Boatyard Hazards
Tips for protecting worker safety and health
Terry Johnson
Boatyard Hazards

Tips for protecting worker safety and health

Terry Johnson

Contents

Introduction ................................................................. 2
Chapter 1 — Who Has Regulatory Authority? ...................... 3
Chapter 2 — Job Hazard Analysis .................................. 5
Chapter 3 — Safety Hazards ......................................... 7
Chapter 4 — Health Hazards ......................................... 9
Chapter 5 — Protective Measures ................................. 12
Appendix I — Lockout/Tagout ...................................... 17
Appendix II — Materials Safety Data Sheets (MSDS) and Other Labels 18
Appendix III — Personal Protective Equipment .................. 20
Introduction

Boatyard work is hazardous. Industry-wide, the injury and illness incidence rate on ships and in boatyards is more than double those of construction and general industry, according to the U.S. Department of Labor’s Occupational Safety and Health Administration (OSHA).

This publication uses the term “boatyard” to include any facility that conducts boat building, boat and related equipment maintenance and repair, and marinas, boat harbors and storage yards where these activities are conducted.

This publication is for you if you work as any of the following:
• boatyard employee
• contract worker or technician
• commercial and recreational boat owner or crewmember.

It will help you understand the risks, and adopt measures that will make you safer from injury and sickness that can result from boat repair and maintenance.

It is not a comprehensive safety and health manual for use by boatyard management in developing a safety and health program. See Chapter 1 for information on meeting federal standards.

Purposes of this manual are to:
1. outline the regulatory authorities who oversee boatyard safety and health
2. summarize how to do a hazard analysis and draft a set of best practices
3. identify types of injury and health risks associated with boatyard work
4. describe preventive measures for a range of risks
5. explain selection and use of personal protective equipment (PPE)
6. clarify how to read and interpret a material safety data sheet (MSDS)
7. recommend steps you can take to ensure your own health and safety.

Acknowledgements

Thanks to those who assisted me with this publication, including Doug Ward and Christopher Comstock of Vigor Alaska, Cy St-Amand of Otter Works, Jerry Dzugan with the Alaska Marine Safety Education Association, Arthur Schultz, Gabriel Dunham of Alaska Sea Grant, and Benjamin Sinclair of NIOSH.
—Terry Johnson
Who Has Regulatory Authority?

The federal Occupational Safety and Health Administration (OSHA) has overall authority over workplace safety standards and enforcement in the United States. There are a few exceptions; for example, the Coast Guard oversees workers on vessels at sea. OSHA sets standards for safety equipment and for safe operating procedures, conducts inspections, conducts research, produces training materials and provides instruction. It implements the Occupational Safety and Health Act of 1970 (OSHA 1970).

OSHA 1970 requires employers to ensure safe and healthful working conditions by, among other things, providing workers “employment and a place of employment that are free from recognized hazards that are causing or are likely to cause death or serious physical harm…” It requires employees to report to their employer any hazardous conditions they encounter, and any job-related death, illness or injury. Employers are prohibited from retaliating against workers who file such reports. OSHA compliance officers may issue citations, which are notices of violation of an OSHA standard, or may assess fines or sanctions against an employer for egregious or repeated violations.

While coastal states in OSHA Region 10 (Oregon, Washington, Idaho and Alaska) have agreements with OSHA allowing state agencies to enforce worker safety in specified kinds of workplace, OSHA maintains jurisdiction in the others. Generally, vessel construction, repair and maintenance facilities fall under OSHA jurisdiction.

Vessel construction and repair facilities standards are found in a 308-page document called OSHA 2268-11R Shipboard Industry Standards (https://www.osha.gov/Publications/OSHA_shipyard_industry.pdf). It is a guide to planning and implementing a worker safety and health program (SHP) for any size of vessel construction, repair or maintenance facility. It outlines both recommendations or best management practices, and enforceable regulations.

However, while OSHA regulations protect regular employees of these facilities, they do not protect contractors and their employees, nor non-employees who work on their own vessels.

General maritime law and the Jones Act, a federal law that regulates maritime commerce in the United States, put the onus on vessel owners to ensure the safety and health of employees, contract workers and crewmembers. Owners can face huge costs if any of those people are sickened or injured while “in the service of the vessel” which includes doing maintenance or repair work ashore. The vessel owner is responsible, at a minimum, for “maintenance and cure” of an injured person, meaning all medical costs plus a living allowance during recovery, which can take months. Crewmembers also may claim wages they would have earned had they not become incapacitated. If permanently disabled, they may sue for a lifetime income. Furthermore, if the vessel owner is found to have been negligent or operated an “unseaworthy” vessel—which courts have defined very broadly—he or she can be held liable for substantial “pain and suffering” or punitive damages. All of which means that it is very much in the interest of a boat owner to keep workers safe and healthy.

