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# OCCUPATIONAL SAFETY AND HEALTH STANDARDS FOR GREAT LAKES COMMERCIAL DIVING OPERATIONS

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# PREFACE

The purpose of this report is to provide a basis for development of occupational safety and health standards for diving contractors and divers working in the Great Lakes area and to provide guidelines to regulatory agencies for preparation of governmental regulations in commercial and industrial diving operations. It is not intended that provisions in this report or standard are to supercede any governmental regulations, present or proposed.

INTRODUCTION

Persons involved in underwater diving operations are subject to certain occupational risk. In order to protect individuals from unnecessary injury or unacceptable risk, certain standards of medical fitness, operational procedures, and equipment must be recognized and compliable. Such standards must maintain the rigidity and specifics required for adequate protection of the individual worker. However, they must not be so "unreasonable" as to prohibit underwater work from an economic and operational requirement standpoint.

Diving technology is a rapidly expanding science, and the variations in techniques and task complexity experienced throughout the industry are vast. For many years industry, standard committees, federal agencies, scientific/educational groups, diver's associations, and so forth have studied and assessed regional differences in diving practices, personnel requirements, and equipment. In addition to regional differences in diving practices, personnel requirements, and equipment, there is a significant difference in these same categories between different diving "groups" or "activities." Although all divers do work in the marine environment and are subject to the same inherent physiological effects of exposure to hyperbaric conditions, there is a vast difference in the extent of exposure, task complexity, and philosophy between the various groups. Can a single "standard" be applied to

all underwater workers? ~~In our opinion, no!~~ Our experience suggest not. The various diver/operational categories that currently appear to be significantly different include:

1) Recreational scuba diving
2) Recreational scuba diving instructor
3) Search, rescue, and related public safety diving
4) Experimental diving involving human subject experimentation and diving apparatus/ procedure research
5) Scientific/educational diving involving primarily, but not exclusively, marine environment research
6) Shallow-water inland or inshore commercial diving
7) Deepwater or offshore saturation diving
8) Scientific saturation diving
9) Industrial saturation diving
10) Military diving

It is likely that 2 or more of the above categories could be addressed in the same standard. However, it is unreasonable to address all categories of civilian diving under one general standard. The diving mode and philosophy of one group may be so completely different from that of another that the presentation of a standard based primarily on the mode and philosophy of the one group may actually provide a basis for erosion of the community concensus standard of safe diving practices

of the other group(s).

Consequently, this report is limited to : (1) diving in commercial and industrial situations, (2) operations in inland and territorial waters of the United States defined as the Great Lakes Basis, and (3) shallow-water diving operations in which the diver's working depth does not exceed 220 fsw and compressed air is the primary breathing gas.

BACKGROUND INFORMATION

The most recent activity in the development of occupational safety and health standards for diving was initiated on 8 August 1975 in a petition by the United Brotherhood of Carpenters and Joiners of America, AFL-CIO, presented to the Secretary of Labor. This petition stated that a situation of grave danger existed within the diving industry and urged that an emergency temporary standard be issued with respect to diving operations to protect exposed employees. Hearings followed and an Emergency Temporary Standard (ETS) was issued on 15 June 1976 (Federal Register, Vol. 41, No. 116). Diving contractors filed suit in the U.S. Court of Appeals of the Fifth Circuit and an indefinite stay of the ETS was issued on 11 August 1976 pending a final decision on the validity of the agency's (OSHA) action. The EMT was not inforced by OSHA.

A proposed permanent standard for Commercial Diving was published on 5 November 1976 (Federal Register, Vol. 41, No. 215) and public hearings were scheduled in New Orleans during December 1976 and January 1977. A total of 81 individuals appeared at the hearings as witnesses representing virtually all facets of the diving community and supporting groups.

Based on a review of the record of the hearings plus numerous items of information submitted to OSHA, a final standard for Commercial Diving Operations was issued on 22 July 1977 (Federal Register, Vol. 42, No. 141). This standard is to be effective on 20 October 1977, except that provisions where decompression chambers or bells are required and such equipment as not yet available, employers shall comply as soon as possible thereafter but in no case later than 6 months after the effective date of the standard. For furhter historical information on OHSA involvement in commercial diving standards consult the Federal Register, Vol. 42, No. 141 ~~(Appendix B)~~; Vol. 41, No 215, and Vol. 41, No. 116.

Despite the fact that the current OSHA standard addresses nearly all diving related employments, some diving authorities suggest that it is not up

~~If the existing OSHA standard is, in fact, law, why is this publication being prepared? Regardless of the conclusions of the Occupational Safety and Health administration, the standard~~ is <u>not</u> representative of the entire diving community. It is a commercial diving standard where the surface-supplied diving mode is primarily used and the task complexity and risk exposure are extremely greater than that of other diving groups. There are, in our opinion, fundamental weaknesses in personnel requirements and operational practices as well as unnecessary and unreasonable requirements in other areas. Although the entire case will not be presented here, there is, in our opinion, a basis for variances, especially for scientific/educational diving.

The Department of Labor has only recently become involved in the development of health and safety standards for diving. The American National Standards Institute Z-135 Committee activities began early in 1968 under the sponsorship of the Marine Technology Society's Committee on Man's Underwater Activities. Work continued on the development of commercial diving standards until 1973 when, for a number of complex and emotional reasons, work ceased. In 1975 a committee of the Association of Diving Contractors reviewed the drafts of the Z-135 standards and published its Manual of Safe Practices in Commercial Diving Operations based largely upon the Z-135 work.

The Z-135 project was reorganized in 1974. Both OSHA and the United States Coast Guard gave general encouragement, particularly citing the importance of ANSI industry consensus standard techniques. At the time of reorganization both labor (the Carpenter's Union) and diving management took a positive and supportive position. In 1976 and early 1977 the re-constituted ANSI Z-135 Committee combined previously proposed standands into a final draft standard which was circulated in accord with ANSI procedures for vote and comment. The historical comments on the Z-135 Committee were taken in part from testimony given at the OSHA Public Hearing on American Diving Standards by Capt. W.F. Searle, U.S.N. (Ret), December 1976 at New Orleans.

It should also be noted that historically the various procedural manuals of the United State Navy have provided a basis of many of the standards of safe diving practices within the civilian diving community. However the scope and magnitude of commercial diving has changed so radically during the last decade, most industrial authorities agree that the U.S. Navy standards and procedures, in themselves, are unacceptable for application, in their entirety, to today's commercial diving operations.

The scientific/educational diving community has operated under community concensus standards for nearly two decades. Scientific/educational applications of scuba diving developed extensively at the Scripps Institution of Oceanography, University of California in the 1950's. Although several colleges, universities, and research agencies used diving to varying degrees in their programs, Scripps, uner the early leadership of Conrad Linbaugh and, later, James R. Stewart, took the lead in scientific diver training, certification and the development of health and safety standards for scientific/educational divers. The University of California's The University Guide for Diving Safety has served as a basis for the development of numerous diving safety programs at colleges, universities, and research agencies throughout the country. This publication is periodically reviewed and revised by University of California

campus Diving Officers and Environmental Health and Safety Officers. On 27 March 1973 representatives of diving safety boards and committees of 10 major institutions participating in scientific/educational diving met at the University of Washington in Seattle to discuss University diving safety. At that meeting it was a concensus agreement that the University of California standards for scientific/educational scuba diving safety would continue to serve as a primary basis for scientific/educational diving programs throughout the country. A significant number of institutions do presently adhere to these standards with certain modifications for regional and operational variations in diving. The University of Miami developed a specific diving training and safety standard which differs in specifics but agrees in concept with that of the University of California. The National Oceanic and Atmospheric Administration operates under a separate and distinct standard specifically developed for that agency's scientific divers.

Clearly, the scientific/educational community has and adheres to specific and rigid diving health and safety standards. The success of these standards is evident by the historically low accident rate in scientific/educational diving operations.

## STANDARD PREPARATION

The University of Michigan researchers are well aware of the problems involved with both inshore and offshore diving operations. An active diving program including hyperbaric chamber operation, lake and ocean diving operations, diving research, saturation diving and related activities has been conducted at the University since 1966. In addition to standard scuba used by many scientific/educational divers, surface-supplied diving apparatus of the type commonly used by military and commercial offshore divers is used extensively in the University's program. Based on 10 years of operational diving at the University of Michigan and a relatively comprehensive understanding of commercial diving, the authors were in a position to objectively evaluate various existing standards.

### Sources of Information

As previously stated there are considerable variations in diving techniques, task complexity, and working environments throughout the diving industry. Consequently, data for this project was collected from a variety of sources. Needless to say, the Department of Labor's Occupational Safety and Health Administration Emergency Temporary Standard for Diving Operations (Federal Register, Vol. 41, No. 116), the Proposed Commercial Diving Standards (Federal Register, Vol. 41, No.

215) and the Commercial Diving Operations Occupational Safety and Health Requirements (Federal Register, Vol. 42, No. 141) provided a substantial amount of information that is used in this report.

In addition to the various OSHA proposed standards, the OSHA/U.S. Coast Guard public hearings on the proposed standard held in New Orleans on December 16-21, 1976 and January 10-14, 1977 provided extensive insight into the views and opinions of offshore and shallow-water divers, diving contractors, large corporate and small business employers, instructors, marine scientists, hyperbaric physiology and medicine specialists, equipment specialists, and other interested parties. These hearings and the International Diving Symposium '77 provided an excellent opportunity to interview numerous divers, contractors, equipment specialists, and others.

Dr. Somers served as a member of the American National Standards Institute/Marine Technology Society Z-135 Committee on Safety in Commercial and Professional Diving Operations. Data from notes made during these committee meetings and various draft standards provided considerable insight into the opinions of contractors, labor, and other authorities. It should be noted that the collective opinion of this group of authorities did differ significantly in some areas from that of OSHA.

In addition to OSHA, the current Z-135 Committee and interviews the following publications were also reviewed:


Association of Diving Contractors, "Manual of Safe Practices in Commercial Diving Operations" (New Orleans: Association of Diving Contractors, 1975).

Compressed Gas Association, "Methods for Hydrostatic Testing of Compressed Gas Cylinders", Pamphlet No. C-1 (New York: Compressed Gas Association).

Compressed Gas Association, "Standards for Visual Inspection Of Compressed Gas Cylinder", Pamphlet No. C-6 (New York: Compressed Gas Association).

Compressed Gas Association, "Suggestions for the Care of High-Pressure Air Cylinders for Underwater Breathing", Pamphlet No. P-5 (New York: Compressed Gas Association).

Compressed Gas Association, "Compressed Air for Human Respiration", Pamphlet No. G-7.0 (New York: Compressed Gas Association).

Compressed Gas Association, "Commodity Specification for Air", Pamphlet No. G-7.1 (New York: Compressed Gas Association).

Department of the Interior, "Underwater Operations", BCF Manual (Washington, D.C.: Bureau of Commercial Fisheries, 1970).

Federal Register (Department of Labor, Occupational Safety and Health Standards, Vol. 36, No. 105, Part 11, 1971).

Federal Register (Department of Labor, Occupational Safety and Health Administration, Safety and Health Standards for Maritine Employment Volume 37, No. 203, Part 11, 1972).

Federal Register (Department of Labor, Occupational Safety and Health Standards, Vol. 37, No. 202, Part 11, 1972).

Federal Register (Department of Labor, Occupational Safety and Health Administration, Safety and Health Regulations for Construction, Vol. 37, N0. 243, Part 11, 1972).

Flemming, N. and Miles, D. (ed.), "Underwater Association Code of Practice for Scientific Diving " (London: Natural Environment Research Council, 1974).

Galletti, J., "Proposed Safety Standards for Commercial Diving Equipment", Undercurrents (January, 1970).

Galletti, J., "Diving Equipment Standards", Recommendations of the American National Standards Institute Z-135 Committee (1972).

Graziano, R. "Tarill No. 27: Hazardous Materials Regulations of the Department of Transportation" (1973).

Hughes, M., "Diving Procedures Standard", Preliminary Recommendations of the American National Standards Institute Z-135 Committee (1971).

Interstate Electronics Corporation, "Oceanics Division Diving Manual", (Anaheim, California: Interstate Electronics Corporation, 1971).

National Oceanic and Atmospheric Administration, "Diving", NOAA Circular.

Neary, R., "Equipment Cleaned for Oxygen Service", Pamphlet No. G-4.1 (New York: Compressed Gas Association, 1959).

Oregon State University, "Diving Guide" (Portland: Department of Oceanography, Oregon State University, 1971).

Schroeder, W. and W. Fife, "University Guide for Diving Safety", Sea Grant Publication No. TAMU-SG-70-602 (College Station, Texas: Texas A & M University, 1970).

Somers, L., "Diving Safety Bulletin", Technical Report 4 (Ann Arbor: Sea Grant Program, The University of Michigan, 1971).

Somers, L., "Research Diver's Manual", MICHU-SG-71-212, Technical Report No. 16 (Ann Arbor: Sea Grant Program, The University of Michigan, 1972).

Somers, L. and M. Nemiroff, "University of Michigan Hyperbaric Chamber Attendant's Handbook", MICHU-SG-74-601 (Ann Arbor: Sea Grant Program, The University of Michigan, 1974).

State of Michigan, Marine Safety Act of 1967.

State of Oregon, "Commercial Diving and Compressed Air Work", Chapter 25 of the Oregon Safety Code for Places of Employment (Salem, Oregon: Workman's Compensation Board,' 1972).

Stewart, J., "Procedures for Shipboard Diving and the University Guide for Diving Safety", IMR TR-23, Sea Grant Publications No. 15 (La Jolla, California: Scripps Institution of Oceanography, 1971).

University of Southern California, "Diving Regulations", (Los Angeles: Santa Catalina Marine Biological Laboratory, University of Southern California, 1973).

University of Washington, "Guide for Diving Safety and Interim Implementation of Guide for Diving Safety" (Seattle: University of Washington, Environmental Health and Safety Department, 1972).

U.S. Navy, "U.S. Navy Diving Manual", NAVSHIPS 0994-001-9010 (Washington D.C.: U.S. Government Printing Office, 1970).

U.S. Navy, "U.S. Navy Recompression Chamber Operator's Handbook", NAVSHIPS 0994-014-5010 (Washington, D.C.: Department of the Navy, 1973).

