

SCIENTIFIC SHIPBOARD DIVING SAFETY

ADDENDUM REPORT APRIL 1996

Introduction

Scientific research diving provides many interesting challenges. The challenges are compounded when divers require research vessels to provide a staging platform for their dives and especially when these dives are in remote locations. The integration of a dive party with a research vessel crew requires extensive planning and coordination. When the dive party is from an institution which differs from the ship's institution additional elements come under consideration. Diving safety is of paramount importance and because various organizations and operating entities can be involved special planning is needed. The purpose of this document is to address safety issues associated with scientific research diving as they relate to research vessels. This document provides planning tools necessary for the safe conduct of shipboard diving aboard UNOLS ships.

Background

The academic oceanographic research community, represented by UNOLS, recognized a need to review the safety aspects of research diving from UNOLS vessels. A workshop was convened 18-20 February 1990 to review the issues and to make recommendations to the community. The product of this workshop was the Final Report of The Workshop on Scientific Shipboard Diving Safety. Limited copies of this report are available at the UNOLS Office and the entire report can be accessed through the UNOLS Home Page <<http://www.gso.uri.edu/unols/unols.html>>.

On 23 October 1995 a small working group ([Appendix I](#)) met to review the 1990 workshop report and to make recommendations as to whether a new workshop was needed to rewrite the report or only minor changes were necessary. This working group concluded that the report was still valid and that an addendum report could provide the update to the 1990 publication. This document is that addendum report.

Addendum Report

Forwarded as part of this addendum report are the revised Findings and Recommendations from the 1990 workshop. These are included as [Appendix II](#). Also included is a reprint of a sample "Pre-Cruise Dive Plan", [Appendix III](#), and the revised chapter of diving from the RVOC Research Vessel Safety Standards ([Appendix IV](#)).

The most critical factor in conducting academic research diving from UNOLS research vessels is effective communications between all parties involved.

APPENDIX I

ATTENDEES DIVE SAFETY MEETING

23 October 1995

Alice Alldredge (U of California, SB)
Tim Askew (HBOI)
Jack Bash (UNOLS)
Annette DeSilva (ONR)
Dolly Dieter (NSF)
John Heine (MLML)
Ken Johnson (UNOLS)
Elizabeth Kintzing (U of NH)
Mike Lang (Smithsonian Institution)
Clifford Newell (NOAA)
Steve Rabalais (LUMCON)
Terrence Rioux (WHOI)
Woody Sutherland (NSF)

APPENDIX II

Final Report of the Workshop on Shipboard Scientific Diving Safety
Rev 1

Authority and Responsibility

Findings

- The major participants during the execution of a diving operation are the vessel's Master (and crew), the Principal Investigator and the On-Board Diving Supervisor.
- The on-site individuals are backed up by a plethora of organizations (Research Vessel Operators' Committee, RVOC; University-National Oceanographic Laboratory System, UNOLS; National Science Foundation, NSF; American Academy of Underwater Sciences, AAUS).
- The organizations' documentation (*UNOLS Shipboard Safety Standards*, *RVOC Safety Training Manual*, *institutional* diving manuals, AAUS Standards) are internally consistent.
- A clearly defined requirement exists for a statement that will clarify the issues of responsibility and authority over scientific diving at sea.
- The process of defining authority and responsibility requires an integrated assembly of planning events, personnel briefings, and document sharing.
- While some responsibilities can be pre-assigned, others must be handled during the actual planning and execution process.

Recommendations

- Section 16 "*DIVING OPERATIONS*" of the *UNOLS Shipboard Safety Standards* be replaced with the version developed at the workshop. (Action complete from original report.)
- Direction of, and authority over, the execution of diving operations lies with the On-Board Diving Supervisor.

Multi-Institutional Cruises

Findings

- The process of preparing for a diving cruise involves a discrete number of invariable steps, interlaced with project specific requirements. The process includes: selection of the lead institution; documentation that all research diver certification requirements have been met; research diver review and approval process; and an initial letter from the lead institution's campus diving administration to the ship operator documenting the above.
- The process is brought to the ship at the beginning of the cruise in a full-scale meeting between the On-Board Diving Supervisor, the vessel's Master, and the Chief Scientist, together with appropriate others such as the Marine Superintendent.