From the worker’s point of view, many ill effects of exposure are not immediately obvious. Long-term or chronic symptoms will be nearly impossible to attribute to any particular cause or exposure. While the Jones Act puts a heavy burden on owners, it does the worker no good if the ill effects appear decades later.

Properly labeling and neatly storing hazardous substances reduces the chance of sickness or injury.
“Hazard recognition is the first step toward reduction of injury and disease in boat building.”

C.R. Brigham and P.J. Landrigan
American Journal of Industrial Medicine, 1985.

Responsible boatyard managers develop a process for job hazard analysis (JHA) and integrate it into the business’ overall safety program. A JHA should be done for each phase of work, for each task, and should include input from all affected workers as well as their acknowledgement of its contents.

A JHA identifies the steps of each task, hazards associated with each step, and measures to control each of those hazards. It also identifies what protective measures (see Chapter 5) should be applied and what Personal Protective Equipment (Appendix III) should be provided to workers. It is a written document or form that adheres to a standard format, and the information it contains is to be communicated to workers. The process begins with hazard recognition.

You can do your own informal job hazard analysis if the manager hasn’t done one, or hasn’t communicated it to everyone at the site. It can be incorporated into what is sometimes called a worksite systems approach, which looks at a worksite as a dynamic process involving independent parts that interact with one another and with the outside world. Each part of the system, including managers, workers and the physical environment, may influence the function of each of the others. This approach requires that employers and employees each anticipate the consequences of their activities and take into account the actions of the others.
This approach requires constant situational awareness on the part of each participant in the operation, with an eye toward continuously recognizing and controlling hazardous conditions.

The Labor Education Research Service at Ohio State University has outlined a hazard-recognition program for use in boatyards. Hazard categories named in the OSU program are:

**Falling hazards**—higher to lower level, or on same level tripping or slipping due to poor housekeeping.

**Being struck or striking against**—falling objects, machinery without proper guards or that moves under power, contact with hard or sharp surfaces, etc.

**Getting caught in, on or between** items or surfaces—including fire or asphyxiation in confined spaces, being pinned by heavy moving objects.

**Contact hazards**—including extreme temperature (hot or cold), electrical current, toxic substances, noise, ionizing radiation, etc.

**Inhalation, swallowing and absorption**—including noxious or toxic vapors and substances that can be swallowed or absorbed through the skin, and can include anything from minor irritants to lethal chemicals and substances that over time can cause cancers, nervous system disorders or organ failure.

A Job Hazard Analysis reporting form for an individual task typically might contain the following information:

- job title
- individual steps of each task
- hazards that each step may present
- control measures for each identified hazard
- notes

A key to effectiveness is identifying what activities and substances are hazardous. Some are obvious but others may not be to an untrained or inexperienced worker. The following sections identify some hazards that might not immediately be recognized.
Safety Hazards

This section lists common and serious boatyard safety hazards, based on the Ohio State University hazards categories.

1. Falling Hazards
Falls, higher to lower level—Ladders, scaffoldings, open hatches and defective safety rails on boats all present falling hazards. Moving boats (on trailers or floating) and wet surfaces increase the risk.

Slips and trips—on wet or unstable surfaces, or over improperly positioned or stored materials or equipment.

2. Struck By or Struck Against Hazards
Falling objects—Tools, materials and equipment can dislodge from overhead locations.

Eye damage—from splinters, dust, smoke, caustic chemicals, and high intensity lighting. Children and pets are particularly vulnerable to serious eye damage from looking at the bright light from arc welding.

3. Getting Caught Hazards
Asphyxiation—depriving the body of oxygen, often occurring in confined spaces. For example, an empty void on a steel ship may have all the oxygen stripped out of the air by the oxidation process of rust. Asphyxiation can also occur when oxygen is displaced by other gases. Methane and hydrogen sulfide gas produced by rotting fish have killed workers in confined spaces. Chemical asphyxiation can result when an inhaled substance chemically bonds to blood cells to prevent the use of oxygen by those cells.

Back injuries—and other musculoskeletal injuries resulting from improper lifting, attempting to lift or move too much weight, improper body positioning, falls and other actions.

Refrigerant exposure—Even minor exposure to ammonia can cause serious injury; hydrochlorofluorocarbons (HCFCs) are less dangerous but can be toxic in confined areas.

Pinned or crushed—by machinery, moving objects, heavy tools.

4. Contact Hazards
Burns—electrical and welding.

Burns from flash fires, explosions—when fuels, lubricants, refrigerants, propane, liquefied natural gas (LNG) or solvents ignite. Hydrogen gas emitted by charging batteries can explode.

