

DYSBARIC OSTEONECROSIS IN DIVERS

I. A Survey of 611 Selected U.S. Navy Divers

by

C.A. Harvey, CDR, MC, USN

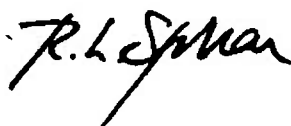
and

R.L. Sphar, CAPT, MC, USN

NAVAL SUBMARINE MEDICAL RESEARCH LABORATORY
REPORT NO. 832

Bureau of Medicine and Surgery, Navy Department
Research Work Unit MF51.524.014-0004.01

Approved and Released by:

A handwritten signature in dark ink, appearing to read 'R.L. Sphar', with a stylized, sweeping flourish at the end.

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SUMMARY PAGE

THE PROBLEM

To determine the prevalence of dysbaric osteonecrosis in U.S. Navy divers and to develop epidemiological data for insight into those aspects of the hyperbaric environment that contribute to the ultimate occurrence of dysbaric osteonecrosis.

FINDINGS

Twelve juxta-articular lesions have been identified among 21 lesions observed in fifteen radiologically positive cases of dysbaric osteonecrosis observed in 611 non-randomly selected U.S. Navy divers. One symptomatic case of dysbaric osteonecrosis has been observed. Lesions tended to appear in older divers. Saturation divers and all other helium divers had almost the same percentage of positive cases but air divers had a slightly lower percentage than either group.

APPLICATIONS

Based on statistically inadequate but strongly indicative data, diving as conducted in the U.S. Navy is related to a low prevalence of dysbaric osteonecrosis, and only rare symptomatic cases. An increased survey population is being obtained to provide additional insight into these preliminary observations.

ADMINISTRATIVE INFORMATION

This investigation was conducted as part of Bureau of Medicine and Surgery Research Work Unit MF51.524.014-0004 - "Dysbaric Osteonecrosis in Navy Divers". The present report is No. 1 on this work unit. It was received for review on 19 February 1976, approved for publication on 24 February 1976 and designated as NavSubMedRschLab Report No. 832.

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ABSTRACT

The Naval Submarine Medical Research Laboratory is conducting a radiological survey to determine the prevalence of dysbaric osteonecrosis in U.S. Navy divers and to develop epidemiological data related to those aspects of the hyperbaric environment that contribute to the ultimate occurrence of the lesions. Twelve juxta-articular lesions and nine head, neck or shaft lesions have been identified in the extremities of fifteen divers who are radiologically positive cases of dysbaric osteonecrosis among 611 non-randomly selected divers surveyed. While the number of positive cases is too small to draw statistically reliable conclusions, certain trends are evident. Lesions were most common in the shoulders and in older divers. Saturation divers and all other helium divers had almost the same percentage of positive cases but air divers had a slightly lower percentage than either group. Data derived from an enlarging survey population should provide additional insight into the epidemiology of the condition.

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ACKNOWLEDGMENTS

The author wishes to thank all those who have contributed so generously of their time, expertise and experience during this study.

The author wishes in particular to express his deepest appreciation to the radiologists who have participated as members of the study's panel of radiologists: CAPT C.W. Gates, MC, USN; CAPT R.E. Thompson, MC, USN; LCDR H.T. Beatty, MC, USN; LCDR G.W. Parker, MC, USNR and John O'Brien, M.D.

The author also wishes to thank his British colleagues who have contributed advice, experience and invaluable insight into the conduct of this study, and interpretation of the films, including: Surgeon Commodore J. A.B. Harrison, R.N., Prof. Dennis Walder, and John K. Davidson, M.D.

HMC(DV) Normand Tetrault, USN has contributed much common sense and outstanding organizational ability to the laborious process of collecting and interpreting the films.

Finally the author would like to express his appreciation to LCDR George M. Adams, MSC, USNR and James R. Nellen, M.D., who established much of the study's procedures currently conducted.

DYSBARIC OSTEONECROSIS IN DIVERS

I. A Survey of 611 Selected U. S. Navy Divers

INTRODUCTION

Radiologically detected lesions in bone representing an acquired abnormality have been observed in individuals with a history of exposure to hyperbaric or hypobaric environments.¹ In Caisson or tunnel workers an occasional non-symptomatic radiologically detected bone lesion in a juxta-articular area has been observed to become symptomatic with articular surface disruption.^{2,3} Pathological evaluation of these lesions has been accomplished in several symptomatic cases and the presence of aseptic bone necrosis has been confirmed.^{4,5} The confirmation of aseptic bone necrosis in Caisson workers prompted several studies of divers to determine if similar lesions occurred within the diving population. While similar radiological lesions were observed in divers,^{6,7,8,9,10} symptomatic joint involvement was infrequent and the pathological etiology has not been fully determined. Dysbaric osteonecrosis¹¹ has been employed as the term to describe the radiological observations of bone density and structure variations which appear to be aseptic bone necrosis occurring in individuals who have been exposed to a hyperbaric or hypobaric environment.

Initial efforts led to the conclusion that several radiographic views and a rigid protocol for obtaining and interpreting the films was necessary.

The present methodology was developed in cooperation with the Medical Research Council in Great Britain for determining the incidence of dysbaric osteonecrosis in this population and gaining insight into those aspects of the hyperbaric environment that may contribute to the ultimate occurrence of dysbaric osteonecrosis. This report contains the initial information compiled from this non-random survey of selected divers in the United States Navy.

METHODS

A specialized radiological regimen was necessary due to its use by a variety of Naval hospitals and dispensaries. Behnke appropriately defined this requirement by stating:

"Routine bone surveys have failed to reveal lesions apparent when rigid techniques were employed and combined with diagnostic search for characteristic lesions".¹³

The protocol for obtaining radiographs of divers (Appendix A) was devised after a careful literature review and consultation with several American radiologists and the Medical Research Council in Great Britain, utilizing those views with documented reliability for observing the radiological lesions of dysbaric

osteonecrosis.¹² Additional radiological or investigative techniques were not routinely employed in this survey.

Initially, a large number of experienced saturation and first class divers were selected for examination. Subsequent diver participation occurred according to geographical assignments without reference to diver qualifications. The radiological film set was obtained on each diver and forwarded to the Naval Submarine Medical Research Laboratory. Upon receipt, each film set was reviewed for technical discrepancies or abnormalities and submitted for double blind radiological interpretation. Interpretative discrepancies were resolved by careful review and discussion involving all 5 radiologists on the reviewing panel at periodic meetings. Radiological observations were recorded in the terminology devised by the British Medical Research Council (MRC) Decompression Sickness Panel.¹⁴ (Table I)

The surveyed divers' age and diving classification status were chronologically correlated with the radiological observations. Since a complete, objective diving history was not available on each diver, the participants' diving classification at the time of survey was used to reflect on a minimum course of diving experience. Table II delineates the diver classifications and training/experience levels utilized in the survey. Divers with dual classifications were grouped with the classification implying the greatest stress in their diving experience (e.g., 8493 corpsmen with saturation qualifications were grouped with the 5311 saturation group). Appendix B, ex-

tracted from the Bureau of Naval Personnel Manual, describes the minimum diving qualifications and designation of U. S. Navy Divers.

RESULTS

Table III describes the results obtained from the initial survey of 611 U. S. Navy divers. When two or more survey results were available, the most recent results were tabulated. Table IV describes the distribution of participants' diver classifications within the various radiological classifications for U. S. Navy divers.

Since many classifications have common diving experiences, certain categories were combined to identify trends related to common diving histories in Table V.

Among the 611 U. S. Navy divers in the survey, 21 lesions were classified in 15 radiologically positive cases, and 17 lesions were classified in 16 radiologically doubtful cases. Bone islands were not considered in these compilations. Table VI describes the distribution of lesions observed in the anatomical areas surveyed.

Participants with bone islands without positive lesions were categorized as radiologically negative for the survey compilation.

Participant ages at the time of survey were available from 569 of the 611 U. S. Navy divers in the survey, and diver classification was reported from 561. Table VII describes the comparison of the participants' age with the radiological results.