- *There is a high probability of breakdown in communication when any divers come from an institution other than that of the vessel operator. New measures must be developed to insure that all the pre-cruise procedures for diving are met and are to the satisfaction of the Chief Scientist, lead diving control board, Marine Superintendent and vessel's Master.*

Recommendations

- A formal walk-through of the ship's equipment that the research divers will need (e.g., small boats, crane) with the Master, Chief Engineer, Diving Safety Officer, On-Board Diving Supervisor, Marine Superintendent and the Principal Investigator prior to a cruise is highly desirable.

The Principal Investigator should work out with the desired ship operator and respective campus diving administrators, the details of the planned diving activities, including emergency procedures, well in advance of the cruise and preferably as soon as funding has been confirmed. An AAUS Diving Control Board (or equivalent) should be selected to govern diving on the cruise. This selection should be approved by the Chief Scientist and the ship's operator. This lead Diving Control Board, or usually it's Diving Safety Officer, is then responsible to insure that all diving-related planning is completed in a timely manner prior to the cruise. All diving policies and procedures for that particular cruise must meet those of the lead diving control board.

- *Blank Pre-cruise Dive Plan Forms should be incorporated into appropriate NSF, UNOLS and RVOC documents. Completed forms are working documents and should be available to all persons involved in the cruise (including, but no limited to, lead Diving Control Board, institutional Dive Safety Officer, Chief Scientist, Principal Investigator, Marine Superintendent, Ship's Captain and onboard Diving Supervisor). Whether the On-Board Diving Supervisor's institution is a member of AAUS should be noted on the UNOLS Ship Time Request Form.*
- *The On-Board Diving Supervisor should collect the diving statistics (e.g. number of dives, dive times, and depths) from the divers prior to departing the ship. Copies of the post-cruise report, including diving statistics, should be submitted to the lead Diving Control Board and the UNOLS Office. The report should include any equipment malfunctions and hyperbaric accidents.*
- Uniformity across the fleet in the requirements placed on diving cruises is highly desirable.

Small Boats and Small Boat Operators

Findings

- Most vessel operators have small boat operation rules and regulations. However, when viewed from a fleet-wide perspective, these are not generally available, complete, or consistent with each other especially as they relate to at-sea diving support.
- A common standard should include operator requirements (training, certification, proficiencies, etc.), operational procedures (launch and recovery, diver assistance, support and communication, special diving conditions, etc.), dive planning involvement, a detailed checklist, and emergency procedures.
- The primary boat operator should normally be a member of the ship's crew. Science party operators must demonstrate, to the vessel Master's satisfaction, acceptable skills and knowledge. Having a boat operator with diving knowledge is useful to both the ship and the science party and should be encouraged.

Recommendations

- UNOLS/RVOC should develop a common set of guidelines for small boats and their operators, not unlike (in form) the standards AAUS developed for research diving. These guidelines should be incorporated, as appropriate, into the *UNOLS Shipboard Safety Standards*, the *RVOC Safety Training Manual* and other UNOLS/RVOC documents. These new guidelines should include coverage of the use of small boats for diving operations. Small boat topics that relate to diving should be incorporated into the documents mentioned above in both the small boat and diving sections.
- Small boats from which diving operations are conducted should, as a high priority consideration, always be equipped with a way of rapidly recalling the divers to the surface in an efficient manner.
- *Small boats should have a fail safe means of communication with the mother ship. In most cases this would include redundant VHF radios, and if possible visual communication with the mother ship.*
- *The dive plan should include plans for retrieving the divers, for a situation where the small boat becomes disabled,. This could include the need for a back up boat or shipboard recovery.*

Diver Evaluation and Training Standards

Findings

- Shipboard diving, when compared to near-shore diving conducted from small boats, requires additional diving skills and knowledge on the part of the scientific party as well as additional skills and knowledge on the part of the ships' crew. The assumption that all members of such expeditions have been adequately trained and indoctrinated in the tasks to be performed may not always be valid. It is imperative that all personnel involved in the diving operation have a clear understanding of the tasks to be performed, how they are to be accomplished and who the responsible individual is.
- The responsibility for the establishment of minimum standards for qualifying and training scientific divers, as well as running research diving safety programs, rests with AAUS. The implementation of those standards rests with the campus diving administrations. AAUS standards cover basic diver training but do not directly address day-to-day shipboard scientific diving operations.
- It is common for diving cruises to include diving personnel from institutions other than the vessel operator. It is sometimes difficult for foreign divers and divers from institutions which lack an AAUS model research diving safety program to demonstrate their qualification for research diving cruises.