A ladder with handrail can protect workers from falling.
Chemical burns—from contact with caustic substances. Lungs and breathing passages can be burned by inhaling chemical gasses or dust. A common problem involves a product called Albright, used to remove the oxides on aluminum. Absorption of this chemical through the skin can cause serious injury.

Injection injuries—High-pressure fuel lines or injectors can inject diesel fuel through the skin and can cause gangrene if not surgically removed. Likewise, airless paint sprayers and high-pressure spray washers can cause injuries.

Electrocution—damaged cord covers, faulty AC wiring and tools, short circuits, unintentionally activated circuits, and electroshock drowning of workers in the water due to stray currents. Even 12-volt DC current has the potential to cause fibrillation of the heart, but 120-volt household current and the much higher voltages found in industrial facilities are deadly. Shore power circuitry is a common cause of both vessel fires and personal electrocution. Electric shock drowning occurs when people enter the water where faulty wiring allows stray current to go into that water.

Explosion injuries—resulting from sparks or heat igniting leaking fuels, gasses, solvents, fumes or dust. When vessels or tanks are brought into warm shops or work bays, the fuels or other potentially explosive materials in their tanks may expand and overflow or vapors may escape, resulting in potentially explosive condition. Charging lead-acid batteries releases explosive hydrogen gas.

Exposure to nonionizing radiation—Eye damage can result from welding (“welder’s flash”), microwave ovens, low pressure mercury lamps, and sunlight.

“Hot work” injuries—from toxic fumes (“galvy poisoning”), radiation and solvents associated with welding, soldering, brazing, burning and cutting. Welding on metal that has been cleaned with chlorinated solvents instantly produces mustard gas, and is deadly.

Hearing damage—Noise produced by running machinery, and sandblasting can cause permanent hearing loss and tinnitus or ringing in the ears.

Conveniently placed dispensers of foam ear plugs can save worker hearing.

Running machinery injuries—from exposure to belts and pulleys on running engines, drive shafts, hydraulic machinery, as well as from accidents with power tools.

Vibration injuries—primarily affecting hand and arm from using power tools and machinery.
4 Health Hazards

“The better it is for boats the worse it is for me.”
Jerry Dzugan, Alaska Marine Safety Education Association and long-time vessel owner

The fifth hazards category includes threats to immediate or long-term health through inhalation, swallowing, or absorption through the skin of hazardous materials. These substances can be merely irritants, or can be toxins or carcinogens that cause illness or death years or decades after exposure.

Hazardous Substances

Asbestos—Prior to the 1970s it was used in fireproofing and insulation. It appears as insulating board, heat shielding tape, tiles and paint. Inhaling airborne fibers can lead to asbestosis and lung cancer, which normally show up 10–40 years after exposure. Grinding-disk dust is a serious breathing hazard. Some low-quality disks are made in part with asbestos.

Bottom paints: Copper, Copper Omadine and cuprous oxide—Biocides in bottom (antifouling) paint are potent neurotoxins and can be absorbed through the skin as well as inhaled during sanding. Tributyltin (TBT), another bottom paint biocide, is so toxic that it is banned but may be in paint still on some boats. Antifouling paints are hazardous materials and must be handled as such.

Cadmium—This metal may be found in some kinds of steel and can be released during welding and inhaled. It is also present in sacrificial zinc anodes. It can cause lung and systemic disease.

Chrome, chromates, chromium—These are used in painting, sheet metal and released during welding; inhalation of fumes causes skin rashes and can lead to lung cancer.

Cleaners—Many types of cleaners can cause skin irritation and sensitivity. A combination of chlorine bleach and ammonia is toxic and can damage lungs and breathing passages. Ammonia occurs in a wide range of products, including ordinary dish soap and many other cleaners.

CO and CO₂—Particularly in enclosed spaces, inhaling carbon monoxide (CO) or carbon dioxide (CO₂) can be fatal. Carbon monoxide displaces oxygen in the blood. It is the product of combustion and is in exhaust from gasoline and diesel engines, and from improperly vented or poorly maintained oil or gas stoves. CO₂ displaces atmospheric oxygen, causing suffocation at higher concentrations; even in lower concentrations its inherent toxicity could cause inhalation to be fatal. NIOSH lists the IDLH (Immediately Dangerous for Life or Health) for CO₂ at 4%. (IDHL of carbon monoxide is 1.2%)

Engine exhaust—Particulates in diesel exhaust are carcinogens, and gasoline engine exhaust contains potentially lethal nitrogen dioxide and sulfur dioxide, as well as carbon monoxide.

Epoxies—Used in painting and fiberglass work, epoxies can cause skin sensitivity and irritation.

Fiberglass, glass wool—These can cause allergic skin reactions, and inhaling particles can cause lung damage after long exposure.

