USCG

Inspections Guide for Sole State Water Vessels

UNITED STATES COAST GUARD

Small Passenger Vessel Guide for State Inspectors

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Chapter 1

Introduction.

This manual is intended as a supplement to the training provided by the Coast Guard and NTSB at the NTSB Academy on October 4th and 5th, 2006. It is intended to provide the reader with some basic information relating to the regulatory oversight of commercial small passenger vessels operating on sole state waters. The manual takes a systems approach to conducting an inspection of a vessel or boat and may be used as a general reference for marine inspections. Since the course includes members from numerous state regulatory agencies, regulatory cites when used are based on the prevailing federal regulations or good marine practice.

This pamphlet's format was designed to give the reader a basic introduction in the multi faceted aspects of marine inspections. Each chapter is followed up with some good solid references to improve the readers understanding and skills in those areas and includes links to additional information.

Due to the complexity of modern recreational and commercial vessels this manual was kept in the most basic form. Additional references, suggested reading material, and professional training are highly recommended to improve the regulators ability to oversee the safe operation of these enterprises.

Questions or comments concerning the content of this manual should be directed to author Lieutenant Tony Guild at the Eleventh Coast Guard District 510-437-2955 or via e-mail at Anthony.D.Guild@uscg.mil.

Acknowledgements

As you read this pamphlet you will notice that much of what I have done is merely copy portions of different Navigation and Inspection Circulars (NVIC) and place them in each chapter. Much of the other content was authored by me as was the general format. Serena Dietrich, the D11 Passenger Vessel Safety Specialist authored chapters 10 and 11, and chapter 13 was provided by the Coast Guard's Marine Inspections School Chief LCDR Kevin Carroll. Copying those portions of various NVIC's was done purposefully as much of that information was well written and does a good job of explaining much of what marine inspectors do as well as how to do it. This means the credit for this document can be spread out over many years and rests on the shoulders of those individuals who helped write and publish those Navigation and Inspection Circulars. Thanks!

The art of marine inspections is very complex. There is need to understand every aspect of vessel operations, from simple navigation, to calculating an electrical load in a vessel's electrical system. Since no two vessels are the same this means you have to have a good grasp of the maritime industry in order to perform this job. I hope the information provided here will help you as you aspire to become an inspector no matter what part of the state or federal government you represent.

I could not capture all of the information needed to teach marine inspection in a small pamphlet like this. The art requires constant learning and a true desire to improve public safety through prevention techniques. Additionally, it requires a commitment from the agency in charge to provide the training and resources necessary to accomplish this important task.

Lastly, special thanks to Paul Newman and Serena Dietrich for there help editing this manual. Thanks to LCDR Jim Nussbaumer (G-PCV) for recommending me for this task and my bosses CDR Han Kim and Capt Gerald Swanson for graciously allowing me to let my other responsibilities slide while I focused my attention on this document and the NTSB training this was created for.

Chapter

2

Definitions

Many of the definitions used in this manual are based on federal regulations and are provided for informational purposes only. If any definitions conflict with those laws from the respective state in question the state definitions should be used.

Approval series – means the first six digits of a number assigned by the Coast Guard to approved equipment. Where approval is based on a subpart of subchapter Q of this chapter, the approval series corresponds to the number of the subpart. A listing of approved equipment, including all of the approval series, is available online at http://cgmix.uscg.mil/Equipment/

Beam – means the maximum width of a vessel from: (1) Outside of planking to outside of planking on wooden vessels; and (2) Outside of frame to outside of frame on all other vessels.

Bulkhead deck – means the uppermost deck to which watertight bulkheads and the watertight shell extend.

Buoyant Apparatus - The term "buoyant apparatus" refers to those devices approved as buoyant apparatus with Coast Guard approval numbers beginning 11160.0l0/....N The term does not include inflatable liferafts or ring life buoys

Cable – means a single or multiple insulated conductors with an outer protective jacket.

Certificate of Documentation – means form CG-1270

Coast Guard District Commander – means an officer of the Coast Guard designated by the Commandant to command Coast Guard activities within a District.

Cockpit Vessel – means a vessel with an exposed recess in the weather deck extending not more than one-half of the length of the vessel measured over the weather deck.

Coastwise Trade – includes the transportation of passengers or merchandise between points embraced within the coastwise laws of the United States.

