are then proportional to the rates of tissue saturation.

In Graph 1 the mean rate of saturation for the 20 subjects studied, is represented by B 1, for 0 to 10 minutes, and by B 2, for 10 to 20 minutes.

The lines A 1 and A 2 denote the slowest rate of saturation, while C 1 and C 2 possess the greatest slope, and hence represent the fastest rate of saturation.

Graph 2.

Curve A is based on data for the absorption of radioactive krypton following occlusion of blood supply to the forearm at a, and again at c. The inhalation of krypton began at 0 time, the pressure cuff was released at b and d.

For comparison curve B shows normal absorption rate for krypton in the same subject. Inhalation of radioactive gas began at b.

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The ratio I, represents the 7 to 28 minute values of saturation.

It is observed that the respective k values of curve A are nearly double those of curve B. The ratios of the two k values for each curve are approximately the same.

DISCUSSION

Susceptibility to decompression sickness in relation to saturation rate for the group of men under consideration is to be considered in the light of the following conditions:

- (a) The group represents a preselected body of men.
- (b) No great diversity in physical characteristics exist with reference to age, weight, height, specific gravity of the body or of the arm, and general fitness.
- (c) Some members of the group possessing excellent basic physical qualifications to withstand rapid decompression may have become unduly susceptible as a result of repeated decompression injuries incident to diving tests, e.g., [REDACTED] and [REDACTED]
- (d) The range of values of the saturation index, I, 41 to 52, is not large.

The data indicate the difficulty, because of the many variables present, of utilizing any one physical characteristic as a selective criterion for tolerance to rapid decompression.

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It is not to be inferred that utilization of radioactive gases will not be of help in other problems pertaining to decompression sickness. The detection of the presence of bubble formation in tissues may be afforded by this technique. As a specific test of fitness for altitude ascent, however, it appears to be of no greater value than three or four procedures employed in this laboratory.

It may be of interest to relate that men with high values for specific gravity of the body, i.e., above 1.070, were found to be far less susceptible to altitude "bends" than men with relatively low values.

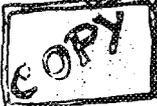
From the data in table 1, it is observed that the least susceptible men (O) as well as some of those most susceptible, have high "I" or "k" values. With reference to physical characteristics the more susceptible men tend to have lower values for the specific gravity of the arm and body, and higher values for abdominal and arm fat. Again, it is apparent that men with desirable physical characteristic may be highly susceptible to compressed air illness -- an acquired susceptibility resulting from diving injury.

The relationship between the "I" index, and the specific gravity of the arm, and body, and the thickness of the abdominal fat layer, may prove to be significant for the development of a quantitative test of physical fitness.

Accuracy of data. The basic, physiologic importance

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of the precise measurements of radioactive gas absorption renders the technique of considerable potential value. To obtain k values that vary less than .02 units requires experimental data that agree within 1 or 2 per cent.

The measurements of nitrogen elimination in anesthetized dogs have at times attained this degree of accuracy. The effort involved, however, in these determinations stands in contrast with the ease of measuring absorption of radioactive gas.

With reference to the basic value of the technique, certain physiologic considerations merit brief discussion.

The occlusion test, Graph 2, permits a breakdown of some of the factors involved in gaseous saturation of the tissues of the hand. The principal determinants appear to be:

- (a) absorption of gas in the lungs,
- (b) cardiac output and the transport of gas from the pulmonary bed to peripheral tissues,
- (c) composition of tissues especially in relation to fat content, and
- (d) the effectiveness of peripheral blood flow in carrying gas to the greatest number of capillaries.

In Graph 2, the rate of saturation depicted by the upper curve A is nearly double that shown by the lower or normal curve B. To account for this difference in rate maintained throughout the whole 20-minute period, it would appear that

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factor (a) in healthy subjects, would be the least variable. During the 10-minute period in which the blood supply to the arm was cut off, on the assumption that the distribution coefficient for krypton is of the same order as it is for nitrogen, equilibrium in pulmonary gaseous exchange will have taken place. Moreover, the tissues of the shoulder and arm above the restriction will have approached half saturation with respect to the absorbed gas.

In view of the maintainance of the resting state, factor 2 which involves cardiac output and some diffusion of gas through walls of large arteries, should not be greatly altered.

Factor (c) relating to tissue composition remains of course, constant.

