UNIVERSITY - NATIONAL OCEANOGRAPHIC LABORATORY SYSTEM

RESEARCH VESSEL SAFETY STANDARDS

11th Edition

November 2021

UNOLS RVSS – Eleventh Edition – November 2021

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These Research Vessel Safety Standards are dedicated to Captain Robertson P. Dinsmore, U.S. Coast Guard, (Ret.) Captain Dinsmore was instrumental in the establishment of UNOLS and has dedicated his life to the safety of those who go to sea and improvement of sound maritime practices.

The UNOLS Office and the UNOLS Research Vessel Safety Committee would like to acknowledge the support of the National Science Foundation and Office of Naval Research for support of this project.

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Photography Credits:

Front Cover: Students from the Oregon Institute of Marine Biology (University of Oregon) deploying an Agassiz trawl from the R/V OCEANUS on the Oregon Shelf. Photo by: Dr. Craig Young, University of Oregon

Back Cover: Sunset CTD operations on R/V ATLANTIC EXPLORER, Photo by: Chief Engineer Eric Hahn

PREFACE

UNOLS Member Institutions first adopted the Research Vessel Safety Standards (RVSS) in May 1976. Later editions were adopted by members at UNOLS meetings in May 1981, May 1985, October 1989, September 1992, October 1995, July 1999, March 2003, March 2009, and July 2015. This eleventh edition was adopted in November 2021. In lieu of published institutional policy, these safety standards are considered the guidelines for the Academic Research Fleet. For that reason, all UNOLS Operators and others involved with research ship operations, should be thoroughly familiar with the contents of this manual and comply with its recommendations as appropriate.

Changes made since last revision (10th Ed.) in July 2015

- Chapter 4: Updated to add policies on egress training, personal use of electronic devices, and swim calls (June 2021).
- Chapter 5: Updated to eliminate outdated references and regulatory details about vessel crewing; added information on crew rest, science party rest, and science party relationships (June 2021).
- Chapter 6: Updated (Dec 2017)
- Chapter 8: Science van information updated (June 2021); information on weight-handling gear deleted due to more up-to-date and detailed standards in Appendices A and B.
- Chapter 9: Updated with lithium battery information (July 2018).
- Chapter 12: Deleted, due to *Alvin* being the only human-occupied submersible in use in the ARF. The National Deep Submergence Facilities (NDSF) has established their own procedures and checklist for *Alvin* (June 2021).
- Chapter 14: Rewritten and renamed to focus on shipboard watertight integrity (June 2021).
- Chapter 16: Updated with EEBD information (Nov 2018).
- Chapter 18: Deleted at direction of the UNOLS Council; refers users to separate UNOLS guidance on use of research vessels outside the ARF (June 2021).
- Chapter 19: Old content on aircraft operations deleted; replaced with guidance on unmanned aerial systems (UAS) (June 2020).
- Appendix B: Rewritten and Re-inserted (Jan 2019).
- Appendix E: Updated (Dec 2017).

The 11th Edition has been extensively reviewed and numerous minor edits were made to update the accuracy of references and terminology, and to streamline format and clarity of wording.

RESEARCH VESSEL SAFETY STANDARDS

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1. INTRODUCTION

The UNOLS Research Vessel Safety Standards (RVSS) are the standards for the operation of oceanographic research vessels owned, operated or chartered by members of the University-National Oceanographic Laboratory System (UNOLS), collectively referred to as the U. S. Academic Research Fleet (ARF), to assure that research at sea is conducted to the highest practicable standards of safety. Full compliance is a requirement to maintain status as an ARF vessel. UNOLS member institutions who operate other vessels or small boats which are not designated as part of the ARF are encouraged to comply with these standards to the extent possible, and must adhere to the requirements of the UNOLS Guidance Document on "Use of Research Vessels outside the U.S. Academic Research Fleet (non-UNOLS vessels)."

These standards are based in major part on applicable laws and regulations. In addition and where appropriate, they supplement, extend, and assist in the interpretation of the legal requirements. Nothing herein is intended to conflict with the legal standards, but rather to encourage and assist the operator to not only meet, but also exceed the legal minimums, as practical. The wide variety of vessel types and sizes, and their diverse operational usage, will necessarily lead to many discretionary interpretations. In such cases, a common-sense application of the principles of good seamanship and sound marine engineering practice will be required, and a waiver to these standards requested in accordance with Section 2.3.

The UNOLS Research Vessel Operators' Committee (RVOC) and the UNOLS Research Vessel Technical Enhancement Committee (RVTEC) are available to assist operating institutions by providing reference materials, and interpreting the laws, regulations and standards.

Operators are reminded that in addition to the legal responsibilities and liabilities associated with Federal laws and regulations, and maritime law, safe operation is one of the factors used by Federal science sponsors in evaluating the merit of a ship as a research platform.

These standards do not apply to human-occupied research submersibles, which are covered by a different, and detailed, set of regulations.

Recognizing that research vessels and ocean research in general should be at the forefront of maritime safety, research vessel operators should take every opportunity to participate in innovative research, procedures, and equipment operation to enhance the practice of safety at sea.

Institutions must develop, update and make available "Cruise Handbooks" or "User Manuals" incorporating important parts of these standards, plus additional information on their particular ships and any pertinent institutional regulations or procedures (see section 4.6.2). For the purposes of this document the adjective "Research Vessel" applies to the terms ship, vessel, boat, or motorboat.

2. PROCEDURES

2.0 SCOPE

These safety standards are not intended to cover all possible cases, but only those where there is a clear-cut, widespread need for guidance, or to fill a gap not covered by laws and regulations. Federal laws, U.S. Coast Guard regulations, American Bureau of Shipping rules or other federal, state, or local regulations supersede these UNOLS standards. To the extent possible, these standards are organized as follows:

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2.1 PROPOSED STANDARDS

Draft standards, or a statement of the need for a modification, may be proposed by any UNOLS member, or any other person or group having an interest in the safe operation of ARF vessels. Proposed standards will be referred to the UNOLS Research Vessel Safety Committee for review, recommendations, and possible action.

2.2 UNOLS SAFETY COMMITTEE RESPONSIBILITIES

The UNOLS Safety Committee's charge is to provide a forum for the formulation, review, and recommendation for approval of the UNOLS Research Vessel Safety Standards (RVSS) for the Academic Research Fleet. Changes to the RVSS will be submitted to the Research Vessel Operators' Committee (RVOC) and transmitted to the UNOLS Council for consideration and adoption under the terms of the UNOLS charter.

2.3 APPLICABILITY AND WAIVERS

Use of these standards by UNOLS members shall be as provided for under the terms of the UNOLS charter.

2.3.1 WAIVERS

If, despite best efforts, compliance with an RVSS standard is not practical or economical, a waiver may be requested. The UNOLS ship operator shall send a written waiver request to the RVOC Safety Committee Chair, using the guidelines in Appendix

D. The Safety Committee will review the request, using subject matter expertise as appropriate, and approve or disapprove the request.

2.3.2 RESEARCH VESSELS NOT PART OF THE U. S. ACADEMIC RESEARCH FLEET

Chapter 18 provides guidelines for the applicability of RVSS requirements to:

- UNOLS institution-operated vessels that are not part of the ARF.
- Vessels chartered by UNOLS institutions for research activities.

2.4 REFERENCE MATERIAL

The UNOLS Office will maintain and provide to members pertinent reference materials, circulars, and other information. The RVOC will provide assistance in interpretation of laws, regulations, and standards, and suggest assistance in areas not covered by these standards.

2.5 CHANGES TO RESEARCH VESSEL SAFETY STANDARDS

Changes to laws, rules, or regulations, which affect or supplement these standards shall be brought to the attention of the member institutions by the RVOC. Periodically, not later than every three years, the Research Vessel Safety Committee shall review the safety standards to ensure that they are current and complete. Necessary changes shall be submitted by the Chair of the RVOC to the UNOLS Council for approval.

3. DEFINITIONS, REGULATIONS AND DOCUMENTATION

3.0 INTRODUCTION

All seagoing vessels are subject to various requirements for documenting their ownership, occupation, and safety. These requirements, as indicated below, vary greatly, depending on the size and type of vessel, its employment, the area of operations, etc. The language used herein is chosen to convey the sense of the regulations; for the actual legal wording, reference is made to the pertinent parts of the Code of Federal Regulations (CFR), the United States Code (USC), or other sources. References to the CFR and USC generally are cited as the Title Number (e.g. 46) Source (e.g. CFR or USC) and Part Number (e.g. 189) such that 46 CFR 188 would be the reference for the beginning of the regulations regarding Oceanographic Research Vessels.

3.1 REFERENCES

- **33 CFR** - Navigation and Navigable Waters
- **33 CFR 101 and 104** - International Ship and Port Facility Security Code (ISPS)
- **33 CFR 138, 33 USC 2702 to 2761** - Oil Pollution Act of 1990 (OPA 90)
- **33 CFR 151 and 155.70** - International Convention for the Prevention of Pollution from Ships 1973 (MARPOL)
- **46 CFR** - Shipping
- **46 CFR 188 – 196 Subchapter U** - Oceanographic Research Vessels
- **46 CFR 10, 12, and 15** - International Convention on Standards of Training, Certification and Watch standing for Seafarers (STCW-95)
- **46 CFR 15.701** - The Seaman's Competency Act and Officer's Competency Certificates Convention 1936
- **46 CFR 15.705** and **46 CFR 15.1111** - respectively - Watches and Rest Periods
- **46 CFR 188.05-10** - International Convention for Safety of Life at Sea (SOLAS)
- **46 USC 41** - Motorboat Act
- **46 USC Sections 30104** - Jones Act
- **46 USC 32, 33 CFR 96.100 et seq**. - International Management Code for the Safe Operations of Ships and Pollution Prevention (ISM)
- **46 USC 43, 46 CFR 24 - 27** - Federal Boat Safety Act of 1971
- **46 USC 51 and 46 CFR 42 et seq**. - International Load Line Act
- **Navigation and Vessel Inspection Circulars (NVIC)** - Informational material published by the USCG.
- **NVIC 8-83** - MARPOL 73/78 Annex I, Regulation 9 and 26

- **NVIC 11-93 Ch. 3** - Applicability Of Tonnage Measurement Systems To U.S. Flag Vessels
- **POLAR CODE**- International Maritime Organization- Polar Code: www.IMO.org

3.2 ORGANIZATIONS

AMERICAN BUREAU OF SHIPPING (ABS): A non-profit organization authorized by the Coast Guard to ensure compliance with load line regulations and other related safety factors. The organization provides inspection services to operators for a fee. ABS documents and publications (including Rules for Shipbuilding) are available online at: www.eagle.org .

AMERICAN BOAT AND YACHT COUNCIL (ABYC): This organization is primarily concerned with private pleasure craft and sets standards for small vessel construction. Some of their standards are referenced in portions of these safety standards and some are incorporated by reference in Coast Guard regulations concerning small craft and commercial fishing vessels. ABYC standards and technical reports are available at www.abycinc.org

U.S. COAST GUARD (USCG): The Federal agency charged with enforcement of many laws and regulations concerning ships and seagoing operations. Information and inspection services are provided either from headquarters in Washington or from several district offices around the country. Operators should always check with their local Coast Guard Sector Office with Officer in Charge of Marine Inspection (OCMI) authority for interpretation of laws and regulations. For information use the website located at: http://homeport.uscg.mil/mycg/portal/ep/home.do.

FEDERAL COMMUNICATIONS COMMISSION (FCC): Federal agency charged with the regulation of radio communications, including those to, from and between ships. (47 CFR) FCC information is at www.fcc.gov.

INTERNATIONAL MARITIME ORGANIZATION (IMO): Established during a 1948 United Nations conference, IMO is an international body devoted exclusively to maritime matters. Headquartered in London, IMO consists of various committees and subcommittees. The Maritime Safety Committee (MSC) is the senior committee that carries out the organization’s technical work. At a 1960 conference, IMO adopted the International Convention on Safety of Life at Sea (SOLAS). SOLAS is the basic international instrument dealing with matters of marine safety. SOLAS has been amended several times. These amendments cover a variety of issues such as vessel construction and fire safety, Roll On – Roll Off (RO-RO) ship safety, passenger ship safety, GMDSS, tonnage admeasurements, traffic separation schemes, INMARSAT, fishing boat safety, STCW, etc. IMO conventions have also led to adoption of oil pollution policies. These include the 1973 International Convention for the Prevention of Pollution from Ships (MARPOL) and the 1990 International Convention on Oil Pollution Preparedness Response and Cooperation (OPRC). IMO information is at www.imo.org.

INTERNATIONAL ORGANIZATION OF STANDARDIZATION (ISO): ISO is a non-government organization that develops various international standards for business, government and society. ISO standards distill an international consensus for standards from a broad base of stakeholders. It is recognized worldwide. Two management systems exist, ISO 9000, which deals with quality management, and ISO 14000, which deals with environmental management. ISO 9000 is the standard that certified auditors for ISM code are trained to meet. To implement ISO 9000, ISO 9001 was developed. It is a series of documents that define the requirements for a Quality Management Safety Standard. Certification under ISO 9001 meets the certification requirements for ISM provided that an alcohol & drug abuse/misuse policy and the handling of contingencies are added to the ISO 9001 standards. ISO does not perform certifications nor are their standards compulsory. However, following ISO 9001 standards as closely as possible will ease the certification process under ISM. Information regarding the standards can be found at www.iso.org.

INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE): A professional group, which develops standards in electrical and electronic practices. Many of these standards are incorporated as legal or prudent requirements for ships. Their standards are located at www.ieee.org.

UNDERWRITERS LABORATORIES (UL): A testing and certification laboratory that provides standards and tests equipment for safety. Some of their standards are used in Coast Guard regulations by reference such as those for smoke detectors and commercial cooking exhaust hoods. UL information can be found at www.ul.com.

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA): A professional organization that sets standards for firefighting equipment and standards for fire prevention. Some of their standards are included in Coast Guard regulations by reference such as those for a National Electrical Code and for pleasure and commercial motor craft. NFPA is available online at www.nfpa.org.

SEAFARERS HEALTH IMPROVEMENT PROGRAM (SHIP):

The Seafarers Health Improvement Program (SHIP) was initiated in 1978 by the United States Public Health Service to improve the health status of seafarers, their health environment, medical care and safety aboard ship, and communication between parties responsible for the health and safety of American seafarers. The program is a collaborative effort of representatives of the maritime industry, physicians, and concerned governmental agencies. Principal achievements of SHIP include establishment of Entry Level Standards and Retention Guidelines for seafarers, development of the Seafarer Emergency Medical Training Program, and initiation of a program making medical records available on board.

3.3 DEFINITIONS

3.3.1 TONNAGE

Other than weight as in displacement, discussed below, other forms of tons and tonnages are arcane descriptors of ship size that may readily be traced back to the *Magna Carta* and beyond. The numbers so derived are used to determine fees and applicability of national and international regulations. For officially determining which version and formula applies and calculating tonnage the services of a professional naval architect are required.

GROSS AND NET REGISTERED TONS: A “registered ton” is a measure of volume, in which one registered ton = 100 ft^3. There are two types of registered tonnages:

“Gross” and “Net”. Gross Registered Tonnage (GRT) is the total enclosed volume of the vessel, minus certain exempted spaces. Net Registered Tonnage (NRT) is the GRT minus certain deducted spaces. Exempted and deducted spaces are determined according to measurement regulations for U.S., Panama, and Suez tonnage. Tonnage certificates, to the extent required by the vessel’s operations, are carried on board with GRT and NRT being permanently affixed to the vessel. (46 CFR 69.107*)*

CONVENTION TONNAGE: This is tonnage as determined under the International Convention on Tonnage Measurement of Ships, 1969. New documented vessels and new vessels engaged on a foreign voyage that are 79 feet or over are required to be measured under the Convention Measurement system. Existing vessels that undergo a change that substantially affects the gross tonnage and are otherwise required, would have to be measured under the Convention Tonnage system. After July 1994 all existing vessels over 79 feet that engage in a foreign voyage have to be measured under the Convention Tonnage System as well as the existing system. (46 CFR 69.11)

NVIC 11-93 Change 3 provides guidelines on applying tonnage measurements to U.S. Vessels and helps to determine how this affects the application of U.S. and International regulations. Convention Tonnage when used to determine application of regulations and treaties will be referred to as Gross Tonnage (GT). Domestic tonnage measurements used for the application of regulations will be referred to as Gross Registered Tonnage (GRT) or Net Registered Tonnage (NRT) as defined above.

DISPLACEMENT: Displacement is the weight of water displaced by a vessel and is equal to the vessel’s actual weight. Displacement is used in stability calculations. A “displacement ton” is a measure of weight stated in long tons of 2,240 pounds/ton, or in metric tons (1,000 kilograms or 2,205 pounds).

DEADWEIGHT: The “deadweight” of a vessel is its total weight when floating at the load waterline, minus its “lightship weight”. Lightship weight includes the vessel’s structure, machinery, permanent outfit and so forth. Deadweight may be subdivided into “operating deadweight” and “payload.” Operating deadweight includes all items required to operate the vessel, including crew and effects, fuel, lube oil, fresh water and stores. Payload includes all items of deadweight not directly concerned with operations, including non-crew personnel and effects, equipment other than that considered part of the ship, instrumentation not concerned with ship operations, and cargo.

Note that the variations of displacement provide an accurate “weight” of the ship, and are to be used in calculations involving stability, loading, and the like. Registered tonnages are to a large extent artificialities, but they are those, which are involved in many licensing and documenting procedures, rather than the actual displacements.

3.3.2 TYPES OF VESSELS

VESSEL: Any watercraft, other than a seaplane, used as a means of transportation.

SHIP: Often used interchangeably with “vessel,” the preferred legal term.

U.S. ACADEMIC RESEARCH FLEET - Those vessels operated by UNOLS operating institutions that are subject to the UNOLS scheduling process. ARF vessels may be owned by NSF, Navy or member institutions.

MOTOR VESSEL: A vessel more than 65 feet in length, which is equipped with propulsion machinery, other than steam. (46 CFR 24.10-1)

MOTOR BOAT: Motorboat includes every vessel propelled by machinery and not more than 65 ft. Excluded are tugboats and towboats propelled by steam, tank vessels, cargo and miscellaneous vessels, and research vessels. Motorboats are classed as; Class A -- less than 16 ft; Class 1 -- 16 ft - 26 ft; Class 2 -- 26 ft - 40 ft; Class 3 -- 40 ft - 65 ft. (46 USC 526 and 46 CFR 24.10-1)

DOCUMENTED VESSEL: A vessel of greater than 5 net tons, which is registered, enrolled or licensed as a "vessel of the United States." This is a requirement for engaging in "trade or commerce." UNOLS research vessels are not ordinarily engaged in "trade or commerce;" commercial vessels ordinarily are.

UNDOCUMENTED VESSEL: Any vessel, which is not required to, and does not, have a marine document issued by the USCG. (46 CFR 188.10-75)

INSPECTED VESSEL: Is one that is inspected and certificated by the USCG. Motor vessels, tank vessels, and the majority of other non-public vessels over 300 GRT are required to be inspected. 46 CFR Table 188.05-1(a) identifies vessels to which the inspection laws apply.

UNINSPECTED VESSEL: A vessel not certificated under the inspection laws or subjected to regular inspections by the USCG. Fishing vessels, recreational motorboats, and oceanographic research vessels less than 300 GRT are examples. Uninspected vessels, however, are still subject to rules about safety and, in some cases, licensed personnel. (46 CFR Subchapter C, 24 et seq.)

VESSEL IN CLASS: A vessel is said to be "in class" when it holds a current certificate of classification issued by a recognized classification society, such as American Bureau of Shipping, Lloyds, Bureau Veritas, and other members of the International Association of Classification Societies (IACS). The certificate of classification signifies conformity with prescribed standards of structural strength, machinery, and equipment, providing for seaworthiness and safety in connection with marine insurance.

OCEANOGRAPHIC RESEARCH VESSEL: A vessel, which the USCG determines is being employed only in instruction in oceanography or limnology, or both, or only in oceanographic or limnological research, including those studies about the sea such as seismic, gravity meter, and magnetic exploration and other marine geophysical or geological surveys, atmospheric research, and biological research. This is a formal designation in writing by the cognizant Coast Guard Marine Safety Office (MSO). (46 CFR 188.10-53, 46 USC 2101(18) and 2113)

NUMBERED VESSEL: A vessel that is numbered under the provisions of the Federal Boat Safety Act of 1971. Oceanographic research vessels not engaged in commerce are not required to be documented, and may therefore become numbered vessels (except for certain federal and state owned vessels). (46 CFR 188.10-49)

PUBLIC VESSEL: Under federal shipping laws (46 USC 2101(24)), a public vessel means a vessel that is owned, or chartered, and operated by the U.S. Government and is not engaged in commercial service. Examples would be USCG and NOAA research vessels.

3.3.3 OPERATIONS

NAUTICAL MILE (nm): The internationally agreed standard sea mile, 1,852 meters or 6,076 feet, is commonly used in laws, regulations and treaties for specifying distance at sea or offshore.

RESEARCH CRUISE: Voyage by a vessel primarily for the purpose of conducting marine research at sea. This is commonly defined as commencing on the day of departure, and terminating on the day of return to a port.

TRANSIT: Voyage of a vessel during which little or no research is being carried out; primarily for the purpose of going from one port to another, or to/from a port and an area of research.

LAY DAYS: Days in homeport for purposes of fitting out, cruise preparation, crew rest, and upkeep. May, in rare cases, include similar periods in other ports.

MAINTENANCE DAYS: Days undergoing overhauls, dry-docking, or other scheduled or unscheduled repairs during which the ship is not available for service.

OPERATING DAYS: All days away from homeport in an operating status incident to the scientific mission.

DAYS AT SEA: All days actually at sea incident to the scientific mission.

DAYS OUT OF SERVICE: Periods in which a ship is laid up out of service for an extended period for reasons of disease, economy, unemployment, or unfitness for service.

OCEAN: Used to describe an operating area or route in any ocean or the Gulf of Mexico, more than 20 nm offshore. (46 CFR 188.10-51)

NEAR COASTAL: "The term near coastal means ocean waters not more than 200 nautical miles off a US shore." (46 CFR 10.103)

NEAR COASTAL AS PER STCW REG I/1: "STCW defines near coastal as a voyage in the vicinity of a signatory party. Each signatory party defines its own boundary for near coastal waters. It may not be consistent with 46 CFR 10.103.

COASTWISE: Used to describe a route or operating area, which is not more than 20 nm offshore, on any ocean, Gulf of Mexico, Caribbean Sea, Gulf of Alaska, and such other waters as may be designated. (46 CFR 188.10-15)

DOMESTIC SERVICE: "Domestic Service means a vessel used in trade from one U.S port to another U.S. port, or a voyage to nowhere that returns to the originating port." (NVIC 7-00

BOUNDARY LINES: "Boundary lines are lines drawn following the general trend of the seaward, high-water shorelines and lines continuing the general trend of the seaward, high-water shorelines across entrances to small bays, inlets, and rivers." (NVIC 7-00 and 46 CFR 7)

INTERNATIONAL VOYAGE: A sea voyage, by a mechanically propelled vessel of 500 gross tons or more, from a country to which SOLAS applies, to a port outside that country, or conversely. Within Subchapter U of 46 CFR, the USCG treats voyages between the contiguous United States, Hawaii and Alaska as international voyages. NOTE: State numbered vessels in accordance with the Federal Boating Safety Act of

1971, or vessels holding a special exemption issued by the Coast Guard need not comply with regulations applicable to vessels on an international voyage. Such voyages are therefore termed "foreign voyages." (46 CFR 188.05-10, 46 CFR 188.10-35)

FOREIGN VOYAGE: A voyage between two countries or between two territories or possessions of the U.S, by a vessel which is not subject to the SOLAS provisions because of its size, propulsion, or documentation. Vessels engaged in such voyages, if 150 gross tons or over that were built before July 21, 1968 or if 79 feet or greater in length and built on or after July 21, 1968, must comply with load line requirements. After July 1984 existing vessels over 79 feet in length, and engaged in a foreign voyage, must be admeasured under the convention measurement system. (46 CFR 42.03-5, 46 CFR 69.9 & 69.11)

COLREGS: The Rules of the Road. Published by the U.S. Coast Guard as *Navigation Rules and Regulations Handbook* (ISBN 9780160954061; GPO Stock Number 050—12-00519-2).

3.3.4 PERSONNEL

CREW: Personnel involved exclusively or primarily in the navigation and operation of a vessel.

PASSENGER: Every person other than the crew or other persons engaged on board a vessel in the business of the vessel. However, on oceanographic research vessels scientific personnel are not considered to be passengers. Research vessels may not carry passengers for hire, because this would constitute engaging in "trade or commerce." (46 CFR 24.10)

SCIENTIFIC PERSONNEL: "Scientific personnel on oceanographic research vessels are not considered to be seamen or passengers, but are considered as persons when requirements are based on total persons on board." and "Scientific Personnel - This term means those persons who are aboard an oceanographic research vessel solely for the purpose of engaging in scientific research, or in instructing, or receiving instruction, in oceanography or limnology, and shall not be considered seamen under the provisions of Title 46, United States Code." (46 CFR 188.10-71 and 46 CFR 188.05-33)

MASTER: The designated member of the crew of a vessel who is in legal overall charge of the entire operation of the vessel. See chapter on "Crewing" for further discussion. The term "captain" is used almost interchangeably.

CHIEF SCIENTIST: The designated member of the scientific personnel who is in overall charge of the research operations on board ship. See section on "Crewing" for further discussion.

PRINCIPAL INVESTIGATOR (PI): The individual in charge of a research grant that is being supported on a research cruise. Research cruises often support more than one PI making it necessary to coordinate cruise planning, safety procedures and science operations for several groups with different goals and from different institutions. This is usually coordinated through the Chief Scientist who may or may not be one of the PIs.

MARINE TECHNICIAN: An employee or representative of the ship operator responsible for at sea operation of oceanographic instrumentation and onboard laboratory facilities. These individuals are legally part of the science party, but are in fact an integral part of the research vessel operator's shipboard personnel supporting the science mission. They are responsible for helping to ensure safety in the laboratories and on deck during science operations and often have key responsibilities during emergency procedures. They serve as a primary point of contact between the scientific party and the ship's crew. Marine Technicians can also be referred to as Resident Technicians, Marine Science Technician or other similar titles.

EXPEDITION LEADER: This is a term that is often applied to the leader of a submersible crew deployed on a research vessel. This individual is responsible for the safe operation of Human Occupied Vehicles (HOV), Remotely Operated Vehicles (ROV) or other submersibles. They are legally part of the science party on a research vessel, but have a key role in helping to ensure the safe operations of submersibles. Other similar titles may be used for this position.

CREDENTIALS FOR MARINERS: Under Title 46 USC, the U.S. Coast Guard is the domestic authority for promulgating requirements and issuing credentials for mariners. Each marine credential has specific requirements as to age, citizenship, physical condition, character, qualifying sea service, assessment and specialized training. The Coast Guard issues Merchant Marine Credentials (MMCs) for all crew positions. Any credential may contain limitations as to vessel type, tonnage, propulsion, horsepower, or water upon which service is authorized. MMCs are also issued to unlicensed personnel who support ship operations. Unqualified rating MMCs are issued to entry-level persons who have little or no sea service. These are ordinary seaman (deck department), wipers (engineering department), or food handler (steward department). Additionally, qualified rating MMCs are issued based on previous sea service or specialized service. Deck department qualified ratings are able seaman and bosun; for engineering the qualified rating is Qualified Member of the Engineering Department (QMED). Various endorsements or rating are also issued on MMCs to qualified individuals. These include oiler, junior engineer, pumpman, lifeboat man, tankerman, GMDSS at sea maintainer, etc. To serve aboard inspected vessels, an individual must possess a credential but must also hold a Domestic and/or an STCW certificate.

INTERNATIONAL CONVENTION ON STANDARDS OF TRAINING, CERTIFICATION AND WATCHSTANDING FOR SEAFARERS (STCW-95): The convention initially held in 1978 was amended in 1995. It requires comprehensive training and assessment of a mariner's practical skills. These standards were adopted by the U.S. under 46 CFRParts 10 and 15 and the STCWcode. To obtain an STCW certification, a seafarer must meet the requirements set forth in the regulations. A license or MMC will not be issued if the STCW certification is not presented when applying for a vessel that works in International Waters.

OFFICER COMPETENCY CERTIFICATES AND CONVENTION OF 1936 (46 CFR 15.701): Provisions of the Officer Certificates Convention of 1936 are incorporated into U.S. regulations in this part of the CFRs. It applies to documented vessels 200 GRT and over navigating outside of the boundary line. Public vessels and undocumented vessels less then 300 GRT are exempted. The convention requires masters, mates and engineers to hold licenses.

3.3.5 TYPES OF CERTIFICATION AND DOCUMENTATION

Certification and documentation of vessels in the various forms is not in itself a safety standard. Rather, it defines categories of vessels to which certain safety rules and standards apply. In most instances certification and documentation are dictated by the pertinent laws and regulations, with which the operator must comply. In a few cases, there is a choice, owing to the unique nature of research vessel operation. In general the standards set by each category of certification will be adequate for ordinary operations, but prudent operators will often go beyond the legal minimums. Examples of this would be in the case of additional fire extinguishers, or lifesaving equipment. UNOLS operators are urged to recognize the legal requirements as minimums, and take additional steps as the situation may justify in each case.

DOCUMENTATION: Certificates of registry, enrollment, or license are Federal maritime documents required by vessels engaged in trade or commerce. Oceanographic research vessels under 46 USC 2101(18) are not required to be documented, but may be at the option of the operator. If documented, however, the certification should clearly define the vessel's service as "Oceanographic Research." No special advantages accrue, nor are restrictions avoided, by documentation, insofar as research vessel safety is concerned. (46 USC 121 and 46 CFR 67)

NUMBERING: Undocumented research vessels are usually numbered in accordance with the Federal Boat Safety Act (excepting certain federal- or state-owned vessels). Thus, the state-issued "Award of Number" becomes the official certificate identifying the vessel. Most state certificates do not have a routine box to check for "research," and it is important for the operator to see that this special use is clearly indicated.

OWNER'S CERTIFICATE: The unique and sometimes confusing role of marine research in the context of the U.S. shipping laws and regulations makes it advisable that all research vessels carry a letter, certificate, or plaque stating that the vessel is operated in oceanographic research under the laws of the U.S. This should include an affirmative statement that the vessel is complying with the provisions of 46 USC 2101(18). Such certification will help to avoid difficulties both in the U.S. and abroad.

USCG LETTER OF DESIGNATION AS OCEANOGRAPHIC RESEARCH VESSEL: 46 CFR 3 establishes US Coast Guard procedures for a designation as oceanographic research vessels. The designation is voluntary and is for the purpose of providing relief from otherwise applicable vessel inspection and the "Employment of Seamen" requirements. Such designation is necessary for the vessel to benefit from the exemptions of Subchapter U (46 CFR 188). Without this letter of designation, scientific personnel on board must be considered either crew or passengers. To be designated, a written request should be made to the local USCG officer in charge of marine inspection. The request must contain the information specified by 46 CFR 3.10-1. If the vessel is found to be employed exclusively in oceanographic or limnological research and/or instruction, a designation will usually be granted. For inspected research vessels, designation will be indicated on the certificate of inspection and is valid for the duration of the certificate. For uninspected research vessels a letter of designation will be issued. This letter of designation, which is valid for two years, must be requested by mail 60 days in advance of expiration.

INSPECTION CERTIFICATE: Oceanographic Research Vessels 300 GRT or greater are usually required to be inspected and certificated by the USCG. (46 CFR Subchapter U; 46 CFR 188.05-1)

ABS CLASSIFICATION: ABS classification of both hull and machinery is a detailed survey of the material condition of the vessel. This is not directly safety-related, but obviously bears heavily on the basic safety and operability of the vessel. In most matters of insurance and equity, ABS classification is attractive, and unless there is some strong reason to the contrary, it is recommended.

COURTESY INSPECTION OR UNINSPECTED VESSEL EXAMINATION: The USCG Auxiliary offers courtesy motorboat inspections for vessels that are moored as well as underway. The USCG may board and inspect any U.S. vessel at any time while underway. The annual sticker that is issued by the auxiliary as a result of a satisfactory inspection will be recognized by the USCG as showing the vessel as in compliance with the Boating Safety Act of 1971. Uninspected vessels may request an "Uninspected Vessel Examination" from a local USCG Sector Office. This service, which is advisory rather than regulatory, depends on the availability of USCG personnel and is not available from all offices. Neither of these "inspections" are mandatory but it is recommended that vessels under 65 ft undergo an auxiliary inspection and large vessels undergo the uninspected vessel examination, if available.

INTERNATIONAL CONVENTION FOR THE PREVENTION OF POLLUTION FROM SHIPS 1973 (33 CFR 151.59 and 33 CFR 155.700) (MARPOL): The provisions of MARPOL and its 1978 modified protocol are incorporated into the US regulations under these CFRs. Designed to minimize pollution of the high seas including the dumping of oil and exhaust pollutions. It contains six annexes. Each addresses a separate area of pollution. Annex 1 - Oil, Annex II - Noxious Liquid Substances carried in bulk, Annex III - Harmful Substances carried in bulk, Annex IV - Sewage, Annex V - Garbage, and Annex VI - Air. Annex I and II are obligatory to parties to the agreement. Annex III to VI are voluntary.

3.4 <u>LAWS AND REGULATIONS</u>

3.4.1 APPLICABLE TO ALL VESSELS

CODE OF FEDERAL REGULATIONS (CFR): A compilation of the rules and regulations made by Federal executive departments and agencies, pursuant to the authority of a Federal law. Most material concerning shipping is contained in Title 46 of the CFR. This is divided into chapters and subchapters, of which Subchapter U contains rules for oceanographic vessels. For example, "46 CFR 192" means Part 192 of Title 46 of the CFR. Not all CFRs apply to all vessels but those that do apply must be followed.

UNITED STATES CODE (USC): A compilation of the laws of the U.S., generally arranged by subject matter under "Titles." Shipping laws are primarily contained in Title 46 of the code, which contains the Oceanographic Vessels Acts of 1964. Note that the USC contains actual laws from Congress; the CFR contains agency generated regulations. Like the CFRs not all code applies to all vessels but those that do apply must be followed.

INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA (SOLAS): An international treaty, periodically modified, concerning safety at sea. The U.S. follows the provisions of the treaty and incorporates them in U.S. laws and regulations. Undocumented vessels, fishing vessels, vessels under 500 GT and certain others are not subject to the general SOLAS rules. (46 CFR 188.05-10)

JONES ACT (46 USC App 688a): The Jones Act was written to protect seamen injured while working. Under the Jones Act, a seaman is entitled to recover damages if he is injured during employment and they can elect a jury trial to recover damages. If a seaman is killed, a personal representative may bring a Jones Act suit to recover damages. The statute of limitations for a maritime injury suit under the Jones Act is three years. However, the courts have applied either the "time of event" rule or also the "discovery" rule in establishing the start of the statute of limitation. Historically, a Jones Act case has provided a very high cash settlement, compared to Workers Compensation, when either the slightest appearance of negligence or un-seaworthiness of the vessel could be demonstrated. Scientists are not considered seamen for the purposes of the Jones Act. The term seaman as defined by the Jones Act historically has been interpreted broadly. ARF vessels must be aware of this when embarking persons who are not part of a science party. (See Workers Compensation below.)

WORKERS COMPENSATION: Workers compensation is a State program that varies widely from state to state. It is traditionally designed to provide medical care, disability payments, and income benefits to employees hurt on the job. Workers Compensation settlements usually provide for lost wages and medical bills. Death benefits generally provide payment for life to a surviving spouse. While some court decisions have ruled that workers compensation may apply in lieu of a Jones Act settlement, this does not prohibit a seaman covered under workers comp from also bringing a Jones Act suit to collect damages nor does it mean he will not receive compensation under the Jones Act. (See Jones Act above.)

IEEE 45: A Standard issued by IEEE titled "Recommended Practices for Electrical Installations on Shipboard." As revised, it is a widely accepted standard for shipboard electrical systems.

3.4.2 APPLICABLE TO INSPECTED VESSELS 46 CFR Subchapter U – Oceanographic Research Vessels. This subchapter defines the regulations for research vessels of 300 GRT or more. They are not all inclusive and further applicable regulations may be found in other parts of the CFRs. While applicable to vessels of 300 GRT or larger, **it is prudent for uninspected vessels to comply with these regulations to the maximum extent possible**.

3.4.3 APPLICABLE TO VESSELS BASED ON TONNAGE

3.4.3.1 VESSELS 200 GT OR GREATER

INTERNATIONAL SHIP AND PORT FACILITY SECURITY CODE (ISPS): In the wake of the 9/11 attacks on the USA, the ISPS code was developed as part of SOLAS. ISPS is a comprehensive set of measures to cope with perceived threats to enhance the security of ships and port facilities. The purpose of the code is to provide a standardized, consistent framework for evaluating risk, enabling Governments to offset changes in threats with changes in vulnerability for ships and port facilities by determining appropriate security levels and corresponding security measures. It has three different security levels based on threats that contracting countries may implement. It requires facilities and ports to assess the threat and evaluate the risk of potential unlawful acts. Measures to minimize and combat these threats must be developed in a security plan and the plan approved by the contracting state's ISPS certification authority. If a ship's security plan is approved, the ship will be issued an International Ship Security Certificate. Ships not holding a valid security certificate may be detained in port until a certificate is received, may be expelled from a port, or may be refused entry. All ships that visit other ports particularly foreign ports should develop a security plan and obtain a ship security certificate. In addition, Automated Information System (AIS), a broadcasting device similar to an aircraft's Identification Friend or Foe (IFF) is required. A Ship Security Alert System (SSAS), an alert system designed to raise the alarm ashore in reaction to security treats or incidents, is being investigated and may become a future requirement.

In the USA, the U.S. Coast Guard reviews and approves ISPS security assessments and plans. It issues security certificates and ensures compliance. It does so under 33 CFR 101 and 104. ISPS code applies to vessels subject to 46 CFR Chapter I Subchapter L. In addition, the Coast Guard enforces the provisions of the Maritime Transport Safety Act of 2003 (MTSA). For this reason, the ISPS code is frequently referred to as ISPS/MTSA. NVIC 04-03 provides guidance in implementing the ISPS/MTSA provisions. Under 33 CFR 401.20 an AIS is required for all commercial vessels over 200 GT and with a length over all of 20 meters or more.

INTERNATIONAL CONVENTION ON STANDARDS OF TRAINING, CERTIFICATION AND WATCHSTANDING FOR SEAFARERS (STCW-95): With few exceptions, STCW applies to mariners employed on vessels 200 GRT or 500 GT that operate seaward of the boundary line specified in 46 CFR 7. Vessels specifically exempted from having STCW-qualified mariners aboard are uninspected passenger vessels defined in 46 USC 2101(42), fishing vessels (46 USC 2101(11) 9(a) and (b), and vessels operating exclusively on the Great Lakes.

ENVIRONMENTAL PROTECTION AGENCY (EPA) GENERAL VESSEL PERMIT: EPA regulates discharges incidental to the normal operation of commercial vessels greater than 79 feet in length and operating as a means of transportation primarily through the Vessel General Permit (VGP). The first VGP was issued in 2008 to be effective until December 19, 2013. On March 28, 2013, EPA re-issued the VGP for another five years. That reissued permit, the 2013 VGP, took effect December 19, 2013 and superseded the 2008 VGP at that time. On December 4, 2018 the Vessel Incidental Discharge Act was signed, requiring the EPA to develop new national standards. Estimated completion of these new standards is in 2022, at which point regulatory authority transfers to the Coast Guard.

3.4.3.2 Vessels 300 GRT or greater

46 CFR SUBCHAPTER U - OCEANOGRAPHIC RESEARCH VESSELS: This subchapter defines the regulations for research vessels of 300 GRT or more. They are not all inclusive and further regulations that apply may be found in other parts of the CFRs.

3.4.3.3 VESSELS 400GT OR GREATER

MARPOL 73/78 ANNEX I, REGULATION 9 AND 26: Contains requirements for maintaining an oil record log for all vessels over 400 GT, specifies the requirements for maintaining a shipboard oil pollution plan and oil transfer procedures (see NVIC 2-93 change 1 for more information).

OIL POLLUTION ACT OF 1990 (OPA 90) (33 CFR 138, 33 CFR 155.1010, NVIC 03-06/ US MARINE TRANSPORTATION ACT OF 2004 (NVIC 01-05)): .

"The act established the Oil Spill Liability Trust Fund. It also requires vessels over 400 gross tons to have an Oil Spill Response Plan that is approved by the US Coast Guard in order to sail and vessels over 300 GT to establish and maintain evidence of financial responsibility in the form of a Certificate of Financial Responsibility (COFR) issued by the U.S. Coast Guard."

OIL SPILL REMOVAL ORGANIZATION (OSRO): A major feature of the National Response System and Marine Transportation Act of 1970 is that vessels over 400 GT are required to ensure the US Coast Guard the availability of response resources to meet their maximum, most probable and worse case discharge of oil into US waters. These resource requirements can be met by private contracts. This requires US Coast Guard approval of the vessel response plan and organization. This requirement is still evolving, however, certain States require these plans when transiting their waters. NVIC 01-05 provides guidance for submission and U.S. Coast Guard approval of these plans.