Cold Water – means a water temperature where the monthly mean low temperature is normally 59 degrees Fahrenheit or less.

Commandant - means the Commandant of the Coast Guard or an authorized Headquarters staff officer designated.

Consideration - means an economic benefit, inducement, right, or profit including pecuniary payment accruing to an individual, person, or entity, but not including a voluntary sharing of the actual expenses of the voyage, by monetary contribution or donation of fuel, food, beverage, or other supplies.

Corrosion resistant material - means made of one of the following materials in a grade suitable for its intended use in a marine environment:
(1) Silver;
(2) Copper;
(3) Brass;
(4) Bronze;
(5) Aluminum alloys with a copper content of no more than 0.4 percent;
(6) Cooper-nickel;
(7) Plastics;
(8) Stainless steel;
(9) Nickel-copper; or
(10) A material, which when tested in accordance with ASTM B 117 (incorporated by reference, see § 175.600) for 200 hours, does not show pitting, cracking, or other deterioration.

Custom Engineered - means, when referring to a fixed gas fire extinguishing system, a system that is designed for a specific space requiring individual calculations for the extinguishing agent volume, flow rate, piping, and similar factors for the space.

Dead cover -means a metal cover to close or protect a port light to avoid glass breakage in case of heavy weather.

Distribution Panel - means an electrical panel that receives energy from the switchboard and distributes the energy to energy consuming devices or other panels.

Draft means the vertical distance from the molded baseline of a vessel amidships to the waterline.

Dripproof - means enclosed equipment so constructed or protected that falling drops of liquid or solid particles striking the enclosure at any angle from 0 to 15 degrees downward from the vertical do not interfere with the operation of the equipment. A National Electrical Manufacturers Association type 1 enclosure with a dripshield is considered to be dripproof.

Drydock Examination means hauling out a vessel or placing a vessel in a drydock or slipway for an examination of all accessible parts of the vessel's underwater body and all through-hull fittings and appurtenances.

Documented Vessel – means a vessel which is the subject of a valid Certificate of Documentation

Ferry - means a vessel that:
(1) Operates in other than ocean or coastwise service;
(2) Has provisions only for deck passengers or vehicles, or both;
(3) Operates on a short run on a frequent schedule between two points over the most direct water route; and
(4) Offers a public service of a type normally attributed to a bridge or tunnel.

Fiberglass reinforced plastic (FRP) - A general term covering any type of plastic reinforced cloth, mat, strands or any other form of fibrous glass.

Finite element analysis (FEA) - A method of analysis used in situations that are difficult to model by standard engineering techniques. The finite element method operates on the assumption that any continuous function over a global domain can be approximated by a series of functions operating over a finite number of small sub-domains. The series of functions are piecewise, continuous and will approach the exact solution as the number of sub-domains approaches infinity.

Inland Waters - means the navigable waters of the United States shoreward of the navigational demarcation lines dividing the high seas from harbors, rivers, and other inland waters of the United States and the waters of the Great Lakes on the United States side of the International Boundary.

Inland Rules or Rules - mean the Inland Navigational Rules and the annexes thereto, which govern the conduct of vessels and specify the lights, shapes, and sound signals that apply on inland waters.

Passenger – means an individual carried on a vessel except; (1) The owner or an individual representative of the owner, or in the case of a vessel under charter, an individual charterer or individual representative of the charterer. (2) The master; or (3) A member of the crew engaged in the business of the vessel who has not contributed for carriage and is paid for onboard services.

Passenger accommodation – means an accommodation space designated for the use of passengers.

Passenger for hire – means a passenger for whom consideration is contributed as a condition of carriage on the vessel, whether directly or indirectly flowing to the owner, charterer, operator, agent, or any other person having an interest in the vessel. (See PVSA for additional details on this definition)

Port light - means a hinged glass window, generally circular, in a vessel's side or deckhouse for light and ventilation.

Pre-engineered - means, when referring to a fixed gas fire extinguishing system, a system that is designed and tested to be suitable for installation without modification as a complete unit in a space of a set volume, regardless of the specific design of the vessel on which it is installed.

Registration – means a certificate of number issued pursuant to rules in 33 CFR Part 173, a record under maritime laws of a foreign country, or a certificate issued by a political subdivision of a foreign country.