TABLE I DYSBARIC OSTEONECROSIS CLASSIFICATION SYSTEM^a

<u>CLASSIFICATION</u>	<u>NOMENCLATURE</u>
0	Normal
<u>JUXTA-ARTICULAR</u>	
A 1	Dense Areas with Intact Articular Cortex
A 2	Spherical Segmental Opacities
A 3	Linear Opacity
A 4	Structural Failure:
A 4a	Translucent Subcortical Bands
A 4b	Collapse of Articular Cortex
A 4c	Cortical Sequestration
A 5	Osteoarthritis
<u>HEAD, NECK, SHAFT</u>	
B 1	Medullary Dense Areas
B 2	Irregular Calcified Medullary Areas
B 3	Medullary Translucent Areas and Cysts

^a A classification system devised by the British Medical Research Council, Panel on Decompression Sickness¹⁴

TABLE II
DIVER CLASSIFICATION AND TRAINING/EXPERIENCE REQUIREMENTS FOR
GROUPS IN WHICH A LARGE NUMBER OF SUBJECTS ARE INCLUDED IN
THE STUDY ^a

<u>CLASSIFICATION CODE</u>	<u>TRAINING/EXPERIENCE REQUIREMENTS</u>
5345 ^{b,c} (SCUBA)	Free Ascent from 35 feet of sea water (FSW). Swim to 100 FSW. Normal Working Depth Less than 130 FSW Compressed Air Only. Biannual Qualification
5343 ^{b,c} (Diver Second Class)	Qualification Dive 50 FSW/60 Min. Maximum Qualification Depth - 200 FSW. Compressed Air Only.
5342 ^{b,d} (Diver First Class)	5343 for 6 Months. Qualification Dive 300 FSW, Air Working Dive 200 FSW, Air. Working Dive 300 FSW, HeO ₂ .
5341 ^{b,d} (Master Diver)	5342 for 24 Months. 12 Months Aboard HeO ₂ Equipped Vessel and/or 12 months aboard Salvage Type Vessel.
5311 (Saturation Diver)	5342 Classification. Complete Saturation Training Program.
8493 (Medical Deep Sea Diving Technician)	Same as 5342 except no requirement for 5343 training.
9313 (Deep Sea-HeO ₂ Diving Officer)	Same as 5442 except for 5343 training.
Other	Chiefly includes hyperbaric tenders and nurses who are qualified for dry chamber exposures only.

^a Summary of requirements is incomplete. Presented for purposes of quick identification only. See Appendix B for complete descriptions.

^b First Class Swimmer.

^c Four Annual Requalification Dives Between 30-150 FSW for 45 Min.

^d Four Annual Requalification Dives as follows: 100-150 FSW, 45 Min; 150-170 FSW 30 Min; 170-200 FSW, 15 Min; 200 FSW or over, 10 Min. When available a Minimum of two (2) HeO₂ Dives. If ashore, requalification as 5343

TABLE III SURVEY RESULTS FROM A NON-RANDOM POPULATION OF U. S. NAVY DIVERS

<u>RADIOLOGICAL CLASSIFICATION^a</u>	<u>NUMBER OF DIVERS</u>	<u>PERCENTAGE OF DIVERS</u>
POSITIVE	15	2.45
DOUBTFUL	16	2.62
NEGATIVE	580	94.93
TOTAL	611	100.

^a Classified according to guidelines in Table I

DISCUSSION

As a result of this initial survey, 15 U. S. Navy divers of 611 examined were observed to have radiological lesions consistent with dysbaric osteonecrosis. While the number of radiologically positive cases clearly documents the existence of dysbaric osteonecrosis in U. S. Navy divers, the non-random structure of the survey does not permit an absolutely definitive establishment of prevalence in U. S. Navy divers. A randomized diver sample will be required prior to a definitive assessment of prevalence. The reported observation of 2.45 percent radiologically positive cases is, therefore, germane only to this non-random survey but it is important to note that the survey sample includes a higher percentage of saturation and helium divers than the U. S. Navy diving population at large

and the figure is possibly high rather than low.

Among the 15 radiologically positive cases, 21 lesions were observed. Twelve of these lesions were near articular surfaces. Sixteen of the twenty-one lesions were associated with the proximal humerus, and ten of these were classified as juxta-articular. The proximal femur was associated with three lesions, of which two were juxta-articular. Two lesions were located in the distal femur and neither was juxta-articular. These data suggest that the proximal humerus and proximal femur are the most likely areas for structural failure of the articulating surfaces, and the development of symptoms. A single radiological observation of collapse of the articular cortex in the proximal humerus was confirmed by a second survey and determined as symptomatic on interview. (The presence of dysbaric osteonecrosis with articular collapse was later verified by post-mortem

TABLE IV THE DISTRIBUTION OF PARTICIPANTS

DIVER CLASSIFICATIONS (WITHIN THE VARIOUS RADIOLOGICAL CLASSIFICATIONS FOR U. S. NAVY DIVERS)					
DIVER CLASSIFICATION	RADIOLOGICALLY POSITIVE	RADIOLOGICALLY NEGATIVE	RADIO- LOGICALLY DOUBTFUL	T O T A L	TOTAL RADIOLOGICALLY POSITIVES AND DOUBTFULS
5311 (Saturation)	5(3.1%)	151	3	159	8 (5%)
5341 (Master)	2(8.7%)	19	2	23	4 (17.4%)
5342 (1st Class)	4(2.9%)	129	4	137	8 (5.8%)
5343 (2nd Class)	0	68	2	70	2 (2.9%)
5345 (Scuba)	0	1	1	02	1 (50%)
8493 (Corpsman)	0	40	1	41	1 (2.4%)
9313 (HeO ₂ Officer)	2 (7.4%)	24	1	27	3 (11.1%)
9230 (EOD Officer)	1 (11.1%)	8	0	09	1 (11.1%)
0090 (Sub.Med.Off.)	0	10	0	10	0
(Div.Med.Off.)	0	8	1	09	1 (11.1%)
9312 (Gen.Div.Off.)	0	4	0	04	0
9314 (Salvage Off.)	0	12	0	12	0
Other	0	59	1	60	1 (1.7%)
Unknown	1 (2.1%)	47	0	48	1 (2.1%)
<hr/>					
TOTAL	15 (2.45%)	580	16	611	31 (5.1%)

TABLE-V

TABLE V THE DISTRIBUTION OF PARTICIPANTS GROUPED BY COMMON DIVING HISTORIES BASED ON THEIR DIVING CLASSIFICATIONS WITHIN THE VARIOUS RADIOLOGICAL CLASSIFICATIONS FOR U. S. NAVY DIVERS

DIVER CLASSIFICATION	RADIOLOGICALLY POSITIVE	RADIOLOGICALLY NEGATIVE	RADIOLOGICALLY DOUBTFUL	TOTAL RADIOLOGICAL POSITIVES AND DOUBTFULS
Saturation (5311)	5(3.1%)	151	3	159 8 (5%)
All Helium Qualified (Except Saturation)	8(3.2%)	230	9	247 17(6.9%)
All Helium Qualified Including Saturation	13(3.2%)	381	12	406 25(6.2%)
All Hard Helmet and Scuba Qualified	0	84	2	86 2 (2.3%)
Scuba Qualified Only	1 (9.1%)	9	1	11 2 (8.2%)
Air Hard Helmet or Scuba Qualified	1 (1%)	93	3	97 4 (4.1%)
Other and Unknown	1 (1%)	106	1	108 2 (1.8%)

examination following the patient's death from cardiovascular disease.) Six medullary lesions were encountered in the proximal humerus, one in the hip and two in the knees. While bone islands were not considered in these compilations, they were ubiquitous to each anatomical area in the radiologically positive population. Nine of the radiologically positive cases represented one lesion at one anatomical site, and two radiological lesions were observed in six participants.

An attempt to relate the participants' age to the presence of dysbaric osteonecrosis for insight into the etiology of this process revealed an apparent

positive correlation with an increase in age. The limited number of participants over 40 years of age does not permit an effective assessment of the apparent increased percentage of positive radiological lesions observed in these individuals. Between the ages of 18 and 40, those individuals in the 36-40 year age bracket had the highest percentage (4.6 percent) of positive lesions. While individual diving histories were not documented for this report, speculation does suggest this age bracket may represent the greatest diving experience. Although these remarks are to a degree speculative in some instances, additional insight into these possibilities will develop as the survey size increases

TABLE VI THE DISTRIBUTION OF LESIONS
OBSERVED IN THE ANATOMICAL AREAS SURVEYED

ANATOMICAL AREA SURVEYED	LESION TYPE									
	A1	A2	A3	A4a	A4b	A4c	A5	B1	B2	B3
Left Shoulder	2	2						1	2	
Right Shoulder	1	4			1			1	2	
Right Hip			1							
Left Hip		1							1	
Right Knee (Femur)									1	
Right Knee (Tibia)										
Left Knee (Femur)									1	
Right Knee (Tibia)										
TOTAL	3	7	1		1			2	7	

TABLE VII

TABLE VII THE DISTRIBUTION OF PARTICIPANTS AGES WITHIN THE VARIOUS RADIOLOGICAL CLASSIFICATIONS FOR U.S. NAVY DIVERS

AGE	RADIOLOGICALLY POSITIVE	RADIOLOGICALLY NEGATIVE	RADIOLOGICALLY DOUBTFUL	TOTAL RADIOLOGICALLY POSITIVES AND DOUBTFULS
20 & under	0	16	1 (5.9%)	17
21 - 25	2 (1.6%)	119	2 (1.6%)	123
26 - 30	1 (0.6%)	153	2 (1.3%)	156
31 - 35	5 (3.1%)	148	7 (4.4%)	160
36 - 40	4 (4.6%)	82	1 (1.1%)	87
41 - 45	2 (10.5%)	16	1 (5.3%)	19
46 & over	0	7	0	7
Unknown	1 (2.5%)	40	1 (2.4%)	42
TOTAL	15 (2.45%)	581	15 (2.45%)	611

^a Ages available for 581 of the 611 divers surveyed

and as repetitive surveys become available.