The most influential factor accounting for the difference in rates according to curves A and B, appears to be factor d, or effectiveness of peripheral blood flow.

Following the return of blood supply to the arm it may be assumed that large capillary beds, quiescent in the normal experiment, open-up so that the transported gas is absorbed with avidity.

The actual diffusion or passage of gas through the capillary wall and into the extra- and intracellular fluids, and fat, is expected to remain unchanged in both experiments A and B.

It is believed that the occlusion test may permit

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an estimate of selective fitness by affording a comparison of rates of gas absorption in individuals prior to and following interference with blood supply.

The difference in saturation rates according to curves A and B, or between the quiescent and active capillary beds, may prove to be least in men possessing the most effective peripheral blood flow tested under basal conditions.

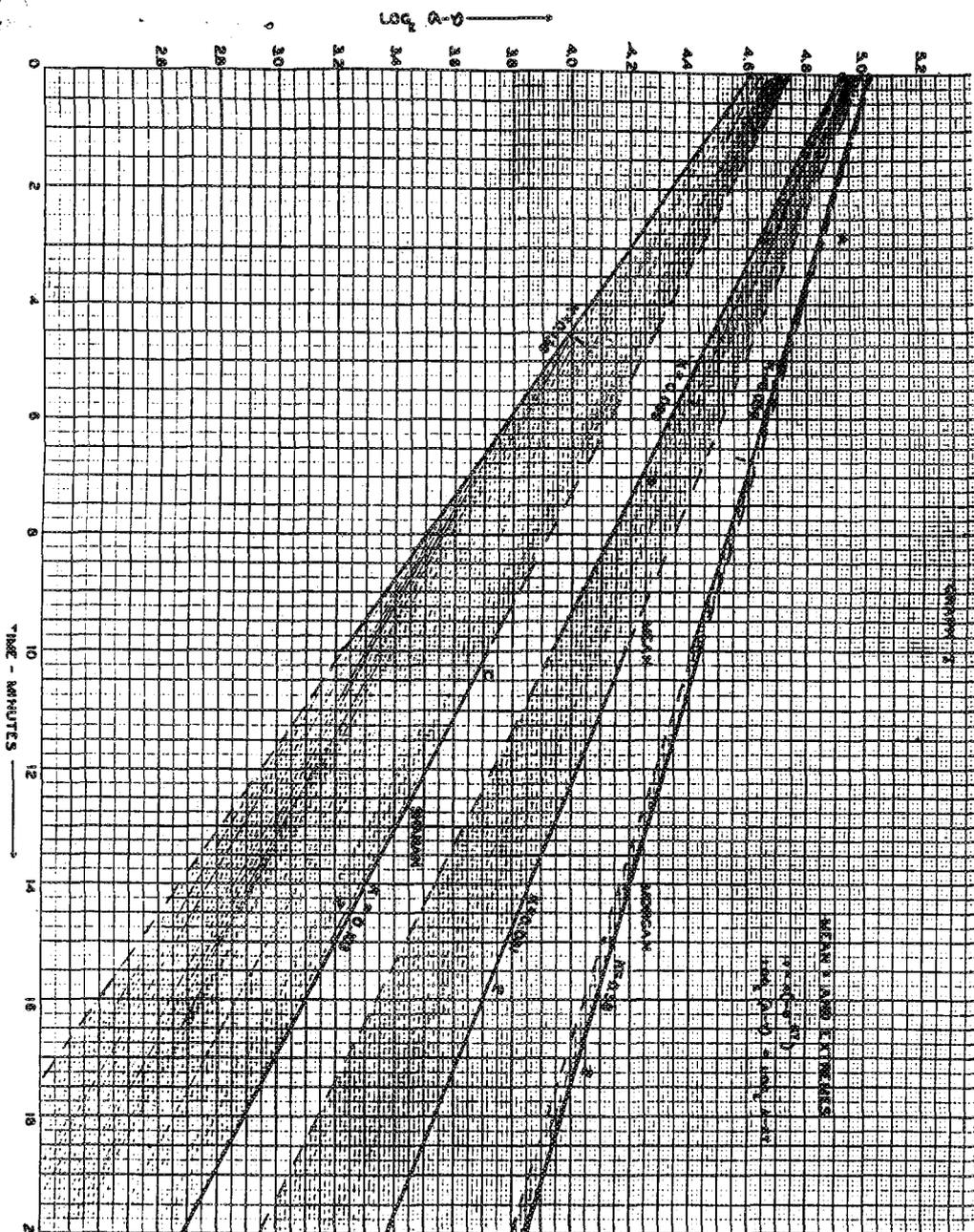
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- (1) BEHNKE, A.R., THOMSON, R.M., and SHAW, L.A., The rate of elimination of dissolved nitrogen in man in relation to the fat and water content of the body. American Journal of Physiology, 114: 137, 1935.
- (2) BEHNKE, A.R., PEEN, B.G., and WELHAM, W.C., The specific gravity of healthy men, Journal of the American Medical Association, 118: 495, 1942.
WELHAM, W.C., and BEHNKE, A.R., *ibid.*