Sailing Vessel – means a vessel principally equipped for propulsion by sail even if the vessel has an auxiliary means of propulsion.

Scantlings – means the dimensions of all structural parts such as frames, girders, and plating, used in building a vessel.

Scupper - means a pipe or tube of at least 30 millimeters (1.25 inches) in diameter leading down from a deck or sole and through the hull to drain water overboard.

Small Passenger Vessel - A U.S. vessel that carries 150 or less passengers, or has overnight accommodations for 49 or less passengers, and that—
(1) Carries more than six passengers, including at least one for hire;
(2) Is chartered with a crew provided or specified by the owner or the owner's representative and is carrying more than six passengers;
(3) Is chartered with no crew provided or specified by the owner or the owner's representative and is carrying more than 12 passengers; or
(4) If a submersible vessel, carries at least one passenger for hire.

State – means a state of the United States or a political subdivision thereof, Guam, Puerto Rico, the Virgin Islands. American Samoa, the District of Columbia, the Northern Marinana Islands, and any other territory or possession of the United States.

T-Boat - See small passenger vessel.

Vessel – includes every description of watercraft or other contrivance capable of being used as a means of transportation on water, but does not include aircraft.

Chapter

3

Documentation & Registration

Since most vessels a state inspector will come in contact with are state registered, this section will only cover a basic introduction to the documentation of vessels.

Some larger recreational vessels may be documented. The certificate of documentation MUST be on board a documented vessel at all times. A document serves as a certificate of nationality and an authorization for a specific trade. A documented vessel is not exempt from applicable state or federal taxes, nor is its operator exempt from compliance with federal or state equipment carriage requirements. A documented vessel may also be required to pay a registration fee and display a validation sticker in some states.

Any vessel of at least 5 net tons which engages in fisheries on the navigable waters of the United States or in the Exclusive Economic Zone, Great Lakes trade, or Coastwise trade, unless exempt under 46 CFR 67.7(c) must have a valid Certificate of Documentation bearing a valid endorsement appropriate for the activity in which engaged.

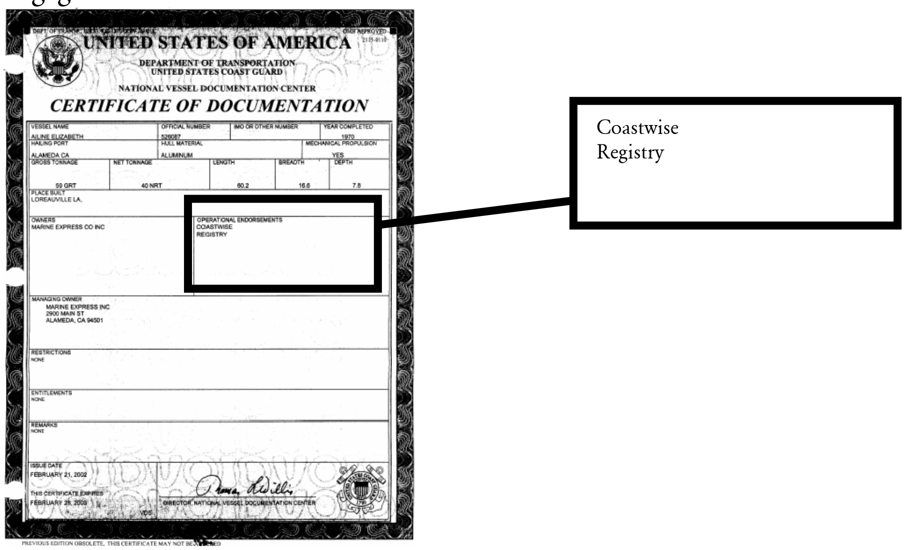


Figure 1

Figure 1 shows a Certificate of Documentation with two endorsement; "Coastwise" & "Registry" This authorizes the vessel to operate in International and Coastwise trade.

Figure 2

Figure 2 shows the expiration date of the CODs. In this case the COD expired on February 28, 2003. CODs are valid for twelve months.

It's important to note that changes to the vessel's name, length, ownership or any basic information contained on the COD invalidate the document. Since the COD is required at all times when operating the vessel, operating the vessel with an expired or invalid document is a violation of federal law.