3.4.3.4 VESSELS 500 GT OR GREATER

INTERNATIONAL MANAGEMENT CODE FOR THE SAFE OPERATIONS OF SHIPS AND POLLUTION PREVENTION (International Safety Management (ISM) Code) (46 USC 32, 33 CFR 96.100 et seq.):

"Adopted by IMO in 1978 and amended in 1995, this convention outlines training requirements for personnel serving as crewmembers aboard vessels in order for them to qualify for the required STCW certification. The ISM code establishes safety management objectives and requires a formal, written Safety Management System (SMS) to be implemented onboard certain vessels and at the management company which assumes responsibility for operating these ships. ISM code also requires every vessel over 500 GT to be issued a safety management certificate (SMC) that verifies the company and its shipboard management operate in accordance with the approved safety management system. To obtain and maintain the SMC, the ISM code requires that a US Coast Guard approved external auditing agent approve the initial SMS and that an annual external audit be conducted. It also requires internal audits be conducted. The ISM code also established a new position, the Designated Person Ashore (DPA), and the distinct responsibilities of this person are delineated. The DPA is designated in writing by the company and must have direct access to the company's highest level of management. The DPA will ensure the safe operation of the vessel and provide a link between the company and those on board. The DPA must have the responsibility and authority to monitor all safety and pollution prevention aspects of vessel operations and ensure that adequate resources and shore-based support are supplied. It is the responsibility of the company to identify the best candidate to fill the role of the DPA. Within the UNOLS fleet, the Institution operating the vessel is the company and in most instances the Institute will designate its Marine Superintendent as the DPA. This is a new concept in the marine industry where responsibility for safety is

now shared between the DPA and vessel's Master. This concept of shared responsibility has yet to be fully tested by the courts."

3.4.4 APPLICABLE TO UNINSPECTED VESSELS

MOTORBOAT ACT: A federal law enacted originally in 1940 and subsequently amended, which covers many aspects of safety for small craft. (46 USC 41)

FEDERAL BOAT SAFETY ACT OF 1971: Act setting forth certain requirements concerning documentation and safety, principally applicable to small craft (46 USC 43, 46 CFR 24-27). Safety for recreational vessels is contained in 33 CFR Subchapter S, 173 et seq.

3.4.5 APPLICABLE TO VESSELS ON INTERNATIONAL OR FOREIGN VOYAGES

INTERNATIONAL LOAD LINE ACT (46 USC 71 and 46 CFR 42 et seq.): This act concerns stability standards and inspections. It is applicable to certain vessels sailing beyond the Boundary Line. This certificate is issued by ABS for U.S. vessels and is required for most vessels on foreign or international voyages.

3.4.6 INTERNATIONAL POLAR CODE

Vessels operating in the Arctic or Antarctic polar regions are required to comply with the International Polar Code. This standard specifies life saving equipment which must be on board.

The date of entry into force of the SOLAS amendments was 1 January 2017, under the tacit acceptance procedure. It applies to new ships constructed after that date. Ships constructed before 1 January 2017 are required to meet the relevant requirements of the Polar Code by the first intermediate or renewal survey, whichever occurs first, after 1 January 2018.

3.5 RECOMMENDATIONS

SAFETY STANDARDS FOR SMALL CRAFT: Standards issued by the ABYC concerning safety of small craft (e.g. ABYC E-1-1972).

LOAD LINE CERTIFICATE: Uninspected research vessels, which do not engage in international voyages, are not required to have a load line certificate, **but unless there is some strong reason to the contrary, it is recommended**.

46 CFR SUBCHAPTER U - OCEANOGRAPHIC RESEARCH VESSELS: While applicable to vessels of 300 GRT or larger, **it is prudent for uninspected vessels to comply with these regulations to the maximum extent possible**.

4. OPERATIONS

4.0 INTRODUCTION

The safe operation of conducting marine research aboard oceanographic research vessels is based on sound seamanship and accepted nautical science practices. This chapter covers operational practices from both a marine operations and scientific research perspective. It is important for crew, technicians and science party members to always consider the unique nature of conducting science at sea. This adds a level of complexity that may not be found in other maritime fields.

4.1 REFERENCES

Certain operations for inspected vessels are regulated by 46 CFR 185-196 of Subchapter U and for uninspected vessels by 46 CFR, Part 26 of Subchapter C. Other operations affecting the navigation of vessels, and “rules of the road” are contained in 33 CFR, Chapter I. Recent developments to combat terrorism have added Subchapter H, Maritime Security, to Chapter 1 of 33 CFR; all operators are encouraged to familiarize themselves with parts 101, and 103 thru 106 of this section. Uninspected vessels, insofar as practicable, should use the provisions of 46 CFR 196 as well as internal policies of the operating institution for essential operational safety.

4.2 REQUIRED BY REGULATIONS FOR ALL VESSELS

4.2.1 SAFETY ORIENTATION

Before getting underway or as soon as possible afterwards, a formal safety orientation for all embarked science party members is required. Participation is mandatory. Areas to be covered should include as a minimum: stowage and proper donning of lifejackets and/or immersion suits, type and location of lifesaving devices, location of emergency equipment, damage control lockers, emergency lighting, emergency escape hatches, and means of egress, the viewing of the RVOC safety and harassment prevention videos, and any other instructions relating to safety for the particular vessel. (46 CFR 185.506 and 46 CFR 26.03-1). Based on recent vessel mishaps, egress training, including practice egress with blindfolds, is required for all new crewmembers and science party personnel.

See also Sections 6.1.3 and 17.5. Appendix G provides a safety orientation guide for newly embarked personnel.

4.2.2 EMERGENCY PROCEDURES

Posted instructions for crew and science party to follow in case of emergency are required. (46 CFR 199.80)

4.2.3 CHARTS AND NAUTICAL PUBLICATIONS

Appropriate charts and publications for the voyage shall be carried. They shall be maintained up to date, and of the appropriate scale to facilitate safe navigation at all times. Electronic charting systems supplement but do not replace the requirement to maintain an up to date chart library for the region of vessel operations. (46 CFR 130.330)

4.2.4 VOYAGE PLANS

The Master must prepare a voyage plan that includes a Crew and Science Party list before departure. The usual Passenger List is often presented as "Scientific Crew List" or something similar to clearly distinguish that the Science party members are not "Passengers." (46 CFR 185.503)

4.3 REQUIRED REGULATIONS FOR CERTAIN VESSELS

4.3.1 REQUIRED BASED ON TONNAGE OR SIZE

4.3.1.1 OIL TRANSFER PROCEDURES

All vessels, whether inspected or uninspected, with a fuel capacity of more than 250 barrels (10,500 gallons) of oil are required to have written oil transfer procedures. These procedures must be available during a USCG inspection and must be permanently mounted where the procedures can be easily seen and used by crewmembers engaged in oil transfers. These procedures must apply to both bulk fuel oil transfers to or from another facility and internal transfers between the vessel's tanks. The requirements for these procedures are contained in 33 CFR 155.720 and 33 CFR 155.730.

If there is an ISM system in place, there should be a specific procedure for the guidance of loading and transfer of fuel oil and lube oil.

4.3.1.2 OIL RECORD BOOK

An oil record book (Form CG-4602A) is required to be maintained by all vessels 400 Gross Tons (GT) and above under International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78, Annex I, Chapter II, Regulation 9. Log entries are to be made whenever a vessel discharges ballast or cleaning water from fuel tanks, disposes oily residue (sludge), bunkers, discharges engine room bilge water or has an accidental discharge into the water. Detailed instructions for maintaining the log are contained in the record book.

4.3.1.3 REFUSE RECORD BOOK

33 CFR 151.55 requires that vessels over 40 meters (131 feet) in length maintain a Refuse Record Book in which log entries are made by the Master whenever garbage is transferred to another ship or shore facility, or whenever garbage is incinerated or dumped over-the-side. The log entry is to include the date, position, or port where disposal occurred and the amount in cubic meters. The log must be available to the USCG during a boarding or inspection. The log must also be kept for two years after a logbook is full. A waste management plan and mounted warning placard that prohibits the discharge of prohibited refuse over-the-side is also required.

4.3.2 REQUIRED FOR INSPECTED VESSELS

4.3.2.1 STABILITY LETTER

If a stability letter is issued in accordance with 46 CFR 170, it shall be posted in the pilothouse (46 CFR 170.120 and 46 CFR 196.12).

4.3.2.2 STATION BILLS

All research vessels should have posted in conspicuous places station bills setting forth the duties of the crew and scientific personnel under emergency situations. New personnel should be indoctrinated in their duties. (46 CFR 199.80)

4.3.2.3 DRILLS

Drills must, as far as practicable, be conducted as if there were an actual emergency. Every crewmember on board must participate in at least one abandon-ship drill and one fire drill every month. The drills for the crew must take place within 24 hours of the vessel leaving a port if more than 25 percent of the crew have not participated in abandon-ship and fire drills on board that particular vessel in the previous month (46 CFR 199.180). A ship specific training manual should be developed. Conduct of drills should be noted in the deck log.

4.3.2.4 MEDICAL

All research ships and boats, of whatever size, must carry first aid kits, jump bags, and other medical supplies as appropriate for the size of vessel, number of persons aboard, and operational pattern. In particular, ships on extended voyages, or in areas remote from shore medical assistance should carry fully adequate medical supplies and instructions. Specific guidance as to medical supplies should be obtained from a competent medical support activity. Selected personnel should be trained in basic First Aid and Cardiopulmonary Resuscitation (CPR). Additionally, the Standards of Training, Certification & Watchkeeping (STCW) requires crewmembers to demonstrate competence to undertake listed tasks, duties, and responsibilities. Competency can be demonstrated by successful completion of an STCW approved medical training courses. Vessels on ocean, international, or extended voyages should have firmly established procedures for obtaining medical assistance by satellite phone or radio from a medical support activity, and administering it on board. Support involving radio advisory services, pharmaceuticals, medical supplies, training, evaluation and repatriation are available from commercial sources on a subscription and/or contractual basis. All operators should be familiar with and avail themselves of the current UNOLS medical contractor who provides emergency medical advice at sea and routine medical support activity ashore. (46 CFR 72.20-35 - Hospital Spaces)

The following reference books are valuable sources of information:

- “The Ship’s Medicine Chest and Medical Aid at Sea”, 2003 Edition. This book has been updated and is available online at: http:www.uscg.mil/hq/g-w/g-wk/wkh/smc/index.htm
- International Medical Guide for Ships”, Second Edition, World Health Organization, Geneva, 1988.

4.3.2.5 LOG BOOKS

A properly kept ship's log is a recognized part of a well-operated vessel. All research vessels, except small boats on day trips, should maintain a formal logbook in which is entered all appropriate records and data. If in doubt, it is much better to log too much than too little. In addition to the purely operational considerations, it is often found that the ship's log is a useful adjunct source of information for the scientific program, and it thus should include sufficient notations of the research operation to permit relating the scientific logbooks to the ship's operational activities. (46 CFR 196.35 and 46 CFR 78.37)

4.3.2.6 CRUISE (VOYAGE) PLANS

Recognizing that planned cruise tracks are often changed between the time a proposal is submitted and the time of the voyage, either the Master or Marine Superintendent of all research vessels shall ensure that a cruise plan is on file with their home office, prior to sailing, which includes the following information:

- The names of all ship's crew (unless recorded elsewhere).
- The names of scientific personnel (including technicians).
- Designation of Master and Chief Scientist.
- Date/time and place of departure.
- Estimated date/time and place of arrival.
- Cruise track and operating areas.
- Capsule summary of science planned.
- Communications instructions to comply with standards as set out in Chapter 6 of these safety standards, and institutional requirements.
- Early and complete information concerning the use of hazardous materials, explosives, and radioactive material. See Chapters 8 and 9 of these standards.
- Other information as appropriate to safe and effective vessel operations.

A copy of the Cruise Plan should be kept at the institutional facility or other designated base, and a copy should be maintained on board. The termination of the cruise or a port arrival should be reported, and it is the responsibility of the Master to see that this is done. The base facility should establish procedures for prompt follow-up action in case of receipt (or non-receipt) of reports.

4.3.2.7 NOTIFICATION OF HAZARDS

The National Geospatial-Intelligence Agency (NGA) is the point of contact for ship operations that use sonic emitters, towed devices, explosive charges, or deploy moored instrumentation. These items could pose a hazard to the safe navigation and operation of submarines and in some cases to surface vessels, particularly those engaged in fishing, towing or other research work. NGA will disseminate this information through the Notice to Mariners and broadcast warnings as well as directly to appropriate Naval commands. Sending the same information directly to the Aids to Navigation office of the appropriate Coast Guard District and in some cases to local Naval Commanders may improve the level of notification and improve local co-ordination of operations.

To contact NGA to update a chart, or submit a notification: http://www.nga.mil

Click on "Products and Services" then on the Nautical section on the web site, and then click on the "Maritime Safety Information" http://www.nga.mil/portal/site/maritime/

4.3.2.8 COLLISIONS, CASUALTIES, AND ACCIDENTS

The actions required at the scene of a collision, accident, or casualty, and the follow-up paperwork, vary with the legal requirements. In most cases, submission of United States Coast Guard (USCG) forms to the USCG Officer in Charge, Marine Inspection (OCMI) is required. As a general rule, if another vessel is involved, the ship is required to render all practicable assistance in addition to identifying itself. Operators and captains should be thoroughly familiar with the particular requirements, which apply, to their vessel since legal and administrative liability will likely be at stake.

In the case of accidents involving injury to personnel, most institutions have very specific requirements for reporting in addition to the USCG requirement noted above. Ship's personnel should be thoroughly familiar with these since they are often crucial to liability or insurance proceedings at the federal, state, or institutional level. Notice of collisions, casualties, and accidents are usually required by the owner of the vessel as part of the Charter Party Agreement.

If the incident qualifies as a "serious marine incident" as defined in 46 CFR 4.03-2, then drug and alcohol testing of the individuals involved, including scientists, is required within twenty four hours and must be reported to the Coast Guard. 46 CFR 4.40

4.3.2.9 SECURITY

Research vessels shall follow the Maritime Security Policies outlined in 33 CFR Subchapter H; parts 101, 104, and 105. Vessels and facilities required by these new regulations shall submit and follow the provisions of a vessel or facility security plan. It is strongly urged that security obligations and requirements be factored into any science expedition.

Marine superintendents and vessel Masters should also consult the National Geospatial-Intelligence Agency web site to download information on piracy and hostile action towards ships. The Office of Naval Intelligence (ONI) *Worldwide Threat to Shipping Report* is a useful tool to avoid trouble spots throughout the world, including piracy updates. The threat of piracy and terrorist groups attacking ships cannot be underestimated or dismissed as unlikely.

4.4 REQUIRED STANDARDS UNDER RVSS

4.4.1 BALLAST WATER MANAGEMENT

33 CFR 151.1510 - Due to the serious problem of invasive species in U.S. waters, all ARF vessels should follow the guidelines established in the USCG Voluntary Ballast Water Management Program. Information can be obtained at: http://www.uscg.mil/hq/gm/mso/mso4/old/estandards.htm.

Vessels over 300 GRT and not owned by the Department of Defense may also have to comply with the EPA regulations regarding Vessel Discharges under the National Pollutant Discharge Elimination System (NPDES). See the EPA web site at: http://cfpub.epa.gov/npdes/home.cfm?program_id=350

4.4.2 USE OF PERSONAL ELECTRONIC DEVICES

While standing any shipboard watch, crewmembers are prohibited from using cell phones, tablets or other computer or electronic systems for personal purposes or entertainment. In particular, bridge personnel using personal electronic devices cannot be deemed as meeting the requirements of Rule 5 of the COLREGs as a proper lookout. This requirement does not preclude the use of cell phones or other devices for the conduct of necessary ship's business, as determined by the ship's Master.

4.4.3 RECREATIONAL SWIM CALLS

Swimming from ARF vessels for recreational purposes is not permitted.

4.5 RECOMMENDATIONS AND BEST PRACTICES

4.5.1 INSTITUTIONAL POLICIES

Policies of a laboratory or institution operating research vessels regarding their safe operation should be clearly stated in written directives and posted or disseminated as appropriate. As operators implement safety management systems in compliance with International Safety Management (ISM) requirements, these policies will become part of the organization's structure of accountability and will be subjected to regular audits and reviews – both at home and by foreign port state authorities. As a minimum, the following should be covered:

- Preparation, use, and handling of cruise plans.
- Communications instructions.
- Authority and responsibility of the Captain and the Chief Scientist.
- Safe loading standards for equipment and personnel.
- Instructions concerning hazardous materials.
- Responsibilities of shoreside support personnel for vessel operations, and procedures for follow-ups in case of overdue vessels or vessels not reporting on schedule.
- A security plan.
- Preventative Maintenance Policy - Each operator is required to have both in writing and in practice a preventative maintenance policy. The policy should include, at a minimum, a designated responsible person(s), qualifications of persons conducting maintenance, inventory of equipment requiring maintenance and inspection, specific maintenance procedures and procedures for reporting and correcting deficiencies.
- Navigation Light Panels - All vessels should have navigation light panels supplied by two sources of power, the panel should visually and audibly signal the failure

of side, masthead, and stern lights at a minimum. There should also be duplicate light sources for the side, masthead, and stern lights.

- Bridge Navigation Watch Alarm - All ships should have a bridge watch alarm system in place.
- 12/24 VDC Navigation and Communication Line Diagram - All vessels should maintain an accurate 12/24 VDC navigation and communication one-line diagram to conduct a load analysis, optimize the bridge electrical distribution, and eliminate the electronic interference problems. Emergency power to critical communications and navigation equipment should be provided via an emergency generator and/or a DC power supply.
- Crew Endurance Management Policy - With the small crew size and 24-hour operations typical on a research vessel, operators should adopt crew endurance management procedures to mitigate risk factors associated with fatigue. See Section 5.3.3.
- Magnetic Compass Deviation Tables - All vessels should have magnetic compass deviation tables posted in clear view of the helm station. They should be updated periodically or when structural or electronic modifications are made in the vicinity of the magnetic compass.
- Warning Placards - All vessels should post a warning placard alerting personnel to remain clear of the antenna deck when electronics are in operation.
- Deck Machinery Controls - All deck machinery controls should be clearly labeled describing the control function and the result of the control movement in words and/or symbols. All deck equipment controls should be labeled consistently and be clearly visible by the operator with adequate lighting and a conspicuous format.
- Hydraulic Hose Preventative Maintenance Program - All hydraulic hoses should be part of a preventative maintenance program which includes an inventory, inspection record, and maintenance and replacement schedule. The information should be entered into a hydraulic hose log containing replacement dates, serial numbers, equipment, hose specifications and supplier information.
- Winch Safety - Personnel protective screens should be installed at each winch control station that is in line with snapback or other tension member dangers. For hydraulically powered winches, a hydraulic pump emergency stop should be installed at each winch control station.
- Deck Safety - A procedure to inform and keep personnel out of harm’s way during deck operations shall be in place. Placards indicating when tension members are in use must be posted.

4.5.2 VESSEL HANDBOOKS

Research vessel operators shall provide cruise handbooks or user manuals with complete information on the ship’s capabilities and procedures for use in planning and conducting cruises. These manuals must be kept current and dated so that users can be sure they have the most current version. These manuals must be posted online and a hard copy placed in each scientist cabin onboard. Principal Investigators and Chief Scientists should thoroughly review and use the appropriate manual when they schedule, prepare for, and carry out their cruise.

5. CREWING

5.0 INTRODUCTION

By their very nature, oceanographic research vessels have unique crewing requirements which must satisfy both governmental regulations, and the science mission requirements of each expedition. In addition, the class of the vessel, (inspected, uninspected, class, SOLAS, domestic, international, inshore, coastal, ocean) will govern manning requirements.

A partial list of the regulatory entities and references include:

- The regulations put forth by the United States Coast Guard (USCG), and the USCG Marine Safety Manual, Chapters 22-26
- Code of Federal Regulations (CFR)
- United States Code (USC)
- Standards of Training, Certification, and Watchkeeping (STCW)
- International Convention for the Safety of Life at Sea, 2004 ed.(SOLAS)
- International Maritime Organization (IMO)
- International Convention on Tonnage Measurement of Ships (ITC)
- Global Maritime Distress and Safety System (GMDSS)

In addition to the crewing requirements set forth by regulations, the number and type of crew on a particular vessel may also be influenced by the science mission requirements of the ship or a particular cruise. The operating area, over-all experience of the science party, length of the voyage, operating tempo and complexity of the science plan all impact the number and mix of scientists and technicians needed to successfully carry out the cruise. Crew fatigue and personnel endurance must also be considered.

The Academic Research Fleet represents a diverse and broad spectrum of vessel types, and crewing requirements will vary for each type of vessel. The Chief Scientist and/or Principal Investigator determine the makeup of the science party for each science mission based on the nature of the work. Although ultimately the Master of the research vessel is responsible for safety, the Chief Scientist has the responsibility to ensure that each task during the cruise is adequately planned and manned with appropriately trained and experienced scientific personnel. The ship operator shall be consulted during the cruise planning phase and factors such as the cruise plan, round-the-clock operations and rest, complexity of over-the-side operations and length of cruise must all be considered. There are several terms found in the various regulations, which must be clearly understood in the interpretation of these laws. The following terms affect manning levels and are defined in Chapter 3.

- Oceanographic Vessel (46 CFR 188.10-53)
- Scientific Personnel (46 CFR 188.05-33 and 46 CFR 188.10-71)
- Near Coastal (46 CFR 10.103)

- Near Coastal as per STCW REG I/1
- International Voyage
- Domestic Service
- Boundary Lines 46 CFR 7)

5.1 REFERENCES

- Code of Federal Regulations (CFR) – 46 CFR 15 covers manning
- United States Code (USC)
- Navigation and Vessel Inspection Circular (NVIC) in particular 4-97 for guidance on STCW
- United States Coast Guard Marine Safety Manual, Chapters 22-26 http://www.uscg.mil/hq/g-m/nmc/pubs/msm/vol3.htm
- Standards of Training and Certification of Watchkeepers (STCW)
- International Convention for the Safety of Life at Sea (SOLAS), 2004 Ed.
- American Boat and Yacht Council (ABYC)

5.2 REQUIRED BY REGULATIONS FOR ALL VESSELS

Crewing regulations are contained in 46 CFR 15. The purpose of the regulations in this part is to set forth uniform minimum requirements for the crewing of vessels. In general, they implement, interpret, or apply the specific statutory crewing requirements in title 46, USC., parts E & F, implement various international conventions which affect merchant marine personnel, and provide the means for establishing the complement necessary for safe operation of vessels.

The regulations in this part apply to all vessels, which are subject to the crewing requirements contained in the navigation, and shipping laws of the United States, including uninspected vessels (46 USC. 7101-9308).

The navigation and shipping laws state that a vessel may not be operated unless certain crewing requirements are met. In addition to establishing a minimum of licensed individuals and members of the crew to be carried on board certain vessels, they establish minimum qualifications concerning licenses, citizenship, and conditions of employment. It is the responsibility of the owner, charterer, managing operator, Master, or person in charge or command of the vessel to ensure that appropriate personnel are carried to meet the requirements of the applicable navigation and shipping laws and regulations.

46 CFR 15.801 states in part that the Masters or individuals in command of all vessels, whether required to be inspected under 46 USC. 3301 or not, are responsible for properly crewing vessels in accordance with the applicable laws, regulations, and international conventions.

5.3 REQUIRED STANDARDS UNDER RVSS

5.3.1 ESTABLISHING AND CHANGING VESSEL CREW ALLOWANCES

Federal laws and regulations govening vessel crew size, qualification and training are complex and may change from time to time. When establishing initial crew allowances for a vessel, or changing a crew structure, institutions must consult closely with the local Coast Guard Sector staff to ensure all applicable laws and regulations are observed.

5.3.2 CREW TRAINING AND ORGANIZATION

All uninspected vessels under 300GRT and inspected vessels over 300GRT of the Academic Research Fleet shall maintain crews that are trained and organized and whenever possible certified per the regulations established by STCW 95 and NVIC 4-97.

5.3.3 CREW REST

Operators must be guided by 46 CFR 15.1111 which addresses work hours and required rest periods when identifying final crew complement. In general, watch standers must receive a minimum of 10 hours of rest in any 24-hour period and 77 rest hours in any 7-day period. Daily hours of rest may be divided into not more than two periods, one of which must be at least 6 hours in length.

5.3.4 CREW PHYSICAL STANDARDS

Institutions employing personnel as crewmembers not possessing a Coast Guard issued license or merchant marine credentials should insure these crewmembers meet the physical standards of the Merchant Mariner Medical Manual, COMDTINST M16721.48 or an equivalent set of physical standards established by their institution.

5.4 RECOMMENDATIONS AND BEST PRACTICES

5.4.1 MASTER OF THE VESSEL AND CHIEF SCIENTIST

MASTER OF THE VESSEL: The interrelationship of the Master of a vessel and the Chief Scientist is unique. The ship's Master is, in both law and tradition, solely and ultimately responsible for the safety and good conduct of the ship and all persons embarked, including the scientific party. Some specific regulatory requirements concerning the responsibilities of the Master of inspected vessels are found in 46 CFR Subchapter U, and these can be extrapolated to the Master of any vessel. To avoid disputes and misunderstandings, the substance of these regulations and customs should be clearly set forth in the ship's Cruise Handbook or similar publication, since many scientists are not aware of the legal and customary constraints.

Because of these legal responsibilities, the Master is also given full legal authority over all operations and personnel, both on board ship and in foreign ports. However, the primary objective of the Master and the crew is to facilitate carrying out the research in a safe and effective manner. In practice, the Chief Scientist informs the Master what is desired, and unless it is unsafe or illegal, it will be carried out. In case of serious disagreement, the question can be referred to the institution's marine manager, but it must be emphasized that if a decision has to be made quickly, the authority of the Master is absolute. (46 CFR Subchapter U)

CHIEF SCIENTIST: One member of the scientific party shall be designated Chief Scientist. This is to avoid placing conflicting demands from scientists on the Master, and asking the Master to referee disputes on scientific matters. The Chief Scientist is responsible for the coordination and execution of the entire scientific mission, not just his/her own portion of it. By custom, the personal and professional conduct of the scientific party on board ship and. ashore is the responsibility of the Chief Scientist, under the overall control of the ship's Master.

In matters of safety, the Chief Scientist must always defer to the Master in case of dispute. In many cases, safety matters are common knowledge, and not unique to research vessels. In other cases there may be safety hazards unique to the research, which the ship's crew may not be aware of. In such instances, the Chief Scientist has a special responsibility to assure safety, and consult with the Master as necessary. (46 CFR 194.15-3; 195.09)

5.4.2 SCIENCE PARTY SIZE AND REST

The maximum number of scientific personnel is regulated for inspected vessels.

For uninspected vessels, the operator shall determine the maximum number allowable. This must be consistent with the safety and lifesaving equipment available on board the vessel and consistent with crew and science accommodations provided on the vessel. For smaller vessels, which have a labeled boat or raft capacity provided by the manufacturer, these ratings shall not be exceeded. This limit should be made known to prospective chief scientists well in advance, so their staffing can be adequately planned. Recommended guidelines in this regard are to be found in manufacturers' specifications, ABYC publications, the Federal Safe Boating Act, and similar sources. (46 CFR 188.05-33; ABYC H-5)

Chief Scientists must ensure that they have adequate numbers of trained personnel to safely carry out their planned science operations. The requirements for crew rest outlined in 46 CFR 15.1111 (described in Section 5.3 above) provide a guide for marine technicians and scientific personnel engaged in science operations, especially those on deck or in the laboratories when the use of equipment or chemicals might present hazards to personnel. If safety is compromised due to a lack of rest, the Master retains the authority and obligation to suspend operations.

6. PERSONAL BEHAVIOR AND INDIVIDUAL SAFETY

6.0 INTRODUCTION

Personal safety and well-being are critically important components of these safety standards. This chapter addresses aspects of behavior and the physical ability of individuals which have an impact on overall safety of the vessel, other embarked personnel, and successful accomplishment of science missions.

REFERENCES

- American's with Disability Act (ADA) - 42 USC 12101
- ADA Regulatory Guidance - 29 CFR 1630 (primary reference), 1602 (EEOC)
- ADA Title II (State and Local Regulatory Guidance) - 28 CFR 35 (DOJ)
- American Disabilities Act (ADA) Guidelines for UNOLS Vessels, 2008, UNOLS
- Sexual Harassment Regulatory Guidance - 29 CFR 1604.11
- Sexual Harassment Prevention- Training Video, Maritime Training Services, 2013 (to be updated in 2017).
- UNOLS Ship Safety Orientation Training Video- 2013 ed.
- Drug and Alcohol Testing Regulatory Guidance - 46 CFR16 and 49 CRF 40
- Resolution by UNOLS Council dated October 5, 2006 regarding the ban of alcohol use on board UNOLS vessels at sea.

6.1 REQUIRED BY REGULATIONS FOR ALL VESSELS

6.1.1 DRUG AND ALCOHOL TESTING

All vessels of the U.S. Academic Research Fleet will comply with U.S. Coast Guard regulations related to non-prescription drug and alcohol testing specified in 46 CFR 16 and 49 CFR 40 in order to eliminate the use of intoxicants and to promote a drug free and safe work environment. Persons embarked in research vessels, including science parties, should be aware that "all persons directly involved in a serious marine incident are chemically tested for evidence of dangerous drugs and alcohol" (46 CFR 16.240).13

6.1.2 ALCOHOL & MEDICAL MARIJUANA USE ON UNOLS VESSELS

It is the policy of UNOLS, as approved by the UNOLS Council, that all UNOLS vessel operators shall ban the consumption of alcoholic beverages on board vessels of the Academic Research Fleet by crewmembers or embarked members of the scientific party. Possession of alcoholic beverages onboard ARF vessels is also prohibited.

Certain exceptions can be approved in writing by institutional management for the purpose of allowing the possession and consumption of alcohol on board ARF vessels while in port for receptions, special occasions and entertainment of visiting dignitaries. Participation by ship's crew in these events shall take into consideration scheduled time of sailing and the need for full sobriety at the time of departure.

It is the UNOLS policy to follow the U.S. Coast Guard directive, “Marine Safety Information Bulletin, MSIB # 01-14” which addresses the use of marijuana. The Coast Guard has continued to prohibit the use of marijuana, (which includes medical marijuana) by those serving in safety-sensitive positions in the maritime transportation industry. Marijuana remains a drug listed in Schedule I of the Controlled Substances Act and is subject to drug testing under Department of Transportation regulations.

6.1.3 SAFETY BRIEFINGS

Upon joining an ARF vessel, all persons must become familiar with the vessel. Vessel crews must provide a comprehensive safety briefing for all science party personnel before sailing or immediately after sailing. This briefing must include, but is not limited to, the location of safety equipment and lifesaving devices, stowage and proper donning of life jackets and/or immersion suits, damage control lockers, emergency lighting, emergency escape hatches and means of egress. Escape routes from the assigned stateroom and all lab spaces must be familiar. “Kickout” panels in doors are there to provide a means of escape in the event of an emergency.

See also Section 4.2.1. Chapter 17 contains additional information on lifesaving equipment. Appendix G provides a shipboard safety guide for newly embarked personnel.

6.1.4 PERSONAL BEHAVIOR AND SEXUAL HARASSMENT

In accordance with federal statutes, discrimination, which includes harassment, of protected classes is a violation of section 703 of title VII. The principles involved here apply to gender, race, color, religion or national origin. Because research cruises often involve educational activities, Title IX of the Education Amendments of 1972, also apply. Ship Operators must adhere to Federal requirements in conjunction with operator’s institutional policies and the UNOLS RVSS. Vessel operators shall consult with the appropriate persons at their institution to ensure they are complying with crew training, posting of information, and the proper procedures to follow in the event a harassment situation arises on board during all phases of a science mission.

Each ARF vessel must address the following issues:

- <u>Institution policy</u>. Ensure that all aspects of the institution’s harassment prevention policy are incorporated in the vessel’s regulations and operating procedures.
- <u>Posting.</u> Post the institution’s harassment prevention policy aboard the vessel in a location easily accessible to all members of the crew and science party.
- <u>Training</u>. Conduct harassment prevention training for all members of the science party before or immediately after getting underway for a science cruise. This training must include viewing of the first two modules of the videos developed for the Federal research vessel fleet. Crew members must view the harassment prevention training videos at least once per year.
- <u>Reporting procedures</u>. Clear reporting procedures for a person experiencing or witnessing an instance of harassment must be available to all persons onboard; these can be provided in the posted policy and pre-cruise training. Appendix E contains amplifying information.

- Off-vessel point of contact. In addition to establishing procedures for reporting incidents to authorities aboard the vessel, a point of contact ashore must be provided. Access must be available by telephone, text or email. An institution's established harassment "hotline" or designated point of contact would satisfy this requirement. Note: the Rape, Abuse and Incest National Network (RAINN) maintains a national sexual assault hotline that may be an asset for UNOLS member institutions.

Appendix E provides a discussion of what constitutes harassment and recommended procedures for anyone experiencing or witnessing a harassment incident.

6.2 RECOMMENDATIONS AND BEST PRACTICES

6.2.1 AMERICANS WITH DISABILITIES ACT (ADA)

By virtue of the "Oceanographic Research Vessel Act" (ORVA), 46 USC 2101, research vessels are considered under U.S. law to be a special class of sea-going platform. The RVSS contends that research vessels are not "public accommodations" as defined in the Americans with Disabilities Act (ADA) and are therefore exempt from these regulations. However, UNOLS operators should strive to set the example for our industry by making every reasonable accommodation with regard to sailing with disabled crew and scientists as long as safety is not compromised.

UNOLS has developed and approved "*American Disabilities Act (ADA) Guidelines for ARF Vessels",* which are available on the UNOLS website. It should be noted that many of the design and outfitting features for the hearing and vision impaired often improve safety for everyone on board the vessel.

The key to making reasonable accommodations is prior planning. The ship's Master and shore-side personnel need the opportunity to consider all of the ramifications and to ensure that adequate procedures can be put in place. It is highly recommended that Pre-Cruise Planning Questionnaires specifically ask about scientists with disabilities.

The following is a list of the items that should be considered by the operator when working with a disabled scientist who accepts the personal risk and chooses to go to sea:

- The particular disability: Some, such as the hearing impaired, may be easier to accommodate than a severe mobility disability.
- The particular individual: Overall physical ability, their determination to overcome obstacles, and their own understanding of the inherent risks involved.
- The particular cruise: Operating area, such as exposed offshore waters (vs. inshore) and remote location and/or access to medical assistance. The type of operations – mooring deployment vs. CTD casts. Number in the science party – and the number of scientists available to assist crew with disabled individual's needs.
- The Ship and Facility: Of particular concern are gangways when the vessel is alongside, emergency debarkation facilities when the vessel is underway, wheelchair accessible compartments/decks, and alternate facilities for dining, sleeping, bathing, and toilets.

It is the ultimate responsibility of the vessel's Master to determine if it is safe to embark ANY individual on a scientific mission regardless of whether or not they are disabled.

Establishing a "buddy system" for an individual with a disability is highly recommended. Develop procedures for moving a disabled individual during an actual emergency.

Ship personnel must assess the overall layout of the vessel to accommodate a particular disability, including lighting, audible and visual alarms, and exits. Conduct a thorough orientation with the disabled individual. The following is a list of simple accommodations, which the operator might find helpful for specific disabilities (although the last three items should be continuously reviewed for all personnel):

- Electric wheel chairs
- Wheel Chair clamps
- "Hearing Impaired Kit"
- Minimize obstacles in passageways and decks
- Adequate lighting
- High contrast markings on trip hazards and ladders

7. COMMUNICATIONS

7.0 INTRODUCTION

Radio communications are essential to the safety of a vessel and must be functional at all times when the vessel is underway. Most communication regulations are based on vessel size and the type of service they are engaged in. Section 7.1 below provides some of the specific references to regulations for certain classes of vessels. All research vessels, including small boats, zodiacs and dive boats must have radio equipment appropriate for the operation.

In recent years, technological advances have led to substantial changes and advances in communication methods, devices, procedures, rules, and regulations. Operators are strongly encouraged to refer to regulations listed below to ensure a comprehensive understanding of associated requirements.

Communications equipment is usually a mix of required and elective systems on board ARF vessels and could include:

- Very High Frequency (VHF) Radio
- Medium Frequency (MF) Radio
- High Frequency (HF) Radio
- Digital Selective Calling (DSC)
- Narrow Band Direct Printing (NBDP) or Simplex Teletype Over Radio (SITOR)
- Cellular Telephone including Iridium
- Satellite Telephone (INMARSAT)
- NAVTEX
- Search And Rescue Transponder (SART)
- Automated Identification System (AIS)
- Long Range Identification and Tracking System (LRIT)

All items listed above except AIS may be components of a Global Maritime Distress & Safety System (GMDSS). GMDSS regulations require that every GMDSS equipped ship shall be capable of the following:

Transmitting ship-to-shore Distress Alerts by at least two separate and independent means, each using a different radio communication service;

Receiving shore-to-ship Distress Alerts; transmitting and receiving ship-to-ship Distress Alerts;

- Transmitting and receiving search and rescue coordinating communications;
- Transmitting and receiving on-scene communications;
- Transmitting and receiving locating signals;
- Receiving maritime safety information;

- Transmitting and receiving general radio communications relating to the management and operation of the vessel;
- Transmitting and receiving bridge-to-bridge communications

AIS is a shipboard broadcast transponder system operating in the VHF maritime band that is capable of sending and receiving ship information such as identification, position, heading, speed, ship length, beam, type, draft and hazardous cargo information, to other ships and to shore.

The LRIT system consists of the already installed (generally) ship borne satellite communications equipment, communications service providers (CSPs), application service providers (ASPs), LRIT data centers, the LRIT data distribution plan and the International LRIT data exchange. Ships must report their position to their flag administration at least four times a day. Most vessels set their existing satellite communications systems to automatically make these reports.

7.1 REFERENCES

Communication references for rules and regulations include:

- 33 CFR 26 - Vessel Bridge-to-Bridge Radiotelephone Regulations
- 33 CFR 164.46 - Vessel Bridge-to-Bridge Radiotelephone Act 33 U.S.C.
- 46 CFR CHAPTER 1 SUBPART J, PART 25, SUBPART 25.26 - Emergency Position Indicating Radio Beacons (EPIRB)
- 47 CFR CHAPTER 1, SUBCHAPTER D, PART 80 - Stations in the Maritime Services
- 33 CFR Part 169 – Ship Reporting Systems, Subpart C – Transmission of Long-Range Identification and Tracking Information
- SOLAS Chapter IV “Radio communications”
- SOLAS Chapter XI-2 “Special Measures to Enhance Maritime Security”
- The majority of relevant regulations for required communication systems and equipment can be found in 47 CFR 80.

7.2 REQUIRED BY REGULATIONS FOR ALL VESSELS

Most communications regulations are based on vessel size and service; see section 7.3 below.

7.3 REQUIRED REGULATIONS FOR CERTAIN VESSELS

Primary communication regulation requirements can be found in 47 CFR, Part 80. A breakdown according to vessel types follows:

- Subpart C General provisions for ship stations (47CFR80.141)
- Subpart F Equipment Authorization for Compulsory Ships (47CFR80.251)

- Subpart R Radiotelephone Installations for Vessels over 300 Gross Tons (47CFR80.851)
- Subpart T Radiotelephone Installation Required for Vessels on the Great Lakes (47CFR80.951)
- Subpart U Radiotelephone Installations Required by the Bridge-to-Bridge Act applicable for vessels over 20 meters (47CFR80.1001)
- Subpart W Global Maritime Distress and Safety System (GMDSS) (Required for vessels over 300 gross tons) (47CFR80.1065)

COMPULSORY SHIP Any ship which is required to be equipped with radio telecommunication equipment in order to comply with the radio or radio-navigation provisions of a treaty or statute to which the vessel is subject.

AIS CARRIAGE REQUIREMENTS can be found in 33 CFR 164.46. Self-propelled vessels of 65 feet or more are required to have fully compliant AIS on board.

SHIP SECURITY ALERT SYSTEM (SSAS) All ships over 500 gross tons are required to be equipped with a SSAS, which is capable of discreetly raising the alarm to the relevant authorities and tracking the vessel if the security of the vessel is compromised.

7.3.1 INSPECTED VESSELS

Inspected vessels must adhere to communication regulations per vessel size breakdowns listed in section 7.3.

7.3.2 CLASSED VESSELS

Classed vessels must adhere to communication regulations per vessel size breakdowns listed in section 7.3. In addition, classed vessels should comply with 47 CFR 80.1069, Subpart W, GMDSS, Maritime Sea Areas, for required GMDSS radio equipment, which is dependent on radio frequency and operating areas.

7.3.3 SOLAS VESSELS

SOLAS Chapter IV, Part A, B, & C of the International SOLAS Convention applies.

7.3.4 UNINSPECTED VESSELS

Uninspected vessels must adhere to communication regulations per vessel size breakdowns listed in section 7.3. There are specific EPIRB requirements for uninspected vessels in 46 CFR CHAPTER 1 SUBPART J, PART 25, SUBPART 25.26: EMERGENCY POSITION INDICATING RADIO BEACONS (EPIRB).

7.3.5 OTHER REGULATIONS

All vessels must adhere to communication requirements listed in 33 CFR 161, VESSEL TRAFFIC MANAGEMENT, when working in areas regulated by Vessel Traffic Service systems.

7.4 REQUIRED STANDARDS UNDER RVSS

7.4.1 REPORTING

All ARF vessels, while operating, must make the following reports to their home base or other base designated to receive such reports:

- At least once daily when underway on cruises overnight or longer than one day.
- When any change in the cruise plan affects the planned position or Estimated Time of Arrival (ETA) at any previously designated point.
- When any equipment failure adversely affects the capability of the vessel.
- When adverse weather or other factors affect the planned operations of the vessel.
- On arrival and departure from an overnight or other designated stop.
- When an injury occurs to personnel that prohibits them from performing their regularly scheduled duties for 24 hours or more.

7.4.2 LOSS OF RADIO CONTACT

As required by the Maritime Safety Act of 1984 (46 CFR 4.04-3), an operating institution's representative having reason to believe (because of the lack of daily communications for two successive days, 48 hours, or non-appearance of a vessel, or other unusual instance) that the status of a vessel is uncertain or imperiled shall notify the cognizant USCG Rescue Coordination Center (RCC). The operating institution shall continue to use all available means to establish communications with the vessel and determine its status. The person notifying the Coast Guard shall provide complete information concerning the vessel's itinerary, identification, and communication capabilities. The purpose of notification is to make the Coast Guard aware that some uncertainty exists concerning the status of the vessel and to save time if and when it becomes necessary to declare an emergency. A vessel unable to communicate with any station for a period of 60 hours will terminate all operations and proceed to the nearest point where communications can be re-established. Normally, the vessel will proceed to the nearest port having communications capability.

