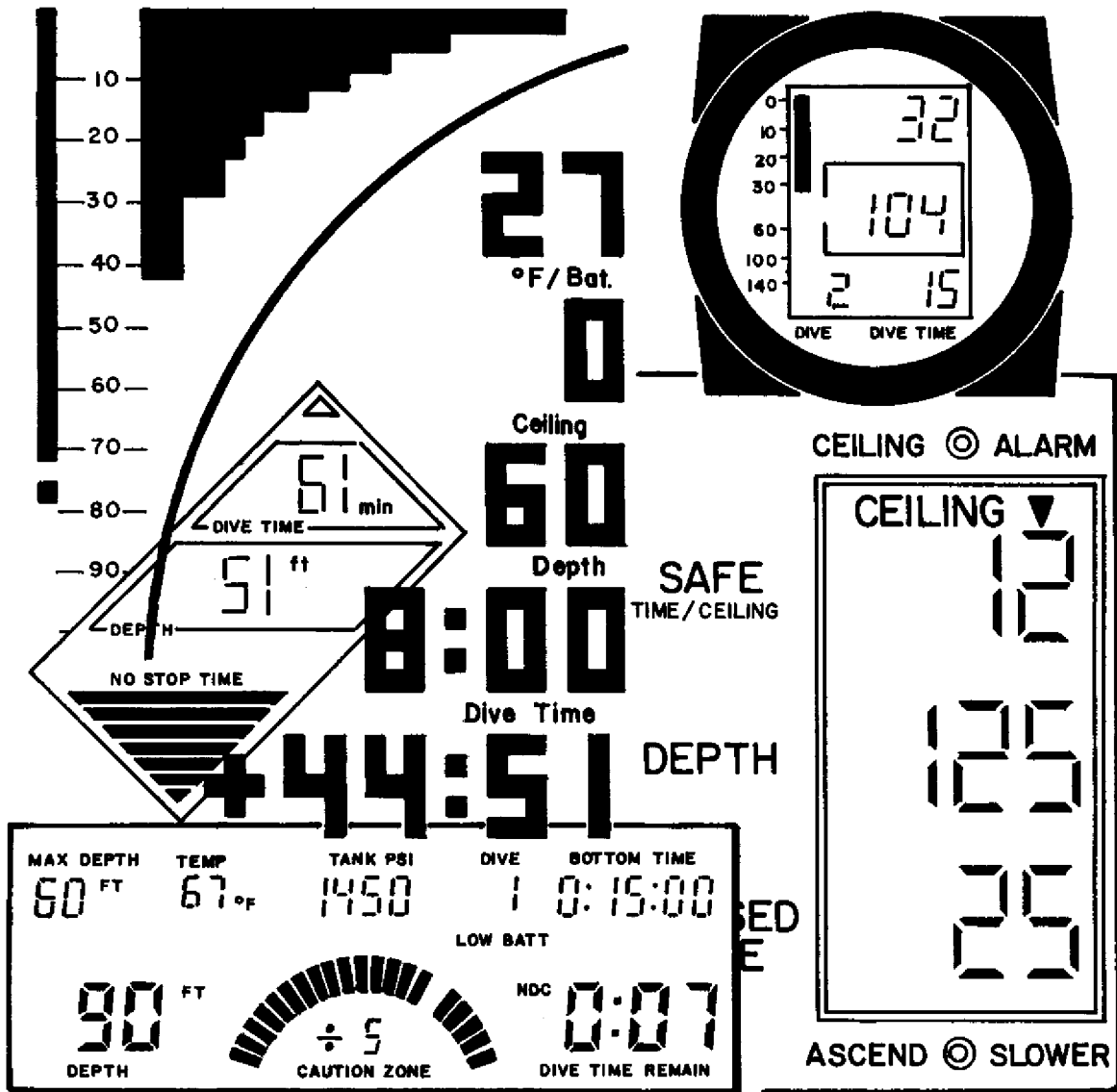


PROCEEDINGS OF DIVE COMPUTER WORKSHOP

PROCEEDINGS COPY



THE AMERICAN ACADEMY OF UNDERWATER SCIENCES

SEPTEMBER 26 TO 28, 1988

USC CATALINA MARINE SCIENCE CENTER
SANTA CATALINA ISLAND, CALIFORNIA

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**PROCEEDINGS OF THE
AMERICAN ACADEMY OF UNDERWATER SCIENCES
DIVE COMPUTER WORKSHOP**

September 26-28, 1988

U.S.C. Catalina Marine Science Center
Santa Catalina Island, California

MICHAEL A. LANG

R. W. HAMILTON

Editors

American Academy of Underwater Sciences
947 Newhall Street, Costa Mesa, California 92627 U.S.A.