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Folger No. 30

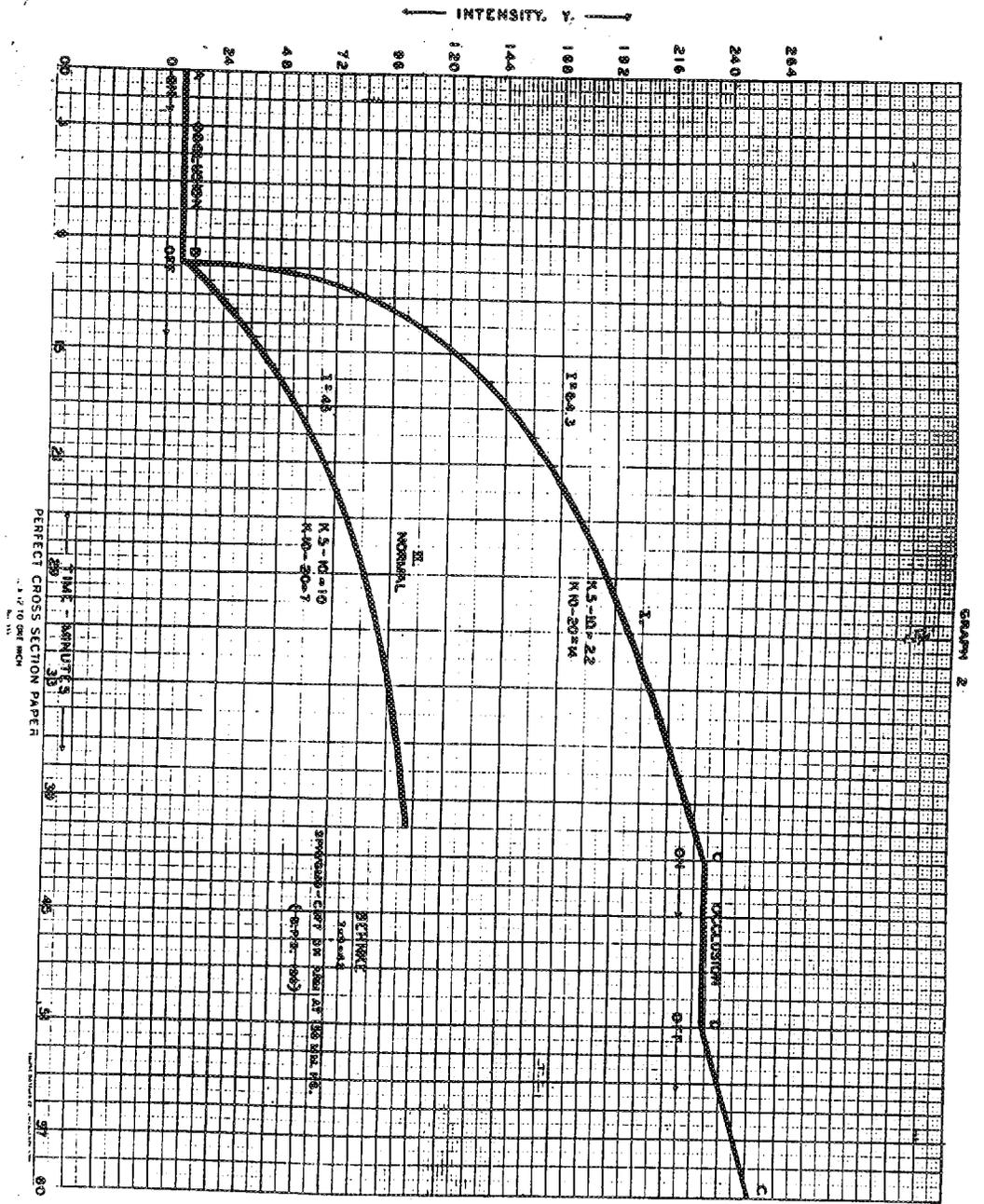
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TABLE No. 1

RATE OF ABSORPTION OF RADIOACTIVE KRYPTON TRANSPORTED FROM LUNGS TO HAND, IN RELATION TO SUSCEPTIBILITY TO DEPRESSION SICKNESS, AND OTHER DATA...