Fire extinguishers—Inhaling ammonium phosphate, the suppression agent in dry chemical fire extinguishers, can cause lung damage and interfere with oxygen transfer to the bloodstream. The federal government considers Halon 1301 “safe” but exposure in high concentration can cause asphyxiation, nerve damage and even heart attack. Halon manufacture was banned in 1994 due to concern about the earth’s ozone layer but some halon systems remain in place. Halon substitutes
such as Halotron (hydrochlorofluorocarbon) and FM-200 (heptafluoropropane) have “acceptable toxicity” according to the government. Carbon dioxide, another common Halon substitute, also can be fatal if inhaled. (See CO and CO₂ above.)

Gases, including hydrogen, hydrogen sulfide, methane, nitrogen dioxide, sulfur dioxide—These gasses can be irritating and damaging to the lungs (nitrogen dioxide, sulfur dioxide), flammable and explosive (LPG, LNG, hydrogen), or immediately fatal if inhaled (CO, methane, hydrogen sulfide).

Glues, sealants, pipe dope—Most are aromatics (release substances in a gaseous form), and are irritants, are flammable, and can cause kidney and liver damage.

Iron dust—Chronic inhalation of iron dust can cause a potentially serious lung disease called pneumosiderosis or “welder’s lung.”

Isocyanates—These chemicals are found in paints, glues and polyurethane foams and can cause skin and eye irritation, and occupational asthma from prolonged inhalation. (See Epoxies above.) They are classified as potential carcinogens.

Manganese—A mineral component of welding rods, prolonged breathing causes respiratory and nerve damage and is linked to bronchitis and symptoms similar to Parkinson’s disease.

Paints, solvents, primers, coatings, antifouling paints and compounds—Different substances can cause problems ranging from skin rashes to nerve damage to fatal liver and kidney disease and cancer. Some can be absorbed through the skin and some release aerosols that are hazardous if inhaled. Polyurethane paints contain dangerous isocyanates (see above).

PCBs—Oily liquids, usually clear or yellowish, PCBs are now banned but still found in some older transformers, capacitors, electrical devices and fluorescent lights. They can pass through the skin or vapors can be inhaled, causing skin damage, liver damage, cancer and birth defects.

Refrigerants—Common refrigerants such as ammonia cause eye, throat, lung and liver damage, and exposure can be fatal. Freon can cause skin irritation and fatal liver damage. Exposure usually results from inhaling gasses released from refrigeration systems that are damaged, under repair or being dismantled. Refrigerant leaks are common and sometimes deadly.
Silica—Used in sandblasting, silica inhalation can cause the lung disease silicosis.

**Solvents, degreasers, metal cleaners**—Including toluene and xylene, these are absorbed through the skin. Different substances have different effects; some cause liver damage and cancer, others sterility and birth defects, many can damage the kidneys, liver and nervous system. Acids in aluminum cleaners, including hydrochloric and hydrogen sulfide, can burn the skin. **Hydrogen fluoride**, gas or liquid hydrofluoric acid, is an ingredient in common metal cleaners and can pass through the skin to destroy bone inside the body.

**Styrene**—A component of many kinds of plastics, and a key component of polyester resin used in fiberglass construction, styrene is a nerve toxin and carcinogen. Exposure can come from inhalation of vapors during construction or fumes when plastic/fiberglass materials burn.

**Tetanus**—This serious and sometimes fatal disease results when a particular kind of bacteria enter the body through punctures or cuts in the skin. Workers could contract other potentially fatal blood borne diseases like **Hepatitis** through contact with contaminated blood or sewage in vessel sanitation systems.

**Used engine oil**—It is absorbed through unprotected skin and can cause dermatitis and skin cancer and is linked to liver cancer.

**Wood dust**—With the ability to cause skin, eye and lung irritation, wood dust is on the California list of carcinogens, and prolonged inhalation can cause serious asthma. Wood dust also can explode.

**Wood preservatives**—Creosote, Cuprinol and “Penta” (pentachlorophenol) are readily absorbed through the skin. They cause a skin condition and may cause nerve damage, endocrine disruption, and fatal liver disease.

**Zinc, zinc oxide**—Breathing the dust, or fumes from welding, can cause a flu-like illness called “metal fume fever” and the dust is flammable.

Many of these substances—asbestos is a classic example—can cling to clothing, skin and hair, so a worker can take them home, thereby continuing exposure, and unwittingly can expose family members to the same health hazards as are found in the workplace. Thorough personal cleanup after work, including a shower and change of clothing, is important to protect loved ones.

