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Recommendations for Improved Air Decompression Schedules for Commercial Diving

Edward L. Beckman

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RECOMMENDATIONS FOR IMPROVED AIR DECOMPRESSION SCHEDULE FOR COMMERCIAL DIVING

by

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ABSTRACT

Decompression schedules for air diving at depths of from 100 to 250 FSW with various times of work on the bottom were computed by Haldane, Workman, and Lambertsen techniques (Decom 1), after the method of Bühlmann (Decom 6), and after the scientific approach of Hills (Decom 8). The resulting dive tables were compared with depth and time diving schedules used by the U.S. Navy on one hand and those recommended by the British Royal Naval Physiological Laboratory on the other. The comparative evaluations disclosed that the U.S. Navy tables have significantly shorter decompression times and use more shallow decompression stops than do the other tables. It is recommended that the British Royal Naval Physiological Laboratory air diving tables of 1968 be adopted for use by the commercial diving industry in this country in an effort to provide greater safety to diving decompression practice.

TABLE OF CONTENTS

LIST OF FIGURES

Figure

LIST OF FIGURES (cont.)

Figure

LIST OF TABLES

Table

PREFACE

This report covers work done by the author for the most part at Texas A&M University under a Sea Grant project entitled "Safer Decompression Procedures for Diving," under Grant No. 04-5-158-19, over the period 1 September 1972 through 31 August 1975, and in part through a contract with the National Institute for Occupational Safety and Health for the "Development of an Improved Decompression Table" from 30 May 1972 through 30 June 1973. The NIOSH contract was supplemented and extended to 30 June 1974. During 1 September 1975 through 31 August 1976, the report was completed and submitted to the Sea Grant College Program, University of Hawaii, where the author is continuing this work.

James Moore, computer scientist of the Data Processing Center, Texas A&M University, provided both mathematical consultation and computer modeling support for this project.

The development of the computer programs used for decompression table computation was accomplished under federal grant support and therefore these calculation methods are in the public domain. The computer programs and techniques developed in the course of preparation of this report will be made available to any agency upon request and payment of a non-profit service fee. For information contact:

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INTRODUCTION

Statement of the Problem

In 1971, legislation was enacted in the United States to "assure, as far as possible, safe working conditions for every man and woman in the country"(1). This legislation is in the form of a law called the Williams-Steiger Occupational Safety and Health Act. Although employers and employees are beginning to accept the need for this legislation, the concept as to what standards are necessary to fulfill the purpose of the Williams-Steiger act differs widely between the two groups. Understandably, the employees are desirous of the maximum amount of safety that can be provided without regard to work efficiency and productivity, whereas the employers who must be competitive in business are interested in the maximum amount of efficiency and work output on the job site. These two interests are not mutually exclusive but are certainly divergent.

Although the National Institute for Occupational Safety and Health has the responsibility for developing criteria for the safety and health of workers, the U.S. Department of Labor has the ultimate federal responsibility for the development of standards for the safety and health of workers under this law. In their first effort to establish standards for divers, the Department of Labor sought the obvious solution, i.e., to establish the *U.S. Navy Diving Manual* (2) as a standard for commercial diving operations, with which the U.S. Navy concurred. However, the diving industry, through its Association of Diving Contractors (ADC), resisted the use of the *U.S. Navy Diving Manual* as a standard and delayed the Department of Labor from establishing it as a standard. The ADC objected to the use of many parts of the diving manual as being unsuitable for commercial use and to the "across the board" acceptance of the diving tables, as did also the divers themselves.

The U.S. Navy has historically believed that its decompression tables were exceptionally safe and that it was only when divers were injudicious in the use of the U.S. Navy diving tables that decompression sickness would occur. It also believed that dysbaric osteonecrosis was a disease affecting caisson and tunnel workers and divers who did not follow the U.S. Navy decompression tables, and that U.S. Navy divers were protected against this disease. It is also the belief of the U.S. Navy that should one of their divers develop Type II, central nervous system, decompression sickness due to some technical error, it would produce only the less serious spinal cord lesion and not affect the critical higher brain centers.

However, the experience of commercial divers working in the Gulf of Mexico oil field development has led them to different conclusions regarding the use of the U.S. Navy diving tables from those held within the naval service. Like other commercial divers, Navy divers who left the Navy and became commercial divers in the "oil patch" had problems with decompression sickness when they used the U.S. Navy air tables below 150 feet of seawater (FSW). Commercial divers were also troubled with decompression sickness regularly when they made successive dives (i.e., one dive every 12 to 16 hours over a period of several days), or "repetitive" dives (i.e., successive dives repeated in less than 12 hours) using procedures approved in the *U.S. Navy Diving Manual*. The U.S. Navy helium diving tables produced decompression sickness so frequently that the commercial diving companies developed their own helium diving tables. A survey of one group of commercial divers who were working in the Gulf and who used the U.S. Navy air tables, some of whom had been trained in the Navy, revealed that 30 percent of them suffered from significant dysbaric osteonecrosis (3). It appears that the use of the U.S. Navy air diving tables for commercial diving had not only produced severe decompression sickness but also caused a high incidence of dysbaric osteonecrosis as well.

In addition, some commercial divers who suffered from severe Type II, central nervous system, decompression sickness were found to have lesions affecting diverse parts of both their brain and spinal cord, including some which caused a significant decrease in their mental capacity (4). This enfeebling type of cerebral dysfunction found in commercial divers who had had Type II decompression sickness of the central nervous system is comparable with the cerebral dysfunction observed among caisson workers who had suffered Type II, central nervous system, decompression sickness described by Rozsahegyi (5). He reported multiple lesions in the telencephalic, diencephalic, mesencephalic, metencephalic, and mylencephalic structures of the brain which he observed both clinically and during autopsies on caisson workers who had suffered from central nervous system decompression sickness.

These facts lend support to the premise of the ADC that the use of the *U.S. Navy Diving Manual* may not be suitable for use as a standard for commercial diving operations, at least insofar as diving tables are concerned.

Importance of the Problem

Since the advent of the Arab energy embargo, the production of offshore subsea energy resources and the requirement for diver support in such efforts have taken on far greater importance than they had five years ago when the problem of developing standards for safe diving arose.

The exploration and production of energy resources beneath the North Sea alone have demanded the support of over 500 commercial divers. This number is expected to increase threefold within the next two years.

Inasmuch as the offshore mineral leases have already been granted, the development of energy reserves in the Texas portion of the Gulf of Mexico is likewise imminent. The energy reserves of the Santa Barbara Channel in California will undoubtedly also be developed, as will those off the Atlantic coast. It has been estimated within the offshore oil production and diving industries that the number of commercial divers needed by the oil industry will increase from 1,000 to 10,000 within the next five years.

This country needs the help of these divers and they, in turn, deserve the protection of adequate federal work standards. It is therefore important to determine what diving tables should be used to permit these divers to carry out their job with safety and with the assurance that they are not undermining their own safety and health in the process.

Approach to the Problem

Although both the ADC, as management, and the commercial divers, as labor, wish to avoid the penalties of decompression sickness and its effects upon the health and safety of the diver, neither is in a position to directly resolve the differences between the Department of Labor, a proponent of the use of the U.S. Navy diving tables, and the diving industry which has had unfortunate experiences from the use of these tables in commercial diving.

In order to satisfactorily evaluate any decompression table, numerous human experiments must be carried out to test the proposed schedule both in hyperbaric chambers and in the open sea. These procedures are not only costly in time and money, but are inherently dangerous to the subjects. Therefore, it is appropriate to first evaluate any new concepts and decompression tables by comparison with standard established tables.

In order to evaluate the various concepts in use and those proposed for calculation of decompression tables and without resorting to extensive testing with human subjects, a program was established in which the various new concepts could be computer modeled so that comparable pressure-time profiles could be calculated. Numerous decompression profiles could be rapidly computed and then compared with each other and with standard tables to determine whether any systematic errors or significant deviations existed.

Since the use of the U.S. Navy diving tables represented the basis of the contention which established the need for this investigation, it was therefore appropriate to compare the Navy tables with other tables.

Comparative studies of all the U.S. Navy diving tables were not indicated. Tables for scuba diving systems and closed-circuit, oxygen-breathing systems which are useful to the military in clandestine operations also were not studied because they are not helpful to the commercial diver who needs the safety of surface-supplied diving equipment. Furthermore, because the various commercial diving companies which comprise the diving industry had already developed their own tables for helium/oxygen diving to permit divers to operate with greater safety and at greater depths than permitted by the U.S. Navy diving tables, this analysis was not directed toward helium/oxygen diving. Comparative studies were limited to the tables for air diving greater than 100 FSW.

If the U.S. Navy standard air decompression tables for diving are to be compared with experimental tables, then some other decompression table should be used as a standard for comparison. Since much commercial diving is currently being done in the North Sea where the British Royal Naval

Physiological Laboratory (RNPL) air diving tables of 1968 (6) are in use, it would be appropriate to consider these tables as a standard for comparison. Des Granges (7, 8) similarly accepted the Royal Naval diving tables as a standard of comparison when he developed the current U.S. Navy air diving tables in 1956.

There are, however, more compelling reasons to accept the British RNPL air diving tables as a standard. First of all, they have been operationally tested. They have also been adopted for commercial diving in the North Sea and have met the test of producing minimal decompression sickness in operational use. Even more important, however, is the fact that these accepted tables represent a scientific and experimental departure from the Haldanian, Des Granges, and USN air decompression tables.

British investigators had long questioned the dedication of U.S. workers to the Haldanian theory (9). However, progress in understanding and applying the basic physical laws applicable to gas uptake and elimination in the tissues as related to diving had been limited until Hempleman (10) began to reevaluate older theory and then introduced his "single tissue" model in 1952. This model was further refined by theory and animal experiments and culminated in the British RNPL *Air Diving Tables* of 1968 (6).

In developing the model for the calculation of these tables, Hempleman (10) made the following limiting assumptions: (1) only one tissue type is involved in the production of the decompression sickness pain known as Type I bends; (2) the rate of uptake of gas in that tissue is limited by diffusion; (3) the rate of gas uptake in that tissue is greater than the rate of gas elimination during decompression by standard methods because "silent" bubbles which interfere with gas elimination form in the tissue even in a "troublefree" dive; (4) a certain critical quantity of gas can be tolerated by the tissue without producing symptoms (bends pain occurs only if that critical excess quantity is exceeded); and, (5) the rate of gas diffusion into the critical tissue could be stated by the equation for linear diffusion of gas into a slab of tissue, one face of which is exposed to the gas tension dissolved in the arterial blood.

Although the principles underlying this model and the method of calculation of RNPL decompression tables are almost diametrically opposite to the method used by Des Granges (7) for calculating the U.S. Navy air decompression tables, each has been considered successful by its respective navy. Thus, these tables should serve as excellent standards by which to judge other decompression tables, as well as a scientific counterpoint to the empiric U.S. Navy tables.

It will also be necessary to review the developments in decompression sickness calculation techniques described in the open literature and to determine which methods represent the optimal developments in both the empiric and the theoretical approaches. These methods or concepts could then be developed into computer models and used to generate appropriate comparative air decompression tables.

ANALYSIS OF THE PROBLEM: HISTORICAL REVIEW

Decompression sickness was recognized as a disease entity affecting divers and caisson workers 100 years ago. Ever since, physicians, physiologists, physicists, chemists, engineers, and even divers themselves have been devising decompression techniques which are intended to prevent the onset of the disease. The results have been disappointing, to say the least.

The most heralded of this group of scientists was Haldane (9) who, with his associates, proposed a method for calculating decompression tables based upon an empiric finding that divers could safely ascend from 33 FSW to the surface, i.e., a pressure change in the ratio of 2:1, 2 atm abs/1 atm abs. This ratio principle has been modified and adapted to accumulating empiric data. Since then, innumerable variations of this technique have accumulated and the original calculation technique has been remodeled by successive investigators. The number of "tissues" has been tripled and the fixed ratio modified by factors which varied for different tissues and depths. The ratio principle has been extended from air diving to the use of breathing different gas mixtures to include nitrogen, neon, argon, helium, oxygen, and various combinations of each.

However, there had been little progress in understanding and applying the basic physical laws pertaining to gas uptake and elimination and bubble formation until Armstrong (11) discovered that aviators suffered from the same decompression sickness syndrome that afflicted divers and caisson workers. As a result, the U.S. National Research Council (NRC), during World War II, appointed a subcommittee to study the problem of decompression sickness from a broad biological standpoint so as to elucidate the factors involved in bubble formation in the tissues and to devise ways of minimizing the dangers of decompression sickness to flying personnel (12). The NRC, through contracts, stimulated some pioneering investigations. Notable among these were the works of Harvey and Nims. Harvey's (13, 14) fundamental work was on the physical factors of bubble formation and the relation of these factors to the formation of bubbles in animal tissues (15). Harvey determined that gas micronuclei had to be present in order for bubbles to form during decompression regardless of the supersaturation tension. He related this physical requirement to the response of biological systems to decompression and the development of decompression sickness. Nims (16) then incorporated Harvey's (13) concepts of "precursor" microbubbles into a theory of the causation of decompression sickness based upon the physical laws affecting gas diffusion into bubbles, bubble growth, and tissue distortion, producing pain and the syndrome of decompression sickness.

Early progress in operational diving in the United States was limited principally to that carried out by the U.S. Navy. Diving research had been primarily directed toward improvement of the basic Haldanian ratio tables (17). As early as 1935, U.S. Navy specialists in diving medicine established that the Haldanian 2:1 ratio was too conservative for the short half-time tissue compartments (18). Nonetheless, when the current U.S. Navy air decompression tables and the repetitive diving decompression tables for air diving were calculated (7, 8) and published in 1963 (19), the "slowest" tissue compartment considered to be of significance was that of T 1/2 = 120 minutes with a surfacing ratio of 2:1. However, when Workman calculated the air saturation decompression tables (20), which later became known as the U.S. Navy Standard Air Decompression Table for Exceptional Exposures, he determined that a tissue compartment with T 1/2 of 160 min and 240 min had to be included in calculations for diving to 300 FSW for 60 minutes. Progress in the development of the empirical Haldane model was limited to increasing the number of "tissue half-times" from Haldane's 5, to 16 and over, and increasing the half-time values from the 5 to 75-minute values used by Haldane to the 5 to 1000-minute T 1/2 values used by later investigators in an attempt to make experimental data fit the model.

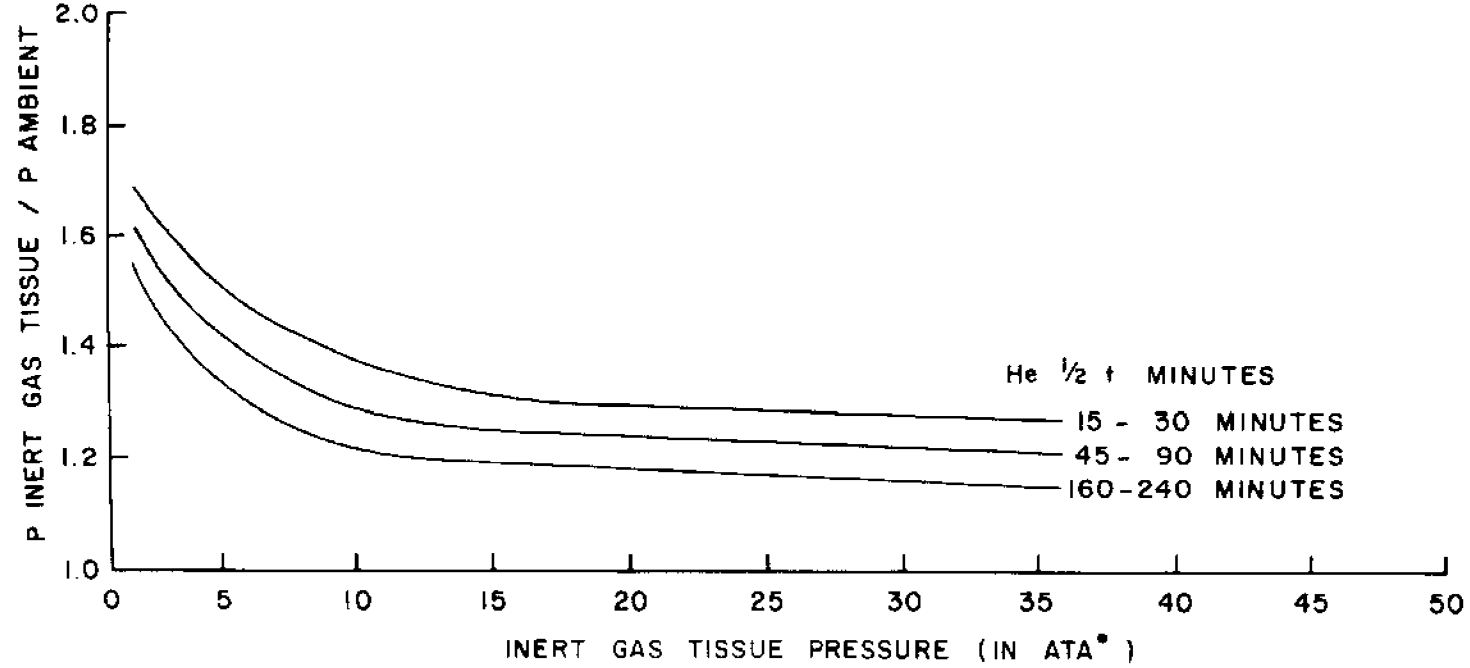
The next significant advance in diving technology occurred in 1960 when Keller, working under the tutelage of Bühlmann, carried out a short dive to over 700 ft in the lake at Zurich, Switzerland (21). This was shortly followed by a dive to 1000 FSW in the open ocean. Both dives not only opened up a new horizon to the diving world, but also demonstrated that the differences in uptake and elimination rates of different inert gases (e.g., helium, neon, argon, and nitrogen) could be used advantageously in diving (22, 23).