NAME	AGE	HT. INS.	WT. LBS.	I SUSCEPTI- BILITY 7/28	BODY SP.GR.	FOREARM						
						ABDOMINAL THICKNESS	X-RAY MEASUREMENTS VOL. PERCENTAGES BONE	MUSCLE FAT BONE	BONE VOL. TO SP.GR. BONE LGTH. COMPUTED RATIO			
[REDACTED]	29	69.8	177	52	0	1.069	9.5	76.4	14.5	9.1	4.91	1.088
[REDACTED]	38	66.0	152	51	+++	1.056	12.4					
[REDACTED]	34	72.5	184	50	0	1.057	10.6					
[REDACTED]	26	67.0	138	50	0	1.082	8.5	78.7	13.2	8.1	3.54	1.084
[REDACTED]	31	68.5	131	49	+++	1.064	5.0	82.7	10.0	7.3	3.24	1.084
[REDACTED]	32	67.0	151	48	+++	1.060	7.4	76.7	14.6	8.7	4.74	1.086
[REDACTED]	30	70.0	164.5	47	+++	1.053	8.1	79.7	12.2	8.1	4.25	1.080
[REDACTED]	34	70.8	163.	47	0	1.069		80.7	11.4	7.9	4.00	1.095
[REDACTED]	35	68.8	153	46	++	1.073	7.6	79.2	13.2	7.6	4.30	1.083
[REDACTED]	30	73.5	195	46	+++	1.060	13.4	75.0	16.7	8.3	3.91	1.082
[REDACTED]	33	72.0	190	45	+++	1.054	13.7	76.2	17.0	6.8	4.11	1.074
[REDACTED]	42	65.6	164	45	0	1.045						
[REDACTED]	32	70.0	171	45	++	1.065	7.6	76.6	15.3	8.1	4.06	1.082
[REDACTED]	38	71.0	189	45	++	1.066	10.5	73.8	18.1	8.1	4.58	1.078
[REDACTED]	34	69.8	180	44	+++	1.061	13.2	79.1	14.7	6.2	3.70	1.073
[REDACTED]	34	69.0	147	44	+++	1.057	10.7	75.7	16.9	7.4	3.43	1.076
[REDACTED]	37	69.0	166	44	++	1.063	11.5					
[REDACTED]	30	66.0	145	42	+++	1.048	11.7	74.0	19.7	6.3	3.44	1.067
[REDACTED]	28	72.0	189	41	+	1.059	10.6	70.1	22.1	7.8	4.65	1.073
[REDACTED]	31	71.0	163	41	+++	1.035	17.6	64.6	28.8	6.6	3.84	1.058

Susceptibility 0 in 1941, see text.

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TABLE No. 2.

RATE OF ABSORPTION (k) RADIOACTIVE KRYPTON IN RELATION TO SUSCEPTIBILITY TO DECOMPRESSION SICKNESS AND THE RATE OF NITROGEN ELIMINATION.

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NAME	AVERAGE k	I 7/28	SUSCEPTI- BILITY	0 - 10 k	10 - 20 k	NITROGEN * ELIMINATION 10 - 20 * k
[REDACTED]	.120	52	0	.138	.103	.044 .064
[REDACTED]	.109	49	+++	.128	.089	
[REDACTED]	.107	51	++++	.123	.091	
[REDACTED]	.100	45	++	.126	.074	
[REDACTED]	.097	47	0	.110	.083	
[REDACTED]	.096	44	++	.127	.065	
[REDACTED]	.095	45	0	.110	.080	
[REDACTED]	.095	47	+++	.110	.080	
[REDACTED]	.094	49	++++	.107	.080	
[REDACTED]	.090	49	0	.090	.090	.069 .079
[REDACTED]	.089	46	++	.107	.071	
[REDACTED]	.089	45	++	.103	.076	.055 .064 .040 .040
[REDACTED]	.089	50	0	.101	.077	.079 .056
[REDACTED] #	.088	46	++++	.102	.074	
[REDACTED]	.081	44	+++	.087	.075	
[REDACTED]	.079	45	++++	.086	.072	
[REDACTED]	.076	44	++++	.086	.065	
[REDACTED]	.066	42	+++	.068	.068	.064 .059
[REDACTED]	.060	41	+	.064	.055	
[REDACTED]	.059	41	++++	.060	.058	.043 .086