## Format

The format used in the presentation of this standard differs from that used by OSHA or ANSI/MTS Z-135. This standard consists of the following sections:

Section 1: Purpose, Scope, and Application

Section 2: Definitions

Section 3: Personnel Qualifications/Requirements

Section 4: Medical Requirements

Section 5: General Operations Requirements

Section 6: Self-Contained Air Diving

Section 7: Surface-Supplied Air Diving

Section 8: Decompression Chambers

Section 9: Recordkeeping Requirements

Equipment requirements for self-contained air diving, surface-supplied air diving, and decompression chambers were separated into separate respective sections instead of having one section on equipment. Many groups will use shallow-water scuba diving exclusively and have no need for the sections on surface-supplied diving or decompression chambers. The separation of diving modes is less confusing and more convenient.

Where possible the wording used by OSHA in the final publication of the Commercial Diving Operations Occupational Safety and Health Requirement was incorporated into this standard. In some areas the specific wording from proposed standards of the ANSI/MTS Z-135 Committee was used.

DISCUSSION

Purpose, Scope and Application

The Occupational Safety and Health Administration clearly designates that, by law, the Commercial Diving Operations Occupational Safety and Health requirements shall apply wherever OSHA has statutory jurisdiction. Diving outside of the Outer Continental Shelf is not covered by an OSHA standard nor is diving in coastal or inland waters not specifically designated as "United States and possessions" listed in Section 4(a) of the Act 29 U.S. 655. United States citizens and employed divers operating in foreign waters may be subject to regulations or standards imposed by foreign governments. However, in many incidences there are no suitable standards enforced. Consequently, standards should be extended to cover such situations so that the employee and employer are protected by a standard equivalent to those imposed within United States waters. This is extremely important in the Great Lakes since U.S. employed divers may easily operate in Canadian waters. An employer or employee could "technically" ~~denounce~~ ignore the United States OSHA standard on a basis of statutory jurisdiction and thus endanger the health and safety of the diver.

The 22 July OSHA Commercial Diving Operations standard specifically applies to diving and related support operations conducted with all type of work and employments over which OSHA has jurisdiction, except in cases where exclusions from

the standard have been explicitly provided. Specific exclusions have been provided where the nature of the diving operations is such that inclusion in this standard would be inappropriate, or whre the safety and health of divers is governed by rules or regulations of another federal agency. The three exclusions are:

(1) Instructional diving utilizing only open-circuit compressed air scuba within the no-decompression limits;

(2) Search, rescue, and related public safety diving by or under the control of a governmental agency; and

(3) Diving governed by the Protection of Human Subjects regulations of the Department of Health, Education and Welfare, (HEW) or equally effective rules or regulations of another federal agency.

In earlier versions of the OSHA standard scientific/educational divers whose operations utilized open-circuit compressed air scuba and were conducted within the no-decompression depth-time limits were excluded. In addition, no distinction is made between the shallow-water inland or inshore diving operations and the deep-water offshore diving operations.

OSHA apparently concurred with the opinion of several parties including the Construction Advisory Committee that the record does not support a conclusion that "the work conditions and risk exposure of scientific divers differ

measurably from those of commercial diving (p. 37655, Federal Register, Vol. 42, No. 141)." It is further stated that "no valid distinction can be drawn between commercial diving and that performed by the excluded groups (scientific/educational divers), because divers in both groups are employees, both work in the same marine environment, and both are subject to some of the same inherent hazards and physiological effects. It has been stated that scuba diving is at least as hazardous as surface supplied diving (p. 37654, Federal Register, Vol. 42, No. 141)."

In our opinion scientific/educational diving operations should be excluded from the present OSHA Commercial Diving Operations Standard (Part 1910 of Title 29 of the Code of Federal Regulations, Subpart T). The following reasons are stated:

(1) Based on data provided by Glen Egstrom, Ph.D., of the University of California, Los Angeles Sea Grant Diving Safety Research Project (~~17 August~~ 20 October 1976, personal communication) the accident rate in scientific/educational diving is not sufficient to warrant the imposing of rigid and, in some cases, unreasonable or unjustifiable standards by OSHA. During the period of 1965-1975 ~~13~~ 14 colleges or universities and ~~24~~ 28 other scientific and research agencies documented ~~219,016~~ 241,811 research dives, ~~15,149~~ 19 609 training dives, ~~360~~ 4 decompression dives and ~~7,697~~ 13,597 recreational dives with only 4 pressure related accidents. The accidents included 2 cases of decompression sickness and 2 fatalities. The fatal accidents included one surface drowning and one apparent "congenital defect." Minor occurrences of ear infections, cuts and abrasions, and so forth were not documented.

(2) The present OSHA standards impose some requirements that ~~are~~ seem unjustifiable and unreasonable ~~for~~ to the scientific/educational community ~~to comply~~. Mandatory compliance will, in many incidences, result in alternative actions such as cancelation of research

projects vital to the study of the marine environment because of unacceptable logistical and economic burdens; severe limitations on the development and advancement of scientific educational diving; and forcing researchers to pursue in-water research activities "on-their-own-time" technically outside of their scope of employment thus circumventing both existing local agency/university standards and OSHA standards and thus constituting potentially uncontrolable hazardous situations.

(3) The provisions of the present OSHA Commercial Diving Operations standard are in some incidences inadequate and suggest acceptable standards of practice below the present "standard of the scientific/educational" community. This is particularly significant in the area of scuba diving and personnel training and qualifications.

(4) In contrast to commercial diving operations the location and subsequent environmental conditions are not generally determined by the particular task and the diving operations are not generally conducted under adverse environmental conditions. The scientific/educational diver can select both the task and environmental conditions consistant with his/her training, physical condition, and experience. For the most part, scientific/educational diving task assignments and environmental exposure are rigidly controlled by the university, agency, or individual diver.

(5) In contrast to the surface-supplied diving mode oriented ~~philosophy~~ of the commercial diving community, the scientific/educational diver is oriented toward a scuba diving mode ~~philosophy~~. Consequently, procedures and standards that are deemed unsafe or unreasonable by the "commercial" diver, and in fact may constitute significant hazard in commercial diving, are readily accepted as "safe practices" by the scuba-oriented "scientific/educational" diver. For example, limiting a single scuba diver is for the most part considered an unacceptable and unsafe practice by many scientific/educational divers. Unlike Navy Standard, commercial divers accept the fact scuba diver needs.

(6) With very few isolated exceptions, scientific/educational divers do not utilize construction tools, handle explosives, or use welding or burning equipment.

(7) Scientific/educational diving operations are shallow water oriented. Of 220,411 dives reported in the UCLA study previously mentioned, ~~191,952~~ 212,538 (~~87~~ 97%) were conducted in depths of 60 fsw or less. Only ~~360~~ 9 (0.16~~%~~) involved decompression.

(8) Because of the nature of underwater scientific investigation, the scientific/educational diver is rarely exposed to adverse sea states, great depths, or heavy work loads, some or all of which are common to the great majority of commercial diving operations.

(9) The scientific/educational diver, with few exceptions, is not employed as a diver. He/she is employed as a scientist, researcher, or scientific technician. Diving is secondary to the primary job description.

(10) The scientific/educational diving community has operated under explicit, self-imposed diving regulations or standards for over two decades. Most universities, colleges, and research agencies engaged in significant diving operations have published and proven standards. Many have diving safety control boards or committees and diving safety officers or coordinators. Many base their standards and diving programs on those developed and continuously upgraded by the University of California. For the most part these standards are more rigid than those proposed in the OSHA Commercial Diving Operations Standard. The success of these scientific/educational diving community concensus standards is evident, in part, by the very low accident rate in scientific/educational diving operations.

Should the same standard apply to shallow-water diving operations where air is the primary breathing gas as to the offshore deep water diving operations where breathing mixtures other than air are used more extensively? Many shallow-water commercial diver employers object to being covered by the same standard which is used for offshore diving operations.

The following comments taken from the Occupational Safety and Health Reporter: Current Report (1976) reflect opinions consistant with those of many inland or inshore small diving representatives:

Juan F. Crofton, president of the Crofton Diving Corporation, Norfolk, Va., said he 'does not object to standards and rules as applied to the safety of our personnel . . . but we do strongly object to the federally proposed rules as they are not applicable to the shallow water diving industry and are grossly inflationary and could possibly force the dissolvement of our corporation.'

'These standards are directed solely toward the deep diving industry, the hazards of deep water diving, and in no way reflect the working conditions of the shallow water harbor diving industry,' Crofton said.

C.F. Logan, president of the Logan Engineering and Contracting Company, Jacksonville, Fla., criticized the proposed standards for making no distinction between shallow water and deep sea divers. Logan said these are 'two completely different professions.'

Jack S. Mixer, vice president of Logan Diving, Inc., Jacksonville, Fla., disagreed with the proposed medical requirements 'as being largely unnecessary for shallow water diving, which composes all of my business.'

'Upon repeated request to OSHA, the Coast Guard, and other knowledgeable bodies, I have not received any evidence of any diving accident caused by non-compliance with medical requirements,' Mixer said.

Crofton also disagreed with the medical requirements of the proposed standard. 'We feel that a general physical examination of a diver upon employment is sufficient for shallow water diving and all other physical requirements as specified in the proposed standards are unnecessary,' he said.

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OSHA's inflation impact assessment for the proposed standard 'borders on the ridiculous,' Wilson said. He noted that of the approximately 400 diving contractors in the United States, OSHA only interviewed nine on the cost of the proposed regulations.

Russell J. Judah, director of environmental and industry affairs, Transcontinental Gas Pipe Line Corporation, criticized OSHA's inflation impact assessment because it did not consider the cost of additional equipment required by the proposal. For example, he said that a fully manned barge to support a diving bell would cost his company $20,000 per day in rental fees and that OSHA did not talk about such costs in its assessment.

Gaspar, who said that his company usually employs three to eight divers, said that he expected his initial cost of compliance to be between $90,000 and $100,000, adding that this would put him out of business. His business is financed with a small business loan obligating all of his assests, which, Gaspar explained, would mean that he would 'probably have to declare bankruptcy.'

After the initial costs, Gaspar estimated the annual cost of compliance at $36,800.

'Don't take the attitude that industrial divers will have to merge with other divers or go out of business,' Gaspar said. In its inflation impact assessment, OSHA found that ' a limited number of firms may be forced to merge or go out of business as a result of the proposed standard.'

Harter, who is a small in-shore diving contractor, estimated that his first year compliance costs would be $53,000.

Judah said that any increased cost will be paid by the public, not by industry, and noted that in the case of his company it will mean higher prices for natural gas.

The Council on Wage and Price Stability criticized the Occupational Safey and Health Administration's proposed standard for commercial diving operations because, it said, 'there is no evidence that the standards will measurably lower the industry's fatality rate' and because the cost of compliance would have a 'sever' impact on smaller firms.

The council also said that 'OSHA's estimate of annual costs of compliance appears to understate total costs that will be passed on to consumers' and that the proposal may 'adversely affect the nation's energy supply.'

William Lilley III, the council's acting director urged OSHA 'to acquire a sense of perspective about this issue. Here is an industry composed of a large number of individual entrepreneurs, many of whom are ex-divers. The divers are true professionals who know well the risks attendent on their jobs; their pay, ranging from $20,000 to over $45,000 per year, reflects the skill and risk involved. If these standards were effective in reducing those risks - an assumption which is questioned in this anaylsis - this high level of compensation might well be reduced.'

The council made its statement on the proposed standard before OSHA and the Coast Guard, at joint public hearings in New Orleans, La, held to consider the proposal (Current Report, January 20, p. 1080).

Concern was expressed by the council that the proposed standard's cost of compliance might put small firms out of business and increase the concentration in an industry where the 10 largest firms already employ more than half the divers currently working. The other divers are spread out among more than 400 firms.

OSHA concluded in its inflation impact assessment that the standards would cost $22 million per year, but the council cited industry figures stating that the cost may well exceed $70 million per year. The council's statement questioned OSHA's conclusion that the cost of the standard did not require the preparation of an inflation impact statement.

The council noted that a large proportion of divers are employed by petroleum firms to monitor undersea pipelines and to respond to accidental breakages. It then suggested that the imposition of these standards might create a temporary shortage of divers and suggested that the increased expense could lead to lower maintenance on these pipelines and thus to greater loss of energy and frequent environmental threats through breakages.

The effectiveness of the proposed standard was questioned by the council, which cited evidence that many fatalities are attributed to 'human error.'

'It seems to us that first priority should be given to the problem of developing properly trained and responsible personnel, an issue which the standards to not address,' the council said.

James C. Miller III, the council's assistant director for government operations and research, expressed concern about OSHA's overall approach, stating that 'not only are engineering controls less cost-effective than some means of financial incentive (such as fines or penalties), but the idea that each work environment must be equally safe and healthful ignores the realities of cost, different preferences among workers about the riskiness of the work environment and wages earned, and the public's interest in having the greatest impact on worker health and safety for the resources spent.'

Mr. David L. Groover, Commercial Diving Service, Grand Rapids, Michigan kindly supplied the authors with his comments relative to the Emergency Temporary Standard for Diving Operations (Federal Register, Vol. 42, No. 116, June 15, 1976). Mr. Groover operates a small operation, engaged almost strictly in construction diving on and around Lake Michigan. Several of the comments directed toward the Emergency Temporary Standard are also relevant to the present OSHA Commercial Diving Operation Standard (Federal Register, Vol. 42, No. 141, July 22, 1977). It is probable that Mr. Groover's comments also reflect the opinions of other "small" diving firm employers operating in the Great Lakes area. Mr. Groover clearly states, however, that "the comments are purely mine, based on my own opinions and experience; I have not acted as a spokesman for any other one or organization (personal communication, 17 February 1977)." The following comments are taken from Mr. Groover's comments on the Emergency Temporary Standard:

Medical Requirements

> I agree that perhaps for large-scale operations, particularly those conducted offshore in deep water, and those using saturation and mix gas techniques, physicals of some sort should be carried out on the divers. However, as my situation does not involve such operations, I must reserve my comments on that point of view, and present my own.
>
> This is perhaps the most objectionable part of the standard in regards to small operators such as myself. My business is seasonal, (though I do work the year round when there is work and I can get it) and there is no way that I can keep a crew

on a regular basis. Most of the jobs that do come in, do so on very short notice, sometimes only a matter of hours. In such cases, I must go the rounds of any number of people who have and do work for me, to see who can make himself available. There is certainly no time for extensive medical prequalifications; and to give these examinations to all potential employees at the season's start, on the off chance that they may work sometime during the year, is an economically impossible gamble.