Bühlmann continued with the development of his empiric method. By painstaking experimentation in his laboratory and careful review of the results of operational testing of his tables, he developed curves relating the allowable safe supersaturation ratio for different half-time tissues to depth (22). He found that these curves can also be related to each other for dives in which different breathing gas mixtures are used, according to Graham's law, on the basis of the relative diffusion coefficient of these gases; i.e., in proportion of the $\frac{1}{\sqrt[2]{\text{mol. wt.}}}$ of the gases.

These relationships were presented to the scientific community in Philadelphia in June 1970. By the use of these changes in allowable safe supersaturation ratios, as shown in the curves in Figure 1, Bühlmann (23) has been able to calculate decompression schedules for short, deep dives, as well as for saturation dives using all types of inert breathing gas mixtures both in the laboratory and in operational diving. It would therefore be appropriate to compare the air diving tables calculated according to Bühlmann's concepts with U.S. Navy and RNPL air decompression tables.

Progress in the development of decompression procedures based upon the opposite approach to that of the Haldanian empiricists, i.e., development of a scientifically conceived model which subsequently was tested in the laboratory and modified on the basis of experiment, was given its greatest impetus by British investigators, notably Hemplemen (24). His efforts and progress have been described previously and his decompression schedules have been established as an appropriate standard.

As might be expected, Italian medical investigators began research on diving and its diseases at the same time that the Italian frogmen were accomplishing so much in their clandestine underwater activities in the



* 1 ATA = 1 ATMOSPHERE TECHNICAL ABSOLUTE OR 735.6 mm Hg

After reference 23

Figure 1. Tolerated supersaturation factor (ordinate) for fast tissues with He half-times to 30 minutes; for slower tissues, from 45 to 90 minutes; and for the slowest tissues, from 160 to 240 minutes, correlated with the total inert gas pressures in the respective tissues (abscissa). The stages of deompression were calculated according to these supersaturation factors.

ports of the Mediterranean Sea. These investigators also challenged the Haldanian concepts and reiterated the concept propounded by Hill (25) that decompression, so as to prevent free bubble growth, depended upon the difference in pressure between the tension of the gas dissolved in the tissues and that of the ambient pressure (i.e., delta P) rather than the ratio of pressures as upheld by the Haldanian doctrine (26). Further clarification of their concept (26) that gas particles in the free state must exist in animal tissue was achieved by Aggazzotti and Ligabue (27). They measured the changes in volume of animal tissues with increased pressure and found that the decrease in volume was greater than that for distilled water and concluded that there were particles of gas in their free state in the animal tissues. Although this monumental finding was accomplished at the same time that Harvey and his co-workers were studying gas micronuclei in fluids in the United States, a world war prevented communication and collaboration and obscured Aggazzotti and Ligabue's work for several decades.

On the basis of these investigations, Albano (28) conceived of a method for decompressing divers by postulating that the growth of the microbubbles could be controlled by application of known laws of physics. He determined "overpressure" (delta P) values for the minimum allowable pressure gradients across the gas nucleus to prevent growth of the bubbles (and the production of decompression sickness) in various tissues, i.e., bone, mesentery, spinal cord, and brain stem (Table 1).

TABLE 1. VALUE OF SOME TISSUE CONSTANTS

Location of Lesions	T/2 (min)		Kp_c (mm Hg)
	Nitrogen	Helium	
Bone	63.59	36.29	605[3]
Mesentery	43.87	18.99	1,020[3]
Spinal Cord	41.01	27.28	1,035[3]
Brain Stem	33.98	23.49	1,270[3]

Kp_c = specific critical constant of the pressure gradient of the gas nucleus.

The decompression tables published by Albano for saturation diving with a nitrogen/oxygen atmosphere were compared with those developed and tested and used operationally for Project Tektite in 1971 (29). The Albano tables were similar to some of the first Tektite experimental tables which were found to be extremely dangerous. It was apparent that this concept of bubble growth control during decompression was deficient in some critical parts of the theory, so this method of calculation was not adopted for comparative evaluation.

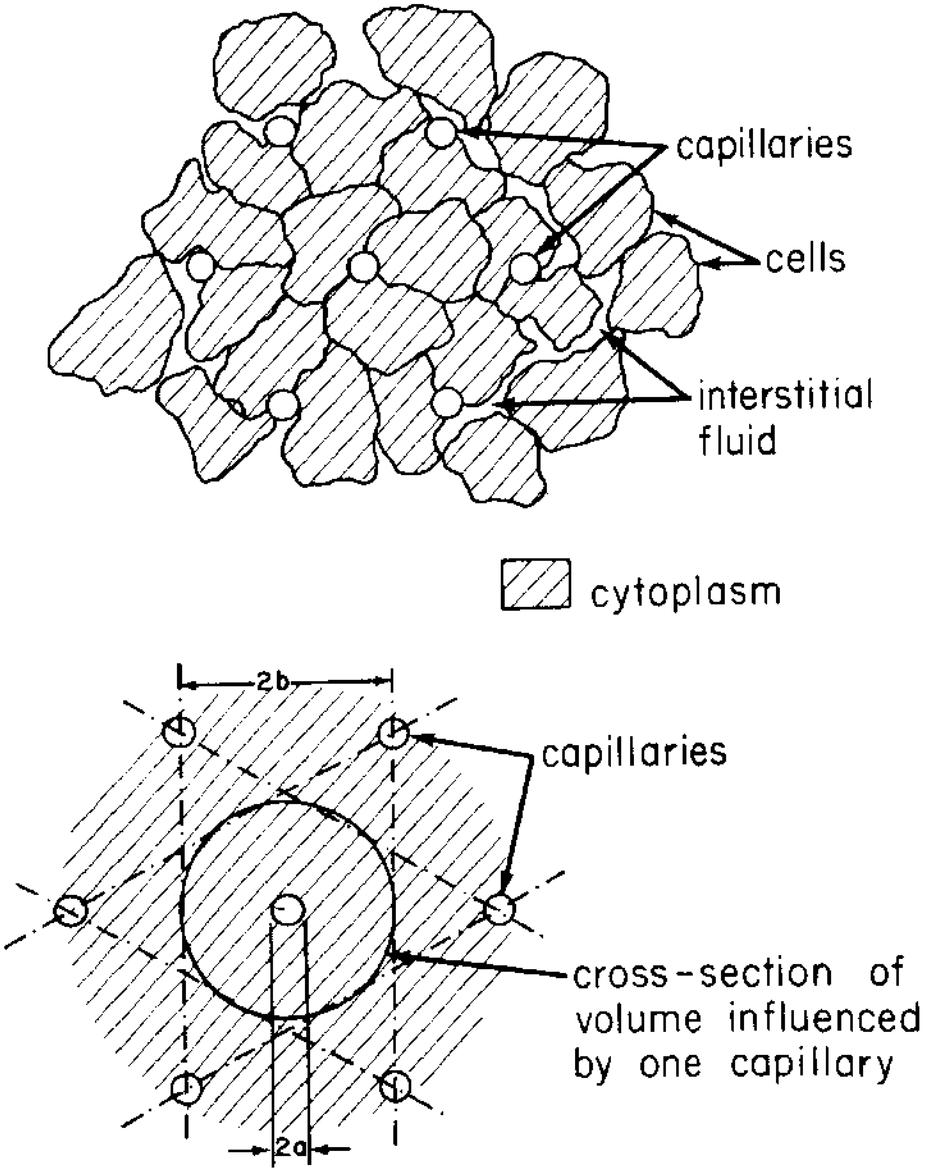
The next significant advancement of the understanding of the scientific basis of decompression sickness occurred in 1966 with the publication of Hills' dissertation entitled, "A Thermodynamic and Kinetic Approach to Decompression Sickness" (30). Hills approached the problem of preventing decompression sickness from the point of view of a physical chemist and, on the basis of this approach, developed an entirely new concept, that of zero tissue supersaturation for determining a rate of decompression for divers. This method permitted no supersaturation of inert gas with respect to ambient pressure to occur in the tissues and thus prevented any bubbles from forming in their tissues at all. This approach was non-Haldanian with no supersaturation ratios and was viewed with considerable skepticism by the "old line" investigators.

In the Haldanian theory, the assumption is made that the rate of inert gas uptake in the tissues for a given change of inert gas pressure is comparable with the rate of inert gas elimination from the tissues for an equal decrease in inert gas pressure. For Haldanian decompression, this assumption was subsequently disproven when "silent" bubbles were detected following U.S. Navy-Haldanian decompression by use of the Doppler flow meter (31, 32). If a gas phase (bubbles) forms in the tissues during decompression, then the rate of gas elimination is slowed significantly by a decrease in the tension gradient of the gas in solution and by the amount of gas sequestered in the bubble. Hills' model is designed to prevent the formation of the gas phase in the tissues at least until the ascent has approached 20 ft from the surface. At this level a rapid ascent to the surface is permitted with the formation of the gas phase, but under controlled conditions.

Hills' gas uptake and elimination model is based upon radial diffusion of inert gas with the assumed geometry of a single capillary surrounded by a cylinder of cells (Figure 2). He assumes that the tissue which causes bends pain is the most sensitive tissue and that if bubble formation is prevented in this most critical tissue, then bubbles will not occur in other tissues, such as those which cause central nervous system decompression sickness.

In order to meet the stipulations of the Hills model, it is necessary to continuously calculate the changing tissue tension in the cylinder of tissue around the capillary. The maximum tissue tension calculated at any point in this tissue cylinder is then used as the controlling value in decompression. However, in this model it is necessary to know not only the value of the maximum tension in the tissue but also the location of the maximum tension with respect to the adjacent capillary. It is then possible to control the rate of decompression so that the ambient pressure does not exceed the value for the "peak" inert gas tension in the tissue cylinder, or permit local areas of tissue supersaturation.

THE WORST POSSIBLE CASE



After reference 32

Figure 2. Hills' worst possible case demonstrating the geometry of the diffusion pathway and the controlling factors.

METHODS

The initial effort of this study was to develop a competence in computer modeling of decompression calculation methods. Professor C.J. Lambertsen, Director of the Institute for Environmental Medicine at the University of Pennsylvania, assisted in this effort by kindly supplying a copy of the PADUA (Pennsylvania Analysis of Decompression for Undersea and Aerospace) computer program. The model provided was programmed by H. Bardin of the same institute in October 1968; it used basic Haldane and Workman concepts with Bühlmann ratios. This program formed the nucleus around which other programs were generated.

The PADUA program is a Haldane model and assumes equal rates for inert gas uptake and elimination. It applies an "M" value test for maximum allowable supersaturation in the various "tissue compartments" which is similar to Workman's (39). The various tissue compartments are assigned a representative rate for gas uptake or elimination described in terms of one-half time for each inert gas to be considered, e.g., nitrogen, helium, neon, and argon. In addition, each tissue compartment is assigned a pair of parameters for each gas, defined as an "M" value, i.e., the maximum allowable inert gas supersaturation tension for that tissue compartment. The tissue half-times determine the tissue partial pressures (or tensions) which are then calculated for each state of the dive profile. The "M" values for each of these tissues indicate that it would be "safe" to ascend to the next "stage" or depth of decompression. In contrast to the Bühlmann model, the delta M values are not varied with increasing depth in this model.

The PADUA program for calculating decompression schedules follows the method used by the U.S. Navy and as described by Workman (39). This model uses a linear ascent from depth to attain a maximum permissible gradient with level stops. The decrease in pressure between stops is defined as a "decompression step" and has been arbitrarily and by U.S. Navy convention established at a default value of 10 FSW.

The model deviated from the Workman method in two ways: (1) the partial pressures in the various tissue compartments are calculated exactly rather than being approximated for the linear decompression; and (2) a combined "M" value for the sum of the partial pressures of the various inert gases is determined for each tissue compartment, after the method of Schreiner and Kelly (40).

The time at each decompression stop is the smallest integral multiple of 1 minute which permits further decompression to the next stop without violating the "M" value for any tissue compartment. If the time at a given stop is computed to be zero, that stop will be skipped until the "M" value again becomes limiting at some shallower stop.

The input values used in this program are shown in Table 2. It should be noted that the delta M values are fixed, as are the surfacing M values. However, the ratios determined from these values may decrease as depth or tissue tension is increased.

TABLE 2. PADUA PROGRAM INPUT VALUES (1969)

Parameter	Inert Gas	Input Values for Tissue Half-Time Compartments									
		1	2	3	4	5	6	7	8	9	10
T 1/2 (Min.)	N_2	5	10	20	40	80	120	160	240	320	480
"M" Values	N_2	100	84	68	53	52	51	50	49	49	48
Delta M	N_2	16	15	14	13	12	11	11	10	10	10
T 1/2 (Min.)	He	5	10	20	30	60	85	100	120	140	180
"M" Values	He	82	71	63	61	56	54	54	53	53	52
Delta M	He	11	11	11	10.5	10	10	10	10	10	10

The inert gas will be lost from the tissue cylinder at a rate depending upon the tissue inert gas to capillary (venous) blood gas gradient which, in this model, is established by the "inherent unsaturation" of the tissue. The "inherent unsaturation" occurs in the tissues as a result of the continuous decrease in total gas tension as oxygen is continuously utilized in metabolism.

The above calculations of peak tissue gas tension must be repeated continuously during decompression, which is obviously very tedious. However, the use of the digital computer makes this a practical model instead of a laboratory monstrosity. The mathematical modeling necessary to adapt these theories to a computer model was proven to be feasible.

Whereas other investigators have utilized the coefficients of diffusion which are listed in standard references, Hills, contending that these are static measurements, utilized dynamic measurements in decompression calculations. He made measurements of coefficients of diffusion for dynamic conditions (33) and obtained values comparable with those published by Krogh (34) for a dynamic system. The values obtained by Hills are thought to be those of a micro-diffusion system rather than those of a macro system. It may be significant that the values for "dynamic" diffusion of a micro system are 1,000 times slower than those obtained for a macro system.

Certainly Hills' concepts merited evaluation and so computer models of his concepts for decompression table calculation (Decom 6, 7, 8, and 11) were developed.

The "bubble birth control" concept of Albano (26) has been augmented through the significant work on growth of bubbles in gelatin by LeMessurier (35) who reported on his work on bubble genesis in gelatin in 1972. Although the data presented were not directly applicable to the concept of providing safe decompression procedures, they did indicate that the genesis of bubbles occurred precipitously whenever gas tension in the gelatin exceeded the ambient pressure by a critical measurable amount.

Recently, more definitive data on the theory of bubble formation have been presented by Yount (36) and Strauss (37). The physical concepts elucidated were then carried over to considering the physics of bubble formation in decompression sickness and applying these rules to improvements in decompression calculation methods.

It was apparent that these concepts would likewise be considered in any comparative study of decompression table calculation methods. To represent these concepts, a computer model which provides reasonable decompression for all types of dives from short, deep dives to saturation dives (38) has been generated. However, much more work is required before this model can be applied. Consideration of this model, other than to report on its inception must be deferred until more required experimentation can be carried out.