* Following 3-minute lung rinsing period. # Susceptibility 0 in 1941, see text.

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TABLE NO. 3.

ABSORPTION OF RADIOACTIVE KRYPTON -- CONSTANCY OF RESULTS IN COMPARISON WITH NITROGEN ELIMINATION..

NAME	I 7/28	0 - 10 k	10 - 20 k	NITROGEN ELIMINATION* 10 - 20* k
[REDACTED]	52.0	.138	.103	.044
[REDACTED]	51.3	.125	.089	.064
[REDACTED]	50.8	.130	.095	
[REDACTED]	50.0	.114	.089	
[REDACTED]	50.0	.092	.087	.079
[REDACTED]	49.0	.110	.067	.036
[REDACTED]	47.0	.120	.073	
[REDACTED]	44.5	.094	.069	
[REDACTED]	43.6	.106	.074	.055
[REDACTED]	45.8	.100	.077	.064
[REDACTED]				.040
[REDACTED]				.040
[REDACTED]	44.0	.087	.074	
[REDACTED]	44.6	.087	.076	
[REDACTED]	42.0	.069	.063	.064
[REDACTED]	41.5	.066	.072	.059
[REDACTED]	42.5	.071	.063	.043
[REDACTED]	40.0	.058	.052	.086
[REDACTED]	39.4	.050	.059	
[REDACTED]				.047
[REDACTED]				.055
[REDACTED]				.069
[REDACTED]				.058
[REDACTED]				.040
[REDACTED]				.047
[REDACTED]				.053
"A" #				.074
"B" #				.053
"C" #				.064
AVERAGE	45.8	.095	.075	.056

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* Following 3-minute lung rinsing period.
Data obtained in 1933.

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Name --- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
10-23-40	24,000	360'	--	No symptoms.
11-27-40	20,000	40'		
	25,000	45'		
	33,000	155'		
	35,000	14'	--	Pain right thigh.
12-3-40	35,000	150'		
	37,000	29'	1 1/2 hrs.	Pain left arm.
3-19-41	30,000	50'		
	35,000	10'	--	No symptoms.
4-17-41	35,000	60'	--	No symptoms.
4-24-41	36,000	60'	--	No symptoms.
4-28-41	37,000	60'	--	No symptoms.
4-30-41	38,000	60'	--	No symptoms.
5-9-41	40,000	60'	--	Pain right shoulder & chest after 18'.
3-28-42	34,000	480'	4 hrs.	No symptoms.
4-9-42	38,500	660'	4 hrs.	No symptoms.

PRIVACY ACT MATERIAL REMOVED

-- 1 --

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title	
Accession No.	326-90-0007
File Code No.	18-1-101
Carton No.	
Folder No.	
Notes	
Found By	
Date	

COPY

3003777

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
2-19-41	28,000	60'	--	No symptoms.
3-19-41	30,000 35,000	50' 10'	--	Pain in right shoulder after 30' at 30,000, run not terminated.
5-6-41	33,600	52'	1 hr.	Pain right forearm, very severe beginning 40' from start of exposure.

D I V I N G _ H I S T O R Y

Highly susceptible.

PRIVACY ACT MATERIAL REMOVED

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No.	326-9-0007
File Code No.	19-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
6-13-42	34,000	60'	--	No symptoms.
7-25-42	34,000	180'	--	No symptoms.

PRIVACY ACT MATERIAL REMOVED

- 3 -

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series T-15	
Accession No.	326-90-0007
File Code No.	19-10
Carton No.	
Folder No.	
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3003779

Name --- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
2-27-41	29,000	60'	--	No symptoms.
3-3-41	30,000	60'	---	No symptoms.
3-31-41	32,000 35,000	50' 10'	---	No symptoms.
4-16-41	35,000	60'	--	No symptoms.
4-24-41	36,000	60'	---	No symptoms.
4-28-41	37,000	60'	--	Fatigue, following run.
4-30-41	38,000	60'	---	Pain, lacrymation left eye after 40 minutes.
5-7-41	38,000	60'	---	No symptoms.
5-9-41	40,000	60'	---	No symptoms.