7.5 RECOMMENDATIONS AND BEST PRACTICES

None.

8. SCIENTIFIC SUPPORT EQUIPMENT

8.0 INTRODUCTION

Scientific Support Equipment is defined as:

- Ship Operator or UNOLS-provided equipment funded by federal agencies, such as winches, handling systems, portable vans, sampling instruments, and laboratory equipment that is specifically designed to support scientific operations
- Portable equipment that is owned or obtained by the science party or the ship operator that is brought aboard for a specific mission.

Scientific support equipment carried on board research vessels ranges from the familiar equipment standard on most cruises (Conductivity-Temperature-Depth (CTD) profilers with rosettes or box cores) to one-of-a-kind developmental hardware which is largely unknown to all hands, perhaps even to the scientists who brought it. This raises two safety concerns: first, extreme familiarity may lead to carelessness with gear, which could be inherently dangerous, and second, novel equipment with unknown potential hazards can lead to unpleasant surprises. In either case, both crew and science party must exercise prudence and caution when deploying, recovering, or staging scientific equipment.

Although the actual operation of scientific equipment may be delegated to the Chief Scientist or others in the science party, ultimate responsibility for safety lies with the Master of the vessel, and it is the responsibility of the Chief Scientist to assure that the Master has full knowledge of and has given consent to every operation on board.

8.1 REFERENCES

With very few exceptions, federal laws and regulations do not cover scientific equipment, other than the general requirements embodied in International Safety Management (ISM) code, which requires pro-active safety management of all operations undertaken on board the vessel. The following code of federal regulations listed below do provide the applicable regulations to adhere to.

- 46 CFR 189.35 - “Weight Handling Gear”
- 46 CFR 194.15 - “Chemical Laboratory and Scientific Laboratory”
- 46 CFR 195.11 – Scientific Equipment
- 46 CFR 195.11 - “Portable Vans and Tanks”
- Institute of Electrical and Electronics Engineers (IEEE) publishes IEEE-45, which is a non-regulatory document that provides Underwriters Laboratory (UL) recommendations for the standards of construction and maintenance that should be observed for electrical equipment and materials that are placed in marine service.
- UNOLS Portable Scientific Vans Manual: https://www.unols.org/document/unols-portable-scientific-vans-manual-2005

- American Bureau of Shipping Pub. 193 – "Guide for Portable Accommodation Modules"

In the majority of cases, the CFRs and other rules delegate the responsibility for safety procedures to the operator, thus placing a heavy burden on those involved. Therefore, it is important that all personnel involved approach research operations with particular care and use the principles of good seamanship, sound marine engineering practices, and common sense.

8.2 REQUIRED BY REGULATIONS FOR ALL VESSELS

None.

8.3 REQUIRED REGULATIONS FOR CERTAIN VESSELS

8.3.1 INSPECTED VESSELS

8.3.1.1 WEIGHT HANDLING GEAR

Inspected research vessels shall comply with 46 CFR 189.35, which includes equipment design, installation, inspection, testing, documentation, and other requirements. Vessel Masters are encouraged to consult 46 CFR 189.35-13, which outlines specific responsibilities.

8.3.1.2 VANS

Portable vans for scientific use are defined as science equipment in 46 CFR 188.10-67. 46 CFR 195.11 contains the Coast Guard regulations concerning the use of certain vans aboard inspected vessels. These regulations consider only three categories; accommodation vans, power/machinery vans, and chemical storage vans, which are subject to both Coast Guard regulatory plan approval and inspections at a two-year interval. Laboratory vans are NOT considered to be in any of the above categories and are not subject to Coast Guard inspection regulations. The use, arrangement, and handling of science vans shall be approved by the Coast Guard prior to placement aboard the host vessel (USCG letter dated May 24, 2001, included in the UNOLS Portable Scientific Van Manual). UNOLS Van Pool vans will be inspected by the cognizant USCG Sector office, provided with placards in accordance with 46 CFR 195.11-20, and entered into the Coast Guard Marine Safety Center's program.

More detailed information concerning containers and securing of vans may be found in International Organization for Standardization (ISO) Standard 1496 and the American Bureau of Shipping (ABS) Guide for Certification of Container Securing Systems and Certification of Cargo Containers. These regulations are helpful for dimensional details and shipping as containerized cargo. For conversion to portable scientific vans, or for new construction of vans, the UNOLS Portable Scientific Van Manual, which is available in the Publications section of the UNOLS website, should be consulted. Table One of the Van Manual contains a summary of van types and requirements.

Accommodation vans, power/machinery vans, and chemical storage vans designed for use aboard uninspected vessels before the implementation of the UNOLS Scientific Van Standards were not subject to Coast Guard inspection. Therefore, such a van cannot be used on an inspected vessel unless the Coast Guard inspects it first.

8.3.2 SOLAS VESSELS

None, other than the requirements in 8.3.1.

8.3.3 UNINSPECTED VESSELS

Operators of uninspected vessels, as a matter of best-accepted practices, should follow the requirements of section 8.3.1 for inspected vessels.

Operators of uninspected vessels must be aware that a van placed aboard a vessel does count as measurable volume for admeasurement purposes. It is possible for a van to increase gross tonnage beyond the uninspected limit (300 GRT domestic or 1600 GRT international), potentially placing the vessel into an inspected status.

For uninspected vessels which are maintained in class beyond Load Line requirements (e.g. hull, machinery, etc.), American Bureau of Shipping Pub. 193 provides detailed requirements for Accommodation and Industrial modules and is a useful resource.

8.4 <u>REQUIRED STANDARDS UNDER THE RVSS</u>

8.4.1 WEIGHT HANDLING GEAR

All vessels shall comply with Appendix A - UNOLS Rope and Cable Safe Working Load Standards and Appendix B - UNOLS Overboard Handling Systems - Design and Operation Standards.

8.4.2 VANS

All ship-owned vans built after January 1, 2002 must meet the requirements given in the UNOLS Portable Scientific Van Manual.

All science-owned vans delivered after January 1, 2010 must meet the requirements given in the UNOLS Portable Scientific Van Manual.

All vans, including vans delivered prior to January 1, 2010, shall be examined and approved for use based on Appendix C – *Safety Inspection Checklist for Shipboard Vans*.

Vans meeting side panel structural requirements of the UNOLS Portable Scientific Vans Manual must be placed in “sheltered locations” as described in the manual.

8.4.3 EQUIPMENT INSTALLATIONS

All science support equipment installations shall be consistent with the approved stability data and structural limits for the vessel for the entire range of weights and heights through which these are deployed.

8.4.4 EPA VESSEL GENERAL PERMIT/VESSEL INCIDENTAL DISCHARGE ACT AND ENVIRONMENTALLY ACCEPTABLE LUBRICANTS (EAL*)*

EPA regulates discharges incidental to the normal operation of commercial vessels greater than 79 feet in length and operating as a means of transportation primarily through the Vessel General Permit (VGP). The first VGP was issued in 2008 and effective until December 19, 2013. On March 28, 2013, EPA re-issued the VGP for another five years. That reissued permit, the 2013 VGP, took effect December 19, 2013, and superseded the 2008 VGP at that time. On December 4, 2018, the Vessel

Incidental Discharge Act was signed, requiring the EPA to develop new national standards. Estimated completion of these new standards is in 2022, at which point regulatory authority transfers to the Coast Guard.

The impact of lubricant discharges (not accidental spills) to the aquatic ecosystem is substantial. The majority of ocean going ships operate with oil-lubricated stern tubes and use lubricating oils in a large number of applications in on-deck and underwater (submerged) machinery. Oil leakage from stern tubes, traditionally considered a part of normal “operational consumption” of oil, results in millions of liters of oil being released to the aquatic environment every year. Where the discharge can’t be eliminated, this permit condition seeks to reduce the potential environmental impact of those discharges. Use of EALs results in discharges that biodegrade more quickly and that are less toxic than discharges from their traditional mineral oil counterparts. For all applications where lubricants are likely to enter the water, EAL formulations instead of mineral oils can offer significantly reduced environmental impacts across all applications.

While use of EALS in deck equipment (fixed or portable) is not mandatory, it is strongly recommended under both the VGP and VIDA standards.

8.4.5 SCIENCE SUPPORT AND OPERATIONS INCLUDING LABORATORY SAFETY

The Chief Scientist is responsible for the general operation and safety of the scientific laboratories and storage areas. Periodic inspections of the vessel’s laboratory spaces must be made by a scientist and one of the ship’s officers to verify safe stowage, securing of equipment, and cleanliness. Particular attention must be paid to the stowage and use of chemicals, flammables, and other hazardous materials; safety labeling; posted standard safety precautions, and common-sense safe operating procedures. Fire extinguishers, ventilation, eyewash facilities, spill kits, and other laboratory safety equipment must be available and marked. Ship’s motion is by far the most common cause of damage and personal injury aboard ship, and experienced ship’s crew must help the science party to secure laboratory and scientific equipment. It must be remembered that while in practice the Chief Scientist is primarily responsible for safety of the science operations, the ultimate legal responsibility (and authority) lies with the Master of the vessel. (46 CFR 194.15-3)

The carrying of portable science equipment including vans, tanks, special winches, crates of equipment, large sampling gear, and other instrumentation must be carefully checked for conformity with approved stability and load line conditions. It is particularly important that accurate weights be provided for equipment being brought on board. Since such installations are temporary, their design, selection of materials, attachments and hold-downs, must be carefully factored in. The use of standard-sized hold-down holes at 2-foot spacing on the deck is commonplace throughout the Academic Research Fleet and all scientific equipment to be embarked must be designed to fit the bolt pattern. While each installation will, of course, be somewhat different, as a basic guide, the van itself and accessory components must be designed and constructed to good marine commercial standards. Electrical and other connections to the permanent ship systems must be to marine standards. Adequate ventilation for the intended use must be provided. Particular attention must be given to van electrical systems since building electrical systems have “grounded neutrals” while ship systems are generally ungrounded. Proper design of van electrical systems, including the provisions to isolate van electrical circuits, is particularly important since it can avoid problems both as shock source and electrolysis. Machinery brought on board must be in good repair and operating condition, because hydraulic leaks and electrical problems pose a safety risk to scientists and crew alike. Acceptable "marine standards" are those standards published by UL for marine service, those found in IEEE-45 and/or Coast Guard regulations.

8.4.6 SCIENTIFIC EQUIPMENT DESIGN AND SAFETY

All scientific equipment shall be designed to good commercial standards and it is the responsibility of the owner to assure their equipment is free of personnel hazards. (46 CFR 109.09)

8.4.7 AUTONOMOUS SCIENCE SUPPORT EQUIPMENT

Equipment such as Autonomous Underwater Vehicles (AUVs), gliders, drifters, and Unmanned Aerial Systems (UASs) are becoming more and more common place. These systems present a different legal framework once they are deployed and free from the vessel. The Master and the Chief Scientist must consult on the details of the particular operation to minimize risk to the instrument itself and outside parties. For UAS operation from vessels, see Chapter 19.

9. SCIENTIFIC AND SHIPBOARD HAZARDOUS MATERIALS

9.0 INTRODUCTION

A hazardous material is any substance or combination of substances that, because of quantity, concentration, physical, chemical, radiological, explosive, or infectious characteristics, poses a substantial present or potential danger to humans or the environment. Generally, such materials are classified as:

- Flammable liquids and solids
- Oxidizing materials
- Corrosive materials
- Flammable and non-flammable compressed gases
- Poisons or toxic substances
- Disease-causing agents
- Combustible liquids
- Explosives and blasting agents
- Radioactive materials
- Other Regulated Materials (ORM) (Department of Transportation (DOT) Hazard Class “ORM”), including hazardous wastes

Radioactive materials are covered separately in Chapter 10.

Hazardous materials will be found among both ship and scientific stores and include such items as organic solvents, corrosives, compressed gases, flammable liquids, and toxic or reactive chemicals. Safety Data Sheets (SDS) contain a list of product ingredients, indicating information about the type of hazard; recommended personnel protection and precautions, spill or leak procedures, and fire, explosion, health (including first aid), and reactivity data. Most importantly, an emergency telephone number for assistance in the event of an accident. Employers are required to inform employees of what hazardous materials are present in the work place and train them, with the aid of the SDS, in their proper use and handling. (29 CFR 1910)

9.1 REFERENCES

- 46 CFR 194 – Subchapter U section on Hazardous Materials
- 29 CFR 1910.1200(g) – SDS
- 49 CFR 172 and 105 – Hazardous Materials

9.2 REQUIRED BY REGULATIONS FOR ALL VESSELS

Rules for stowage, labeling, and handling of hazardous materials for all vessels are given in 46 CFR 194.

A Hazardous Material Table can be found in 49 CFR 172.101. This table lists and classifies those materials, that have been designated as hazardous materials, and prescribes the requirements for shipping, labeling, and transporting. Additional regulatory information and guidelines for hazardous waste are in 49 CFR 172.205 and 49 CFR 105.

9.2.1 EXPLOSIVES, PERMITS, AND AUTHORIZATION

USCG rules dealing with explosives are stringent and strictly enforced. The Coast Guard Sector Office should be contacted at least 8 weeks prior to the cruise departure date. In addition, Fish and Game Departments, local and state law enforcement agencies, the fire department etc., should be contacted for information on possible restrictions, truck routing, spot assistance and inspections, etc.

The use of explosives, sonic emitters, or towed devices (as well as instrumented moorings) present special hazards to submarine operations and navigation. The National Geospatial-Intelligence Agency (NGA) (Formerly the National Imagery and Mapping Agency) has agreed to disseminate information concerning underwater hazards as part of the Notice to Mariner system. See chapter 4 (Operations) for details on reporting these hazards.

Rules for carrying, stowage, and labeling of explosives on board inspected ships are given in Subchapter U, CFR. All ARF vessels should follow these rules. In addition, 49 CFR 176 prescribes requirements for all vessels carrying hazardous materials in the domestic waters of the United States, with some exceptions. Magazines and storage areas should be properly labeled and inspected daily, and safety precautions should be posted. (46 CFR 194.05, 194.10, 196.80, 196.85)

9.3 <u>REQUIRED REGULATIONS FOR CERTAIN VESSELS</u>

9.3.1 INSPECTED VESSELS - None.

9.3.2 CLASSED VESSELS - None.

9.3.3 SOLAS VESSELS

The SOLAS-Consolidated Edition 2004, Chapter VI, Carriage of Cargoes governs the carriage of cargoes. Some of these cargoes may present hazards to ships or persons on board and may require special precautions. The following regulations will guide you in the safe handling of these cargoes:

Part A - Regulation 1 - Application states: “this chapter may require special precautions in all ships to which the present regulations apply and in cargo ships of less than 500 gross tonnage. However for cargo ships of less than 500 gross tonnage, the Administration (i.e. U.S. Government) if it considers that the sheltered nature and conditions of the voyage are such as to render the application of this chapter unreasonable or unnecessary, may take other effective measures to ensure the required safety for these ships.”

Note: For this ruling ARF vessels are considered cargo ships.

Part A - Regulation 2 - Cargo Information.

In this regulation the shipper (i.e. scientist) shall provide the Master or his/her representative with appropriate information on the cargo sufficiently in advance of loading to enable the precautions, which may be necessary for proper stowage and safe carriage.

Scientific supplies, which may include hazardous goods are normally brought aboard research vessels in small quantities in packaged form and not as bulk cargoes. In SOLAS Chapter VII- Carriage of Dangerous Goods guidelines are provided for these instances.

In Part A - Regulation 1, Dangerous goods means the substances, materials, and articles covered by the International Maritime Dangerous Goods (IMDG) Code. Therefore if a chemical is on the IMDG list, the handling of it is governed by these SOLAS regulations.

Note: Regulation 2 states that this part does not apply to ship's stores and equipment. In this case RVSS does not consider scientific cargo as part of the ship's stores.

Regulation 3 states the carriage of dangerous goods shall be in compliance with the IMDG Code.

Regulation 4 - Documents - All documents must use the proper shipping name of the goods and a correct description. The transport documents prepared by the shipper must provide certification that the item is properly packaged, marked, labeled or placarded, and in proper condition for carriage.

Regulation 5 governs that the cargo units shall be loaded, stowed, and secured throughout the voyage.

Regulation 6 provides instructions that require the reporting of incidents involving dangerous goods. The master or other person in charge must report without delay when an incident takes place involving the loss or likely loss of dangerous goods into the sea.

9.3.4 UNINSPECTED VESSELS

None.

9.4 REQUIRED STANDARD UNDER RVSS

CRUISE PLANNING: The Chief Scientist is responsible for providing the following information to the ship operator at least 30-days prior to the cruise departure date unless a shorter time is specifically allowed by the ship:

- A list of all hazardous materials by chemical name, common name, UN identification number, type and classification of hazard, quantity (size of containers and number of each size container), user name and contact information
- SDS sheets for all materials listed above
- A list of the spill response materials and the amount to be brought aboard to address spills or accidents

- The plans for offloading all materials brought aboard at the end of the scheduled cruise.

The ship operator will review the provided material and contact the Chief Scientist if there are any questions or concerns. The ship operator will then forward copies of the required information to the vessel or request that the Chief Scientist carry a copy to the vessel for delivery to the Master.

TRANSPORTATION AND DISPOSAL: The Chief Scientist will be responsible for the proper transportation, shipping and disposal of hazardous materials and waste, including the empty containers, associated with their project. Transportation and disposal must be carried out in accordance with Federal, State and Local regulations. In no case will this responsibility be passed to the ship's crew or operating institution. Each Institution's Shipping Department can provide up-to-date information about regulatory requirements.

CHEMICAL STORAGE LOCKER SYSTEM: A chemical storage locker system should be installed on the weather deck. Lockers should be provided with a fire suppression system and the ability to separate incompatible chemicals, (i.e. bases from acids). Alternatively, a designated chemical storeroom in accordance with Subchapter U 46 CFR 194.20 should be provided.

HAZARD COMMUNICATION PROCEDURES: A procedure should be in place which can be followed in the event of a hazardous spill to be able to provide information to the crew and scientists. The type, location, hazard, and spill response plan must be communicated to the ship's complement in an effective manner. The location of MSDS information must be clearly labeled. A list of chemicals in use and in storage must be posted outside the entry to the space so as to inform emergency response teams as to the danger present.

SHIPBOARD HAZARDOUS MATERIALS AND POLLUTION: Many of the materials associated with normal operation and maintenance of research vessels are classified as hazardous materials. In addition, waste products and sewage are the subject of pollution control regulations issued by the Coast Guard and other agencies. Research vessel operators have an obligation to ensure that their crews and science parties are informed of the hazards associated with these materials and that they are aware of the pollution control regulations so that wastes are not disposed of in violation of the law. Several regulatory documents apply to this area. These are: International Convention for the Prevention of Pollution from Ships 1973 as modified by the Protocol of 1978 (MARPOL 73/78), 46 CFR 131.935 Prevention of Oil Pollution and the Federal Water Pollution Control Act 33 USC-1321.

INCOMPATIBLE MATERIALS: These are materials that should not be stored together. See 49 CFR 176.83 and Table 176.83(b), General Segregation Requirements for Hazardous Materials for information on incompatible materials. The table found in 49 CFR 172.101 is also helpful in this area.

STORAGE CONTAINERS: Material should remain in their original shipping containers (as received from the vendor) with labeling intact. Working quantities in the amount of a one-day supply can be stored inside the ship. Working containers must be marked as follows: Common or trade name, UN identification number (49 CFR 172.101, Hazardous Material Table), the nature of hazard (flammable, acid, poison, etc.), and the contact information (name and work phone number) of the person using the material aboard the vessel.

COMPRESSED GASES: Must be securely held to the ship structure with metal brackets or positive cargo straps to hold them in place. Ropes or other similar lashings must be avoided. All gas cylinders must have their safety cap in place unless they are in use with a regulator. No cylinder should be moved without the cap in place. See 46 CFR 194.05-15, 46 CFR 194.15-17 and 49 CFR 172, 173, 176.

SPILL RESPONSE: The Chief Scientist shall be responsible for providing spill response procedures and remote monitoring equipment as applicable for each hazardous material brought aboard. Kits or materials to address spills or accidents are supplied by the user, not the ship. The amount of material brought aboard must be sufficient to address a spill of the entire amount of the specific materials being brought aboard. (For example, if you bring 1 liter of Hydrochloric acid, you need to supply spill response material to clean up a spill of 1 liter of Hydrochloric acid.)

SHARPS DISPOSAL: Syringes, sharps, hypodermic needles brought on board should be treated as a safety hazard and proper provisions should be made for safe use and disposal. Safe disposal of other sharp objects such as broken glass, pipettes, etc. should be included in the laboratory safety plan. The science party is responsible for providing the appropriate “Sharps” container(s).

LAB SINKS: Signs should be conspicuously posted at each lab sink indicating if they drain directly overboard or to a holding tank.

LAB WASTE: Laboratory waste and disposal plans must be arranged as part of the pre-cruise planning process. It is the responsibility of the owner of the lab chemicals or other hazardous material to safely handle, package, document and dispose of these materials at the conclusion of each cruise.

EMERGENCY SHOWER AND EYE WASH STATIONS: An emergency shower and eye wash station should be installed in every lab where chemicals are used. Flow rates should be at least 20 gpm. Emergency showers should be tepid water where a person could remain in the shower for 15 minutes.

FUME HOODS: A fume hood is ventilation equipment that vents separately from the ship’s heating, ventilation and air conditioning (HVAC) system. The primary means of controlling airborne chemical exposure is a fume hood. Fume hoods should be used when working with toxic compounds or compounds with a boiling point below 120°C. Air flow surveys of fume hoods should be certified at least annually by the owner of the hood with the proper sash height indicated on the fume hood. Fume hoods must have stainless steel trays to catch any spillage. The trays should have a restraining system to prevent chemical containers from sliding due to the ship’s motion. Fume hood exhausts must have a closure external to the compartment to be able to shut off in case of a fire or chemical release. The exhaust must be clearly labeled and designed so that exhaust fumes are directed away from personnel. OSHA CFR 1910.1450, is the federal laboratory standard. It simply states that you must have a chemical hygiene plan for the lab that includes “A requirement that fume hoods and other protective equipment are functioning properly and specific measures that shall be taken to ensure proper and adequate performance of such equipment.”

Other applicable industry group standards are the Scientific Equipment & Furniture Association (SEFA 1-2006) which recommends annual testing of fume hoods. For additional testing criteria, refer to AIHA (Laboratory Ventilation Z9.5-2003), ASHRAE (110-1995), and ANSI. Check with the appropriate department at your operating institution for their rules and regulations regarding fume hood use, safety, and testing.

RESPONSIBILITY: Proper storage, labeling, and spill response (clean-up) is the responsibility of the user. Anyone using hazardous material should be trained in proper laboratory safety procedures. The Chief Scientist shall be responsible for ensuring that safe laboratory procedures are followed including use of personal protective equipment, prohibiting the consumption of food and drinks in labs, and other safety precautions as outlined on MSDS and considered standard laboratory procedures.

9.4.1 LITHIUM BATTERIES: Lithium batteries are used extensively in consumer electronics and within the oceanographic community. This section provides a general overview; more detailed information and procedures are provided in the references below. There are two types of lithium batteries:

- Primary lithium batteries – non-rechargeable, containing lithium metal which reacts with water.
- Secondary lithium-ion batteries – rechargeable, containing no lithium metal. These are the type normally found in consumer products such as laptop computers.

The most dangerous failure of primary and secondary lithium batteries is a hot cell condition, caused by an internal or external short-circuit of a cell or battery. If the temperature continues to rise, the battery may vent fumes that can irritate the respiratory tract, eyes and skin, and it may explode. Manufacturers report that inadvertent short circuits caused by abuse during handling are the largest single source of field failures for both lithium and lithium-ion cells. **All primary lithium batteries must be treated as hazardous material while aboard a vessel**.

Guidelines for **primary lithium batteries** onboard research vessels.

- *Identification*. It is important that the planned use of primary lithium batteries aboard an R/V be identified and discussed as part of cruise planning. It is the responsibility of the Chief Scientist to provide the R/V crew a list of all primary lithium batteries to be brought aboard, including identification of type, size and any special handling instructions.
- *Handling, stowage and use aboard R/Vs*. Primary lithium batteries must be handled carefully during loading, unloading and use to prevent battery damage. New, unused lithium batteries that arrive in undamaged condition from the manufacturer pose less risk than batteries that have been used and recovered from the "hostile" marine environment. After use, especially in an underwater deployment, lithium batteries should be carefully inspected for possible damage. Whether new or used, primary lithium batteries must be stowed in a flammables storage cabinet and identified on the space hazard placard. Both crew and embarked science parties must be trained in safe handling procedures and to recognize an unsafe lithium battery condition.

- *Charging*. Improperly charging lithium batteries usually degrades battery performance and life but can cause more serious issues such as fire or explosion. There are many types, chemistries, and cell configurations for lithium-batteries used to power remote controlled vehicles (drones, boats, underwater vehicles, etc.), portable electronics, or other equipment. If the equipment has a dedicated, simple (no user input) charger, the battery charger and cables should be inspected for damage, labeled, and only used for the specified equipment. Generally, most consumer based electronic devices (phones and laptops) have dedicated chargers. However, remote controlled vehicles (and possibly other devices) often do not come with a dedicated battery or battery charger. Because of the varying types and chemistries, many chargers used for these batteries can accommodate many different battery configurations. Inputting the correct settings for each battery type and chemistry is important, and not necessarily intuitive. Therefore, it is important that personnel responsible for the equipment be properly trained on charging the batteries safely.
- *Emergency procedures*. In general, hot cells or fires in or around primary lithium batteries should be cooled with ample amounts of water, and affected spaces secured and vented to prevent the spread of fumes. A portable ABC extinguisher should be used on secondary lithium batteries. Previous guidance may have advised use of a class D extinguisher, but more recent information indicates that a class D extinguisher should not be used for either type of lithium battery. Halon 1301 has also been shown to be ineffective for lithium batteries. Emergency response teams must be trained in lithium battery emergency procedures. If an onboard fire threatens to raise the temperature of lithium batteries significantly, the batteries may be jettisoned.

Guidelines for **secondary lithium batteries** aboard research vessels.

- *Identification*. No special inventory or identification is required for secondary lithium batteries in widely used consumer electronics.
- *Handling, stowage and use aboard R/V*. No special handling or stowage requirements, beyond normal care and avoidance of exposure to high temperatures, flames, corrosive chemicals, etc., are required. Secondary lithium batteries may remain installed in the equipment powered by the batteries.
- *Charging*. Secondary lithium batteries in consumer electronics should only be charged with the dedicated charger in accordance with manufacturer instructions.
- *Emergency procedures*. A portable ABC extinguisher should be used in the event of a hot cell condition or fire in a secondary battery. A class D extinguisher, contrary to previous guidance, should not be used. As with primary batteries, secondary batteries may be jettisoned if threatened by an onboard fire.

Specific R/V preparations. Each vessel must develop comprehensive procedures for primary lithium battery handling, use, stowage and emergency response.

Informational resources.

- FAA testing information: http://www.fire.tc.faa.gov/pdf/systems/lithium-ion_battery_04112006.pdf

- UL 1642: Standard for Safety of Lithium Batteries. URL: https://standardscatalog.ul.com/standards/en/standard_1642_5
- UL 2054: Standard for Household and Commercial Batteries. URL: https://standardscatalog.ul.com/standards/en/standard_2054_2
- NAVSEA TM-S9310-AW-SAF-010: US Navy Technical Manual for Batteries, Navy Lithium Safety Program Responsibilities and Procedures. https://my.nps.edu/documents/103425239/106436235/LithBatt_NAVSEA_TMS9310-TechManual-Rev2-2010.pdf/f274b46d-ca26-4e0f-83e7-cf13df49dc62
- NAVSEA SG270-BV-SAF-010: High-Energy Storage System Safety Manual file:///C:/Users/user/Downloads/SG270-BV-SAF-010_27APR2011.pdf
- USCG 46 CFR Subchapter J, Electrical Engineering. https://www.gpo.gov/fdsys/granule/CFR-2005-title46-vol4/CFR-2005-title46-vol4-chapI-subchapJ

9.5 RECOMMENDATIONS AND BEST PRACTICES

CHECK VESSEL REQUIREMENTS: Individual ship operators may have additional (and more stringent) policies regarding the handling, storage and use of hazardous materials. Users should contact the ship operator as early as possible in the cruise planning process to ensure they comply with the vessel requirements.

10. RADIOACTIVE MATERIALS

10.0 INTRODUCTION

Radioactive materials on board ship pose unique problems not found in shore-based laboratories. Normally all radioisotope work is conducted in a laboratory van set-aside exclusively for this purpose. Even when all radioisotope work is conducted in a dedicated van, the potential to inadvertently transport small amounts of isotopes to other areas of the vessel is greater due to the confined nature of research ships and the inherent instability of the laboratory space. Because of this, research ship operators and scientists have a particular obligation to assure adherence to prudent laboratory procedures; including monitoring, preventing spills, cleanup, and record keeping. These precautions are necessary for the protection of personnel and to ensure the integrity of measurements made by different investigators of environmental levels of natural or artificial radionuclides. In most cases, it is necessary for these programs to measure extremely low levels of ambient radioactive activity. As a result, this work is sensitive to contamination by very small amounts of isotope material, far below levels having any public health significance. The SWAB program mentioned at the end of this chapter can provide assistance in monitoring and cleaning lab spaces.

UNOLS has developed a Rad Awareness Program (https://www.unols.org/unols-radioisotope-awareness-program) which has resources available to operators to help inform users of the importance of good laboratory hygiene when working with radioisotopes.

10.1 REFERENCES

Activity and quantity of the materials shall not exceed that authorized by the operating institution's Nuclear Regulatory Commission (NRC) Byproduct Material License, or equivalent, which is monitored by that institution's Radiation Safety Committee, or equivalent. This committee must consist of a Radiation Safety Officer (RSO) and representatives from the user community, and ship operations if desired. Provisions of such a license usually apply to a research vessel at sea or away from homeport. The use, storage, transportation, labeling and disposal of such materials shall conform to applicable regulations of the NRC, any state agencies that have jurisdiction, and the operating institution's procedures.

10.2 REQUIRED STANDARDS UNDER RVSS

AUTHORIZATION: As part of the procedure for obtaining authorization to use radioisotopes at sea, the PI must submit an application which includes information on the amount and type of isotope to be used, the qualifications of all users listed in the request, protocols for the experiments in which these isotopes will be used, and how radioactive waste will be stored or disposed of. The operating institution's Radiation Safety Committee, RSO, or equivalent, will review and authorize the proposed use of the isotope or isotopes.

VANS AND WORK AREAS: Laboratory vans and other work areas designated for isotope use shall conform to minimum standards for such facilities. A properly rated

(120 Linear Feet per Minute (LFM) or greater) and vented fume hood must be available for all activities for which there is a potential of airborne radioactivity. It is important to know where this fume hood exhaust exits the ship to make sure that personnel are not exposed directly or indirectly. All working surfaces must be constructed of materials that are nonporous and resistant to corrosion by seawater and chemical solutions. A refrigerator/freezer capable of being locked must also be available for storage of isotope stocks. No food items may be stored in this appliance with appropriate signage indicating this restriction.

DISPOSAL: Regulations prohibit the disposal of liquid or solid radioactive waste into the ocean. The scientific user must provide facilities for the safe and secure storage of liquid and solid radioactive waste. The operating institution's RSO and the science user's RSO will approve these containers with proper certification. In order to reduce the possibility of spills, the waste containers must be located in the radiation laboratory van when one is available or in another certified safe storage van/location. The Principal Investigator (PI) assumes all responsibility for the necessary activities and costs to properly dispose of all radioactive materials at the end of the cruise.

PLANNING: It is essential that ship operators be informed of the intent to use radioisotopes as early in the scheduling process as possible. To this end, the following is required:

- The amounts and types of isotopes to be used aboard ship and the name, email address, and telephone number of the RSO from the PI's home institution must be provided on the UNOLS Marine Facility Planning (MFP) Shiptime and Maritime Equipment Request (SME) form or the ship operators Cruise Planning Documents.
- Upon notification of funding, the PI will be required to initiate the procedure required to obtain authorization to use radioisotopes on ARF vessels; i.e. to immediately contact ship operators for instructions and to notify their own RSO.

10.2.1 SCIENCE GROUP RESPONSIBILITIES

The Chief Scientist must ensure that all onboard radioisotopes user(s) have been granted written authority by their home institution's Radiation Safety Committee, RSO, or equivalent, to possess and use radioisotopes. Upon notification of funding, the PI must contact the operating institution and initiate the procedures required to obtain authorization to use radioisotopes on the assigned vessel. The RSO of the radioisotope users' home institution(s) must verify to the operating institution that the user is an authorized user.

Once the radioisotope users have been authorized to use isotopes by the operating institution, the PI must notify the Chief Scientist and confirm the laboratory space or radioisotope van that will be used and restricted for isotope work. The senior radioisotope user will be responsible for posting the area, monitoring, cleanup of spills, and ensuring that the work area is clean upon completion of the isotope work. All users must employ personal dosimeters as required by the radioisotope use permit. All spills must be reported to the Chief Scientist who will immediately report them to the Master and Marine Technician. Upon completion of the cruise, the senior radioisotope user must report the results of all surveys and the disposition of waste, unused isotopes, and labeled samples to the Chief Scientist. The Chief Scientist must provide this information in a post cruise report to the operating institution and the funding agencies if they require it. In any event, the PI will supply a survey report of the work area to the ship's technician.

The responsibilities for cleanup, disposal and transport of all waste and the associated costs will be borne by the PI. If subsequent wipe or SWAB testing finds isotope contamination above the defined limits, the associated cost of decontamination is the responsibility of the Chief Scientist.

10.2.2 OPERATING INSTITUTION RESPONSIBILITIES

Operators must require that the members of the science party using isotopes onboard, and the Chief Scientist, are familiar with NRC procedures as well as specific shipboard rules and regulations. These shipboard regulations must be specific as to the science party's responsibility during the cruise, especially with regard to an isotope spill and the appropriate method for cleanup. These procedures can be found in the ship's cruise planning manual or handbook and must be discussed with the Marine Technician during the cruise planning process.

Of central importance is the establishment of procedures by which a PI may be granted the authority to use radioisotopes at sea. This responsibility rests with the operating institution and its RSO. The information upon which authority is granted must include at least the following:

- The names of all personnel that will be engaged in the use of isotopes aboard ship, and the quantities and forms of all isotopes to be used.
- Written verification by the RSO of the PI's home institution that the PI and/or the personnel listed above is currently authorized to possess and use the quantity and type(s) of isotope(s) proposed by the PI.
- A description of experimental protocol. This should include the proposed location of the work and procedures for storage and manipulation, isolation and control of samples, containment and cleanup of spills, and the disposition of liquid and solid waste.

To ensure the safe and orderly use of radioisotopes at sea, the operating institution must also assume the following responsibilities:

- Provide suitable facilities for use and storage. Such facilities include appropriately designed laboratory space, preferably a laboratory van designated exclusively for radioisotope use, and monitoring equipment (scintillation counter). Personal dosimeters, if required, and any other required personal protective equipment, must be supplied by the user's home institution.
- Prior to departure, ship's personnel and the scientific party must be briefed on the types of isotopes to be used, location of van and storage, and potential hazards.
- A member of the ship's complement (i.e. an officer or marine technician) must be trained in basic radiation safety and emergency procedures. This individual, designated as the ship's radiation safety officer (RSO), will work with the radioisotope users to ensure that the isotope work is conducted in designated

areas that are properly posted and monitored, and that spills are properly cleaned up and reported.

10.3 RECOMMENDATIONS AND BEST PRACTICES

10.3.1 FACILITIES, INSTRUMENTATION AND TRAINING

The use of laboratory vans restricted for radioisotope use is required for shipboard use. All operating institutions should have access to at least one laboratory van for this purpose. Appendix C is a checklist for inspecting shipboard vans and contains a reference to the standards to be used in fabricating a van for this purpose. Using a radioisotope van for other purposes; e.g., storing gear and paints, transporting spares, etc., is strictly prohibited.

In order to ensure proper monitoring of work areas, all ARF vessels must be equipped with monitoring equipment such as a liquid scintillation counter, single source counter or Geiger counter with pancake probe. Personal dosimeters shall be provided by the scientific user's home institution, as appropriate, for the isotopes being used.

Likewise, operating institutions are encouraged to require a member of the ship's complement to be trained in basic radiation safety procedures. At the beginning of each cruise, this person is responsible for briefing the crew and scientific party on the isotopes to be used, where they must be used and stored, waste disposal, monitoring requirements, and potential hazards.

10.3.2 SWAB PROGRAM

ARF uses the NSF-funded Operation SWAB run by the University of Miami Tritium Lab to monitor shipboard contamination. This group will conduct tests to detect low levels of ^{14}C and ^{3}H being brought aboard a research vessel. SWAB tests will serve as a mechanism for determining when an unreported spill has occurred or if radioisotopes are tracked around the ship. The operator can request SWAB tests directly from the University of Miami. A SWAB test is recommended both immediately before a cruise measuring natural abundance isotopes and immediately after a cruise where elevated levels of ^{14}C and ^{3}H were used. If logistics prevent personnel from the University of Miami performing the test, a sample collection kit and instructions can be sent to the ship for samples to be collected and returned to the University of Miami for testing.

Contact information for the Tritium Lab is:

Tritium Laboratory
University of Miami, Rosenstiel School of Marine and Atmospheric Sciences
4600 Rickenbacker Causeway, Miami, FL 33149
Attention: Jim Happell or Charlene Grall
E-mail: Tritium@rsmas.miami.edu
Phone: 305-421-4100
Web site: https://tritium.rsmas.miami.edu/

11. DIVING OPERATIONS

11.0 INTRODUCTION

Scientific diving is a normal part of oceanographic research vessel operations. Such diving conducted from a vessel of the Academic Research Fleet 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.

11.1 REFERENCES

The American Academy of Underwater Sciences Standards for Scientific Diving www.aaus.org/downloads/aausstandards.pdf.

11.2 REQUIRED BY REGULATIONS FOR ALL VESSELS

As required by AAUS Standards, a single lead institution's campus diving administration will be designated for all cruises requiring diving. This is usually accomplished by the agreement of all campus diving administrations involved. Items in the AAUS Standards, which refer to the campus diving administration, may 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. All ARF vessels must comply with the AAUS standards.

11.3 REQUIRED STANDARDS UNDER RVSS

All ARF vessels must comply with the AAUS "standards".

11.3.1 CRUISE PLANNING

The Principal Investigator will prepare and supply a cruise dive plan 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 (i.e., small boats and tank racks).

The lead institution's diving administration will, after approving this plan, forward it to the operator's Marine Office one month prior to the cruise.

11.3.2 CRUISE PERSONNEL

The **Master** has responsibility for the safety of all activities aboard, including diving. The Master must ensure that appropriate safety procedures are in place for conducting research diving from the vessel or it's small boats, including but not limited to ensuring that high powered acoustics sources are turned off, potentially hazardous over-board discharges are secured, propellers and bow-thrusters are not turning with divers in the vicinity and that proper notifications and signals are made.

The **Chief Scientist** is responsible for the coordination and execution of the entire scientific mission including the research diving plans and certifications.

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 research diving operations.

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 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, Principal Investigator/Chief Scientist and lead Dive Safety Officer when possible. The On-Board Diving Supervisor's responsibilities include:

- Meeting with the Master and Chief Scientist to review the cruise dive plan and emergency procedures prior to diving.
- Remaining in regular communication with the Master on the progress of the research diving operation.
- Assuring that both the lead and operating institution's diving manual are available to the scientists and crew aboard the vessel. The lead institution's manual will take precedence in the event of a conflict unless otherwise agreed to in advance.
- Inspecting high-pressure cylinders and breathing air compressors to assure that they meet the lead institutions' standards.
- Ensure that air used to refill tanks is of proper quality and that all air tanks used by divers have a current hydrostatic test.

11.4 RECOMMENDATIONS AND BEST PRACTICES

It is important to ensure that the placement of the air intake for any compressor used for breathable air on board a vessel is made with regards to the location of the vessel's exhaust systems and how it may change with the wind.

Other "in-the-water" research activities such as small boat operations, swimming or snorkeling must be treated similarly to diving operations. At the very least a statement of the qualifications and physical ability to undertake the planned operations and a plan of operations detailing safety precautions should be provided and approved by the ship operator.

Research divers must also recognize their individual responsibility for their safety.

12. BLANK

Please contact the National Deep Submergence Facility (https://ndsf.whoi.edu/) regarding safety standards for the Human-Occupied Vessel (HOV) ALVIN. For general questions around HOV safety standards, please contact the UNOLS office (office@unols.org).

13. STABILITY

13.0 INTRODUCTION

An understanding of the principals of ship stability is essential to the safe operation of any vessel, but particularly so for the operation of a research vessel which can be subject to greatly varying deck loads, towing loads and crane loads from overboard handling systems. These and other factors such as ice loads, must all be considered in the trim and stability calculations. The vessel operators must understand the concepts of stability and in the event that any questions do arise, the services of a qualified naval architect must be contracted. A vessel's stability characteristics are based on its hull form, sail area (windage profile), weight (displacement), center of gravity, and free surface of liquids on board. Changes in any of these characteristics will impact the vessel's stability.

Hull form is rarely changed during the life of a vessel. If a hull form change is needed for a particular operation, e.g., addition of a transducer pod, additional sea chests, etc., a naval architect can evaluate potential impacts to stability.

Sail area can change from voyage to voyage, most commonly by the addition of science or equipment vans. Some vessel's stability booklets account for the addition of a van by including an alternate required GM curve based on the additional windage area. If a vessel's existing stability documentation does not account for planned increases in sail area, a naval architect should be consulted to verify that stability criteria can be met.

Weight and center of gravity are typically determined by calculations that add loads to an approved lightship value (determined via stability test). Changes to the lightship weight must be documented in accordance with the guidance given in section 13.3.1 below for inspected research vessels.