Decom 1

After the PADUA system was used to compute various test dive profiles, a few minor changes were made in the input values, principally in adding longer tissue half-time compartments in modifying slightly the "M" and delta M values in light of the Tektite program decompression results (29). The input values for Decom 1 are shown in Table 3.

TABLE 3. DECOM 1 INPUT VALUES

Parameter	Inert Gas	Input Values for Tissue Half-Time Compartments									
		1	2	3	4	5	6	7	8	9	10
T 1/2 (Min.)	N_2	5	10	20	40	80	160	240	360	480	760
"M" Values	N_2	100	84	68	53	52	51	50	49	48	48
Delta M	N_2	16	15	14	13	12	11	11	10	10	10
T 1/2 (Min.)	He	5	10	20	30	60	80	120	180	210	240
"M" Values	He	80	71	62	59	56	54	53	52	51	51
Delta M	He	11	11	11	10.5	10	10	10	10	10	10

These Decom 1 values were used to compute a series of air dive profiles which had been compared with those of the U.S. Navy (USN) and the RNPL and with decompression tables which were calculated using other models.

Decom 3 and 5

These computer models were developed after the concepts and input values supplied by Professor A.A. Bühlmann (Department of Internal Medicine, Kantonsspital Zurich, Zurich, Switzerland 8091) and through direct consultation with him.

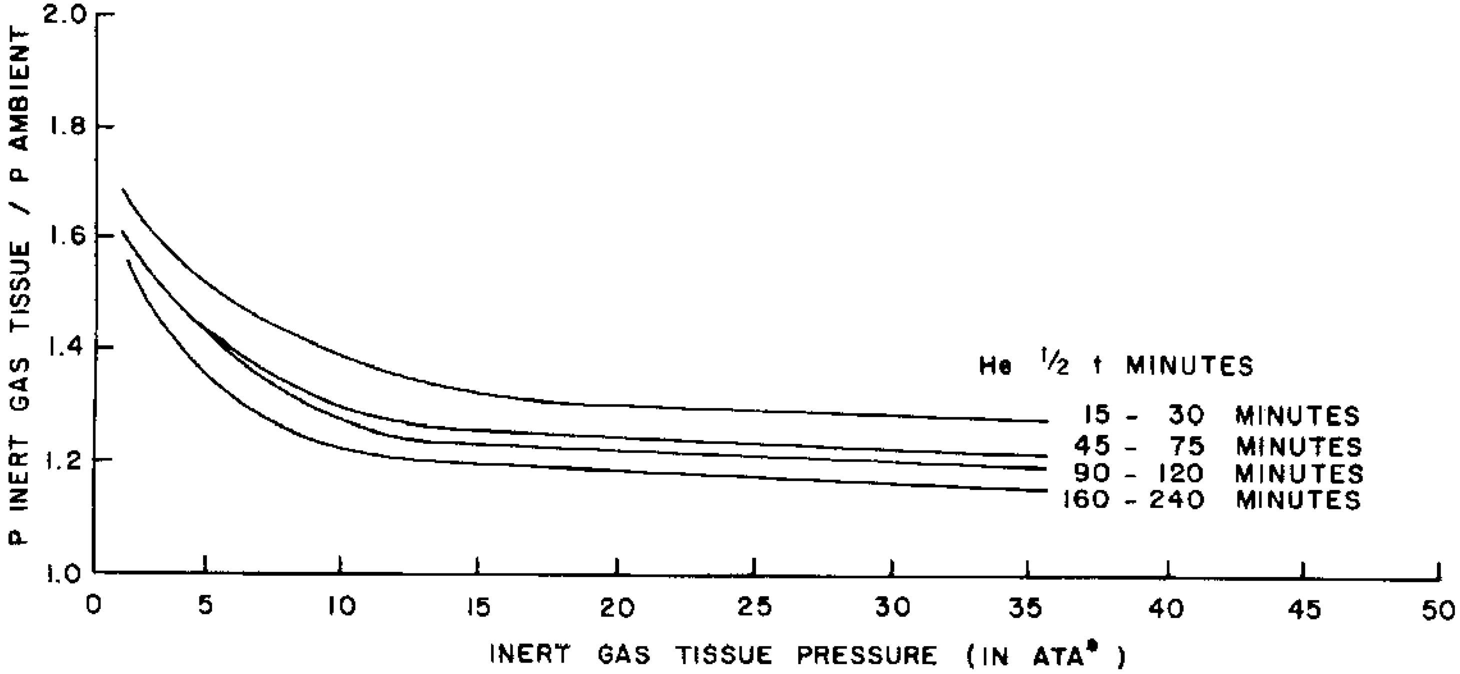
Bühlmann has developed a method of computing decompression tables which is purely empiric; he continually modifies his system to incorporate the results of all tests on dive profiles which he has calculated. This is apparent from his ratio curves for 1968 (Figure 1) which are compared with those of 1972 (Figure 3) and then with those of 1975 (Figure 4). The ratios of Figure 3 served as a basis for the decompression computation system of 1973, Decom 3. Figure 4 provided the ratios for Decom 5.

Bühlmann's method is basically a Haldanian ratio system. However, as is shown in Figures 1, 3, and 4, (1) the ratios vary with depth, (2) different tissue compartments have different ratios, and (3) the difference between these compartment ratios likewise varies with depth. In Figure 1, he assumes that the tissue compartments which are modeled for helium can be related to similar compartments for nitrogen or any other inert gas in proportion to the square root of their molecular weight. This relationship is obviously based upon a gas diffusion concept. Thus, the tissue compartments depicted in the curves for helium in Figure 1 can be equated with values on the same curve for the nitrogen values for tissue half-times equal to:

$$\frac{\sqrt{\text{mol. wt. } N_2}}{\sqrt{\text{mol. wt. He}}} \text{ or } \frac{\sqrt{28}}{\sqrt{4}} = \frac{5.29}{2.00} \text{ or } 2.64 \times 15\text{-}30 \text{ min. T } 1/2 \text{ He} = 40\text{-}80 \text{ min. T } 1/2\ N_2$$

A spectrum of tissue half-time compartments was then generated for nitrogen on the basis of the helium curves in Figure 3 and more recently for the 1975 curves. Equivalent tissue half-time compartments for N_2 were obtained from the 2.64 ratio of the square root of their molecular weight. The values established for the tissue half-time compartments for the 1975 curves, when rounded, are shown in Table 4.

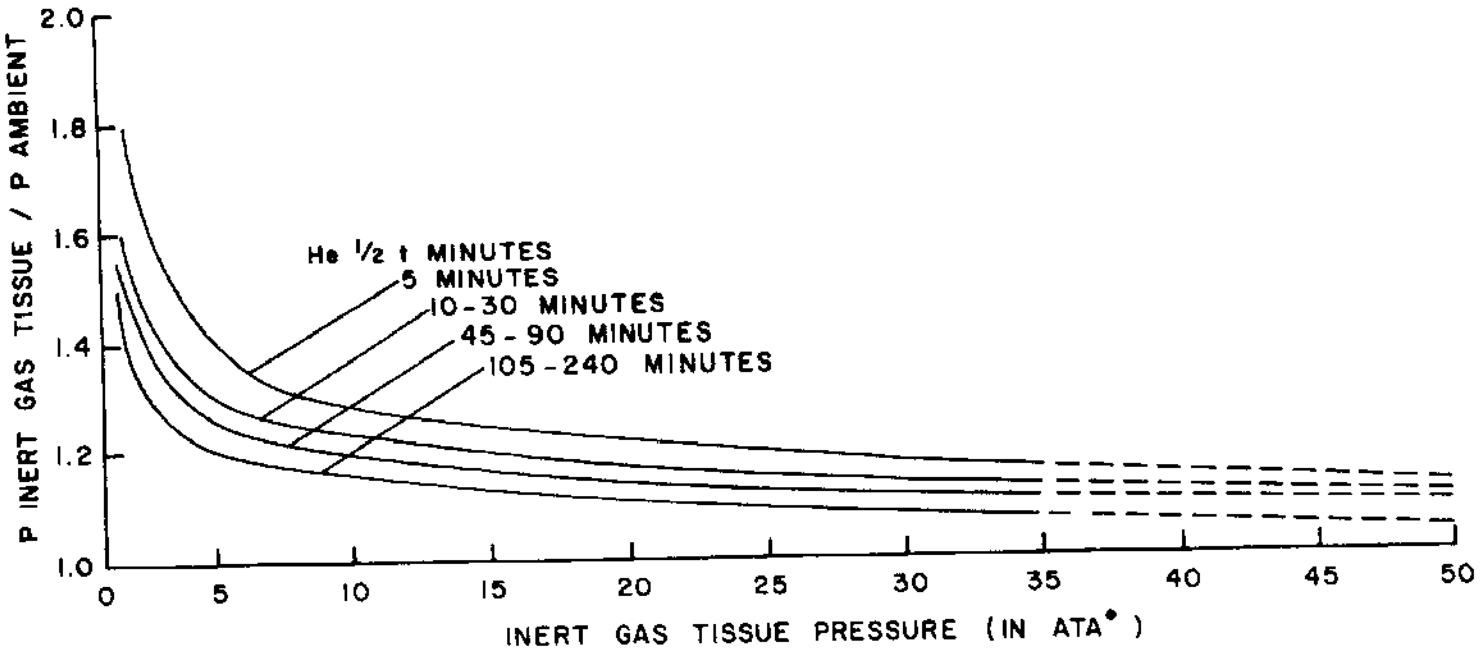
In developing a model from Bühlmann's curves, it was necessary to convert these ratio values to absolute "M" and delta M values. The values of ATA as used by Bühlmann stand for 1 atmosphere technical absolute, or 1 kg/cm^2, which equals 735.6 mm Hg. (This value is often incorrectly equated with 1 atm abs, or 760 mm Hg, as used in the United States.)



* 1 ATA = 1 ATMOSPHERE TECHNICAL ABSOLUTE OR 735.6 mm Hg

From Bühlmann, 1972: personal communication

Figure 3. Bühlmann's P inert gas tissue/P ambient vs inert gas tissue pressure curves



* I ATA = I ATMOSPHERE TECHNICAL ABSOLUTE OR 735.6 mm Hg
From Bühlmann, 1975: personal communication

Figure 4. Bühlmann's inert gas tissue pressure/P ambient ratio vs inert gas tissue pressure

A series of allowable safe tissue supersaturation values, or "M" and delta M values, were then obtained from the tissue compartment safe ratio-graphs. Since Bühlmann's ratios are variable with depth and tissue compartment and in relation to each other, tables for surfacing values and for a pressure of 900 FSW are shown in Tables 4 and 5 for comparison.

TABLE 4. SURFACE VALUES USED FOR COMPUTER INPUT OF DECOM 5 PROGRAM

Parameter	Inert Gas	Input Values for Tissue Half-Time Compartments							
		1	2	3	4	5	6	7	8
T 1/2 (Min.)	N_2	5.3	13.3	26.5	39.7	52.9	79.4	119.1	158.8
"M" Values	N_2	60.8	59.5	57.3	55.1	52.9	52.6	52.0	51.5
Delta M	N_2	13.5	13.5	13.5	13.5	13.5	13.3	13.1	12.8
T 1/2 (Min.)	He	2.0	5.0	10.0	15.0	20.0	30.0	45.0	60.0
"M" Values	He	60.8	59.5	57.3	55.1	52.9	52.6	52.0	51.5
Delta M	He	13.5	13.5	13.5	13.5	13.5	13.3	13.1	12.8
		9	10	11	12	13	14	15	16
T 1/2 (Min.)	N_2	198.4	238.1	277.8	317.5	396.9	476.2	555.6	635.0
"M" Values	N_2	51.1	50.6	50.3	49.8	49.0	48.2	47.4	46.6
Delta M	N_2	12.5	12.5	12.2	12.1	11.8	11.4	11.1	10.7
T 1/2 (Min.)	He	75.0	90.0	105.0	120.0	150.0	180.0	210.0	240.0
"M" Values	He	51.1	50.6	50.3	49.8	49.0	48.2	47.4	46.6
Delta M	He	12.5	12.5	12.2	12.1	11.8	11.4	11.1	10.7

TABLE 5: COMPUTER INPUT VALUES FROM RATIO CURVES FOR USE AT 980 FEET DEPTH IN DECOM 5 PROGRAM

Parameter	Inert Gas	Input Values for Tissue Half-Time Compartments							
		1	2	3	4	5	6	7	8
T 1/2 (Min.)	N_2	5.3	13.3	26.5	39.7	52.9	79.4	119.1	158.8
"M" Values	N_2	1088.0	1082.6	1073.5	1064.4	1055.5	1050.7	1043.8	1036.9
Delta M	N_2	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
T 1/2 (Min.)	He	2.0	5.0	10.0	15.0	20.0	30.0	45.0	60.0
"M" Values	He	1088.0	1082.6	1073.5	1064.4	1055.5	1050.7	1043.8	1036.9
Delta M	He	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
		9	10	11	12	13	14	15	16
T 1/2 (Min.)	N_2	198.4	238.1	277.8	317.5	396.9	476.2	555.6	635.0
"M" Values	N_2	1031.3	1026.9	1022.5	1018.1	1009.4	1000.6	991.6	983.1
Delta M	N_2	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
T 1/2 (Min.)	He	75.0	90.0	105.0	120.0	150.0	180.0	210.0	240.0
"M" Values	He	1031.3	1026.9	1022.5	1018.1	1009.4	1000.6	991.6	983.1
Delta M	He	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0

Because the input data varied continuously, it was necessary to calculate input values such as those shown in Tables 4 and 5 for each 10-ft increment of depth to be considered. This bank of data was used for the input values in the decompression model called Decom 5 (Bühlmann, 1975: personal communication). This model includes the use of work factors which are applied to tissues 12, 13, 14, and 15--if a working dive is being considered. These factors effectively increase the rate of gas uptake in these "slow" tissues, but only during the work period.

Decom 8

Brian A. Hills, professor of Physiology, Marine Biomedical Institute, Galveston, Texas, was then consulted regarding his thermodynamic concepts of decompression. A computer model was then generated through the combined efforts of Hills, Beckman, and Moore (41) in which the technique of Gauss-Lengendre Quadrature was utilized. A series of dive-decompression profiles were then produced by use of this model and compared with the other tables. All of the Hills schedules were calculated for ascent to the surface although the 15, 10, and 5 ft stops are not shown. Hills recommends a direct ascent to the surface from 20 FSW, eliminating the 15, 10, and 5-ft stops entirely. This procedure is based upon Hills' belief that the complete tissue equilibration to surface equilibrium is very time consuming and that the probability of decompression sickness occurring at this time is very low.

Although some 16 different computer programs were generated, several of these were iterations of one of the basic models to include refinements which were indicated from the study of the primary model. A listing of eleven of the principle models generated is as follows:

Decom 1.*	TAMU adaption of PADUA to include Texas input values.
Decom 2.	Second iteration of Decom 1.
Decom 3.	Model development after data concepts provided by Bühlmann (22) and data of 1972.
Decom 4.	Second iteration of Decom 3, with input data of 1975. This model has only 12 tissue half-times.
Decom 5.*	Third iteration of Bühlmann's concepts developed to include 16 tissues, work factors, and M values and delta M values for all tissues in accordance with Bühlmann 1975 curves (Figure 4).
Decom 6.	First model developed in consultation with Hills to incorporate concepts of zero-supersaturation decompression.
Decom 7.	Iteration of preliminary model of Decom 6.
Decom 8.*	Final model of Hills' (41) concepts including subroutine calculation of oxygen toxicity after the University of Pennsylvania model UPTD (Unit Pulmonary Toxicity Dose) and CTOX, Hills' concepts of cumulative oxygen toxicity.
Decom 10.	Preliminary model developed in consultation with Professor David E. Yount to generate a decompression profile based upon constraints imposed by the physical laws governing bubble formation as derived from gelatin studies and extrapolated to human decompression.
Decom 11.	Final version of Hills' (41) model with decompression optimization based upon UPTD-CTOX limits.
Decom 13.	Refinement of Decom 10 to include crushing and regeneration of nuclei.

The basic input data relative to the different computation methods are compared in Table 6.

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*These models are described in more detail. The decompression profiles generated by the use of these models are compared with each other with the USN and British RNPL tables as standards.