The fines for violations of documentation laws can be significant and in some cases can be as much as $10, 000.00 per day.

For additional information regarding documentation laws or the documentation of vessels go to the following links on the World Wide Web

References:

http://www.uscg.mil/hq/g-m/vdoc/nvdc.htm
http://cgls.uscg.mil/groups.php?ID=6
http://www.uscgboating.org/recalls/mic_database.htm

Chapter

4

Safe Navigation

The safe operation of any vessel is ultimately is the responsibility of the master or operator. When using the term safe navigation in this context it means a multitude of things. The operator or master needs to be aware of where his or her vessel is at all times and also needs to simultaneously consider many things; displaying the correct navigation lights, maintaining the correct sound signaling devices, the weather, tidal and river currents, water depth, communications with shore, as well as maintaining the accurate position of the vessel. Navigational awareness means the vessel's master or operator has an understanding of all of these things on top of ensuring the passengers are enjoying their ride. Much of this is regulated by the navigation rules.

Vessels operating seaward of the demarcation line are required to adhere to the 1972 COLREGS however, a vessel operating on inland navigable waters must adhere to the Inland Rules.

SOLE STATE WATERS

Since the 1972 COLREGS and Inland Rules apply to very specific bodies of water vessels operating on sole state waters maybe required to meet different standards. Many states have incorporated the Inland Rules by reference and therefore you must be familiar with your state statutes before enforcing the Inland Rules on any vessel.

1972 COLREGS

The International Rules were formalized in the Convention on the International Regulations for Preventing Collisions at Sea, 1972, and became effective on July 15, 1977. The Rules (commonly called 72 COLREGS) are part of the Convention, and vessels flying the flags of states ratifying the treaty are bound to the Rules. The United states has ratified this treaty and all United States flag vessels must adhere to these Rules where applicable. President Gerald R. Ford proclaimed 72 COLREGS and the Congress adopted them as the International Navigational Rules Act of 1977. The 72 COLREGS were developed by the Inter-Governmental Maritime Consultative Organization (IMCO) which in May 1982 was renamed the International Maritime

Organization (IMO). In November 1981, IMO's Assembly adopted 55 amendments to the 72 COLREGS which became effective on June 1, 1983. The IMO also adopted 9 more amendments which became effective on November 19, 1989. The International Rules in this book contain these amendments. These Rules are applicable on waters outside of established navigational lines of demarcation. The lines are called COLREGS Demarcation Lines and delineate those waters upon which mariners shall comply with the Inland and International Rules.

Inland Rules

The Inland Rules in the 1972 COLREGS book replaced the old Inland Rules, Western Rivers Rules, Great Lakes Rules, their respective pilot rules and interpretive rules, and parts of the Motorboat Act of 1940. Many of the old navigation rules were originally enacted in the last century. Occasionally, provisions were added to cope with the increasing complexities of water transportation. Eventually, the navigation rules for United States inland waterways became such a confusing patchwork of requirements that in the 1960's several attempts were made to revise and simplify them. These attempts were not successful. Following the signing of the Convention on the International Regulations for Preventing Collisions at Sea, 1972, a new effort was made to unify and update the various inland navigation rules. This effort culminated in the enactment of the Inland Navigational Rules Act of 1980. This legislation sets out Rules 1 through 38 — the main body of the Rules. The five Annexes were published as regulations. It is important to note that with the exception of Annex V to the Inland Rules, the International and Inland Rules and Annexes are very similar in both content and format. The effective date for the Inland Navigation Rules was December 24, 1981, except for the Great Lakes where the effective date was March 1, 1983.

Charts and Pubs

Along with abiding by the Inland Rules operators must have some kind of chart or map that shows their operating area. Normally this would include depths and the operating channel but in sole state waters maps and charts may not be available. In these cases the operator should have some acceptable means to navigate by. For those vessels operating below dams the vessel should also have some knowledge on the river's current based on the flow rate through the damn. Because of Bernoulli's Principle the determination of an exact current is very difficult as rivers are not consistent with regard to the depth and width of the river below the dam.