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PREFACE

These proceedings contain twenty-three invited papers, presented at the American Academy of Underwater Sciences Dive Computer Workshop, September 26 -28, 1988, at the U.S.C. Catalina Marine Science Center. This workshop was one of several held in conjunction with the 8th Annual AAUS Scientific Diving Symposium "*Advances in Underwater Science...1988*". In addition to the invited papers, personal experiences and perspectives were presented, dive computer manufacturers offered a hands-on opportunity to acquaint the workshop with the various units, and the discussions and recommendations throughout the workshop were recorded, transcribed and edited. It was the goal of the Academy, with support from the California Sea Grant College Program and the U.S.C. Sea Grant Institutional Program, to bring together scientists, manufacturers and knowledgeable members of the various sectors of the international diving community, to provide the opportunity for sharing objective information and scientific data on dive computers and their use.

The need for an objective, scientific examination on the applicability of these dive computers to the scientific diving community's needs was met by this panel of experts and knowledgeable participants. This workshop came at the very opportune point in time when the proliferation of dive tables and decompression devices left the entire diving community with several fundamental questions regarding the issues of diving, physiology and decompression.

The invited speakers were requested to provide their papers by the time of the Workshop. In addition to a hard copy, the papers were to be on computer disk. This was complied with reasonably well, and the remaining few were obtained after the workshop. We then edited and printed the papers in a uniform format. We did not have access to a court reporter to transcribe the proceedings, so we elected to do the best we could to summarize the important parts of the discussions, with as much rationale and opinion as we could reasonably include. The discussions are inserted at the end of each session. This method means that we have no doubt overdone the matter of condensing, and because much of this had to be taken from a remote microphone in a noisy room we have no doubt attributed some comments to the wrong people, have missed some gems, and have misinterpreted others. We take full blame for this, and apologize to any that may be offended and to the readers for any minor inaccuracies. We do feel that what we have here reflects the mood, if not always the consensus, of the participants.

For consistency throughout this document, the workshop participants agreed to refer to these electronic devices as "Dive Computers" or DC's, which was then substituted in these transcripts in lieu of the myriad of other existing acronyms and terms.

Though it was the scientific diving community that took the initiative and formulated the questions regarding the use of dive computers for the diving scientist's safety, the results presented here prove to be applicable to the recreational, commercial and cave diving communities as well.

Michael A. Lang
R.W. Hamilton
Editors



AMERICAN ACADEMY OF UNDERWATER SCIENCES

Dedicated to the advancement and practice of scientific diving

ABOUT AAUS

The American Academy of Underwater Sciences (AAUS) is a non-profit, self-regulating body dedicated to the establishment and maintenance of standards of practice for scientific diving. The AAUS is concerned with diving safety, state-of-the-art diving techniques, methodologies, and research diving expeditions. The Academy's goals are to promote the safety and welfare of its members who engage in underwater sciences. These goals include:

- To provide a national forum for the exchange of information on scientific diving;
- To advance the science and practice of scientific diving;
- To collect, review and distribute exposure, incident and accident statistics related to scientific diving;
- To promote just and uniform legislation relating to scientific diving;
- To facilitate the exchange of information on scientific diving practices among members;
- To engage in any or all activities which are in the general interest of the scientific diving community.

Organized in 1977 and incorporated in 1983, the AAUS is governed by a Board of Directors. An Advisory Board of past Executive Committee members provides continuity and a core of expertise to the Academy. Individual membership in AAUS is granted at the Member, Associate Member, and Student Member categories. Organizational membership is open to organizations currently engaged in scientific diving activities. Maintenance of membership is dependent on a continued commitment to the purposes and goals of the Academy, compliance with the reporting requirements and payment of current fees and dues.