TABLE 6. COMPARATIVE DATA ON DECOMPRESSION SCHEDULES

Table	Investigators	Type of Gas Uptake & Elimination	No. of Tissues	Range (T 1/2 N_2 Uptake in Min)	Decom Principles	Change in M-Value	Delta M	Rate of Descent	Rate of Ascent
USN									
1. Standard Air	Haldane Des Granges	Perfusion	6	5.0-120	Ratio	Depth	Fixed	60 ft/min	60 ft/min
2. Exceptional Exposure	Haldane Workman		8	5.0-240					
Decom 1	PADUA Modified	Perfusion	12	5.0-760	Ratio	Depth	Fixed	60 ft/min	60 ft/min
Decom 5	Bühlmann TAMU	Perfusion	16	5.3-635	Ratio		Varies with Depth	60 ft/min	33 ft/min
Decom 8	Hills TAMU	Diffusion	1		Delta P			Instan-taneous	40 ft/min
RN	Hempleman	Diffusion	1		Delta P			50 ft/min	*50 ft/min

*To first stop; 10 ft/min between stops

RESULTS

The air decompression tables that were calculated according to the computer programs called Decom 1 (after Haldane, Workman, and Lambertsen), Decom 5 (after Bühlmann), and Decom 8 (after Hills) are tabulated with comparable U.S. Navy standard air decompression tables and the British Royal Naval Physiological Laboratory air diving tables in the appendix. Air decompression schedules for depths of 100 FSW down through 200 FSW in increments of 10 FSW are given. In addition, schedules for 240 and 250 FSW are included. Schedules for different dive times (i.e., time on bottom which is defined by the U.S. Navy as including the time of descent and time on the bottom up to the time of beginning ascent) for the various depths have been calculated by the different methods for comparison with the U.S. Navy tables. There are approximately 150 depth time parameters tabulated with comparative schedules for the different decompression concepts given for most of the depth time parameters.

It is apparent from even a cursory perusal of the comparative tables that the U.S. Navy tables have a significantly shorter decompression time than the RNPL air decompression tables. Likewise, the U.S. Navy tables in general have significantly shorter decompression times than the tables calculated by the other three methods.

The decompression schedule calculation methods developed during the course of this study provide a capability for calculation of decompression schedules for mixed gas diving as well as for air diving. Two such comparable schedules are included, one for 250 FSW for 60 minutes and the other for 500 FSW for 30 minutes (Figures 5 and 6). The relative differences in the schedules are apparent. No comparative laboratory or field testing of these respective schedules has been carried out; however, the 500 FSW x 30 minutes schedule labeled "Duke" was chosen as a standard for comparison because this dive schedule has been proven in laboratory testing at the Duke Hyperbaric Facility.

DISCUSSION

The calculation of decompression schedules by computer provides printouts of information which would otherwise not become available, purely on the basis of the voluminous calculation which would be required by manual methods. Much is to be gained from such analyses. In Figure 7, a decompression schedule using the Decom 1 model is plotted for a 180 FSW x 30 minutes air dive with 10 FSW decompression stops. In addition, the decompression schedule is calculated for ascent stops every 0.1 ft which approximately describes a continuous rate of ascent during decompression. There is essentially no difference in the duration of the decompression with continuous ascent and the one with decompression stops every 10 FSW.

The advantage of the "continuous ascent" decompression over the 10 FSW stage decompression lies in the fact that the abrupt increases in pressure difference between the inert gas tension in the tissues and the

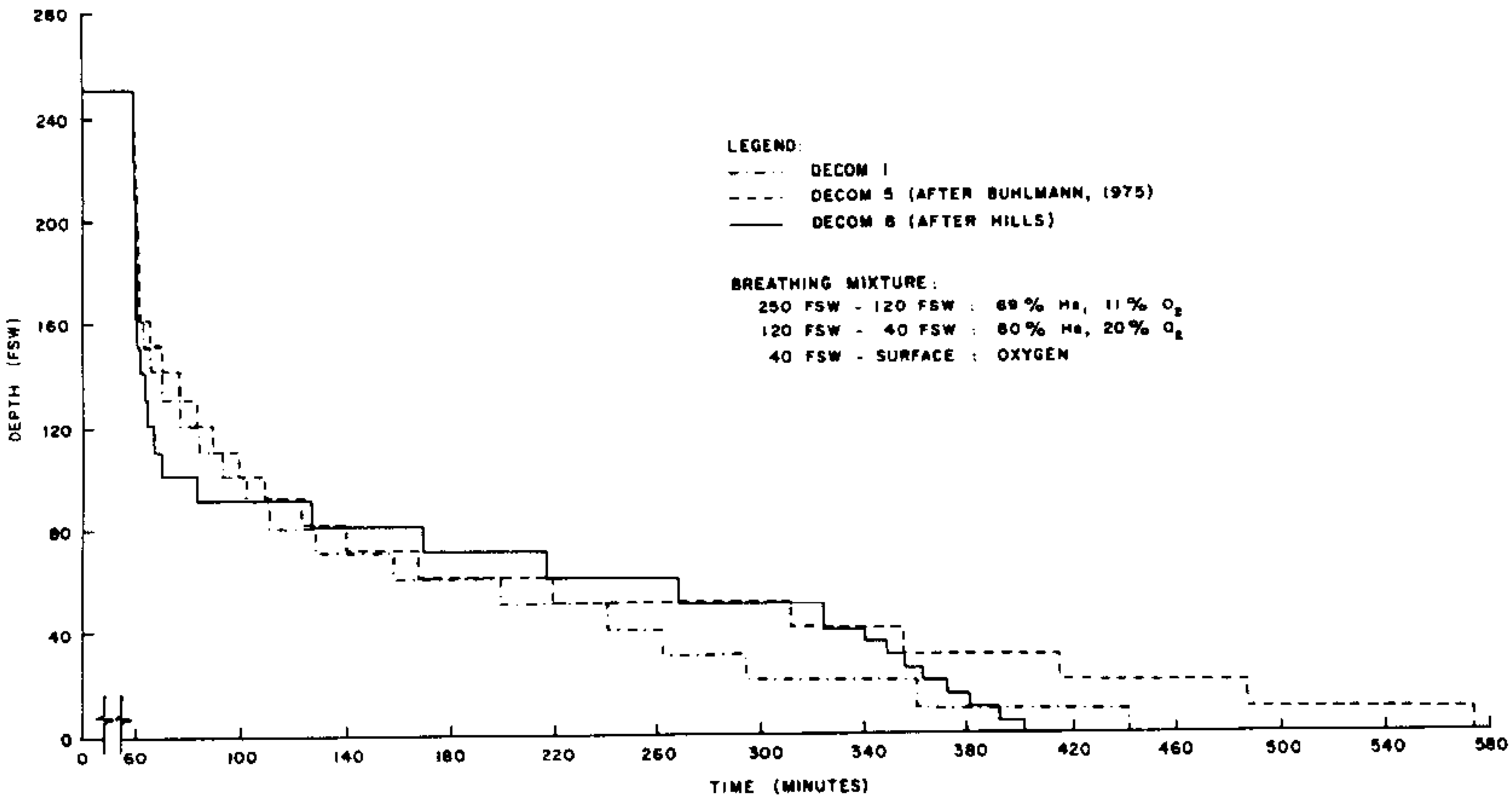

Figure 5. Decompression schedule for 250 FSW dive for a bottom time of 60 minutes

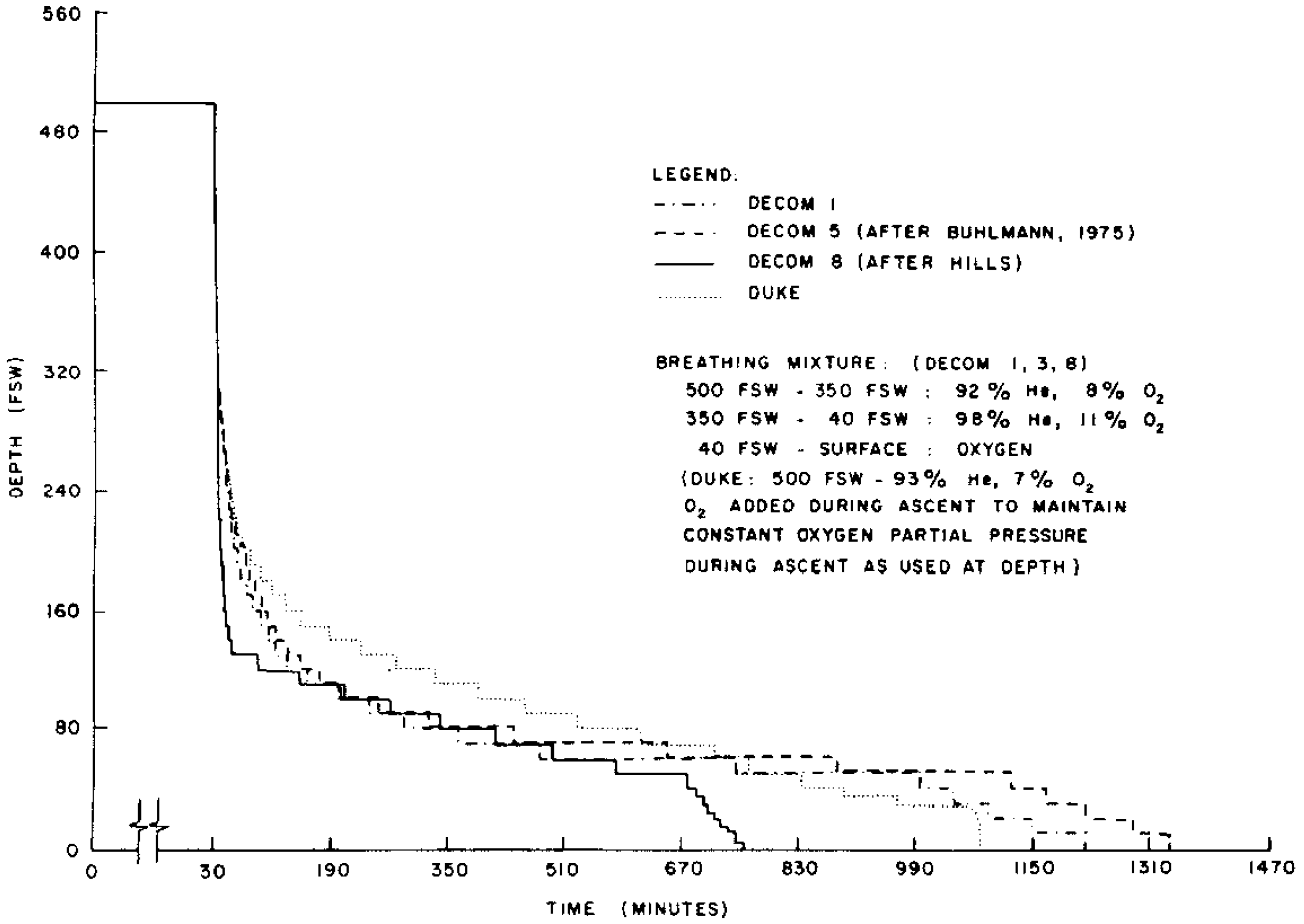

Figure 6. Decompression schedule for 500 FSW dive for a bottom time of 30 minutes

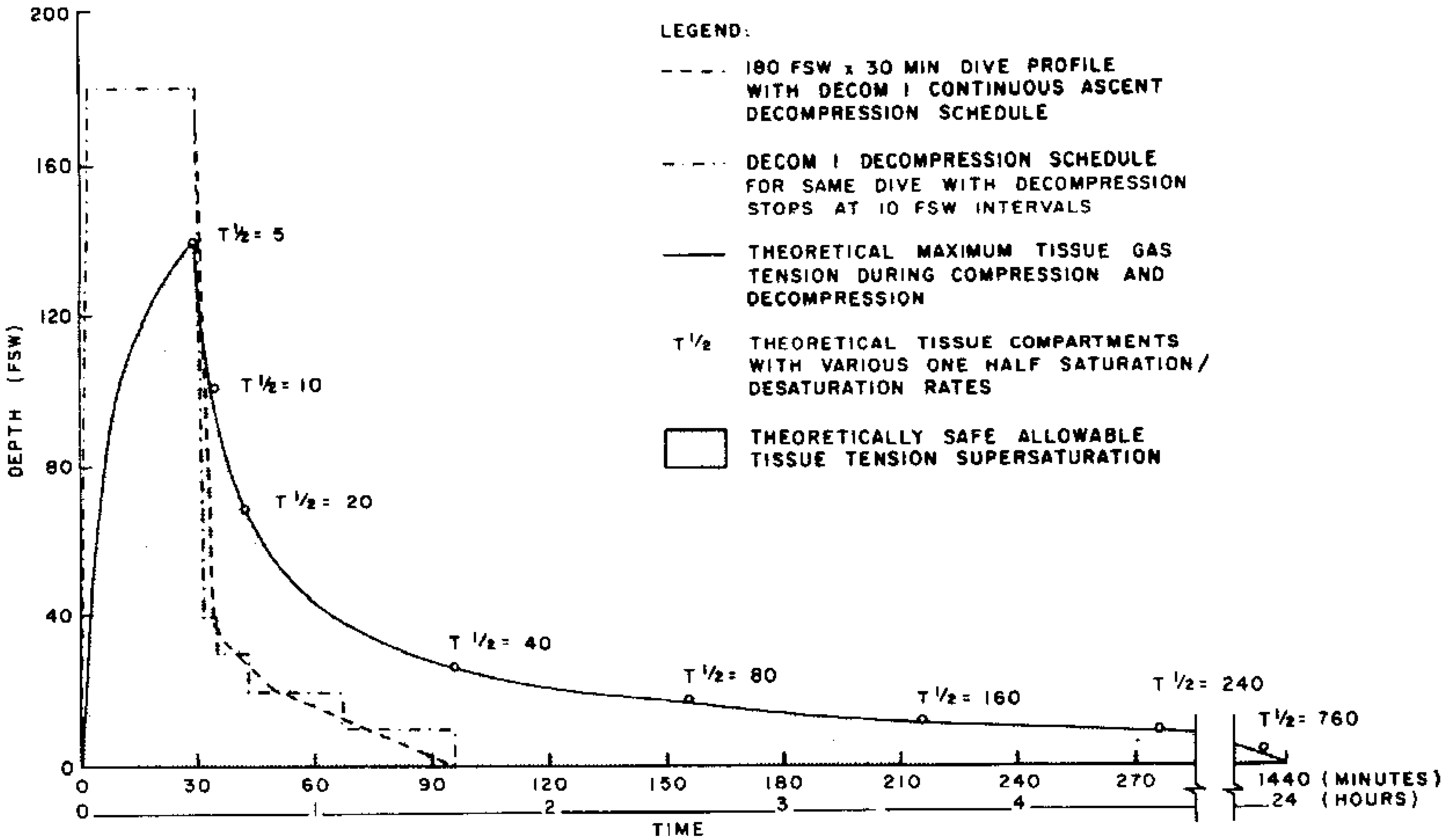

Figure 7. Decompression schedule Decom 1 calculated after Haldanian concepts showing calculated safe tissue inert gas supersaturation

ambient hydrostatic pressure which occur at the time of the ascent to the next stop are eliminated, thus decreasing the likelihood of bubble formation. In addition, the continuous ascent curve demonstrates that the ascent rate is essentially linear for the period that a given theoretical T 1/2 tissue is controlling or limiting the ascent.

The third plot on Figure 7 represents the theoretical maximum inert gas (nitrogen) supersaturation above the sea level tension which is calculated to exist at any time during decompression in any tissue of the body. This curve demonstrates the magnitude of the residual nitrogen tension remaining in the tissues as the diver ascends to the surface on this schedule and also indicates the slow rate of nitrogen elimination after the diver has reached the surface. The difference in the ambient pressure indicated by the dive profile line and the maximum inert gas tensions indicated by the inert gas tissue tension plot suggests that a pressure difference between the tissue tension of the inert gas and ambient pressure of greater than 30 FSW is permitted to exist during ascent, according to this model. Experiments on fish (42) and on shrimp by the author have demonstrated that an inert gas tension difference between the tissue and the ambient hydrostatic pressure of water of 10 FSW is sufficient to produce bubbles in these species. These data likewise are consistent with the observations of Spencer et al. (43) that bubbles occur in the venous circulation during standard U.S. Navy decompressions.

