

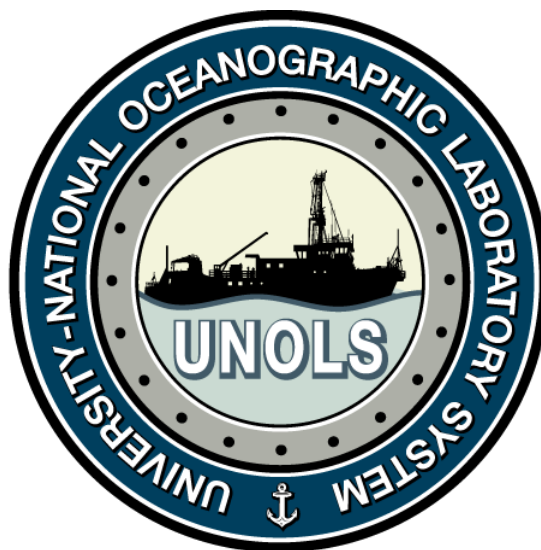


RESEARCH VESSEL SAFETY STANDARDS

11th Edition

Appendix G

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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 cliché "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 workdays. 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 carelessness.

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 to 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 situations. 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 members 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 than 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 sfttill 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 information 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 hindrance 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 Liferrafts. 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 retroreflective 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 floatation.

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 instances 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 further 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, maintain 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. This 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.

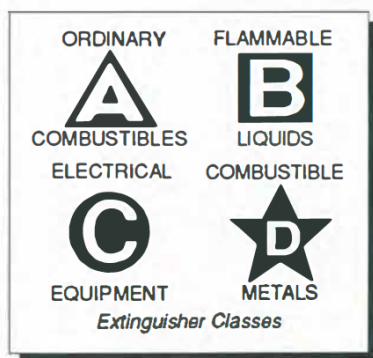
Class A fires are fueled by combustible solids such as wood, paper, clothing, bedding, and some plastics; any material which leaves an ash. These fires can be extinguished by the use of water.

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 electrical 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.

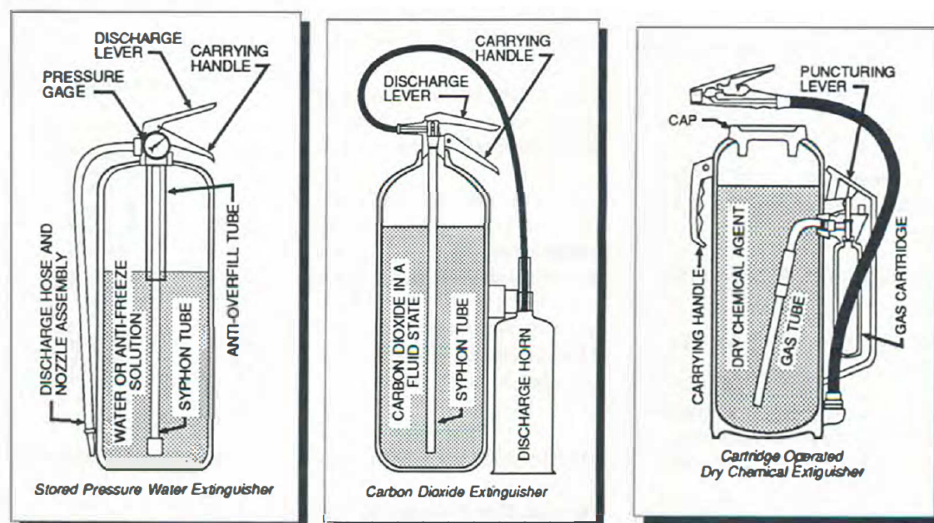
Safety Rules for Portable Extinguishers. If you discover a fire, call out the discovery, sound the fire alarm, and summon help. Close doors to isolate the fire if it can be done quickly and safely.

- 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 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.

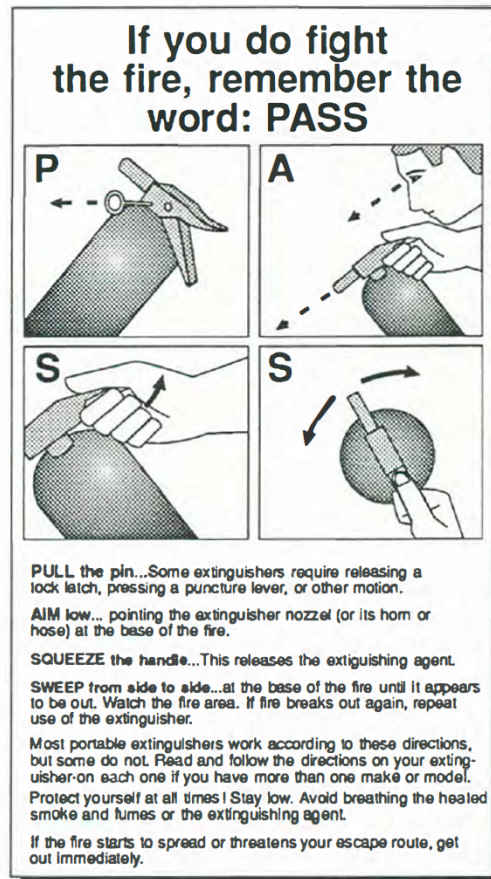
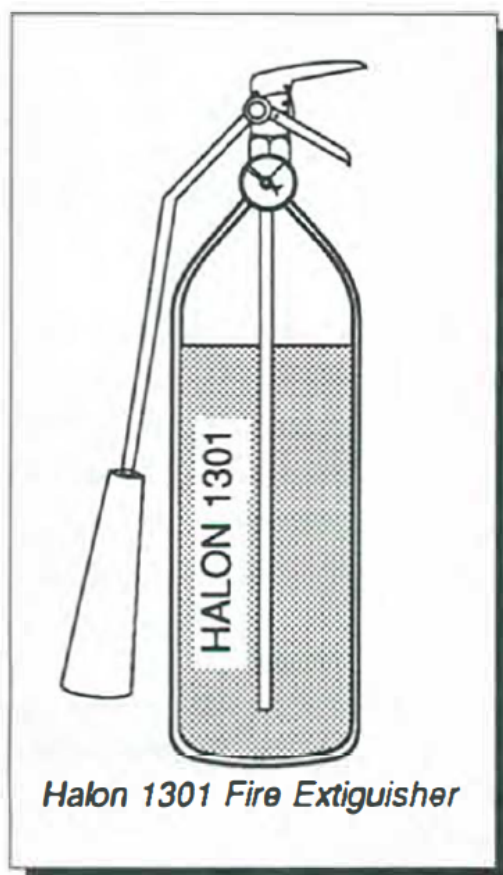


When activating a cartridge-operated dry chemical extinguisher, aim the top of the cylinder away from you. If the top has not been screwed on properly, it may come off violently and cause injury when the propellant gas charges the cylinder. Also, test the extinguisher before taking it into a fire by 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 about 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 accompanied 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.

UNGROUNDING 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 milliamper 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.
- **Report 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 (NO₂) 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	THE NEVER LIST
<ul style="list-style-type: none"> • 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. 	<ul style="list-style-type: none"> • 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 labeled 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 protective 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 successful cruise!