PRIVACY ACT MATERIAL REMOVED

ENCLOSURE (A)

DOCUMENT SOURCE	
Lawrence Berkeley Laboratory	
Archives and Records Office	
Records Series Title	
Accession No.	320-90-0007
File Code No.	19-1-10
Control No.	
Field No.	
Notes	
Found By	
Date	

COPY

3003180

Name --- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
11-28-40	27,000	60'	--	No symptoms.
3-14-41	29,000	60'	--	Legs tired.
3-19-41	30,000 35,000	50' 10'	--	Pain in calf of leg and right knee after 54'.

3-4-40

NOTE --- Compressed air illness - severe, sudden collapse
of legs, requiring prolonged treatment.

PRIVACY ACT MATERIAL REMOVED

- 5 -

ENCLOSURE (A)

DOCUMENT SOURCE	
Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title	_____
Accession No.	326-90-007
File Code No.	11-1-12
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

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3003781

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
10-30-40	26,000 35,000	240' 120'	--	No symptoms.
12-3-40	29,000	51'	--	Pain left hand, right arm.
4-1-41	30,000 35,000	30' 10'	--	No symptoms.
5-8-42	38,500	128'	4 hrs.	Pain left knee, left leg.
5-18-42	38,500	720'	4 hrs.	No symptoms.
6-5-42	38,500	360'	4 hrs.	No symptoms.
6-23-42	30,000	120'	--	No symptoms.

PRIVACY ACT MATERIAL REMOVED

D I V I N G

DATE	DEPTH	EXPOSURE	DECOMPRESSION	REMARKS
5-19-38	100 ft.	28 mins.	2 mins.	Pain left arm.
1-5-40	38 ft.	12 hrs.	1.5 mins.	Rash, dizziness.
1-16-40	38 ft.	9 hrs.	1.5 mins.	Pain arms & shoulders.
2-5-40	38 ft.	6 hrs.	1.5 mins.	Soreness right knee & left arm.

* 6 -

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title	_____
Accession No.	324-90-0007
File Code No.	10-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

3003782

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
5-4-42	38,500	720'	4 hrs.	No symptoms.
6-23-42	30,000	84'	--	Pain left knee, right arm after 59'.
6-30-42	38,500	330'	3 hrs.	No symptoms.
7-21-42	38,500	300'	2 hrs.	No symptoms.
7-25-42	34,000	57'	--	Pain left shoulder, knee, and foot.

PRIVACY ACT MATERIAL REMOVED

- 7 -

enclosure (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title	_____
Accession No.	326-50-0007
File Code No.	19-7-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Dates	_____

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3003783

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
2-26-41	29,000	60'	--	No symptoms.
3-3-41	30,000	60'	--	No symptoms.
4-11-41	33,000 35,000	50' 10'	--	No symptoms.
4-24-41	36,000	60'	--	No symptoms.
4-28-41	37,000	60'	--	No symptoms.
4-30-41	38,000	60'	--	No symptoms.
5-7-41	38,000	60'	--	No symptoms.
5-9-41	40,000	60'	--	No symptoms.
4-6-42	38,500	360'	4 hrs.	No symptoms.
6-3-42	38,500	360'	4 hrs.	No symptoms.
7-2-42	38,500	360'	3 hrs.	No symptoms.
7-17-42	38,500	270'	2 hrs.	No symptoms.

PRIVACY ACT MATERIAL REMOVED

- 8 -

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No.	3210-90-0007
File Code No.	15-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

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3003784

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
12-11-40	28,000	60'	---	No symptoms.
12-21-40	20,000 30,000	4' 120'	--	No symptoms.
3-14-41	29,000	32'	---	Pain in calf left leg.
3-27-41	17,900 33,600	31' 8'	--	Fatigue.
3-14-42	18,000 34,000	25' 22'	---	No symptoms.
3-17-42	18,000 34,000	24' 15 1/2'	---	No symptoms.