The differences in the decompression schedules calculated according to the different Haldanian models are apparent in Figure 8. It is of interest that Decom 5, modeled after Bühlmann's empirical data of 1975, has not only the deepest decompression stop (at 80 FSW) but also the longest total decompression time.

The decompression schedule developed by the use of the Hills model is shown in Figure 9. The similarity between the schedule calculated after Hills and the schedules published by RNPL using Hempleman's diffusion equations is striking. It is also noteworthy that both these investigators recommend the final ascent stop to be no more shallow than 20 FSW or 6 meters. This practical recommendation is in keeping with the findings of Kindwall et al. (44) that the rate of inert gas elimination after a 100 FSW dive for 40 minutes on air is greater if the first decompression stop is at 50 FSW than if the first decompression stop is at 10 FSW in accordance with the U.S. Navy decompression table. (See 100 FSW x 40-minute table in appendix.)

In order to better comprehend the inferences to be gained from the plots of the decompression schedules, the descriptive data on the series of 180 FSW x 30-minute dives have been tabulated in Table 7. The decompression schedules are similar in two respects: (1) in the rate of ascent from the bottom to the first stop and (2) in the fact that the process of decompression brings the diver to the surface with a residual amount of gas and a residual inert gas tension, which requires a significant period of time at surface pressure before this excess inert gas can be lost. The decompression schedule for Decom 8 (Hills zero-saturation model), with decompression stops all the way to the surface, is an exception to the latter generalization in that the diver would arrive on the surface with zero

TABLE 7. COMPARATIVE AIR DECOMPRESSION TABLES FOR 180 FSW x 30 MINUTES

TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)												TIME TO SURFACE	TOTAL ASCENT TIME	SURFACE INTERVAL (HR 6 MIN) REQUIRED BEFORE ZERO PENALTY REPETATIVE DIVE ALLOWED
		80	70	60	50	40	35	30	25	20	15	10	5			
USN	2.5							6		17		27			53.0	> 9 hr 44 min
D-1	2.33					3		8		23		30			66.3	> 18 hr
D-5	3.05	1	2	3	4	6		8		15		37			79.0	> 7 hr 20 min
RNPL	2.4			5		5				125				2	139.4	> 16 hr
D-8-A	2.75		.75	2	2	2	3	6	36	33				.5	88.0	Repeat in 24 hr
D-8-B	2.75		.75	2	2	2	3	6	36	33	36	39	42	.5	205	Zero supersaturation to surface; immediate repetitive dives permitted

NOTE:

(1) Time given in minutes or decimal fractions of minutes
(2) USN: U.S. Navy Standard air decompression table
(3) D-1: Haldane-Type computer decompression program (Modified PADUA)
(4) D-5: Computer decompression program modeled after concepts of Bühlmann (1975)
(5) D-8: Computer decompression program modeled after concepts of Hills
(6) RNPL: Royal Naval Physiological Laboratory air diving tables, 1968

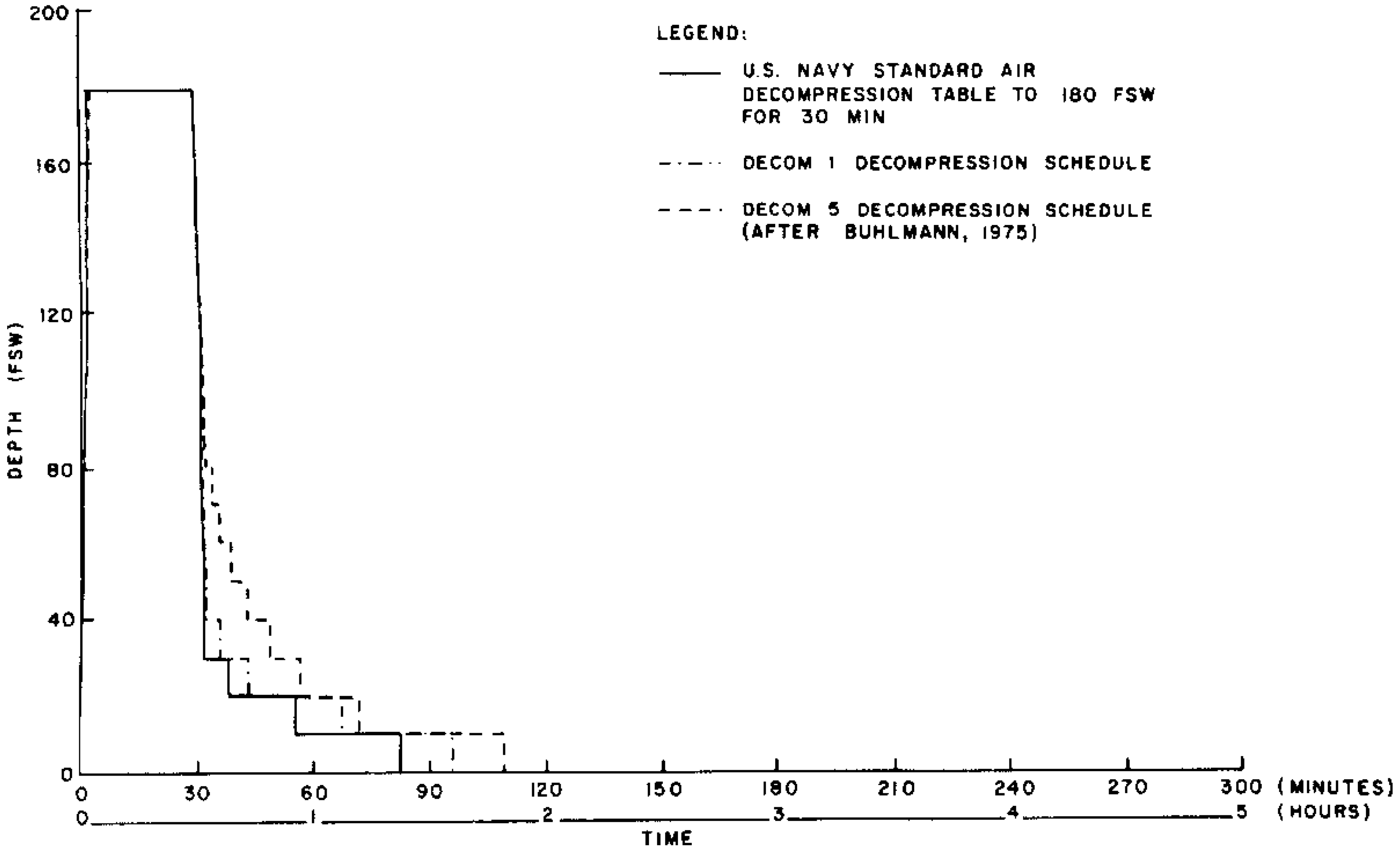

Figure 8. Comparison of United States Navy Decom 1 and Decom 5 decompression schedules

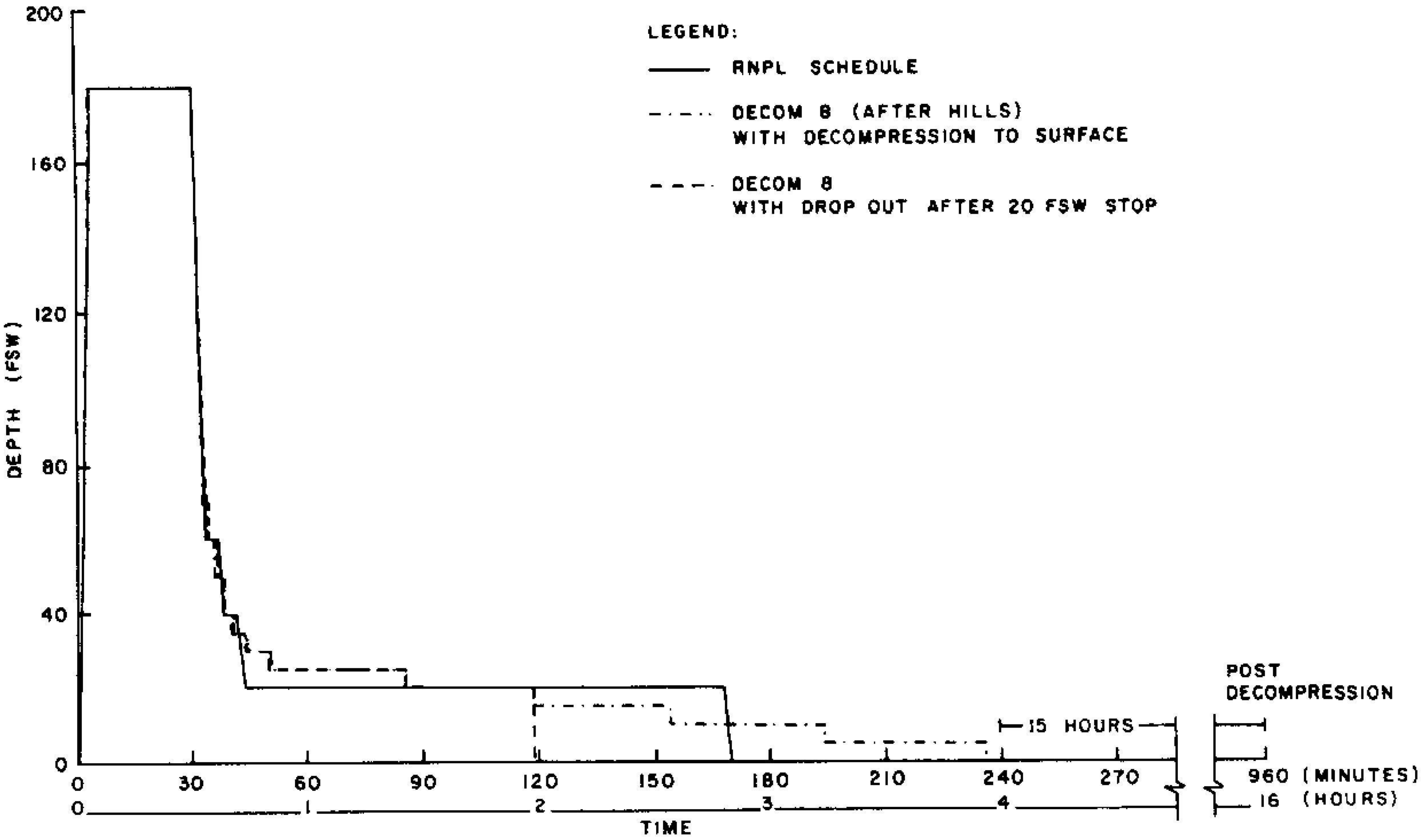

Figure 9. Royal Naval Physiological Laboratory Decompression Schedule compared with Hill's Decom 8 Zero-supersaturation Decompression Schedule for 180 FSW x 30 minutes dive

inert gas supersaturation in his tissues. Theoretically, the diver could immediately repeat the same dive without adjusting the decompression or the length of the dive to account for residual inert gas in his body. Unfortunately, this facet of the Decom 8 program has not been tested experimentally. However, if this concept proves to be correct, it is apparent that this type of decompression would save the commercial diver a great deal of time in the repetitive dive, decompression process.

In other respects, the decompression schedules are different. The U.S. Navy schedule has the shortest decompression times and likewise does not require the first decompression stop until a depth of 30 FSW, which is shallower than the first stops of the other tables. The ratio between the total decompression time of the shortest (USN) and the longest (RNPL) schedules is 53 minutes to 139.4 minutes, or 1:2.6. Similarly, the first decompression stop of the RNPL table is at a depth of 60 FSW compared with an ascent to 30 FSW for the first stop which is allowed in the USN table.

In order to compare the decompression schedules of all models of computation over such a wide range of depths and times on the bottom, the relative lengths of the decompression schedules were compared by assigning the value of unity to the total decompression time of the shortest table and then obtaining the relative lengths of the longer decompression times of the other methods for tables of the same depth and dive duration. The results of such a compilation are given below:

Decompression Table Source:	USN	Decom 1	Decom 5	Decom 8	RNPL
Relative Total Decompression Time:	1.08	1.35	2.15	1.55	2.67

In a similar manner, the depth at which the decompression process is slowed during ascent by insertion of the first decompression stop can be compared using the different calculation methods. Since the five methods of decompression considered each use the stage-decompression technique and since the rates of ascent to the first stop of the different techniques are essentially the same (see Table 7), then a comparison of the depth of the first stop will provide a relative indication of the depth at which decompression requirements exceed the standard rate of ascent in that particular calculation technique. Therefore, if the decompression schedule with the deepest stop of the five comparable tables is given a value of 5 and the one with the most shallow first stop is given a value of 1 and then, if the values for each calculation method are summed and the mean obtained, a relative value for the depth of the first stop for the various methods of calculation can be obtained. These results are given below:

Calculation Method:	USN	Decom 1	Decom 5	Decom 8	RNPL
Relative Value:	1.08	1.92	3.60	3.92	4.77

If the relative values for the duration of the decompression process and the relative values for the depths at which the first decompression stop which are initiated according to the different methods of decompression being considered are plotted, then it is possible to obtain an indication of the relative rates of decompression. These values are plotted in Figure 10.

If these two sets of data are considered together, it can be seen that the RNPL air decompression schedules have the slowest rate of decompression and the deepest first decompression stops of the five decompression schedules compared. It can also be easily seen that the U.S. Navy air decompression tables, in general, have not only the shortest decompression times, but also the shallowest first decompression stops and therefore the fastest rate of decompression.

The decompression schedules calculated according to Haldanian concepts (Decoms 1 and 5) used different maximum tissue gas uptake times from those used in calculating the U.S. Navy standard air decompression table and the repetitive dive tables for air. The maximum tissue half-time was 120 minutes for U.S. Navy standard air tables and repetitive dive tables. Workman, as previously pointed out, used a maximum tissue half saturation time of 240 minutes for calculation of the U.S., Navy standard air decompression schedules for exceptional exposures. Although consideration of the maximum tissue-half saturation time without considering the related M values and delta M values is perhaps a game of numbers, suffice it to say that, in some of the air decompression schedules calculated on the Haldanian systems (i.e., Decoms 1 and 5), the ascent rate of longer dives at both shallow (140 FSW x 360 minutes) and deeper depths (180 FSW x 240 minutes) were limited by the so-called slowest (720 minutes and 635 minutes half-time) tissues. Since the decompression schedules using newer concepts and newer experience each has longer total decompression time and deeper first decompression stops than the decompression tables which were calculated in the 1950's, it would appear that the current trend is toward decompression tables with deeper first stops and longer total decompression times than those of the U.S. Navy tables.

Since the commercial diving industry has found use of the U.S. Navy tables unsatisfactory, safer standard commercial tables are needed. The RNPL tables were first published in 1968 and have been proven satisfactory for operational use in the North Sea oil fields. Thus, it would seem that their use would provide decompression procedures with a significantly better margin of safety than that provided by the use of the U.S. Navy tables.

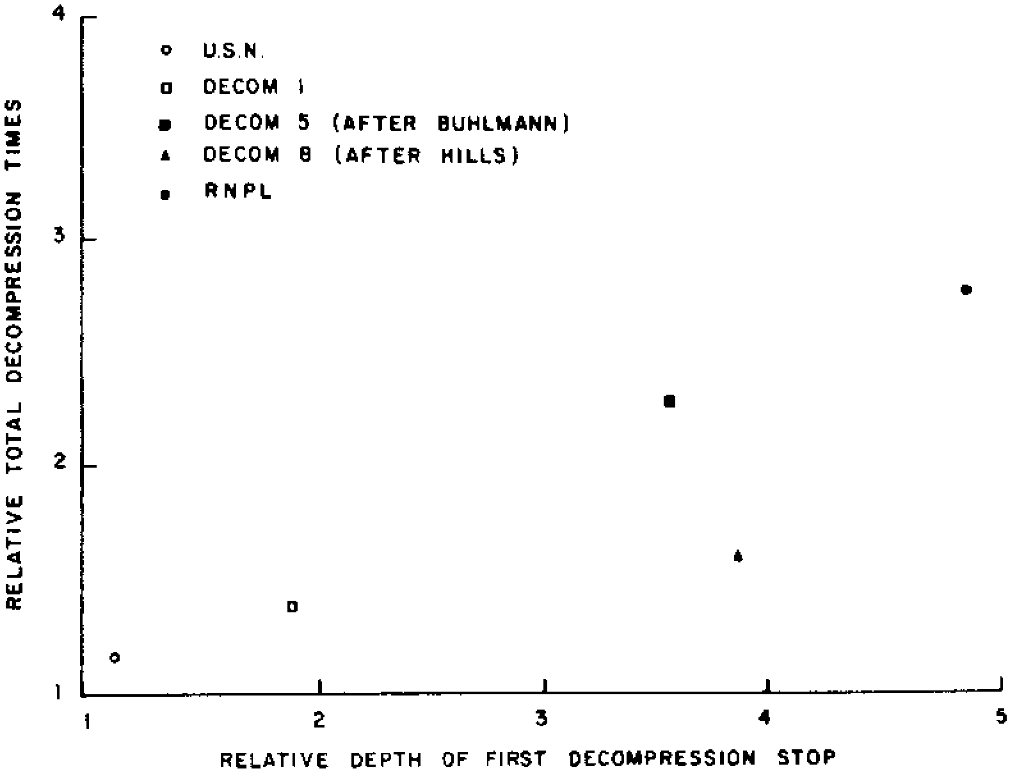

Figure 10. Relationship of total decompression time and depth of beginning decompression stops for different methods of calculation.