Parts of this section are adapted from *Hazardous Materials on Board* (Marine Advisory Bulletin No. 43, 1997) by Carl Hild (https://seagrant.uaf.edu/bookstore/pubs/MAB-43.html).
5 Protective Measures

Boatyards can be unhealthy and dangerous places, but as a boat owner, crew member, marine technician, contractor or one of their employees, you have to work there anyway. OSHA’s position is that engineering or work practice controls are the best approach to protecting workers but many smaller facilities do not meet OSHA standards. As a worker you have to take measures to ensure your own safety and health. Here are some suggestions.

Before Starting a Job

**Attitude**—Adopt a “safety is no accident” approach to the job. Make “safety job #1.”

**Assessment**—Before starting to work, study the site to find and identify all safety and health hazards. Think through all the tasks involved, even those that come later in the job. Note potential hazards, discuss them with the other workers, point them out to the facility manager. Identify any confined spaces that worker may need to access (https://www.osha.gov/SLTC/confinedspaces/).

Employ signage that instructs, reminds of safe procedures or warns of hazards. Keep individual signs simple, use pictures or symbols where possible, and don’t use more than necessary. OSHA standardized signs are good.

Ensure vaccinations are up-to-date, particularly tetanus and hepatitis. Also ensure required medications are accessible, including items like inhalers for asthma and foods for overcoming diabetic seizures, if appropriate.

Locate safety equipment. Make sure an adequate number of the correct type and size of fire extinguishers are located in appropriate and easy-to-reach places, and likewise for first aid kits, eye wash kits or stations, and similar items. Locate radios, telephones, and contact numbers for emergency calls.

Read the Materials Safety Data Sheet (MSDS) on each potentially hazardous chemical agent before opening the container.

Equip power tools with HEPA vacuums. Grinders and cutting tools that produce fine dust should have high efficiency vacuum attachments that prevent dust from escaping into the air.

Ensure adequate ventilation. Where volatile chemicals, fumes or dust are released, make sure there is adequate cross ventilation or powered ventilation for fume removal.

During Any Job

**On-going awareness**—Continuously monitor the work and the site to identify new hazards that might arise. Note any new problems, point them out to other workers and to the management.

Wear Personal Protective Equipment (PPE) including hard hats, protective clothing, Tyvek suits, aprons, safety boots, or other items that provide protection from injury hazards identified at the site. Make sure that adequate supplies of these items are available so that if clothing wears through, gloves tear, breathing filters clog, or whatever, replacements are readily available. Do
not forget gloves suited to the job (for protection from hot, abrasive or sharp tools or materials).

Use **eye protection**. Properly fitting safety glasses protect eyes from dust, fragments and splinters. Include goggles or face shields with appropriate filters for protection from radiant energy during welding or cutting. Consult state or federal guidelines on correct shade numbers for various activities, and for safe exposure limits. Welding hoods should protect neck and side of face.

**Wear hearing protection**—The level of noise reaching the ear should be no more than 85 dB (conversational voice is 65 dB). Ear muffs and good quality ear plugs usually suffice.

**Use Proper Lifting Techniques.** Keep back straight, lift with legs, use correct equipment for lifting, and get help moving or lifting awkward or heavy loads.

**Around Gasses, Dust and Other Airborne Substances**

Always wear **dust mask or respirator**. When sanding, grinding or cutting, wear a properly fitted dust mask. When working with paints, solvents, polyester or epoxy resins and other chemicals, wear a respirator with an organic vapor cartridge appropriate to the types of fumes present. Change filters regularly. Facial hair prevents a good seal, and stubble or a “leaky goatee” is no better: if working with toxic aerosols consider going to a tightly trimmed goatee or clean-shaven for the duration of the project.

**Wear respirator when welding.** Welding hoods protect eyes and heads, but not lungs from welding fumes.

Use the **welding fume extractor** if your facility has one. If welding stainless steel, this helps to prevent hexavalent chromium (hex chrome) poisoning.

**Follow OSHA guidelines when sand blasting.** Wet abrasive blasting produces less dust than dry. Enclose blasting in cabinets or rooms, or substitute other stripping methods such as water stripping or dry ice pellets. Always wear full personal protective equipment. Dispose of residuals from blasting correctly.

**Follow confined spaces protocols** when entering holds, lazarettes, refrigerated spaces and other areas where there could be toxic gasses, reduced oxygen, or the possibility of being trapped. Use the buddy system and appropriate respirators.

**Around Hazardous Materials**

Comply with **OSHA requirements** in six steps: Know the regulations, develop a chemical inventory list, label all containers (if they don’t come labeled), obtain MSDS for all hazardous materials, develop a written plan, and provide or participate in training. See Appendix II.
Around Electrical Hazards

Use “lockout/tagout.” To ensure that electrical circuits are deactivated and vessel machinery is prevented from starting, use a procedure in which warnings are placed at control points and systems can’t be started without removing locking mechanisms. See Appendix I.

Clip a ground wire to a vessel on the hard. If it is connected to shore power there is potential that faulty or damaged wiring could result in current that could electrocute a worker who touches the boat or items that are connected to it.