Liquids in tanks can reduce a vessel's stability. Stability letters and booklets typically document tank-loading requirements for a specific vessel including the number of tanks that are allowed to be slack at any one time.

In applying the required and recommended stability standards, the operator must also take into account any unique vessel mission requirements which require additional stability measures.

STABILITY STANDARDS for the design, construction, and operation of oceanographic research vessels may be placed into one of two categories:

- Standards required for inspected and certain uninspected vessels, and
- Those recommended for the remaining uninspected vessels.

Required standards have been set forth by the USCG and by International Conventions (see next section). Generally these take the form of minimum righting energy requirements, minimum GM, and in the case of larger (inspected) vessels, damage stability requirements.

Additionally, vessels engaged in towing and lifting operations must meet additional criteria. Vessels that operate in areas where ice accretion is possible should meet stability criteria with icing loads.

Uninspected vessels with an assigned load line, although not subject to the requirements of Subchapter S, must still demonstrate adequate stability. The requirements of Subchapter S may be used for guidance. Alternatively, the guidelines for fishing vessels may be used, although these criteria may be more demanding than those outlined for oceanographic research vessels in Subchapter S.

STABILITY TESTS include formal inclining experiments and, in some cases, rolling period tests. Inclining experiments are conducted to obtain "as inclined" data from which "light ship" displacement and centers of gravity can be derived to define the "light ship condition." This experiment is normally conducted under the auspices of a qualified Naval Architect, and witnessed by the US Coast Guard or its designee, commonly ABS. Various loadings can then be added to this basic condition to obtain prescribed "service conditions" and associated stability information. This becomes the basis for a "Stability Letter" or "Stability Book".

STABILITY INFORMATION includes (1) specific information pertinent to the safe operation of a specific vessel and (2) general information, the understanding of which promotes the safe operation of vessels in a more general sense. Specific information is contained in "Stability Booklets" and "Stability Letters," or their equivalents, which are carried on board. General information should also be carried on board and made readily available to all personnel on board having duties or functions, which may affect the vessel's stability.

13.1 REFERENCES

- Title 46 CFR 170 - Subchapter S, the International Maritime Organization (IMO) Code of Safety For Special Purpose Ships Resolution A.534 (13).
- Commercial Fishing Vessel regulations (46 CFR 28). This reference concerns commercial fishing vessels but contains much information of value for uninspected oceanographic research vessels.

13.2 REQUIRED BY REGULATIONS FOR ALL VESSELS

Requirements are based on sizes and service.

13.3 REQUIRED REGULATIONS FOR CERTAIN VESSELS

13.3.1 INSPECTED VESSELS

Inspected oceanographic vessels, including motor-driven vessels of 300 and over gross registered tons and steam ships over 65 ft long, must comply with stability criteria set forth in Title 46 CFR, Subchapter S, Parts 170 and 173.

New inspected oceanographic vessels are required to be inclined in accordance with inclining experiment details set forth in 46 CFR, Subchapter S, Part 170, Subpart F.

Any research vessel should be re-inclined any time a significant change in magnitude and/or location of a "light ship" weight occurs or there is a major change in hull shape. For inspected vessels the Coast Guard, in MTN 04-95, requires the following actions based on the amount of aggregate (magnitude of weight removed and weight added) weight change:

- Weight-moment Calculation only when the aggregate weight change does not exceed 2% of the lightship weight and the Longitudinal Center of Gravity (LCG) does not shift by more than 1% of the Length Between Perpendiculars (LBP).
- Deadweight Survey Only when the aggregate weight change is between 2-10% or LCG shifts by more than 1% of LBP.
- Full Stability Test when the total aggregate weight change exceeds 10%.

Inspected oceanographic vessels are required to carry the following stability information on board as set forth in Title 46 CFR, Subchapter S, Part 170, Subpart D:

- Stability Booklet (Section 170.110).
- Stability Letter (Section 170.120).
- Lifting information for vessels engaged in lifting operations (Section 170.125).

The above reference does not specify that vessels engaged in towing are required to carry towing information pertinent to stability. Nevertheless, it is recommended that these vessels carry this information.

13.3.2 CLASSED VESSELS

Uninspected oceanographic vessels engaged in international or foreign voyages and subject to load line assignment, as described in Chapter 14, are treated as inspected vessels with regard to stability tests and stability information.

13.3.3 SOLAS VESSELS

An uninspected vessel subject to SOLAS requirements, i.e., over 500 GT Convention Tonnage yet under 300 GRT domestic tonnage will be subject to load line requirements and SOLAS stability requirements. The SOLAS requirements for vessels under 100m (328 ft) in length are not well defined, but compliance with the IMO Code of Safety For Special Purpose Ships would be a reasonable minimum requirement. For a load line, ABS would seek compliance with a “recognized” stability standard such as those outlined in Subchapter S for oceanographic vessels or, alternatively, the requirements contained in IMO’s Code of Safety For Special Purpose Craft.

An inspected vessel subject to SOLAS must meet the stability criteria of Subchapter S.

13.3.4 UNINSPECTED VESSELS

Other uninspected vessels that are not in “class” have no required stability standards unless they have an assigned load line, in which case ABS will require compliance with IMO A167/A206 with A562 or “recognized” criteria suitable to vessel type, such as Subchapter S criteria for oceanographic research vessels. Standards for these vessels under the RVSS are described below.

13.4 REQUIRED UNDER THE RVSS

It shall be the Master‘s responsibility to maintain the vessel in a satisfactory stability condition at all times through control and management of liquid, solid and science loads. It is the Operating Institution‘s responsibility to insure that (1) current stability data are correct and available to the Master, and (2) changes to the vessel are controlled and managed to insure compliance with all regulatory requirements and the recommendations of this section.

As a minimum, a deadweight survey shall be performed every five years. If the deadweight survey shows a shift in LCG over 1% and/or a change in weight over 10%, the vessel must undergo a complete stability test (inclining).

Un-classed and uninspected oceanographic vessels, while not required by regulation to undergo inclining experiments, will be inclined and have sufficient data and documentation to determine safe loading. These vessels will carry operators' directives containing specific stability information equivalent to that required for inspected vessels.

13.5 RECOMMENDATIONS AND BEST PRACTICES

Recommended intact stability standards for vessels 79 to 328 feet in length are contained in IMO's Code of Safety For Special Purpose Craft, which invokes IMO A167/A206 with A562.

No firm criteria exist for recommended stability standards applicable to vessels shorter than 79 feet. Again, criteria set forth in the fishing vessel regulations provide useful guidelines but one must be cautious in their direct use to establish stability standards for these small vessels and it may be necessary to increase IMO Resolution A.168 (ES.IV) criteria. While the basis for this increase has not been established, the practice of some European countries is to increase all criteria by twenty percent.

It is recommended that all uninspected oceanographic vessels carry general stability information on board. Consideration should be given to following the regulations for commercial fishing vessels in 46 CFR 28.

Instructions and data contained in Stability Booklets and Stability Letters, or their equivalents, should be set forth in a clear and concise manner to facilitate stability analysis either by hand or by use of a personal computer. In this regard, it is recommended that vessels be provided with user-friendly stability software for intact and damaged conditions (if feasible) and on board personal computers.

The North Pacific Fishing Vessel Operators Association (NPFVOA) also publishes a safety manual and a series of videotapes that are excellent training resources with regard to stability on smaller vessels.

13.5.1 RECOMMENDED READING

For those interested in learning more about the basics of vessel stability, the following publications are recommended:

- NPFVOA, "Vessel Safety Manual." Available at: www.npfvoa.org
- "Stability and Trim of Fishing Vessels for Skippers & Second Hands" by J. Anthony Hind, Published by Fishing News (Books) Ltd.
- USCG, A Best Practices Guide to Vessel Stability- http://www.uscg.mil/hq/cgcvc/cvc3/references/Stability_Reference_Guide.pdf

14. WATERTIGHT INTEGRITY AND LOAD LINES

14.0 INTRODUCTION

The basic concept of watertight integrity is to ensure that a vessel does not flood with water and sink. The watertight integrity of a vessel is essential to calculations of required freeboard, stability and subdivision characteristics, so it plays an important role in causing the vessel to remain upright in operation through waves and weather.

The historic regulatory approach to ensuring a vessel can meet and maintain a minimum level of watertight integrity is the assignment of loadlines. Originally developed to prevent overloading of commercial vessels, loadlines are implemented by international conventions and and are required by U.S. statutes and regulations. The substantial majority of ARF vessels will require a load line.

Watertight integrity is vital to vessel safety. A tragic reminder of this truism is the December 1978 loss with all hands of the *M/V Holo Holo*, under charter for oceanographic work in the North Pacific Ocean. According to the Coast Guard Marine Casualty Report, the most probable cause of the sinking was a catastrophic event involving boarding seas flooding the inadequately-drained foc's'le, and loss of watertight integrity followed by progressive flooding of the ship.

14.1 REFERENCES

- 46 CFR 42.15 (Subchapter E), entitled "Conditions of Assignment of Freeboard," contains details on doors, hatches, machinery space openings, miscellaneous openings, ventilators, air pipes, cargo ports, scuppers, inlets and discharges, side scuttles, and freeing ports.
- 46 CFR 69.117 (Subchapter G) contains information on tonnage openings.
- 46 CFR 72.05 (Subchapter H) contains information on windows and air ports for passenger vessels.
- 46 CFR 78.15 and 78.17 (Subchapter H) contain information on doors to be closed at sea and closing appliances for passenger vessels.
- 46 CFR 97.15 (Subchapter I) contains information on hatches and other openings for cargo and miscellaneous vessels.
- 46 CFR 170.248 and 171 (Subchapter S) contain information on watertight bulkhead doors and vessel subdivision.
- 46 CFR Subchapter C Part 28 Subpart E contains regulations for commercial fishing vessels on stability and watertight integrity.
- U.S. Coast Guard, Naval Architecture Division, Office of Design and Engineering Standards, "Load Line Policy Notes," 22 September 2008, provides a comprehensive summary of U.S. load line policies and regulations. https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/5ps/Design%20and%20Engineering%20Standards/Naval%20Architecture%20Division/Load%20Lines/LLPN.pdf?ver=2018-06-14-155644-780

- U.S. Coast Guard Marine Casualty Report, “M/V Holo Holo Disappearance in the Pacific Ocean on 11 December 1978 with Presumed Loss of Life,” Report # USCG 16732/01280, 18 November 1981 https://www.dco.uscg.mil/Portals/9/DCO%20Documents/5p/CG-5PC/INV/docs/boards/holoholo.pdf

14.2 LOAD LINES

Historically, the concept of a load line evolved during the 1870s in Great Britain to provide a visual check against merchant ships being overloaded. Lloyd’s Register established a minimum freeboard requirement for its classed ships, to ensure that a ship had good reserve buoyancy in heavy boarding seas. After considerable persuasive efforts by Samuel Plimsoll, Parliament extended the requirement to all British merchant ships; thus was born the “Plimsoll mark.”

Similar load line requirements were adopted by other maritime nations, until they were internationally standardized in the Load Line Convention of 1930. The present International Convention on Load Lines (ICLL) was drawn up in 1966 (in force since 21 July 1968), and modified by the Load Line Protocol of 1988 (in force since 3 February 2000). The Convention is administered by the IMO, a specialized agency of the United Nations. Vessels of countries signatory to the Convention are required to have an ICLL certificate for international voyages. As of May 2016, 161 countries (representing 98.5% of world tonnage) are signatory to the 1966 ICLL, and 103 countries (representing 95.3% of world tonnage) are signatory to the 1988 Load Line Protocol (Source: USCG). The U.S. is signatory to both the ICLL and the Protocol.

Load line marks are affixed to vessel side shell plating amidships and indicate the maximum drafts to which the vessel can be lawfully loaded in several different maritime venues. These load line marks are also related to freeboard. The distance at the side of a vessel measured vertically from the edge of its “freeboard deck” to the upper edge of a particular load line mark represents “statutory freeboard”.

For U.S. vessels, domestic load line certificates are issued by the American Bureau of Shipping (ABS) on behalf of the Coast Guard.

Because the assignment of a load line to a vessel is almost universally done as part of the original construction or major conversion of a vessel, the material contained in this chapter serves mainly as background information to the operator. Vessel operation must conform to load line restrictions as a basic safety principle.

14.3 WATERTIGHT INTEGRITY

14.3.1 BASIC CONCEPTS

Establishing the ability of a vessel to keep afloat, in a variety of sea and weather conditions over its life time, is obviously a primary design and construction objective. Reserve buoyancy, subdivision of the vessel and hull strength are all critical to classification by the American Bureau of Shipping (ABS). Freeboard is critical to reserve buoyancy and therefore to the performance of the vessel in stormy weather.

During inspections and surveys, ABS is particularly concerned with these items in maintaining watertight integrity:

- Freeing ports - Drainage must be adequate from all weather deck areas and not blocked. Particular attention is given to potential water-trapping areas such as wells formed by structure or pockets formed by cargo or equipment.
- Sill heights - Access openings in superstructure and deck houses must have sills of varying heights, depending on location.
- Vent and hatch coaming heights and fittings above the assigned freeboard deck.
- Watertight doors and fittings - Any penetration of watertight boundaries must be as high and as far inboard as possible. As a minimum, three dogs are required on a circular fitting and four on an oblong fitting.
- Subdivision in general - Subdivision requirements must be met as applicable for vessels being inspected/surveyed.

During the construction of a vessel, appropriate mechanisms must be incorporated to allow for secure and efficient closure of openings in watertight areas of the vessel such as the hull, watertight bulkheads and sections of the superstructure considered watertight. Examples of such openings include hatches, side openings, and internal watertight doorways.

In order to maintain the watertight integrity of vessels, watertight closures must be utilized as required, properly operated, and properly maintained. It should also be remembered that some watertight doors are set to close automatically under certain conditions and that such doors can close with potentially harmful force.

14.3.2 REQUIRED STANDARDS UNDER THE RVSS

In general, operators must scrupulously maintain a vessel's watertight envelope. The National Science Foundation research vessel inspection program will regularly examine the status of:

- Watertight bulkheads, doors and closures, hatches, scuttles and other penetrations.
- Coamings and closures of ventilators to spaces below the freeboard deck and into enclosed superstructures, hatchway coamings, hatch covers, and all of their supports.
- All accessible parts subject to rapid deterioration, such as overboards and other hull and superstructure penetrations. On vessels of sufficient age, or where condition is questionable, the plating and framing below a representative number of portlights may be examined. This may require suitable inspection openings to be cut in sheathing.
- Freeing ports in bulwarks; scuppers; and deck drains.
- Condition of deck, hull and superstructure coatings and/or coverings.
- Shell plating. The Hull and Machinery Inspector shall evaluate the readings and adequacy of the most recent audio gauge report.
- Bilges, fore peak tanks, voids and cofferdams.
- Fuel oil, ballast, black and gray water, and other tanks shall be examined internally as operational conditions permit. The Hull and Machinery inspector shall verify and evaluate the vessel's tank inspection program in conjunction with recent ABS and USCG surveys as applicable.

- Any alterations in structural arrangements, fittings and appliances upon which load lines are conditional.

All ARF vessels will be designed to and maintained in accordance with the applicable load line and watertight integrity requirements as set forth in US regulations, international conventions and accepted marine standards for the size and operating area of the vessel.

While not legally required for uninspected oceanographic research vessels that are below 500 GT (international), 46 CFR, Part 28, Subpart E (Stability) and 46 CFR 179 (Subdivision, Damage Stability and Watertight Integrity) may provide useful guidance.

15. ELECTRICAL AND MARINE ENGINEERING

15.0 INTRODUCTION

This chapter covers Marine and Electrical Engineering practices on vessels of the Academic Fleet (ARF) and certain aspects of science-related equipment. Scientific or science-related equipment installations on vessels may be unique, non-standard and/or temporary. Particular attention must be given to such specialized installations, since the equipment is frequently experimental in nature and the researchers providing and using it may not be familiar with accepted marine and electrical engineering practices. Such equipment may have been designed for operation in a shore-based environment; and shipboard application may present additional environmental factors such as moisture, motion, vibration, temperature variations, and power supply fluctuations. For example, one area of potential problems entails equipment designed for use with grounded neutral electrical systems (the norm for office and laboratory equipment) on ships with ungrounded distribution systems.

The textbook “Marine Engineering” published by the Society of Naval Architects and Marine Engineers (SNAME) includes the following with regard to shipboard electrical systems:

“All ships have an electric power plant similar to a land-based electric utility. Electric power is required for propulsion, propulsion system auxiliaries, deck machinery, illumination, heating, ventilation, air conditioning, stores and cargo refrigeration, galley, fresh water and sanitary systems, and safety and casualty control such as fire and bilge systems, fire detection and alarm systems, and remotely operated watertight and firescreen doors. Power must also be supplied for interior communication systems, controls, radio communications, radar, and other electronic aids to navigation and shipboard operation.”

On research vessels, power must also be supplied for scientific work, in addition to all of the above functions. Such “scientific” power must often be especially “clean” and/or delivered from uninterruptible sources. Scientific power may also entail different voltages that must be transformed from those available on the ship’s service electrical bus.

15.1 REFERENCES

The following documents are referenced by this chapter:

- 46 CFR Subchapter F - Marine Engineering
- 46 CFR Subchapter J - Electrical Engineering
- 46 CFR Subchapter H - Passenger Vessels
- 46 CFR Subchapter I - Cargo and Miscellaneous Vessels
- 46 CFR Subchapter U - Oceanographic Research Vessels
- 46 CFR Subchapter D - Tank Vessels
- 46 CFR Subchapter T - Small Passenger Vessels (Under 100 Gross Tons)
- 46 CFR Subchapter C - Uninspected Vessels
- American Bureau of Shipping (ABS). “Rules for Building and Classing Steel Vessels”

- International Convention for the Safety of Life at Sea (SOLAS) 1974 (and all amendments)
- American Boat and Yacht Council, Inc. (ABYC), “Safety Standards for Small Craft“
- Federal Motorboat Act of 1940 (and all amendments)
- 46 CFR 197, Subpart B - Commercial Diving Operations
- Marine Engineering, edited by Harrington, Society of Naval Architects and Marine Engineers, 1992
- UNOLS “RVOC Safety Training Manual“ Chapter One, accessed January 2008
- Other Relevant Standards (not expressly referenced herein):
- IEEE 45, “Recommended Practice for Electrical Installations on Shipboard”
- National Fire Protection Association, “The National Electrical Code”
- U.S. Coast Guard Marine Safety Center Technical Note 01-10, “Review of Systems Containing Plastic Pipe” (USCG MTN 01-10)

15.2 REQUIRED BY REGULATIONS FOR ALL VESSELS

Nearly all ARF vessels are subject to marine and/or electrical engineering regulations promulgated by the Coast Guard and other regulatory bodies, as well as possibly classification rules. Due to differences in size, mission and areas of operation, not all the same regulations and rules necessarily apply to all ARF vessels. Thus, it is important that a careful analysis be made to ascertain which ones apply to a particular vessel.

For existing vessels, as a general rule, any significant changes to the vessel’s machinery or electrical systems must be designed or reviewed for compliance with applicable regulatory and classification requirements.

15.3 REQUIRED REGULATIONS FOR CERTAIN VESSELS

15.3.1 INSPECTED VESSELS

Inspected vessels are generally subject to the marine engineering regulations of 46 CFR Subchapter F – Marine Engineering and electrical engineering regulations of 46 CFR Subchapter J – Electrical Engineering. This is specifically required for vessels regulated by any of the following subchapters:

- 46 CFR Subchapter H - Passenger Vessels,
- 46 CFR Subchapter I - Cargo and Miscellaneous Vessels,
- 46 CFR Subchapter U - Oceanographic Research Vessels, and
- 46 CFR Subchapter D - Tank Vessels (except as specifically modified by that subchapter).

Oceanographic research vessels, which are subject to 46 CFR Subchapter U, are subject to certain additional regulations. For example, Subchapter U includes some discussion of marine and electrical engineering concerns related to scientific equipment such as the following:

- Subpart 194.15 - Chemistry Laboratory and Scientific Laboratory, and

- Subpart 195.09 - Scientific Equipment, and Subpart 195.11 - Portable Vans and Tanks.

15.3.2 CLASSED VESSELS

U.S. flag vessels of the ARF are typically classed by the American Bureau of Shipping ("ABS") and maintained in accordance with associated ABS requirements for their class. In addition to all other applicable Regulatory Body requirements, such classed vessels must comply with the set of ABS "Rules for Building and Classing Steel Vessels" that is appropriate to their size and service. These rules contain numerous requirements pertaining to marine and electrical engineering. Even if a vessel is not "classed," those Rules provide guidance on good practices.

15.3.3 SOLAS VESSELS

UNOLS vessels which fall under SOLAS rules should refer to Chapter II-1 "Structure, subdivision and stability, machinery and electrical installations".

15.3.4 UNINSPECTED VESSELS

The marine and electrical engineering requirements for uninspected vessels are contained in 46 CFR Subchapter C - Uninspected Vessels. Beyond that which is expressly required by Subchapter C, additional guidance for marine engineering and electrical systems aboard UNOLS vessels can be found by consideration of Subchapter C Part 28 (for fishing vessels) and 46 CFR Subchapter T (for small passenger vessels), as well as 46 CFR Subchapters F and J. There is no prohibition against using the inspected vessel requirements for uninspected vessels; those requirements cited above for inspected vessels should be considered for guidance as well.

15.3.5 OTHER REGULATIONS

For vessels under 65 feet in length, "Safety Standards for Small Craft" published by American Boat and Yacht Council (ABYC) shall be met. Some examples relating to the mechanical and electrical systems include these ABYC standards:

- A-27 Alternating Current (AC) Generator Sets
- E-11 AC & Direct Current (DC) Electrical Systems on Boats
- H-30 Hydraulic Systems
- H-33 Diesel Fuel Systems

ABYC standards related to the control or documentation of electrical and mechanical systems such as: "T-5, Safety Signs and Labels" shall be adhered to. Also, any and all applicable safety requirements from the Motorboat Act of 1940, including all amendments, must be complied with.

15.4 REQUIRED STANDARDS UNDER THE RVSS

15.4.1 VESSEL SYSTEM REQUIREMENTS

ARF vessels will be designed to and maintained in accordance with all applicable marine and electrical engineering requirements as set forth in US regulations, international conventions and accepted marine standards for the size and operating area of the vessel.

PIPING: The use of PVC piping must be kept to a minimum. U.S. Coast Guard Marine Safety Center Marine Technical Note 01-10 provides relevant detail about this issue.

NON DESTRUCTIVE TESTING: Principal plating and structure must be monitored by a systematic non destructive testing program. Areas exhibiting wastage must be plotted on the shell expansion drawing. In addition, new plating replacement and repairs must be noted on the shell expansion plan.

ANNUAL MEGGER READINGS: Annual megger readings must be part of a maintenance/inspection program.

EMERGENCY STEERING: Instructions for changing to emergency and secondary steering gear must be posted in the steering gear room and at each secondary steering station in 1.3 centimeter (1/2 inch) letters and numerals of contrasting color to the background.

HYDRAULIC FLUIDS: Hydraulic Fluids should meet EPA Vessel General Permit requirements for environmentally acceptable lubricants.

DIESEL ENGINE OVERSPEED TESTING: All the engines on board a ship run in a particular speed range. Any deviation from this speed range might damage the engine. In order to ensure that the engine speed doesn't overshoot the pre-set speed limit, over speed trips are used. The over speed trip must be tested regularly.

CONFINED SPACE ENTRY: Many workplaces contain areas that are considered "confined spaces" because while they are not necessarily designed for people, but are large enough for workers to enter and perform certain jobs. A confined space also has limited or restricted means for entry or exit and is not designed for continuous occupancy.

OSHA uses the term "permit-required confined space" (permit space) to describe a confined space that has one or more of the following characteristics: contains or has the potential to contain a hazardous atmosphere; contains a material that has the potential to engulf an entrant; has walls that converge inward or floors that slope downward and taper into a smaller area which could trap or asphyxiate an entrant; or contains any other recognized safety or health hazard, such as unguarded machinery, exposed live wires, or heat stress.

Each ship operator must have a formal policy for identifying confined spaces and procedures for safely entering these spaces. The type of work to be performed, including hot work, must be part of the procedures and policies for confined space entry.

LOCK-OUT/TAG OUT SYSTEMS: Each operator is required to have a policy for persons working in/around electrical circuits. A formal policy which addresses training, personnel qualifications and procedures must be established.

15.4.2 PORTABLE EQUIPMENT

Major portable scientific equipment such as winches, seismic air compressors, and laboratory vans or powered sampling equipment present potential hazards of injury to personnel or damage to the vessel or vessel systems. Such equipment shall be designed to meet the requirements of 46 CFR Subchapter F and J when applicable. The use of these standards will help in ensuring that the equipment is safe and suitable for use on all vessels.

The following examples demonstrate how the requirements may apply to portable equipment. They do not form a complete list of applicable requirements.

FUEL TANKS: Fuel tanks for portable, engine-driven equipment; see 46 CFR 58.50 - Independent Fuel Tanks.

MACHINERY GUARDS: 46 CFR 58.01-20 requires that "Gears, couplings, flywheels and all machinery capable of injuring personnel shall be provided with adequate covers or guards." By extension, this includes exposed shafts, which can snag a person's clothing.

HYDRAULIC AND PNEUMATIC SYSTEMS: For hydraulic and pneumatic systems on winches, portable A-frames and cranes, etc., see 46 CFR 58.30-50 - Requirements for miscellaneous fluid power and control systems.

PRESSURE VESSELS: For pressure vessels, (including hydraulic accumulators which may be part of a winch or over-the-side recovery system), see 46 CFR 54 - Pressure Vessels.

DIVING SUPPORT EQUIPMENT: For diving support equipment including compressors, chambers, etc., see 46 CFR 197, Subpart B – Commercial Diving Operations. Additional information can be found in Chapter 11 (Diving Operations) of this manual.

SYSTEMS IN VANS: Electrical and mechanical systems contained in laboratory vans, machinery vans and chemical storage vans shall meet all applicable requirements of 46 CFR Subchapters F, J, and U. Note especially 46 CFR 195.11 - Portable Vans and Tanks. Additional information can be found in Appendix C of this manual.

GROUNDING OF PORTABLE EQUIPMENT: All portable electric powered equipment must be safely grounded; see 46 CFR 111.05. Specific attention is directed to vans, winches and other equipment connected to the ship's electrical supply by portable cords.

Most shipboard electrical distribution systems are not grounded, and in that respect are different from household or shore systems. Neither of the two conductors in a shipboard system is grounded, while the potential between them is about 120 volts. If an individual, while grounded, were to touch either of these two conductors, that person would receive a severe shock. All live electrical circuits are always treated as potential hazards.

Scientific equipment (including power supplies and clean power sources) and the metal racks usually erected for stowage of scientific equipment must be properly grounded. Any discrepancies found must be reported to the Chief Engineer and remedied before such equipment is energized. Temporary electrical cables rigged for scientific equipment shall be arranged to the satisfaction of the Chief Engineer. This includes marking the cable for identification and ensuring the cable is properly supported, free from possibility of chaffing, is properly protected by an overcurrent device, and is of proper size and construction for the application. Further, such cables must be removed after they have served their purpose.

SURGE PROTECTORS AND UNINTERRUPTIBLE POWER SUPPLIES (UPS): Surge protectors, power strips and UPS's are often brought on board by the science party. These typical commercially available devices are designed for ashore and will interrupt only the hot conductor when a surge occurs and may be a fire risk aboard vessels. The ship operator crews must check and approve all surge protectors, power strips and UPS's in use or brought on board for compatibility with the vessel's electrical distribution system, prior to use.

15.5 RECOMMENDATIONS AND BEST PRACTICES

General electrical safety guidelines:

Consider the results of each act. There is absolutely no reason for individuals to take chances that will endanger their lives or the lives of others.

Assume circuits are live. Don't take the word of others. Stored capacitance can be fatal. Take time to test/discharge circuits before starting work.

Test your tester. When testing circuits to see if they are live, test a known voltage source first to see if your tester works.

Heed warning signs. If a sign warns that there may be two sources of power to a cabinet, take time to identify and secure both sources before reaching into the cabinet.

Use your senses. Be alert to smoke, overheating, and an "electrical smell" which are signs that trouble may not be far off.

Authorized personnel only. Only personnel authorized by the Chief Engineer may work on installed shipboard electrical equipment. Researchers must coordinate their requirements with the Chief Engineer before proceeding with work, which may impact a ship's distribution system.

Keep covers closed. Close covers to fuse panels, junction boxes, etc., when not in use. Covers are there to keep moisture and debris out.

Count tools. When working in cabinets or other equipment, count the tools you take in with you and be certain that you remove the same number when you leave.

Beware of dual voltages. Some switchboard panels have both 440/220-volt and 120-volt circuits. If servicing a 120-volt circuit, beware that a higher voltage circuit is close by.

Remove jewelry. Don't wear jewelry when working with electrical equipment or moving machinery. Remove rings, necklaces, and bracelets when you need to work near live components. The jewelry may serve as a path to ground or cause a short circuit, which could be fatal or cause injury. Make sure to avoid contact with metal zippers on clothing.

Tagged-out equipment. The ship's electricians and engineers place equipment out-of-service if it could jeopardize safety of personnel or cause equipment damage if started. Know how to secure all sources of possible power to such equipment. Never violate a tag by energizing that equipment.

- Leave equipment in working order, or tag it out-of-service before you leave.
- Do not service high-voltage equipment alone.

Do not ground yourself. Make sure you are not grounded when adjusting equipment or using measuring equipment. Use only one hand when servicing energized equipment. Keep the other hand behind you or in your pocket.

- Don't energize wet equipment.
- Use only properly grounded power tools.
- Use fuse puller when pulling fuses.
- Examine extension cords and portable cords and remove from service if unsafe.

16. FIRE FIGHTING EQUIPMENT & FIRE PROTECTION

16.0 INTRODUCTION

The risks associated with fire at sea cannot be over emphasized. This chapter, will identify practices and standards, which when applied on vessels of the U. S. Academic Research Fleet (ARF), will help to ensure that a vessel is adequately outfitted, that equipment is properly maintained, that proper training is carried out and that adequate plans and procedures for fire safety emergencies exist.

These practices and standards identified herein will not relieve a vessel from complying with existing class standards, Code of Federal Regulations (CFR) requirements, SOLAS requirements or other rules and guidelines, and may in some instances establish or recommend a more stringent standard for the operator of an oceanographic research vessel than contained in the CFR.

This section does not address structural fire protection requirements for any group of vessels.

16.1 REFERENCES

The following documents contain information, rules, and requirements pertaining to fire safety on vessels, which may be applicable. They include:

- 46 CFR Subchapter C-Parts 24-28 Uninspected Vessels
- 46 CFR Subchapter U-Parts188-196 Oceanographic Research Vessels
- American Boat and Yacht Council (ABYC), Project A-4 Standard and Technical Information Reports for Small Craft
- SOLAS-Chapter II-2, Consolidated Edition 2004, International Maritime Organization Note: For classification purposes, the fire and safety measures in the International Convention for the Safety of Life at Sea (1974 SOLAS), as amended are applicable to vessels of type, size and service coming under that convention.
- American Bureau of Shipping, Chapter 4, Part 3, Rulesfor Building and Classing Vessels Under 90 meters (295 ft) in length (2006).
- International Maritime Organization (IMO), Safety of Life at Sea (SOLAS) 11-2, Regulation 13.
- National Institute of Occupational Safety and Health (NIOSH), https://www.cdc.gov/niosh/npptl/topics/respirators/ccer/default.html

16.2 REQUIRED BY REGULATION FOR ALL VESSELS

Required fire protection equipment for inspected vessels is prescribed by 46 CFR 193 Subchapter U, and for uninspected vessels by 46 CFR 25.30 Subchapter C. In addition, further practices and standards for them are contained in ABYC's "Safety Standards For Small Craft."

On all vessels, including non-self-propelled vessels of less than 300 gross tons, where fire detecting or extinguishing systems or other equipment are not required but are installed, the system or equipment and its installation shall meet the requirements of 46 CFR 193.

16.3 REQUIRED REGULATIONS FOR CERTAIN VESSELS

16.3.1 INSPECTED VESSELS

16.3.1.1 PORTABLE FIRE EXTINGUISHERS

Inspected vessels over 300 gross tons must follow the requirements of subpart 46 CFR 193.50 for classification, number, size, type, location and spares required.

16.3.1.2 FIXED FIRE EXTINGUISHING SYSTEMS

All inspected research vessels shall have an approved fixed fire extinguisher system installed to protect paint lockers, chemical storerooms, and similar spaces. Machinery spaces containing gasoline engines and machinery spaces containing any internal combustion engines on vessels over 1,000 GRT and total power over 1,000 HP must have fixed CO_2 systems installed. (46 CFR 193.05)

Installations must adhere to the details contained in subpart 193.15 and in particular, protected spaces which are normally accessible to personnel while the vessel is underway should be fitted with an approved audible alarm which will sound automatically during a 20 second delay prior to fire suppression materials being discharged into the space. (46 CFR 193.15-30)

16.3.1.3 FIRE PUMPS

Inspected vessels must be equipped with at least one (two if over 1,000 gross tons) independently driven fire pump and the appropriate number of hydrants and hose. If the fire pump is located in an unmanned machinery space, inspected vessels must have the controls for its operation remotely located at a fire control station, on the bridge, or other readily accessible space. (46 CFR 193.10-5)

16.3.1.4 FIRE AXES

All inspected vessels shall carry on board at least the minimum number of fire axes using guidelines set forth in Table 46 CFR 193.60-5(a). The axes should be distributed so as to be most readily available in the event of an emergency. Fire axes shall be located where they maybe readily seen or they should be placed in enclosures together with fire hose, and the enclosure so marked. (46 CFR 193.60)

16.3.1.5 TESTS AND INSPECTIONS

Tests and inspections of portable and fixed fire extinguishing equipment must be conducted at least once every twelve months. Records of these tests shall be maintained and the equipment tagged to indicate that it has been inspected. It is encouraged, where practicable, that such tests and inspections be conducted by a company recommended by the manufacturer and for classed vessels by a company approved by the classification society. Fire hoses shall be tested every 12 months at a pressure equivalent to the maximum pressure they will be subjected to in service, but not less than 100 psi. (46 CFR 189.25-20 and 46 CFR 196.15-60)

16.3.1.6 FIREMAN'S OUTFIT

All inspected vessels must have aboard, in an accessible area, at least two Fireman's Outfits, each to include: one pressure-demand or positive-pressure self contained breathing apparatus (SCBA), one lifeline with belt, one flashlight, one flame safety lamp or combination oxygen/combustible gas indicator (must be intrinsically safe and UL or Factory Mutual (FM) approved), one spanner wrench, an approved firefighters outfit (to include approved rigid helmet, boots, gloves, coat, trousers and coveralls), and one fire axe. These outfits shall be stored in widely separated, accessible locations. A spare charge is required for each SCBA (46 CFR 195.35, NVIC 12-86 and NVIC 6-01).

16.3.1.7 SELF CONTAINED BREATHING APPARATUS

Two of these appliances are mandatory for inspected vessels as part of a fireman's outfit (46 CFR 195.35).

Consideration should be given to ease of operation and response time in selecting from the list of approved equipment. Lockers and spaces containing the apparatus shall be marked "Self-Contained Breathing Apparatus" (46 CFR 196.37-20). Selected members of the crew must be instructed in SCBA use. Apparatus shall be Mine Safety and Health Administration (MSHA) or National Institute for Occupational Safety and Health (NIOSH) approved for 30 minutes. A spare bottle shall be available for each apparatus and one additional bottle for training. This equipment is not approved for medical use.

16.3.1.8 FIRE AND SMOKE DETECTORS

Fire detecting, manual alarm, and supervised patrol systems are not required on inspected vessels by Subchapter U, but if installed, the systems shall meet the applicable requirements of 46 CFR-part 76 of Subchapter H (Passenger Vessels) (46 CFR 193.05-1).

See 16.3.3 for SOLAS vessel requirements.

16.3.1.9 MARKINGS FOR FIRE EQUIPMENT

Fire equipment for all inspected vessels shall be marked in accordance with the guidelines as set forth in 46 CFR 196.37 if the specified equipment is on board a vessel.

16.3.1.10 FIRE CONTROL PLANS

Fire control plans for inspected vessels must be submitted to the Coast Guard for new construction under 46 CFR 189.55-5.

It is required that all manned vessels have available a set of plans which include a general arrangement showing fire retardant bulkheads with particulars of fire-detection, manual alarm and fire extinguishing systems, fire doors, ingress to various compartments, ventilation, location of remote means of stopping fans and identification of sections of ship served by. These requirements are applicable to inspected vessels. When in port, vessels shall have fire control plans immediately available for emergency personnel called to the vessel for fire emergencies. (46 CFR 196.36)

16.3.2 SOLAS VESSELS

16.3.2.1 GALLEY

SOLAS compliant oceanographic vessels are required to have fixed suppression system in galleys outfitted with a broiler or deep fat fryer (SOLAS Chapter II-2 Part C Regulation 10).

16.3.2.2 FIRE AND SMOKE DETECTORS

For vessels subject to SOLAS, Chapter II-2 Part C Regulation 7 requires that a fixed fire detection and fire alarm system shall be installed in periodically unattended machinery spaces, in machinery spaces where the installation of automatic and remote control systems and equipment has been approved in lieu of continuous manning of the space and in spaces where the main propulsion and associated machinery including sources of the main sources of electrical power, are provided with various degrees of automatic or remote control and are under continuous manned supervision from a control room. Additional requirements call for smoke detection systems in accommodation and service spaces.

16.3.2.3 EMERGENCY ESCAPE BREATHING DEVICE (EEBD)

The intent of an EEBD is to allow personnel to escape from smoke-filled areas of a ship, as well from areas where a total flooding fire suppression system has been discharged. Minimum requirements are established SOLAS regulations. EEBDs are **not** intended or approved for confined space entry or firefighting purposes. The U.S. Coast Guard has designated NIOSH as the approving authority for EEBDs. Smoke hoods or other respiratory devices not certified by NIOSH do not meet maritime EEBD requirements. The following are minimum EEBD requirements for **all** vessels of the Academic Research Fleet:

- One EEBD placed near each cabin bunk (crew, science party, observers).
- At least one EEBD in each machinery space.
- Additional EEBDs should be considered for any other non-sleeping spaces not adjacent to or readily accessible to a weather deck.

Inspected vessels may have additional requirements based on SOLAS regulations; requirements for each inspected vessel are established by the most recent U.S. Coast Guard inspection.

EEBDs must be periodically inspected by qualified members of the ship’s crew, as recommended by the manufacturer.

Training in the use of EEBDs must be part of shipboard familiarization training. Use of a training EEBD to permit actual donning of the equipment is highly recommended.

16.3.3 UNINSPECTED VESSELS

Uninspected vessels requirements for fire-fighting equipment are contained in 46 CFR 25.30 in Subchapter C.

In general, the minimum requirements of Subchapter C are substandard for a research vessel. All uninspected research vessels over 65 ft and less than 300 gross tons shall meet the standards set out in Subchapter U (46 CFR 193) for vessels of their size or to the extent possible when the requirements are stated for large vessels only. Those vessels under 65 ft at a minimum must comply with Subchapter C and with elements of Subchapter U appropriate for vessels of their size. See Section 16.4 below.

16.3.4 OTHER REGULATIONS

Under STCW, mariners with safety-related duties must complete a Basic Safety Training course. Incorporated in this requirement is 16 hours of Basic Fire Fighting. STCW also requires that "Seafarers designated to control fire-fighting operations shall have successfully completed advanced training in techniques for fighting fires, with organizational tactics and command." This competence must have been demonstrated within the previous five years. Participation and compliance with these training requirements is encouraged; however, the U.S. exempts mariners from STCW requirements who serve on small passenger vessels under subchapters T and K and other vessels of less than 200 Gross tons sailing on near coastal, domestic voyage, that being a voyage that begins and ends in a U.S. port, does not touch at a foreign port or enter foreign waters, and is not more than 200 miles from shore.

16.4 REQUIRED STANDARDS UNDER RVSS

The requirements for firefighting equipment contained in subchapter U (46 CFR 193) provide specifications in many sections for vessels smaller than 300 GT. The use of wood and other flammable materials must be kept to a minimum. Any wood or flammable material that is used must be properly insulated from heat sources.

16.4.1 PORTABLE FIRE EXTINGUISHERS

Uninspected vessels less than 300 gross tons and over 65 ft shall comply with the requirements of 46 CFR 193.50 regarding classification, number and location of fire extinguishers. In lieu of carrying spare charges if the vessel when meeting the requirements of 46 CFR 193.50 meets or exceeds the requirements of 46 CFR 25.30-20(c) then no spare charges will be required.

Uninspected vessels under 65 ft are required to follow the requirements in Subchapter C concerning the carriage of portable fire extinguishers. (46 CFR 25.30)

A portable dry chemical and CO2 fire extinguisher must be provided in each science space.

16.4.2 FIXED FIRE EXTINGUISHING SYSTEMS

Any uninspected vessel operating beyond the boundary line and with overnight accommodations for science party and crew shall have a fixed fire extinguishing system for spaces containing an internal combustion engine over 50 hp, an oil fired boiler, an incinerator or a gasoline storage tank. Equipment for a fixed system installed on an uninspected vessel must be type-accepted by the Coast Guard or the Coast Guard Marine Safety Center and installed properly. (46 CFR 25.30-15)

Protected spaces which are normally accessible to personnel while the vessel is underway must be fitted with an approved audible alarm which will sound automatically during a 20 second delay prior to fire suppression materials being discharged into the space. (46 CFR 25.30-15, 46 CFR 193.05-10 and 46 CFR 193.15-30)

16.4.3 FIRE PUMPS

Uninspected vessels over 65 ft in length and under 300 gross tons whenever practicable shall be equipped with at least one independently driven fire pump and provided with an appropriate number of 1 1/2 inch-hydrants and hoses complying with table (46 CFR 193.10-5). If the fire pump is located in an unmanned machinery space vessels must, so far as practicable, have the ability to start a fire pump remotely from an accessible space.