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APPENDIX: DECOMPRESSION SCHEDULES

Key to Table Source for Decompression Schedules

USN = U.S. Navy

Decom 1*

Decom 5*

Decom 8*

RNPL = Royal Naval Physiological Laboratory

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*See page 19 for details of computer programs.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
100	15	USN	No Stop																				1.67	1.67
		D-1	No Stop																				1.67	1.67
		D-5	2.13																1		2	4		9.13
		D-8	2.00																	1	2	7		12.00
		RNPL	No Stop																				2.0	2.00
	20	USN	No Stop																				1.67	1.67
		D-1	1.50																			1		2.50
		D-5	2.13																2		2	7		13.13
		D-8	2.00																.75	.25	2		.5	5.50
		RNPL	1.60																		5		2.0	8.60
	25	USN	No Stop																				1.67	1.67
		D-1	1.50																			3		4.50
		D-5	2.13																2		4	8		16.13
		D-8	2.00																.75	1	2		.5	6.25
		RNPL	1.40																5		5		2	13.40
	30	USN	1.50																			3		4.67
		D-1	1.50																			13		14.50
		D-5	2.13																2		6	10		20.13
		D-8	1.75															.75	1.25	2	2		.5	7.25
		RNPL	1.40																5		15		2	23.40
	40	USN	1.50																			15		16.67
		D-1	1.33																		2	28		31 33
		D-5	2.13																4		7	17		30.13
		D-8	1.50														.75	.25	1	2	4		.5	10.00
		RNPL	1.40																5		50		2	58.40
	50	USN	1.33																		2	24		27.67
		D-1	1.33																		12	30		43.33
		D-5	2.13																6		9	27		44.13
		D-8	1.50														.75	1	2	4	26		.5	35.75
		RNPL	1.20														5				85		2	93.20

Note: (1) Time is given in minutes or decimal fractions of minutes;
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
100	60	USN	1.33																		9	28		38.67
		D-1	1.33																		22	30		53.33
		D-5	1.83														2		5		13	35		56.83
		D-8	1.25													.75	1	2	3	23	34		.5	65.50
		RNPL	1.20														5				115		2	123.20
	70	USN	1.33																		17	39		57.67
		D-1	1.17																5		25	31		63.17
		D-5	1.83														2		8		16	39		66.83
		D-8	1.25													.75	2	2	17	31	33		.5	89.50
	75	RNPL	1.00													5			5		140		2	153.00
	80	USN	1.33																		23	48		72.67
		D-1	1.17																11		25	41		78.17
		D-5	1.83														2		10		20	42		75.83
		D-8	1.25													1.75	2	6	34	32	33		.5	110.50
	(90)	RNPL	1.00													5			10		155		2	173.00
	90	USN	1.17																3		23	57		84.67
		D-1	1.17																16		25	49		91.17
		D-5	1.83														3		11		25	46		88.83
		D-8	1.25													2.75	3	28	30	31	34		.5	130.50
		RNPL	1.00													5			10		155		2	173.00
	100	USN	1.17																7		23	66		97.67
		D-1	1.17																20		25	56		102.17
		D-5	1.83														4		14		27	63		99.83
		D-8	1.25													3.75	17	29	30	31	34		.5	146.50
	(120)	RNPL	.80												5		5		20		170		2	202.80
	110	USN	1.17																10		34	72		117.67
		D-1	1.00														2		21		29	59		112.00
		D-5	1.83														5		16		30	56		108.83
		D-8	1.00												.75	6	30	28	30	31	34		.5	161.25
	(120)	RNPL	.80												5		5		20		170		2	202.80

Note: (1) Time is given in minutes or decimal fractions of minutes;
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
100	120	USN	1.17																12		41	78		132.67
		O-1	1.00														5		21		35	59		121.00
		O-5	1.83														6		19		30	66		122.83
		O-8	1.00												.75	27	30	23	29	32	33		.5	176.25
		RNPL	.80												5		5		20		170		2	202.80
110	20	USN	No Stop																			0		1.83
		O-1	1.67																			2		3.67
		O-5	2.44																3		3	8		16.44
		O-8	2.00															.75	.25	1	2		.5	6.50
		RNPL	1.80																5		10		2	18.80
	25	USN	2.67																			3		4.83
		O-1	1.67																			10		11.67
		O-5	2.13														1		2		6	9		20.13
		O-8	2.00															.75	1	1	2		.5	7.25
		RNPL	1.80																5		20		2	28.80
	30	USN	1.67																			7		8.83
		O-1	1.67																			20		21.67
		O-5	2.13														2		4		7	16		31.13
		O-8	1.75														.75	.25	1	2	2		.5	8.25
		RNPL	1.60														5				40		2	46.60
	40	USN	1.50																		2	21		24.83
		O-1	1.50																		7	30		38.50
		O-5	2.13														2		6		7	22		39.13
		O-8	1.50													.75	.25	1	2	3	7		.5	16.00
		RNPL	1.60														5				90		2	98.60
	50	USN	1.50																		8	26		35.83
		O-1	1.33																1		20	30		52.33
		O-5	2.13														3		6		12	32		55.13
		O-8	1.50													.75	1.	2	3	9	39		.5	56.75
		RNPL	1.40													5			5		120			133.40

Note: (1) Time is given in minutes or decimal fractions of minutes.
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
110	60	USN	1.50																		18	36		55.83
		D-1	1.33																6		25	30		62.33
		D-5	2.13														4		8		15	39		68.13
		D-8	1.50													1.75	1	3	9	37	34		.5	87.75
		RNPL	1.40													5			5		145		2	158.40
	70	USN	1.33																1		21	48		73.83
		D-1	1.33																14		25	40		80.33
		D-5	2.13														5		11		19	42		79.13
		D-8	1.50													2.75	2	6	36	31	34		.5	113.75
(120)	(75)	RNPL	1.20												5		5		15		160		2	188.20
	80	USN	1.33																7		23	57		88.83
		D-1	1.33																20		25	49		95.33
		D-5	2.13														6		12		26	48		94.13
		D-8	1.25												.75	3	5	31	30	31	34		.5	136.50
(120)	(90)	RNPL	1.00											5			5		30		165		2	208.00
	90	USN	1.33																12		30	64		107.83
		D-1	1.17														4		21		25	57		108.17
		D-5	2.13														8		15		28	54		107.13
		D-8	1.25												.75	5	24	28	30	31	34		.5	156.50
		RNPL	1.00											5			5		30		165		2	208.00
	100	USN	1.33																15		37	72		125.83
		D-1	1.17														9		21		31	59		121.17
		D-5	2.13														10		18		30	59		119.13
		D-8	1.25												1.75	21	30	28	29	32	33		.5	176.50
(120)	(120)	RNPL	.80										5			5	20		40		170		2	242.80
120	10	USN	No Stop																				2	2.00
		D-1	No Stop																				2	2.00
		D-5	2.74																1		3	3		9.74
		D-8	2.50																	1	2		.5	6.00
		RNPL	No Stop																				2.4	2.40

Note: (1) Time is given in minutes or decimal fractions of minutes;
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
170	15	USN	No Stop																			0		2.00
		D-1	2.00																			0		2.00
		D-5	2.74														1		2		3	6		14.74
		D-8	2.25															.75	.25	1	1		.5	5.75
		RNPL	2.00																		10		2	14.00
	20	USN	1.83																			2		4.00
		D-1	1.83																			4		5.83
		D-5	2.44														2		2		4	9		19.44
		D-8	2.00														.75	.25	1	1	2		.5	7.50
		RNPL	1.60																5		10		2	18.80
	25	USN	1.83																			6		8.00
		D-1	1.67																		1	16		18.67
		D-5	2.44														2		3		6	12		25.44
		D-8	2.00														.75	1	1	1	3		.5	9.25
		RNPL	1.80																5		20		2	28.80
	30	USN	1.83																			14		16.00
		D-1	1.67																		3	25		29.67
		D-5	2.44														2		5		6	16		31.44
		D-8	1.75													.75	.25	1	2	2	3		.5	11.25
		RNPL	1.60														5				40		2	48.60
	40	USN	1.67																		5	25		32.00
		D-1	1.67																		15	30		46.67
		D-5	2.13													1	4		6		10	27		50.13
		D-8	1.75													.75	1	2	2		4	29		50.00
		RNPL	1.60														5				90		2	98.60
	50	USN	1.67																		20	31		48.00
		D-1	1.50																4		24	30		59.50
		D-5	2.13													1	5		7		14	37		66.13
		D-8	1.75													1.75	1	3	4		33	33	.5	78.00
		RNPL	1.40													5			5		120		2	133.40

Note: (1) Time is given in minutes or decimal fractions of minutes;
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
120	60	USN	1.50																2		22	45		71.00
		D-1	1.50																14		25	36		76.50
		D-5	2.13													2	5		11		18	41		79.13
		D-8	1.50												.75	2	3	5	32	32	33		.5	109.75
		RNPL	1.40													5			5		145		2	158.40
	70	USN	1.50																9		23	55		89.00
		D-1	1.33														1		21		25	47		95.33
		D-5	2.13													3	7		15		25	47		96.13
		D-8	1.50												.75	4	5	31	30	31	34		.5	137.75
	75	RNPL	1.20												5		5		15		160		2	188.20
	80	USN	1.50																15		27	63		107.00
		D-1	1.33														8		21		25	57		112.33
		D-5	2.13													3	10		15		28	54		112.13
		D-8	1.60												1.75	6	29	28	30	31	34		.5	161.75
	(90)	RNPL	1.00											5			5		30		165		2	208.00
	90	USN	1.50																19		37	74		132.00
		D-1	1.33													13	13		21		32	59		126.33
		D-5	2.13													4	11		19		30	60		126.13
		D-8	1.50												2.75	29	29	28	30	31	34		.5	185.75
		RNPL	1.00											5			5		30		165		2	208.00
	100	USN	1.50																23		45	80		150.00
		D-1	1.33														17		21		40	59		138.33
		D-5	2.13													5	12		23		31	71		144.13
		D-8	1.25											.75	4	47	29	28	29	32	33		.5	204.50
	(120)	RNPL	.80										5			5	20		40		170		2	242.80
	110	USN																						
		D-1	1.17													3	19		21		48	74		166.17
		D-5	2.13													7	14		25		35	79		162.13
		D-8	1.00											1	2	58	29	28	30	31	34		.5	219.50
	(120)	RNPL	.80										5			5	20		40		170		2	242.80

Note: (1) Time is given in minutes or decimal fractions of minutes;
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
120	120	USN*	1.33														10		19		47	98		176.00
		D-1	1.17													6	19		25		50	87		188.17
		D-5	2.13													8	16		27		39	86		178.13
		D-8	1.00											2	27	55	29	28	29	32	33		.5	236.50
		RNPL	.80										5			5	20		40		170		2	242.80
130	10	USN	No Stop																					2.17
		D-1	2.17																					2.17
		D-5	3.05																2		2	4		11.05
		D-8	2.75																.75	1	1		.5	6.00
		RNPL	2.40																		5		2	9.40
	15	USN	2.00																			1		3.17
		D-1	2.00																			2		4.00
		D-5	2.74														2		2		3	8		17.74
		D-8	2.25														.75	.25	1	1	1		.5	6.75
		RNPL	2.20																5		5		2	14.20
	20	USN	2.00																			4		6.17
		D-1	2.00																			8		10.00
		D-5	2.44													1	2		2		6	9		22.44
		D-8	2.00													.75	.25	1	1	1	2		.5	8.50
		RNPL	2.20																5		15		2	24.20
	25	USN	2.00																			10		12.17
		D-1	1.83																		2	21		24.83
		D-5	2.44													1	2		5		6	14		30.44
		D-8	2.00													.75	1	.25	2	2	2		.5	10.50
		RNPL	2.00														5				40		2	49.00
	30	USN	1.83																		3	18		23.17
		D-1	1.83																		6	28		35.83
		D-5	2.44													2	2		6		6	20		38.44
		D-8	2.00													.75	1	1	2	2	5		.5	14.25
		RNPL	2.00														5				70		2	79.00

Note: (1) Time is given in minutes or decimal fractions of minutes;
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

*For exceptional exposures, data are given according to U.S. Navy *Standard Air Decompression Table*.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
130	40	USN	1.83																		10	25		37.17
		D-1	1.67																4		19	30		54.67
		D-5	2.44													2	5		6		12	32		59.44
		D-8	2.00													1.75	1	2	3	9	39		.5	58.25
		RNPL	1.80													5			5		120		2	132.00
	50	USN	1.67																3		21	37		63.17
		D-1	1.67																11		25	30		67.67
		D-5	2.44													4	5		10		16	39		76.44
		D-8	1.75												.75	2	2	4	23		32	33		99.00
		RNPL	1.60												5				10		145		2	163.60
	60	USN	1.67																9		23	52		86.17
		D-1	1.50														3		19		25	44		92.50
		D-5	2.44													5	7		12		22	45		93.44
		D-8	1.75												1.75	3	4	26	30	32	33		.5	132.00
		RNPL	1.40											5			5		15		165		2	193.40
	70	USN	1.67																16		24	61		103.17
		D-1	1.50														9		21		25	54		110.50
		D-5	2.13												1	5	10		14		28	52		112.13
		D-8	1.50											.75	2	6	27	28	30	31	34		.5	160.75
(140)	(75)	RNPL	1.40											5		5	10		30		170		2	223.40
	80	USN	1.50														3		19		35	72		133.17
		D-1	1.50														16		21		30	59		127.50
		D-5	2.13												1	6	11		19		30	59		128.13
		D-8	1.50											.75	3	32	29	28	30	31	34		.5	189.75
(140)	(90)	RNPL	1.20										5			5	20		40		170		2	243.20
	90	USN	1.50														8		19		45	80		154.17
		D-1	1.33													3	18		22		39	59		142.33
		D-5	2.13												2	8	.12		23		31	72		150.13
		D-8	1.50											.75	5	51	29	28	30	31	34		.5	210.75
		RNPL	1.20										5			5	20		40		170		2	243.20

Note: (1) Time is given in minutes or decimal fractions of minutes;
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
140	10	USN	No Stop																			0		2.33
		D-1	2.33																			0		2.33
		D-5	3.35																3		2	4		12.35
		D-8	2.75															.75	.25	1	1		.5	6.25
		RNPL	2.40																		5		2	9.40
	15	USN	2.17																			2		4.33
		D-1	2.17																			3		5.17
		D-5	3.05														2		3		3	8		19.05
		D-8	2.25													.75	.25	1	1	1	2		.5	8.75
		RNPL	2.20																5		5		2	14.20
	20	USN	2.17																			6		8.33
		D-1	2.00																		2	13		17.00
		D-5	2.74													2	2		3		6	11		26.74
		D-8	2.25													.75	1	.25	1	2	2		.5	9.75
		RNPL	2.20																5		15		2	24.20
	25	USN	2.00																		3	24		18.33
		D-1	2.00																		5	24		31.00
		D-5	2.74													2	2		6		6	16		34.74
		D-8	2.25													.75	1	1	2	2	3		.5	12.50
		RNPL	2.20														5				40		2	49.20
	30	USN	2.00																		5	21		28.33
		D-1	1.83																1		9	30		41.83
		D-5	2.44												1	2	4		6		8	23		46.44
		D-8	2.25													1.75	1	1	2	3	14		.5	25.50
		RNPL	2.00														5				70		2	79.00
	40	USN	1.83																2		16	26		46.33
		D-1	1.83																7		22	30		60.83
		D-5	2.44												1	4	5		7		14	36		69.44
		D-8	2.00												.75	2	2	2	4	33	33		.5	77.75
		RNPL	1.80													5			5		120		2	133.80