- For the diving scientist, AAUS provides a forum to share information on diving research, methodologies and funding;
- For the diving officer, AAUS provides an information base of the latest standards of practice for training, equipment, diving procedures and managerial and regulatory experience.
- For the student, AAUS provides exposure to individuals, agencies and organizations with on-going programs in undersea research.

Scientific diving means diving solely as a necessary part of a scientific activity by employees whose sole purpose for diving is to perform scientific research tasks. Scientific diving does not include tasks associated with commercial diving such as: rigging heavy objects underwater, inspection of pipelines, construction, demolition, cutting or welding, or the use of explosives.

Scientific diving programs allow research diving teams to operate under the exemption from OSHA. This reduces the possibility of an OSHA fine and some concern regarding civil liability. Civil suits examine whether the "standards of practice of the community" have been met. Diving programs which conform to AAUS Standards reflect the standard of practice of the scientific diving community and allows divers from different institutions to perform underwater research together. This reciprocity between programs is the product of years of experience, trust and cooperation between underwater scientists.

EXECUTIVE SUMMARY

Historically, the diving community has depended on the United States Navy Air Decompression tables to accomplish safe time and depth limits. These tables have served the military and civilian sector well for over four decades. Today, in the quest of safely extending bottom time, industry has developed the *in situ* dive computer. Utilizing mathematical models of human tissue compartments and gas exchange dive computers allow the constant computation of the "decompression status" during the dive.

At present there are a number of dive computers on the market and they all vary in the assumptions utilized in the model and in their capabilities. Since these tools have the potential for widespread use in the scientific diving sector, this workshop was planned and implemented by the American Academy of Underwater Sciences.

Technical representatives of the leading dive computer manufacturers, authors of the most widely used decompression algorithms, diving physiologists and knowledgeable users were invited to a two-day workshop. After intense information exchange, discussions, and evaluations of each of the dive computers, it was concluded that they are presently in the second generation of development. After evaluating the available database on pressure related injuries to examine the effectiveness of dive computers, it was the consensus that such devices have demonstrable potential for use in the entire diving community. The usefulness of specific dive computers varied among manufacturers and as a result guidelines for their use within the scientific diving community were formulated.

In addition, recommendations for future uniformity or standardization in data displays and capabilities were discussed as well as dive profile recall capabilities.

It is clear that neither tables nor dive computers can eliminate all decompression problems. It is also clear that this second generation of technology, if utilized conservatively, represents an important tool for improving diver safety.

Dive computers are expanding rapidly and will doubtlessly form an important element of the safety equipment for the scientific diver. In the future, exposure data must continue to be collected from users to provide a proper statistical base with which to monitor their effectiveness.

ACKNOWLEDGEMENTS

The organization of this workshop and the production and assembly of a document of this size and diversity would not have been possible without the assistance of a number of people. I thank the workshop organizing committee Bill Hamilton (Program Chair), Glen Egstrom (AAUS President-Elect), Chuck Mitchell (AAUS Workshops Chair), Andy Pilmanis and Jack Engle (Local coordinators and Workshop hosts at the Catalina Marine Science Center) for a job well done. I extend my personal thanks to the contributing authors, participants and manufacturers for working so cooperatively in the pursuit of safe diving. I appreciate the distances people had to travel, many at their own or their organization's expense and the time they invested in preparing their presentations for this workshop.

In the initial stages of workshop organization, Ann Muscat, Andy Pilmanis, Jim Fawcett and Lindy Nagata were of great support and encouragement. Thanks also to Capt. Ed Thalmann, Dr. Paul Weathersby and Prof. A.A. Bühlmann for their support and supplying information on dive profiles, maximum likelihood analysis and decompression models. I thank my co-editor Bill Hamilton, who is credited with the division of topics and questions that were addressed by the speakers.

Special thanks to Bill Morris and Jim Varnell of the SDSU Life Sciences Computer Center for the transcription of the various floppy disks.

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Michael A. Lang
President
American Academy of Underwater Sciences