Contrary to previous supposition,¹⁵ the percentage of saturation divers categorized as radiologically positive (3.1 percent) was not significantly different from the percentage of radiologically positive divers first class (2.9 percent), or all other helium divers as a group (3.2 percent). As all saturation divers were previously diver first class, the added saturation experience

did not appear to significantly increase the ultimate occurrence of dysbaric osteonecrosis. However, a definitive statistical assessment of these observations cannot be made at this time. Definitive insight into the possible effects of mixed gas breathing (e.g., helium/oxygen mixtures) on the ultimate occurrence of dysbaric osteonecrosis cannot be made until the population size of divers second class and scuba divers is increased. The present evidence suggests that mixed gas

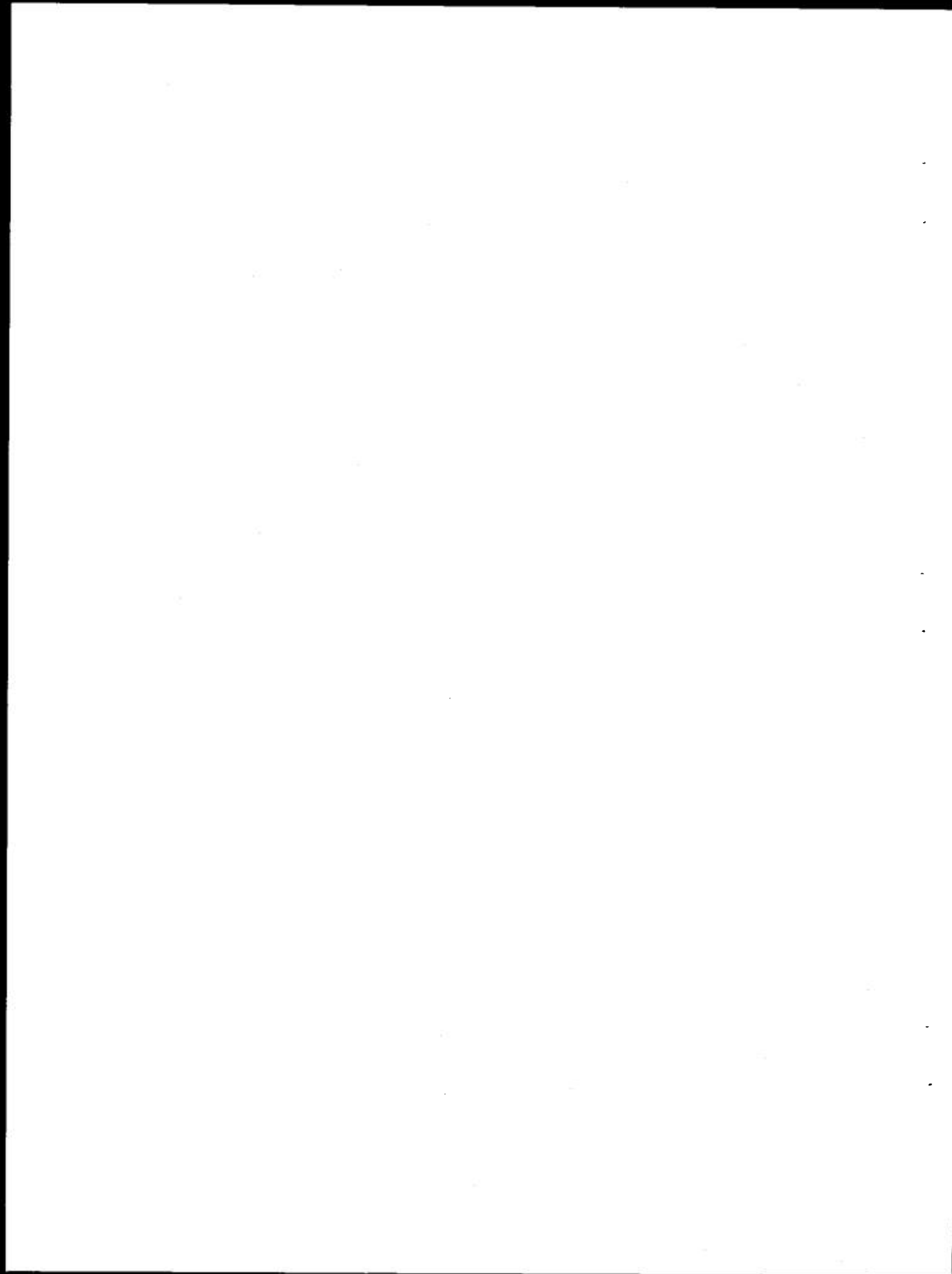
breathing might be involved in the etiology of dysbaric osteonecrosis but this is a tenuous observation at best. The lowest percentage of positive cases was observed in individuals solely utilizing compressed air as the breathing medium, medical personnel and diving officers.

Periodic data compilations derived from an expanding survey will ultimately permit more definitive insight into the observations and suggestions presented in this report. While dysbaric osteonecrosis does occur in U. S. Navy divers, the etiology of this process remains obscure, and its prevalence low. The divers' age and diving history, as reflected in diver classification, have suggested that age may be related to the etiology of dysbaric osteonecrosis. Diving history correlations rather than diving classification correlations may ultimately yield additional insight into this process. An increased population of divers in the various classifications should clarify the suggested relationships. As the population of divers in the survey increases and repetitive radiographs are chronologically collected from the participants, the doubtful category should be reduced and the data required for statistically effective evaluations developed. These data in conjunction with alternate investigative information derived from tomograms, radioisotope evaluations, quantitative radiological bone density evaluations, and histological examinations where possible should assist in ultimately defining the etiology of dysbaric osteonecrosis from the initial insult to the final progression.

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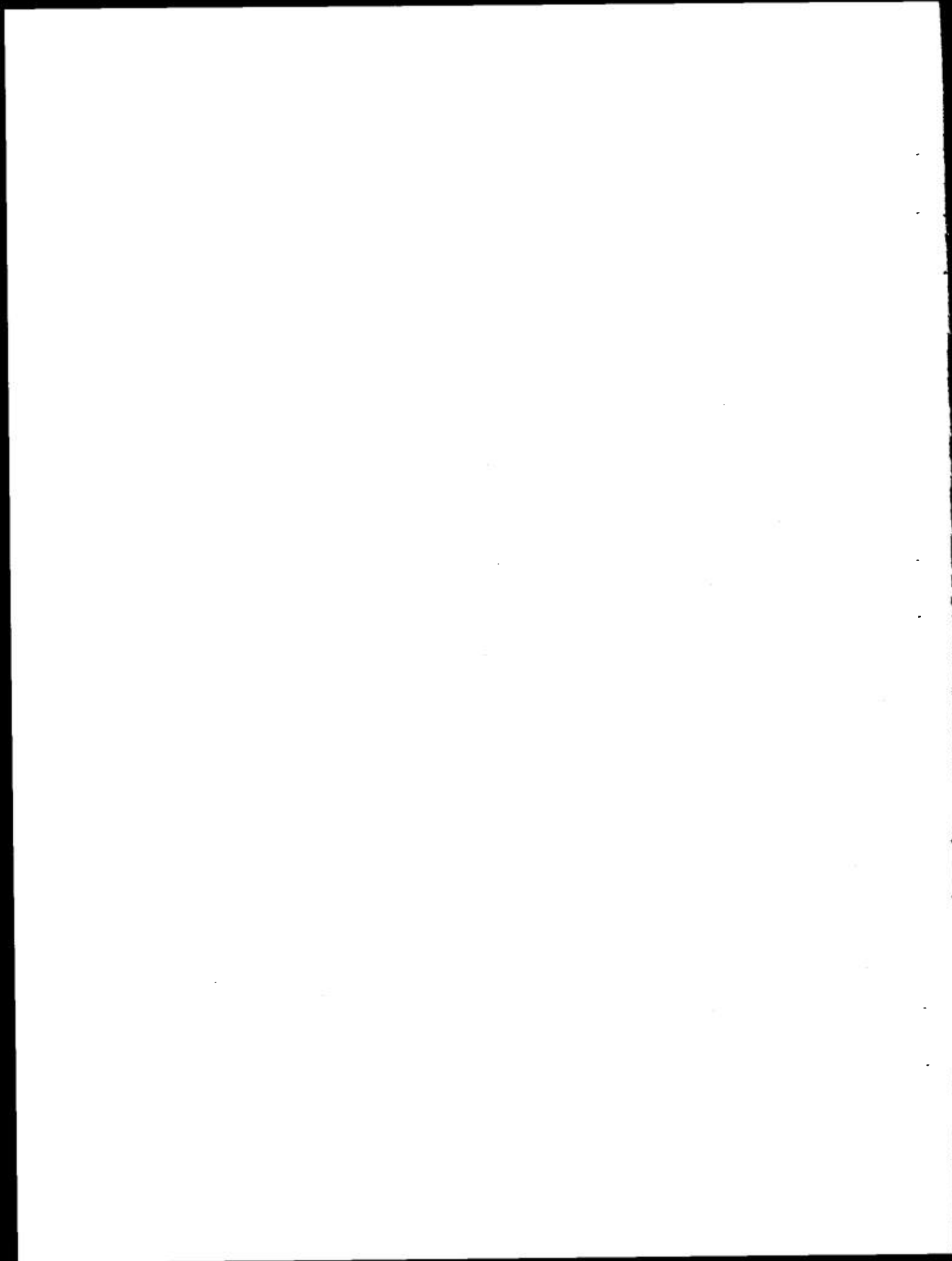
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APPENDIX A