On the other hand, these men are all quite well known to me on a regular basis, including non-commercial diving expeditions. One does not have to be a doctor to determine whether a man has sinus trouble, epilepsy, is drunk, or otherwise unsuited for work. Aside from that, I, and every small operator with whom I am familiar, are very discriminating about whom we hire, as a matter of survival and common sense. Those of us who work on these levels do not view the world from report folders, memorandum sheets, and staff reports. We work on the front lines, and can see with our own eyes what is going on.

Again, I can not speak for large firms, but this particular standard is a little ridiculus for small operators; indeed, it is impossible regardless of how well it looks on paper.

Safe Practices Manual

In general, for certain items, this is a good idea. However, the wording ... 'develop and maintain a safe practices manual and shall follow the procedures set out in such manual for all diving operations' tends to eliminate the flexibility which divers need in order to work and ensure their own safety. It is also in conflict with the statement contained in the preamble to the Standards that recognizes that '... no single set of procedures can anticipate all operating situations. Sound judgement, an ability to recognize present or developing hazards, and maximum attention to personnel safety must continue to be the cornerstones of safe diving operations.'

The above sentence contains a lot of truth. Each and every diving job is different; no two are ever exactly alike, and no set of rules or procedures is ever going to cover all situations. For this reason, it is virtually impossible to develop a specific safe practices manual.

At the same time, small firms such as mine do not command large staff of Harvard graduates capable of authoring a work of literary art. Nor can we afford the luxury of hiring consultants for such in-house work. This does not mean that we are incapable of burning off a mooring cell or floating a barge, but it does mean we can not give precise, step-by-step operational details beforehand.

I do agree that lists of emergency aid, first aid suppliers, fire-fighting equipment, and general or specific (as practicable) directions for given emergencies, such as those listed, are desirable. But foreseen emergencies are almost always circumvented, and unforeseen emergencies must be handled as they have been in the past, by having capable people with 'sound judgement' on the scene. Judgements must be made to reflect reality, rather than hoped-for conditions.

As for pre-dive instructions, no one begins a job without first learning as much about it as he can.

Scuba Diving Buddy System/Comments

In principle, I agree that phones should be used if possible, but there are circumstances when a lone SCUBA diver, without the aid of a tender or buddy, can or must be used. Such instances include dives around a dock, in the old ditch, tec., where the diver need only stand to get out of the water. Also, even in open water, under good conditions, a lone SCUBA diver may be safer. I will even be specific - in pitch darkness due to heavy silt, etc, a buddy diver is of little help, if any, value. At the same time, the risks of fouling a signal line are increased, which may hold the diver down. This is a rule that should not be strictly enforced under given circumstances, which have to be determined at the time.

I strongly advocate the mandatory use of a life vest, and a line from the diver to a surface float if he is required to operate at any distance from his platform. Personally, I have more faith in a

surface float than a buddy diver, but, again, all this has to reflect the conditions present at the time, and can not be adequately reckoned with beforehand.

Scuba Diving Air Supply Requirements

I agree with this for bottom times, but feel that a diver should be able to utilize auxiliary tanks tied off on the decompression line for use in decompressing. He need not even change tanks, merely insert the regulator in his mouth. This procedure is routine to anyone who calls himself a diver.

Ventilation Requirements for Surface-Supplied Helmets and Masks

We, as divers, have little or no control of this, except to buy appropriate equipment. I agree with the ventilating requirements, but feel that this should be directed more to the manufacturers. Also, (and I am not qualified to state with any certainty) it may be that some of the newer, light-weight open-circuit rigs on the market today, though they may not be able to pass 4.5 cfm, never-the-less do meet the requirements of a diver just the same.

Two-Way Audio-Communication Requirements

This is fine, and almost always done. However, I must point out two points for consideration.

First, I fail to see a significant difference between a hat diver's umbilical and a SCUBA diver's signal line for the purposes of relaying signals; why should one require a phone and the other not? Admittedly, the phone is more desirable and practical, but there is a certain inconsistancy in the rules here.

Secondly, under certain conditions, such as the old ditch again, a phone is not necessary, though I can not myself see a hat or mask not being provided with one. The point is, that the rule applies a blanket provision to all hats/masks under all conditions, with no allowances for specific conditions which may allow that the absence of a phone does not detract from a safe operation. Please allow us some flexibility.

Interval Marking of Gas Hoses

This is good, but I do not see that it should be anything but voluntary. Almost always, no more hose will be out than is necessary to reach the diver, and markings will not affect this distance. Also, shallow water hoses are often short enough that one can easily tell how much is out. I would agree to marking long hoses (in excess of 300 feet) used for deep-water work.

Oxygen Cleaning of Hoses

I am not familiar with this, but assume it involves mixed-gas operations; I use strictly air.

Equipment Records

As for the equipment log, I do maintain a system of records, but, feel that your record requirements are a little far-reaching when applied to small operators. We know all of the items of our equipment individually, and well, because we are the ones who use them. Again, we run our affairs from the field, not a far-distant office building, through a staff. I know the history and condition of all my gear without having to open a record file. I think your records requirements could be toned down a bit.

Definitions

The list of definitions for the standard is relatively extensive. The purpose in providing definitions is to clarify the intent of specific terms as used in substantive provisions of the standard. In some cases, the same word or term has a different meaning, depending upon geographic location or segment of the diving community using the term. For example, "live boating" in commercial diving refers only to a surface-supplied diving practice where a diver is working from a vessel which is underway. On the other hand, the scientific/educational diver uses "live boating" in the context of a scuba diver towed behind a boat on an underwater diver's plane or shot line.

This report will be reviewed by many non-diving scientists, government officials, university officials, and members of the general public who are not familiar with diving terminology. In addition, many scientific/educational divers now subject to OSHA standards are completely unfamiliar with commercial diving terminology.

## Personnel Qualifications

This is a very difficult section to prepare. Unlike the scientific/educational diving community, the commercial diving community does not appear to have a common standard of training or personnel advancement on a basis of experience. The Z-135 Committee has prepared a protocol for training, diving proficiency, and field experience. Unfortunately, at this time, there is significant dissatisfaction with this portion of the Z-135 standard. Imposing the scientific/ educational community standard on the commercial diving community would be unacceptable. Consequently, we consider this as an area that will require further study. In the meantime, the standard requirements imposed by OSHA are included in ths standard. Unfortunately, the OSHA standard is not adequate to provide guidelines for personnel training, qualification advancement or task assignment. For more information on the OSHA position on personnel qualifications see Appendix B.

Medical Requirements

The medical examination is, in our opinion, an important aspect of diving health and safety. Consequently, we support the requirement for the annual medical examination. The contents of the annual examination have been modified slightly from that required by OSHA.

One of the major deviations from the OSHA requirement is the designation of who shall bear the expense of the examination. OSHA requires the employer to bear all medical examination and test costs. This is acceptable for larger firms with relatively stable groups of diving employees. However, this is a very difficult and often unreasonable requirement for small firms which operate on a seasonal basis or use independent divers on a daily basis. It is virtually impossible and impractical to expect an employer to arrange for and bear the cost of examination for daily employees or seasonal employees who dive on a limited basis. In this case we feel that it is the responsibility of the employee to provide the employer with a notarized copy of his/her current medical examination report.

The medical requirement test which appear in this standard are basic examination requirements. The chest x-ray is necessary to detect gross pulmonary abnormalities and the physician is encouraged, at his discretion, to use pulmonary function evaluations. The standard EKG identifies

certain cardiac abnormalities not detectable by auscultation. Many diving physicians prefer the use of a stress EKG for persons working in strenuous occupations. A hearing test is essential because hearing degradation is more probable in diving and high noise level environments (in chambers) than in many other industrial employments. Hearing is essential if the critical voice communications requirements specified in the standard are to be effective. Unfortunately, the level of hearing degradation that is considered disqualifying is not defined in either the OSHA or Z-135 standards. This is an area worthy of further study. Eventually this will have to be defined.

A visual acuity test is necessary to the extent vision may be relevant to job performance. As in hearing, the level of visual acuity that is disqualifying has not been defined by either OSHA or Z-135 standards. The basic medical examination may establish a basis for further professional examination and possible corrective measures. Vision is critical for safety, especially when working at the dive station as a tender, supervising overhead lifting, or for scuba divers on the surface. On the other hand, the diver working in poor visibility waters common to the Great Lakes would generally not find visual deficiency restricting. It is more vital that surface support personnel have adequate visual acuity. A color blindness test has been indicated because color coding is commonly used for piping and hose

markings. Although not disqualifying in itself, the person-in-charge must be aware of color perception deficiencies so appropriate work assignments or adjustments can be made. Blood and urine tests are important because some conditions such as anemia and diabetes are generally detected this way. Diabetes can produce unconsciousness; anemia reduces work capacity and therefore fatigue and exhaustion. A white blood count is an indicator for acute infections. The sickle cell index test for hemogloblinopathies is included. Abnormal hemoglobins produce sickling under conditions of hypoxia, which causes blockage of blood vessels throughout the body and injury to many organs and tissues; exposure to low oxygen partial pressure might precipitate a sickling crisis, which would be incapacitating underwater. Since the incidence of cardiovascular disease and related mortality is much higher in the over 35 age group, medical discretion is to be used in the requirements for more complete testing such as annual EKG and stress EKG.

Although there is considerable concern regarding the qualifications of examining physicians, the use of several physicians to obtain a qualification to work by majority rule as indicated in the OSHA standard appears to be an unacceptable practice. The OSHA regulation states,

> If the examining physician has recommended a restriction or limitation on the dive team member's exposure to hyperbaric conditions, and the affected employee does not concur, a second physician selected by the employee shall render a medical opinion on the nature and extent of the restriction or limitation, if any.

> If the recommendation of the second opinion differs from that of the examining (first) physician, and if the employer and employee are unable to agree on the nature and extent of the restriction or limitation, an opinion from a third physician selected by the first two physicians shall be obtained. The employer's determination of the dive team member's fitness shall be consistent with the medical opinion of the third physician unless the employer and employee reach an agreement which is otherwise consistent with the recommendation or opinion of at least two of the physicians involved.
>
> Nothing in this procedure shall be construed to prohibit either a dive team member from accepting, or an employer from offering, an assignment which is otherwise consistent with at least one medical opinion while a final determination on the employee's fitness is pending.

Certainly, it is acceptable to request that the examined diver seek consultation with other experts in the field of diving medicine. Realistically, however, any ~~employee~~ diver can probably find a physician who will qualify him/her to dive. For example, it would not be at all difficult to find two "less-informed" physicians that would allow a pregnant woman to continue diving throughout most of the term of pregnancy. Yet, in the opinion of many authorities this constitutes an unacceptable risk to both the woman and the unborn child. Although this is probably not a problem for the commercial diving community, it is a definite consideration in other employments such as the scientific/educational diving community. Incidentally, we have included pregnancy as a temporary disqualification.

For more information on OSHA's position on diving medical requirements consult Appendix B.

General Operational Requirements

The general operationsl requirements of this report parallel those stated by OSHA with some modification.

The following changes are noted:

(1) Inclusion of the requirement for maintaining a list of addresses and telephone numbers of all employees at the work location in the event that special medical consent is required in handling an injury.

(2) The need for a physician to approve every first aid kit used on a work location is impractical. Most text and company manuals have appropriate lists of first aid supplies.

(3) Mouth-to-mouth resuscitation is as good as the use of a resuscitation bag. It takes special training and practice to use the bag correctly and effectively.

(4) The requirement for an oxygen breathing unit was added. In the event of a shallow-water air embolism where a chamber is not required on site, oxygen can make the difference between probable recovery with minimum residual damage and serious permanent impairment.

(5) The OSHA regulation specifically states that the use of the international code flag "Alpha" is to be used as a warning signal. The State of Michigan requires the use of the American diver's flag. Most boaters will not know the significance of the "Alpha" flag.

(6) The requirements for overhead lifting operations, in-water welding and burning, underwater electrical equipment, hand-held power tools and equipment, and explosives have been supplemented with information from the Z-135 Committee standard.

(7) Liveboating has been placed under the in-water procedure section instead of being included as a separate section as in the OSHA standard.

(8) The flying after diving requirement is more rigid than the OSHA requirement.

## Self-Contained Air Diving

Self-contained underwater breathing apparatus (scuba) receives only limited use in commercial diving. However, scuba is used extensively in scientific/educational diving. Since OSHA clearly intends to classify scientific/educational divers as commercial divers, scuba diving must be addressed in much more detail in these standards. For purposes of this standard only open-circuit scuba utilizing compressed air breathing medium is addressed at present. However, one must keep in mind that several types of recirculating pure oxygen and mixed-gas scuba are used in scientific/educational diving and will possibly be employed in some commercial diving operations in the near future. The topic of mixed gas scuba diving will require additional study and preparation of specific regulations beyond the scope of this standard.

The OSHA standard states a specific depth limit of 130 fsw for scuba diving. This is the limt generally recommended for recreational divers. The U.S. Navy (1973) also specifies 130 fsw as the maximum working limit for scuba. On the other hand, MTS/ANSI Z-135 Committee (January 1977) approved a maximum depth limit of 190 fsw for open-circuit air scuba diving. The University of Miami authorizes diving up to depths of 240 fsw on compressed air. In a letter to the Docket Officer, Technical Data Center (3 December 1976) Mr.

Stuart McCormick and Dr. Warren Wisby state "that of the 4735 dives conducted in the past five years in depths ranging from 10 fsw to 240 fsw there have been only four diving accidents; three occurred 36 hours after decompression from a saturation dive, and one occurred after a non-decompression repetitive dive to 90 fsw. None of the accidents resulted in any residual injury. Of these 4735 dives, 1322 (27.8%) were decompression dives. THERE WERE NO CASES OF DECOMPRESSION ILLNESS ASSOCIATED WITH ANY OF THE DECOMPRESSION DIVES, excluding saturation diving." The saturation dive depth in the above was, to my knowledge, approximately 50 fsw.