PRIVACY ACT MATERIAL REMOVED

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No.	326-50-0007
File Code No.	5-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

3003785

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
2-19-41	28,000	60'	--	No symptoms.
2-27-41	29,000	60'	--	No symptoms.
3-31-41	32,000 35,000	50' 10'	--	No symptoms.
4-25-41	36,000	60'	--	No symptoms.
5-12-41	40,000	60'	--	No symptoms.

NOTE -- May, 1941 Torn muscle (fibers?), acute flexion right leg.

5-6-42	38,500	120'	4 hrs.	Pain right knee.
5-15-42	38,500	300'	5 hrs.	Pain right knee.
5-25-42	38,500	270'	6 hrs.	Pain right knee.
7-25-42	34,000	44'	--	Pain right knee.

PRIVACY ACT MATERIAL REMOVED

ENCLOSURE (A)

DOCUMENT SOURCE
Lawrence Berkeley Laboratory
Archives and Records Office

Records Series Title _____

Accession No. 326-50-002

File Code No. 75-1-10

Carton No. _____

Folder No. _____

Notes _____

Found By _____

Date _____

COPY

3003786

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
11-1-40	20,000	40'		
	28,000	200'		
	35,000	120'	--	No symptoms.
2-19-41	28,000	60'	--	Pain right shoulder after 22'.
2-20-41	37,000	390' (Helium & O ₂) 90' (oxygen)		Pain right shoulder after 122'.
5-6-41	33,600	52'	1 hr.	No symptoms.
5-13-42	38,500	720'	4 hrs.	No symptoms.
7-2-42	38,500	360'	3 hrs.	Slight pain left knee & left hand, disappeared after 67'.

PRIVACY ACT MATERIAL REMOVED

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title	_____
Accession No.	326-50-0007
File Code No.	19-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

3003787

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
11-22-40	20,000 25,000 33,000	40' 45' 25'	--	Pain right ankle and knee.
11-27-40	33,000 35,000	150' 120'	88 mins.	No symptoms.
12-11-40	37,000	240'	5 hrs.	No symptoms.
2-19-41	28,000	60'	--	No symptoms.
3-14-41	30,000	60'	--	No symptoms.
3-25-41	30,000 35,000	50' 10'	--	No symptoms.
4-11-41	33,000 35,000	50' 10'	--	No symptoms.
4-16-41	35,000	60'	--	No symptoms.
4-25-41	36,000	60'	--	No symptoms.
4-30-41	38,000	60'	--	No symptoms.
5-12-41	40,000	60'	--	No symptoms.
5-27-42	38,500	720'	4 hrs.	No symptoms.
6-18-42	38,500	360'	4 hrs.	No symptoms.
7-6-42	38,500	360'	3 hrs.	No symptoms.

PRIVACY ACT MATERIAL REMOVED

- 12 -

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No.	326-90-0007
File Code No.	19-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

3003788

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
11-4-40	20,000 29,000 35,000	40' 200' 120'	--	No symptoms.
12-10-40	28,000	60'	--	No symptoms.
12-14-40	37,000	133'	--	Oxygen inhalation prior to ascent, pain left ankle & right calcaneus.
3-14-41	29,000	32'	--	No symptoms.
6-1-42	38,500	133'	3 hrs.	Pain right heel, right wrist.
7-25-42	34,000	125'	--	Pain left heel and ankle.

PRIVACY ACT MATERIAL REMOVED

- 13 -

ENCLOSURE (A)

DOCUMENT SOURCE	
Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title	_____
Accession No.	32-90-0007
File Code No.	19-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

3003789

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
10-28-40	25,000 35,000	240' 120'	--	Pain right shoulder. Pain right knee.
12-5-40	20,000 25,000 30,000 37,000	40' 42' 117' 49'	--	Pain both knees & left shoulder.
11-29-40	37,000	120'	3 hrs.	Intestinal gas pains.
3-13-41	30,000	60'	--	Pain both shoulders.
3-27-41	17,900 33,600	31' 8'	--	Fatigue.
3-31-41	28,000 34,000	30' 28'	--	No symptoms.
5-7-41	38,000	60'	2 hrs.	No symptoms.
8-22-41	40,000	68'	2 hrs.	Pain left arm.
11-5-41	18,000 34,000	18 1/2' 19'	--	No symptoms.
3-31-42	34,000	1440'	4 hrs.	No symptoms.
4-8-42	38,500	22 1/2'	1/2 hr.	Pain both arms.

