

Pressure Related Incidence Rates in Scientific Diving

Michael R. Dardeau¹ and Christian M. McDonald²

¹ Dauphin Island Sea Lab, Dauphin Island, AL 36528, USA; mdardeau@disl.org

² Scripps Institute of Oceanography, La Jolla, CA 92093, USA; cmcdonald@ucsd.edu

Abstract

In 1982 the US Occupational Safety and Health Administration (OSHA) examined records of scientific divers and, based on their finding of an exemplary safety record resulting from self-regulation, partially exempted scientific diving from the strict control placed on commercial diving activities. A retrospective examination of recent scientific diving statistics and incident reports was undertaken to determine if the original reasoning behind the partial exemption is still valid. Available data going back to 1998 indicated a total injury incident rate per 100 workers comparable to the earlier OSHA study.

Introduction

Training of scientists to use SCUBA as a research tool began in the early 1950s at Scripps Institute of Oceanography and spread to many other research programs in the ensuing decades (Hanauer, 2003). The scope of scientific diving may range from simple observations to use of sophisticated technology (Sommers, 1988; Hicks, 1997; Sayer, 2005) but most agree that perceived hazards may include cold and arduous dives, task loading and time at depth limitations. Given the potential for workplace injury, in 1977, the US Occupational Safety and Health Administration (OSHA) established mandatory occupational safety and health standards for commercial diving operations (29 CFR Part 1910, Subpart T - Commercial Diving Regulations). Because scientific diving was not specifically exempted from these regulations, OSHA was requested by academic organizations involved in diving to consider an exemption, based on effective self-regulation, for diving performed for research purposes (Butler, 1996). OSHA examined the safety records of science diving programs, conducted hearings regarding the safety of scientific diving and concluded in 1982 that, because of an exemplary safety record, a partial exemption was warranted (Federal Register, 1982). Scientific diving has since grown to encompass more than 100,000 dives per year. To determine if the original reasoning behind the partial exemption is still valid, a retrospective evaluation of scientific diving statistics from 1998 to 2005 was undertaken.

Methods

The by-laws of the American Academy of Underwater Sciences (AAUS) contain a provision requiring organizational members to submit statistical summaries of the number of dives and divers, the mode of diving and any incidents associated with scientific diving at intervals (typically annual) specified by the Academy. Although incident types (hyperbaric, near drowning, etc.) are defined, incident itself is not, leaving the diving safety officer (DSO) to determine whether or not to report. For the past eight years, these statistics have been collected in an identical manner and stored to a database. Review of the statistics for quality assurance purposes revealed that comparisons to the OSHA review of scientific diving safety from 1965-1981 were possible.

To evaluate scientific diving safety, OSHA calculated an annual incidence rate for pressure related injuries in their Final Ruling (Federal Register, 1982) using a formula that is still used by the Bureau of Labor Statistics (BLS) today:

$$(N/EH) \times 200,000 = \text{incidence rate per 100 full-time workers where--}$$

N = number of injuries and illnesses (including deaths) or lost workdays

EH = total hours worked by all employees during calendar year

$200,000$ = base for 100 full-time equivalent workers (working 40 hours/week, 50 weeks/year)

The AAUS database was employed to calculate an incidence rate for pressure related injuries for each year from 1998 to 2005.

Results

Summaries of the annual diving activity by AAUS members from 1998-2005 are shown in Table 1. Number of scientific dives increased from a low of 69,520 in 1999 to a peak of 124,722 in 2005. Number of incidents ranged from 3 to 17, averaging 8.4 per year. Pressure related incidents ranged from 2 to 13, averaging 6 per year.

Table 1. Summary of annual diving activity by AAUS organizational members from 1998-2005.

	1998	1999	2000	2001	2002	2003	2004	2005
Organizational Members Reporting	55	57	61	70	70	80	89	90
# of dives	71,042	69,520	77,368	90,644	100,989	108,702	123,103	124,722
# of divers	2,997	2,816	2,728	3,200	4,015	3,770	3,967	3,984
Total # of incidents (# pressure related)	5 (3)	11 (8)	9 (8)	8 (5)	17 (13)	9 (5)	3 (2)	5 (5)

Each of the incidents reported between 1998 and 2005 was included in Figure 1. The only criterion for inclusion was that a diver or a DSO thought it necessary to file an incident report. About half the total of 67 incidents reported were thought to be some form of decompression illness. Sinus/ear barotrauma involved mostly minor incidents, some not even requiring first aid. Environmental trauma included bites, stings, shocks and injuries from contact with rigs or rocks. The other category included no injury, anxiety, shallow water blackout, foreign object in the ear, hypothermia and other infrequent occurrences. Neither the environmental trauma nor the other category was included in the calculation of the incidence rate.

A survey of 88 organizations within the scientific diving community contracted by OSHA estimated a diving population of 5,441 with a total of 39 pressure related incidents in the period between 1965 and 1981 (Federal Register, 1982; Sharkey and McAniff, 1984). Making various assumptions about the number of divers and the number of incidents per year, OSHA calculated incidence rates ranging from 0.04-1.66 per hundred divers per year (Table 2).