, Professor of Kinesiology and UCLA Diving Officer,

~~In December 1976~~ Dr. Glen Egstrom supplied me with data collected from ~~37~~ 42 scientific and research agencies for the years 1965-1975. This work was completed under the auspices of the University of California, Los Angeles Sea Grant Diving Safety Research Project. Of ~~220,411~~ 241,000 scientific/educational dives logged, ~~1891~~ 3532 (1.47) (~~1.3%~~) were in excess of 130 fsw and ~~328~~ 460 (~~0.16%~~) 0.19%) involved decompression. Only 4 pressure related accidents were reported which included 2 cases of decompression sickness, and 2 deaths. The deaths included one surface drowning and one diver with a possible congenital defect. ~~The second death occurred on a "deep" cable survey at night (depth not specified).~~

Most, if not all, of the above mentioned dives were conducted using open-circuit air scuba. In light of these

but impressive figures one may subjectively conclude that "imposing a stringent depth limit on scientific/educational scuba diving" in unjustified. Naturally, these figures do not represent the sum total of all scientific/educational diving in the United States nor do they include all of the accidents. However, I feel they are "representative." The UCLA data shows an incidence of 1.1 deaths per 100,000 exposures in scientific/educational diving. Depth does not appear to be a significant factor in scientific/educational diver mortality.

One must understand that the University of Miami, University of California, and many other universities and research agencies have imposed strict training, qualification, and procedural regulations on their divers for years. The programs and divers are very "controlled."

The recommendation of the 190 fsw depth limit for specifically trained and authorized scientific/educational or commercial scuba divers must not be construed to include approval of recreational scuba diving beyond a depth of 130 fsw. Recreational scuba divers generally lack the training, rigid program control, supervision, and support facilities necessary for deep diving authorization. Under such conditions scuba diving beyond 130 fsw is considered an unacceptable risk.

The requirement for a more stringent depth limit for commercial scuba diving may well be justified. Commercial divers are in general not as competent and experienced in scuba diving as the scientific/educational diver. The

commercial diver may also attempt to use scuba in a environmental or task situation or procedural manner that is completely inconsistent with the accepted practices in the scientific/educational diving community. As long as the OSHA standards include jurisdiction over scientific/educational divers, the limits for scuba must be extended.

The OSHA standard states that scuba diving shall not be conducted (1) against currents exceeding one knot unless line tended or (2) in enclosed or physically confining spaces unless line-tended. In routine scuba diving line tending is generally only associated with under ice diving.

Scuba divers often "drift" dive in currents with a boat overhead, a pick-up boat downstream, or selected and separate entry and exit points. Working or swimming against a current in excess of one knot is not recommended. However, the "unattached" drift diving technique is a very useful and safe technique in research activities and select environments. If the diver(s) must return to the precise entry point, then line tended techniques may well be indicated. One must keep in mind that line tending techniques are not commonly associated with scuba diving and therefore indiscriminate application of such a regulation may actually constitute a hazard. In any case a number of factors control the selection of technique. The matter of line tending should be left to the discretion of the person-in-charge.

Diving in enclosed confined spaces such as underwater caverns involves use of a lightweight safety line reeled out by the diver. The safety line is not designed to "pull the diver back" nor is it attached to the diver; it is a hand-held guide line. Conventional line tended diving techniques are considered inadequate and, in some cases, extremely hazardous by cave diving authorities. The scuba cave diving line technique is also considered adequate for entry into wrecks and underwater structures.

The OSHA standard also ~~is inadequate in the area of~~ also does not fully address scuba equipment. Scuba and associated scuba diving equipment must meet certain minimum requirements in both mechanical function and maintenance. Within the recreational and scientific/educational diving communities a common standard of selection and care does exist. Failure to apply this standard to commercial diving would, in our opinion, be unfortunate.

For example, there is apparently no federal regulation that requires the internal inspection of a scuba air cylinder on an annual basis. Yet this is a standard practice in the scuba diving community. Annual visual cylinder inspection is recommended in this standard.

Emergency flotation equipment is covered to some degree in the OSHA standard. However, that standard fails to address flotation capacity or inspection protocol.

The standard of performance of scuba diver depth gauges does differ from that of the pneumofathometer used in commercial diving. Realistic accuracy requirements are recommended in this standard.

Probably one of the most awkward areas of scuba diving procedures specified in the OSHA standard is the "apparent" unrestricted application of the line-tended scuba diver. Line tending of scuba divers where a single diver is involved is for most part an unacceptable and, in some situations, considered an extremely hazardous procedure. The OSHA standard "apparently"

endorses line-tended scuba diving (single diver) up to their specified limit of 130 fsw.

The American National Standards Institute - Marine Technology Society Z-135 Committee on Safety in Commercial and Professional Diving Operations not only endorses line tended scuba dives, apparently to the depth of 190 fsw, but also suggests that a single diver can operate to the same depth with no direct connection to the surface or accompanying diver as long as a wireless communications system and a "means of positive location" is used. Positive location means can be interpreted as "bubbles breaking the surface with visual sight of the diving station." Most scuba diving authorities consider such practices as unacceptable. Unfortunately, endorsement of such procedures in the OSHA and Z-135 standards could encourage both recreational divers and scientific/educational divers to adopt previously unacceptable diving techniques and procedures. A significant safety hazard would thus exist.

Both OSHA and Z-135 fails to address mid-water scuba dives and open-sea or open-lake scuba diving. These activities do require added precautions.

Surface-Supplied Air Diving

Surface-supplied diving is covered more extensively in this standard than in the OSHA standard. Many small company divers have traditionally used heavy gear in the Great Lakes and the modern equipment has only been introduced relatively recently. Consequently, ~~it is~~ we considered that the Great Lakes diver and employer will need more guidelines than their offshore counterparts.

Our information suggests that the ~~The~~ limits ~~have been~~ can be extended for diving without a chamber. Most diving is shallow-water, no-decompression diving. However, occasionally inspection dives are required beyond 100 fsw and, in some cases, decompression is required. Historically, the incidence of decompression sickness among Great Lakes commercial divers has been relatively low. Very few companies own chambers in the Great Lakes area. It seems impractical to require a chamber on location for one or two deep inspection dives. On the other hand, the few companies that do deep diving on a routine basis do provide chambers for employee protection. We feel that some employer discretion must be exercised in this area of protection for employees. If the dive location is a considerable distance from a treatment facility, then a chamber should be available on the job location.

We do not feel it is necessary to discuss each element of the surface-supplied air diving requirements since they parallel those recommended by OSHA and/or the Z-135 Committee.

Unlike scuba diving, the surface-supplied requirements are relatively consistant with current practices in the commercial diving community.

## Decompression Chambers

A separate section has been prepared on decompression chambers. The decompression chamber is relatively uncommon in Great Lakes diving operations. We feel that both employers and emplyees need more comprehensive guidelines in this area. The requirements given in this standard are more or less in accord with those specified by OSHA and/or the Z-135 Committee.

## Recordkeeping Requirements

The recordkeeping requirements are essentially the same as those required by OSHA.

# OCCUPATIONAL SAFETY AND HEALTH STANDARDS FOR GREAT LAKES COMMERCIAL DIVING OPERATIONS

## SECTION 1: Purpose, Scope and Application

### 1.1 Purpose

The purpose of this standard is to provide guidelines which shall be considered as minimum reasonable requirements of safety in shallow water commercial and industrial diving. It is not intended that provisions in this standard are to supercede any governmental regulations, present or proposed.

### 1.2 Scope

1.2.1 This standard applies to every place of employment within the inland and territorial waters of the United States defined as the Great Lakes Basin where diving and related operations are carried out.

1.2.2 This standard applies to shallow water diving operations in which the diver's working depth does not exceed 220 fsw and compressed air is the primary breathing gas.

1.2.3 This standard establishes minimum requirements for the safety of divers in commercial and industrial diving work and employments, including industry, construction, ship repair, shipbuilding, shipbreaking, and longshoring.

1.2.4 This standard does not apply to any diving operation:

1.2.4.1 Performed solely for instructional purposes, using open-circuit, compressed-air scuba and conducted within the no-decompression limits;

1.2.4.2 Performed solely for recreational purposes;

1.2.4.3 Performed solely for scientific/educational purposes;

1.2.4.4 Performed solely for search, rescue, or related public safety purposes by or under the control of a governmental agency; or

1.2.4.5 Governed by 45 CFT Part 46 (Protection of Human Subjects, U.S. Department of Health, Education, and Welfare) or equivalent rules or regulations established by another federal agency, which regulate research, development, or related purposes involving human subjects.

1.3 Applications in emergencies

An employer may deviate from the requirements of this standard to the extent necessary to prevent or minimize a situation which is likely to cause death, serious physical harm, or major environmental damage, provided that the employer:

1.3.1 Notifies the Area Director, Occupational Safety and Health Administration within 48 hours of the onset of the emergency situation indicating the nature of the emergency and extent of the deviation from the prescribed regulations; and

1.3.2 Upon request from the Area Director, submits such information in writing.

SECTION 2: Definitions

As used in this standard, the listed terms are defined as follows:

Acute alcoholism: an episode of repeated or continuous excessive consumption of alcoholic beverages over a relatively shor period of time.

Acute gastrointestinal syndrome: refers to nausea, vomiting, diarrhea, or any combination, with abrupt onset and persisting a few days or less.

Air diver: a diver who, while executing his diving duties, utilizes air as a breathing medium.

Air diving supervisor: an individual qualified to supervise air diving operations and a diving team functioning on an underwater project and who is currently, or has formerly been, a qualified diver.

Ascent time: the time interval between starting ascent and arriving at surface pressure.

ASME: refers to the American Society of Mechanical Engineers.

ATA: an abbreviation for atmospheres absolute, a unit of pressure equivalent to ambient gauge pressure in atmospheres plus 1 atmosphere.

ATM: an abbreviation for atmosphere, a unit of pressure equivalent to 760 millimeters of mercury (mm Hg) or 14.7 pounds per square inch (psi).

Bottom time: the time interval between leaving the surface and beginning ascent back to the surface.

Burst pressure: the pressure at which the containment vessel will structurally fail.

Chronic: existing for a prolonged period of time.

Chronic alcoholism: repeated or continuous excessive consumption of alcoholic beverages over a prolonged period of time.

Closed-circuit: a system by which the diver breathes a gas supply that is recirculated through a carbon dioxide absorbent with periodic manual or automatic replenishing of oxygen.

Commercial diving: diving which is performed as a part of general industry, construction, ship repairing, shipbuilding, shipbreaking, and longshoring.

Cystic: an adjective meaning an enclosed hollow space.

Decompression: the reduction of environmental or ambient pressure to atmospheric pressure.

Decompression dive: a dive during which the diver must stop at a given depth or depths in accordance with U.S. Navy Decompression Tables and cannot proceed directly to the surface at the prescribed rate.

Decompression schedule: a time-depth profile with a specific bottom time and depth, for which a specific pressure reduction or decompression time sequence has been calculated.

Decompression sickness: a physiological condition with a variety of symptoms which may result from the formation of gas or gas bubbles in the blood or body tissues of divers during or subsequent to ascent or other pressure reduction.

Decompression table: a set of decompression schedules computed on common parameters.

Demand system: a gas-supply system that supplies gas to the diver only when the diver inhales.

Diabetes: a physiological condition involving excess sugar in the blood.

Disconnect switch: a safety switch, located at the surface, by which power can be quickly removed from the underwater cutting/welding lead.

Diver: an employee engaged in work using underwater breathing apparatus which supplies compressed breathing gas at ambient pressure from a self-contained or remote source.

Diver/tender: an individual qualified to conduct limited underwater work under the supervision of a full qualified diving personnel and tend divers.

Diving bell (open): an open vessel designed for transporting the diver to and from the work site and not designed to be operated with an internal pressure differential.

Diving bell (pressurized): a closed pressure vessel designed for transporting the diver to and from the underwater work site and operated with an internal differential pressure at least as great as the pressure at the working depth.

Diving harness: a harness assembly which the diver wears to which his umbilical unit connects and by which he can be lifted, with the harness distributing the load.

Diving supervisor: the person responsible for planning the dive, instructing the crew, making certain all necessary equipment is available and functioning properly, taking all necessary precautions against foreseeable contingencies, and is responsible for safety of the operation.

DOT: refers to the Department of Transportation (formerly designated on cylinders as ICC).

Drug addiction: the inability, either physiologically or psychologically, to function without the use of a drug or medication.

Drug intoxication: ill or undesirable effects caused by excessive use of a drug or medication.

Dry suit (variable volume): a diving suit capable of being inflated for buoyancy or insulation which maintains the diver's body essentially dry.

Epileptiform disease: a disease characterized by convulsive seizures.

Field experience: field days (offshore, inland lakes, harbors, rivers) directly participating as a diver, supervising divers, operating diving equipment or surface tending divers engaged in underwater operations.

Filter: a device used in gas supply systems to remove moisture, oil, and particulate matter from the breathing gas.

Free-flow system: a gas supply system that supplies gas to the diver by continuous flow.

FSW: the abbreviation for feet of seawater, a unit of pressure generally defined as 1/33 of a standard atmosphere, which represents the pressure exerted by a foot of seawater having a specific gravity of 1.027, equal to approximately .445 pounds per square inch. This pressure unit is used in freshwater diving since most diver's gauges and decompression tables use fsw as the standard unit. In freshwater the pressure at 34 feet is equal to that at 33 feet in seawater.

Hard piping: rigid permanent or semi-permanent piping, as distinguised from temporary, flexible hoses.

Heart disease: any abnormal or morbid condition of the heart.

Heavy-gear diving: diving which employes the use of conventional deep sea dress, including helmet and breastplate, suit of rubberized canvas, and heavy weighted shoes.

Helmet: diving apparatus constructed of hard material which completely encloses the diver's head and keeps it dry.

High pressure air: air supplied at a pressure in excess of 500 psi.

Hyperbaric chamber (also recompression chamber or decom-compression chamber): a pressure vessel suitable for, and in used in, recompression-decompression of divers.

Hyperbaric conditions: refers to pressure conditions in excess of surface pressure.

Lead diver (diver in charge): a diver who by virtue of experience and proficiency is qualified and responsible for the conduct of a diving operation when a designated supervisor is not assigned or present.

Life-support equipment: equipment designed to provide the diver with an appropriate respirable atmosphere and other protection as required.

Live boating: refers to a diver working from a boat which is under power and not anchored. The diver may be under tow on a diver's plane or shot line or he may be followed by the boat to which he is tethered while swimming or walkin the bottom.

Low pressure air: air supplied at a pressure of less than 500 psi.

Mask: a breathing and protective apparatus which covers the diver's face and is secured to the diver's head by a strap or harness assembly.