Remove metallic jewelry such as necklaces and bracelets before working around exposed electrical contacts. Rubber gloves can protect hands and fingers and can cover rings. Remove tools and other metal items from belts and pockets prior to entering tight spaces to do electrical work.

Stay out of the water. Do not enter the water in any industrial facility, including marinas and boat harbors because there is a chance that improperly installed or maintained circuitry could allow electrical currents to stray. Avoid puddles and standing water around work sites, and if necessary to enter wet areas, wear high top rubber boots and thick rubber gloves and avoid contacting any metal or wiring with any part of the body. Divers doing underwater construction or maintenance are at particular risk and must take measures to ensure there are no stray currents and that vessel engines are shut off and prop shafts locked.

Heights

Use harness and safety line (tether) when working five feet or more above the next lower deck or ground. Ensure rigging is rated for the purpose and inspected regularly. Provide guardrails where a walkway surface is more than 30 inches above the adjacent deck or ground. Use a secondary belay if working up a mast.

Use stairways with handrails. To work on elevated areas, use a stairway rather than a ladder. A good one can be built in a few hours with inexpensive materials that can prevent serious injuries from falling. If space or time constraints require use of a ladder, secure it firmly to the boat to prevent it from shifting or falling.

During and After Work

A place for everything, and everything in its place. Put away all tools after use. Label storage locations, color code straps, chains and other items that have working capacity limits.

Designate a place for equipment in need of repair. Don’t use power tools with faulty circuitry, frayed power cords, or broken parts. Place in a designated location for repair or disposal.
Replace gloves, respirator filters, and other PPE as needed. Also, clean and spray down with disinfectant any area with biological contamination such as where sewage systems are being repaired, and periodically sanitize respirator masks and other personal items that may be shared among workers. Clean hands before and after using the restroom. Groin area and genitals can be the site of the greatest contaminants.

Practice good housekeeping at the work site. Clean up contaminates, slippery substances on the floor, remove tripping hazards, repair damaged doors, steps, railings, etc. Store oily rags and materials soaked with flammable liquids in covered metal waste cans and dispose of them properly and frequently. Wipe dusty surfaces with a damp rag and dampen dusty areas with a light water spray to contain dust before sweeping. Dump all trash at the end of every shift. Do not weld near trash bins.

**Before Going Home**

Bag, seal and dispose of waste. Keep dust and fibers from getting into the air.

Mark or label substances legibly. Make sure everyone knows what substances are in each can or container. Use stick-on hazardous materials warning labels.

Store flammables in designated lockers including paints and solvents, and return them to metal cabinet “paint lockers” after use. Keep toxic substances together in a designated location rather than scattered around the site.

**Maintain personal hygiene.** Remove and wash dust- or chemical-contaminated clothing at the end of the work day, shower and wash hair, to ensure toxins don’t get inhaled, swallowed or absorbed through the skin, and don’t contaminate family members at home by wearing work clothing in family living and eating areas.

**Change clothes at work site** prior to getting into vehicle for drive home.

**Regarding Personal Protective Equipment**

Nearly all boatyard work warrants use of personal protective equipment (PPE). See Appendix III for definitions and links to PPE specifications and standards. But simply purchasing and wearing PPE items may not be enough. Here are some considerations:

Select the correct items and ensure they have the right specs. A dust mask is useless when working around aerosols. A metal hardhat poses serious risk of electrocution if worn while working on exposed electrical circuitry. Ensure that the PPE you select is designed for the job you are doing. Ascertain that the PPE is strong enough, protects against the materials you will be using, has the correct pore size (filter canisters), sound reduction (hearing protectors), face and eye protection (masks, goggles) for the job. Read the product description and specifications before purchasing or putting the items into use.
Get a proper fit. Try on the items, flex arms and fingers, apply whatever stresses you are likely to encounter. In general, hazardous materials suits or coveralls should be one size larger than that size chart indicates since sleeves and pant legs tend to ride up in use. Repeated bending and stretching can cause materials to weaken or split, allowing hazardous materials to enter. Wearable PPE should be comfortable and non-restricting.

When working with hazardous substances, seal up entry points. Tape suit wrists to gloves, pant legs to boots (or insert into boots), tighten drawstrings, and take all other measures to prevent substances from contacting your skin or being inhaled. When removing these items check skin, hair and under clothing for indication of leaks, and thoroughly clean the area or wash before leaving the work site.

Don't share breathing devices including face masks and respirators, as they easily transmit bacteria, viruses and fungi from the airways of one user to another. If these devices do need to be used by more than one person, be sure to sanitize them after each use. In general, breathing devices should be sanitized regularly anyway since they can harbor germs.