PROTOCOL FOR RADIOGRAPHIC EXAMINATION
FOR DYSBARIC OSTEONECROSIS



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PROTOCOL FOR RADIOGRAPHIC EXAMINATION
FOR DYSBARIC OSTEONECROSIS

October 1974

The examination must include independent views of the head and proximal shaft of the humerus and femur and lateral views of each knee, including two thirds of the femur shaft and one third of the tibia shaft. While other views may be included if suspicion of clinical involvement is present, they are not included in the standard survey views.

The following factors are standard on each view:

Moving Bucky grid (employing 1:16 ratio grid if available)

10 x 12 cassettes

Par Speed Screens

40 inch distance (variable with equipment available)

One view per film

Gonadal shielding, 1/4 inch lead or equivalent

The following independent views comprise a routine ten film survey:

Right shoulder and left shoulder joint with humeral shaft

Grashey position internal rotation

Grashey position external rotation

Right hip and left hip joint with femoral shaft

Antero-posterior projection

Frog-leg lateral

Right and left knee

Lateral projection

The following positioning descriptions must be employed in obtaining the aforementioned views:

- a) Shoulder -- The patient is placed in a supine position with the trunk rotated at an angle approximately 45° to bring the shoulder to be radiographed in contact with the table. This arm is straight and follows the trunk. Center 1 inch below the coracoid process of the scapula. Angle the tube head 5° caudally (toward feet). Cone to show as much humerus as possible bringing in the lateral diaphragm to show only the head and shaft of the humerus. This positioning should show a clear joint space and the acromion should not overlap the head of the humerus.

With the patient positioned as above, and without moving body position, the two required views are accomplished as follows:-

Internal Rotation - Palm down with the hand flat against the table

External Rotation - Palm up with the hand flat against the table

- b) Hip. Antero-posterior positioning. The patient is placed in a supine position with the feet 90° to the table top. The edge of the Gonad shield should be as near the femoral head as possible but not obscuring the femoral head. Center the cone over the head of the femur, that is 1 inch below the mid-point of a line joining the anterior superior iliac spine and the upper border of the pubic symphysis.

Frog leg lateral - The patient is placed in a supine position on the table with the foot of the side for examination level with the opposite knee. The flexed knee is elevated about 10° and supported. Gonadal shielding and centering are the same as in the hip antero-posterior view.

- c) Knee. Lateral Projection. The patient is placed in a supine position on the table and rotated to bring the outside of the knee to be examined in contact with the table and the leg straight. The opposite leg is rotated anteriorly to the knee being examined to result in the pelvis being perpendicular to the table. Center at the level of the upper border of the patella. The field should include the lower 2/3 of the femur and the upper 1/3 of the tibia and fibula.

GONAD SHIELDING MUST BE EMPLOYED IN ALL VIEWS. Forego the survey if shielding is not available. Immediate notices will be forwarded to facilities that do not employ gonadal shielding.

The radiographs in this survey must be of a high standard and must show good trabecular detail. A radiologist review and reading at the time of survey is requested unless a radiologist is not available to the facility. Probably the greatest error lies in under-penetration of the radiographs resulting in inadequate trabecular detail in which small dense areas near the joint surfaces will not be identified. Other difficulties in interpretation arise from

malformation of the shoulder joint resulting in the superior border of the greater tuberosity appearing as a dense layer which could be misinterpreted as osteonecrosis.

Note: Protocol adapted from the independent efforts of:

Dr. James R. Nellen

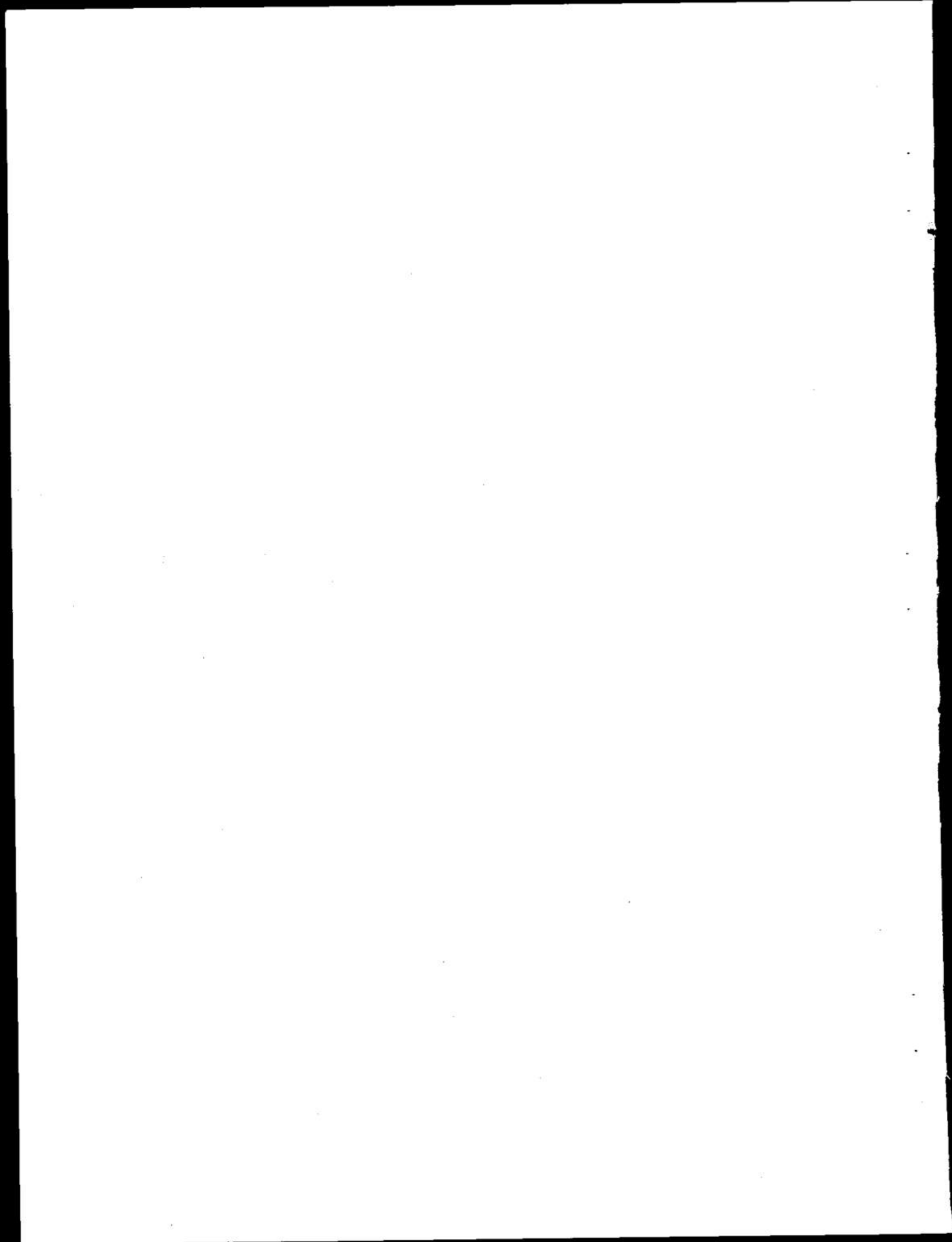
Dr. John K. Davidson

Dr. John L. Heard and Dr. Coleman Schneider

APPENDIX B

BUREAU OF NAVAL PERSONNEL MANUAL

1410380 DIVER DESIGNATION



1410380 DIVER DESIGNATION

1. Qualified divers are divided into the following classes, with Navy Enlisted Classification (NEC) Code, according to their degree of qualification:

- a. Master Diver (5341).
- b. Saturation Diver (5311).
- c. Diver First Class (5342).
- d. Medical Deep Sea Diving Technician (8493).
- e. Salvage Diver (Mobilization only).
- f. Diver Second Class (5343).
- g. Scuba Diver (5345).