Mixed gas: refers to a mixture of oxygen and an inert gas appropriate for diver breathing at a given depth range and with given apparatus. Unless otherwise specified all breathing gas referred to in this document shall be air.

Mixed-gas diver: a diver who, while executing his diving duties, utilizes mixed gas as a breathing medium.

Mixed-gas diving: a diving mode in which the diver is supplied with a gas mixture other than air.

Mixed-gas supervisor: an individual qualified to supervise mixed-gas diving operations and a diving team functioning on an underwater project and who is currently, or has formerly been, a qualified diver.

Neurological decompression sickness: decompression sickness involving the brain, spinal cord, or nerves.

No-decompression limit: the time-depth combination which indicates that a diver can safely ascend to the surface at a prescribed rate without stopping to decompress.

Non-return valve: a one-way check valve installed at the hose-helmet or -mask attachment point or elsewhere in the diving system, which is designed to prevent pressure loss should the hose be severed or the gas supply be interrupted.

Obesity: a conduct of excessive body weight and fat content, generally accepted as 20% over the recommended level for a given height, weight, age, body type, and sex.

Open circuit: a system by which the diver inhales breathing gas directly from the supply and exhales or exhausts directly into the surrounding water.

OSHA: refers to the Occupational Safety and Health Administration.

Oxygen cleaning: a special cleaning procedure to remove contamination in apparatus used in supplying oxygen under pressure. This is a precaution used to prevent oxygen related ignition or explosion.

Oxygen compatibility: the ability of a substance to come into contact with high-pressure oxygen without ignition.

Oxygen service equipment: equipment or components which store or convey a gas having an oxygen concentration of 40% or greater.

Oxygen toxicity: the adverse physiological response to excessive partial pressure of oxygen.

P.A. Projections: a standard x-ray technique wherein the x-rays are emitted from behind the individual toward the front.

Partial pressure: that portion of the total gas pressure exerted by a particular constituent of the gas mixture.

Personnel lock: a chamber compartment through which personnel pass from air pressure environment to another.

Pneumofathometer: a depth measuring device indicating depth in fsw, consisting of an open-ended hose fixed to the diver or diving bell, with the other end connected to an air supply and pressure gauge at the surface.

Pressure: defined as force per unit area. In diving, pressure denotes an exposure greater than surface pressure (1 ATA).

PVHO: the abbreviation for "pressure vessel for human occupancy", a pressure vessel designed to contain human beings.

Qualified diver: a person medically fit for diving, trained or experienced in diving who possesses the mechanical skills and technical knowledge required for safe and satisfactory completion of a given underwater task. The diver must be able to show satisfactory proof of training and/or experience. He shall possess a diving logbook with recorded diving experience and/or letters from past employers or instructors attesting to his diving proficiency and experience. He must comply with the certification requirements given in this standard.

Rack/console operator: an individual qualified to operate a gas rack/console.

Receiver: a pressure vessel designed for the storage of gas. In conventional diving this is generally a low-pressure reserve gas located between the breathing gas source and the diver's hose connection.

Safety factor: the ratio of burst pressure to working pressure when used in reference to pressure vessels, piping, hose, and other pressure containing apparatus common to diving.

Saturation dive: refers to a dive during which the personnel have been exposed to a given pressure for a sufficient amount of time for a state of equilibrium to be established between the body and the breathing atmosphere.

Saturation habitat: a fixed or movable system of single or multiple PVHO's in which divers live under saturation conditions on the sea floor and from which they make working excursions.

SCUBA: a self-contained underwater breathing apparatus.

Self-contained diving (or scuba diving): a diving mode which allows the diver to carry his own breathing gas supply and be independent of the surface with regard to breathing gas.

Semi-closed circuit: a system by which the diver breathes a gas partially from the supply and recirculated gas from a breathing bag or canister after it has passed through a carbon dioxide absorbent.

Standby diver: a qualified diver who is suited up and prepared with proper equipment for the dive involved to enter the water immediately in the event of an emergency or upon orders of the diving supervisor.

Surface decompression: a special diver decompression procedure conducted in a deck decompression chamber in accordance with procedures given in the U.S. Navy Manual.

Surface supplied: refers to a system by which the diver is supplied with breathing gas through a hose from the surface.

Tender: a person possessing the mechanical skills and technical knowledge of setting up and operating the diver's gas supply (compressor and/or gas storage unit) and all other diving equipment. He shall be conversant with the use of appropriate decompression and repetitive dive tables and familiar with various diving injuries and appropriate first aid. He shall be skilled in tending the diver's hose assembly while the diver is submerged and sending and receiving hand (line) signals.

Timekeeper: a person responsible for keeping the diver's time and completing the information required for the diving record.

Treatment table: a time-pressure-gas profile which is calculated to eliminate the symptoms of decompression sickness.

Umbilical assembly(life-support hose bundle): a composite of hoses/cables or separate cables extending from the surface to the diver or diving bell which supplies breathing gas, power, heat, depth measurement, safety line and/or communications, as necessary.

Weight belt: a belt worn by the diver to which weights are attached to adjust buoyancy or provide negative buoyancy.

Working pressure: the normal maximum operating pressure exerted by a medium such as a breathing mixture.

Work site: a vessel or surface structure from which dives are supported and/or the underwater location where work is performed.

## SECTION 3: Personnel Qualifications

3.1 General

3.1.1 Each dive team member shall have the training and/or experience necessary to perform tasks assigned in a safe and proper manner.

3.1.2 Each dive team member shall have training and/or experience in the following:

3.1.2.1 Techniques of the assigned diving mode;

3.1.2.2 The use of equipment, systems, and tools relevant to the assigned task; and

3.1.2.3 Diving operations and emergency procedures.

3.1.3 All dive team members shall be trained in cardio-pulmonary resuscitation and first aid.

3.1.4 Dive team members who are exposed to or control the exposure of others to hyperbaric conditions shall be trained in diving-related physics and physiology.

3.2 Assignments

3.2.1 Each dive team member shall be assigned tasks in accordance with the employee's experience and/or training, except that limited additional tasks may be assigned to an employee undergoing training provided that these tasks are performed under the direct supervision of an experienced dive team member.

3.2.2 The employer shall not require a dive team member to be exposed to hyperbaric conditions against the employee's will, except when necessary to complete decompression or treatment procedures.

3.2.3 The employer shall not permit a dive team member to dive or be otherwise exposed to hyperbaric conditions for the duration of any temporary physical impairment or condition which is known to the employer and is likely to affect adversely the safety or health of a dive team member.

3.3 Designated person-in-charge.

3.3.1 The employer or an employee designated by the employer shall be at the dive location in charge of all aspects of the diving operation affecting the safety and health of dive team members.

3.3.2 The designated person-in-charge shall have the experience and training in the conduct of the assigned diving operation.

3.4 Employee responsibility.

3.4.1 It shall be the individual diver's responsibility to maintain himself/herself in good physical condition and at a high level of diving proficiency.

3.4.2 Each diver has the responsibility and privilege to refuse to dive if, in his/her judgement:

3.4.2.1 Conditions are unfavorable;

3.4.2.2 He/she is not in proper physical or mental condition for diving;

3.4.2.3 He/she would violate the dictates of proper diving safety procedures or this standard.

3.4.3 The employee is responsible for reporting immediately to the designated person-in-charge any equipment malfunction or discrepancy in safety procedures.

3.5 Diving after illness or injury.

3.5.1 No diver shall be allowed to dive following decompression sickness exhibiting CNS or vestibular symptoms or following a pulmonary barotrauma unless he/she has received medical clearance for diving from a physician recognized as qualified by the employer.

3.5.2 No diver shall be allowed to dive following extended hospitalization or illness unless he/she has received medical clearance for diving from a physician.

SECTION 4: Medical Requirements

4.1 General.

4.1.1 The employer shall determine that dive team members who are, or are likely to be, exposed to hyperbaric conditions are medically fit to perform assigned tasks in a safe and healthful manner.

4.1.2 The employer shall verify that each dive team member who is, or is likely to be, exposed to hyperbaric conditions has complied with all medical examinations required by this standard.

4.1.3 All medical examinations required by this standard shall be performed by, or under the direction of, a qualified physician.

4.1.4 The medical examination requirements of this standard shall be provided for in the following manner:

4.1.4.1 The employer shall provide each dive team member who is, or is likely to be, exposed to hyperbaric conditions with all medical examinations required by this standard at no cost to the employee; or

4.1.4.2 The employee shall provide a current certified or notarized copy of his/her current annual medical examination report as required by this

this standard before exposure to hyperbaric conditions.

4.1.5 The employer and the employees or their designated representatives shall determine the policy for medical examination payment.

4.1.6 The employer shall bear the cost of any test specified by the employer which is beyond the requirements of this standard.

4.2 Physician qualifications. Examining physicians shall be familiar with the physical requirements and medical aspects of diving.

4.3 Frequency of medical examinations. Medical examinations shall be provided:

4.3.1 Prior to initial hyperbaric exposure with the employer, unless an equivalent medical examination has been given within the preceding 12 months and the employer has obtained the results of the examination and an opinion from the examining physician of the employee's medical fitness to dive or to be otherwise exposed to hyperbaric conditions;

4.3.2 At one year intervals from the date of initial examination or last equivalent examination;

4.3.3 After an injury or illness requiring hospitalization of more than twenty-four (24) hours;

4.3.4 Following decompression sickness with vestibular or central nervous system involvement or pulmonary barotraum; or

4.3.5 If the employer has doubts as to the employee's medical qualification to continue diving.

4.4 Information provided to examining physician:

4.4.1 A copy of the medical requirements of this standard; and

4.4.2 A summary of the nature and extent of hyperbaric conditions to which the dive team member will be exposed, including diving modes and types of work to be assigned.

4.4.3 A summary of the examiner's diving-related work history; and

4.4.4 A medical history provided by the diver.

4.5 Content of medical examination:

4.5.1 Medical examinations conducted initially and annually shall consist of the following:

4.5.1.1 Medical history;

4.5.1.2 Diving-related work history;

4.5.1.3 Basic diver's physical examination;

4.5.1.4 The test required in Table I;

4.5.1.5 Any additional tests or requirements imposed by the employer as dictated by specific activities; and

TABLE I. - Tests for diving medical examinations

| Test | Initial Examination | Annual Examination |
|---|---|---|
| Chest X-ray (PA projection | X | X |
| Visual acuity | X | |
| Color blindness | X | |
| Audiogram (Hearing Test) | X | X |
| Pulmonary Function (VC and FEV$_1$) | (1) | (1) |
| EKG (Standard 12 L) | X | X (2)(3) |
| EKG (Stress) | (1) | (1) |
| Hematocrit or hemoglobin | X | X |
| Sickle cell index | X | |
| White blood count | X | X |
| Urinalysis | X | X |
| Bone and joint x-ray series | (4) | (2)(4) |

(1) If medically indicated; at physician's discretion.

(2) Required at 3 year intervals.

(3) Annually over the age of 35.

(4) If required by employer for specific diving activities.

4.5.1.6 Any additional tests that the physician considers necessary.

4.5.2 Medical examinations conducted after an injury or illness requiring hospitalization of more than 24 hours shall be appropriate to the nature and extent of the injury or illness as determined by the examining physician.

4.6 Physician's written report.

4.6.1 After any medical examination required by this standard, the employer shall obtain a written report prepared by the examining physician containing:

4.6.1.1 The date and location of the medical examination;

4.6.1.2 The results of the medical examination; and

4.6.1.3 The examining physician's opinion of the employee's fitness to be exposed to hyperbaric conditions, including any recommended restrictions or limitations to such exposure (see Appendix A).

4.6.2 The employer shall provide the employee with a copy of the physician's written report.

4.7 Determination of employee fitness. The employer shall determine the extent and nature of the dive team member's fitness to engage in diving or be otherwise exposed to hyperbaric conditions consistent with the recommendations of the examining physician's report.

SECTION 5: General Operations Requirements

5.1 Safe Practices Manual

5.1.1 General. The employer shall develop and maintain a safe practices manual which shall be made available at the dive location to each dive team member.

5.1.2 Contents

5.1.2.1 The safe practices manual shall contain a copy of this standard and the employer's policies for implementing the requirements of this standard.

5.1.2.2. For each diving mode engaged in, the safe practices manual shall include:

5.1.2.2.1 Safety procedures for diving operations;

5.1.2.2.2 Equipment procedures;

5.1.2.2.3 Assignments and responsibilities of diving team members;

5.1.2.2.4 Emergency procedures for fire, equipment failure, adverse environmental conditions, illness and injury.

5.2 Pre-Dive Procedures

5.2.1 General. The employer shall comply with the following requirements prior to each diving operation, unless otherwise specified.

5.2.2 A competent designated person-in-charge (lead diver or diving supervisor) shall be delegated the authority to take charge of each diving operation at the dive location.

5.2.2.1 The designated person-in-charge shall:

5.2.2.1.1 Maintain the provisions of this standard;

5.2.2.1.2 Maintain additional safety provisions specifically established by the employer;

5.2.2.1.3 Assure that all diving is conducted in accordance with accepted procedures and practices; and

5.2.2.1.4 Under no circumstances tolerate violation of these standards or other designated/accepted diving safety practices.

5.2.3 Emergency aid. A list shall be maintained at the dive location of the telephone or call number and location of the following:

5.2.3.1 Primary and alternate decompression chambers (if not at the diving location);

5.2.3.2 Accessible hospitals;

5.2.3.3 Available physicians;

5.2.3.4 Available means of transportation;

5.2.3.5 The nearest U.S. Coast Guard Rescue Coordination Center and facilities;

5.2.3.6 Employer offices;

5.2.3.7 Name, location, and telephone number of nearest relative of each employee; and

5.2.3.8 Other emergency facilities in area of operation.

5.2.4 First aid supplies

5.2.4.1 A first aid kit appropriate for the diving operation and location shall be available at the dive location.

5.2.4.2 When used in a decompression chamber, the first aid kit shall be suitable for use under hyperbaric conditions.

5.2.4.3 An American Red Cross Standard First Aid Manual or equivalent and a manual or specific instructions on first aid for diving accidents shall be available at the dive location.