Recommendations

- When a cruise is leaving from a port other than the home port, and there are research divers meeting the ship who are not yet qualified, inclusion of the Diving Safety Officer (or an authorized representative) in the scientific party as the On-Board Diving Supervisor is the preferable mode of operation. This approach permits the On-Board Diving Supervisor to conduct the required in-water checkouts of the divers and to qualify them on the spot. When this approach is used, research divers need to consider that they will not be permitted to dive if they do not meet the qualification criteria. *Demonstrated proficiency in blue water diving techniques is required for all participating divers*

who engage in this diving specialty from a UNOLS vessel.

- The development of common policy approaches, evaluation criteria, and protocols for testing the proficiency of shipboard scientific divers and support personnel is needed. Consensus standards covering these items should be developed.
- All UNOLS members whose scientists carry out diving research or who operate a UNOLS research vessel should be Organizational Members of the AAUS so that they can fully participate in the development and evolution of research diving safety standards.

Emergency Planning

Findings _____

- Masters and mates are prepared to respond to life-threatening events at sea on an ad hoc basis.
- Diving cruises require specific plans to deal with medical advisory communication, evacuation, and location of operational hyperbaric chambers that have medical support.
- Available chamber location information receives little distribution even though it is useful in operational area planning.

Recommendations _____

- *The On-Board Diving Supervisor should be given primary responsibility for the assembly of the information and protocols that go into the pre-cruise Dive Plan. Part of this plan should include details concerning: diving operations; emergency chain of command, including 'first-responder aid' communication; and contacting the appropriate medical advisory groups (DAN, MHS etc.). The Diving Supervisor should familiarize themselves with the locations of suitable medical/hyperbaric facilities to be used in an emergency for that particular cruise area.*
- *At the start of the cruise the Master of the vessel, the Chief Scientist and the Diving Supervisor should meet to discuss the emergency diving protocols. This information should then be passed along to the other divers and appropriate crew members.*
- *Emergency drills should be held on vessels conducting diving operations.*
- *If an accident occurs, the Master has the responsibility for establishing communication with pre-defined medical advisory personnel. Both the scientific party and the ship's crew should understand how to communicate with the agencies involved in medical emergency and rescue.*
- *Research divers (working with the vessel EMT when available) should be prepared to deal with oxygen administration and management of emergency situations.*
- *General cruise emergency planning would benefit from documentation in existing UNOLS, RVOC and AAUS marine safety publications.*

Recompression Chambers

Findings _____

- A review of the history of academic research diving does not justify the requirement of on-board recompression chambers
- Chambers may be desirable for diving techniques/equipment that are outside of the current practice of the scientific diving community.
- Of the chambers available, a double lock multi-place unit is the superior choice.

Recommendations _____

- Normal at-sea scientific diving from UNOLS vessels does not require the provision or use of an on-board recompression chamber.
- Diving beyond the experienced norm, especially in a remote site, should be reviewed on a case-by-case basis as part of the dive planning process to determine if a chamber is warranted.
- The general level of emergency medical preparedness should be enhanced by encouraging the training of crew members (and even interested research divers as Emergency Medical Technicians).
- *The use of NITROX (nitrogen enriched air) should be considered as a method of providing a greater safety margin.*
- *The use of "no-decompression" diving profiles will further reduce the need for a recompression chamber, however, this could severely restrict diving activities.*

New Technologies

Findings _____

- *Modes other than compressed air SCUBA may prove of benefit to the diving scientist. Some, e.g. NITROX, are in frequent use by selective institutions.*
- *Diving equipment and aids, (e.g. dive tables, dive computers and rebreathers) are continually being introduced into the diving community. These must be evaluated before being put into common practice by diving scientists.*

Recommendations _____

- *Periodically, UNOLS should form an ad hoc committee of diving scientists, research vessel operators, diving safety officers and, when appropriate, diving equipment manufacturers to examine new diving technologies and formulate a plan to evaluate and implement those which are decided to be of benefit to the scientific diving community.*

Future Needs and Projects

Findings _____

- Since 1977 the AAUS has been the national body representing the U.S. Scientific Diving Community. However, no formal links exist between AAUS and UNOLS/RVOC despite commonality of interest and congruity of membership.
- AAUS has the expertise to provide services to UNOLS/RVOC in the area of diving information,

standards, statistics, reciprocity, expert assistance and representation as well as a forum for resolving research diving issues.