For vessels less than 65 ft in length, operated beyond the boundary line with overnight accommodations for crew and science party, a ¾ inch hose (46 CFR 193.10-5) of good commercial grade together with a commercial nozzle may be used. The pump may be hand operated, and the length of hose shall be sufficient to assure coverage of all parts of the vessel.

16.4.4 FIRE AXES

All uninspected vessels shall carry on board at least the minimum number of fire axes using guidelines set forth in Table 46 CFR 193.60-5(a). The axes must be distributed so as to be most readily available in the event of an emergency. Fire axes shall be located where they maybe readily seen or they should be placed in enclosures together with fire hose, and the enclosure so marked. (46 CFR 193.60)

16.4.5 TESTS AND INSPECTIONS

This section is applicable to all ARF vessels. Tests and inspections of portable and fixed fire extinguishing equipment must be conducted at least once every twelve months. Records of these tests shall be maintained and the equipment tagged to indicate that it has been inspected. It is encouraged, where practicable, that such tests and inspections be conducted by a company recommended by the manufacturer and for classed vessels by a company approved by the classification society. Fire hoses shall be tested every 12 months at a pressure equivalent to the maximum pressure they will be subjected to in service, but not less than 100 psi. (46 CFR 189.25-20 and 46 CFR 196.15-60)

16.4.6 GALLEY

Galley areas in general, and deep fat fryers in particular, are high fire risk areas and merit specialized protection by a smothering system, which can be remotely or automatically activated.

While Coast Guard regulations do not call for a suppression system on inspected or uninspected vessels, the standards used for other inspected vessels as well as uninspected fishing vessels call for the following: each grease extraction hood must be equipped with a pre-engineered dry or wet chemical fire extinguishing system meeting the applicable sections of NFPA 17 or 17A or other standard set by the Coast Guard and must be listed by an independent lab (46 CFR 28.330 and 46 CFR 181.425) . All ARF vessels must install remotely or automatically activated systems that at least meet these requirements.

16.4.7 FIREMAN'S OUTFIT

Vessels over 65 ft in length and less than 300 gross tons operating beyond the boundary line and providing overnight accommodations for crew and science party shall carry firemen's outfits as required for inspected oceanographic vessels (46 CFR 195.35, NVIC 12-86 and NVIC 06-01).

(a) Each fireman's outfit must consist of one self-contained breathing apparatus, one lifeline with a belt or a suitable harness, one flashlight, one flame safety lamp, one rigid helmet, boots and gloves, protective clothing, and one fire axe.

(b) Every vessel shall carry at least two fireman's outfits. The fireman's outfits must be stored in widely separated, accessible locations.

Vessels less than 65 ft in length are not required to carry a fireman's outfit.

16.4.8 SELF CONTAINED BREATHING APPARATUS

Two of these appliances are required as part of the fireman's outfit (46 CFR 195.35).

Vessels less than 65 ft in length shall consider whether a self-contained breathing apparatus is appropriate.

Consideration must be given to ease of operation and response time in selecting from the list of approved equipment. Lockers and spaces containing the apparatus shall be marked "Self-Contained Breathing Apparatus." (46 CFR 196.37-20) Selected members of the crew must be instructed in its use. Apparatus shall be Mine Safety and Health Administration (MSHA) or National Institute for Occupational Safety and Health (NIOSH) approved for 30 minutes. Each SCBA must have a spare bottle. Spare SCBA bottles must be stowed in the same location as the equipment they are intended to replenish. A spare bottle shall be available for each apparatus and one additional bottle for training. This equipment is not approved for medical use.

16.4.9 FIRE AND SMOKE DETECTORS

All ARF vessels with accommodations for overnight berthing of crew and science party must be provided with smoke detection devices. Each accommodation space shall be equipped with an independent modular smoke detector or a smoke actuated fire detecting unit installed in accordance with 46 CFR 76, Subpart 76.33. If an independent modular smoke detector is installed, it must meet UL 217 and be listed as a "Single Station Smoke Detector - Also suitable for use in Recreational Vehicles" (46 CFR 28.325). Further consideration must be given to installation of detection and alarm devices in unattended machinery spaces.

16.4.10 MARKINGS FOR FIRE EQUIPMENT

Fire equipment for uninspected vessels shall be marked in accordance with the guidelines as set forth in 46 CFR196.37 if the specified equipment is on board a vessel.

16.4.11 FIRE CONTROL PLANS

Uninspected vessels 65 ft or over in length and less than 300 gross tons must have a fire plan as provided for in 46 CFR 196.36. In the event such a plan is not available, a general arrangement drawing, at a minimum, shall be readily available for this purpose. When in port, vessels shall have fire control plans immediately available for emergency personnel called to the vessel for fire emergencies.

No requirement exists for vessels less than 65 ft in length; however, it is strongly recommended that a general arrangement drawing of the vessel be readily maintained for emergencies.

16.4.12 TRAINING

Vessel crews must receive adequate training to properly operate the fire-fighting equipment available aboard their vessel. It is further recommended that all crewmembers, no matter the size of vessel, meet the STCW training requirements for Basic Safety Training and remain current in this training. If possible, the crew should attend as a group.

16.5 RECOMMENDATIONS AND BEST PRACTICES

All vessels must consider carrying portable pumps of appropriate size for fire fighting and dewatering.

Vessels less than 65 ft in length shall give due consideration to the benefit of having a fire axe available onboard. In the event a fire axe is carried they shall be located where they maybe readily seen or they should be placed in enclosures together with fire hose and the enclosure so marked

Operators must be aware of hazards posed by specialized spaces or contents of spaces, e.g., labs, spaces with hydraulic oil storage, etc., and ensure these specialized hazards are identified and addressed with additional fire fighting systems to accommodate the added potential danger.

Consideration must be given to providing EEBDs, as specified for SOLAS vessels in 16.3.3 above, on uninspected vessels with the number available taking into account the location and arrangement of berthing spaces as well the science and crew.

For all uninspected vessels there are any number of operational issues, which must be given consideration by the operator when outfitting a vessel. These considerations include the size of the vessel and its capability, area of operation, distance offshore, the number of crewmembers, the training and experience of the crew, and the number of persons in the science party. The standards identified herein are minimum standards.

17. LIFESAVING APPLIANCES

17.0 INTRODUCTION

In general, the minimum standards set out in 46 CFR for inspected vessels are adequate for research vessels. Within SOLAS, oceanographic research vessels fall into a group defined as "Special Purpose Vessels" and are subsequently grouped as "Cargo Vessels." For vessels operating in the Arctic or Antarctic polar regions, compliance with the International Polar Code will be required. This standard specifies lifesaving equipment which must be on board.

The Polar Code entered into force 1 January 2017, under the tacit acceptance procedure. It applies to new ships constructed after that date. Ships constructed before 1 January 2017 are required to meet the relevant requirements of the Polar Code by the first intermediate or renewal survey, whichever occurs first, after 1 January 2018.

However, the minimum standards set forth by 46 CFR 25-28 of Subchapter C for uninspected vessels are substandard for any vessel which operates on coastal or ocean routes unless a vessel is operating well inshore. The RVSS requires that research vessels, while operating on ocean routes (20 or more miles offshore), shall meet the general principles and standards set forth by 46 CFR 199 Subchapter W for vessels not subject to SOLAS.

The following definitions apply to this chapter:

- "Survival craft" is a craft capable of sustaining the lives of persons in distress from the time of abandoning the vessel on which the persons were originally carried. This term includes lifeboats, life rafts, buoyant apparatus, and life floats, but does not include rescue boats.
- "Rescue boat" as defined in the CFR 's means a boat designed to rescue persons in distress and to marshal survival craft. (46 CFR 160.056)
- "Buoyant apparatus" is floatation equipment, (other than lifeboats, life rafts, and personal floatation devices), designed to support a specified number of persons in the water and of such construction that it retains its shape and properties and requires no adjustment or preparation for use. The types generally in use are of a box float type or peripheral buoyant apparatus. (46 CFR 160.010-2)
- "Inflatable buoyant apparatus" is floatation equipment that depends on inflated compartments for buoyancy and is designed to support a specific number of persons completely out of the water. (46 CFR 160.010-2)
- "Life float" is a buoyant apparatus with a peripheral body designed so that persons are supported only partially submerged with approximately 40 lbs of buoyancy required per person. Each float must have a platform that drops through the center of the float. (46 CFR 160.027)
- "Lifeboats" refer to 46 CFR 199- Subchapter W
- Life rafts are "SOLAS A" (equivalent to ocean service), "SOLAS B" (equivalent to limited service) and "coastal" service life rafts. (46 CFR 160.151)

17.1 REFERENCES

- Title 46 CFR 199, Subchapter W - Inspected Vessels 199.
- Title 46 CFR 25-28, Subchapter C - Uninspected Vessels.
- NVIC 03-19 – Maintenance, Thorough Examination, Operational Testing, Overhaul and Repair of Lifeboats and Rescue Boats, Launching Appliances and Release Gear, November 20, 2019.
- SOLAS - Consolidated Edition 2004 or more recent.
- International Code for Ships Operating in Polar Waters IMO Polar Code- http://www.imo.org/MediaCentre/HotTopics/polar/Pages/default.aspx

17.2 REQUIRED BY REGULATION FOR ALL VESSELS

17.2.1 PERSONAL FLOATATION DEVICES (PFD)

All vessels shall be provided with a USCG approved PFD for each person on board. Vessels over 65 ft and all vessels operating in the open ocean should carry Type 1 PFDs. Vessels under 65 ft operating in protected waters must carry life jackets for their size as prescribed by 46 CFR 25.25-5. Each life preserver must be fitted with a USCG approved light (USCG and SOLAS approved for SOLAS vessels), and retro reflective material of approved type. Lifejackets must be marked with the name of the vessel or operating institution. Details on lifejackets may be found in 46 CFR 199.70 and 46 CFR 25.25.

17.2.2 IMMERSION SUITS

Immersion suits are required for vessels operating north of 32 degrees north latitude and south of 32 degrees south latitude, and must be type-approved under 46 CFR 160.171. See 46 CFR 199.70c for details of requirements, markings, stowage, and required attachments and fittings. The immersion suits must be marked and equipped the same as life preservers and stowed in close proximity to working or living areas.

Because immersion suits take longer to don than life preservers, periodic donning drills must be scheduled per CFR for both crew and scientists. 46 CFR 199.180(d)(12) requires all persons other than crew to receive instruction on donning immersion suits monthly. 46 CFR 199.180(d)(11) requires all crewmembers to don an immersion suit every 3 months.

17.2.3 RING LIFE BUOYS

All inspected and uninspected vessels under 328 ft (100m) in length in ocean service shall carry a minimum of eight ring life buoys that shall be stowed, marked, and have attachments per 46 CFR 199.70(a). Life buoys must be stowed so they can be rapidly cast loose, may not be permanently attached to the vessel, and each position must be marked with either the words “LIFEBUOY” or “LIFE BUOY” or the appropriate IMO designated symbol. They must be distributed so they are readily available on either side of the vessel, with at least one near the stern. At least two life buoys fitted with self-activating smoke signals shall be stowed near the bridge where they can be easily released. Life buoys fitted with self-activating smoke shall also be fitted with self-illuminating lights. Each life buoy must be marked in block capital letters with the vessels name and homeport. At least one life buoy on each side shall be fitted with a buoyant lifeline at least 100 ft long. Half the total number of life buoys shall be fitted with approved self-illuminating lights.

For vessels 65 ft or over in length and in services other than ocean (not more than 20 miles offshore), lifebuoys must be stored, marked, and fitted with attachments and fittings as per 46 CFR 199.70(a). For vessels over 65 ft and under 98 ft the minimum number of life buoys to be carried shall be three and for vessels over 98 ft and under 196 ft a minimum of four life rings shall be carried (46 CFR 199.630). One ring buoy on either side of the vessel shall have 100 ft (30m) of buoyant line attached. All ring buoys shall be marked in capital letters with the name and homeport of the vessel. At least two of the ring buoys with water lights attached shall also be provided with a self-activated smoke signal and capable of quick release from the bridge. While these are not legally required on other voyages, they are strongly recommended minimums.

All uninspected vessels over 26 ft and under 65 ft in services other than ocean (not more than 20 miles off shore) shall be equipped with a minimum of at least one ring life buoys which shall be equipped with a line at least 60 ft in length and shall be placed so as to be readily accessible to the persons on board. The position of the life buoy shall be plainly indicated. (46 CFR 25.25-5)

17.2.4 PYROTECHNIC DISTRESS SIGNALS

All vessels in coastwise or ocean service must carry, in the pilothouse or other suitable location, the following minimum pyrotechnic distress signals: 12 approved rocket, parachute, red flare distress signals contained in an approved portable water-tight container. Each approved signal must have an expiration date marked on it and that date must not be more than 42 months from the date of manufacture. (46 CFR 199.60(c))

17.3 <u>OTHER REQUIRED REGULATIONS FOR CERTAIN VESSELS</u>

17.3.1 INSPECTED VESSELS

Rescue Boat: All inspected vessels must have a rescue boat approved under approval series 46 CFR 160.156 and be equipped as specified in table 46 CRF 199.175 and shall comply with requirements for stowage, launch and embarkation (46 CFR 199.262).

17.3.2 SOLAS VESSELS

<u>Survival Craft</u>: SOLAS vessels constructed after July 1, 1986 must be in conformance with the new requirements. Existing SOLAS ships were subject to these requirements July 1, 1991. Older vessels may continue to use life rafts approved for “ocean service” with an “ocean service” equipment pack so long as they remain in good condition. Inspected vessels not required to comply with SOLAS may use the SOLAS A Pack, Ocean Service, or Limited Service (with SOLAS B equipment pack) life rafts as appropriate. “Coastal” service life rafts with a “coastal” equipment pack shall only be used for uninspected vessels operating within 20 miles of the coast.

<u>Lifeboats, rescue boats, launching appliances, and release gear</u>: Effective January 1, 2020, an authorized service provider must perform the required annual thorough examination and operational tests, and the five-year thorough examination, overhaul

and operational tests, on lifeboats, rescue boats, launching appliances and release gear. Details are provided in NVIC 03-19 (see references).

17.3.3 UNINSPECTED VESSELS

Requirements for Life Preservers and Lifesaving equipment on uninspected vessels in Subchapter C are contained in 46 CFR 25.5. ARF vessels should adhere to the higher standards in this chapter under section 17.4 in addition to the basic requirements in section 17.2.

17.3.4 NON-SOLAS VESSELS

Lifeboats, rescue boats, launching appliances, and release gear: The Coast Guard recommends vessels not subject to SOLAS follow the provisions of NVIC 03-19 (see references).

17.4 REQUIRED STANDARDS UNDER RVSS

17.4.1 PERSONAL FLOATATION DEVICES

ARF vessels shall carry an additional number of life preservers readily accessible for the personnel on watch in the engine room, pilothouse, laboratories, and lookout. Lifejackets must be distributed throughout the crew and scientific quarters and other places accessible to each person on board.

17.4.2 IMMERSION SUITS

In addition to the legal requirements, each UNOLS operator shall carry this equipment, based on local or operational circumstances. Operators must consider water temperature in all areas of operations, local or otherwise. 46 CFR 199.70 applies to vessels operating north of 32 degrees north and south of 32 degrees south. The guidelines of the IMO Polar Code must also be followed.

17.4.3 WORK VESTS AND WORK SUITS

The work vest, Type V PFD, is an item of safety apparel and an adequate number of approved work vests must be carried for use by personnel working near or over water. They are not an acceptable substitute for life jackets and shall not be stowed in the same location. Operators shall outfit their work vests with retro reflective material as a minimum, with a PFD light and Global Positioning System (GPS) locators being additional recommendations. Because of the nature of their use, these vests will require replacement more frequently than other lifesaving equipment and frequent inspections are therefore necessary. There are a number of floatation suits and coats available that are recommended when operations take place in a low temperature environment. However, unless these are Coast Guard approved, they may not be substituted for work vests. (46 CFR 26.30 and 46 CFR 196.34)

17.4.4 LIFE BUOYS

All ARF vessels between 65 ft and 98 ft shall comply with the inspected vessel standards.

17.4.5 RESCUE BOAT

All vessels need to maintain a capability to quickly recover a person in the water. On inspected vessels, rescue boats provide this means. All uninspected vessels have a responsibility and must maintain a capability to recover a person in the water. There is no requirement for uninspected vessels to carry rescue boats. However, consideration must be given to types of operations the vessel will be conducting, vessel maneuverability, and vessel freeboard. It is recommended that uninspected vessels have a designated rescue boat when operating in ocean service, coastwise service, or in the Great Lakes. The vessel's workboat may be designated as the rescue boat. In so doing due consideration must be given to the workboats suitability for such purposes and the need to be readily launched, embarked, easily recovered, and suitable for existing conditions (46 CFR 199.640(g)). Since the vessel's workboat may be used for other science support purposes, the vessel operator must decide whether or not the boat should comply with state motorboat registration rules or be marked as a ship's boat.

17.4.6 SURVIVAL CRAFT

Statutory survival craft needs for uninspected vessels are unclear and inadequate. Therefore, the following minimum standards shall apply for ARF Vessels:

Inflatable life rafts are the only type of buoyant apparatus acceptable for uninspected vessels operating in the open ocean more than 20 miles from shore. Each vessel shall carry life rafts or a SOLAS A life raft (or equivalent ocean service if they remain in good condition) with an aggregate capacity sufficient to accommodate the total number of persons on board and that are stowed in a position providing for easy side to side transfer at a single open deck level, or with an aggregate capacity on each side of the ship to accommodate the total number of persons on board (46 CFR 199.261 and 46 CFR 199.640). Life raft capacity shall be prominently displayed near each raft. They shall be of a capacity of six persons or more. They shall be stowed and equipped with hydrostatic release or float free link (46 CFR 199.130). Life rafts and releases shall be inspected and serviced at approximately 12-month intervals at a facility approved by the manufacturer and US Coast Guard to service the specific type of life raft.

Vessels over 65 ft in length and not operating more than 20 miles beyond shore shall give due consideration to vessels service, operating area, and environmental conditions including water temperature when selecting an appropriate survival craft. Any US Coast Guard approved type buoyant apparatus may be used. The institutional decision to carry equipment must be based on the vessel's service and operating area. When carried, the apparatus must be of a capacity sufficient for all persons on board, or the number of persons on board limited to the capacity of the apparatus. The apparatus shall be mounted so it can be readily launched and, when unlashed, will float free should the vessel sink. Each will be attached to the vessel by a painter and float free link (NVIC 1-83). Each apparatus will be marked as per 46 CFR 199.640(j)(3). Also, each shall be equipped for the service of the vessel and periodically examined for integrity and condition.

Vessels operating in "cold water" where the monthly mean low water temperature is below 59 degrees F (15 degrees C) shall carry an inflatable life raft with a coastal service pack. Cold-water areas are defined in NVIC 7-91. Each vessel shall carry life rafts with an aggregate capacity sufficient to accommodate the total number of persons on board and are stowed in position providing easy side-to-side transfer at a single open deck level, or with an aggregate capacity on each side of the ship to accommodate the total number of persons on board. Each raft shall prominently display life raft capacity. Rafts shall be stowed and equipped with a hydrostatic release or float free link. Life rafts and releases shall be inspected at approximately 12-month intervals at a facility approved by the manufacturer and the U. S. Coast Guard to service the specific type of life raft. If a life raft canister is damaged or the seal broken, the life raft shall be serviced again promptly by an approved facility. Hydrostatic releases shall be provided with stainless steel tags on which is stamped their annual test dates (46 CFR 160.062-4).

Embarkation aids in the form of ladders or other suitable devices and continuous illumination shall be provided at life raft stowage and launching areas. (46 CFR 199.110)

Vessels operating in “warm water” where the monthly mean low water temperature is normally more the 59 degrees F (15 degrees C) may give consideration to carrying inflatable buoyant apparatus. Vessels opting to carry inflatable buoyant apparatus, or life floats shall ensure they are stowed, equipped and marked in accordance with guidelines set forth in 46 CFR 199.640(j).

17.4.7 TRAINING AND DRILLS

Inspected vessels shall comply with those requirements for Muster List and Emergency Instructions contained in 46 CFR 199.180. These same requirements shall apply to all vessels in ocean service.

For uninspected vessels, clear instructions must be provided to each person on board a vessel in the event of an emergency. Copies of muster lists shall be posted in conspicuous locations and shall be current for the particular voyage. Each muster list shall include at a minimum, instructions for operating the general emergency alarm system, emergency signals, actions to be taken when an emergency signal is sounded, and duties assigned to members of the ship’s crew.

Emergency instructions and illustrations shall be posted in each cabin occupied by personnel on board. The instructions and illustrations shall include fire and emergency signals, muster station, location of lifejackets, and methods of donning lifejackets. As an alternative smaller uninspected research vessels may consider complying with 46 CFR 28.265 for uninspected fishing vessels.

Training and drills for inspected vessels are addressed in 46 CFR 199.180. These same requirements shall apply to all vessels in ocean service. As an alternative uninspected vessels may comply with those requirements for drills and orientation on fishing vessels contained in 46 CFR 28.270.

17.4.8 TETHERS

Vessel operators shall also make available tethers for use as appropriate by persons involved in deck operations. These should be comprised of an easy-release belt or shoulder harness and buoyant line. There is no Coast Guard approval requirement.

17.4.9 RETRO REFLECTIVE MATERIAL

Lifeboats, life rafts, ring life buoys, rescue boats, work boats, life floats, and personal floatation devices shall have retro reflective material which is Coast Guard approved for that application and is approved under 46 CFR 164.018. (46 CFR 25.25-15)

17.4.10 LINE THROWING APPLIANCES

The handling of oceanographic equipment poses a high risk of a person on deck falling overboard, and a vessel with equipment over the side is usually not able to maneuver freely to make a recovery. All ARF vessels must maintain a capability to recover a person in the water. Depending on the vessel's operating characteristics and responses to weather and sea conditions this capability may include a line-throwing appliance. Reliability and speed are the main criteria for developing a recovery capability. On the approved equipment list there are two approved line-throwing devices:

- Rocket propelled, canister type, line-throwing appliances are relatively inexpensive to procure and maintain, but the rocket that is used to propel the line must be replaced at its expiration. At least two should be carried to provide back up capability.
- The shoulder gun type has a higher initial cost, and greater maintenance requirements. However, it has the advantage of allowing more than one shot with out having multiple units. One gun can be provided with several projectiles and canisters of line. At least one reload shall be available if this type of appliance is carried.

Training in the use of the line throwing gun or device shall be held quarterly and logged. All vessels should actually fire these devices at a frequency appropriate to maintain proficiency. (46 CFR 199.170 and 46 CFR 199.180(e))

17.4.11 ADDITIONAL LIFESAVING DEVICES

17.4.11.1 LIGHTWEIGHT PERSONAL FLOATATION DEVICES

Vessels equipped with Stearns Ultra 4000 inflatable PFDs (or equivalent) with manual and automatic features and outfitted with the ACR ResQFix™ 406 PERSONAL LOCATION BEACON (PLB) will provide them to scientists and crew while working on the open deck. Should an overboard situation arise, the vest will inflate automatically and the PLB can be activated giving a GPS location while simultaneously transmitting a signal on 121.5 MHz (Search and Rescue (SAR) homing frequency) to assist rescuers once in the general area. NOTE: Some vessels are equipped with Radio Direction Finders that can track on 121.5 MHz.

17.4.11.2 RETRIEVAL DEVICES

Vessels equipped with the MUSTANG SURVIVAL RESCUE STICK or other new water-rescue devices will place them in locations in close proximity to existing throwable life rings. The RESCUE STICK ™ is a throwable personal floatation device that inflates into a horseshoe shape upon contact with the water. The RESCUE STICK can be thrown over 100 feet with good accuracy making it more effective than a standard life ring.

17.5 RECOMMENDATIONS AND BEST PRACTICES

Lifesaving equipment carried in excess of CFR requirements should still be of a type approved by those regulations and should be maintained in accordance with those regulations.

The Master should determine when activities on deck or circumstances require the wearing of work vests, work suits or inflatable work vests and ensure these requirements are known and followed by all personnel on board.

Care must be used in designating and marking life rafts. Life rafts are approved for service separately from the equipment pack provided.

Immersion suits must be available in the sizes and numbers for each member of the ship's complement. Vessels should have available small adult and oversize adult sizes if there will be persons on board under 110 lbs or over 330 lbs. If persons with disabilities are on board, special suits may be required.

Immersion suits are expensive and must be ready for use when needed. To save wear on emergency equipment, operators may want to have some suits marked "not serviceable-drill only" and separately stowed for this purpose. These suits often tend to crack along fold lines when packed and stored for long periods, and at least quarterly suits should be hung unfolded for a day. Immersion suits shall be tagged or marked on the outside of the bag with the date of the last inspection.

When re-stowing life preservers after drills, each shall be checked for condition. At least semi-annually a thorough inspection of each lifejacket shall be made by a qualified crewmember, including a squeeze to ensure floatation pads are still sealed.

Chemiluminescent type lights should be avoided on vessels operating in near-freezing waters.

Litters and Stretchers: Litters or stretchers that are used to evacuate an ill or injured person from a vessel should be equipped with floatation.

Dated Materials: Many items of lifesaving equipment, such as flares, EPIRB batteries and life raft supplies, have a specified, limited service life. Care shall be taken to ensure these items are marked with an expiration date upon being placed into service, and records shall be kept to ensure timely replacement.

Training and Drills: The key to emergency response is training and drills. Therefore uninspected vessels must at minimum:

- Have training materials relating to emergency equipment and procedures readily available on board
- Ensure every crewmember on board is familiar with emergency duties before a voyage.
- Provide a safety briefing for special personnel/science party before sailing or immediately after sailing.

Drills shall include:

- One fire and abandon ship drill every month and within 24 hours of leaving port.

- As far as practical, rescue boats must be launched with assigned crew aboard and maneuvered in the water at a minimum of every three months.
- Emergency lighting for muster and abandon ship must be tested at every abandon ship drill.
- Line throwing appliance drills shall be conducted every quarter with actual firing at the Master's discretion.

<u>Every new crewmember shall be provided</u>:

- Onboard training in use of vessels lifesaving appliances, survival craft and fire extinguishing appliances within two weeks of arrival.
- Onboard training in heat, stress, hypothermia and other appropriate first aid.
- Instruction in the use of fire and lifesaving equipment at the same interval as drills.
- See also Sections 4.2.1 and 6.1.3.

A record of all training, drills and personnel attending must be maintained on board the vessel. The date, time and type of drill must be documented in the vessel's log.

18. USE OF NON-ACADEMIC RESEARCH FLEET VESSELS

The provisions of the former Chapter 18 and Appendix D have been deleted from the RVSS. Principal Investigators and Marine Superintendents should consult "Guidance Document: Use of Research Vessels outside the Academic Research Fleet (non-UNOLS vessels)," available on the UNOLS web site.

19. SHIP-BASED USE OF UNMANNED AERIAL SYSTEMS (UAS)

19.0 INTRODUCTION

The rapid development of unmanned aerial systems (UAS) technology has offered dramatic new capabilities for at-sea research and data collection. However, the technology has often out-paced implementation of regulatory and safety procedures.

With recent publication of the Federal Aviation Administration (FAA) small UAS rule, policy for academic research vessels (ARVs) has been developed by the UNOLS Scientific Committee for Oceanographic Aircraft Research (SCOAR). This policy, including detailed procedures and regulatory information, is contained in the UAS Operators Manual, referenced in section 19.1 below.

Operation of UAS, or drones, from or over ARVs may not take place without demonstrated compliance with national or international regulations (International Coalition for Sustainable Aviation, ICSA, Federal Aviation Administration, FAA) and specific approval of the ship's captain or designee, as a minimum. This policy also applies to the high seas, or the airspace above areas beyond the exclusive economic zones of the nations of the world. This policy applies to crew, technicians and members of the science party, and refers to all operations, whether recreational, educational, or professional.

UNOLS recognizes that UAS must be safely integrated into the airspace of the proposed experiment site. All UAS operation must also demonstrate compliance with ship operation requirements, and any other oversight entities (e.g. Institution Center of Excellence or Risk Management office) associated with the operator institution or with funding agencies (e.g. ONR environmental review). The UNOLS UAS Operator's Handbook recognizes that UAS are built in a variety of shapes and sizes and serve diverse purposes, and therefore there is not a unique approach to operating UASs from research vessels.

19.1 REFERENCES

Unmanned Aerial Systems (UAS) Operations from the U.S. Academic Research Fleet: Operator's Handbook (March 2019), https://www.unols.org/document/unmanned-aerial-systems-uas-operations-us-academic-research-fleet-operator's-handbook

Policy for UAS Operations on UNOLS Vessels (July 2016),
https://www.unols.org/sites/default/files/UNOLS_UAS_Policy_July2016.pdf?

19.2 REQUIRED STANDARDS UNDER RVSS

19.2.1 GENERAL UNOLS POLICY

In the summer of 2016, the UNOLS Council directed that:

- Operation of UAS from or over U.S. academic research fleet ships may not take place without demonstrated compliance with national or international regulations (ICSA, FAA).

- Specific approval by the ship's Master or designee, is required for all UAS operations.
- UNOLS UAS policy applies to crew, technicians and members of the science party, and applies to all UAS operations.
- Obtaining national approvals, such as FAA's Sec 333 exemption or Certificate of Authority or Waiver (COA), as well as pilot qualifications, are not a guarantee the operations will be approved by the ship's Master.
- Recreational or hobbyist freedom of use over land is not available at sea, so it is critical that planned use of UAS research from ships of the Academic Research Fleet (ARF) be coordinated with the ship's operator ahead of time.
- In addition to research, educational and research use of UAS are permitted subject to the general policy provisions.

The full UNOLS policy is referenced above.

19.2.2 UAS OPERATOR'S HANDBOOK

This handbook provides a wealth of detailed information for ship-based research using unmanned aerial systems. Procedures in the Operator's Handbook are mandatory requirements for UAS shipboard operations and must be consulted when planning any UAS operations from an ARF vessel. Because UAS technology and applications are developing quickly, questions and suggestions for updated procedures should be referred to the UNOLS Scientific Committee for Oceanographic Aerial Research (SCOAR) through the UNOLS Office.

19.2.3 PLANNING AND PREPARATION

A ship-based UAS project involves careful attention to issues such as approval of the intended UAS usage by the vessel's operating institution, pre-cruise planning meetings, liability insurance, and pilot training and certification. The UAS Operator's Handbook provides detailed information.

19.2.4 SHIPBOARD PROCEDURES

ARF vessels must develop a ship-specific checklist for the launch and recovery of UAS. At a minimum, the checklist should include provisions for:

- A pre-flight plan for the field experiment using UAS.
- Completing a risk assessment prior to UAS flight operations (see Appendix 1 of the Operator's Handbook).
- Completing appropriate notifications (see Appendix 3 of the Operator's Handbook).
- A communications plan (see Appendix 2 of the Operator's Handbook).
- A safety brief for all personnel involved with the operation.
- Provisions for safe and appropriate retrieval of waste in the event the UAS suffers an accident as part of its operations.
- Record-keeping requirements (see Appendices 4 and 5 of the Operator's Handbook).
- Reporting actions in the event of a UAS accident, incident or near miss (see Appendix 6 of the Operator's Handbook.

Vessels should conduct exercises and/or walk-through drills to verify the readiness of rescue and emergency equipment and to train personnel tasked with emergency responses.

Important: UAS recreational use from research vessels is prohibited.

19.2.5 INFORMATIONAL POINTS OF CONTACT

The UAS Operator's Handbook provides contact information for institutions that have active UAS programs.

APPENDICES

A. UNOLS Rope and Cable Safe Working Standards

B. UNOLS Overboard Handling Systems—Design and Operation Standards

C. Safety Inspection Check List for Shipboard Vans

D. Waivers of RVSS Standards

E. Harassment Prevention

F. List of Acronyms

G. Safety Training for Science Parties

H. Vessels of the Academic Research Fleet

APPENDIX A
UNOLS Rope and Cable Safe Working Standards

A.0 INTRODUCTION

46 CFR 189.35 – “Weight Handling Gear” describes design standards for handling systems aboard inspected oceanographic research vessels. However, this standard does not address Factor of Safety (FS) on the tension members. The purpose of this appendix to the RVSS is to establish safe and effective operating limits for vessels in the UNOLS fleet for tension members loaded beyond traditional shore-side limits. The primary goal of these requirements is to maintain a safe working environment for all personnel aboard. The secondary goal is to minimize damage to tension members and handling equipment, and the loss of scientific equipment, while still permitting the science objective to be met.

Normal operation beyond the parameters defined in this standard is forbidden, unless an emergency situation is declared by the Master or other officer in charge of the vessel as noted in Section 0. Waivers of specific standards may be requested in accordance with section 2.3 and Appendix D of the RVSS.

A.1 REFERENCES

- **A.1.1 HANDBOOK OF OCEANOGRAPHIC WINCH, WIRE AND CABLE TECHNOLOGY, Third Edition.**
- **A.1.2 Mechanics of Materials, Second Edition, Gere and Timoshenko, 1984**
- **A.1.3 Wires and Cables Deployed Overside of RVS Vessel – Generic Operating Limits, Document Number SE301050, Issue No.: 001, 12/01/00.**
- **A.1.4 Rules for Building and Classing Underwater Vehicles, Systems and Hyperbaric Facilities, ABS, 2014, Section 17 Handling Systems**
- **A.1.5 UNOLS Wire Pool Wire Maintenance Policy, 2014**

A.2 DEFINITIONS

A.2.1 Assigned Breaking Load, (ABL)	Will be the lowest of the Nominal Breaking Load and Tested Breaking Load. In practice ABL will be equal to NBL used unless testing shows TBL to be less than NBL. An ABL that is greater than the NBL may never be used. Depending on the intended use of the tension member there may be two ABLs for fixed end and free to rotate conditions.
A.2.2 Auto-Render	The capability of the winch to automatically pay out at a pre-set maximum tension in order to prevent the tension member from exceeding the pre-set tension.
A.2.3 Cable	A woven, flexible tension member with internal conductors or other means of transmitting data such as glass fiber.
A.2.4 “D”	The root diameter of the sheave.
A.2.5 “d”	The outside diameter of the cable or rope.
A.2.6 “d1”	For cable the largest diameter wire in the armor wires. For wire rope the largest of the outer wires.
A.2.7 Dynamic Loads	Loads induced due to vessel motion (heave, roll, pitch, etc.)
A.2.8 Elastic Limit	The elastic limit or yield point of a material is the stress at which a material begins to deform plastically. Prior to the yield point the material will deform elastically and will return to its original shape when the applied stress is removed. Once the yield point is passed some fraction of the deformation will be permanent and non-reversible. For rope or cable this is the load that causes permanent set, or deformation, of the wires. (See Background Information)

A.2.9 Estimated Maximum Tension (EMT)	An estimate of the greatest line tension that will occur during a given deployment. It’s calculated using specific properties of the OHS, the science package, and other factors.
A.2.10 Factor of Safety (FS)	Factor of Safety is defined as the ratio of the maximum stress that a structural part of other piece of material can withstand to the maximum

	stress estimated for it in the use for which it is designed. For the purposes of this standard, FS shall be considered the value selected by the operator. Section 0 defines the minimum standards that must be met to select specific FS values.
A.2.11 Fixed Ends (FE)	Both ends of the tension member being fixed without the ability to swivel. Most wire rope and cable NBL values are based on FE. An example of a fixed end application is towing a MOCNESS.
A.2.12 Free to Rotate	The end of the tension member is free to rotate either because a swivel is at the end of the tension member or the package at the end of the tension member can rotate freely. Tension members used in free to rotate applications typically have a NBL below the fixed end NBL. An example of a free to rotate application is a lowered CTD package.
A.2.13 "g"- question on def.	The vertical acceleration due to gravity. For normal static loading (no dynamic effect), "g" is equal to 1.0. To take into account dynamic effect due to ship's motion and package drag, the simple static load is multiplied by a factor higher than 1.0. Under ABS standards, normally 1.75 or 2.0 for vertical accelerations is used depending on the application. "g" is applied to the mass of the package and tension member, not the weight. For permanently installed systems, consideration may be given to lesser loads where it can be shown that the maximum expected loads are less than those given above. (Ref □)
A.2.14 Induced Rotation	Induced rotation occurs when external forces cause torque to be applied to the tension member. An example of an induced rotation situation would be a tow vehicle that spins while being towed but a swivel is not in place to decouple the vehicle from the tension member. This situation could develop if the tail fin of a corer was bent. Induced rotation should never be allowed to occur on a tension member that has not been specifically designed for this purpose.
A.2.15 Nominal Breaking Load (NBL)	Manufacturer's minimum published breaking load for a rope or cable.
A.2.16 Render-and-Recover	A winch's combined ability to auto render, then haul the tension member back when the tension drops to an amount below the pre-set tension. Generally, recovery haul back is limited to the point of the initial rendering.

A.2.17 Rope	A woven, flexible tension member with no internal conductors. It may be made from natural fibers, synthetic fibers, or metal.
A.2.18 Safe Working Tension (SWT)	The maximum tension that is allowed to be applied to the tension member (rope, wire or cable) during normal operation. SWT = ABL / FS and is determined by a break test. Because there may be two different ABLs (fixed end & free to rotate) there may be two SWTs. The term SWT may also be applied to systems other than tension members (see B.0.3).
A.2.19 Tension Member	Generic name used to describe a rope or cable in service for over the side work.
A.2.20 Tested Breaking Load (TBL)	The actual load required to pull a tension member to destruction as determined by testing. Depending on the intended use of the tension member testing may need to be done under fixed end and free to rotate conditions.
A.2.21 Transient Loads	Loads induced which are temporary by nature, including the weight of entrained mud, weight of entrained water, pull out loads, drag due to package characteristics and/or winch speed, etc.
A.2.22 "w"	The width of the sheave groove supporting the sides of the tension member.
A.2.23 Winch Owner	The party or their representative who is normally responsible for the operation, inspection, maintenance, and testing of the winch. This could be the vessel operator or the scientific party.

A.3 LIMITATIONS

Loading limitations are expressed in terms of Factor of Safety (FS) on Assigned Breaking Load (ABL) in this document.

The limits in this document may not be used where other regulations are applicable, for example, on cargo cranes. In such cases, the shore-side regulations, which apply, must be adhered to. For example, the Occupational Safety and Health Administration (OSHA) generally require a 5.0 FS on cable breaking strength.

This standard assumes that the tension member is properly used for its intended purpose.

A.4 COMPLIANCE DATES

Appendix A standards are effective upon promulgation of Edition 11 of the RVSS.

A.5 TESTING AND PREVENTATIVE REQUIREMENTS

A.5.1 TESTING PROGRAM

Cable paths and fairlead arrangements vary widely from ship to ship and change over both the short term (from cruise to cruise) and the life of the vessel. It is impossible to develop a set of standards, which tries to quantify the precise effects on breaking strength, or tension member life, as a result of system design. Instead, each vessel must have a testing program in place, which suits how their tension members are used, and routinely evaluates the status of each. The assumption is that the results of testing will indicate the effect of both the loading and system design on the breaking strength of the tension member.

The testing program followed shall be based on the FS selected by the Owner, which is in turn based on use and the particulars of the handling system employed. The Owner shall have documentation in place specifying the FS for each tension member in use.

Tension member test samples shall be a clean, "representative" length from the end that will be put into future use, not simply the end immediately adjacent to the existing termination. Although this may not be the location of maximum loading during operations, this represents a practical means of determining ABL from an operational standpoint.

The initial ABL shall be assigned through testing by the UNOLS Wire Pool before distribution to the fleet. If the initial test results in an ABL less than the NBL, the Wire Pool shall reject the tension member.

If subsequent testing results in a TBL that is greater than or equal to the initial ABL, the initial ABL shall be used by the Vessel Operation for the purposes of this standard.

If subsequent testing results in a TBL that is less than the initial ABL, then the new TBL shall be used in lieu of the initial ABL by the Vessel Operation for the purposes of this standard.

A.5.2 METHOD OF DETERMINING (TBL) – STEEL WIRES AND CABLES

ASTM A931-96, "Standard Test Method for Tension Testing of Wire Rope and Strand" (Re-approved 2002) shall be used. Tests shall be done with one end of the tension member free to rotate.

The Vessel Operator shall send samples to a UNOLS-accepted test facility (UNOLS Wire Pool at WHOI) for consistency of testing purposes and maintaining statistics. For steel cables and wire rope, the Operation shall send a five-meter (16 ft.) test sample (as described in Section 4.3) terminated on both ends with the fittings normally used in the field. If the field terminations are found to not develop full breaking strength, a test may be conducted using standard poured epoxy resin terminations.

The Vessel Operator shall also provide a copy of the wire history or wire log information with the sample and, as a minimum, this should include the following:

- UNOLS wire identifier.
- Winch and system manufacturer.
- Number and/or duration of deployments since last test.
- Maximum tension of each deployment.
- Maximum payout of each deployment.
- Wire out at time of maximum tension.
- Description of wire train: the number of sheaves between winch and water. Sheave material and values of "D" and "w" for each sheave.

Lubrication Log- A log of the lubrication and maintenance on the wire shall be maintained.

A hard copy and/or electronic copy of the TBL test results and ABL will be provided to the Vessel Operator for each sample tested.

A.5.3 METHOD OF DETERMINING (TBL) – SYNTHETIC TENSION MEMBERS

Reserved

A.5.4 ELECTROMAGNETIC TESTING

Reserved

A.5.5 DC RESISTANCE TESTING

Reserved

A.5.6 RETIREMENT OF STEEL TENSION MEMBERS

Beside obvious physical damage (kinks, bird caging, abrasion, broken strands, excessive corrosion, etc.), a length of tension member shall be removed from service, or cut back so that the unacceptable length is removed, if any of the three following criteria are met:

- If the ABL, with the appropriate FS applied as described above, does not meet future scientific requirements.
- If the ABL deteriorates below 50% of NBL.
- Peak tension over-turning sheaves at any time during operations exceeds the Elastic Limit (FS of 1.8 for cable, FS of 1.33 for wire rope).