Maintain PPE and discard any that wears out or fails. Some equipment requires maintenance. Respirators need filter cartridges replaced. Suits, boots and gloves get splits and holes that in some cases can be repaired, but usually it’s best to throw them away and replace with new. Do not leave defective equipment where another worker might find and use it.
Appendix I. Lockout/Tagout

Lockout/tagout (LOTO) is a safety procedure that can prevent injury by an electrical, mechanical, hydraulic, chemical, pneumatic or thermal power system or piece of machinery (what OSHA terms “hazardous energy”). The OSHA standard for control of hazardous energy outlines procedures for disabling equipment during repair or maintenance. The classic LOTO application is a lock on an electrical breaker panel that prevents switches from being flipped on until electrical system repair is complete and workers are no longer in physical contact with exposed elements. LOTO for electrical systems is explained at https://www.osha.gov/SLTC/controlhazardousenergy/.

LOTO is actually two different approaches that can be combined. **Lockout** uses a hard key lock to prevent the device or system from operating; the key to the lock is kept in a separate location from the lock itself, usually in possession of a supervisor or other person who can ensure that all workers are out of danger before it is unlocked. **Tagout** employs a specially designed warning tag that alerts a potential operator that the device/system is currently dismantled, undergoing repair, or not safe to use. A protocol determines who can remove the tag and under what conditions.

The standard six steps of LOTO are:
1. preparation
2. shutdown
3. isolation
4. lockout/tagout
5. stored energy check
6. isolation verification

Industrial supply and safety companies sell a range of items for LOTO use, such as cable locks, flange locks, electrical switch lockouts, steering wheel lockouts, specifically designed padlocks, and various kinds of tagout tags for specific uses.

They also sell LOTO kits that contain a selection of lockout devices and tags. If you’re working on your own vessel and not under OSHA regulation you can use your own locking devices and handmade tags. Many boat operators routinely use tags to indicate, for example, that fluids have been drained from engines, or through-hull valves are closed. Everyone working on the project must understand the meaning of the tags and how to use them.

Appendix II. Materials Safety Data Sheets (MSDS) and Other Labels

Federal law requires manufacturers to provide specified kinds of information about hazardous materials they produce. OSHA requires employers to provide the information to workers who use hazardous chemicals, and to local fire departments and emergency responder agencies. The format is a Materials Safety Data Sheet (MSDS) or Safety Data Sheet (SDS), or a label on the package or can containing the hazardous product. Data presentation adheres to standardized formats. All workers who use hazardous materials should know how to read and understand safety data sheets and hazardous chemicals labels. See https://www.osha.gov/Publications/OSHA3514.html. Trainings on these forms of hazard communications are on YouTube.

The MSDS and SDS use a 16-part format that includes information such as name of product, chemical composition, health effects, possible antidotes, reactivity to other substances, and so on. The 16th part, titled “Other” may or may not include additional information. Commonly, manufacturers don’t send safety data sheets with their products so the worker may have to track them down. Usually the sheets are posted on the manufacturer’s website, or can be found via a third-party website that catalogs printable safety data sheets for free download, such as http://www.ilpi.com/msds/index.html and https://www.msdsdigital.com/msds-database. The MSDS requirement doesn’t apply to household products but many of those products comply anyway.

Federal law requires containers of toxic and dangerous chemicals to have hazardous material labels drafted under standards of OSHA3636. The U.S. Department of Transportation requires these labels on materials shipped in commerce. Details of label contents are spelled out, and pictograms are illustrated, in a nine-page OSHA document called Hazard Communication Standard: Labels and Pictograms, found at https://www.osha.gov/Publications/OSHA3636.pdf.

OSHA has adopted new hazardous chemical labeling requirements as part of its recent revision of the Hazard Communication Standard. This includes aligning its 12-part format with the United Nations’ Globally Harmonized System of Classification and Labelling of Chemicals (GHS). These changes will help ensure improved quality and consistency in the classification and labeling of all chemicals, and will also enhance worker comprehension. As a result, workers will have better information available on safe handling and use of hazardous chemicals, thereby allowing them to avoid injuries and illnesses related to exposure to hazardous chemicals.

The revised HCS changes the existing Hazard Communication Standard (HCS/Title 29) from a performance-based standard to one that has more structured requirements for the labeling of chemicals. The revised standard requires that information about chemical hazards be conveyed on labels and in the safety data sheet using quick visual notations to alert the user, providing immediate recognition of the hazards. Labels provide information about what precautions to take; the safety data sheet (SDS) tells the user how to use them.

The label provides information to the worker on the specific hazardous chemical. While labels provide important information for anyone who handles, uses, stores, and transports hazardous chemicals, they are most critical to workers who are exposed. SDSs, in turn, provide Safety Data Sheets (SDSs), which must accompany hazardous chemicals, the more complete resource for details regarding hazardous chemicals. The revised standard also requires the use of a 16-section safety data sheet format, which provides detailed information regarding the chemical, its health hazards, and its physical characteristics.