Recommendations

- UNOLS/RVOC should utilize the AAUS to provide consultation and advice on research diving issues. In support of this utilization UNOLS/RVOC and AAUS should establish formal and consistent links to assure such benefits as cross-representation at significant meetings, cross-reporting in newsletters and, most importantly, cross-convening of joint issue topical conferences such as this workshop.
- The AAUS Board of Directors should establish a committee within the AAUS composed of the UNOLS Diving Officers.
- Statistics should be kept by UNOLS concerning diving from vessels in the academic fleet. Copies of institutional diving logs from all *diving* cruises should be provided by the Chief Scientist as part of the normal Post-Cruise Report to UNOLS.
- The diving-related portion of the UNOLS research vessel inspections should be enhanced. This review should concentrate on the diving equipment and the ship equipment (i.e., small boats and motors) as well as procedures for use and access to accident-response equipment.
- All UNOLS member institutions who either conduct scientific diving or whose ships are used for research diving cruises should be Organizational Members of the AAUS.
- *Procedures* should be developed for divers whose institutions do not have formal scientific diving programs in order that they may fulfill certification requirements when they need to participate in UNOLS cruises.

APPENDIX III

Pre-Cruise Diving Plan

Pre-Cruise Dive Plan		Research Vessel	
Chief Scientist		Cruise Number	
Cruise Start		Cruise End	
Operating Area		Lead Institution	
Diving Site Locations			
Dive Plan (Check all that apply)			
Type of Diving		Diving Mode	
<input type="checkbox"/> Bottom oriented (near shore)	<input type="checkbox"/> Repetitive diving	<input type="checkbox"/> Open Circuit SCUBA	
<input type="checkbox"/> Bottom oriented (off shore)	<input type="checkbox"/> Multi-day diving	<input type="checkbox"/> Mixed Gas (NITROX)	
<input type="checkbox"/> Buoyed down-line at site	<input type="checkbox"/> Cold water	<input type="checkbox"/> Mixed Gas (other)	
<input type="checkbox"/> Blue Water - tethered	<input type="checkbox"/> Under ice	<input type="checkbox"/> Surface Supplied	
<input type="checkbox"/> Blue Water - untethered	<input type="checkbox"/> Cave	<input type="checkbox"/> Dry Suit	
<input type="checkbox"/> Night diving	<input type="checkbox"/> Wreck	<input type="checkbox"/> Diving Computer	
<input type="checkbox"/> Decompression diving	<input type="checkbox"/> Other:	<input type="checkbox"/> Other:	
Maximum Depth of Dives:		Diving Tables used:	
<input type="checkbox"/> 30 ft.	<input type="checkbox"/> 130 ft.	<input type="checkbox"/> U.S. Navy	<input type="checkbox"/> Huggins'
<input type="checkbox"/> 60 ft.	<input type="checkbox"/> 150 ft.	<input type="checkbox"/> Swiss	<input type="checkbox"/> NAUI
<input type="checkbox"/> 100 ft.	<input type="checkbox"/> 190 ft.	<input type="checkbox"/> Canadian	<input type="checkbox"/> PADI
		<input type="checkbox"/> Royal Navy	<input type="checkbox"/> Other:
		<input type="checkbox"/> Diving Computer Model:	
Possible Hazards			
Physical		Biological	
<input type="checkbox"/> Strong Currents	<input type="checkbox"/> Low visibility	<input type="checkbox"/> Sharks	<input type="checkbox"/> Stinging organisms
<input type="checkbox"/> Fog	<input type="checkbox"/> Pollution	<input type="checkbox"/> Spiny organisms	<input type="checkbox"/> Other:
<input type="checkbox"/> Ice	<input type="checkbox"/> Other:	<input type="checkbox"/> Large ugly marine mammals	
Briefly describe scientific diving procedures to be used on cruise (i.e., Special diving protocols, collection methods) and typical daily diving schedule (time & duration of dives)			