Communications

Under Construction

References:

Rules of the road
FCC
http://www.safeboating.org.au/Boating/Go_boating_safely/Navigation_lights.asp
http://www.safeboating.org.au/Boating/Go_boating_safely/PDF/Sea%20Safety%2011%20-%20In-shore%20navigation%20in%20sheltered%20waters..pdf
http://www.safeboating.org.au/Boating/Go_boating_safely/Sound_signals.asp
http://www.safeboating.org.au/Boating/Go_boating_safely/Small_craft_handling_and_rules_of_the_road.asp
NVIC 9-83_Charts and Publications

Chapter

5

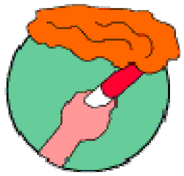
Life Saving Systems

Lifesaving equipment is carried on board vessel to mitigate a casualty should one occur. The equipment is designed to keep a person floating and in some cases dry when a person enters the water after, or as a part of, a casualty. The point that something has gone terribly wrong is not the time to see if the lifesaving equipment is working; however, history has repeatedly shown that this is sometimes the case. As an inspector it's extremely important to inspect and evaluate the vessel's lifesaving devices periodically! For Coast Guard certificated vessels these occurs annually and while you would think that owners are all keeping up with the maintenance and care of their lifesaving equipment, the truth is not all of them are.

There are several concerns when people are in the water, from preventing the obvious, drowning, to the more subtle effects of hypothermia. The idea is that each person on board a vessel has a personal floatation device or PFD that is capable of keeping an unconscious person's head upright and out of the water. This may not prevent hypothermia but it will to a major extent prevent drowning. Ideally, a person would never need a PFD. In a perfect world the vessel itself would become the lifeboat if it was disabled or began sinking. This is why we require subdivision bulkheads on many small passenger vessels; however, as we all know we don't live in a perfect world and vessels unfortunately do sink. Additionally, Coast Guard regulations only require the installation of subdivision bulkheads when the passenger count exceeds 49 or if the vessel is greater than 65 feet. This leaves a large portion of the small passenger vessel community at risk and why the installation of bilge alarms is now mandatory on all certificated small passenger vessels.

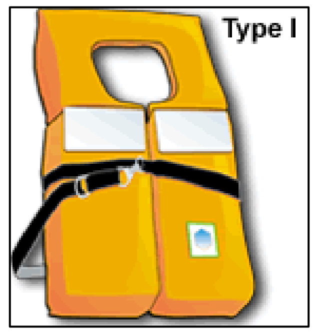
Additional measures can be taken to ensure the safety of passengers and crew is addressed. They include the use of work vests, buoyant apparatus, lifefloats, liferafts, inflatable buoyant apparatus (IBA's) and 406 Emergency Position Indicating Radio Beacons. Your job as an inspector to ensure the minimum standard is being met and that the required equipment is fit for service.

Pyrotechnics



Pyrotechnic Visual Distress Signals must be Coast Guard approved, in working condition, and readily accessible. They are marked with a date showing the service life, which must not have expired. The Coast Guard requires pyrotechnic distress signals on all small passenger vessels, except those on short runs of less than 30 minutes. Because the risks are greater when carrying passengers the distress signals are required to meet stricter standards than those required on recreational vessels. Hand held red distress signals are required to meet approval series 160.021 and the orange day flares are required to meet approval series 160.037. Distress flares should be stowed in a portable watertight container and marked in ½ inch letters "DISTRESS SIGNALS"

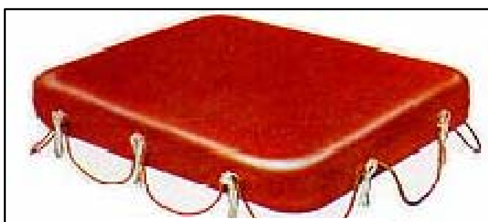
Personal Floatation Device (PFD)



If you conduct a Google search on the internet you'll see there are many different types of life jackets and about 39 million references to life jackets. The names for them include Lifejacket, Mae West, Buoyancy Compensator, Work Vest to name a few. For the Coast Guard we use the term Life Preserver or Personal Floatation Device. All PFD's are required to be approved by the Coast Guard and there are specific federal regulations that refer to each type PFD and the standards are extremely specific.