The revised HCS takes effect June 1, 2015. All hazardous chemicals shipped after June 1, 2015, must be labeled with specified elements including pictograms, signal words and hazard statements, whereas manufacturers, importers, and distributors must begin using the new labeling system in the revised HCS before the June 1, 2015 effective date. Until the June 1, 2015 effective date, manufacturers, importers and distributors may continue to use the requirements of the revised standard. Distributors may continue to ship containers labeled by manufacturers or importers that do not comply with the new labeling requirements.

This document is designed to inform chemical receivers, chemical purchasers, and trainers about the new labeling requirements. It includes the new labeling elements, identifies what goes on a label, and describes what pictograms are and how to use them.

Label Requirements

Labels, as defined in the HCS, are an appropriate group of letters, printed or graphic informational elements concerning a hazardous chemical or a mixture that are affixed to, printed on, or attached to the immediate container of a hazardous chemical or to the outside packaging.

The HCS requires chemical manufacturers, importers, or distributors to ensure that each container of a hazardous chemical that is shipped is marked with a label that has the specified elements and information concerning it. The label must also be affixed to or printed on, or attached to the immediate container of a hazardous chemical or to the outside packaging.
Labels are briefer than the MSDS format and normally are attached to or printed on the box or container, and they contain pictograms and codes. They include the NFPA 704 color-coded label with four quadrants that indicate level of hazard. Red indicates flammable, blue indicates health hazard, and yellow indicates reactivity (with another substance), and the numbers 1 to 4 indicate the level of hazard with 4 the highest. Special codes such as OX indicate an oxidizer that reacts with water, and SA an asphyxiant such as nitrogen or hydrogen.

Chemical containers must have a label or tag that indicates the producer (name, address and phone number), product identifier, signal word, hazard statement, precautionary statement, and pictograms.

**Signal words:** “Danger” is more severe than “warning.”

**Hazard statement:** Describes the nature of the hazard, such as effects on the body.

**Precautionary statement:** Recommended measures to minimize or prevent harm, including response, storage and disposal.

**Pictograms:** there are nine variations of a red square frame with black hazard symbols on white squares.

The DOT requires **hazardous waste to be labeled** prior to disposal, which means removal from the site of its use. DOT compliant labels can be purchased or downloaded and printed. Instructions are at [http://blog.idrenvironmental.com/how-to-properly-label-hazardous-waste-containers](http://blog.idrenvironmental.com/how-to-properly-label-hazardous-waste-containers).
Appendix III. Personal Protective Equipment

Personal protective equipment (PPE) includes a wide range of items, including Tyvek coverall hazmat suits, gloves, boots, pads, guards, hard-hats and helmets, goggles and safety glasses, face shields, hearing protectors, masks, respirators, harnesses with safety lines (tethers), and other devices that workers wear to minimize risk of injury, contamination or disease. OSHA definitions and guidelines are at https://www.osha.gov/SLTC/personalprotectiveequipment/. Employers are required to provide appropriate PPE to their workers, free of charge in most cases.

PPE is categorized either by the kind of injury it is intended to prevent, or by the part(s) of the body it protects. Most types have some sort of quantitative or qualitative rating; hearing protectors reduce sound by a specified dB, for example, respirator filters are designated by the size of particles they exclude, tethers by the weight they support. Ratings should be compared to the intended use; match the PPE to the hazard, based on your hazard assessment (see Chapter 2).

OSHA’s 48-page publication Personal Protective Equipment, which includes descriptive and quantitative standards for some of the most common kinds of PPE is at https://www.osha.gov/Publications/osha3151.pdf.


A Tyvek suit is a popular form of PPE for working around hazardous substances.
Boatyard Hazards
Tips for protecting worker safety and health

Boatyard work is hazardous, with an injury and illness incidence rate more than double that of construction and general industry. This manual identifies the regulatory authorities overseeing boatyard safety and health, summarizes how to do a hazard analysis and draft a set of best practices, identifies types of injury and health risks associated with boatyard work, describes preventive measures for a range of risks, explains the selection and use of personal protective equipment (PPE), clarifies how to read and interpret a material safety data sheet (MSDS), and recommends steps to take to ensure personal health and safety.

About the Author
Terry Johnson is a professor emeritus with the Alaska Sea Grant Marine Advisory Program, University of Alaska Fairbanks. He has been a marine safety instructor, a Coast Guard license prep instructor, and member of the Alaska Boating Safety Advisory Council. For more than 30 years, he has owned, operated, repaired and maintained small commercial fishing and passenger vessels.