Equipment and Personnel Needs			Supplied by		
Item or person needed			Science	Ship	Other
Scuba tanks	Number:		<input type="checkbox"/>	<input type="checkbox"/>	
	Size:				
Compressor	CFM:		<input type="checkbox"/>	<input type="checkbox"/>	
	Pressure:				
Tank Filling Cascade	Size:		<input type="checkbox"/>	<input type="checkbox"/>	
	Pressure:				
Dive Boat	Size:		<input type="checkbox"/>	<input type="checkbox"/>	
Dive Boat Motor	Size:		<input type="checkbox"/>	<input type="checkbox"/>	
Lifting Harness for Boat			<input type="checkbox"/>	<input type="checkbox"/>	
Emergency O ₂	Amount:		<input type="checkbox"/>	<input type="checkbox"/>	
Demand valve for O ₂			<input type="checkbox"/>	<input type="checkbox"/>	
Diving Computers	Model:		<input type="checkbox"/>	<input type="checkbox"/>	
	Number:				
Boat Operator			<input type="checkbox"/>	<input type="checkbox"/>	
Emergency signaling device	Type:		<input type="checkbox"/>	<input type="checkbox"/>	
Diving flag	<input type="checkbox"/> Alpha <input type="checkbox"/> U.S.		<input type="checkbox"/>	<input type="checkbox"/>	
First aid kit			<input type="checkbox"/>	<input type="checkbox"/>	
Portable O ₂ kit			<input type="checkbox"/>	<input type="checkbox"/>	
Radar reflectors	Type:		<input type="checkbox"/>	<input type="checkbox"/>	
Diver recall device	Type:		<input type="checkbox"/>	<input type="checkbox"/>	
Other			<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/>	Emergency Plan Appended				
<input type="checkbox"/>	Emergency Evacuation Plan Appended				

16. DIVING OPERATIONS

16.0 POLICY

Scientific diving is a normal part of oceanographic research vessel operations. Such diving conducted from a University-National Oceanographic Laboratory System (UNOLS) vessel must be under the auspices of a diving program that meets the minimum American Academy of Underwater Sciences' (AAUS) Standards for Scientific Diving Certification and Operation of Scientific Diving Programs. Operators without a program may accommodate scientific diving cruises which are under the auspices of an institution with such a diving program.

16.1 DIVING PROCEDURES, RULES AND REGULATIONS

For all cruises a single lead institution's campus diving administration will be designated. This is usually accomplished by agreement of all campus diving administrations involved. Items which refer to the campus diving administration may, in fact, be the concern of the Diving Safety Officer according to the practices of the institutions involved. The procedures, rules and regulations that govern the diving operation are those of the designated lead institution, subject to the approval of the operator's Marine Office.

16.2 CRUISE PLANNING

In a timely fashion prior to the cruise:

- 1. The Principal Investigator will insure that a cruise dive plan is supplied to his or her campus diving administration who will forward the cruise plan, once approved, to the lead institution's campus diving administration and the Chief Scientist. The dive plan, prepared in a standard format includes: diving credentials for all diving members of the scientific party, detailed operational plans, emergency plans including accident management and emergency evacuation protocols, a list of needed medical supplies, a specified quantity of medical grade oxygen with a positive pressure demand delivery system and required diving support equipment (e.g., small boats).
- 2. The lead institution's diving administration will, after approving this plan, forward it to the operator's Marine Office.

16.3 CRUISE PERSONNEL

- 1. The Master has responsibility for the safety of all activities aboard including diving (Section 14.4).
- 2. The Chief Scientist is responsible for the coordination and execution of the entire scientific mission (Section 14.5).
- 3. The Principal Investigator of the diving project (who may or may not be the Chief Scientist) is responsible for the planning and co-ordination of the research diving operations.
- 4. The On-Board Diving Supervisor will be proposed by the Principal Investigator and approved by the lead institution's diving administration. The On-Board Diving Supervisor is responsible for the execution of the research diving operations in accord with the cruise dive plan. He or she has the authority to restrict or suspend diving operations and alter the cruise dive plan in consultation with the Master and the Principal Investigator/Chief Scientist. The On-Board Diving Supervisor's responsibilities include:
 - a. Meeting with the Master and Chief Scientist to review the cruise dive plan and emergency

procedures prior to diving.

- b. Remaining in regular communication with the Master on the progress of the research diving operation.
 - c. Assuring that both the lead and operating institution's diving manual are available to the scientists and crew aboard the vessel.
 - d. Inspecting high pressure cylinders and breathing air compressors to assure that they meet the lead institutions' standards.
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- 5. Research Divers must recognize their individual responsibility for their safety.