2. When a member has been trained and qualified as a diver, an entry shall be made on the Administrative Remarks page, Page 13, of his service record as follows:

"(Date): Qualified as (class diver) to a depth of (fill-in) feet. Qualification lapse date (fill-in). Authorized assignment to NEC (fill-in) Diving Billets (see OPNAV Form 1000/2) and entitled to receive appropriate pay when performing the duties of the billet. Assignment of NEC (fill-in) recommended to BUPERS. (Signature)"

3. Navy enlisted classifications and NEC codes which include a degree of diving qualification, collateral to basic classification, are as follows:

- a. Underwater Demolition Team Swimmer (5321).
- b. Underwater Demolition Team Swimmer/Explosive Ordnance Disposal Technician (5322).
- c. Combatant Swimmer (SEAL Team) (5326).
- d. Combatant Swimmer (SEAL Team/Explosive Ordnance Disposal Technician) (5327).
- e. Explosive Ordnance Disposal Technician (5332).
- f. Underwater Photographer (8136).
- g. Hospital Corpsman, Special Operations Technician (8492).

When a member has been trained and qualified in one of the above categories, an entry shall be made on Page 13 of his service record as follows:

"(Date): Qualified as (fill-in) to a depth of (fill-in) feet. Qualification lapse date (fill-in). Authorized assignment to NEC (fill-in) billet (see OPNAV Form 1000/2) and entitled to receive appropriate pay when performing the duties of the billet. Assignment of NEC (fill-in) recommended to BUPERS. (Signature)"

4. Classification and designation:

a. After a BUPERS Report 1080-14, Enlisted Distribution and Verification Report, listing the appropriate NEC has been received and an entry made on Page 4, Navy Occupation/Training and Awards History, of the enlisted service record assigning the appropriate NEC, this code shall not be removed because the member's qualification as a diver lapses but shall be retained as long as he is capable of being requalified as a diver. Members no longer volunteering or capable of requalifying for diving duties shall be reported to the Chief of Naval Personnel in order that their diver NEC's can be revoked.

b. The enlisted designator "DV" shall be placed immediately after the member's rating abbreviation in parenthesis and shall appear with his rating abbreviation on all service record pages and on all correspondence pertaining to him thereafter as long as he remains a qualified diver. In the case of a diver's failure to requalify by the end of his qualification period, the DV designator shall be removed on the date following the last date of the qualification period. The DV designator may be restored by the commanding officer upon completion of the necessary requalification dives not later than one year after lapse of qualification. Should qualification lapse continuously for a period of one year, the member must be retrained. All actions which result in the assignment or removal of the enlisted designator DV shall be reported immediately to the cognizant PAMI by an appropriate diary entry.

c. The Chief of Naval Personnel will remove the diver NEC and designator of divers second class being advanced to pay grade E-7 who have not applied for diver first class training.

5. Selection and training:

a. In the selection and training of members as divers, commanding officers and examining boards shall be guided by the Bureau of Naval Personnel Manual, the Manual of the Medical Department, and the Formal Schools Catalog, NAVPERS 91769 series.

b. An officer shall be assigned responsibility for any and all diving. That officer shall study all diving publications available and shall make every effort to assure himself that all diving is conducted in accordance with good diving practice. He shall particularly

ensure that the man in charge of the actual diving operations is a diver whose competency, responsibility, and reliability are commensurate with the particular operation.

6. No member shall be allowed to dive unless he has been found physically qualified by examination in accordance with the Manual of the Medical Department within the preceding 12 months, or following any intervening illness or accident considered likely to affect physical qualification for diving.

7. Periodic qualification of all divers is necessary to ensure continuous proficiency and maximum safety. Commanding officers shall ensure that divers are afforded an opportunity to maintain their qualification without lapse. Divers will be qualified for six-month periods. An entry shall be made in the service record to show the period of a diver's qualification. When dives are conducted in accordance with the requirements listed below within the period of qualification, a diver will be considered qualified for another six-month period beginning on the date his qualification would have lapsed. If dives are conducted in accordance with the requirements listed below within one year of the date on which qualification lapsed, the diver will be considered requalified and an entry to that effect shall be made in the service record. If a diver's qualification has lapsed continuously for more than one year, he will be retrained and redesignated only after his permanent interest in diving and his sincere desire for redesignation are established. Entitlement to special pay for diving duty depends upon the maintenance of qualification by actual performance of dives according to the tables listed below. No extensions of diver qualifications are authorized, except by the actual performance of prescribed qualification dives. Four dives in accordance with the tables listed below are required to maintain diver qualifications, except that UDT Swimmers, EOD Technicians, Underwater Photographers, Hospitalman Special Operations Technicians, and Scuba Divers are required to perform a combination of dives and swims using scuba equipment.

a. Master Divers, Divers First Class, and Medical Deep Sea Diving Technicians must perform four dives under any of the depth-time requirements below:

Depth of water — Minimum bottom time

100-150 feet — 45 minutes
150-170 feet — 30 minutes
170-200 feet — 15 minutes
200 feet and over — 10 minutes

When attached to helium-oxygen equipped vessels or activities, the above divers must perform a minimum

of two of the required four dives using helium-oxygen as a breathing medium.

b. UDT/SEAL Swimmers (NECs 5321, 5322, 5326, 5327):

(1) Day, two dives to a minimum depth of 120 feet with a minimum bottom time of 10 minutes, two scuba swims on compass course, one 1000 yards minimum distance and one 1500 yards minimum distance.

(2) Night, two scuba swims on compass course, one 1000 yards minimum distance. In addition to the above, NECs 5322 and 5327 shall make two dives to a depth of 30 to 130 feet in connection with an EOD/NWD problem involving the location and disposal or rendering safe of ordnance.

c. EOD Technicians:

(1) Two dives to a minimum depth of 120 feet with a minimum bottom time of 10 minutes. Two dives to a depth of 30 to 130 feet in connection with an EOD/NWD problem involving the location and disposal or rendering safe of ordnance.

(2) Two scuba swims of 500 yards minimum distance each.

d. Salvage Divers and Divers Second Class shall perform four dives (search or salvage work problems) under the depth — minimum time requirement of 30-150 feet — 45 minutes (operational and requalification).

e. Scuba Divers, Underwater Photographers; and Hospital Corpsman, Special Operations Technicians:

(1) One dive to a depth of 50-70 feet with a minimum bottom time of 10 minutes, and one dive to a depth of 70-130 feet with a minimum bottom time of five minutes.

(2) Two scuba swims of 500 yards minimum distance each.

f. Master Divers, First Class Divers, and Medical Deep Sea Diving Technicians may take requalifying dives as for Divers Second Class, when permanently attached to activities which are part of the shore establishment or activities permanently located where available water depths or equipment limitations preclude requalification in accordance with the requirements above. This provision does not apply to activities having wet pressure tanks installed. Other classes of divers in the above category may make requalifying dives as for Divers Second Class but shall, in addition, complete scuba swims as applicable.

g. Dives and swims made during regular diving operations shall count for retaining diver qualification, provided they meet the requirements above. Minimum depths and duration of qualification and requalification dives outlined therein are not intended to prescribe operational diving limitations.

h. Commanding officers are to ensure that divers maintain proficiency in the use of all types of diving equipment for which qualified, insofar as the activity's authorized equipment will permit. Training and requalification diving should be planned to include salvage, search, and repair exercises utilizing deep sea, lightweight, scuba and helium-oxygen equipment if so outfitted.

i. All divers should receive free ascent training at one of the Submarine Escape Training Tanks when possible. This training shall not be conducted at other activities unless a recompression chamber is readily available and the training is under the direct supervision of a Diving Officer and Submarine Medical Officer assisted by instructors well qualified in free ascent techniques.

8. Commanding officers may recommend to the Chief of Naval Personnel the revocation of the designation of any class of diver with reasons therefor. Whenever a designation is revoked, an entry shall be made on Page 13 of the service record, showing date of revocation and reasons therefor, and reported as a miscellaneous change to the cognizant PAMI.

9. An enlisted member who qualifies as a diver is authorized to wear a distinguishing mark as prescribed by the Navy Uniform Regulations. Authorization to wear the distinguishing mark shall continue throughout the tenure of qualification. Master Divers are authorized to wear the Master Diver Insignia. Master Divers who, through no fault of their own, are physically disqualified from continuance in diving may continue to wear the Master Diver Insignia.