A.5.7 RETIREMENT – SYNTHETIC TENSION MEMBERS

Reserved

A.5.8 LUBRICATION

Appendix A does not directly deal with requirements for tension member lubrication. Lubrication of tension members is detailed in the UNOLS Wire Pool Wire Maintenance Policy (Ref). This policy prescribes the application of a lube/corrosion inhibitor at a frequency of no less than once every twelve months while in service and when the tension member is taken out of service.

A.5.9 FRESH WATER WASH DOWN

While understanding that fresh water is limited at sea, an automatic system that washes the tension member on retrieval is highly encouraged since it greatly extends service life. This is expanded upon in the UNOLS Wire Pool Wire Maintenance Policy. The policy dictates for a tension member in use that a wash down occur at the end of every cruise, but at an interval no greater than one month.

A.6 <u>BACKGROUND INFORMATION</u>

A.6.1 PERFORMANCE OVER A ROLLING SHEAVE

When a steel wire rope or cable passes over a rolling sheave, up to a 30% reduction in breaking strength occurs (Ref Section 6.4, Pg. 8-22). For a tension member with a nominal breaking load of 10,000 lbs., this would be a reduction in strength of 3,000 lbs. to an anticipated breaking load of 7,000 lbs. Using a FS of 1.5 in this example, the Safe Working Tension equals 6,667 lbs., just below the reduced strength anticipated. Since all oceanographic tension members pass over at least one sheave, this is the primary argument for not having a FS less than 1.5.

A.6.2 YIELD POINT AND ELASTIC LIMIT

“Yield Point” is where continued deformation will occur without adding significantly more load. The “Elastic Limit” is considered to be the load, which induces permanent set or deformation. For steel, the “Yield Point” and “Elastic Limit” are essentially the same for all practical purposes. However, these two points may be quite different for other materials such as synthetics and glass fiber. Since wire rope and cables are made of strands and are not solid bars of steel, the precise Yield Point can be hard to determine by testing. A point on the stress-strain curve known as “0.2% Offset Yield” is used instead. The 0.2% Offset Yield for three-strand wire rope can be found in Section 2.2 (pg. 1-5) of Reference .

For cables with copper conductors, the yield point generally occurs anywhere from 50-55% of the breaking strength (FS = 1.8) at which point the performance of conductors deteriorates. This is the principal argument for not having a FS less than 2.0 for steel cables with copper conductors, the goal being to maintain conductor performance over the life of the cable.

For wire rope, the yield point generally occurs around 75% of the breaking strength (FS = 1.33). This is the other reason for not having a FS less than 1.5 on steel wire rope, the goal being to maintain the useful life of the wire rope. This limit matches well with the performance over rolling sheaves above.

A.6.3 TENSION MONITORING JUSTIFICATION

When using low FS in oceanographic research, the capabilities of the tension member monitoring system become critical with respect to capturing and displaying dynamic loads. This standard is divided into four primary sections (

Table –

Table), with each section having increasingly stringent requirements for the monitoring system. If the monitoring system is not capable of reliably capturing peak (or low) dynamic loads, then the chosen FS must keep the tension member below its yield point.

For example, on a tension member with a breaking strength of 20,000 lbs., the approximate yield point would be 20,000 x 0.75 = 15,000 lbs. Using a FS of 2.5, the allowable loading would be 20,000/2.5 = 8,000. If the system is not capable of reliably capturing dynamic effect, then a worst-case scenario of 1.75 times static load would have to be assumed (i.e., “g” = 1.75), or 8,000 x 1.75 = 14,000. 14,000 is below the approximate yield strength of 15,000 so the integrity of the tension member would be preserved despite the monitoring system. Figure 1 illustrates this and is why a FS of 2.5 is used as the lower limit in Table .

Figure 1: Tension Member Integrity

When a tension measuring system is not available, which forces using a minimal FS of 5.0, EMT calculations must be done based on mass not weight. In general, the weight of the package, entrained water and the cable or rope in air is roughly equal to the mass. Do not use weight in water for the dynamic loading estimates.

A.7 <u>WINCHES AND HANDLING SYSTEM DESIGN</u>

All handling systems and winches, whether portable or permanently installed, must be properly designed to an appropriate standard as described in Appendix B of the RVSS.

A.7.1 LOAD LIMITING DEVICES

For operations where the weak link itself might be entangled or buried, then Auto-Render shall be the preferred method of strain relief.

A.7.2 HEAVE COMPENSATION

Heave compensation may not be used as a load limiting device but may be used to minimize the dynamic accelerations during deployments. When using heave compensation, it must be realized that most methods work a small section of a tension member over a sheave or sheave train. For this situation it is important to make adjustments so that a different section of the tension member is worked on each deployment or over extended deployments.

A.8 REQUIREMENTS

A.8.1 ESTIMATED MAXIMUM TENSION (EMT)

This is an assessment of the maximum tension that a payload can exert on a tension member during a deployment. The EMT is the sum of static loads (package weight, sample weight, tension member weight), quasi-static loads (drag force), transient loads (pull out forces), and dynamic loads (the effects due to accelerations from heave). Not every deployment will involve every type of load.

The effect the EMT has on a given deployment depends on the monitoring system employed. For cases where there is no monitoring system or a low-resolution monitoring system (as described in and Table), the EMT for a deployment needs to be equal or less than the SWT of a tension member and the SWT of the OHS (see Appendix B) for a deployment to be allowed. In cases where there is a high-resolution monitoring system (as described in Table and

Table), the EMT without dynamic loads should be less than the tension member SWT and the SWT of the OHS with the provision that should the monitored tension exceed the SWT the deployment will be halted. Section 0 provides examples of calculating EMT.

A.8.2 STEEL TENSION MEMBERS

Operating tension members with a Factor of Safety (FS) less than 5.0 results in increasingly higher levels of risk to personnel and equipment. To manage the higher risks so that operations stay within a manageable level,

Table to

Table were developed. These tables outline the procedures and equipment requirements that must be in place to operate at different ranges of Factor of Safety. It is the operator's discretion at which FS they choose to operate under as long as they meet the requirements for that FS.

The impact that the diameter of sheaves in the wire path have on tension member service life and safety is significant. For higher loads such as those seen when operating with a FS less than 5.0, having adequately sized sheaves is critical. Further study has shown that the diameter of load carrying rollers has an equally critical impact on tension member service life. A load carrying roller would be any roller in the wire and cable path that serves to change the direction of the loaded tension member.

Examples of rollers where the requirements of Appendix A apply:

- Rollers on a level wind whose function is to ensure a small fleet angle to the level wind sheave is maintained. There is the potential for the tension member to come up hard against one of these rollers and change the direction of the tension member when under load.
- Any level wind that only uses rollers without a sheave has the potential for the tension member to come up hard against one of the rollers and change the direction of the tension member when under load.

Examples of rollers where the requirement of Appendix A do not apply:

- Sense rollers such as what are used on an electro-active level wind that senses when a level wind needs to change direction.
- Capture rollers that are there to help keep the tension member in a sheave groove during no load pre- and post-deployment periods, but that once the tension member is loaded it is not in contact with the capture rollers.

Table A.8.1 Steel Tension Member – Factor of Safety 5.0 or Greater – Minimum Requirements

General	Wire Rope or Cable of steel construction may be operated to a nominal FS = 5.0 on the ABL, including transient and dynamic loads, as long as the following precautions in this section are adhered to.
	When the minimum Factor of Safety of 5.0 is reached, the deployment must be halted, or the next level of standards described in Table must be used.
	Sea conditions and the resulting ship motion will affect the transient loads created on the tension member. Thus, the trend in prevailing weather should be assessed before committing to a deployment, which could approach the limits specified above.
Tension Monitoring	Tension monitoring is not required. If tension monitoring is not available tension should be determined by calculation of EMT, as long as the Owner is confident that a FS of 5.0 will not be compromised. If no other precise information is available on package drag and/or vessel accelerations, the Vessel Operator should use the ABS “g” factor of 0.75 as a minimum.
Alarms	None
Sheaves & Load Carrying Rollers	The sheave and roller diameter should be as large as practicable.
Deck Safety	Personnel on deck should follow good safety practices when working in the vicinity of tension members during use.
Testing	Wire samples from the end closest to the termination shall be sent for testing every two years. If a 10% decrease in ABL is detected, then the testing shall be increased to every year. Alternatively, the owner may cut back to and re-test a new representative length.
Logbooks	At a minimum, the Owner shall maintain logs showing cutbacks, spooling operations, lubrication, wire train description, maximum payout and maximum loading (as determined by monitoring system or by calculation for each cast) for the full-service life of the rope or wire. The information shall transfer with the tension member if it is removed and placed in storage or transferred to another winch or Owner. It is highly recommended that the NSF Wire Pool Database be used to meet this requirement.
Winch Operator	The Owner and the Master of the vessel must deem competent, in writing, all winch operators. “Deemed Competent” means that both the Owner and the Captain are confident, given the particulars of the winch and the overall operational scenario (weather conditions, equipment being deployed, etc.), that the Winch Operator has the necessary experience to operate the winch safely. If there are configuration changes to controls or to the hardware, then the operator qualifications must be refreshed and documented.

Table A.8.2 Steel Tension Member – Factor of Safety From Less Than 5.0 to 2.5 – Minimum Requirements

General	Wire rope or cable of steel construction may be operated to a nominal FS =2.5 on the ABL, including transient and dynamic loads, as long as the following precautions in this section are adhered to.
	When the minimum Factor of Safety of 2.5 is reached, the deployment must be halted, or the next level of standards described in Table must be used.
	Sea conditions and the resulting ship motion will affect the transient loads created on the tension member. Thus, the trend in prevailing weather should be assessed before committing to a deployment, which could approach the limits specified above.
	Motion-compensation may be used to reduce the dynamic loads below the permissible limit and/or to reduce the chances of a "zero load" condition.
Tension Monitoring	Tension must be monitored at the winch operator's station with a display refresh rate of at least 3 Hz (every 330 mS). The system must also be capable of logging tension data at a minimum frequency of 3 Hz (every 330 mS). The tension measuring system must be calibrated at a minimum of every 6 months at load equal to the imposed at the selected FS. The tension measuring system must be maintained with an accuracy of 4% of the applied load.
Alarms	The handling system shall be fitted with both audible and visual tension alarms that sound and illuminate prior to a FS=2.8 of a wire's Assigned Breaking Load (ABL). Alarm conditions must automatically be included in the logged data.
Sheaves & Load Carrying Rollers	The D/d ratio must be at least 40:1 or 400d1 (whichever is greater) throughout. Grooving of the sheaves should be as close to "d" as practical, and generally no larger than 1.5d.
Deck Safety	The Operator should identify "Danger Zones" around ropes, wires and cables under tension. To the extent possible, given the nature of operations involved, all personnel should be excluded from these zones such that a sudden failure cannot result in injury.
Testing	Wire samples from the end closest to the termination shall be sent for testing every two years. If a 10% decrease in ABL is detected, then the testing shall be increased to every year. Alternatively, the owner may cut back to and re-test a new representative length.
Logbooks	At a minimum, the Owner shall maintain logs showing cutbacks, spooling operations, break tests, lubrication, wire train description, maximum payout and maximum loading (as determined by monitoring system or by calculation for each cast) for the full-service life of the rope or wire. The wire log shall transfer with the wire if it is removed and placed in storage or transferred to another winch or Owner. It is highly recommended that the NSF Wire Pool Data Base be used to meet this requirement.

Winch Operator	The Winch Owner must certify that all Winch Operators are competent. By “Certified Competent” it is meant that the Owner must have written documentation in place showing that the operator has been through and successfully passed a formal owner/operator developed training program on the winch, handling apparatus, and monitoring system. The system vendor or the Owner, depending on the complexity of the system, may conduct a formal training program. The certification must be renewed annually. The master shall verify certifications and designate the approved winch operators. If there are configuration changes to controls or to the hardware, then the operator qualifications must be refreshed and documented.

Table A.8.3 Steel Tension Member – Factor of Safety From Less Than 2.5 to 2.0 – Minimum Requirements

General	Wire rope or cable of steel construction may be operated to a nominal FS =2.0 on the ABL, including transient and dynamic loads, as long as the following precautions in this section are adhered to.
	FOR CABLES - When the minimum Factor of Safety of 2.0 is reached, the deployment must be halted. FOR WIRE ROPE -When the minimum Factor of Safety of 2.0 is reached, the deployment must be halted, or the next level of standards described in Table must be used.
	Sea conditions and the resulting ship motion will affect the transient loads created on the wire. Thus, the trend in prevailing weather should be assessed before committing to a deployment, which could approach the limits specified above.
	Motion-compensation may be used to reduce the dynamic loads below the permissible limit and/or to reduce the chances of a "zero load" condition.
Tension Monitoring	Tension must be monitored at the winch operator's station with a display refresh rate of at least 10 Hz (every 100mS). The system must also be capable of logging tension data at a minimum frequency of 20 Hz (every 50 mS). Tension must be continuously monitored using a "tension trending" graph at the winch operator's station. The tension measuring system must be calibrated at a minimum of every 6 months at load equal to the imposed load at the selected FS. The tension measuring system must be maintained with an accuracy of 3% of the applied load.
Alarms	The handling system shall be fitted with both audible and visual tension alarms that sound and illuminate prior to a FS=2.2 of a wire's Assigned Breaking Load (ABL). Alarm conditions must automatically be included in the logged data.
Sheaves & Load Carrying Rollers	The D/d ratio must be at least 40:1 or 400d1 (whichever is greater) throughout. Grooving shall be per Ref A.1.1, Chapter 1, and Section 11.0 to provide adequate support.
Deck Safety	The Operator should identify "Danger Zones" around ropes and wires under tension. To the extent possible, given the nature of operations involved, all personnel shall be excluded from these zones such that a sudden failure cannot result in injury. Warning notices should be displayed at points of access indicating the danger. Physical and/or visual barriers should be erected as needed. Existing doors and accesses to the area should be secured when possible
Testing	Wire Samples from the end closest to the termination shall be sent for testing annually. If a 10% decrease in ABL is detected, then the testing shall be increased to every six months. Alternately, the Owner may cut back to and re-test a new representative length.

Logbooks	At a minimum, the Owner shall maintain logs showing cutbacks, spooling operations, lubrication, wire train description, maximum payout and maximum loading (as determined by monitoring system for each cast) for the full-service life of the rope or wire. The wire log shall transfer with the wire if it is removed and placed in storage or transferred to another winch or Owner. It is highly recommended that the NSF Wire Pool Data Base be used to meet this requirement.
Winch Operator	The Winch Owner must certify that all Winch Operators are competent. By "Certified Competent" it is meant that the Owner must have written documentation in place showing that the operator has been through and successfully passed a formal owner/operator developed training program on the winch, handling apparatus, and monitoring system. The system vendor or the Owner, depending on the complexity of the system, may conduct a formal training program. The certification must be renewed annually. The master shall verify qualifications and designate the approved winch operators. If there are configuration changes to controls or to the hardware, then the operator qualifications must be refreshed and documented.

Table A.8.4 Steel Tension Member – Safety Factor From Less Than 2.0 to 1.5 – Minimum Requirements

General	Wire rope of steel construction may be operated to a nominal FS =1.5 on the ABL, including transient and dynamic loads, as long as the following precautions in this section are adhered to.
	Once a FS = 2.0 is reached a regular check on wire loading shall be performed. This will require halting a deployment at regular intervals (~ 500 m) and conducting a slow haul until the nominal and peak tensions are established and verified. A decision on whether to proceed must then be based upon the limiting value of SF = 1.5. The deployment must be halted, when the minimum Factor of Safety of 1.5 is reached.
	Sea conditions and the resulting ship motion will affect the transient loads created on the wire. Thus, the trend in prevailing weather should be assessed before committing to a deployment, which could approach the limits specified above.
	Motion-compensation may be used to reduce the dynamic loads below the permissible limit and/or to reduce the chances of a "zero load" condition.
Tension Monitoring	Tension must be monitored at the winch operator's station with a display refresh rate of at least 10 Hz (every 100mS). The system must also be capable of logging tension data at a minimum frequency of 20 Hz (every 50 mS). Tension must be continuously monitored using a "tension trending" graph at the winch operator's station. The tension measuring system must be calibrated at a minimum of every 6 months at load equal to the imposed load at the selected FS. The tension measuring system must be maintained with an accuracy of 3% of the applied load.
Alarms	The handling system shall be fitted with both audible and visual tension alarms that sound and illuminate at prior to a FS=1.7 of a wire's Assigned Breaking Load (ABL). Alarm conditions must automatically be included in the logged data.
Sheaves & Load Carrying Rollers	The D/d ratio must be at least 40:1 or 400d1 (whichever is greater) throughout. Grooving shall be per Ref A.1.1, Chapter 1, and Section 11.0 to provide adequate support.
Deck Safety	The Operator should identify "Danger Zones" around ropes and wires under tension. To the extent possible, given the nature of operations involved, all personnel shall be excluded from these zones such that a sudden failure cannot result in injury. Warning notices should be displayed at points of access indicating the danger. Physical and/or visual barriers should be erected as needed. Existing doors and accesses to the area should be secured when possible
Testing	Wire Samples from the end closest to the termination shall be sent for testing annually. If a 10% decrease in ABL is detected, then the testing shall be increased to every six months. Alternately, the Owner may cut back to and re-test a new representative length.

Logbooks	At a minimum, the Owner shall maintain logs showing cutbacks, spooling operations, lubrication, wire train description, maximum payout and maximum loading (as determined by monitoring system or by calculation for each cast) for the full-service life of the rope or wire. The wire log shall transfer with the wire if it is removed and placed in storage or transferred to another winch or Owner. It is highly recommended that the NSF Wire Pool Data Base be used to meet this requirement.
Winch Operator	The Winch Owner must certify that all Winch Operators are competent. By "Certified Competent" it is meant that the Owner must have written documentation in place showing that the operator has been through and successfully passed a formal owner/operator developed training program on the winch, handling apparatus, and monitoring system. The system vendor or the Owner, depending on the complexity of the system, may conduct a formal training program. The certification must be renewed annually. The master shall verify qualifications and designate the approved winch operators. If there are configuration changes to controls or to the hardware, then the operator qualifications must be refreshed and documented.

A.8.3 Synthetic Tension Members

Reserved

A.8.4 Extenuating Circumstances

Ship operators and their seagoing staff must understand that if, by force of circumstance or by the desire to maintain scientific operations while on a cruise, when they do not meet the operating requirements as described in tables 8.1 through 8.4, they are embarking on a potentially dangerous activity. The consequences of this activity could be loss of valuable equipment, damage to the vessel and its fixed equipment, and, in the worst case, injury to personnel. Operators shall develop a procedure on how, and under what circumstances, the vessel will safely continue operations in the event the operating requirements are not met.

A.9 <u>Examples</u>

A.9.1 Safety Factor of 5.0

Examples of where a SF of 5 has to be used because a tension measuring system is not available or the sheave/roller diameters are smaller than required.

Figure 1

A grab is planned on 500m of 0.25" 3x19 wire rope using a FS of 5.0.		
Assigned Breaking Load (Free to Rotate)	6,750	
Factor of Safety	5	
Safe Working Tension = ABL/FS	1,350	
Weight of Grab (in seawater)	175	
Weight of Sample (in seawater)	25	
Weight of wire rope (in seawater) = 0.284 lbs/m x 500m	142	
Static Total		**342**
Quasi-Static Load (drag)		**35**
Pound-mass of Grab (in air)	200	
Pound-mass of Entrained Mud (in air)	50	
Pound-mass of 500m of wire rope (in air) = 0.327 lbs/m x 500m	164	
Total Mass of System	414	
Dynamic Load (multiply Mass Total by 0.75 for g=1.75)		**310**
Transient Load Pull Out Load	100	**100**
Estimated Maximum Tension Pounds-force		**787**
Because the estimated maximum tension of 787 pounds is less than the SWL of 1,350 pounds it is acceptable to proceed with this grab.		

Figure 2

A CTD cast is planned on 500m of 0.322 cable using FS of 5.0.		
Assigned Breaking Load (Free to Rotate)	10,000	
Factor of Safety	5	
Safe Working Tension = ABL/FS	2,000	
Weight of CTD (in seawater)	600	
Weight of Sample (in seawater)	-	
Weight of tension member (in seawater) = 0.474 lbs/m x 500m	237	
Static Total		**837**
Quasi-Static Load (drag)		**300**
Pound-mass of CTD (in air)	1,000	
Pound-mass of Samples (24btls*10liters sea water =240 liters*2.2lb/l)	528	
Pound-mass of 500m of tension member (in air) = 0.573 lbs/m x 500m	287	
Total Mass of System	1,815	
Dynamic Load (multiply Mass Total by 0.75 for g=1.75)		**1,361**
Transient Load		**-**
Estimated Maximum Tension Pounds-force		**2,498**
Because the estimated maximum tension of 2,498 pounds is more than the SWL of 2,000 pounds it is NOT acceptable to proceed with this CTD cast.		
Vessel Operator must either: know the actual dynamic loading on the package (based on location on vessel, drag, weather conditions, etc.) and/or meet the requirements allowing a lower FS described in Section 6 in order to proceed.		

Figure 3

A tow is planned on 1000m of 0.322" cable using a FS of 5.0.		
Assigned Breaking Load (Fixed Ends)	11,600	
Factor of Safety	5	
Safe Working Tension = ABL/FS	2,320	
Weight of Grab (in seawater)	350	
Weight of Sample (in seawater)	-	
Weight of wire rope (in seawater) = 0.474 lbs/m x 1000m	474	
Static Total		**824**
Quasi-Static Load (drag)		**180**
Pound-mass of Grab (in air)	500	
Pound-mass of Entrained Mud (in air)	-	
Pound-mass of 500m of wire rope (in air) = 0.573 lbs/m x 1000m	573	
Total Mass of System	1,073	
Dynamic Load (multiply Mass Total by 0.75 for g=1.75)		**805**
Transient Load Pull Out Load	-	**-**
Estimated Maximum Tension Pounds-force		**1,809**
Because the estimated maximum tension of 1,809 pounds is less than the SWL of 2,320 pounds it is acceptable to proceed with this grab.		

A.9.2 Finding a Factor of Safety for an Operation

An example of estimating the FS requirements that will need to be met for a particular operation.

Figure 4

A piston core is planned on 4000m of 9/16" wire rope with an ABL of 32,000 lbs. The winch and frame are both rated for 50,000 lbs.		
Weight of corer (in seawater)	2,000	
Weight of Sample (in seawater)	100	
Weight of 4000 m of wire rope (in seawater) = 1.404 lbs/m x 4000m	5,616	
Static Total		**7,716**
Quasi-Static Load (drag)		**300**
Pound-mass of corer (in air)	2,600	
Pound-mass of mud sample (in air)	350	
Pound-mass of 4000m of cable (in air) = 1.614 lbs/m x 4000 m	6,456	
Total Mass of System	9,406	
Dynamic Load (multiply Mass Total by 0.75 for g=1.75)		**7,055**
Transient Load Pull Out Load		**2,000**
Estimated Maximum Tension Pounds-force		**17,071**
FS = Assigned Breaking Load (32,000)/Estimated Maximum Load (17,071)		**1.87**
In order to proceed with this core the requirements in Section 6 for operating at a safety factor (FS) of 1.5 will need to be met.		
Since there is a "substantial risk" of entanglement with this kind of operation, a weak link should be selected by the Vessel Operator to protect the wire rope and personnel.		

Figure 5

A 36-bottle CLIVAR CTD cast deploying 6000 meters of .322-diameter cable is planned. The steel cable has a Free to Rotate ABL of 10,000 lbs. The SWT of the handling system is 10,000 lbs. The minimum FS permitted for E.M. cables is 2.0 per Section 8; therefore, the maximum tension allowed on the cable is 5,000 lbs.		
Weight of CTD (in seawater)	1,000	
Weight of Sample (in seawater)	-	
Weight of tension member (in seawater) 0.474 lbs/m x 6000m	2,844	
Static Total		**3,844**
Quasi-Static Load (drag)		**500**
Pound-mass of CTD (in air)	1,500	
Pound-mass of Samples (36btls*10liters sea water =360 liters*2.2lb/l)	572	
Pound-mass of 6000m of cable (in air) = 0.573 lbs/m x 6000 m	3,438	
Total Mass of System	5,510	
Dynamic Load (multiply Mass Total by 0.75 for g=1.75)		**4,133**
Transient Load		**-**
Estimated Maximum Tension Pounds-force		**8,477**
FS = Assigned Breaking Load (10,000)/Estimated Maximum Tension (8,477)		**1.18**
6,000-meter deployments with a 36-bottle rosette on 0.322 cable easily falls below a FS of 2.0 and can only be accomplished in very calm weather or with motion compensation. Without good cable monitoring this should be a no-go situation.		
Note: It is clear that deep CTD operations using 0.322 cable in heavy weather or with a large/heavy CTD will easily exceed an FS of 2.0 and easily could go lower than 1.5. This is below the advisable limit for conductor cable because of the increased potential failure of the internal conductors. If FS is reduced to this level, parting of the cable or decreased cable life due to failure of internal conductors should be anticipated. Operators should do everything possible to reduce ship or deployment system movement. Operators can use a motion compensation package, auto render, or slow down the rate of winch operation in order to reduce the dynamic loads. As an alternative, a stronger cable could be considered, however most stronger UNOLS Cables also weigh more – see next example		

Figure 6

A CLIVAR CTD cast deploying 6000 meters of 0.680-diameter coax cable is planned. The steel cable has a Free to Rotate ABL of 37,000 lbs. The SWT of the handling system is 45,000 lbs. The minimum FS permitted for E.M. cables is 2.0 per Section 6; therefore, the maximum tension allowed on the cable is 18,500 lbs.

The Vessel Operator has chosen to use a FS of 2.0 on the cable under Section 6 above. The Vessel Operator must either know the actual dynamic loading on the package (based on location on vessel, drag, etc.) and/or monitor cable tensions closely as required in Section 5.0, or use motion compensation to reduce dynamic effect.

Weight of CTD (in seawater)	1,000	
Weight of Sample (in seawater)	-	
Weight of tension member (in seawater) 1.814 lbs/m x 6000m	10,884	
Static Total		**11,884**
Quasi-Static Load (drag)		**500**
Pound-mass of CTD (in air)	1,500	
Pound-mass of Samples (36btls*10liters sea water =360 liters*2.2lb/l)	572	
Pound-mass of 6000m of cable (in air) = 2.271 lbs/m x 6000 m	13,626	
Total Mass of System	15,698	
Dynamic Load (multiply Mass Total by 0.75 for g=1.75)		**11,774**
Transient Load		**-**
Estimated Maximum Tension Pounds-force		**24,158**
FS = Assigned Breaking Load (37,000)/Estimated Maximum Tension (24,158)		**1.53**

6,000-meter deployments with a 36-bottle rosette on 0.680 cable gives a slightly better FS than 0.322 cable for deep casts. An even greater FS can be achieved with 0.681 F.O. cable that has a breaking strength of around 46,000 and is only slightly heavier than 0.680. A 36 place CTD with all bottles full can be handled at a FS of 2.0 in conditions that yield a "g" factor as high as 1.4.

Note: In all circumstances, a full ocean depth CTD cast will require using the procedures contained in Table 6.3 for FS between 2.0 and 2.5 as long as a steel cable is being used due to the weight and mass of the deployed cable. The level of tension monitoring will allow the operator to use actual dynamic loading to make decisions about whether or not to continue a cast.

Appendix B
UNOLS Overboard Handling Systems—Design and Operation Standards

B.0 INTRODUCTION

B.0.1 OBJECTIVE AND APPROACH

The objective of this appendix is ensuring the safety of personnel and the integrity of equipment in the practice of deploying oceanographic instrumentation with overboard handling systems from research vessels. The standards and procedures in Appendix B complement the rope and cable safe working standards contained in Appendix A.

B.0.2 ACRONYMS

- ABL Assigned Breaking Load
- ARF Academic Research Fleet
- CFR U.S. Code of Federal Regulations
- DLT Design Line Tension
- EMT Estimated Maximum Tension
- FS Factor of Safety
- MCD Maximum Capability Document
- NAME Naval Architecture and Marine Engineering
- NBL Nominal Breaking Load
- OHS Overboard Handling System
- RVSS Research Vessel Safety Standards
- SWT Safe Working Tension
- UDT Ultimate Design Tension
- UNOLS University-National Oceanographic Laboratory System
- USCG United States Coast Guard

B.0.3 DEFINITIONS

Component	Any part of an Overboard Handling System (e.g. winch, tension member, hydraulic pump, deck bolt).
Design Line Tension (DLT)	The greatest tension an OHS or component is designed to withstand.
Factor of Safety (FS)	For components: FS = S_{fail} / S_{calc}, where S_{fail} is the stress at which a component yields or otherwise begins to fail, and S_{calc} is the greatest calculated stress in a component when submitted to a line tension (e.g., UDT, DLT or SWT). FS differs for tension members: See Appendix A.
Fixed System	A complete or partial Overboard Handling System installed on a vessel.
Inspected Vessel	A vessel that is inspected and certificated by USCG as required by 46 CFR subchapter U.
Load Geometry	The range of directions that a tension member might enter into or depart from a component.
Maximum Capability Document (MCD)	A document that defines a component's or system's safe working tension (SWT).
Nominal Breaking Load (NBL)	Defined in Appendix A: manufacturer's minimum published breaking load for a tension member
Overboard Handling System (OHS)	A system used to tow objects, to lower them beneath the surface of the water, or to retrieve them from beneath the surface of the water. A system is only considered an OHS if it features a tension member coupling the object and vessel, and payed beneath the surface of the water.
Safe Working Tension (SWT)	The calculated greatest line tension that may be placed on an OHS or component under normal operating conditions. SWT differs for tension members: see A.2.18.
Wet Weight Handling Gear	Gear used to lower equipment, apparatus or objects beneath the surface of the water or for trailing objects, where the wire rope or cable is payed out beneath the surface and becomes part of the line pull at the head sheave or winch drum. Wet weight handling gear may constitute an OHS or be an OHS component.

B.1 <u>BASIS AND SCOPE OF APPLICATION</u>

The design and operation standards in this appendix are based on the requirements of the United States Code of Federal Regulations, 46 CFR Subpart 189.35 - Weight Handling Gear installed on oceanographic vessels. 46 CFR 189.35 legally applies only to U.S. inspected vessels. However, it is UNOLS policy that the standards in this appendix are applicable to overboard handling systems in all vessels in the ARF.

Although based on the requirements of 46 CFR 189, Appendix B does not replace nor supersede applicable federal and/or classification society regulations or standards.

The requirements of this Appendix shall apply to all wet weight handling gear installed on oceanographic research vessels except weight handling gear designated to handle primary lifesaving equipment or manned submersibles. For the purposes of the RVSS, items of *wet weight handling gear,* as the term is used in 46 CFR 189.35, are considered sub-systems or components of overboard handling systems.

Weight handling gear placed under the inspection and testing required for cargo gear by the classification society or cargo gear bureaus may be considered as having met the intent of this subpart.

Wet weight handling gear shall be considered gear used to lower equipment, apparatus or objects beneath the surface of the water or for trailing objects, where the wire rope or cable is payed out beneath the surface and becomes part of the line pull at the head sheave or winch drum. When the ship's crane is utilized in the deployment of gear over the side, at the point when the instrumentation is lowered beneath the surface of the water, then the ship's crane is considered a piece of wet weight handling gear.

Appendix B applies to all overboard handling systems (OHS), both new and existing, used onboard ARF vessels including:

- Both fixed and portable systems.
- Each and every component of the overboard handling system. (From the deck bolts, winch foundations and winches, to the shackles, sheaves, rollers, fairleads, A-frames and the entire wire train including all shipboard structures that serve as attachment points).
- Cranes that are used to deploy any science package below the sea surface.

B.2 OVERBOARD HANDLING SYSTEM DESIGN

Systems should incorporate the following minimum design criteria:

- System components shall be designed, as a minimum, to withstand and operate in excess of the Design Line Tension (DLT).
    - For inspected vessels the DLT is defined as the Nominal Breaking Load (NBL) of the strongest tension member used.
    - For uninspected vessels the DLT is defined as either the NBL of the tension member or the maximum tension when a load limiting device is used.

- The factor of safety for all metal structural parts shall be a minimum of 1.5 (i.e., the yield strength of the material shall be at least 1.5 times the calculated stresses resulting from application of a load equal to the DLT).

- Suitable assumptions for the actual loading conditions shall be used in the design of wet weight handling gear. The lead of the wire rope from the head sheave or winch drum shall be considered to vary from the vertical and in azimuth in a manner to represent the most adverse loading condition.

B.2.1 LOAD LIMITING DEVICES are designed to prevent a load exceeding the DLT autonomously.

B.2.1.1 WEAK LINKS shall be acceptable for use when the setting prevents the tension at the head sheave from exceeding the DLT. Weak links shall be of a calibrated design.

B.2.1.2 AUTO-RENDER is a setting causing a winch to pay out in order to prevent the DLT from being exceeded. The winch shall not free spool but rather automatically pay out, in a controlled fashion, then resume its previous operating state.

B.2.1.3 TORQUE LIMITERS are devices that limit that maximum torque applied to a drum and are calibrated. This is limited to devices designed to operate in this manner without damage, wear is acceptable (IE brake pads). Further, devices shall not allow free spooling and automatically reset to operable state after an over torque event. Acceptable devices include torque limiting couplers with automatic reset, relief valves, brake slipping, and electronic motor torque control.

B.2.1.4 HEAVE COMPENSATORS, WIRE CUTTERS, AND NON-AUTONOMOUS DEVICES are not load limiting devices.

B.2.2 RECOMMENDED DESIGN FEATURES

The following items must be considered as part of the design process for new equipment and major retrofits of existing equipment.

B.2.2.1 GUARDS must be installed to prevent personnel injuries from rotating equipment, pinch points, and other hazards.

B.2.2.2 SIGNALING DEVICES must be installed and setup to warn personnel of unexpected equipment startup, especially when equipment may be operated automatically or is operated remotely.

B.2.2.3 ACCESSIBLE E-STOPS must be placed at all operator stations as well as locally to the equipment, when equipment may pose a hazard to personnel.

B.2.2.4 ELECTRICAL SAFE GUARDS must be in place to accommodate lock out/tag out procedures as well as either a fused disconnect or circuit breaker.

B.2.2.5 MANUAL OPERATING DEVICES must be considered to require constant operator intervention. Dead man style controls, (i.e. spring centered joysticks, no friction locks), interlocks (mechanical or electrical), prevent inadvertent operation.

B.2.2.6 MAXIMUM CAPABILITY DOCUMENTS (MCD) must be considered for new equipment when it is acquired.

B.3 <u>INSTALLATION, INITIAL TESTING AND LABELLING</u>

B.3.1 INSTALLATION

All components of an OHS must be properly installed in accordance with the manufacturer's requirements. In addition:

- Suitable safety guards must be installed around rotating machinery, hazardous cable runs and at other appropriate locations.
- Operating limitations must be posted in an appropriate manner.
- The installation must not violate the approved trim and stability limitations of the vessel.

B.3.2 INITIAL TESTING

An installation load test and safety assessment shall be conducted by the owner, ship's master and the equipment operator. For inspected vessels, it is the responsibility of the owner or operator to notify the Coast Guard Officer in Charge-Marine Inspection, of the time and place of the installation tests when occurring in a port of the United States to permit a marine inspector to witness the tests if desired. For uninspected vessels the owner or operator shall make every effort to meet the requirements of an inspected vessel for installation load tests. Subsequent owner or operator conducted tests may be required at the time of the vessel's inspection periods if a visual examination or review of the equipment record reveals evidence of an unsafe condition.

Tests should normally consist of exercising the equipment as a unit with a proof load 25 percent in excess of the equipment's normal working load; however, manufacturer's design limitations should not be exceeded. Consideration shall be given to the plans of loading when conducting these tests. Braking, safety and limiting devices shall be tested whenever feasible.

Safety assessment examinations of weight handling gear will normally consist of a visual examination with access covers removed. Suitability of the equipment for the service intended will be emphasized. Disassembly of the equipment will be required only when there is evidence of a deficiency or an unsafe condition. Non-destructive tests, such as radiography, ultrasonic, electronic, or other methods may be used if appropriate, but are not required.

B.3.2.1 STANDARD DECK HARDWARE such as deck bolts, shackles, swivels, and cleats do not normally require initial testing provided they are deemed acceptable via manufacturer's data sheets or manufacturer's proof loading.

B.3.3 LABELING

OHS components must be labelled with SWT, most recent test date, and whenever possible, a SWT diagram providing a clear illustration of the tension member's allowable range of angles when loaded to SWT. For deck hardware including deck bolts, and shackles, manufacturer's markings indicating the grade of bolt or load rating for that component will satisfy the labelling requirement.

B.4 <u>ROUTINE OHS TESTING</u>

B.4.1 GENERAL REQUIREMENTS

Test loads must be measured with a calibrated instrument, or by using a certified test weight. Test loads may not exceed the SWT of the test rig. The component being tested must be loaded to 125% of the applicable SWT. Tests must be conducted in a manner that most closely mimics the use of a system or component at sea.

B.4.2 REQUIREMENTS FOR FIXED OHS

In accordance with international standards, after installation an OHS must be tested at least once every five years, and after major repairs or modifications to the system. See B.4.5 for documentation requirements.

B.4.3 REQUIREMENTS FOR PORTABLE SYSTEMS

An OHS that is entirely portable, or is formed by combining both fixed and portable components, shall only be used on a vessel if it has been tested in a configuration(s) that mimics or exceeds that in which it will be used, in the previous five years. This can be done piecewise or in an assembled fashion. After every installation the system must be tested to ensure it is operating properly.

B.4.4 REQUIREMENTS FOR COMPONENTS

If the test loads for a general-purpose component are effectively applied during the course of an OHS test, then the OHS test satisfies the component testing requirements.

B.4.4.1 DECK SOCKETS AND FOUNDATIONS

These components need only be load tested if they are used as part of an OHS.

B.4.4.2 TENSION MEMBERS

Testing must be done in accordance with Appendix A of the RVSS.

B.4.4.3 PORTABLE COMPONENTS

For components that are not part of a fixed or self-contained portable OHS, i.e., portable winches and sheaves, shall be tested independently in a manner simulating component use.

B.4.4.4 STANDARD DECK HARDWARE such as deck bolts, shackles, swivels and cleats must be maintained in good condition. The manufacturer’s markings indicating the grade of bolt or load rating will serve the requirement of identifying the safe working tension load. Hardware damaged or loaded beyond its safe working tension/load must be immediately marked as “not for use” and disposed of.

B.4.4.5 DECK SOCKETS that are damaged must be prominently marked to prevent inadvertent use.

B.4.5 TEST LOGS must encompass every OHS and component, and contain at a minimum:

- A test date for each entry.
- The test method and names of testing personnel.
- Sufficient information to determine the test date for each piece of standard deck hardware (e.g., deck bolts, shackles, swivels and cleats).
- Entries whenever an OHS or component is inspected, repaired, or experiences a casualty.

All test logs must be made available to representatives of regulatory agencies and funding agency inspection teams.

B.5 DOCUMENTATION

B.5.1 PLANS

Plans should be normally available for each fixed OHS, portable OHS, and components on a vessel, including:

- One-line electrical diagrams showing appropriate overload protection as currently required by subchapter J (Electrical Engineering) of 46 CFR 189.35.
- Plans showing hydraulic or pneumatic equipment.
- Stress and/or arrangement diagrams with supporting design calculations as appropriate to the specific equipment in question.

For inspected vessels, submission of plans or other technical information may be required by the Coast Guard Officer in Charge-Marine Inspection.

B.5.2 EQUIPMENT RECORDS must include test logs as described in section B.4.5 of this Appendix. Records including entries for inspections, important repairs, and casualties are required for fixed systems and recommended for portable systems and components.

B.5.3 OHS OPERATOR'S MANUALS

An OHS Operator's Manual must be maintained for each OHS (except for those combining portable and fixed equipment). Each Operator's Manual must contain at a minimum:

- A detailed description of the OHS layout, including:
    - The location of each major component.
    - The orientation of each major component in each OHS configuration.
    - The geometry of the tension member in each OHS configuration.
    - The overall dimensions of each major component.
    - The weight of major portable components.
    - System particulars (i.e. operating order or considerations, not duplicating component manuals. Example: Turn on A-Frame HPU then Winch HPU, or operate equipment synchronized as described in A-Frame manual and Winch Manual).
- OHS test procedures.
- Procedural safety requirements.
- Operator training procedures.
- References to individual component manuals or data sheets as applicable.
- Routine maintenance procedures should be documented or referenced.

B.5.4 TRAINING RECORDS

As indicated in section B.6, records of initial operator training and annual competency checks must be maintained and made available for regulatory and funding agency inspections.

B.5.5 TEST LOGS must be maintained in accordance with B.4.5.

B.5.6 OTHER OPTIONAL SYSTEM DOCUMENTATION

Vessels and operating institutions are encouraged to maintain any other documentation, such as manufacturer's manuals and information, that may be useful over the service life of the OHS or component. This information should be readily available for shipboard operators and repair personnel.

Maximum Capability Documents (MCDs) may be available for many systems and components. MCDs provide detailed technical information that can enhance safe operation. The MCD generally specifies the design line tension (DLT) and safe working tension (SWT) of an OHS or component, and generally includes a description of the reaction forces the OHS or component will produce. Manufacturers' data sheets may serve as MCDs for standard deck hardware, such as shackles and swivels, and for tension members.

B.6 OHS TRAINING

Personnel who will operate OHS must receive training and be able to demonstrate competency in operating equipment and knowledge of safety procedures. A training program must be developed for each operating station, appropriate to the complexity of the OHS or component, and include the system operator's manual, monitoring guidelines, and Appendix A requirements as applicable. Training should be conducted in hands-on fashion whenever possible.