For example: Type I PFDs as shown in the picture above are approved under series 160.002, 160.005 & 160.055 and are the only PFD allowed for use on certificated small passengers vessels. While the PFDs meet many strict standards one worth mentioning is the fact that they are designed to support the wearer in the water upright or in a slightly backward position and provide support to the head so that the face of an unconscious or exhausted person is held above the water. Additionally, life preservers must be of such construction and workmanship that it can perform its intended function in all weather and at all temperatures which may be expected in the normal usage of the life preserver (46 CFR 160.001)

Liferafts, Lifefloats & Buoyant Apparatus



Buoyant Apparatus

The term "primary lifesaving equipment" is used to describe a lifeboat or an acceptable substitute. For small passenger vessels this means a life raft, lifefloat, rescue boat or a buoyant apparatus under certain conditions. Life preservers and ring buoys are not included in the definitions of "primary lifesaving equipment".

We can divide primary lifesaving equipment into two different types: wet and dry. Simply put, they are devices that when used keep their passengers wet or dry. These include Lifefloats, buoyant apparatus and items that provide a measurable amount of buoyancy; however the major drawback of these systems is they that do not keep the user dry. Consequently the risks for hypothermia can be extreme depending on the prevailing water temperature. On the other hand, inflatable buoyant apparatus and life rafts are designed to keep the user relatively dry and thus reduce the risks of weather exposure, these systems are always preferable to their wet counterpart.

Primary lifesaving devices like PFDs are designed to add to the overall safety of a vessel by providing a means to prolong an individual's survivability while awaiting rescue. This means in order for these systems to work they must be maintained in good working order and should be installed correctly so they can perform as intended in the event of a casualty.

How to Inspect PFDs and Primary Lifesaving Devices

First thing an inspector should do is determine how many passengers the vessel is authorized to carry. Then determine what standards the vessel must maintain. At a minimum the vessel will need at least one PFD for each individual carried. On commercial vessels the Coast Guard also requires that an additional 10% capacity of lifejackets be carried for children but also stipulates one child sized PFD for each person weighing less than 90 lbs. For average adults a child PFD is not adequate; however, there are some individuals who while are clearly adult in age require a child PFD because of size and weight.

PFDs

Since PFDs are made to very specific standards we can use that standard when inspecting them. For example the body straps on a Type I PFD are capable of withstanding a breaking strength of 360 lbs when manufactured. That doesn't mean you should put that much force on an older PFD but it does give you some idea how the body strap is designed. Likewise the drawstrings are capable of carrying a force of 200 lbs. Therefore a quick pull on each strap to ensure the drawstrings and body straps are OK is perfectly acceptable. If the PFD is one with kapok inside you should conduct a squeeze test to ensure the kapok is air tight and that the envelope covering and all stitching remains acceptable. Whistles and lights, if provided should be operational and all retroreflective tape should function as intended. So what is acceptable? Basically, a PFD's workmanship shall be of first-class workmanship and shall be free of defects materially affecting their appearance or serviceability. If in doubt, have it repaired or replaced.

Stowage

A nice new PFD will not help save anybody's life if it is tightly wrapped in its factory cellophane wrapper and stowed in a place that is not ready available or apparent to the operator or passenger. PFDs must be stowed in convenient places distributed throughout the accommodation spaces. The storage containers should never be locked and they must be capable of floating free in an emergency and should be labeled to identify their location and number. A donning placard should be placed in an area available to the passengers which displays the proper procedures for putting on a PFD.

PFD Repairs

Often an inspector will discover a problem with a PFD that requires it to be repaired. When this happens the inspector is faced with determining if the repair in question can be made without affecting the design capabilities of the life preserver. 46 CFR 160.006-2 states the specific requirements and restrictions for repairing PFDs. Essentially no repairs may be made except in an emergency to an approved life preserver without advance notice to the Officer in Charge, Marine Inspections (OCMI). When emergency repairs are made those repairs should be reported as soon as possible to the OCMI. 46 CFR 160.006-2 goes on to state that tapes or straps may not be repaired but may be renewed, and that small rips or tears in the envelope fabric may be repaired at the discretion of the local OCMI. While this does not apply to vessels operating on sole state waters it gives you some idea how serious the Coast Guard considers PFDs and their repair.