10. Requirements for Master Divers:

a. The commanding officers of a diving activity may recommend any Diver First Class by letter to the Chief of Naval Personnel for designation as Master Diver who fulfills the qualification requirements listed below. The Chief of Naval Personnel will consider, on an individual basis upon recommendation by the commanding officer, the waiver of one type vessel service requirement in the case of members whose performance is of such excellence as to warrant special consideration. The letter of recommendation shall note the fulfillment of each requirement and shall contain a summary of duties performed as a diver.

b. The eligibility requirements are:

(1) Be a chief petty officer or above, other than hospital corpsman, a minimum of one year.

(2) Have served a minimum of two years with the designation and qualification of Diver First Class.

(3) Have served as a qualified Diver First Class a minimum of 12 months aboard a helium-oxygen equipped diving vessel and/or as a qualified salvage diver a minimum of 12 months aboard an ARS or ARSD type diving vessel.

(4) Have averaged at least 3.5, with no individual mark less than 3.2, on the Enlisted Performance Evaluation Report, NAVPERS 792 series, or no mark less than "Top 50%" on the Evaluation Report, NAVPERS 18658 series, whichever was last submitted.

(5) Be a graduate of the Master Diver Qualification Course conducted at the Naval School, Diving and Salvage, Washington, D. C.

c. The qualification factors are:

(1) Demonstrate ability to take charge of all phases of helium-oxygen diving.

(2) Demonstrate ability to plan and take charge of all diving operations.

(3) Demonstrate ability to take charge of operation and maintenance of a submarine rescue chamber.

(4) Demonstrate knowledge of all Navy procured types of self-contained underwater breathing equipment, including their advantages and limitations.

(5) Know the methods and materials used in un-beaching ships on strand under various conditions of beach, sea, and water, and refloating sunken vessels.

(6) Demonstrate knowledge of the types of compressors used habitually in diving operations, including the various filtering methods and the necessary precautions to observe.

(7) Understand the principles of the General Gas Law and its derivatives (Boyle's and Charles' Laws).

(8) Understand the principles of Dalton's Law of partial pressures and Henry's Law of fluid saturation.

(9) Understand the theory of inert gas saturation and desaturation of body fluids and tissues.

(10) Understand the principles involved in the computation of various decompression tables.

(11) Recognize the different forms of decompression sickness and know the treatment required.

(12) Understand the effect upon the respiratory system of such poisonous gases as may be encountered in diving and know the treatment required.

(13) Know the name and use of equipment required for safe diving operations.

(14) Know the causes, symptoms, treatment of, and preventive measures for all types of diving accidents.

(15) Have a comprehensive knowledge of the scope, content, and application of Navy publications and instructions pertaining to diving such as the Diving Manual, NAVSHIPS 250-538, and applicable sections of the NAVSHIPS Technical Manual, Manual of the Medical Department, and this Manual.

11. The Saturation Diver NEC 5311 assignment is contingent upon completion of the specialized Saturation training program and formal recommendation by the Saturation Training Officer. A prerequisite for an NEC 5311 assignment is the possession of an NEC 5342. The Saturation diver must be able to live and work at great depths for extended periods of time, conduct large object salvage to continental shelf depth, operate, maintain, and support SEALAB equipment systems and underwater salvage tools and equipment, and possess an extensive knowledge of marine life, ocean science, and mixed-gas scuba equipment. Master Divers, while assigned to the Saturation Program, shall retain their NEC 5341.

12. Requirements for Diver First Class:

a. Divers First Class are trained, qualified, and designated at the Naval School, Diving and Salvage, Washington, D. C. No member will be placed in training for Diver First Class at any other place without prior authority from the Chief of Naval Personnel.

b. Members must meet the following requirements to be eligible for the special course of instruction for Diver First Class:

(1) Be recommended by his commanding officer.

(2) Be a currently qualified Diver Second Class, PO3 or above, and have served at least six months in a diving billet.

c. The qualification factors are as follows:

(1) Withstand pressure equal to 300 feet of water while breathing air.

(2) Dive and accomplish work using self-contained underwater breathing apparatus (scuba), shallow water diving equipment, deep sea diving equipment, and helium-oxygen diving equipment.

(3) Dive and accomplish work at depth of 200 feet of water, while breathing air.

(4) Dive and accomplish work at depth of 320 feet of water, while breathing helium-oxygen mixture.

(5) Demonstrate proficiency in the use of all underwater tools, both in the shop and under actual diving conditions; the operation and maintenance of a submarine rescue chamber; and marlinspike seamanship commonly used aboard salvage and rescue vessels.

(6) Demonstrate knowledge of diving physics, particularly showing proficiency in mixing and analyzing synthetic breathing mixtures and in computing pressures of gases required to operate underwater cutting torches at various depths.

(7) Demonstrate knowledge of diving physiology; know the use of standard decompression tables; recognize symptoms of decompression sickness; and know the treatment required for all common diving accidents.

(8) Demonstrate proficiency in the use of the recompression chamber for treatment of diving accidents and for surface decompression procedures.

(9) Care for, test, repair, and adjust all diving equipment and determine whether they are safe for use.

(10) Equip a boat for both self-contained and surface supplied diving.

(11) Demonstrate ability to direct two or more divers on the bottom in their tasks.

(12) Know the advantages, limitations, and techniques involved in the use of helium-oxygen, surface supplied air, and self-contained diving apparatus.

(13) Demonstrate ability to perform all required rigging for salvage and rescue operations.

(14) Demonstrate ability to perform and supervise independent diving operations using surface supplied air, helium-oxygen, and self-contained apparatus.

(15) Plan simple diving operations.

(16) Understand safety precautions necessary in handling of gases and use of apparatus required for underwater cutting.

(17) Perform proficiently underwater work such as taking measurements, making templates, making fittings and placing shores, pouring cement, using excavating nozzles, and removal and repair of ships appendages.

(18) Maintain, rig and operate salvage pumps, air compressors, winches, jacks, beach gear, and high line assemblies.

(19) Rig for lifts encountered in salvage operations up to a maximum of 300 tons, including underwater lifts.

(20) Install necessary pumps, air compressors, and lay necessary beach gear for hauling off stranded vessels. Understand in general the salvaging of vessels, including stability, structural strength and groundings.

(21) Enter submerged vessels with discrimination and only as decided and planned by the supervising officer.

(22) Demonstrate proficiency in the use of explosives underwater and have knowledge of materials and methods used in such varied salvage activities as harbor clearance, harbor bottom alteration, rock and concrete blasting, steel and timber cutting, and removal of propellers for replacement.

13. Requirements for Medical Deep Sea Diving Technicians:

a. Medical Deep Sea Diving Technicians are designated by the Chief, Bureau of Medicine and Surgery after satisfactory completion of the prescribed course of instruction at the Naval School, Diving and Salvage, Washington, D. C.

b. Members must meet the following requirements to be eligible for the Medical Deep Sea Diving Technician course of instruction:

(1) Volunteer for and be recommended by his commanding officer.

(2) Meet basic eligibility requirements as set forth in BUMED directives.

c. Medical Deep Sea Diving Technicians shall be required to meet the same qualification factors as Divers First Class except as modified below:

(1) Completely meet qualification factor 1, 2, 3, 4, 5, 9, and 10 above, and also demonstrate proficiency in the operation and maintenance of the submarine rescue chamber.

(2) Demonstrate more extensive knowledge and greater proficiency in qualification factors 6, 7, 8, 12, and 16 above.

(3) Be exempt from qualification factors 11, 13, 14, 15, 17, 18, 19, and 20.

(4) Demonstrate knowledge of health and safety aspects of the use of underwater tools, entering submerged vessels, and use of explosives underwater.

14. Requirements for Salvage Divers:

a. This diver classification is being retained only as a category for expansion in event of an increase in diver requirements on mobilization, consequently initial training of Salvage Divers has been discontinued.

b. Personnel must have satisfactorily completed the prescribed course in ship salvage.

c. The qualification factors are as follows:

(1) Withstand pressure equal to 200 feet of water while breathing air.

(2) Demonstrate mechanical ability.

(3) Dive and accomplish work using self-contained underwater breathing apparatus (scuba), shallow water diving equipment, deep sea diving equipment.

(4) Demonstrate proficiency in the operation and care for machinery and apparatus required for underwater cutting including oxygen-hydrogen and oxygen-electric torches underwater.

(5) Understand safety precautions necessary in handling of gases and use of apparatus required for underwater cutting.

(6) Perform proficiently underwater work such as taking measurements, making templates, making, fitting, and placing patches, placing shores, pouring cement, using excavating nozzles, and removal and repair of ship's appendages.

(7) Maintain, rig and operate salvage pumps, air compressors, winches, jacks, beach gear, and high line assemblies.

(8) Rig for lifts encountered in salvage operations up to a maximum of 300 tons, including underwater lifts.