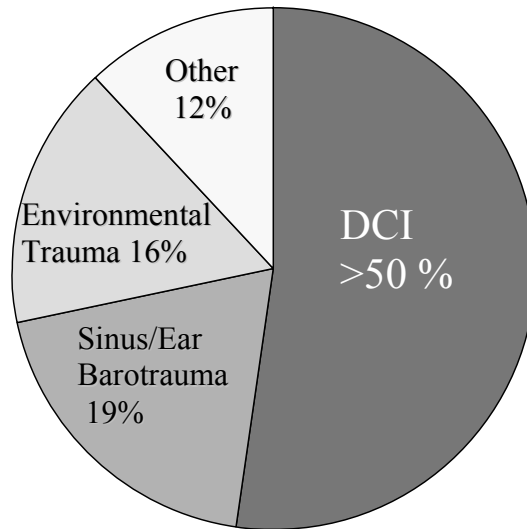


Figure 1. Types of incidents reported, n=67 (DCI, n=35; Sinus/Ear barotrauma, n=13; Environmental trauma, n=11; Other, n=8).

Table 2. Incidence rates calculated by OSHA for scientific diving from 1965-1981 (Federal Register, 1982).

Assumptions	Calculation	Incidence Rate
All 39 incidents in one year	$(39/(5441 \times 2000)) \times 200,000$	0.7
All incidents attributable to an early 1970s estimate by NOAA of a diving population of 2,340 divers in one year	$(39/(2340 \times 2000)) \times 200,000$	1.66
All incidents averaged over 15 years using 2,340 divers	$(2.6/(2340 \times 2000)) \times 200,000$	0.1
All incidents averaged over 15 years using 5,441 divers	$(2.6/(5441 \times 2000)) \times 200,000$	0.04

OSHA also noted that these values compared favorably with BLS rates from other industries. Incidence rates for AAUS divers and BLS statistics for 1998-2005, as well as the baseline 1979 OSHA numbers, are shown in Table 3.

Table 3. Total injury incidence rates for AAUS diving and various Bureau of Labor Statistics industry summaries. Rates from 1979 are from (Federal Register, 1982) and industry rates from 1998-2005 are from www.bls.gov

	1979	1998	1999	2000	2001	2002	2003	2004	2005
AAUS Diving	0.04-1.66	0.07	0.28	0.29	0.16	0.32	0.13	0.05	0.13
Construction	16.2	8.7	8.4	8.2	7.8	7.1	6.8	6.4	6.3
Transportation		7.0	7.0	6.7	6.6	6.1	7.8	7.3	5.2
Ag, Forestry and Fishing		6.2	7.0	6.8	7.0	6.4	6.2	6.4	6.1
Wholesale		6.3	6.0	5.8	5.4	5.3	4.7	4.5	4.5
Finance	1.7	1.7	1.6	1.6	1.5	1.7	1.7	1.6	1.7
Manufacturing	13.3	8.5	8.0	7.8	7.0	7.2	6.8	6.6	6.3
Mining	11.4	4.7	4.1	4.6	3.9	4.0	3.3	3.8	3.6
Service		4.9	4.6	4.6	4.4	4.6	2.5	2.4	2.4

Discussion

The use of scientific diving by researchers between 1998 and 2005 is higher than levels of annual activity in the seventies estimated by OSHA. The average number of incidents reported per year is also higher than during that period. Incidence rates among AAUS institutions between 1998 and 2005, however, remained within the 0.04-1.6 range calculated by OSHA for the late seventies. Some of the apparent increase in both divers and incidents is, unquestionably, a function of more and better record keeping resulting from participation in AAUS. Increased emphasis on reporting symptoms as a result of training also probably contributed to some of the incidents reported. Many of these incidents did not meet the OSHA criteria for inclusion (injuries and illnesses that result in days away from work, restricted work or transfer to another job, medical treatment beyond first aid and loss of consciousness) but were included to avoid underestimating the incidence rate.

Despite the obvious increase over time in the numbers of AAUS individuals and organizations reporting dives, many agencies and organizations conducting scientific diving under the OSHA partial exemption do not report to AAUS. For example, NOAA conducted 208,459 scientific dives between 1981 and 2004 (Dinsmore and Vitch, 2005) and the Alaska Department of Fish and Game made over 10,933 dives between 1990 and 2000 (Pritchett, 2001). Clearly, the 766,090 dives reported to AAUS between 1998 and 2005 were not the only scientific dives being performed during that period.

The operational definition of scientific diving adopted by OSHA implies oversight of the diving activity. The partial exemption specifies a diving safety manual detailing operational procedures and a diving control board to approve and monitor diving projects (Butler, 1996). The medical, training and operational standards specified by AAUS exceed those detailed by OSHA and include record keeping requirements, diving under the supervision of a diving safety officer, and advanced training in rescue, CPR, first aid and oxygen administration. They distinguish scientific diving from recreational diving and are generally considered the standard of practice for scientific diving in the U.S. (Lang, 2003). It is clear that self-regulation and oversight of diving activity within the scientific community has effectively maintained the incidence rate at levels considered acceptable by OSHA when granting the partial exemption for scientific diving operations.

Acknowledgments

Thanks to all the divers and DSOs dedicated to safe scientific diving who turned in over three quarters of a million dive records and to AAUS for allowing the use of them.

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