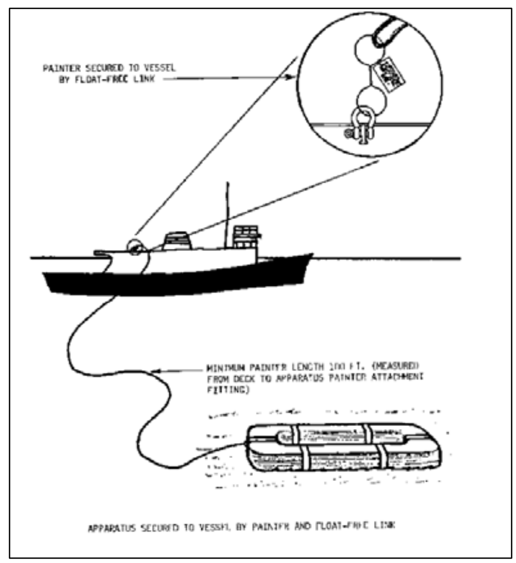


Figure 3

Primary lifesaving Devices

Since most sole state water vessels will not have liferafts this section will be limited to lifefloats and buoyant apparatus. When inspecting lifefloats and buoyant apparatus one should start with the passenger and crew capacity of the vessel, then checked against the requirements for the vessel. When there is a lack of regulation or standards to enforce then you should use common sense. If a vessel owner has installed equipment that is not otherwise required but may be relied upon in an emergency then the equipment must be maintained and installed correctly.

Lifefloats and buoyant apparatus must be secured to the vessel by a painter at least 100 ft. long in one continuous length. The painter must be attached to the vessel by a float-free link at the vessel end of the painter as shown in figure 3.

The painter should have a breaking strength of at least 1500 lb., except for apparatus of 50 persons or more capacity, which must have 3000 lb. breaking strength. The painter may be of manila or synthetic fiber rope but if synthetic fiber rope is used, it must be certified to be UV resistant.

NOMINAL WIRE SIZES FOR FLOAT FREE LINKS *			
	100-134 LB. (APPARATUS FOR 10 PERSONS OR LESS)	**200-268 LB.** (APPARATUS FOR 11 TO 20 PERSONS)	**400-436 LB.** (APPARATUS FOR 21 PERSONS OR MORE)
Stainless Steel or Galvanized Cable			
1 x 7 **	.024" DIA (100LB.) .027" DIA (125 LB.)	.036" DIA (210LB.) .039" DIA (250 LB.)	1/16 " DIA (500 LB.)
1 X19	.025" DIA (120 LB.)	.040" DIA (225 LB.)	1/16 " DIA (500 LB.)
3 X 7	1/32 " DIA (110 LB.)	.042 " DIA (200 LB.) 3/64 " DIA (235 LB.)	
7 X 3	1/32 " DIA (110 LB.)		
7 x 7	.027" DIA (100 LB.) 1/32 " DIA (110 LB.)	.045 " DIA (200 LB.)	1/16 " DIA (480 LB.)
Monel Cable			
6 x 42			1/8 " DIA (440 LB.)
7 x 7	3/64 " DIA (135 LB.)	1/16 " DIA (215 LB.)	3/32 " DIA (480 LB.)
7 x 19			3/32 " DIA (480 LB.)
Bronze Cable			
7 x #24 gage		.060 " DIA (230 LB.)	

* CABLE AND WIRE STRENGTHS VARY DEPENDING UPON THE MANUFACTURE AND METHOD OF CONSTRUCTION. CONSULT MANUFACTURER'S DATA FOR MORE EXACT ONFO.
** CONSTRUCTION OF CABLE (NUMBER OF STRANDS X NUMBER OF WIRES PER STRAND OR GAUGE SIZE OF SINGLE WIRE STRAND.)

Table I

The float-free link is described in 46 CFR 160.073 is not a Coast Guard approved item. It is certified by the maker to meet the requirements of Subpart 160.073, and this certification is on the identification tag. The devices are available from most apparatus manufacturers, but they can be made by anyone with the proper corrosion resistant wire and means to permanently secure the loops in the wire. Table I lists the different materials and nominal size wires for their respective breaking strengths.

When stowing lifefloats and buoyant apparatus two or more apparatus may be grouped on a single painter and float-free link, provided that the weight of the group does not exceed 400 lb. In this case, the strength of the painter and float-free link are determined by the combined capacity of the apparatus in the group. At the apparatus end of the painter, there must be individual lines leading to each apparatus which are long enough to allow each one to float without stacking up on another. Two possible arrangements are pictured in figure 4.