(9) Install necessary pumps, air compressors, and lay necessary beach gear for hauling off a stranded vessel. Understand in general the salvaging of vessels, including stability, structural strength, and groundings.

(10) Enter submerged vessels with discrimination, and only as decided and planned by the supervising officer.

(11) Demonstrate proficiency in the use of explosives underwater and have knowledge of materials and methods used in such varied salvage activities as harbor clearance, harbor bottom alteration, rock and concrete blasting, steel and timber cutting, and removal of propellers for replacement.

(12) Demonstrate knowledge of diving physics and of diving physiology; know the use of standard decompression tables; recognize symptoms of decompression sickness; and know the treatment required for all common diving accidents.

(13) Demonstrate proficiency in the use of the recompression chamber for treatment of diving accidents and for surface decompression procedures.

(14) Care for, test, repair, and adjust all diving equipment and determine whether they are safe for use. Salvage Divers will not dive beyond the depths for which qualified, as stated in their service record, except for qualification purposes which will be limited to a maximum depth of 150 feet. In emergencies, the senior officer present shall be the judge of a deviation from the above.

15. Requirements for Divers Second Class:

a. Divers Second Class are trained, qualified, and designated by any command having the proper equipment and competent members for safe and efficient instruction so designated by the Chief of Naval Personnel.

(1) The following are required on vessels and naval stations authorized to train, qualify, and designate Divers Second Class:

(a) A designated Diving Officer and a Master Diver or Diver First Class who will serve as an instructor.

(b) In general, the amount of equipment will depend upon the number of members being trained and qualified, but the minimum equipment shall include two deep sea diving outfits, two lightweight diving outfits, three open-circuit demand self-contained

underwater breathing apparatus, and one recompression chamber. (Shall be on board ships authorized to conduct such training or in the case of authorized activities shall be in the nearby area.)

(c) Sufficient copies of the Diving Manual, NAVSHIPS 250-538, so there will be one for each trainee and copies of Curriculum for Diver Second Class and Scuba Diver, NAVPERS 93206.

b. The eligibility requirements are:

(1) Be a designated striker (pay grade E-3) or petty officer (pay grades E-4 through E-6) in one of the source ratings. Source ratings and selection standards for diver training are specified in the Bureau of Naval Personnel Formal Schools Catalog, NAVPERS 91769 series.

(2) Meet the physical and psychological standards prescribed in the Manual of the Medical Department.

(3) Be at least Swimmer First Class.

c. Qualification factors are:

(1) Understand the care, preservation, and use of all air diving equipment such as compressors, hose, helmets, suits, and scuba.

(2) Test, repair, and adjust all air diving equipment and determine whether they are safe for use.

(3) Know the nomenclature of diving equipment and function of component parts.

(4) Dress and tend diver expertly.

(5) Know standard diving signals.

(6) Know the instructions for keeping a diving log and entries required.

(7) Understand the theory and practice of decompression and use of the decompression table.

(8) Know the cause, symptoms, treatment, and prevention of air embolism.

(9) Know the dangers of oxygen poisoning during the administration of oxygen under pressure, its usual symptoms, warnings, and treatment.

(10) Demonstrate the back-pressure arm lift method of manual artificial respiration.

(11) Knowledge of first aid related to the treatment of common diving accidents.

(12) Know the physics of diving.

(13) Know the methods and procedures employed in searching for and recovering of objects from the bottom.

(14) Know how and when to use a recompression chamber. Know how to properly administer oxygen for decompression and treatment purposes.

(15) Demonstrate practical application of marlin-spike seamanship to diving operations.

(16) Perform work at depth of 50 feet of water for one hour, this to constitute a qualifying dive.

(17) Know the contents and use of the Diving Manual.

(18) Estimate an underwater situation and give an intelligent description of same. Training and examination of this ability requires a number of actual or simulated practical diving jobs such as small patches, clearing screws, and taking measurements.

(19) Use oxygen-electric torch underwater.

(20) Use and know the advantages, limitations, and safety precautions of open-circuit demand scuba.

Divers Second Class will not dive beyond the depths for which qualified, as stated in their service record, except for qualification purposes which will be limited to maximum depths of 200 feet. In emergencies, the senior officer present shall be the judge of a deviation from the above.

16. Requirements for Scuba Divers:

a. Personnel are trained and designated as Scuba Divers at the Naval School, Underwater Swimmers, Naval Station, Key West, Florida, and such other activities specifically authorized by the Chief of Naval Personnel.

b. The following are required to be on board ships and naval activities authorized to conduct training in the use of scuba equipment:

(1) A designated diving officer assisted by an experienced Scuba Diver or above who will serve as an instructor.

(2) Sufficient copies of Part 3 of the Diving Manual, NAVSHIPS 250-538, so that there will be one for each trainee.

(3) Copies of Curriculum for Diver Second Class and Scuba Diver, NAVPERS 93206.

(4) Recompression chamber shall be on board ships authorized to conduct such training or in the case of authorized activities shall be in the nearby area.

c. The eligibility requirements are:

(1) Enlisted members in one of the source ratings who are identified strikers or petty officers. Source ratings and selection standards for diver's training are specified in the Bureau of Naval Personnel Formal Schools Catalog, NAVPERS 91769 series.

(2) Meet the physical and psychological standards prescribed in the Manual of the Medical Department.

(3) Be at least Swimmer First Class.

d. Qualification factors for Scuba Diver are as follows:

(1) Swim 1000 yards on surface in open water without fins but with face mask, life jacket, and knife as necessary equipment.

(2) Swim 500 yards underwater using fins, face mask, and scuba.

(3) Clear scuba underwater.

(4) Ditch and don scuba underwater.

(5) Make a positive buoyancy free ascent from a depth of at least 35 feet.

(6) Swim with scuba to a depth of 100 feet.

(7) Conduct day and night general underwater search and detailed ship bottom search.

(8) Use underwater compass, depth indicators, and associated underwater equipment.

(9) Perform routine inspection, adjustment, field and shop maintenance on scuba and underwater accessories.

(10) Know safety precautions to be observed in use of scuba.

(11) Understand the theory and practice of decompression and use decompression tables.

(12) Knowledge of divers' diseases including oxygen and carbon dioxide toxicity, nitrogen narcosis, decompression sickness, and air embolism; and emergency remedial procedures.

(13) Know underwater hazards.

(14) Understand use of current and tide tables.

e. Scuba Divers will not dive beyond the depths for which qualified in their service record. Normal working depths for a Scuba Diver breathing compressed air is considered to be less than 130 feet.

17. All diving-type activities shall maintain the Activity Diving Log, NAVSHIPS 1000, as a permanent official record of each individual command. Instruction for use of the Activity Diving Log are contained in the Navy Diving Manual, NAVSHIPS 250-538.

18. A Military Pay Order, DD Form 114, or Certificate for Performance of Hazardous Duty, DD Form 122, shall be submitted in accordance with provisions contained in pay directives in all instances wherein Special Pay for Diving is affected.

a. Diving Officers (General), Deep Sea Diving Officers, Submarine Medical Officers, Master Divers, Divers First Class, and Medical Deep Sea Diving Technicians attached to ships and activities having helium-oxygen diving capabilities shall use helium-oxygen as a breathing mixture for a minimum of two of the four qualification dives prescribed in this Article in order to be entitled to receive special pay for diving duty. Commanding officers of activities with a helium-oxygen capability shall certify on Page 13 of the Enlisted Service Record that each enlisted member assigned to diving duty at their activity and qualified in the use of helium-oxygen as a breathing mixture in the execution of deep sea diving has met the above minimum requirements. In the case of officers so qualified and so assigned, a similar certification shall be made in letter form to the officer concerned and be filed on the left side of the officer's service record.

b. Officers not included in the subparagraph above shall fulfill, as a minimum, the requirements set forth as follows:

(1) Diving Officer (General) (9312); Deep Sea (He02) Diving Officer (9313); and Submarine Medical Officer (0090) as for Master Diver.

(2) Ship Salvage Diving Officer (9314) and Ship Salvage Operations Officer (9375) as for Diver Second Class.

(3) UDT Officer (9294) and SEAL Officer (9293) as for UDT/SEAL Swimmer.

(4) EOD Diving Officer (9230) as for EOD Technician.

1410400 DIVING OFFICER DESIGNATION

1. Diving Officers are divided into four classifications according to their specialization or degree of qualification as follows:

- a. Diving Officer (General) (9312)
- b. Deep Sea (He02) Diving Officer (9313)
- c. Ship Salvage Diving Officer (9314)
- d. Ship Salvage Operations Officer (9375)

2. Naval Officer Billet Classifications which include a degree of diving qualification collateral to the basic classification are as follows:

- a. Explosive Ordnance Disposal Officer (9230)
- b. Underwater Demolition Team Officer (9294)
- c. Seal Officer (9293)
- d. Submarine Medical Officer (0090)

3. Officers desiring training in deep sea or ship salvage diving should so indicate in the remarks block of their Officer Preference and Personal Information Card, NAVPERS 2774.