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
140	50	USN	1.83																6		24	44		76.33
		D-1	1.67														3		16		25	36		81.67
		D-5	2.44												2	5	5		12		19	41		86.44
		D-8	2.00												1.75	3	3	7	35	12	33		.5	117.25
		RNPL	1.60												5				10		145		2	163.60
	60	USN	1.83																16		23	56		97.33
		D-1	1.67														8		21		25	50		105.67
		D-5	2.44												3	5	9		14		26	50		109.44
		D-8	1.75											.75	2	5	20	29	29	12	33		.5	153.00
		RNPL	1.40											5			5		15		165		2	193.40
	70	USN	1.67														4		19		32	68		125.33
		D-1	1.50													1	16		21		27	59		125.50
		D-5	2.44												4	6	11		17		30	57		127.44
		D-8	1.75											.75	3	28	29	28	30	31	34		.5	186.00
	75	RNPL	1.40											5		5	10		30		170		2	223.40
	80	USN	1.67														10		23		41	79		155.33
		D-1	1.50													5	19		21		38	59		143.50
		D-5	2.44												4	9	12		23		30	70		150.44
		D-8	1.75											1.75	5	51	29	28	30	31	34		.5	212.00
	(90)	RNPL	1.20										5			5	20		40		170		2	243.20
	90	USN*	1.50													2	14		18		42	68		166.33
		D-1	1.50													12	18		22		48	75		176.50
		D-5	2.44												5	10	15		26		36	78		172.44
		D-8	1.50										.75	2	25	55	29	28	30	31	34		.5	236.75
		RNPL	1.20										5			5	20		40		170		2	243.20
	120	USN*	1.50													12	14		36		56	120		240.33
		D-1	1.33												6	17	18		42		50	114		248.33
		D-5	2.44												9	14	24		30		50	142		271.44
		D-8	1.50										2.75	30	49	55	29	28	29	32	33		.5	289.75
		RNPL	1.00									5			5	20	30		45		170		2	278.00

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*For exceptional exposures, data are given according to U.S. Navy *Standard Air Decompression Table*.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
140	165	USN																						
		D-1	1.33												14	20	38		44		99	160		376.33
		D-5	2.13											2	16	21	29		43		77	317		507.13
		D-8	3.25									1.75	36	45	49	55	29	28	29	32	33		.5	339.50
		RNPL	.60							5				5	20	30	35		45		170		2	312.60
	360	USN*	1.00										9	32	42	64	84		122		142	187		684.33
		D-1	1.17											19	33	74	80		161		260	404		1032.17
		D-5	2.13											18	30	50	97		219		461	567		1444.13
		D-8	1.00								24.75	38	41	45	49	55	29	28	29	32	33		.5	405.25
		RNPL	.60							25	25	30	35	40	50	55	60		70		240		2	632.60
150	5	USN	No Stop																			0		2.50
		D-1	2.50																					2.50
		D-5	3.96																		1	4		8.96
		D-8	3.50																	.75	1		.5	5.75
		RNPL	3.20																					3.20
	10	USN	2.33																			1		3.50
		D-1	2.33																			1		3.33
		D-5	3.35														1		3		2	6		15.35
		D-8	2.75														.75	.25	1	1	1		.5	7.25
		RNPL	2.60																5		5		2	14.60
	15	USN	2.33																			3		5.50
		D-1	2.33																			4		6.33
		D-5	3.05													1	2		3		4	9		27.05
		D-8	2.50													.75	.25	1	1	1	2		.5	9.00
		RNPL	2.60																5		10		2	19.60
	20	USN	2.17																		2	7		11.50
		D-1	2.17																		3	17		22.17
		D-5	2.74												1	2	2		4		7	13		31.74
		D-8	2.50													.75	1	1	1	2	3		.5	11.75
		RNPL	2.40														5				30		2	39.40

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*For exceptional exposures, data are given according to U.S. Navy *Standard Air Decompression Table*.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
150	25	USN	2.17																		4	17		23.50
		D-1	2.00																1		7	27		37.00
		D-5	2.74												1	2	3		6		7	19		40.74
		D-8	2.25												.75	1	1	1	2	3	5		.5	16.50
		RNPL	2.20													5			5		65		2	79.20
	30	USN	2.17																		8	24		34.50
		D-1	2.00																3		14	30		49.00
		D-5	2.74												2	2	5		6		10	27		54.74
		D-8	2.25												.75	2	1	2	2	4	30		.5	44.50
		RNPL	2.20													5			5		100		2	114.20
	40	USN	2.00																5		19	33		59.50
		D-1	1.83														2		9		25	30		67.83
		D-5	2.74												2	5	5		9		16	38		77.74
		D-8	2.25												1.75	2	2	3	17	33	34		.5	95.50
		RNPL	2.00												5		5		5		140		2	159.00
	50	USN	2.00																12		23	51		88.50
		D-1	1.83														6		19		25	43		94.83
		D-5	2.74												4	5	8		12		23	45		99.74
		D-8	2.00											.75	2	4	4	29	30	31	34		.5	137.25
		RNPL	1.80											5			5		15		165		2	193.80
	60	USN	1.83														3		19		26	62		112.50
		D-1	1.67													2	13		22		25	55		118.67
		D-5	2.44											1	5	5	11		16		29	53		122.44
		D-8	2.00											1.75	2	10	33	28	30	31	34		.5	172.25
		RNPL	1.60										5		5	5	20		40		170		2	248.60
	70	USN	1.83														11		19		39	75		146.50
		D-1	1.67													5	19		21		34	59		139.67
		D-5	2.44											2	4	9	12		21		30	65		145.44
		D-8	1.75										.75	2	4	47	29	28	30	31	34		.5	208.00
	75	RNPL	1.40									5			5	5	20		40		170		2	248.40

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
150	80	USN	1.67													1	17		19		50	84		173.50
		D-1	1.67													17	19		21		45	65		163.67
		D-5	2.44											2	2	10	15		25		35	76		171.44
		D-8	1.75										.75	1	24	55	29	28	29	32	33		.5	236.00
	90	RNPL	1.20								5				5	15	35		40		170		2	273.20
160	5	USN	No Stop																			0		2.67
		D-1	2.67																					2.67
		D-5	4.27																		2	3		9.27
		D-8	3.50																.75	.25	1		.5	6.00
	5.5	RNPL	No Stop																				3.70	3.20
	10	USN	2.50																			1		3.67
		D-1	2.50																			1		3.50
		D-5	3.66														2		2		3	6		16.66
		D-8	2.75													.75	.25	1	.25	1	2		.5	6.50
		RNPL	2.80																5		5		2	14.80
	15	USN	2.33																		1	4		7.67
		D-1	2.33																		1	5		8.33
		D-5	3.35													2	2		2		6	9		24.35
		D-8	2.75													.75	1	1	1	1	2		.5	10.00
		RNPL	2.60																5		10		2	19.60
	20	USN	2.33																		3	11		16.67
		D-1	2.17																1		3	21		27.17
		D-5	3.05												2	2	2		5		7	15		36.05
		D-8	2.50												.75	1	1	1	2	2	3		.5	13.75
		RNPL	2.40														5				30		2	39.40
	25	USN	2.33																		7	20		29.67
		D-1	2.17																3		7	30		42.17
		D-5	3.05												2	2	4		6		8	22		47.05
		D-8	2.50												.75	2	.25	2	2	3	10		.5	23.00
		RNPL	2.20													5			5		65		2	79.20

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
160	30	USN	2.17																2		11	25		40.67
		D-1	2.00														1		5		17	30		55.00
		D-5	2.74											1	2	3	5		6		13	31		63.74
		D-8	2.50												.75	2	2	1	3	7	39		.5	57.75
		RNPL	2.20													5			5		100		2	114.20
	40	USN	2.17																7		23	39		71.67
		D-1	2.00														5		13		25	31		76.00
		D-5	2.74											1	4	4	6		11		18	40		86.74
		D-8	2.25											.75	2	3	2	5	32	31	34		.5	112.50
		RNPL	2.00												5		5		5		140		2	159.00
	50	USN	2.00														2		16		23	55		98.67
		D-1	1.83													2	9		21		25	48		106.83
		D-5	2.74											2	5	4	10		14		26	49		112.74
		D-8	2.25											1.75	2	5	21	29	29	32	33		.5	255.50
		RNPL	1.80											5			5		15		165		2	198.60
	60	USN	2.00														9		19		33	69		132.67
		D-1	1.83													5	17		21		28	59		131.83
		D-5	2.74											3	5	8	11		19		30	57		135.74
		D-8	2.00										.75	2	4	36	29	28	30	31	34		.5	197.25
		RNPL	1.60										5			5	10		25		170		2	218.60
	70	USN	1.83													1	17		22		44	80		166.67
		D-1	1.67												1	11	19		21		41	59		153.67
		D-5	2.74											4	6	10	14		24		32	74		165.74
		D-8	2.00										.75	3	10	59	29	28	30	31	34		.5	227.25
	75	RNPL	1.40									5			5	5	20		40		170		2	248.40
	90	USN																						
		D-1	1.67												10	17	18		35		50	100		231.67
		D-5	2.44										1	5	9	14	21		26		45	104		227.44
		D-8	1.50									1	3	21	50	54	29	28	30	31	34		.5	783.00
		RNPL	1.20								5				5	15	35		40		170		2	273.20

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
160	120	USN																						
		D-1	1.50											7	14	17	33		44		79	141		336.50
		D-5	2.44										2	8	14	20	24		40		63	220		393.44
		D-8	1.25								1	3	33	45	49	54	29	28	30	31	34		.5	338.75
		RNPL	1.00							5				5	20	25	35		45		170		2	308.00
	130	USN																						
		D-1	1.50											9	15	17	39		43		91	153		368.50
		D-5	2.44										3	9	15	22	27		41		71	264		454.44
		D-8	1.25								1	5	43	45	49	55	29	28	29	32	33		.5	350.75
		RNPL	1.00							5			5	15	25	30	35		50		180		2	348.00
	360*	USN*	1.20								22	34	40	52	60	98	114		122		142	187		873.80
		D-1	1.33										16	29	41	73	81		165		262	407		1075.33
		D-5	2.13									1	17	26	34	50	104		219		460	566		1479.13
		D-8	.60					25	25	30	35	40	50	55	60	70	75		80		275	2		822.00
170*	360*	USN*	1.20								22	34	40	52	60	98	114		122		142	187		873.80
170	5	USN	No Stop																			0		2.83
		D-1	2.83																					2.83
		D-5	4.57																		3	3		10.57
		D-8	3.75																.75	.25	1		.5	6.25
		RNPL	No Stop																				3.6	3.60
	10	USN	2.67																			2		4.83
		D-1	2.67																			2		4.67
		D-5	3.66													1	2		2		3	7		18.66
		D-8	3.00													.75	.25	1	1	1	2		.5	9.50
		RNPL	3.00																5		5		2	15.00
	15	USN	2.50																		2	5		9.83
		D-1	2.50																		2	8		12.50
		D-5	3.35												1	2	2		3		6	11		28.35
		D-8	3.00													1.75	.25	1	1	2	2		.5	11.50
		RNPL	2.80														5				20		2	29.80

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*For exceptional exposures, data are given according to U.S. Navy *Standard Air Decompression Table.*

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
170	20	USN	2.50																		4	15		21.83
		D-1	2.33																2		5	24		33.33
		D-5	3.05											1	2	2	3		5		7	17		40.05
		D-8	2.75												.75	1	1	2	1	2	4		.5	15.00
		RNPL	2.60													5			5		50		2	64.60
	25	USN	2.33																2		7	23		34.83
		D-1	2.17														1		3		12	30		48.17
		D-5	3.05											1	2	3	5		6		10	26		56.05
		D-8	2.75												.75	2	1	2	2	4	27		.5	42.00
		RNPL	2.60													5			5		90		2	104.60
	30	USN	2.33																4		13	26		45.83
		D-1	2.17														2		7		20	30		61.17
		D-5	3.05											2	1	5	5		7		13	35		71.05
		D-8	2.50											.75	1	2	2	2	4	26	34		.5	74.75
		RNPL	2.40												5		5				125			139.40
	40	USN	2.17														1		10		23	45		81.83
		D-1	2.00													1	7		18		25	37		88.00
		D-5	3.05											2	5	4	7		12	•	21	42		96.05
		D-8	2.50											.75	2	4	3	20	31	31	34		.5	128.75
		RNPL	2.20											5			5		15		155		2	184.20
	50	USN	2.17														5		18		23	61		109.83
		D-1	2.00													5	12		22		25	53		119.00
		D-5	3.05											4	5	6	11		15		29	53		126.05
		D-8	2.25										.75	1	3	10	33	28	29	32	33		.5	172.50
		RNPL	2.00										5			5	10		25		170		2	219.00
	60	USN	2.00													2	15		22		37	74		152.83
		D-1	1.83												2	8	19		21		34	59		144.83
		D-5	7.74										2	4	5	9	13		22		30	67		154.74
		D-8	2.25										.75	3	5	52	29	28	30	31	34		.5	215.50
		RNPL	1.80									5			5	5	20		35		170		2	243.80

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
170	70	USN	2.00													8	17		19		51	86		183.83
		D-1	1.83												4	15	19		21		46	69		175.83
		D-5	2.74										2	4	8	10	16		27		36	79		184.74
		D-8	2.00									.75	2	4	36	55	29	28	29	32	33		.5	251.75
(180)	(75)	RNPL	1.60								5			5	5	15	30		45		180		2	288.60
180	5	USN	No Stop																			0	3.00	3.00
		D-1	No Stop																			0	3.00	3.00
		D-5	4.57																1		3	3		11.57
		D-8	3.75															.75	.25	1	1		.5	7.25
	4.5	RNPL	No Stop																				3.6	3.60
	10	USN	2.83																			3		6.00
		D-1	2.83																			2		4.83
		D-5	3.96													2	2		2		3	8		20.96
		D-8	3.25													.75	1	.25	1	1	2		.5	9.75
		RNPL	3.00																5		5		2	15.00
	15	USN	2.67																		3	6		12.00
		D-1	2.50																1		2	12		17.50
		D-5	3.66												2	2	2		4		6	12		31.66
		D-8	3.00												.75	1	1	1	1	2	3		.5	13.25
		RNPL	2.80														5				20		2	29.80
	20	USN	2.50																1		5	17		26.00
		D-1	2.50																3		6	26		37.50
		D-5	3.35											2	1	2	4		6		7	20		45.35
		D-8	3.00												.75	2	1	1	2	3	5		.5	18.25
		RNPL	2.60													5			5		50		2	64.60
	25	USN	2.50																3		10	24		40.00
		D-1	2.33														2		4		15	30		53.33
		D-5	3.35											2	2	3	6		5		12	30		63.35
		D-8	2.75											.75	1	2	1	2	3	6	37		.5	56.00
		RNPL	2.60													5			5		90		2	104.60

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
180	30	USN	2.50																6		17	27		53.00
		D-1	2.33														3		8		23	30		66.33
		D-5	3.05										1	2	3	4	6		8		15	37		79.05
		D-8	2.75											.75	2	2	2	3	6	36	33		.5	88.00
		RNPL	2.40												5		5				125		2	139.40
	40	USN	2.33														3		14		23	50		93.00
		D-1	2.17													3	7		19		25	42		98.17
		D-5	3.05										1	4	4	5	9		12		24	46		108.05
		D-8	2.50										.75	1	2	5	5	32	30	31	34		.5	143.75
		RNPL	2.20											5			5		15		155		2	184.20
	50	USN	2.17													2	9		19		30	65		128.00
		D-1	2.00												2	6	16		21		25	58		130.00
		D-5	3.05										3	4	4	8	11		18		30	56		137.05
		D-8	2.50										.75	2	4	33	29	28	30	31	34		.5	194.75
		RNPL	2.00										5			5	10		25		170		2	219.00
	60	USN	2.17													5	16		19		44	83		168.00
		D-1	2.00												4	12	19		21		40	59		157.00
		D-5	3.05										4	4	7	10	14		24		33	73		172.05
		D-8	2.25									.75	1	3	20	56	29	28	30	31	34		.5	235.50
		RNPL	1.80									5			5	5	20		35		170		2	243.80
	70	USN																						
		D-1	1.63											1	10	17	18		28		50	86		211.83
		D-5	2.74									1	4	5	9	12	19		26		40	87		205.74
		D-8	2.00									1	3	6	50	55	29	28	29	32	33		.5	268.50
	75	RNPL	1.60								5			5	5	15	30		45		180		2	288.60
	90	USN																						
		D-1	2.20											7	15	16	20		44		51	115	.	270.20
		D-5	2.74									2	5	8	12	18	24		33		54	154		312.74
		D-8	1.75								1	3	17	47	49	54	29	28	30	31	34		.5	325.25
		RNPL	1.40							5				5	15	25	35		50		190		2	328.40