Operator training programs shall require an annual demonstration of competence and must include auditable records of initial training and competency checks.

B.7 RESPONSIBILITIES

B.7.1 UNOLS OPERATING INSTITUTION AND MARINE SUPERINTENDENT

The Marine Superintendent, acting on behalf of the UNOLS Operating Institution and the owning agency or institution, is responsible for ensuring overall compliance with the provisions of Appendix B as it pertains to overboard handling systems and wet weight handling components.

When purchasing a new OHS or major component, the Marine Superintendent must work with the manufacturer, and UNOLS technicians or other subject matter experts, to ensure that all potential uses, deployment modes and system configurations are identified. The Marine Superintendent must ensure installation, system testing, and sea trials are supervised by a qualified person, and approve the manufacturer's training program for the equipment.

B.7.2 RESEARCH VESSEL MASTER

The master of the vessel shall ensure:

- Onboard OHS and components are properly installed, secure for sea and do not violate approved trim and stability information.
- Suitable safety guards are installed.

- Operating limitations are posted in an appropriate manner.
- Only qualified operators are permitted to operate OHS, training is documented, and qualified operators are designated by the master of the vessel in writing.
- When gear is being operated, the minimum number of necessary persons are in the immediate area and comply with all safety requirements.
- Equipment and records are maintained on the equipment as indicated in section B.5.2.
- Prior to a vessel's departure, an entry is made in the official logbook that the ship's weight handling gear is in compliance with the applicable requirements.

B.7.3 SCIENCE PARTY

The principal Investigator shall:

- Consult with the Marine Superintendent and vessel personnel, as appropriate, to determine planned use of OHS equipment. Expected maximum tension, dimensions, and weight of equipment to be deployed with ship's equipment must be provided. The written cruise plan must include sufficient detail to determine that onboard equipment can be safely used for planned operations at sea. The Overboard Handling Data Document (Figure B-1) should be used for complex or high-tension operations.
- Ensure science party-provided handling systems have been tested in accordance with section B.4 of this Appendix or make suitable arrangements to test the OHS aboard the vessel prior to departure from port.
- Ensure science party personnel are briefed on safety requirements and emergency procedures prior to beginning OHS operations

Figure B.1: Overboard Handling Data Document (see section B.7.3)

Primary Deployment Information:	Science Party Response
Deployment Type	
Provide a brief narrative of scientific purpose and the equipment to be deployed. Attach drawings or other documents as required to describe the nature of deployment and the OHS or other equipment used/needed to carry it out.	
Package Type	
Maximum Package Weight (in water) (lbf)	
Maximum Package Mass (weight in air) (lbm)	
Added Weight (in water) (lbf)	
Added Mass (weight in air) (lbm)	
Maximum Drag (lbf)	
Maximum Extraction Force (lbf)	
Maximum Anticipated Tension Member Deployment Length (m)	
Deployment Depth (m) / Water Depth (m) / Percent of tension member deployed length to water depth	
OHS/Components Furnished by Science Party	
Vessel Services Required	
Tension Member Type	
Maximum Tension Member Weight (in water) (lbf)	
Maximum Tension Member Mass (weight in air) (lbm)	
Tension Member ABL/SWT@FS (lbf)	
Load Mitigating Devices	

APPENDIX C
Safety Inspection Check List for Shipboard Vans

The attached checklist is intended for use by UNOLS Marine Superintendents and the Masters of ARF vessels who need to determine if portable laboratory vans brought for use on their ships by Principal Investigators or other scientific personnel are reasonably safe. The placement and use of vans on research vessels is a complex issue involving many regulatory issues as well as common sense and an understanding of the shipboard environment. It is to be particularly noted that the United States Coast Guard and the American Bureau of Shipping regulate portable vans in various ways depending on the vans intended use and the registered gross tonnage of the vessel (i.e., a van acceptable for use on an “uninspected” vessel, such as the UNOLS “Intermediate” class vessels, may not be suited for a larger inspected vessel such as the ARF “Global” class).

Those responsible for inspecting vans as well as scientists planning to use vans should familiarize themselves with the “UNOLS Portable Scientific Vans Manual.”

Table 1 in the referenced manual provides an outline of requirements for vans. As an example, a chemical storage, machinery or accommodation van, going on an inspected vessel must have a current USCG Inspection Certificate to be used on the vessel. In many cases, decisions about scientist-supplied vans will be less clear and more subject to judgment.

The attached checklist is intended as a guide. It is not intended to cover accommodation, chemical storage, power/machinery or explosives storage vans which all have specific requirements (see Table 1 in the referenced manual). It need not be used for vans brought on for storage use only. It is intended for laboratory vans of various types that will have scientific personnel working in them during the time the ship is at sea. The goal of the checklist is to reasonably determine if the van is safe for the personnel that will be using the van and that it will not pose an unreasonable hazard to the vessel and embarked personnel.

Safety Inspection Check List for Shipboard Laboratory Vans

Ship:______________ Date: _____________ Inspected by:________________

Van Description: __________________ Van Purpose: ____________________

PI or Owner: ____________________ Cruise(s): ________________________

A. EXTERIOR

Yes	No	
		Does the van appear structurally adequate for the intended use and location (wind, spray, vessel motion, “green water on deck”)? See Table 1 in the referenced document for the UNOLS bulkhead stiffening requirements?
		If the van is to be used on an inspected vessel has it been inspected by the USCG, provided with placards in accordance with 46 CFR 195.11-20 and entered into the MSC’s electronic commerce program?
		Does the van appear to provide some level of fire boundary between the working space inside the van and the exterior? Will it be located a safe distance from the ship’s structure? See Table 1 in the UNOLS Portable Scientific Vans Manual document for the Fire Boundary Requirements.
		Is the van constructed of steel, aluminum or other substantial material suitable for marine use?
		Are there suitable attachment points for securing to vessel?
		Is the exterior condition acceptable: holes, obvious structural damage, etc.?
		Are doors equipped with latches to prevent self-releasing from vessel motion?
		Are doors that will be left open during van use equipped with holdbacks?
		Do doors open outward (escape direction)?
		Does the van have a minimum of two means of escape?
		Are external doors and hatches “weather tight?” Are overhead escape hatches “watertight?”

		Is there a label stating the tare weight, maximum gross weight, and allowable load?
		Has the actual weight of the van been verified before installing onboard?
		When applicable, is there a label stating power requirements?
		Are the hook up fittings (power, water, etc.) in good condition?

B. INTERIOR

Yes	No	
		Are there two means of egress that can be opened from both the interior and exterior of the van? (Container doors do not qualify.) (Does not apply to storage vans.)
		If overhead escape hatch, does it open? Test it.
		If fitted with an overhead escape hatch, does it have a unobstructed ladder, footholds, steps or other method for accessing the hatch? Is there a safe method to get down from the top of the van?
		Is the electrical system in accordance with Subchapter J of 46 CFR 110-113 (Shipboard Wiring Requirements), IEEE Standard 45-1998 (IEEE Recommended Practice for Electric Installations on Shipboard)?
		Is the electrical system equipped with adequate and accessible fuse and/or circuit breaker protection?
		Are any internal doors free of locking devices and unblocked (Exterior doors may be fitted with locking devices for security and shipping as long as they remain unlocked while in use)?
		Is there adequate ventilation for the intended purpose?
		Are there suitable fire extinguishers?
		Are there a first aid kit, eyewash, and emergency shower if applicable?
		Is there emergency lighting for egress in the event of a power failure?
		Is there provision for internal communication (intercom, general announcing system, fire alarm, general alarm)?

APPENDIX D
RVSS Waiver Requests

D.1 CRITERIA FOR EVALUATION OF WAIVER REQUESTS

The following criteria will be used by the UNOLS Safety Committee to evaluate a request for an exemption from the RVSS. The Committee will consult with subject matter experts as appropriate. While these criteria are not necessarily applicable in all situations, they seek to focus the Committee's evaluation and ensure the most important factors are considered.

Waiver Review Criteria:

- Will the waiver increase risk to the safety of personnel?
- Will the waiver increase risk of damage to equipment?
- Does the waiver request include mitigation measures?
- Will the waiver reduce costs, save man-hours, or improve effectiveness and efficiency of science operations?
- Will the waiver violate other regulations, laws or generally accepted procedures and practices? Will it conflict with other sections of the RVSS?
- Is the requirement to be waived clearly addressed in the RVSS, or does it indicate a need for better clarification in RVSS language?
- Does the waiver involve a unique piece of equipment, system or procedure, or would it have wide impact on other ships and operators?
- Would the waiver set a precedent that may have desirable or undesirable implications?

D.2 FORMATTED REQUEST FOR RVSS WAIVERS

Waiver requests should be submitted in the following format. Attach drawings and data as needed:

- Summary of Waiver Requested
- Specific RVSS Section(s) Applicable to the Waiver Request—e.g., 2.1.3 or A.8.1
- Reason for Waiver—explain why the RVSS cannot be met, including, but not limited to: a cost analysis of meeting the requirement and a technical analysis. How are others meeting this challenge? How will the waiver affect the science performed or operations of the vessel?
- Operational Guidelines and Procedures Employed
- Risk Mitigation Techniques Employed—how is the risk of not following the RVSS minimized?
- Benefit of the Waiver—would this waiver benefit the community as a whole or is it applicable to a single user or unique equipment system?

APPENDIX E
Harassment Prevention

UNOLS institutions and vessel operators are committed to maintaining a positive working and learning environment, free of illegal discrimination and any forms of harassment. While recognizing operator institutions have their own internal policies, this appendix builds on these and reemphasizes the unique nature of being at sea.

What is harassment?

Harassment includes verbal or physical conduct, whether on or off the premises, which has the intent or effect of unreasonably interfering with any individual's or group's academic or work performance, which significantly affects an individual's ability to participate in the activities of the vessel or field expedition (whether on or off duty), or which creates an intimidating, hostile or offensive educational or work environment, when such conduct is based upon age, race, color, national origin, gender, sexual orientation, religion, creed, disability or status as a veteran.

What types of behavior constitute harassment?

Harassment can take many forms. It can be blatant or subtle, verbal or physical, printed on paper or communicated electronically. Examples of conduct that can constitute harassment are:

- Outright propositions and improper suggestions or requests for sexual favors
- Threats or promises regarding compliance with sexual behavior
- Sexist, racial or ethnic jokes, slurs or cartoons; lewd or obscene remarks; disparaging remarks relating to gender, race, ethnicity, etc.
- Abuse, insults or jokes concerning sexual orientation, including insinuations or offensive comments about private life or lifestyle
- Sexual or racial innuendoes or offensive sexual or racial statements disguised or presented as humorous
- Unwanted physical contact, including touching, pats, hugs, or squeezes.
- Unwelcome advances such as repeatedly asking someone out on a date in spite of past refusals
- Actions or sounds – whistling, cat-calls, suggestive sounds, obscene gestures, display of offensive pictures or graffiti that would be found offensive by a reasonable colleague
- Stalking or following someone in an unacceptable unprofessional fashion
- Imbalance of attention, whether it be positive or negative, towards one employee or student that has the intent or effect of providing an inequitable work or educational environment
- Any form of assault – sexual or otherwise

Special conditions at sea.

Social conditions in remote locations such as at sea or at an ice camp are very different from those typically faced at conventional workplaces. The close quarters demand utmost consideration of others at all times. Privacy is greatly reduced, and as a result, interactions can become more intense, intentionally or not. When in these situations, anyone may be subject to more excessive personal attention, welcomed or un-welcomed, than might be experienced in a more typical work situation. Sexual awareness and tensions may be heightened, especially if people feel lonely, overtired or homesick and the resulting behavior may be so disruptive as to constitute harassment.

What should you do if you witness or experience an inappropriate or uncomfortable incident or situation?

<u>Speak up</u>: If you believe you may have experienced or witnessed harassment, and you are comfortable doing so, the first step may be to speak with the offender. Many situations can be resolved very simply by directly and promptly telling the offending party that his/her behavior is making you feel uncomfortable and asking the person to stop. If you feel uncomfortable speaking with the person one on one, approach the individual with a trusted friend or colleague.

<u>Tell someone</u>: It is your right and responsibility to inform your supervisor or other designated individual in the event that you witness or are a victim of any form of harassment. You are strongly encouraged to report the matter to the ship's Captain and/or the Chief Scientist if appropriate. They are responsible for maintaining a safe working and learning environment, free of harassment and discrimination. However, if you are uncomfortable talking to those in authority aboard the vessel, or if they are involved in the incident, you have the right to contact a neutral party off the vessel. The harassment point of contact or "hotline" designated by the UNOLS institution and provided by the posted institution policy would clearly be an option. In any event, whether you are a victim or a witness, **it is critical that you report the incident** as soon as possible. Note: There are statutes of limitations on reporting, although institutions may waive the limits if they choose.

<u>Keep records</u>: Keep notes describing the incidents noting the date, place, time and any witnesses to the behavior.

<u>Seek advice</u>: While speaking directly to the offender or reporting your concerns to the Captain or Chief Scientist are the first options to consider, there may be instances when neither of those is appropriate. In that case, you should seek advice from someone else that is in a position to help, such as the Marine Superintendent, the operator's or the complainant's Title IX officer, or the funding agency's Title IX officer. It may also be helpful to speak with a friend, colleague or other member of the crew or science party.

APPENDIX F
List of Acronyms

AAUS	American Academy of Underwater Sciences’
ABL	Assigned Breaking Load
ABS	American Bureau of Shipping
ABYC	American Boat and Yacht Council
AC	Alternating Current
ADA	Americans with Disabilities Act
AIS	Automated Identification System
ARF	Academic Research Fleet
ASAM	Anti-shipping Activity Messages
AUV	Autonomous Underwater Vehicle
CFR	Code of Federal Regulations
COR	Certificate of Registry
CPR	Cardiopulmonary Resuscitation
CTD	Conductivity-Temperature-Depth
DC	Direct Current
DPA	Designated Person Ashore
DSC	Digital Selective Calling
EEBD	Emergency Escape Breathing Device
EMT	Estimated Maximum Tension
EPIRB	Emergency Position Indicating Radio Beacons
ETA	Estimated Time of Arrival
FCC	Federal Communications Commission
FM	Factory Mutual
FS	Factor of Safety
GMDSS	Global Maritime Distress and Safety System
GPS	Global Positioning System
GRT	Gross Registered tonnage
GT	Gross tonnage
HF	High Frequency
HOV	Human Occupied Vehicle
IACS	International Association of Classification Societies LTD.

ICLL	International Convention on Load Lines
IEEE	Institute of Electrical and Electronics Engineers
IFF	Identification Friend or Foe
IMDG	International Maritime Dangerous Goods
IMO	International Maritime Organization
INSURV	Inspection and Survey
ISM	International Safety Management
ISO	International Organization for Standardization
ISPS	International Ship and Port Facility Security
ITC	International Convention on Tonnage Measurement of Ships
LBP	Length between perpendiculars
LCG	Location of the Center of Gravity
LFM	Linear Feet per Minute
LL	Load Line
MARPOL	International Convention for the Prevention of Pollution from Ships
MEOL	Maximum Expected Operating Load
MF	Medium Frequency
MFP	UNOLS Marine Facility Planning System
MMD	Merchant Mariner Document
MSC	Maritime Safety Committee
MSO	Marine Safety Office
MSDS	Material Safety Data Sheets
MSHA	Mine Safety and Health Administration
MSM	Marine Safety Manual
MTN	U.S. Coast Guard Marine Safety Center Marine Technical Note
MTSA	Maritime Transport Safety Act
NBDP	Narrow Band Direct Printing
NBL	Nominal Breaking Load
NFPA	National Fire Protection Association
NGA	National-Geospatial Agency
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NPFVOA	North Pacific Fishing Vessel Operators Association
NRC	Nuclear Regulatory Commission

NRT	Net Registered Tonnage
NSF	National Science Foundation
NTSB	National Transportation Safety Board
NVIC	Navigation and Vessel Inspection Circular
OCMI	Officer in Charge, Marine Inspection
ONI	Office of Naval Intelligence
ONR	Office of Naval Research
OPA	Oil Pollution Act
OPRC	International Convention on Oil Pollution Preparedness Response and Cooperation
ORM	Other Regulated Materials
ORVA	Oceanographic Research Vessel Act
OSHA	Occupational Safety and Health Administration
OSRO	Oil Spill Removal Organization
PFD	Personal Floatation Device
PI	Principal Investigator
PLB	Personal Locator Beacon
PPE	Personal Protective Equipment
QMED	Qualified Member of the Engineering Department
RCC	Rescue Coordination Center
RO-RO	Roll On – Roll Off
RSO	Radiation Safety Officer
RVOC	Research Vessel Operators' Committee
RVSS	Research Vessel Safety Standards
SAR	Search And Rescue
SART	Search And Rescue Transponder
SHIP	Seafarers Health Improvement Program
SITOR	Simplex Teletype Over Radio
SMC	Safety Management Certificate
SME	Shiptime and Marine Equipment Request Form
SMS	Safety Management System
SNAME	Society of Naval Architects and Marine Engineers
SOLAS	International Convention for the Safety of Life at Sea
SSAS	Ship Security Alert System

STCW	Standards of Training, Certification & Watchkeeping
SWAB	Service offered by the Tritium Lab at the University of Miami to detect very low levels radio activity in shipboard labs and vans..
SWL	Safe Working Load
TBL	Tested Breaking Load
UL	Underwriters Laboratories
UNOLS	University-National Oceanographic Laboratory System
USC	United States Code
USCG	United States Coast Guard
VHF	Very High Frequency

APPENDIX G
Safety Training for Science Parties

Purpose

This appendix provides basic safety information primarily intended for science party members who do not have extensive shipboard experience. It may also be used as a training guide and refresher for new vessel crewmembers and others who may be new to underway operations on a research vessel.

Accident Prevention and Safety at Sea - An Overview

SAFETY PHILOSOPHY. At sea, just as ashore, most accidents are preventable. However, the environment and working conditions aboard seagoing vessels pose additional hazards not found ashore. The responsibilities to avoid accidents flow from the top down; from the shore establishment to the Master, to each and every individual aboard. "Safety awareness" by all hands is the biggest single factor in reducing accidents.

The old cliche "It's not my job" does not apply at sea. Ashore, you can go home and forget about work and the safety-related aspects of your workngs. You can easily travel a different route if there is construction work on your normal route. A power failure at home is an inconvenience. You are aware of any medical emergency only by the ambulance sirens. Aboard your ship, not only will you need to be aware of any construction or deck operations, you must be able to determine when and where it is safe to pass. A power failure aboard ship can be catastrophic. A medical emergency aboard ship affects everyone--you may be the only person available to assist the victim.

ACCIDENT-CAUSING FACTORS.

Shipboard Environment. As a research party member, you must learn to live and work safely in a potentially dangerous shipboard environment. Such factors as motion, noise, vibration, temperature extremes, close living conditions, rotating machinery, and lines under tension are not normally encountered on shore. Almost all who go to sea will, at one time or another, be seasick. The saying that “you first fear that you will die and later fear that you won't” is not too far from fact. A seasick person should be given only light duties until recovered and should never be assigned duties that require alertness, caution, or agility. Medicines that prevent motion sickness can sometimes cause drowsiness-beware of this! Ship's motion can cause fatigue in two ways. First, it's sometimes very difficult to sleep when the vessel is pitching and rolling. Even in fairly calm seas, a newcomer needs one or two nights to adjust. Secondly, just moving about on a vessel in angry seas takes physical effort which, in time, will wear down the most fit. Fatigue promotes careless-ness.

There are a number of factors which contribute to accidents; few accidents have a single cause. The immediate cause is usually the most apparent but is not necessarily the underlying cause which may be harder to pinpoint and usually answers the question "why" for any accident. Some of the major factors contributing to accidents on research vessels are:

- Shipboard Environment
- Equipment and Materials
- Training and Experience
- Communications

When temperature extremes are too great, overall performance is impaired. Besides the debilitating effects of sunstroke, heat exhaustion, frostbite, hypothermia, etc., lesser physical impairments are possible. These include increased reaction time, decreased mental awareness, loss of dexterity and coordination, and fatigue.

Noise can have both a physiological and a psychological effect. Permanent hearing loss can be the result of sustained high noise level as well as extreme loud noises of short duration. Confinement aboard a ship in the fog can be unnerving with the constant sound of the fog horn. Similar detrimental effects can be caused by days of air gun firing. These noises create tension and an atmosphere which may promote an accident. Working around noisy equipment for an extended period of time can cause physical and psychological damage. It is important that you recognize and avoid these potential dangers.

The sun shines brightly at sea, causing glare conditions. Proper eye shading is a necessity. At the other end of the spectrum is night vision. A bright light on a dark bridge or other working area can be blinding. It takes several minutes for eyes to adjust. It is important that you determine the time needed to establish your night vision; it is equally important that you learn to avoid blinding others who have already established their night vision with an unmindful flashlight in the face or any bright white light. Red lights do not have a blinding effect and must be used when maintaining night vision.

In a shipboard environment--especially in confined spaces--you may be exposed to chemical agents in the air. Containing and exhausting laboratory fumes present an additional challenge aboard ships. Recognize these potential hazards! What is acceptable in a shoreside lab may not be suitable in a much more confined shipboard environment.

At sea, slips and falls are the leading causes of injury. Do you know how lo properly climb a ladder? Developing "sea legs" is not only gaining experience in navigating wet decks but also knowing what footwear to wear as well as learning to be wary and cautious.

If you do not want to go through life being called "Lefty," learn how to steady yourself without placing your hands on the knife edge (the doorjamb) when traveling through watertight doors.

Equipment and Material. Defective, improperly installed, or improperly used equipment is a major contributing cause of accidents. In doing research from a ship at sea, a lot of faith is placed in machinery and equipment. Whether deploying science packages, working in the labs, or going about your daily routine, you must rely on properly functioning shipboard and scientific equipment. The sudden failure of equipment due to overloading or defective materials often leads to an injury. Many pieces of machinery are inherently dangerous and are therefore provided with safety guards, warning signs, and are assigned safe working loads. Ignoring these safety features defeats their purpose.

Training and Experience. A lack of skill, experience, and knowledge concerning shipboard procedures can easily lead to accidents. During your initial exposure to a procedure or a piece of equipment, extra care and supervision may be necessary until everyone is far enough along on the "learning curve" to make for a safe operation. By paying attention and learning proper procedures, you can eliminate unnecessary accidents.

Communications. People react to what they think they hear, not necessarily what the person speaking actually says. Poor communications due to such factors as language barriers, unfamiliar terminology, background noise, or failure to speak distinctly lead to misunderstanding, mistakes, and ultimately, accidents. The person in charge must establish and maintain good communications in order to coordinate the efforts of a team. Listen so that you clearly understand the hazards you face and their possible consequences.

ACCIDENT PREVENTION. An effective accident prevention program is built on the tenets of management and supervisory commitment, safety awareness, and training.

Management and Supervisory Commitment. This includes budgeting time and funds for safety-related activities and equipment; the willingness to reject unsafe practices which might at times, especially under pressure, seem expedient; and positive reaction when risks and/or safer ways to do things are pointed out by crew members.

Safety Awareness. Safety aspects of every operation should be routinely considered by all hands. All hands should be aware of the effectiveness of the safety program. The RVOC has collected accident statistics showing the collective accident rate to be rather low (good). However, there is no justification for accepting the current rate as "good enough" since virtually all accidents can be prevented.

What are the side effects of some motion sickness medicines? What are the more subtle physical impairments of temperature extremes? Do you know why ships use internal red light at night? Do you know how the basic deck machinery works and where not to be when it is activated? Do you know how, or even why you would want to dog a hatch? Learning to find your way around the ship, to understand the terminology, and to recognize factors that have traditionally proven to be causes of accidents takes a little time; take time now!

Shipboard living aboard a research vessel Is not a passive exercise--if you are not constantly aware of your surroundings, then you can endanger yourself and other crew and scientific members. Although your circumstances as a research party member may not allow you to participate in most shipboard duties, the limited amenities and services of a research vessel require that at the very least you be able to take care of yourself.

Learning to move around your vessel will provide you many new challenges. When climbing vertical ladders, always face the ladder--do not attempt to go backwards. Always hold on to the rail. Avoid using portable ladders unless absolutely necessary--and then, only if it is lashed to an immovable object. When two or more people are using the ladder at the same time, the second person should stay far enough below as not to get kicked in the head, and should not look upward in case of falling dirt or rust. Avoid carrying large objects up or down ladders or stairs; instead, pass or hoist them in assembly-line fashion. Avoid blocking stairways while stopped in conversation or by placing an object in front of stairs or ladders.

Corridors and passageways should be kept free. While entrance and exit passageways serve as travel routes from one end of the ship to another, they also serve as emergency exit routes. Never block entrance and exit passages with objects. When objects are stored in a passageway, they should not block or be on top of any emergency escape hatch.

Watertight doors normally remain closed, even during calm seas. Watertight doors that are required to be open must be latched in an open position (even in calm seas, be very wary of watertight doors that "swing" with ship movement). During heavy weather, dog all watertight doors. Dog the side opposite the hinge side first

Training. Ships' crews and researchers must be trained in both emergency procedures and in safe practices. The RVSS, including this Appendix, is the basis for such training.

The following are normally included in shipboard safety orientation for new people:

- An explanation of the general alarm signals and where and how personnel should proceed to assigned stations.

- An explanation of station bill and bunk cards.
- How to don life jackets and survival suits.
- What to do in case of man overboard, fire, and other emergencies.
- Requirements for hard hats, shoes, exposure suits, work vests, harnesses, and safety lines.
- When, how, and who to notify for over-the-side research evolutions.
- Discussion of other matters of general safety interest.
- Shipboard drills.

Orientation

Immediately prior to or immediately after departure, the research party and new crew members, upon hearing the general alarm, gather at a central location with their life jackets. At this time, you will receive an orientation for new people regarding shipboard safety.

STATION BILL. A vessel's Station Bill assigns each person aboard various duties associated with emergencies. It also assigns individuals to muster stations and survival craft on many research vessels. The Station Bill details specific duties for vessel crew members, while a subset of the Station Bill as well as emergency procedure information (also referred to as a Bunk Card) is posted in research party staterooms. The orientation briefing is to ensure that you know your assigned stations and duties as they are listed on the Station Bill, and if applicable, your Bunk Card. Examine these documents carefully; memorize your duties and muster stations. You should know two routes for getting out of your living and workspaces in the event of emergency siruations. Know how to exit these spaces in the dark!

The Station Bill lists the various emergency signals to be used for calling the crew and the research party membrs to their stations or to give instructions while at their stations. Your vessel uses standard signals, commonly used in the merchant fleet, and required by regulatory agencies. The Master of your vessel may establish additional emergency signals to ensure that all crew members and research party members take positive notice of the existing emergency.

Fire Stations or Fire Drills. The fire alarm signal Is a continuous blast of the whistle for a period of not less than 10 seconds, supplemented by the continuous ringing of the general alarm bells for not less 1han 10 seconds. For dismissal from fire stations, three short blasts of the whistle are sounded, along with three short rings on the general alarm.

Boat Stations or Boat Drills. The signal for boat stations or drill is a succession of more than six short blasts followed by one long blast of the whistle, supplemented by a comparable signal on the general alarm bells. Where whistle signals are used for handling the lifeboats, one short blast means to lower, while two short blasts mean to stop lowering. For dismissal from boat stations, three short blasts of the whistle and three short rings on the general alarm are sounded.

GENERAL SAFETY PRECAUTIONS. Many injuries and accidents can be avoided by using the proper tools and following safety precautions. The extra ten minutes saved by not following procedures may result in a long-term injury. Most general safety precautions are normally routine practices that we often neglect when we are in a hurry.

Most staterooms and corridors have smoke detectors similar to those used in homes. Learn what to do and where to go when you hear its sftrill alarm.

The following are a few examples of common shipboard safety practices:

- When sea conditions are rough and topside work is being performed, everyone works in pairs. You should always wear a work vest.
- Because lines, deck openings, or wet surfaces can cause falls and slips, one eye should always be kept on the deck while walking.
- Bare feet are allowed only in staterooms.
- Examine all labels and warnings before using any equipment or products. If there is a question as to the use of a tool, product, or piece of machinery, consult the proper authority before proceeding.
- Always know the function of anything before touching it.
- Wipe up any spill immediately--the decks are slippery enough!

Seamanship/Deck and Science Operations

SMALL BOATS. All personnel embarked in small boats should have a basic knowledge of seamanship. They should be aware of the particular dangers associated with small boats; stability of the boat and safety of all personnel being considered foremost. When you board a small boat prior to removal of the hoisting equipment, you must wear a hard hat. Wear a lifejacket when boarding or debarking. The boat should not be hoisted until all personnel have debarked.

- Your conduct aboard a boat should always emphasize safety.
- Become familiar with basic emergency radio procedures.
- Learn the emergency response procedures prior to any boat trip.

When transferring from a small boat to the research vessel, time your "jump” to the boarding ladder. Make the jump at the time you are able to reach the highest point on the boarding ladder. Keep your hands inboard of the boat to avoid crushing them between the boat and ship's side.

Loading and stowage. A ship's officer is responsible for loading, handling, and stowage of cargo and scientific gear; the Chief Mate is responsible for securing deck areas; the Chief Engineer for engineering spaces; and the Chief Steward for commissary, galley, and dining spaces. The Chief Scientist is responsible for securing gear and equipment in science laboratories and storage areas. However, as some researchers may not be experienced mariners, the work is checked by the Chief Mate and the marine technicians prior to getting underway. On research ships, gear is loaded either by hand or cranes. Before heavy lifts are made with shipboard cranes, the Master is informed so that steps can be taken, if necessary, to ensure adequate stability for the operation. The Master is also consulted for the placement of heavy items such as winches and vans. Prior to encountering heavy weather, the ship is battened down to ensure the vessel's watertight integrity. Lifelines may be rigged topside, "no-go" areas designated, and a system implemented to account for personnel who must go out on weather decks. You will need to secure gear in your stateroom and work area. Since storm tracks are far from predictable, everyone should be prepared for the worst. Battening down includes securing heavy topside pieces of science equipment with wire or chain; checking all spaces for loose gear; dogging down weather doors, hatches and vents; and, generally increasing watertight integrity.

Deck Machinery. Deck machinery and deck systems are used to move cargo, handle mooring lines and anchors, and launch and recover scientific apparatus and boats to support the missions of oceanographic research vessels. The inherent hazards of working near tensioned cables, rotating machinery, and heavy moving weights are increased when these operations are conducted on the heaving deck of a vessel at sea. During deck operations individuals can be injured by cables or machinery, knocked overboard (possibly unconscious), or injured by flying debris if all posted safety precautions. are not followed.

Frames. Extreme care must be exercised when working in the vicinity of frames to ensure that personnel are not knocked overboard or pinned between the frame and other structures when rigging the frame in or out.

General Rigging. Snapback results from the energy stored in a line as it is stretched. If a tensioned line parts or is released suddenly, the line "snaps back" to its original length--much like an elastic band. You should stay well clear of potential recoil paths of any line or cable in use.

General Safety Precautions. Observe these precautions during all deck operations:

- Observe all posted safety precautions.
- Keep clear of loaded lines, wires, and cables, and moving equipment such as cranes, frames, booms and davits.
- Wear hard hats and adequate foot protection around weight-handling equipment.
- Avoid getting hands, feet, or loose clothing caught in bights of line, wire, or cables, or in rotating machinery such as moving frames.
- Wear leather gloves when handling wire rope, except when it is moving. Gloves, if snagged, can drag the wearer into danger.
- Keep loose gear away from open cargo hatches. Personnel below could be Injured by falling objects.
- Keep noise to a minimum--confusion and misunderstanding between operators and workers can lead to serious Injury and damage to equipment.
- Do not permit horseplay.

SCIENCE OPERATIONS. Much of research ship time is spent towing instruments, working gear over the side or fantail, or placing heavy objects on the seafloor. On a large ship, there may be many independent groups working on different projects at the same time. Nothing goes over the side unless permission from the watch officer is obtained--whether launching scientific gear or disposing of garbage.

When scientific gear goes under the ship, it could entangle the ship's rudder or propeller. This can be extremely dangerous when line or cable is going over the side. As it becomes wound up in the propeller, line and the attached equipment may whip off the deck, injuring persons in the process. If during launching or pickup of towed gear, it appears the propeller or rudder may be fouled, the watch officer will immediately stop the screw.

When working over the side, observe proper safety precautions at all times. Wear a safety harness; a lifejacket or work vest must be worn over the safety harness. Doublecheck all knots. This should be done by another crew member who is fully qualified in marlinespike seamanship. Watch out for the "Might Knot"—the knot that might NOT hold!

Health and Medical

Personal Care. Proper diet, rest, hygiene, and attitude are all contributing factors to maintaining a healthy body--both physically and mentally. -When you are not in the proper physical or mental state, your actions may adversely affect the well-being of other personnel.

Attitude. When on board a ship, adjust your attitudes to adapt to tight working and living quarters and many different types of personalities. Cigarette smoke is irritating to many people. It is important to be considerate when others are asleep; noise level should be kept down to a minimum at all times.

Rest. The ability to function properly and to maintain the body's resistance to disease and infections depends on adequate rest. When fatigue sets in, strength, coordination, judgement, and attitude are adversely affected. If you feel fatigue setting in, inform your supervisor; failing to do so could put the ship and crew in jeopardy.

Diet. A proper diet is necessary to maintain the body's energy level. Without proper eating habits, fatigue sets in at a quickened pace and resistance to diseases, colds, and infections is lowered. While at sea, the sun and salt air deplete the body's fluid and salt levels. To compensate for this loss, increase your intake of liquids and salt If you are on a special diet due to a medical reason (diabetes, high cholesterol, etc.), report this infonnation well in advance of the cruise so that meals and provisions can be properly planned.

Personal Hygiene. Personal hygiene is important in the close quarters of shipboard living. It makes a statement to others about your attitude. An unclean body fosters unpleasant odors and a greater chance of the development of skin ailments and/or diseases, especially in humid and cramped quarters. Wear clean clothing to the extent allowed by onboard laundry facilities.

Drugs and Alcohol. The use of drugs and/or alcohol does affect the way you perform. Emergencies are usually unannounced and unexpected; a functionally impaired individual would be more of a hinderance than a help. When an individual is drunk or impaired, there is an increased chance of falling overboard, falling off a ladder, slipping on a wet deck, etc. Many prescription and nonprescription medicines (antihistamines, cough syrups, etc.) have side effects that can impair judgement and the ability to function properly. If taking medication, you should consult a physician or pharmacist to find a medication that alleviates the problem while causing the least amount of side effects. If you are required by a physician to take prescription medication, notify your supervisor; bring an adequate supply of the medication for the duration of the cruise.

All vessels of the Academic Research Fleet have a policy of zero-tolerance for illegal substances and follow Federal regulations for use of alcohol onboard ships at sea.

Proper Clothing. Bring appropriate clothing. Sunblock and clothing that provide protection against the sun are recommended when travelling to warm climates. Colder climates naturally require warmer clothing. Wool and polypropylene materials provide warmth and repel moisture. These materials also retain their insulating properties when wet. In either climate, proper head covering is necessary. Footwear should fit properly. Tired or sore feet can cause considerable problems such as back ache, and general discomfort. Shoes should have nonslip soles, and steel toes are recommended for deck operations, cargo-handling, or other heavy jobs. Foul weather gear should include a jacket, pants, head covering, and proper footwear. Because ship space is limited, the amount of clothing, as well as the type, should be considered when planning a cruise. Bring enough underclothing to last ten days without laundry facilities. Sandals are not permitted when working on a wet deck, near machinery, or in a laboratory.

Ship sanitation. This is critical to the health and attitude of personnel as well as the smooth operation of a ship. The careless disposal of materials not only poses a safety hazard but also detracts from the appearance of the ship. Personnel should clean up work areas; dispose of trash in the proper containers and wash down the work surface when work is complete. Mops should be rinsed in hot soapy water and left out to dry before stowing--this prevents odors and germs from forming. Liquid spills and/or broken objects should be cleaned up at once. It is imperative to inform the Master immediately if a container of hazardous material breaks or spills to prevent damage to the ship or injury to the crew. Personnel living spaces serve as home for the duration of the cruise. Shared living quarters must be kept neat as a courtesy to fellow members. Dirty laundry may cause offensive odors and should be put away; bed linen should be changed at least once a week. Toilet/shower facilities must be kept clean and drains unclogged.

MEDICAL. When medical problems occur at sea, more attention is needed than when in port because of the distance from qualified medical personnel. Small problems, left unattended, can become major emergencies.

General Precruise Medical Requirements. All personnel should have a complete physical as required by their institution. A dental exam is also highly recommended. The above may seem like a waste of time and money, but it should be remembered that as the vessel undergoes an overhaul periodically, so should you. All appropriate inoculations (including tetanus) that are necessary for ports of call should be up to date. If you need inoculations--whether daily or in an emergency (e.g., for diabetes or allergic reactions) ensure that another person knows how to administer the medication. General medical information should be provided by each person on board. This should include any past or current medical problems (such as diabetes, high blood pressure, etc.), inoculation record, allergy information, prescription drug usage and dosage, and generic names for prescription drugs. Eye prescriptions should be listed for personnel who wear eyeglasses, and an extra pair of eyeglasses should be carried on board.

General Information. The names of personnel who are qualified to administer general first aid, CPR, or emergency medical treatment are posted. At the beginning of the cruise, you will be informed of the location of emergency equipment (eyewash stations, wash-down showers, fresh water, emergency oxygen, etc.) and how to use it.

FIRST AID KITS. First aid kits are located throughout the vessel and are equipped with basic medical supplies, including Band-Aids, eyewash solutions, ointments, etc.

Seasickness. Medications may be carried on board and dispensed as needed for seasickness. If you get seasick, drink plenty of fluids to prevent dehydration.

Sunburn. Sunburn can be very painful and bothersome and may occur quickly. It only takes about four hours to get second-degree burns in the Tropics. In the case of mild sunburn, moisturizing creams such as Aloe Vera should be applied. The affected area should be covered to avoid further exposure to the sun. Also, drink plenty of fluids to avoid dehydration. Exposure time to direct sun should be increased gradually. Clean the burn area and apply cold water to relieve pain of severe sunburn. The best way you can avoid sunburn is to use a sunblock, wear protective clothing, and limit exposure time to direct sunlight.

First Aid. Proper administration of first aid can mean the difference between life and death, short or long-term recovery, and permanent or temporary disability. First aid is an interim step until professional medical treatment can be sought. There are two steps that should occur as quickly as possible in a medical emergency: first, ensuring the victim's immediate survival; and secondly, summoning assistance. Before going to sea, all personnel should have a basic knowledge of the more serious medical emergencies that can develop and the first steps in treatment. When approaching an accident victim, survey the area before entering. There may still be danger (i.e., live electrical lines, rotating machinery, hazardous materials, lack of oxygen, etc.).

HYPOTHERMIA. The condition of hypothermia results when body temperature is reduced because of exposure to cold water or air. While at sea, it is important to remember that exposure to cold water causes heat loss twenty times faster than exposure to cold air. Even a few minutes of exposure under these conditions can cause hypothermia. Hypothermia can even take place in tropical waters.

A victim of hypothermia should be treated at once. The first step is to get the victim to a warm area. Secondly, all cold, wet clothing should be removed, and the extremities wrapped in blankets. The torso area should be covered, and a hat should be placed on the victim's head. The first area to warm up is the torso, since this area contains all the vital organs of the body. A good way for the rescuer to warm this area is to remove his or her clothing (shirt) and jump around for a few minutes to elevate the body temperature then lie down chest to chest with the victim. This method transfers the heat of one body to another. A warm or hot shower should never be used to warm a victim or hypothermia. The circulatory system to the extremities has been shut down by the body to keep the warm blood near the vital organs. A warm or hot shower would make the body resume full blood circulation throughout the body before the blood in the extremities is warm enough. The shock of the cold blood from the extremities to the vital organs could be more than the body could withstand. Shivering is a good sign because it means the body's natural defense mechanism is working. The body or limbs of a hypothermia victim should not be rubbed due to the possibility of more damage occurring to a circulatory system that is already in severe shock.

Even if a hypothermia victim is not breathing when found, treatment must be initiated at once. It's the body's natural defense mechanism to shut down as much as possible.

Lifesaving Equipment and Survival Procedures

INTRODUCTION. The sea can be a fierce, unforgiving force of nature, capable of sending a ship to the bottom, and its crew "into the drink." Without the proper equipment to protect you from the weather, provide sustenance, signal rescue resources, and, above all, keep you afloat, the odds are heavily against your ability to survive. The only defense you have is the proper amount and type of lifesaving equipment, ready for immediate use. This equipment is vital to survival. Survival at sea depends on sufficient and properly maintained lifesaving equipment coupled with training in survival procedures and the proper use of the equipment.

PRIMARY LIFESAVING EQUIPMENT.

Lifeboats and Liferafts. Research vessels carry sufficient numbers of lifeboats or liferafts to accommodate 100% of the persons on board. Inflatable life rafts are the primary lifesaving equipment on most research vessels. They are mounted as far outboard as possible, free of overhead obstructions, and high enough to be protected from heavy seas. A hydrostatic release and weak link are provided on each container to allow for automatic deployment and inflation of the raft should the vessel sink before the rafts can be deployed. Rafts may be removed from cradles and moved to opposite sides and launched by hand if necessary. Instruction cards for the proper stowage and launching of inflatable life rafts are posted in various locations throughout the ship.

Bouyant apparatus and life floats. Other acceptable primary lifesaving equipment includes, under certain conditions, buoyant apparatus and life floats. A buoyant apparatus is a flat, box-like flotation device with grab lines installed around its edges; the life float is similar to the buoyant apparatus except it is open in the center and fitted with a net and wooden floor suspended from the center of the float. These are stowed on an open deck or in racks in such a manner to float free in case of emergency.