5.2.4.4 An emergency oxygen breathing unit shall be available at all dive locations.

5.2.5 Planning and assessment. Planning of a diving operation shall include an assessment of the safety and health aspects of the following:

5.2.5.1 Diving mode;

5.2.5.2 Surface and underwater conditions and anticipated hazards;

5.2.5.3 Breathing gas supply including source, purity, quantity, and reserves;

5.2.5.4 Thermal protection requirements;

5.2.5.5 Diving equipment and system;

5.2.5.6 Dive team assignments and physical status of dive team members;

5.2.5.7 Repetitive dive designation or residual inert gas status of dive team members;

5.2.5.8 Decompression and treatment procedures (including altitude corrections); and

5.2.5.9 Emergency procedures.

5.2.5.10 The designated person-in-charge shall inform the vessel's master, work site foreman, and/or designated personnel of all diving operations to be conducted from the vessel or structure, emphasizing pertinent safety factors and coordination with other activities.

5.2.6 Hazard activities. To minimize hazards to the dive team, diving operations shall be coordinated with other activities in the vicinity which are likely to interfere with the diving operation.

5.2.7 Employee briefing.

5.2.7.1 Dive team members shall be briefed on:

5.2.7.1.1 The task to be undertaken;

5.2.7.1.2 Safety procedures for the diving mode;

5.2.7.1.3 Any unusual hazards or environmental conditions likely to affect the safety of the diving operation;

5.2.7.1.4 Emergency aid procedures; and

5.2.7.1.5 Any modification to operating procedures necessitated by the specific diving operation.

5.2.7.2 Prior to making individual dive team member assignments, the employer or designated person-in-charge shall inquire into the diving team member's current state of physical fitness, restrict diving activities of individuals suffering from obvious illness or abnormal physical conditons contraindicated in diving.

5.2.7.3 Dive team members shall be informed of the procedures for reporting physical problems or adverse physiological effects during and after the dive.

5.2.8 Equipment

5.2.8.1 Equipment to be used must meet the specifications set forth in this standard.

5.2.8.2 All life-support and associated equipment including mask, helmets, umbilical assemblies, thermal protection, scuba, flotation units, and compressors shall be inspected and determined to be in proper operating condition prior to each dive.

5.2.8.3 An adequate and appropriate primary and contingency air supply shall be available for the diving operation.

5.2.8.4 All hoses supplying the diver's life support equipment shall be protected against probable damage.

5.2.8.5 Except when heavy gear is worn or in scuba diving (not line tended), each diver shall wear a safety harness.

5.2.8.6 Adequate thermal protection provisions shall be

made to minimize body heat loss or gain during the dive.

5.2.8.7 A multi-lock decompression chamber capable of recompressing a diver at the surface to a minimum depth of 165 fsw shall be available at the dive location or within ~~2 hours~~ reasonable travel time from the dive location for:

5.2.8.7.1 Surface-supplied or scuba air dives to depths deeper than 130 fsw; and

5.2.8.7.2 Dives beyond the no-decompression limit.

8 Dives requiring

5.2.8.7.3 ~~If~~ stage decompression in excess of 30 minutes ~~is~~ shall required ~~unless~~ a decompression chamber ~~is~~ available and ready for use at the work site.

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5.2.8.8 Protective clothing shall be worn by divers whenever marine life, sharp objects, or abrasive surfaces present a potential hazard.

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5.2.8.9 Surface personnel shall wear approved personal flotation equipment, safety hats, and safety shoes whenever the nature of the operation demands.

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5.2.8.10 A sharp knife shall be carried by the diver either closed or in an appropriate scabbard at all times while in the water.

5.2.8.11 A safe means of entering and exiting the water appropriate to the dive platform, environmental conditions, and nature of the dive shall be provided.

5.2.9 Warning signal. An appropriate warning shall be displayed at the dive location in a manner which allows all-round visibility, and it shall be illuminated at night when divers are operating in areas capable of supporting marine traffic.

5.2.10 Diving station.

5.2.10.1 Adequate diving stations from which safe diving operations can be conducted shall be provided at the entry/exit location on all platforms, structures, or vessels used for diving operations.

5.2.10.2 Platforms, structures, or vessels used for diving operations shall be determined as adequate and safe by the designated person-in-charge.

5.3 Procedures during dive.

5.3.1 General. The employer shall comply with the following requirements which are applicable to each diving operation unless otherwise specified.

5.3.2 Water entry and exit.

5.3.2.1 A means capable of supporting the diver shall be provided for entering and exiting the water.

5.3.2.2 The means provided for exiting the water shall extend below the water surface.

5.3.2.3 A means shall be provided to assist an injured diver from the water.

5.3.3 Communications.

5.3.3.1 An operational diver - surface voice communications system shall be used for all surface-supplied dives.

5.3.3.2 An operation, two-way communication system shall be available at the dive location to obtain emergency assistance.

5.3.4 Overhead work and lifting operations.

5.3.4.1 For all lifting operations conducted while a diver is in the water, a workable communications system must be established between the dive team and the crane or winch operator.

5.3.4.2 The crane or winch operator shall accept instructions only from a designated person.

5.3.4.3 The diver in the water shall be advised prior to any movement of the load.

5.3.4.4 For all crane operations in which the diving team member giving instructions to the diver in the water is out of visual contact with the crane operator, and on all cranes of 100 tons or more capacity, an audio communications system shall be established between the two parties.

5.3.4.5 Under normal conditions, divers will not be required to dive is work is being performed by other personnel directly over the diver unless the dive team is satisfied that the overhead work does not pose a hazard.

5.3.5 In-water welding and burning.

5.3.5.1 Personnel designated to operate welding and burning equipment shall be properly instructed and familiar with all precautions necessary for safe in-water welding and burning.

5.3.5.2 A positive operating current supply switch to interrupt the current flow to the welding or burning electrode shall be:

5.3.5.2.1 Tended by a dive team member in voice communication with the diver performing the welding or burning; and

5.3.5.2.2 Kept in the open position except when the diver is welding or burning

5.3.5.2.3 Of adequate capacity to handle the maximum electrical current of the power supply and be enclosed to prevent electric shock to the operator.

5.3.5.3 The welding machine shall be grounded and a ground wire shall connect the machine directly to the work.

5.3.5.4 Welding and burning calbes, electrode holders, and connections shall be capable of carrying the maximum current required by the work, and shall be properly insulated.

5.3.5.5 Precautions shall be taken to prevent contact between power supply cables and welding cables in such a way as to create a potential short.

5.3.5.6 A.C. power supplies of less than 500 Hz output shall not be used for welding or burning.

5.3.5.7 Rubber gloves or other insulated gloves shall be used by divers performing welding and burning operations.

5.3.5.8 Welding and burning gas supplies.

5.3.5.8.1 Compressed gas cylinders shall be handled in accord with accepted safety procedures and properly secured to prevent damage to cyclinders and valves or injury to personnel.

5.3.5.8.2 Regulators shall be used only for the gas for which they were intended.

5.3.5.8.3 Regulators shall be maintained and tested by qualified personnel.

5.3.5.9 Prior to welding or burning on closed compartments, structures, or pipes which may contain a flammable or unknown vapor or in which a flammable vapor may be generated by the work, they shall be vented, flooded or purged with a mixture of gases which will not support combustion, except for hot tap operations.

5.3.6 Underwater electrical equipment.

5.3.6.1 When electrical apparatus is employed underwater which requires operating potential in excess of 36 volts, ground fault interrupters shall be installed, where practical, on the electrical supply circuit.

5.3.6.2 When technical considerations preclude the use of ground fault interrupters on underwater electrical circuits in excess of 36 volts, isolation transformers shall be installed on the electrical supply circuit.

5.3.7 Hand-held power tools and equipment.

5.3.7.1 Hand-held electrical tools and equipment shall be de-energized before being placed into or retrieved from the water.

5.3.7.2 Hand-held power tools shall not be supplied with power from the dive station until requested by the diver.

5.3.8 Explosives.

5.3.8.1 Explosives shall be handled only by specially qualified and appropriately licensed personnel.

5.3.8.2 Explosives shall be transported, stored, and used in accordance with this section and the applicable provisions of sections 1910.109 and 1926.912 of Title 29 of the Code of Federal Regulations.

5.3.8.3 Blasting caps shall not be connected to the primacord until the diver is out of the water.

5.3.8.4 Electrical continuity of explosive circuits shall not be tested until the diver is out of the water.

5.3.8.5 Explosives shall not be detonated while the diver is in the water.

5.3.9 Decompression tables. Decompression, repetitive, and no-decompression dive tables (as appropriate) shall be available at the dive station.

5.3.10 Dive profiles. A depth-time profile, including when appropriate, any breathing gas changes, shall be maintained for each diver during the dive including decompression.

5.3.11 Liveboating. Employers engaged in diving operations involving liveboating shall comply with the following requirements:

5.3.11.1 Limits. Diving operations involving liveboating shall not be conducted:

5.3.11.1.1 With an in-water decompression time of greater than 120 minutes;

5.3.11.1.2 In rough seas (~~beyond sea state 3~~ (wave height exceeding 3 feet));

5.3.11.1.3 In other than daylight hours; or

5.3.11.1.4 From a vessel of insufficient manueverability.

5.3.11.2 Procedures.

5.3.11.2.1 The propeller of the vessel shall be stopped before the diver enters or exits the water.

5.3.11.2.2 A device shall be used which minimizes the possibility of entanglement of the diver's hose in the propeller of the vessel.

5.3.11.2.3 Precautions shall be taken to properly lead the diver's hose away from the vicinity of the vessel's propellers and to prevent loss of the depth control in the event of loss of vessel control.

5.3.11.2.4 Two-way voice communication between the designated person-in-charge and the person controlling the vessel shall be available while the diver is in the water.

5.3.11.2.5 The tender shall be specifically qualified in liveboating tending.

5.3.11.2.6 A standby dive shall be available while a diver is in the water.

5.3.11.2.7 A self-contained emergency breathing air supply shall be carried by each diver engaging in liveboating operations.

5.3.11.2.8 The vessel operator shall be qualified to the satisfaction of the designated person-in-charge.

5.4 Post-dive procedures

5.4.1 General. The employer shall comply with the following requirements which are applicable after each diving operation, unless otherwise specified.

5.4.2 Precautions.

5.4.2.1 After the completion of any dive, the employer shall:

5.4.2.1.1 Check the physical condition of the diver;

5.4.2.1.2 Instruct the diver to report any physical problems or adverse physiological effects including symptoms of decompression sickness;

5.4.2.1.3 Advise the diver of the location of a decompression chamber which is ready for use; and

5.4.2.1.4 Alert the diver to the potential hazards of flying after diving.

5.4.2.2 A diver shall remain awake for at least one hour after completion of any dive.

5.4.2.3 For any dive beyond the no-decompression limits or deeper than 100 fsw, the employer shall instruct the diver to remain within access of a decompression chamber and competent operator for at least two hours following completion of the dive.

5.4.2.4 Flying after diving shall be limited to:

5.4.2.4.1 No flying for a minimum of 2 hours following a no-decompression dive providing that all dives performed in the previous 12 hours were also no-decompression dives.

5.4.2.4.2 A maximum of 800 feet altitude during the first 12 hours following a no-decompression dive.

5.4.2.4.3 No flying for a minimum of 24 hours following a decompression dive.

5.4.3 Record of dive

5.4.3.1 The following information shall be recorded and maintained for each diving operation pressure exposure by both the employer and the employee:

5.4.3.1.1 Name of dive team member including designated person-in-charge and member assignments;

5.4.3.1.2 Date, time, and location;

5.4.3.1.3 Diving modes and equipment used;

5.4.3.1.4 General nature of work performed;

5.4.3.1.5 Estimated underwater and surface conditions (visibility, water temperature, sea state, current, and atmospheric temperature and conditions);

5.4.3.1.6 Maximum depth and bottom time for each diver;

5.4.3.1.7 Repetitive dive group designations or time of last pressure exposure;

5.4.3.1.8 Any unusual conditions;

5.4.3.1.9 Signature of designated in charge; and

5.4.3.1.10 Employer's name and address.

5.4.3.2 For each dive beyond the no-decompression limit or deeper than 100 fsw, the following additional information shall be recorded and maintained:

5.4.3.2.1 Depth-time and breathing gas profiles;

5.4.3.2.2 Decompression tables designation (including modification, if any); and

5.4.3.2.3 Elapsed time since last pressure less than 24 hours or repetitive dive group designation for each diver.

5.4.3.3 For each dive in which decompression sickness is suspected or symptoms are evident, the following additional information will be recorded and maintained:

5.4.3.3.1 Description of decompression sickness symptoms (including depth and time of onset); and

5.4.3.3.1 Description and results of treatment.

5.4.4 Decompression procedure assessment. The employer shall:

5.4.4.1 Investigate and evaluate each incident of decompression sickness based on the recorded information, consideration of the past performance of the decompression schedule used, and individual susceptibility;

5.4.4.2 Take appropriate corrective action to reduce the probability of recurrence of decompression sickness; and

5.4.4.3 Prepare a written evaluation of the decompression procedure assessment, including any corrective action taken, within 45 days of the incident of decompression sickness.

SECTION 6: Self-Contained Air Diving

6.1 General. Employees engaged in scuba diving using compressed air breathing medium shall comply with the following requirements, unless otherwise specified.

6.2 Limits. Scuba diving shall not be conducted:

6.2.1 At depths greater than 190 fsw;

6.2.2 At depths greater than 130 fsw or beyond the no-decompression limits unless a decompression chamber is available and ready for use at the dive location or within ~~2 hours~~ reasonable travel time from the diving location; or

6.2.3 If stage decompression in excess of 30 minutes is required unless a decompression chamber is available and ready for use at the work location.

6.3 Equipment.

6.3.1 Scuba regulators shall comply with the following requirements:

6.3.1.1 All demand regulator components shall be of sufficient design and construction to operate at the maximum pressure of the cylinder unit on which the regulator is used.

6.3.1.2 All scuba regulators shall be inspected and designated satisfactory annually by an approved/ qualified person, or more frequently if the regulator is used for deep or unusual diving operations or exhibits signs of malfunction.

6.3.2 All scuba shall be equipped with a submersible pressure readout gauge. The submersible pressure gauge shall comply with the following requirements:

6.3.2.1 Be within ± 5% of full scale accuracy over the entire gauge pressure range;

6.3.2.2 Be equipped with a means of relieving internal case over pressure without explosively ejecting the gauge lens or bursting the case; and

6.3.2.3 The pressure hose shall not show signs of cuts or abrassions extending to the hose reinforcing brade and not leak air through the braid fiber.