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
180	105	USN																						
		D-1	2.00										8	10	12	30	40		50		102	170		424.00
		D-5	2.74									2	7	10	14	22	25		40		65	229		416.74
		D-8	2.00								1.75	6	45	45	49	55	29	28	29	32	69	81		471.75
		RNPL	1.20						5				5	10	25	30	35		55		205		2	373.20
(200)	(240)	USN*	1.20						6	20	24	24	36	42	54	68	114		122		142	187		842.20
180	240	D-1	1.80									8	24	28	32	72	81		131		240	373		990.80
		D-5	2.44								1	16	17	27	32	50	87		197		427	567		1423.44
		D-8	1.50						29.75	33	36	38	41	45	49	55	29	28	29	32	69	81		596.25
		RNPL	.60			15	20	25	30	35	45	50	55	60	70	75	80		90		295		2	947.60
190	5	USN	No Stop																			0	3.17	3.17
		D-1	No Stop																			0	3.17	3.17
		D-5	4.88																2		2	3		11.88
		D-8	4.00															.75	.25	1	1		.5	7.50
		RNPL	3.40																5		10		2	20.40
	10	USN	2.83																		1	3		7.17
		D-1	2.83																		1	2		5.83
		D-5	4.27													2	2		2		4	8		22.27
		D-8	3.50													.75	1	1	1	1	2		.5	10.75
		RNPL	3.40																5		10		2	20.40
	15	USN	2.83																		4	7		14.17
		D-1	2.67														1		3		7	15		21.67
		D-5	3.66											1	2	2	2		5		6	14		35.66
		D-8	3.25												.75	1	1	1	2	2	3		.5	14.50
		RNPL	3.20														5				30		2	40.20
	20	USN	2.67																2		6	20		31.17
		D-1	2.50														1		3		7	29		42.50
		D-5	3.35										1	1	2	2	5		6		9	22		51.35
		D-8	3.00											.75	1	2	1	1	2	4	15		.5	30.25
		RNPL	3.00													5			5		70		2	85.00

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
180	25	USN	2.67																5		11	25		44.17
		D-1	2.50														3		6		17	30		58.50
		D-5	3.35										1	2	2	5	5		6		13	33		70.35
		D-8	3.00											.75	1	2	2	2	4	20	34		.5	69.25
		RNPL	7.80												.5		5				115		2	129.80
	30	USN	2.50														1		8		19	32		63.17
		D-1	2.33													2	4		8		25	30		71.33
		D-5	3.35										2	1	4	5	5		11		16	39		86.35
		D-8	3.00											.75	2	3	2	4	22	32	34		.5	103.25
		RNPL	2.60											5			5		5		140		2	159.60
	40	USN	2.50														8		14		23	55		103.17
		D-1	2.33													6	8		21		25	47		109.33
		D-5	3.35										2	4	5	4	11		14		26	50		119.35
		D-8	2.75										.75	2	2	6	23	29	29	32	33		.5	156.00
		RNPL	2.40										5			5	5		20		165		2	204.40
	50	USN	2.33													4	13		22		33	72		147.17
		D-1	2.17												4	6	19		21		30	59		141.17
		D-5	3.05									1	4	4	5	9	12		21		30	63		152.05
		D-8	2.50									.75	1	3	5	48	29	28	30	31	34		.5	212.75
		RNPL	2.20									5			5	5	15		35		170		2	239.20
	60	USN	2.33													10	17		19		50	84		183.17
		D-1	2.00											3	6	15	19		21		45	66		175.00
		D-5	3.05									2	4	4	9	10	16		26		37	78		189.05
		D-8	2.50									.75	2	5	38	54	29	28	30	31	34		.5	254.75
		RNPL	2.00								9			5	5	10	35		45		180		2	289.00
200	5	USN*	3.10																			1		4.20
		D-1	3.17																			2		5.17
		D-5	5.18																2		3	3		13.18
		D-8	3.50													1	.25	.25	1	1	1		.5	8.50
	3.5	RNPL	4.00																					4.00

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
200	10	USN*	3.00																		1	4		8.20
		D-1	2.83																1		3	11		17.83
		D-5	4.27												1	2	2		2		5	8		24.27
		D-8	3.25												1	1	.25	1	1	2	2		.5	12.00
		RNPL	3.40																5		10		2	20.40
	15	USN*	2.50																1		4	10		18.20
		D-1	2.67														1		3		7	27		40.67
		D-5	3.96											2	1	2	2		6		7	15		38.96
		D-8	3.25												1	2	1	1	2	2	3		.5	15.75
		RNPL	3.20														5				30		2	40.70
	20	USN*	2.50																3		7	27		40.20
		D-1	2.67														3		6		17	30		58.67
		D-5	3.66										1	2	2	3	5		6		10	26		58.66
		D-8	3.00											1	1	2	1	2	2	4	27		.5	43.50
		RNPL	3.00													5			5		70		2	85.00
	25	USN*	2.50																7		14	25		49.20
		D-1	2.50													2	5		8		25	30		72.50
		D-5	3.66										2	2	3	4	5		8		14	36		77.66
		D-8	3.00											1	2	2	2	3	4	31	34		.5	82.50
		RNPL	2.80												5		5				115		2	129.80
	30	USN*	2.40														2		9		22	37		73.20
		D-1	3.00													2	6		11		25	30		77.00
		D-5	3.35									1	2	2	5	4	6		12		18	40		93.35
		D-8	2.75										1	1	2	3	3	5	33	32	33		.5	116.25
		RNPL	2.20											5			5		5		140		2	159.20
	40	USN*	2.30													2	9		17		23	59		112.20
		D-1	2.33												4	6	15		21		25	57		130.33
		D-5	3.35									1	3	4	5	6	11		16		28	53		130.35
		D-8	2.75										2	1	4	9	33	28	30	31	34		.5	175.25
		RNPL	2.40										5			5	5		20		165		2	204.40

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
200	50	USN*	2.30													6	16		22		39	75		161.20
		D-1	2.17											2	6	11	18		22		41	59		163.17
		D-5	3.35									3	4	4	6	10	14		23		31	70		168.35
		D-8	2.50									1	2	3	8	59	29	28	29	32	33		.5	227.00
		RNPL	2.20									5			5	5	15		35		170		2	239.20
	60	USN*	2.20												2	13	17		24		51	89		199.20
		D-1	2.17											5	10	16	19		26		50	85		213.17
		D-5	3.35									4	4	6	9	11	19		27		39	85		207.35
		D-8	2.25								1	1	3	6	51	55	29	28	29	32	33		.5	270.75
		RNPL	2.00								5			5	5	10	35		45		180		2	289.00
	90	USN*	1.50									1	10	10	12	12	30		38		74	134		324.20
		D-1	2.00										8	13	15	17	36		43		82	143		359.00
	80	D-5	3.05								2	3	8	8	13	19	24		35		56	159		330.05
		D-8	2.00							1	3	10	46	45	49	55	29	28	29	32	33		.5	362.50
	80	RNPL	1.60						5				5	5	20	25	45		55		205		2	368.60
	120	USN*	1.40								6	10	10	10	24	28	40		64		98	180		473.20
		D-1	1.83									7	12	14	19	35	38		74		104	215		519.83
		D-5	3.05								5	7	12	16	20	26	36		57		125	406		713.05
		D-8	1.75						1	5	35	38	41	45	49	55	29	28	29	32	33		.5	422.25
	180	USN*	1.20						1	10	10	18	24	24	42	48	70		106		142	187		685.20
		D-1	1.67								6	11	19	29	31	51	81		106		209	346		890.67
		D-5	2.74							1	10	15	17	22	30	43	60		137		336	567		1240.74
		D-8	1.50					4	35	33	36	38	41	45	49	55	29	28	29	32	33		.5	489.00
		RNPL	.60	5	10	15	25	30	35	40	50	55	60	70	75	80	85		95		315		2	1047.60
	240	USN*	1.20						6	20	24	24	36	42	54	68	114		122		142	187		842.20
		D-1	1.67								9	25	26	29	64	73	98		196		288	450		1259.67
		D-5	2.74							5	15	16	25	27	46	59	130		272		475	566		1638.74
		D-8	1.25				5	36	31	33	36	38	41	45	49	55	29	28	29	32	33		.5	521.50
		RNPL																						

Note: (1) Time is given in minutes or decimal fractions of minutes;
(2) Number given in parenthesis is according to Royal Naval Physiological Laboratory schedule.

*For exceptional exposures, data are given according to U.S. Navy Standard Air Decompression Table.

COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
200	360	USN*	1.10					12	22	36	40	44	56	82	98	100	114		122		147	187		1058.20
		D-1	1.50							10	22	33	58	62	75	157	200		289		418	559		1884.50
		D-5	2.74							11	22	25	39	51	102	171	297		427		492	567		2206.74
		D-8	1.00			2	36	29	31	33	36	38	41	45	49	55	29	28	29	32	33		.5	547.50
		RNPL																						
240	5	USN*	3.50																			2		6.00
		D-1	3.67																		2	3		8.67
		D-5	6.10														2		2		3	5		18.10
		D-8	4.50													1	1	.25	1	1	2		.5	11.25
		RNPL																						
	10	USN*	3.30																1		3	6		14.00
		D-1	3.33														1		3		6	24		37.33
		D-5	5.18											2	1	2	2		4		7	12		35.18
		D-8	4.00											1	1	1	1	1	2	2	2		.5	15.50
		RNPL	4.00														5				15		2	26.00
	15	USN*	3.30																4		6	21		35.00
		D-1	3.17													2	3		6		17	30		61.17
		D-5	4.57									1	2	1	2	3	5		6		9	24		57.57
		D-8	4.25											.75	2	2	1	2	2	4	24		.5	42.50
		RNPL	3.80													5			5		55		2	70.80
	20	USN*	3.20														3		6		15	25		53.00
		D-1	3.00												2	3	5		11		25	30		79.00
		D-5	4.27								1	2	1	2	4	4	6		8		14	37		83.27
		D-8	3.75										1	1	2	3	2	3	5	35	34		.5	90.25
		RNPL	3.40											5			5				110		2	125.40
	25	USN*	3.10													1	4		9		24	40		82.00
		D-1	2.83											1	3	5	7		20		25	43		106.83
		D-5	4.27								2	1	2	4	4	5	7		12		20	42		103.27
		D-8	3.50									1	1	1	3	3	4	30	31	31	34		.5	133.00
		RNPL	3.40											5			5		10		140		2	165.40

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
240	30	USN*	3.10													4	8		15		22	56		109.00
		D-1	2.83											2	5	6	14		21		25	55		130.83
		D-5	3.96							1	1	2	4	4	4	6	11		15		27	51		129.96
		D-8	3.75									.75	1	2	3	7	28	28	30	31	34		.5	169.00
		RNPL	3.20										5			5	5		15		160		2	195.20
	40	USN*	3.00												3	7	17		22		39	75		167.00
		D-1	2.67										2	5	6	15	18		22		43	61		174.67
		D-5	3.96							1	3	4	4	4	8	10	14		24		32	72		179.96
		D-8	3.25								1	1	2	4	20	56	29	28	29	32	33		.5	238.75
		RNPL	2.80								5			5		5	20		35		185		2	259.80
	50	USN*	2.50											1	8	15	16		29		51	94		218.00
		D-1	2.50									1	5	5	14	17	19		32		50	94		239.50
	45	D-5	3.96							2	4	3	4	6	9	11	18		26		38	81		205.96
		D-8	3.00							1	1	2	4	27	50	54	29	28	30	31	34		.5	294.50
		RNPL	2.60							5				5	6	10	25		40		195		2	289.60
	60	USN*																						
		D-1	2.50									4	5	11	15	16	23		44		55	118		295.50
		D-5	3.66						2	3	3	5	7	9	12	18	24		34		53	144		317.66
		D-8	3.00						.75	1	2	4	28	45	49	55	29	28	29	32	33		.5	339.25
		RNPL	2.20						5			5		30	15	25	40		56		230		2	389.20
	90	USN*																						
		D-1	2.33								6	11	13	13	18	34	39		68		100	203		507.33
		D-5	3.66						3	6	6	8	12	16	20	24	37		55		110	363		663.66
		D-8	2.75					.75	3	7	43	38	41	46	49	55	29	28	29	32	33		.5	434.00
		RNPL	1.60		5	15	20	25	30	40	45	50	55	65	70	75	80		90		300		2	968.60
250	5	USN*	3.50																		1	2		7.10
		D-1	3.67																		2	4		10.67
		D-5	6.40														2		3		2	6		19.40
		D-8	4.75													1	1	.25	1	1	2		.5	11.50
		RNPL																						

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW) 170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10	ASCENT FROM LAST STOP	TOTAL ASCENT TIME
250	10	USN*	3.40																1		4	7		16.10
		D-1	3.33													1	1		3		7	27		42.33
		D-5	5.18										1	1	2	2	2		5		6	13		37.18
		D-8	4.25											1	1	2	25	1	2	2	3		.5	17.00
		NMPL	4.00													5					20		2	31.00
	15	USN*	3.30														1		4		7	22		38.10
		D-1	3.17												1	2	3		7		19	31		66.17
		D-5	4.88									2	1	2	2	3	5		6		11	27		63.88
		D-8	4.25										.75	1	1	2	2	2	2	5	32		.5	52.50
		NMPL	3.80												5				30		65		2	80.80
	20	USN*	3.30														4		7		17	27		59.10
		D-1	3.17												3	2	7		14		25	31		85.17
		D-5	4.57								2	1	2	2	4	5	4		10		16	39		89.57
		D-8	4.00										1	2	1	3	2	4	17	33	34		.5	101.50
		NMPL																						
	25	USN*	3.20													2	7		10		24	45		92.10
		D-1	3.00											2	2	7	8		22		25	47		116.00
		D-5	4.27							1	2	1	3	4	4	5	9		12		23	45		113.27
		D-8	3.75									1	1	2	2	5	5	28	30	31	34		.5	143.05
		NMPL																						
	30	USN*	3.20													6	7		17		23	59		116.10
		D-1	2.83										1	2	8	6	14		21		26	59		139.83
		D-5	4.27							2	1	3	3	4	5	7	11		17		28	54		139.27
		D-8	3.50								1	1	1	2	4	18	31	28	29	32	33		.5	184.00
		NMPL																						
	40	USN*	3.10												5	9	17		19		45	79		178.10
		D-1	2.83										4	5	7	16	19		21		48	70		192.83
		D-5	3.96						1	2	3	8	3	5	9	10	16		26		30	77		193.96
		D-8	3.50								1	2	2	4	35	54	29	28	30	31	34		.5	254.00
		NMPL																						

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COMPARATIVE AIR DECOMPRESSION TABLES

DIVE DEPTH (FSW)	BOTTOM TIME	TABLE SOURCE	TIME TO FIRST STOP	DECOMPRESSION STOPS (FSW)																			ASCENT FROM LAST STOP	TOTAL ASCENT TIME
				170	160	150	140	130	120	110	100	90	80	70	60	50	40	35	30	25	20	10		
250	60	USN*	2.40									4	10	10	10	12	22		36		64	126		298.10
		D-1	2.50								2	4	7	14	15	16	29		43		66	127		325.50
		D-5	3.96						3	3	3	7	7	9	14	20	24		36		57	160		346.96
		D-8	3.00						1	1	3	5	40	45	49	55	29	28	29	32	33		.5	353.50
		RNPL																						
	90	USN*	2.10						8	10	10	10	10	10	28	28	44		68		98	186		514.10
		D-1	2.33							2	9	12	12	13	24	34	39		78		108	219		552.33
		D-5	3.66					2	4	6	7	10	12	18	20	27	37		59		178	403		736.66
		D-8	2.50				1	2	3	28	35	38	41	45	49	55	29	28	29	32	33		.5	450.50
		RNPL																						

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