Rescue Boat. The handling of oceanographic equipment creates a potential risk for falling overboard. Since a ship with equipment over the side is usually unable to maneuver freely for a recovery, the rescue boat provides a rapid means of rescuing the victim. It is also ideal for marshalling all the ship's inflatable life rafts or buoyant apparatus in the event the ship has sunk and motor lifeboats are not available. A rescue boat is generally a small, lightweight boat of rigid or semirigid construction fitted with built-in buoyancy and an outboard motor.

SECONDARY LIFESAVING EQUIPMENT. This equipment is provided for individual survival in distress situations. These items will allow a person to remain afloat until rescued.

Lifejackets. All vessels are required to carry one Type I Adult Lifejacket for every person on board. A Type 1 jacket is designed to turn a person face up in the water. Additional lifejackets are accessible to the engine room, bridge, and science labs in sufficient numbers to accommodate all persons normally on watch or working in these areas.

Lifejackets are normally distributed throughout the crew's and scientist's quarters, providing one lifejacket per bunk, and stowed so that they are readily accessible. All lifejackets are provided with a light, whistle, and retroflective tape.

Ring Lifebuoys. Ring Lifebuoys are the first means of rescue for the person who falls overboard. Lightweight and round, the ring buoy is easy to toss to the victim and will keep them afloat until help can arrive.

Immersion (Exposure) Suits. Exposure to the elements involves the threat of hypothermia--the rapid and continued loss of body heat. Immersion suits are designed to provide full-body thermal protection similar to a diver's wet suit, as well as built-in floatation, and are required to be on vessels operating in higher latitudes.

Work Vests. A work vest may be used by persons working on deck or in small boats where the bulk of a regular Type I lifejacket would be confining. **The work vest is not a substitute for a life jacket!**

Thermal Protective Aids. The Thermal Protective Aid (TPA) is a bag or suit made of waterproof material with low thermal conductivity. Its function is to minimize the effects of hypothermia or aid in the recovery from the effects of hypothermia. It may be used as an alternative for immersion suits while in a life raft or lifeboat, or a person suffering from hypothermia may be placed inside so that body heat is maintained inside the bag. The TPA does not provide any flotation.

GENERAL LIFESAVING EQUIPMENT AND INFORMATION. Not all casualties at sea result in "taking to lifeboats." Distress situations are more often limited to vessel breakdowns, personnel evacuations, or other inst.ances which require that the vessel be located and assisted by a search and rescue resource. To facilitate the rescue efforts, research vessels carry various devices for location and signalling.

Distress Signals. When a mariner sees a flare displayed in the night sky or unusual smoke rising from the horizon, the first consideration must be that a vessel is potentially in distress. If so, these signals mark the location of the vessel. For this reason, distress signals are a necessary part of a ship's lifesaving equipment. The RVSS manual requires all research vessels to carry at least 12 red rocket flares. Research vessels also carry additional visual signals, such as searchlights, international code flags, and signalling lights.

Line-throwing Appliance. In situations where a line must be passed over some distance, the line-throwing appliance may save considerable time and effort while providing a greater margin of safety than the conventional heaving line. A line-throwing appliance may be considered when attempting to pass a line to a person overboard. In such cases, only the lightweight, plastic-tipped form of projectile should be employed.

EPIRB. The Emergency Position Indicating Radio Beacon (EPIRB) is a battery-operated, self-activating emergency transmitter. The unit is stowed in a rack, inverted, with the power switch in automatic. When righted, the EPIRB's signal provides a precise location for search and rescue resources. An aircraft or vessel can home in on the signal and follow it to a disabled vessel.

SURVIVAL PROCEDURES. Having to abandon ship is a traumatic experience--gone are the comforts and security of the vessel, exposing personnel to the elements, either in lifeboats or rafts, or immersed in the water with only a lifejacket. Survival at sea in a distress situation requires individual knowledge and training in survival procedures. Abandoning ship is NOT a hopeless situation. Modern technology now makes distress communications and location by rescue resources a routine operation.

Abandon Ship. The Station Bill is where preparations for distress situations begin. It is here that the crew is assigned various duties associated with emergencies (including what equipment to bring, such as an EPIRB) and individuals are assigned to muster stations and survival craft. When the time arrives for this ultimate in survival procedure, all hands must conduct the evolution in a calm, orderly manner--without panic. Adequate preparations and training will ensure a safe evacuation.

Training. Being properly prepared is the best way to ensure survival at sea. Since it is somewhat impractical to actually sink a ship for practice, the alternative is training. Crew members and research personnel should be thoroughly informed in all aspects of survival techniques from the Station Bill to launching lifeboats. You should participate in the weekly emergency drills as if they were the real thing. In an actual emergency, you may not have time to go back to your quarters.

When the command "Prepare to Abandon Ship" is given, along with the appropriate emergency signal, the crew instantly begins a planned series of actions similar to the following scenario:

- *Muster at your assigned station; provide all equipment to the scene as assigned on the Station Bill; come to your station fully clothed with your lifejacket on and carrying your immersion suit. If there is sufficient time before the actual evolution begins, don your immersion suit first and keep your lifejacket handy. The suit provides floatation and protects you from the elements.*
- *Prepare all survival craft for immediate launching. Swing out lifeboats or prepare life rafts according to standard procedures. DO NOT LAUNCH any equipment until instructed to do so by the Master. Stand by calmly at your station and await furthar orders.*
- *When the Master orders "Abandon Ship," launch all survival craft. Enter boats and rafts using ladders rather than jumping over the side. Keep calm and organized.*

- *Once boarded, all rafts or boats are tethered and towed away from the ship by a motor lifeboat or the rescue boat. Keep all craft together in the vicinity of the ship's last position.*
- *While waiting for rescue units to arrive, malntaln a continuous visual and radio communication watch. Your lifeboat or life raft is well-stocked with equipment and provisions to sustain life comfortably. Use the supplies in the survival craft with care--they may have to last a while. Just sit back, relax, and await rescue.*

Fire Prevention and Control

INTRODUCTION. Fire prevention should be part of everyday shipboard routine. Because accidents do happen, the ability to control and extinguish a fire quickly is essential to the safety of the vessel and everyone aboard. Persons aboard a research vessel are particularly at risk because their vessel often operates independently in remote areas and is at sea for long, extended periods. Should a fire occur, they must be self-sufficient, since the nearest assistance may be hundreds of miles and several days away. Therefore knowledge, training, and experience with regard to fire safety are imperative to the Academic Research Fleet.

Keep combustibles and hazardous materials off the ship. If it isn't there, it won't burn. Tthis philosophy applies to materials brought aboard ship as well as those used in its construction.

Smoking can be particularly hazardous aboard ship. An improperly disposed cigarette or cigar butt can ignite other materials. Smoking is prohibited in many areas and under certain conditions, such as while in your bunk, while the ship is refueling, or while in ship spaces such as paint lockers, battery rooms, and laboratories. Cigarette butts must be disposed of in approved containers and can never be thrown overboard.

PREVENTION. There are basic principles of ship design that can reduce the risk of fire. To prevent fire from spreading, ARF vessels are divided into zones that usually coincide with subdivision watertight bulkheads. Main vertical zone boundaries consist of insulated steel bulkheads designed to contain fire, smoke, and heat within limits. Spaces in which fire is most likely to occur, such as laboratories, galleys, and machinery spaces, are required to be separated by similar boundaries. Many materials used in the construction of research vessels are noncombustible. Some vessels have permanently installed detection systems that sound an alarm in a normally manned space such as the pilothouse. Doors are fitted on all spaces, and ventilation systems are segregated by fire zones to assist in containing any fire. Spaces having greatest fire risk have a fixed extinguishing system. Ships are designed so that two firehoses will reach any part of the vessel. Two means of escape are provided from every space that is normally occupied. If one access is blocked by fire, another is always available.

Many fires have been started by bunk lights. Light bulbs generate a great deal of heat, and under certain conditions, can cause surrounding materials to catch fire. Fires have been started from bedding placed over the top of bunk lights.

CLASSIFICATION OF FIRE. Fires are classified by the National Fire Protection Association (NFPA). Fire classification is used to select the proper type of fire extinguisher. There are four basic fire classifications, lettered A, B, C, and D.

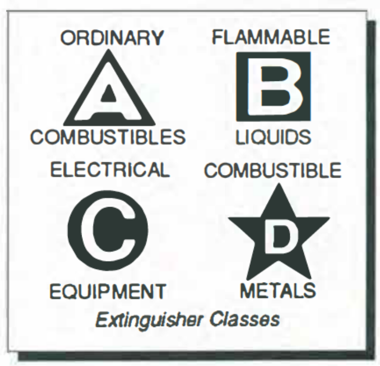
Class A fires are fueled by combustible solids such as wood, paper, clothing, bedding, and some plastics; any material which leaves an ash. These fires can be extinguished by the use of water.

Class B fires involve flammable or combustible liquids, flammable gases, greases, and similar products. These fires can be extinguished by smothering agents, such as foam, CO2, and dry chemicals. Water spray can also be used.

Class C fires are fueled by energized electrical equipment, conductors, or appliances. To protect personnel from shock, nonconducting extinguishing agents, such as CO2, Halon, or dry chemical, must be used. Secure electrical power to the circuit causing the problem.

Class D fires involve combustible metals, e.g., sodium, potassium, magnesium, titanium, and aluminum. These fires are extinguished through the use of a heat-absorbing extinguishing agent, such as certain dry powders (different from dry chemicals), that do not react with the burning metals. Specific firefighting agents are used for specific metals.

Knowing the classifications of fire and what type of extinguisher to use on each type of fire is not enough information to fight a fire effectively. You should know where extinguishers are, how to activate them, where to aim the agent, how much to use, how and when to notify others.



FIREFIGHTING EQUIPMENT.

Portable Fire Extinguishers. Portable extinguishers are used for a fast attack that will knock down flames. They can be carried to the fire, but continuous application can be sustained for only a minute or less. Portable extinguishers are classed with one or more letters and with a numeral. The letters correspond to the class/classes of fire on which the extinguisher is effective. A Class A extinguisher should be used on a wood or bedding fire while a Class C extinguisher should be used on an eleclrical fire. A Class AB extinguisher should be used on an electrical fire. A Class AB extinguisher should be used on fires involving common combustibles, such as wood, and also on fuel or both. The NFPA rates portable extinguishers with Arabic numerals according to their efficiency. An extinguisher rated 4A extinguishes twice as much Class A fire as a 2A extinguisher, etc. The Coast Guard uses Roman numerals to indicate the sizes of portable extinguishers with I being the smallest size and V being the largest size.

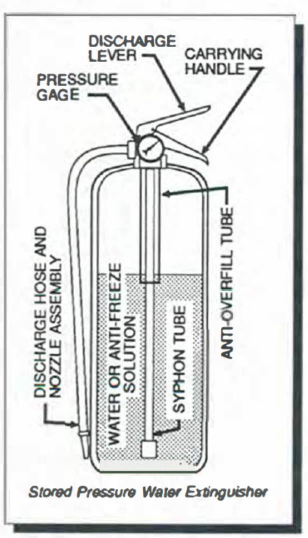
Safety Rules for Portable Extinguishers. If you discover a fire, call out the discovery, sound the fire alarm, and summon help. Close doors to isolate the fire if it can be done quickly and safely.

- Never pass a fire to get to an extinguisher. A dead-end passageway can trap you.
- If you must enter a room or compartment, **don't let the fire get between you and the door.**
- **If you enter a room or compartment and your attack with a portable extinguisher fails, get out Immediately.** Close the door to confine the fire and wait for the help you called. Your knowledge will help them.

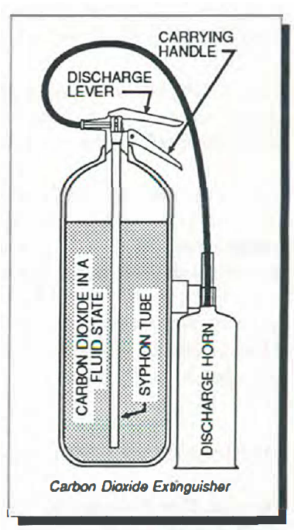
Water Extinguishers. Water extinguishers use water or a water solution as the extinguishing agent. In general, water extinguishers have application for only Class A fires, except for the foam-type extinguishers which may be used on Class A and B fires. These extinguishers hold 2½ gallons of liquid and discharge their contents in less than a minute. The stored-pressure extinguisher is activated by first pulling the ring pin. The hose is then directed with one hand while the discharge lever is squeezed with the other hand. The stream is aimed at the base of the fire and moved back and forth for complete coverage. Short bursts can be used to conserve water.

Carbon Dioxide Extinguishers. Portable carbon dioxide extinguishers are used primarily for Class B and C fires, with the most common sizes having 5 to 20 pounds of CO2. These extinguishers have a range of about 3 to 8 feet and will discharge their contents in 30 seconds or less. A CO2 extinguisher is activated by removing the locking pin and squeezing two handles together while holding the hose handle (not the horn) in the other hand. For combatting a Class B fire, the horn should be aimed at the base of the fire nearest the operator and then "swept" slowly back and forth across the fire. To combat a Class C fire, the electrical equipment should be de-energized and the horn discharge aimed at the base of the fire. It is important that the hose handle be held and not the horn so that ice or frost that forms on the horn cannot become a current path to the operator if the horn should come in contact with live electrical parts.

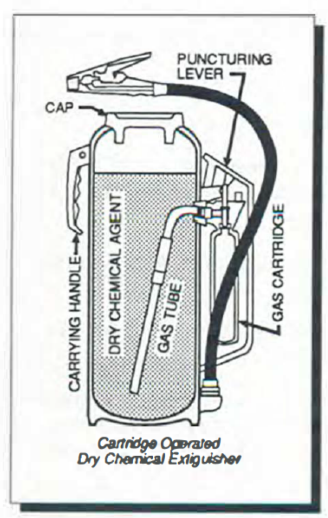
Dry Chemical Extinguishers. Dry chemical portable extinguishers, available in several different sizes, may use any one of five different dry chemical agents as an extinguishing medium. These extinguishers have at least a BC rating, while some have an ABC rating. Portable cartridge-operated extinguishers range in size from 2 to 30 pounds, while semi-portable models contain up to 50 pounds of extinguishing agent. Units under 10 pounds have a discharge extinguishing agent. Units under 10 pounds have a discharge duration of 8-10 seconds; the larger units have up to 30 seconds of discharge time. The cartridge-operated extinguisher uses a small cartridge filled with inert gas mounted on the side of the cylinder to propel the extinguishing agent. The extinguisher is activated by removing the ring pin, and depressing the puncturing pin. These actions release the propellant gas which forces the extinguishing agent up to the nozzle. The discharge should be directed at the seat of the fire, starting at the near edge. The stream should be moved from side to side with rapid motions, to sweep the fire off the fuel. The initial discharge should not be directed onto the burning material at close range (3 to 8 feet), as the stream of extinguishing agent may scatter the fire or spray burning liquid about. The agent may be applied in short bursts by opening and closing the nozzle with the squeeze grips.



Stored Pressure Water Extinguisher



Carbon Dioxide Extinguisher



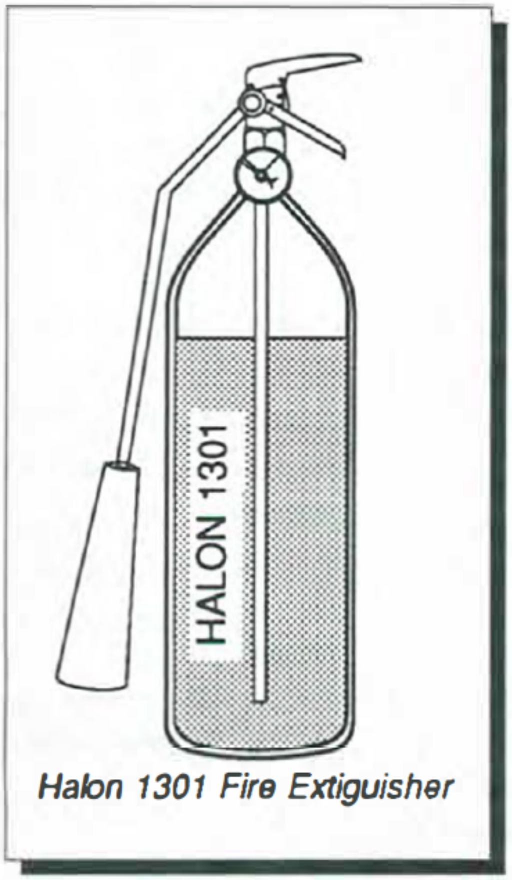
Cartridge Operated Dry Chemical Extiguisher

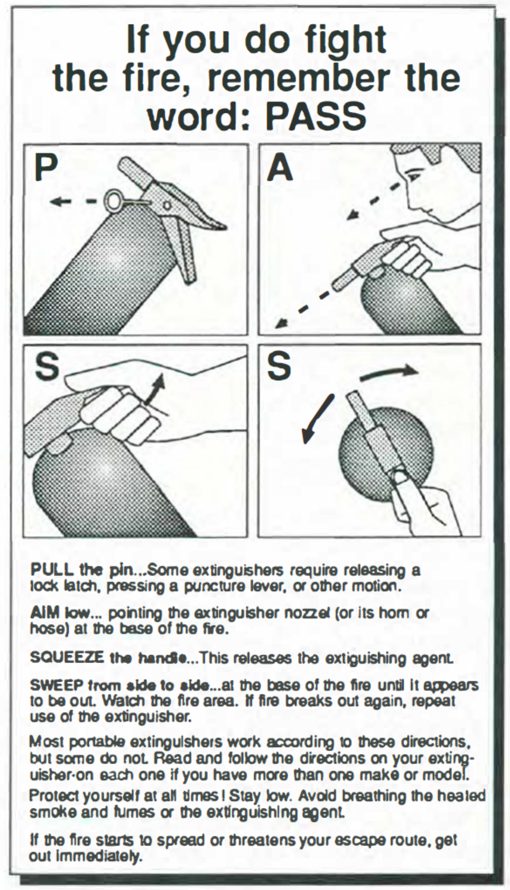
When activating a cartridge-operated dry chemical extinguisher, aim the top of the cylinder away from you. If the top has not been screwed on properly, it may come off violently and cause injury when the propellent gas charges the cylinder. Also, test the extinguisher before taking it into a fire by giving the hose nozzle a quick squeeze--then you know whether it will work or not.

Halon Extinguishers. Halon portable fire extinguishers come in two types, Halon 1211 and Halon 1301, and several sizes from 1 to 20 pounds. They are rated for Class B and C fires. Some Halon 1211 extinguishers are also rated for use on Class A fires. The discharge range from these extinguishers is from 4 to 15 feet and they are discharged quickly. Halon 1211 is not affected by the wind as much as CO2 or Halon 1301, and on a weight-of-agent basis, is at least twice as effective as CO2. Persons should avoid breathing the extinguishing agent or the gases produced by the thermal decomposition. Halon 1301 is at least as effective as CO2 on a weight-of- agent basis, is suitable for cold weather operation, and leaves no residue. On Class B fires, Halon from portable extinguishers is applied in the same manner as CO2.

Semi-portable Fire Extinguishers. A semi-portable fire extinguisher (or extinguishing system) is one from which a hose can be run out to the fire. The two types of semi-portable systems are CO2 hose-reel and dry chemical hose systems. Semi-portable extinguishers provide a means of getting a sizable amount of extinguishing agent to a fire rapidly. These systems have greater capacity and have slightly more range (nozzle to fire distance) than hand-portable extinguishers. As the name implies, they offer only limited portability and fires may be fought only within the range allowed by the discharge hose. They cannot be carried about the ship like hand-portable extinguishers.

Fixed Fire Extinguishing Systems. Fixed fire extinguishing systems are usually built into the ship at the time of its construction. These systems are carefully designed: they consider the fire risks aboard the vessel, must meet exacting regulatory standards, and are available for use in an emergency. If a large fire develops, such as one in a machinery space, these systems may be the best means to extinguish it. There are four types of fixed systems common to research vessels: the fire main system, carbon dioxide system, Halon 1301 system, and the galley range system.





COMBATING THE FIRE. When a fire is noticed, the first thing to do is sound an alarm. The pilothouse must be notified of the location, and if known, the type of fire. This is important no matter how small the fire. It can be done by intercom, sound-powered phone, going to or sending someone else to the pilothouse, or by yelling. Don't be a hero and try to fight a fire without sounding an alarm first. A fire can quickly get out of control and you could be trapped or overcome. If the fire is small, the previous information is designed to help you choose the right extinguisher and put it out. If the fire is larger or gets out of control, then the training, coordination, efficient use of manpower, and a more thorough assessment of the situation that comes with the crew's damage control team will be necessary.

If your first indication of a possible fire is the sight or smell of smoke coming from a closed compartment, you must be careful before opening that space. Feel the door or hatch for heat (cautiously, with the back of your hand). If it is hot or warm, do not open It. Notify the pilothouse or firefighting party immediately.

Stability and Watertight Integrity

STABILITY. Stability of a ship depends on the hull form chosen by the designer, and how major weights, such as fuel, stores, provisions, scientific equipment, etc., are distributed about the ship. Vessel operators have little control over the vessel's form. They do, however, have great control over how much weight is taken aboard, how and where that weight is stowed, and the consequent effects on vessel stability.

As a research party member, you have the responsibility of making known to the crew the nature and amount of weights you have brought on board, and strictly abide by the Master's instructions regarding weight stowage and locations, particularly liquid weights and weights stowed high in the ship. Because all stability assessments assume a watertight shell and weather deck, everyone must keep designated watertight fittings closed at all times. Report any damaged or inoperative fittings to the Master.

Water on deck increases the probability of downflooding through any opening. Freeing ports are fitted in bulwarks to allow water from boarding seas to drain overboard quickly. Ensure that freeing ports are unobstructed. Do not block freeing ports!

The act of lifting or hanging any weight from the vessel's crane, boom, A-frame, J-frame, etc. changes the vessel's center of gravity. As soon as the weight is lifted clear of the deck, the downward force of the weight acts at a point at the top of the weight handling equipment. If a crane is hoisting a weight over the side, the center of gravity is also shifted off center, introducing a list. When planning heavy lifts or over-the-side science operations, consult with the Master to ensure that effects on the ship's stability from such operations are within acceptable limits.

Science operations, such as towing instruments, working gear over the side or fantail, or placing heavy objects on the seafloor, can influence stability in several ways:

- *The vessel may be constrained from assuming the course and speed most favorable to stability and may be subjected to icing, boarding seas, beam winds, etc.*
- *Working heavy weights over the side reduces stability.*
- *The tension of the towline or gear line may introduce a heeling moment similar to that of a beam wind.*

WATERTIGHT INTEGRITY. A ship's form and subdivision are calculated to provide adequate stability and resistance to damage at her design draft. These design features are defeated if the skin of the ship and subdivision bulkheads are not watertight. The original watertight integrity of a vessel is determined by its design and the quality of its construction. The proper maintenance of that integrity is a vital part of any ship's preparations to resist damage. Each undamaged tank or compartment aboard ship must be kept watertight if flooding is to be controlled and not become progressive after damage.

Know the importance of watertight fittings-strive to keep them closed when not in use. It is equally important to keep freeing ports clear. Report inoperative, damaged, or leaking fittings to the Master.

Electrical Systems/Equipment

INTRODUCTION. Individuals who work with shipboard electrical equipment must be particularly vigilant aout safety, as injuries from electric shock and short circuits are too often fatal. A shipboard environment is particularly dangerous with regard to the electrical systems. Because decks are made of steel and form a direct electrical path to seawater, a person touching live electrical parts would normally become a part of this circuit. The body's resistance to current flow falls with an increase in moisture level in the skin. For example, a perspiring individual working in a hot machinery space coming in contact with live electrical components would have minimal resistance to current flow and would receive much more current than a person with dry skin. This adds to the hazards of working around machinery. Because short circuits are usually acompanied by arcs and sparking, there is always the possibility of a resulting fire. When working with electrical installations, be attentive to the risks of fire.

UNGROUNDED ELECTRICAL SYSTEM. Most shipboard electrical distribution systems are not grounded, and in that respect are different from household or shore systems. Neither of the two conductors in a shipboard system is grounded, while the potential between them is about 120 volts. If an individual, while grounded, were to touch either of these two conductors, that person would receive a severe shock. All live electrical circuits are always treated as potential hazards.

A 100 milliampere current can be fatal--this is about 1/1,000 of the current regularly flowing through a household light bulb. Ventricular fibrillation--the uncoordinated actions of the walls of the heart's ventricles--occurs when current flowing through the body approaches 100 milliamperes, which in turn causes the heart to stop pumping. Ventricular fibrillation will usually continue until some force is used to restore the heart's movements to a coordinated pumping action. Current flow of 200 milliamperes or higher through the body will cause severe burns and unconsciousness. It will also cause a clamping action of the heart muscles which prevents the heart from going into ventricular fibrillation. If breathing can be restored immediately, victims will often recover from these injuries.

PERSONAL AND SCIENTIFIC EQUIPMENT. Electrical equipment brought aboard for personal use, such as music systems, hair driers, etc., should be examined by the Chief Engineer. This examination determines whether they are wired with one conductor connected to the chassis, as is common with some electronic equipment. If such equipment is used aboard a ship, it provides a hazardous path to ground for the electrical distribution system, and must be rewired to the satisfaction of the Chief Engineer.

Scientific equipment (including power supplies and clean power sources) and the metal racks usually erected for stowage of scientific equipment should be properly grounded. Any discrepancies found should be reported to the Chief Engineer and remedied before such equipment is energized. Temporary electrical cables rigged for scientific equipment should be arranged to the satisfaction of the Chief Engineer. This includes marking the cable for identification, and ensuring the cable is properly supported, free from possibility of chafing, is properly protected by an overcurrent device, and is of proper size and construction for the application. Such cables should be removed after they have served their purpose.

ELECTRICAL SAFETY PRACTICES.

- ***Consider the results of each act.*** There is absolutely no reason for individuals to take chances that will endanger their lives or the lives of others.
- ***Assume circuits are live.*** Don't take the word of others. Stored capacitance can be fatal. Take time to test/discharge circuits before starting work.
- ***Test your tester.*** When testing circuits to see if they are live, test a known voltage source first to see if your tester works.
- ***Heed warning signs.*** If a sign warns that there may be two sources of power to a cabinet, take time to identify and secure both sources before reaching into the cabinet.
- ***Use your senses.*** Be alert to smoke, overheating, and an "electrical smell" which are signs that trouble may not be far off.
- ***Authorized personnel only.*** Only personnel authorized by the Chief Engineer should work on installed shipboard electrical equipment. Researchers should coordinate their requirements with the Chief Engineer before proceeding with work which may impact a ship's distribution system.
- ***Keep covers closed.*** Close covers to fuse panels, junction boxes, etc., when not in use. Covers are there to keep moisture and debris out.

- ***Count tools.*** When working in cabinets or other equipment, count the tools you take in with you and be certain that you remove the same number when you leave.
- ***Beware of dual voltages.*** Some switchboard panels have both 450-volt and 120-volt circuits. If servicing a 120-volt circuit, beware that a higher voltage circuit is close by.
- ***Remove jewelry.*** Don't wear jewelry when working with electrical equipment or moving machinery. Remove rings, necklaces, and bracelets when you need to work near live components. The jewelry may serve as a path to ground or cause a short circuit which could be fatal or cause injury. The same applies to metal zippers on clothing.
- ***Tagged-out equipment.*** The ship's electricians and engineers place equipment out-of-service if it could jeopardize safety of personnel or cause equipment damage if started. Know how to secure all sources of possible power to such equipment
- ***Leave equipment in working order***, or tag it out-of-service before you leave.
- ***Do not service high-voltage equipment alone.***
- ***Do not ground yourself.*** Make sure you are not grounded when adjusting equipment or using measuring equipment. Use only one hand when servicing energized equipment. Keep the other hand behind you or in your pocket.
- ***Don't energize wet equipment.***
- ***Use only properly grounded power tools.***
- ***Use a fuse puller when pulling fuses.***
- ***Examine extension cords and portable cords before use.***

Engineering Safety and Practices

INTRODUCTION. Danger to personnel exists to some degree in every shipboard engineering operation. Because that danger is a constant companion, you may tend to discount the disastrous possibilities and ignore measures necessary to prevent accidents. Hazards to personal safety exist in virtually every system in the engineering department. High pressures and temperatures, volatile fluids, and rotating machinery which may start without notice are waiting for the unsuspecting crew member to make a mistake.

Become familiar with the following precepts of safety:

- ***Report unsafe conditions.*** Notify your supervisor or a ship's officer if you feel a condition, equipment, or material is unsafe.
- ***Warn others.*** Take the time to remind shipmates of safety precautions.
- ***Use protective equipment.*** Ear and eye protection, protective clothing, and breathing equipment are provided for your safety--use them.
- ***Use safety guards.*** Safety guards and devices are placed on tools and equipment to prevent injury- use them correctly. If you find a safety guard missing or misaligned, inform the Chief Engineer.
- ***Reprt injury or ill health.*** Report any injuries or evidence of impaired health to your supervisor or a ship’s officer.

- ***Exercise caution.*** Be alert to the hazards of the workplace and take all necessary precautions.

Gasoline presents a far greater hazard than diesel fuel. It must only be stored and transferred topside on weather decks. Exercise great care when fueling.

FUELING SMALL BOATS AND ENGINES. Fueling procedures for small boats and small engines depend on specific equipment. Fuel may be transferred from ship's tanks or drums to the boat tank by hose (diesel boats), gasoline cans may be simply placed in a boat and connected to the engine by hose (outboard-motor-driven boats), or gasoline or a gas/oil mixture may be poured from storage cans to a built-in fuel tank (portable pumps, chain saws). Whatever the method, take precautions to avoid spills, fires or injuries. When using a transfer hose from the ship's tanks, ensure proper alignment of valves, adequate communications, and pre-established emergency procedures. For drum or can transfers, provide drip pans under the transfer points and be cautious of overflows. When refueling portable equipment, use good judgement to prevent spills on deck or on the equipment. Never refill a tank over a hot engine. A small amount of gasoline spilled on the engine may flash and ignite the whole can with disastrous results. Contain and clean up any spills immediately.

REPAIRS. Machinery and equipment must be maintained and repaired properly. When making repairs, do it right the first time! Make-shift repairs could injure an unsuspecting person who doesn't know that the machine has been jury-rigged.

Hazardous Materials

INTRODUCTION. Research and shipboard personnel can expect to encounter hazardous materials in the form of ship's stores, paints, laboratory chemicals, cleaning agents, etc. Therefore, a working knowledge of these materials and their hazards will assist personnel in handling and storing them in a safe, responsible manner.

You are assumed to have experience and a good working knowledge of procedures for handling, storing, and disposing of hazardous materials within a shore-based laboratory. It is anticipated you will continue your reading of the RVOC Safety Training Manual-especially Chapter 13, "Hazardous Materials," as well as resource documents that are listed therein.

Hazardous material is any substance which, because of its chemical properties, can cause the deterioration of other materials or injury to living organisms. Hazardous materials are grouped into five major classes:

- *Flammable or explosive*
- *Corrosive*
- *Reactive*
- *Toxic or poisonous*
- *Cryogenic*

Procedures for handling hazardous material aboard a research vessel may be different than what you are used to. Plan your experiments with minimal waste--you are limited to the storage aboard for disposal; you just don't heave HAZMAT overboard! Containers are prone to spill when the deck is moving. While at sea, some of your procedures that used to be “automatic" will have to be altered to accommodate the new environment.

PROTECTION. In order for hazardous materials or chemicals to harm the body, they must first gain entrance. Methods of prevention include removal or confinement of hazards, use of protective equipment, or a combination thereof.

Hazard Removal. The best way to protect yourself from hazardous materials is to eliminate the possibility of contact. Hazard removal may be accomplished by physically removing the hazardous substance or rendering it harmless. Potential hazards can be removed or reduced by limiting the types and quantities of hazardous materials stowed and used on board and properly disposing of hazardous waste.

Hazard Containment. Hazardous materials that are carried must be properly packaged and stored to prevent injury. Storage and use areas are designed to contain or limit the spread of any spilled materials.

Personal Protective Devices. Personal protective devices are worn when working with any known or unknown hazard. The skin and the respiratory tract provide only limited natural protection against harmful substances. Personal protective equipment (PPE) provides a barrier between the person and the environment to prevent harmful effects from hazardous chemicals.

When presented with a spill or other hazardous situation, try to:

- *Limit the spread of the hazardous material to the smallest area possible with physical barriers.*
- *Limit access of personnel to the hazard area and vicinity.*
- *Shut down or plug up the source of the hazardous material.*
- *Neutralize the HAZMAT with other chemicals.*

LABORATORY CHEMICALS. Various forms, types, mixtures, and quantities of chemicals will be found in a laboratory. Safety in their use is paramount. There are chemicals that react with each other, water, metals, and other common items. The storage and handling of laboratory chemicals must be done carefully and by trained professionals.

When working in the lab, wear proper clothing: goggles, lab coat or coveralls, and gloves when necessary. Know the location and how to use the protective equipment on board: ventilation hoods, eye wash stations, fresh water, personal showers, and disposal units. All chemicals in the lab must be properly marked and stored in proper containers. Acids, which are highly corrosive, cannot be stored in metal containers. Any chemicals brought on board in large quantities should be stored in the appropriate lockers until they are needed. Chemicals that react with each other must not be stored in the same place; acids should not be stored with alkalis.

Any chemicals used or created on board and ready for disposal should be placed in a clearly labeled disposal unit and properly stored until port is reached. Dispose of chemicals in accordance with applicable regulatory requirements.

If a spill occurs in the lab, the personnel cleaning the spill should know what was spilled, and what substances react with the spilled chemicals before cleaning. There are chemicals that will react violently with water and should be cleaned up with dry cloths. If personnel are splattered with a chemical, the affected areas should be washed with lots of water and medical attention sought.

Personnel Protection:

- *Use a face mask or goggles to protect eyes against irritating fumes or corrosive liquids.*
- *Do not enter spaces that have been closed for significant periods of time without respiratory protection until it has been established that a safe atmosphere exists.*

- *Wear full face shields, rubber gloves, rubber boots, and aprons when handling corrosive materials.*
- *Wear lab coats and goggles in laboratories when necessary.*
- *Exposure to particulate matter requires the use of a respirator with an appropriate filter for protection against dust, fumes, mists, fogs, liquids, and solids.*
- *Use protective skin cream or gloves, or both, when handling sensitizers or potential skin irritants such as epoxy and polyester resins and hardeners.*

REACTIVITY. Many chemicals that are nonhazardous in a natural state, or have a low to medium degree of hazard, can become highly hazardous when placed in contact with another chemical. The resultant mixture can be more reactive, produce more hazards, and be several times more toxic than each chemical by itself. In some cases, chemicals may react violently, even explosively, when brought together. Spontaneous explosion or heat sufficient to ignite nearby combustibles may result. Electrical currents or arcs or extreme heat can liberate or cause the formation of hazardous compounds, or the decomposition of harmless substances into hazardous materials. For example, nitrogen dioxide (N02) is formed by welding arcs; electrolysis in seawater releases chlorine and hydrogen gas and may produce other compounds. Oxygen in a gaseous state increases the flammable potential of other materials around it; as a liquid, it has the ability to freeze living tissue to the point of shattering. Water, when added to certain burning metals, can increase the intensity of the fire; the moisture in the air or perspiration on one's skin can cause some chemicals to ignite spontaneously.

COMPRESSED GASES. Compressed gases such as oxygen, helium, nitrogen, and other inert gases are used on board for many different reasons. They can be used for medical purposes, cutting and welding, weather balloons, and for laboratory experiments. Cylinders should always be kept securely contained. If a cylinder ruptures, it could cause an explosion, feed a fire, or become a missile hazard.

Basic safety precautions for handling compressed gasses:

THE ALWAYS LIST

- Always open cylinder valves slowly to allow a gradual pressure buildup and to prevent diesel effect in the line or regulator.
- Always keep cylinders away from hotwork (welding/cutting) areas so that sparks, slag, or flames will not reach them.
- Always store cylinders, both full and empty, so they won't be knocked over.
- Always keep valve protection caps in place and hand tight, except when in use or connected for use.
- Always clear the cylinder valve connections of any dirt particles by briefly opening and closing the valves before connecting regulators. Do not stand in direct line of a cylinder valve when opening it.
- Always purge manifolds in a similar manner before connecting regulators.
- To lessen the chance of rupturing the diaphragm, always ensure the regulator adjusting screw is backed out all the way before opening bottle valve.
- Always remove faulty regulators from service.

THE NEVER LIST

- Never use a cylinder or its contents for other than its intended use, and NEVER use a cylinder (not even an empty one) as a roller or support.
- Never use valve protection caps for lifting cylinders.
- Never use a magnet for lifting.
- Never use slings for lifting. Use a cradle or pallet with proper cylinder spacers.
- Never use a hammer or wrench to open cylinder valves.
- Never drop or allow any cylinder to fall, especially one that contains oxygen.
- Never tamper with safety plugs (safety relief valves).
- Never connect a regulator to a cylinder containing a gas other than that for which the regulator was designed.
- Never pressurize cylinder, tank, or compressed gas system higher than its rated pressure.

PAINTS AND SOLVENTS. Aboard a ship, one can find a supply of paints, strippers, thinners, and cleaners (such as turpentine), all of which have a hazard potential. Many of the paints and solvents have low flash points which increase the risk of fire. Paints and solvents produce toxic fumes when they are applied, drying, or removed. Wear respiratory protection and appropriate clothing (long-sleeve shirt, long pants, etc.) when painting.

Maintain proper ventilation (either natural or forced), do not smoke, and avoid using electrical equipment when applying paint and during drying and curing. Personnel handling the substance should wear a respiratory mask whenever there is a risk of inhaling toxic fumes.

RADIOACTIVE MATERIAL. Most science work using radioactive isotopes involves very low levels of radioactivity. Normally, even prolonged exposure would have no harmful effect on an individual. While spills could cause contamination or "dirty" a lab or van, these terms refer only to the negative effect on minute scientific measurements.

Radioactive materials are defined as any material or combination of materials that spontaneously emit alpha or beta rays (sometimes gamma rays) by the disintegration of the nuclei of atoms. Containers with radioactive materials must be labeled with the propeller symbol.

Keep radioactive material in one area, preferably a separate van. The working surfaces should be made of a nonporous material that is resistant to seawater and radioactive materials. Any materials that have the ability to become airborne should be worked on only in an approved fume hood.

All radioactive material should be stored in one locker clearly marked, “RADIOACTIVE.” Radioactive materials are kept in their original containers until they are used. Solid waste materials may be stored in cans that are properly labled and sealed. Liquid radioactive waste may be stored in plastic jars or bottles. The locker should be protected from the weather and unauthorized removal of contents. In any area where radioactive materials are being processed or handled, film badges or other exposure-measuring devices could be required and the area clearly marked, “RADIOACTIVE MATERIALS IN USE.” While working with isotopes, wear lab coats and gloves. Protective clothing should not leave the lab until declared radiation free. Eating, drinking, or smoking must not be permitted in areas where radioactive materials are being handled or stored. Food and beverages should never be stored near radiological laboratories or in the same refrigeration units as radioisotopes. All radioactive waste materials and any materials suspected of being contaminated should be placed in properly labeled waste containers.

In the event of a spill of radioactive material, the following general procedures should be followed:

- *Keep all personnel who were in the area of the spill together until they can be tested for contamination levels. Seek qualified medical help as soon as possible.*
- *Block off the area where the spill occurred.*
- *If the clothing of the personnel has been contaminated, remove and dispose of properly.*
- *Keep all unaffected personnel away from area until uncontaminated personnel in full pro-tective clothing arrive to clean up the area.*

MARINE SANITATION DEVICES. Marine sanitation devices (MSD) installed on board ships are used to hold or treat raw sewage and waste water. While these systems perform well in abating water pollution, the tanks and the chemical processes present hazards to personnel required to operate and maintain them.

The primary hazard to personnel from marine sanitation systems is hydrogen sulfide (H2S) gas. This gas is invisible and has a characteristic odor of rotten eggs. It is highly toxic and flammable.

If a marine sanitation leak or spill occurs, or if the odor of H2S is detected, leave the space immediately. You may return to the area only when the space is certified to be safe.

Summary

Living and working aboard a research vessel can be safe for those who know and practice safety. Emergencies must be reported and handled properly. Are you ready for this cruise? Safety is the responsibility of every person aboard. In the laboratory, you have learned to control the environment to ensure consistent results of your experiments. Although you cannot totally control the shipboard environment, you can control your actions and be prepared. Have a safe and successrul cruise!

APPENDIX H
Vessels of the Academic Research Fleet

	Operator	LOA/ Beam	Gross Tonnage	Built	Science Party	Owner	Inspected?	Classed
Global Class								
Thomas G. Thompson	UW	274/84		1991	36	Navy	Yes	ABS
Roger Revelle	SIO	274/84		1996	37	Navy	Yes	ABS
Atlantis	WHOI	274/84		1997	37	Navy	Yes	ABS
Sikuliaq	UAF	261/179		2014	24	NSF	Yes	ABS
Marcus G. Langseth	LDEO	235/72	3834	2006	35	NSF	Yes	ABS
Ocean/Intermediate Class								
Kilo Moana	UH	186/57		2001	29	Navy	Yes	
Oceanus	OSU	177/54		1975/94	18	NSF	Yes	
Endeavor	URI	185/56		1976/93	18	NSF		
Atlantic Explorer	BIOS	170/52		1982/06	22	BIOS		
Neil Armstrong	WHOI	230/73	2641	2014	24	Navy	Yes	ABS
Sally Ride	SIO	230/73	2641	2014	24	Navy	Yes	ABS
Regional Class								
Hugh R. Sharp	UDel	146/45		2005	14	UDel		
Coastal/Local Vessels								
Robert G. Sproul	SIO	125/38		1981/85	12	UCal		
Pelican	LUMCON	116/36		1985/05	14	LUMCON		
F.G. Walton Smith	UMiami	96/29		2000	12	UMiami		
Savannah	Skidaway	192/28		2001	16	Skidaway		
Blue Heron	UMinn-Duluth	86/26		1985/97	8	UMinn		
Rachel Carson	UW	72/22		2003/17	9	UW		