6.3.3 All scuba shall include a low-pressure warning device or reserve breathing gas supply consisting of:

6.3.3.1 A manually activated reserve;

6.3.3.2 A submersible pressure gauge;

6.3.3.3 An independent reserve cylinder with separate regulator or connected to the breathing apparatus; or

6.3.3.4 An audible low-pressure warning mechanism; and

6.3.3.5 If the scuba is equipped with an integral low-pressure warning mechanism, the mechanism shall activate at a cylinder pressure of not less than 250 psig.

6.3.4 High-pressure cylinders used for scuba shall comply with the following:

6.3.4.1 Cylinders shall be designed, constructed, maintained, and stamped in accordance with the requirements of the U.S. Department of Transporation for transportable high-pressure cylinders (applicable provisions of 29 CFR, Sections 1910.166-171.

6.3.4.2 Scuba cylinders shall have safety relief devices in accordance with applicable Department of Labor and/or Department of Transportation specified safety codes.

6.3.4.3 Scuba cylinders shall be inspected internally and externally for rust, corrosion, and damage annually in accordance with C.G.A. Pamphlet C-6, and hydrostatically tested in accordance with DOT specifications every five years or more frequently if subjected to damage or signs of significant rust or corrosion are evident.

6.3.4.4 Scuba cylinders shall be inspected/tested by an approved/qualified person.

6.3.4.5 Scuba cylinders shall be stored in a ventilated area and protected from excessive heat.

6.3.4.6 Scuba cylinders shall be secured from falling.

6.3.5 An approved emergency gas inflatable, flotation device or buoyancy compensator shall be required for all scuba dives. Emergency flotation units shall comply with the following requirements:

6.3.5.1 Provide a minimum buoyancy of 25 lbs. when fully inflated at the surface;

6.3.5.2 Be gas tight and capable of holding a pressure of 2 psig for 2 hours when the over-pressure relief valve is blocked;

6.3.5.3 Be equipped with a device for manual inflation from a compressed gas supply and an oral inflation-deflation tube;

6.3.5.4 Be equipped with an over-pressure relief valve capable of relieving a fully inflated unit when released by itself from 33 fsw without sustaining structural damage to the unit;

6.3.5.5 Be so designed that it will turn an unconscious diver into a face-up position and support the head out of the water;

6.3.5.6 Be equipped with an inflation source separate from the breathing gas supply;

6.3.5.7 Be inflated by manual activation of the inflation system at least once every 6 months or 30 dives, whichever comes first, and must hold full inflation for 2 hours.

6.3.6 All depth gauges used for scuba shall be selected so that the maximum scale depth is at least 30 fsw in excess of the intended use depth. The depth indicator shall comply with the following requirements:

6.3.6.1 Each depth gauge shall comply with an accuracy of $\pm$ 1 percent of full scale depth at 20 fsw and not exceed $\pm$ 3 percent of full scale the maximum at maximum depth;

6.3.6.2 Each depth gauge shall be calibrated against a master reference gauge of ± .25% accuracy when new, every six months thereafter, and when there is a discrepancy greater than 2% of full scale between any two equivalent gauges.

6.3.7 All scuba used for dives in excess of 100 fsw, in enclosed or physically confining spaces, or around nets shall be equipped with an auxiliary breathing unit.

6.3.8 All scuba harnesses and weight belts shall be equipped with a quick release device which allows the scuba or weights to be rapidly jettisoned with either hand in an emergency, unless otherwise specified.

6.3.9 Scuba divers shall have a knife in their possession at all times while diving. The knife shall be carried in a suitable scabbard or in a closed position when not in use.

6.3.10 Air compressors and supply systems for charging scuba cylinders shall:

6.3.10.1 Air compressors shall be operated and maintained in accordance with the manufacturer's instructions and specifications unless such instructions or specifications shall result in infraction of the purity standards for breathable compressed air.

6.3.10.2 An operation and maintenance record shall be maintained for all compressors and shall include operating time, repairs, type and number of filters used, oil consumption and changes, filter replacements, air analysis and other pertinent details.

6.3.10.3 All pressure fittings, hoses, plumbing, and pressure system components shall comply with a maximum burst pressure rating specified as 4 times the maximum intended working pressure.

6.3.10.4 The air intake to the compressor shall be so located as to prevent contamination of the air by noxious gases or materials.

6.3.10.5 Filters and separators shall be incorporated into the diver air supply system to remove moisture, oil-mist, particulates, and noxious odors.

6.3.10.6 Respired air supplied to a diver shall not contain:

6.3.10.6.1 A level of carbon monoxide (CO) in excess of 20 ppm;

6.3.10.6.2 A level of carbon dioxide ($CO_2$) in excess of 1000 ppm;

6.3.10.6.3 A level of oil mist in excess of 5 milligrams per cubic meter;

6.3.10.6.4 Detectable gross moisture, dust, or particulates; and

6.3.10.6.5 A noxious or pronounced odor.

6.3.10.7 The output of air compressor systems shall be tested for carbon monoxide, odor, and oil droplets every six months or 25 hours of operation, whichever comes first, by means of samples taken at the connection to the distribution system, except that non-oil lubricated compressors need not be tested for oil mist.

6.3.10.8 Compressed gas cylinders shall:

6.3.10.8.1 Be designed, constructed and maintained in accordance with the appropriate provisions of 29 CFR, Sections 1910.166-171;

6.3.10.8.2 Be stored in ventilated area and protected from excessive heat;

6.3.10.8.3 Be secured from falling; and

6.3.10.8.4 Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifolded (scuba diving cylinders excluded).

6.4 Procedures

6.4.1 Self-contained divers shall use only open-circuit scuba and air or equivalent breathing media.

6.4.2 A scuba diver shall be accompanied by another diver in the water in continuous visual contact during the diving operation except as provided for below:

6.4.2.1 When visibility is limited and continuous visual contact is impossible, the divers shall be linked together by a short line; and

6.4.2.2 A single scuba diver may dive to a depth of 15 fsw using a surface-tended line providing that the water is clear enough for the diver to be seen from the surface at all times.

6.4.3 Surface tended scuba divers shall wear a safety harness with:

6.4.3.1 A positive buckling device; and

6.4.3.2 An attachment point for the surface tended line.

6.4.4 A depth indicator and watch/timing device shall be required for all scuba dives to depths exceeding 30 ~~50~~ fsw.

6.4.5 The scuba cylinder pressure shall be determined immediately before each dive.

6.4.6 The planned time of a scuba dive (including decompression) shall not exceed the gas supply duration of the apparatus in use, exclusive of reserves.

6.4.7 For any mid-water scuba dives where the bottom depth exceeds 130 feet, the diver must be equipped with a buoyancy compensator and a depth gauge and a marked line shall be suspended from a boat or surface float.

6.4.8 During open-sea or open-lake scuba dives (beyond normal swimmer distance from shore), a small boat shall tend the divers.

SECTION 7: Surface-Supplied Air Diving

7.1 General. Employers engaged in surface-supplied air diving shall comply with the following requirements, unless otherwise specified.

7.2 Limits. Surface-supplied air diving shall not be conducted:

7.2.1 At depths deeper than 190 fsw, except that dives with bottom times of 30 minutes or less may be conducted to depths of 220 fsw;

7.2.2 At depths greater than 130 fsw or beyond the no-decompression limits unless a decompression chamber is available and ready for use at the dive location or ~~within 2 hours~~ reasonable travel time from the diving location; or

7.2.3 If stage decompression in excess of 30 minutes is required unless a decompression chamber is available and ready for use at the work location.

7.3 Equipment.

7.3.1 Air compressor and supply systems

7.3.1.1 Compressors used to supply air to the diver must be independent of any other operation, unless an adequate contingency air supply is maintained under direct control of the diver's tenders.

7.3.1.2 The air supply system shall be of sufficient design and capacity to provide a minimum supply of 4.5 cfm measured at the diver's working depth.

7.3.1.3 The system shall supply air at a hose pressure of at least 50 psi over ambient pressure for dives to less than 100 fsw and 100 psi over ambient pressure for depths in excess of 100 fsw.

7.3.1.4 A compressor used to supply divers air shall be equipped with an air receiver or volume tank.

7.3.1.5 The air receiver or volume tank shall be equipped with a check valve on the inlet line, a pressure gauge, a pressure relief valve, and a drain valve.

7.3.1.6 Air receivers and volume tanks and safety relief devices used with compressed air systems shall conform to ASME and/or other required and applicable codes and certifications; they shall conform to U.S. Coast Guard specifications and be so certified when used on job sites within U.S.C.G. jurisdiction.

7.3.1.7 All pressure fittings, hoses, plumbing, and pressure system components shall comply with a maximum burst pressure rating specified as 4 times the maximum intended working pressure.

7.3.1.8 Air compressors shall be operated and maintained in accordance with the manufacturer's instructions and specifications unless such instructions or specifications shall result in infraction of the purity standards for breathable compressed air.

7.3.1.9 An operation and maintenance record shall be maintained for all compressors and shall include operating time, repairs, type and number of filters used, oil consumption and changes, filter replacements, air analysis and other pertinent details.

7.3.1.10 The air intake to the compressor shall be so located as to prevent contamination of the air by noxious gases or materials.

7.3.1.11 Filters and separators shall be incorporated into the diver air supply system to remove moisture, oil-mist, particulates, and noxious odors.

7.3.1.12 Respired air supplied to a diver shall not contain:

7.3.1.12.1 A level of carbon monoxide (CO) in excess of 20 ppm;

7.3.1.12.2 A level of carbon dioxide ($CO_2$) in excess of 1000 ppm;

7.3.1.12.3 A level of oil mist in excess of 5 milligrams per cubic meter;

7.3.1.12.4 Detectable gross moisture, dust, or particulates; and

7.3.1.12.5 A noxious or pronounced odor.

7.3.1.13 The output of air compressor systems shall be tested for carbon monoxide, odor, and oil droplets every six months or 50 hours of operation, whichever comes first, by means of samples taken at the connection to the distribution system, except that non-oil lubricated compressors need not be tested for oil mist.

7.3.1.14 When air for surface-supplied diving is supplied from a high-pressure cylinder system, the volume of air contained must be sufficient to complete the dive with a minimum of 30% safety factor without requiring recharge.

7.3.1.15 For any surface-supplied dive, a secondary supply of sufficient capacity to complete the diver's decompression must be available at the surface to be used in event of the failure of the primary supply.

7.3.1.16 Compressed gas cylinders shall:

7.3.1.16.1 Be designed, constructed and maintained in accordance with the appropriate provisions of 29 CFR, Sections 1910.166-171;

7.3.1.16.2 Be stored in a ventilated area and protected from excessive heat;

7.3.1.16.3 Be secured from falling; and

7.3.1.16.4 Have shut-off valves recessed into the cylinder or protected by a cap, except when in use or manifolded (scuba diving cylinders excluded).

7.3.2 Helmets and masks shall comply with the following requirements:

7.3.2.1 Helmets and masks shall be used in accord with the limitations specified by the manufacturer of the equipment unless the equipment is tested under new conditions in a manner equal to or more rigid than performed by the manufacturer.

7.3.2.2 Helmets and masks shall be equipped with non-return valves made of materials resistant to corrosion in sea water between the air supply hose and the helmet or mask to prevent sudden loss of air pressure if the hose is severed.

7.3.2.3 All control, non-return, and exhaust valves in the diving unit when properly supplied and used in accord with the manufacturer's specifications shall be capable of passing air at a rate of 4.5 acfm.

7.3.2.4 Helmets and mask except for oral-nasal masks, shall have a minimum ventilation rate capability of 4.5 acfm at any depth at which they are operated.

7.3.2.5 Helmets and masks attached directly to "dry-type" diving dress shall be equipped with manually operated exhaust valves to facilitate rapid discharge of air in order to minimize the possibility of blow-up.

7.3.2.6 All modifications which may affect the performance of the helmet or mask must be approved by the employer or the manufacturer of the equipment prior to use and verified by tests equal to or more rigid than those performed by the manufacturer.

7.3.2.7 Helmets and mask shall be equipped with reliable surface-diver oral communications equipment.

7.3.3 Dive air supply hoses and umbilical assembly

7.3.3.1 Breathing air hoses shall:

7.3.3.1.1 Have a bursting pressure at least equal to 4 times the working pressure;

7.3.3.1.2 Have a minimum working pressure of 100 psig plus the maximum ambient pressure at the depth of the dive;

7.3.3.1.3 Be of a size capable of the required flow rates for the system or equipment used;

7.3.3.1.4 Be kink resistant;

7.3.3.1.5 Be marked with a serial number for record purposes;

7.3.3.1.6 Be taped, capped, or plugged when not in use to eliminate the possibility of foreign material entering the hose.

7.3.3.2 Hose fittings shall:

7.3.3.2.1 Be constructed of sea water corrosion resistant materials;

7.3.3.2.2 Have connections of a type that are resistant to accidental disengagement from the compressor or air source;

7.3.3.2.3 Be attached to the hose with clamps or devices that are constructed of sea water resistant materials and that can not be accidentally loosened;

7.3.3.2.4 Be capable of sustaining a 200 lb tensile load on the hose attached to the fitting without showing signs of slippage; and

7.3.3.2.5 Have a working pressure at least equal to the working pressure of the hose to which they are attached.

7.3.3.3 Umbilical assemblies shall:

7.3.3.3.1 Be marked at 10 foot intervals to a length of 100 feet beginning at the diver's end and at 50 foot intervals thereafter;

7.3.3.3.2 Be constructed of kink-resistant components;

7.3.3.3.3 Include a pneumofathometer hose when used for diving in excess of 30 fsw;

7.3.3.3.4 Be fitted with a device for attaching the assembly to the diver's harness.

7.3.3.4 Umbilical assembly inspection and testing shall include:

7.3.3.4.1 Visual inspection for abrasion of the outer cover, exposed reinforcement, fitting slippage or misalignment, fitting damage, fitting corrosion shall be performed prior to each diving day and following exposure to unusual stresses or abuse.

7.3.3.4.2 Pressure testing of breathing air hoses at least once annually to the rated working pressure.

7.3.4 Gauges and timekeeping devices

7.3.4.1 Gauges indicating diver depth which can be read at the dive station shall be used for all dives greater than 30 fsw.

7.3.4.2 All gauges used to determine diver's depth shall have at least a ± 1% of full scale accuracy.

7.3.4.3 Each depth gauge shall be dead weight tested or calibrated against a master reference gauge every six months or when there is a discrepancy greater than 2% of full scale between any two equivalent gauges.