PRIVACY ACT MATERIAL REMOVED

- 14 -

ENCLOSURE (A)

DOCUMENT SOURCE	
Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title	_____
Accession No.	326-90-0007
File Code No.	19-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

3003790

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
2-25-42	30,000 34,000	6 1/2' 31 1/2'	--	No symptoms.
3-24-42	34,000	60'	2 hrs.	Pain left knee.
3-26-42	34,000	309'	4 hrs.	Pain left knee.
3-30-42	34,000	22'	--	No symptoms.
4-2-42	34,000	240'	2 hrs.	Pain right knee.

PRIVACY ACT MATERIAL REMOVED

- 15 -

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No.	326-96-0007
File Code No.	19-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

3603791

Name --- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
11-26-40	20,000 25,000 30,000	40' 45' 90'	--	Dull pain right knee after 60'.
12-2-40	37,000	120'	3 hrs.	Pain right knee.
12-12-40	20,000 37,000	300' 10'	--	Intense pain right knee.
2-25-42	30,000 34,000	6 1/2' 31 1/2'	--	Pain right shoulder.
3-30-42	34,000	22'	--	Pain left knee.

PRIVACY ACT MATERIAL REMOVED

* 16 -

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No.	326-50-0007
File Code No.	9-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found By	_____
Date	_____

COPY

3003792

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
3-4-42	34,000	43'	--	Pain right knee.
3/24-42	34,000	60'	2 hrs.	No symptoms.
3-31-42	34,000	15'	--	No symptoms.
4-3-42	34,000	19'	--	Pain right knee.

PRIVACY ACT MATERIAL REMOVED

- 17 -

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No.	<u>3206-90-0007</u>
File Code No.	<u>19-1-10</u>
Carton No.	_____
Folder No.	_____
Notes	_____
Found On	_____
Date	_____

COPY

3003793

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
3-13-41	29,000	60'	--	No symptoms.
3-27-41	33,600	30'	--	No symptoms.
3-28-41	33,600	98' (O ₂)	--	Pain both knees after 23'.
5-13-41	34,000	75' (O ₂)	--	Pains right foot and knee after 36'

PRIVACY ACT MATERIAL REMOVED

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No. _____	326-90-0007
File Code No. _____	19-1-10
Carton No. _____	
Folder No. _____	
Notes _____	
Found By _____	
Date _____	

COPY

3003794

Name -- [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
11-18-40	20,000	40'		
	25,000	45'		
	32,000	155'		
	35,000	120'	--	Fatigue in evening.
12-6-40	37,000	138'	4 hrs.	Pain left knee after 130'
3-19-41	30,000	50'		
	35,000	10'	--	No symptoms.
4-17-41	35,000	60'	--	No symptoms.
4-25-41	36,000	60'	--	Pain right leg 27'
5-21-42	38,500	360'	3 hrs.	No symptoms.
6-17-42	38,500	94'	4 hrs.	Off oxygen 27' before ascent. Pain right knee.
7-15-42	38,500	210'	2 hrs.	Drowsy, unable to stay awake.

PRIVACY ACT MATERIAL REMOVED

ENCLOSURE (A)

DOCUMENT SOURCE	
Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title	<u>High Altitude Studies</u>
Accession No.	<u>326-90-007</u>
File Code No.	<u>7-19-1-10</u>
Carton No.	<u>7</u>
Folder No.	<u>30</u>
Notes	
Found By	<u>P. W. W.</u>
Date	

COPY

3003795

Name -- Lieut. [REDACTED]

DATE	ALTITUDE	TIME	OXYGEN DECOMPRESSION	REMARKS
11-5-41	18,000 34,000	18 1/2' 19'	--	Pain right thumb.
3-4-42	34,000	43'	--	Pain right thumb.
3/14/42	18,000 34,000	25' 22'	--	No symptoms.
3/17/42	18,000 34,000	24' 15 1/2'	--	No symptoms.

PRIVACY ACT MATERIAL REMOVED

- 20 -

ENCLOSURE (A)

DOCUMENT SOURCE Lawrence Berkeley Laboratory Archives and Records Office	
Records Series Title _____	
Accession No.	326-90-0004
File Code No.	19-1-10
Carton No.	_____
Folder No.	_____
Notes	_____
Found On	_____
Dates	_____

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