4. Diving Officers (General); Deep Sea (He02) Diving Officers; Ship Salvage Operations Officers; and Ship Salvage Diving Officers must be graduates of the Naval School, Diving and Salvage (or the Naval School, Ship Salvage prior to its disestablishment in the case of Ship Salvage Operations Officers and Ship Salvage Diving Officers).

a. Diving Officers (General) are those experienced officers skilled in all phases of diving, ship salvage, and submarine rescue operations. Only those officers who have completed the Deep Sea (He02) and the Ship Salvage Diving courses or those officers who have completed the Deep Sea (He02) course and have gained extensive ship salvage experience in the field, equivalent to the formal ship salvage course, are eligible for this designation. The Chief of Naval Personnel will select and designate qualified officers upon recommendation of their commanding officers. The letter of recommendation shall contain a chronological summary of all billets held in connection with diving and ship salvage including participation in significant diving or salvage operations.

b. Deep Sea (He02) Diving Officers are those officers skilled in Deep Sea (He02), and associated diving operations including submarine rescue operations. Upon graduation from the appropriate course of instruction, officers are designated as Deep Sea (He02) Diving Officers by the Chief of Naval Personnel.

c. Ship Salvage Diving Officers are those officers skilled in ship salvage and salvage diving operations.

Upon graduation from the appropriate course of instruction, officers are designated as Ship Salvage Diving Officers by the Chief of Naval Personnel.

d. Ship Salvage Operations Officers (9375) are those officers highly skilled in Ship Salvage and Salvage Diving operations who have gained extensive experience in these fields. Such officers must have been previously designated and satisfactorily occupied a billet as a Ship Salvage Diving Officer (9314), Deep Sea (He02) Diving Officer (9313), or a Diving Officer (General) (9312), in a salvage ship or a salvage activity for a minimum of two years and have satisfactorily participated, in a responsible role, in at least two ship salvage operations. The Chief of Naval Personnel will select and designate qualified officers upon recommendation of their commanding officer. The letter of recommendation shall contain a chronological summary of all billets held in connection with diving and ship salvage including participation in significant diving or salvage operations.

5. Applicants for Deep Sea (He02) Diving Officer and Ship Salvage Diving Officer training shall:

a. Be line officers in the grade of ensign, lieutenant (junior grade), or lieutenant who volunteer for the training.

b. Be physically qualified for diving duty in accordance with the Manual of the Medical Department.

c. Be qualified as Swimmers, First Class.

d. Recognize the requirement of serving, or obligate themselves to serve, at least two years on active duty following completion of diving training.

e. Demonstrate leadership ability, responsibility of action, and temperament for hazardous duty.

6. The qualification standards are:

a. To qualify as Deep Sea (He02) Diving Officer, officers shall:

(1) Satisfactorily complete the prescribed course at the Naval School, Diving and Salvage.

(2) Dive and accomplish work using self-contained underwater breathing apparatus (scuba), shallow water diving equipment, deep sea diving equipment, and helium-oxygen diving equipment.

(3) Withstand pressures equal to 300 feet of water while breathing air.

(4) Satisfactorily complete a dive in water using deep sea diving equipment to an equivalent depth of 200 feet while breathing air.

(5) Satisfactorily complete a dive in water using helium-oxygen equipment to an equivalent depth of 320 feet while breathing a helium mixture.

(6) Demonstrate proficiency in the use of all underwater tools, both in shop and under actual diving conditions, basic marlinspike seamanship commonly used aboard salvage and rescue vessels, and handling of explosives used in repair and salvage operations. (Medical officers excepted.)

(7) Demonstrate knowledge of diving physics showing proficiency in mixing and analyzing synthetic mixtures and in computing pressures of gases required to operate underwater cutting torches at various depths.

(8) Demonstrate ability to plan and take charge of diving operations. (Medical officers excepted.)

(9) Demonstrate knowledge of all types of self-contained underwater breathing equipment including their advantages and limitations.

(10) Demonstrate the ability to take charge of operation and maintenance of a submarine rescue chamber. (Medical officers excepted.)

(11) Be familiar with approved methods of ship salvage including methods of unbeaching ships and refloating sunken vessels. (Medical officers excepted.)

(12) Demonstrate knowledge of the types of compressors used habitually in diving operations including the various filtering methods and the necessary precautions to observe.

(13) Understand the general gas law and its derivatives.

(14) Understand Dalton's law of partial pressures and Henry's law of fluid saturation.

(15) Understand the theory of inert gas saturation and desaturation of body fluids and tissues.

(16) Understand the methods of computation of various decompression tables.

(17) Recognize different forms of decompression sickness and know the treatment required.

(18) Understand the effects upon the respiratory system of such poisonous gases as may be encountered in diving and know the treatment required.

(19) Have a comprehensive knowledge of the scope, content, and application of Navy publications and instructions pertaining to diving such as the Diving Manual, NAVSHIPS 250-538, and applicable sections of the Navy Ships Organization Manual, Manual of the Medical Department, and the BUPERSMAN.

b. Medical officers who have completed the prescribed course of instruction at the Naval School, Diving and Salvage, shall be considered qualified deep sea diving officers. These officers shall conform to the same qualifications standards as line officers with the exceptions noted for the qualifications listed above.

c. To qualify as a Ship Salvage Diving Officer, officers shall:

(1) Operate and care for machinery and apparatus required for underwater cutting.

(2) Understand safety precautions necessary in handling of gases and use of apparatus required for underwater cutting.

(3) Demonstrate proficiency in the use of underwater tools including oxygen-hydrogen and oxygen-electric torches underwater.

(4) Perform proficiency underwater work such as taking measurements, making templates, making, fitting, and placing patches, placing shores, pouring concrete, and using excavating nozzles.

(5) Maintain, rig, and supervise the operation of salvage pumps, air compressors, winches, jacks, beach gear, and high line assemblies.

(6) Plan and supervise the installation of pumps, air compressors, and beach gear necessary for hauling off stranded vessels. Understand the salvaging of vessels.

(7) Plan a safe layout for entering submerged vessels with emphasis on the ability to get out.

(8) Demonstrate proficiency in the use of explosives underwater and have a comprehensive knowledge of materials and methods used in such varied salvage tasks as harbor clearance, harbor bottom alterations, rock and concrete blasting, steel and timber cutting, and removal of propellers for replacement.

(9) Demonstrate proficiency in the use of a recompression chamber for treatment of diving accidents and for surface decompression procedures.

(10) Have a comprehensive knowledge of the scope, content, and application of Navy publications and instructions pertaining to diving such as the Diving Manual, NAVSHIPS 250-538, and applicable sections

of the Navy Ships Organization Manual, Manual of the Medical Department, and the BUPERSMAN.

(11) Dive and accomplish work using scuba, shallow water, and deep sea diving equipment.

7. An officer, once designated as a Diving Officer (General), Deep Sea (He02) Diving Officer, Ship Salvage Diving Officer, or Ship Salvage Operations Officer will be considered to retain such designation indefinitely unless it is revoked by the Chief of Naval Personnel upon request of the officer concerned or because his performance in diving duties is such as to demonstrate his unfitness. In case of unfitness to retain the designation, the immediate superior in command shall report the circumstances to the Chief of Naval Personnel via official channels and recommend that the officer's designation be revoked. Diving officers shall be currently qualified when serving in diving billets eligible for diving pay.

8. Officers authorized to wear the Diving Officer Insignia are:

a. General Diving Officers (SQ/SD-025) and Ship Salvage Operations Officers (SQ/SD-028).

b. Deep Sea (He02) Diving Officers (SQ/SD-026) and Ship Salvage Diving Officers (SQ/SD-027) after one year of active supervision of operational diving when recommended by their commanding officer and approved by the Chief of Naval Personnel.

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<p>The Naval Submarine Medical Research Laboratory is conducting a radiological survey to determine the prevalence of dysbaric osteonecrosis in U. S. Navy divers and to develop epidemiological data related to those aspects of the hyperbaric environment that contribute to the ultimate occurrence of the lesions. Twelve juxta-articular lesions and nine head, neck or shaft lesions have been identified in the extremities of fifteen divers who are radiologically positive cases of dysbaric osteonecrosis among 611 non-randomly selected divers surveyed. While the number of positive cases is too small to draw statistically reliable conclusions, certain trends are evident. Lesions were most common in the shoulders and in older divers. Saturation divers and all other helium divers had almost the same percentage of positive cases but air divers had a slightly lower percentage than either group. Data derived from an enlarging survey population should provide additional insight into the epidemiology of the condition.</p>		

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