7.3.4.4 A timekeeping device shall be available at each dive station.

7.3.5 Weights and harness

7.3.5.1 Except when heavy gear (deep sea diving outfit) is worn, divers shall be equipped with a weight belt or assembly capable of quick release designed to prevent accidental release.

7.3.5.2 Except when heavy gear (deep sea diving outfit) is worn, each diver shall wear a safety harness with:

7.3.5.2.1 A positive buckling device;

7.3.5.2.2 An attachment point for the umbilical assembly to prevent strain on the mask or helmet;

7.3.5.2.3 A lifting point to distribute the pull force of the line over the diver's body.

7.3.5.2.4 Capability to withstand a minimum of 500 lbs linear pull.

7.3.6 Buoyancy control equipment.

7.3.6.1 A dry suit or other buoyancy changing equipment not directly connected to the helmet or mask shall be equipped with an exhaust valve.

7.3.6.2 Exhaust valves used on buoyancy control equipment must be capable of exhausting the full volume of the suit or vest plus 10% during an ascent rate of 60 fpm.

7.3.7 Self-contained emergency air supply systems.

7.3.7.1 Self-contained emergency air supply systems shall be of a capacity sufficient to provide at least 5 minutes at working depth and must function independent of surface control or surface reserve supply.

7.3.7.2 The first stage of regulators attached to on-off valves on masks or helmets shall be equipped with an over-pressure relief valve.

7.4 Procedures.

7.4.1 The minimum personnel requirements for surface-supplied air diving are as follows, unless otherwise specified:

7.4.1.1 One diver and one tender shall be required for dives to 100 fsw or less.

7.4.1.2 A standby diver and tender shall be required for dives to depths greater than 100 fsw or beyond the no-decompression limits.

7.4.2 A diver shall be stationed at the underwater entry point when diving is conducted in enclosed or physically confining spaces.

7.4.3 For dives deeper than 60 fsw or beyond the no-decompression limits:

7.4.3.1 A secondary surface air reserve shall be provided which will insure the diver of a minimum of 5 minutes continuous operation at working depth in

the event of primary supply failure.

7.4.3.2 The diver shall be equipped with a self-contained reserve air supply which will provide 5 minutes of air at working depth, except when heavy gear is worn.

7.4.4 Except when heavy gear is worn, a self-contained air supply shall be carried by the diver whenever the configuration of the dive prevents ascending directly to the surface.

7.4.4.1 The self-contained air supply shall be of sufficient capacity to permit exit from the structure and completion of decompression.

7.4.5 For heavy gear diving deeper than 100 fsw or beyond the no-decompression limits:

7.4.5.1 An extra breathing air hose capable of supplying air to the diver in the water shall be available to the standby diver.

7.4.5.2 An in-water stage shall be provided to divers in the water.

7.4.6 Satisfactory surface-diver voice communication shall be provided for all surface-supplied dives.

7.4.6.1 A standby communication system shall be available for dives deeper than 100 fsw and beyond the no-decompression limits.

7.4.7 A protective hard-hat type safety helmet shall be worn by divers using a mask where overhead hazards or obstructions are evident.

## SECTION 8: Decompression Chambers

8.1 Decompression chamber design and construction.

8.1.1 Decompression chambers manufactured after the effective date of this standard shall be constructed in accordance with applicable ASME Unfired Pressure Vessel Codes.

8.1.2 Decompression chambers used on vessels and structures within U.S. Coast Guard jurisdiction shall be U.S.C.G. certified and shall be tested and inspected as required by the jurisdictional authority.

8.1.3 Except for small portable emergency chambers a decompression chamber shall:

8.1.3.1 Have a minimum inside diameter of 48 inches except existing chambers with a minimum diameter of 40 inches may be used until 1982;

8.1.3.2 Have at least two compartments or locks designed so as to permit transfer of personnel and supplies to the outside while the main compartment remains pressurized;

8.1.3.3 Accommodate more than one person; and

8.1.3.4 Be capable of recompressing the diver at the surface to a minimum depth equivalent of 165 fsw.

8.1.4 Piping, tubing, and fittings shall comply to the following unless otherwise specified:

8.1.4.1 All permanently installed piping or tubing shall have a design bursting pressure of at least 4 times the working pressure.

8.1.4.2 Each chamber compartment shall be equipped with appropriate valves to enable the outside attendant to control the supply and discharge of compressed air and oxygen.

8.1.4.3 Chamber piping and valves shall be so located as to provide adequate ventilation and eliminate dead air spaces.

8.1.4.4 The inner compartment or working compartment of the chamber shall be fitted with an emergency safety pressure relief device which may be activated by the compartment occupants in event of overpressurization or disability of the outside attendants. The uses of automatic pressure relief devices is optional.

8.1.4.5 The inner compartment or working compartment of the chamber shall be fitted with an emergency safety pressure relief device to prevent damage from over pressurization.

8.1.4.6 Internal exhaust outlets shall be fitted with an antisuction device or positioned to prevent suction of hands or materials into the exhaust system.

8.1.4.7 Air pressurization line outlets inside the chamber and exhaust lines inside and outside the chamber shall be equipped with noise muffling devices.

8.1.5 Oxygen piping and fittings shall conform to the following requirements unless otherwise specified:

8.1.5.1 Equipment used with oxygen or mixtures containing more than 40% oxygen by volume shall be designed for oxygen service.

8.1.5.2 Components exposed to oxygen or mixtures containing more than 40% oxygen by volume shall be cleaned of flammable materials before use.

8.1.5.3 Hard piping, fittings, and tubing in oxygen service shall be of corrosion resistant materials.

8.1.5.4 Oxygen systems over 125 psig shall have slow-opening type on-off valves.

8.1.6 Each decompression chamber shall be equipped with:

8.1.6.1 Each compartment of the chamber shall be equipped with a view port at least 4 inches in diameter located in such a position so as to permit observation of all occupants from the outside.

8.1.6.2 Each chamber compartment shall be fitted with an externally mounted depth indicator (gauge) visible at the operating station.

8.1.6.3 The inner or working compartment of the chamber shall be equipped with a depth indicator (gauge) visible to the occupants.

8.1.6.4 An effective means of oral communication shall be provided between the outside attendant and the occupants of the chamber.

8.1.6.5 A means to maintain the atmosphere below a level of 25% oxygen by volume.

8.1.6.6 A built-in breathing system with a minimum of one mask per occupant.

8.1.6.7 Illumination capability to light the interior.

8.1.6.8 A means for extinguishing fire.

8.1.7 Fire prevention measures shall include:

8.1.7.1 Equipment, fixtures and furnishings used inside hyperbaric chambers shall be constructed of non-combustible materials when possible.

8.1.7.2 Chamber lighting equipment shall be designed to eliminate possibility of electrical malfunction leading to ignition of components or chamber atmosphere contamination.

8.1.7.3 Only fire retarding paint shall be used on the interior of the chamber.

8.1.7.4 Combustible accessory equipment used in decompression chambers shall be kept to an absolute minimum.

8.2 Decompression chamber pressurization and ventilation system.

8.2.1 The primary pressurization system for a hyperbaric chamber shall be of sufficient capacity to allow pressurization to a depth of 33 fsw within one minute under actual working conditions.

8.2.2 The system shall be capable of ventilation at a rate of 4 acfm per occupant at depth in an air breathing atmosphere.

8.2.3 A chamber used for pressurizing personnel shall have tow independent and separate sources of air. One air source shall be independent of primary electrical power. The secondary source may consist of a low pressure air compressor powered by an internal combustion engine or generator system or ahigh pressure air storage system.

8.2.4 An emergency or secondary system shall be of sufficient capacity to pressurize the chamber to 165 fsw and ventilate the chamber for 1 hour in accord with the specified minimum ventilation rates for one patient and one attendant.

8.2.5 The emergency or secondary air supply system shall be periodically activated to insure workability of the equipment in an emergency. The pressure of the high pressure storage system shall be periodically checked and must be retained within 10% of the total capacity of the sytem.

8.2.6 The air intake of compressors used for pressurizing and ventilating hyperbaric systems shall be maintained in the same fashion prescribed for diving compressors.

8.2.7 Hyperbaric chamber air supplies shall be periodically analyzed to insure that the air is within the limits designated for diving in this standard

and a record shall be maintained of all tests.

8.3 Decompression chamber maintenance.

8.3.1 Hyperbaric chambers shall be maintained free of refuse, discarded materials, grease, dirt and unnecessary equipment at all times.

8.3.2 Chamber depth indicators (gauges) shall be dead weight tested or calibrated against a master reference gauge every 6 months, whenever the chamber is moved, or whenever a malfunction is suspected and calibration sheets shall be maintained on file and correction tags or labels attached to the gauge.

8.4 Treatment tables, treatment gas appropriate to the diving mode, appropriate first aid supplies and timekeeping devices shall be available at the chamber station.

SECTION 9: Recordkeeping Requirements

9.1 Personnel records. Personnel records shall be maintained by the employer.

9.1.1 Personnel records shall contain the following information:

9.1.1.1 Complete personal and employment history of all divers and diving support personnel.

9.1.1.2 Technical training records including:

9.1.1.2.1 Federal service qualification certificates;

9.1.1.2.2 Diving school certificate of completion; and/or

9.1.1.2.3 Employer training program completion statements or equivalent of proof of competency.

9.1.1.3 Field experience records including:

9.1.1.3.1 Employment records;

9.1.1.3.2 Written statements from other employers;

9.1.1.3.3 Written statements from commanding officers or diving officers;

9.1.1.3.4 Field operation records; and/or

9.1.1.3.5 Individual personal diving records.

9.1.1.4 Proficiency dive records including:

9.1.1.4.1 Company field operations records; and/or

9.1.1.4.2 Federal service operations records.

9.1.2 Personnel records shall be retained for a minimum period of 5 years after termination of employment.

9.2 Medical records.

9.2.1 The examining physician shall provide a complete report of the medical examination and associated tests to the employer.

9.2.2 The medical records shall be retained by the employer for a minimum of 5 years.

9.3 Diving records (Section 5.4.3) shall be retained by the employer for a minimum of 1 year, except 5 years where there has been an incident of decompression sickness.

9.4 Decompression procedure assessment evaluations shall be retained by the employer for 5 years.

9.5 Diving equipment inspection, testing, maintenance, and repair records shall be retained in accord with the following unless otherwise specified:

9.5.1 Helmets and masks.

9.5.1.1 Specification and test procedures supplied by the manufacturer shall be maintained on file for each unit.

9.5.1.2 A record of all test, modifications, and maintenance shall be maintained for each unit.

9.5.2 Pressure test records shall be maintained for all breathing air hoses and fittings (Section 7.3.3.4.2).

9.5.3 Records shall be maintained on all compressors maintenance and repairs (Section 7.3.1.9).

9.5.4 Records shall be maintained on all gauge calibrations and correction tags attached to the gauge (Section 7.3.4.3 and 6.3.6.2).

9.5.5 Records of all decompression chamber pressurizations, maintenance, tests and repairs shall be maintained for a minimum of 5 years.

9.6 Accident recording and reporting.

9.6.1 The employer shall record and report occupational injuries and illinesses in accordance with requirements of 29 CFR Part 1904.

9.6.2 The employer shall record the occurence of any diving related illness which requires any dive team member to be hospitalized for 24 hours or more, specifying the circumstances of the incident and the extent of the injuries or illnesses.

9.6.3 Records of hospitalization shall be retained for five years.

9.7 Availability of records.

9.7.1 Upon the request of the Assitant Secretary of Labor for Occupational Safety and Health, or the Director, National Institute for Occupational Safety and Health, Education and Welfare or their designees, the employer shall make available for inspection and copying any record or document required by this standard.

9.7.2 Upon request of any employee, former employee or authorized representative, the employer shall make available for inspection and copying any record or document required by this standard which pertains to the individual employee or former employee.

~~9.7.3~~ After the expiration of the retention period of any record required to be kept for 5 years, the employer shall forward such records to the National Institute for Occupational Safety and Health, Department of Health, Education, and Welfare.

~~9.7.4~~ 3 In the event the employer ceases to do business:

~~9.7.4.1~~ The successor employer shall receive and retain all dive and employee medical records required by this standard; or

~~9.7.4.2~~ If there is no successor employer, dive and employee medical records shall be forwarded to the National Institute for Occupational Safety and Health, Department of Health, Education and Welfare.

# APPENDIX A

## CONDITIONS WHICH RESTRICT OR DISQUALIFY AN INDIVIDUAL FOR DIVING AND EXPOSURE TO HYPERBARIC CONDITIONS

The following disorders are considerd as a basis for absolute disqualification for occupational exposure to diving or hyperbaric conditions:

- Epileptiform disease.
- Chronic inability to equalize sinus and/or middle ear spaces.
- Cystic, obstructive, cavitary, or restrictive disease of the lungs.
- Seriously impaired pulmonary function.
- Significant central nervous system disease.
- Cardiac adnormalities (e.g. pathological heart block, valvular disease, intraventricular conduction defects other than isolated right bundle branch block, angina pectoris, arrhythmia, coronary artery disease).
- Malignancies (active) unless treated and without recurrence for 5 years.
- Psychotic disorders.
- Chronic alcoholism.
- Drug addiction.
- Significant hemoglobinopathies.

The following conditions or disorders may restrict, limit, or disqualifiy an individual for occupational exposure to hyperbaric conditions depending upon severity, presence of residual effects, response to therapy, number of occurences, diving mode, or degree or duration of isolation:

Diabetes.

Obesity.

History of serious neurological decompression sickness.

Conditions requiring continuous medication for control.

Frequent fainting spells.

Peptic ulcer disease.

Visual acuity deficits.

History of seizure disorder other than early febrile convulsions.

Pregnancy.

The following conditions or disorders may be a basis for temporary restriction or disqualification from occupational diving or exposure to hyperbaric conditions:

Acute alcoholism and/or drug intoxication.

Acute gastrointestinal syndrome.

Acute infections (e.g. skin, upper respiratory, ear).

Recent incident of decompression sickness or pulmonary barotrauma.

Perforated typmpanic membrane.

# APPENDIX B

## COMMERCIAL DIVING OPERATIONS
## OCCUPATIONAL SAFETY AND HEALTH REQUIREMENTS
## PART 1910 of Title 29 of
## the Code of Federal Regulations,
## Subpart T