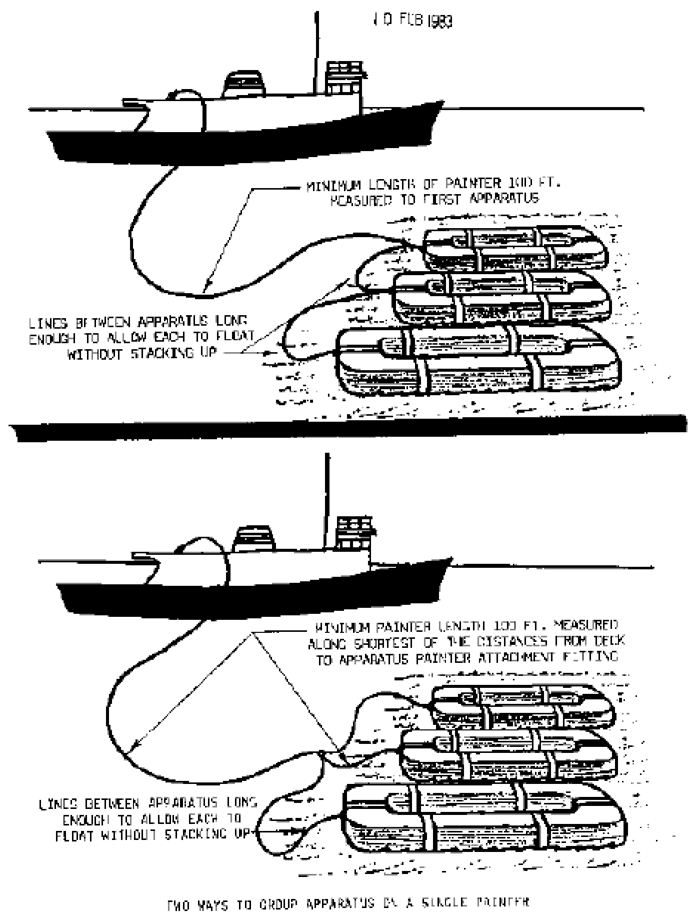


Figure 4

If the apparatus does not have a painter attachment fitting on it, one can be made by securing a line around the body of the apparatus. The line should be the same as the painter, but other materials such as corrosion resistant wire or hardware can be used if they are of at least the strength of the painter. The painter must not be attached to the lifelines or pendants on the apparatus. The webbing used to hold the lifelines and pendants on some apparatus can be used on any apparatus of 10 persons capacity or less. If the webbing is 3 inches wide, it can be used on apparatus up to 20 persons capacity.

The float-free link is not required if the vessel operates only in waters that are not as deep as the length of the painter. For example, a vessel that operates in waters up to 120 ft. deep could either fit 120 ft. of painter with no link, or 100 ft. of painter with a link. A vessel that operates in waters up to 50 ft. deep would have to have a 100 ft. painter, but the link could be omitted.

Care must be taken in attaching the float-free link to the vessel. This needs a strong connection so that if any break in the painter system occurs, it occurs at the float-free link. If rope or wire is used, it must be the same or stronger than the rope used for the painter and also be dark or UV resistant, or must be corrosion resistant wire.

The painter must be stowed in a way that allows it to run out freely. This can be done in a number of ways. If the apparatus is stowed flat, the painter can be faked or coiled loosely underneath. Other acceptable arrangements include coiling the painter in a basket or hanging it on a peg. The peg should not have a hook on the end that could snag the painter as it pays out. The painter can be gathered into a hank and secured by one or two turns of light twine or the hank can be inserted into a section of pipe or tube.

Apparatus are required by the regulations to be stowed in such a way that they float-free or else be secured so they can be readily cast loose. The best arrangement is one that allows the apparatus to float free so it's available immediately in case of an accident that occurs so quickly that there is no time to cast it loose. This can be accomplished by securing the apparatus with a Coast Guard approved hydrostatic release. These releases must be renewed every two years or tested annually at an approved servicing facility. A less expensive alternative is to construct a rack that holds the apparatus in place, but that allows it to float off. Stowing the apparatus in a way that requires it to be manually released is not recommended unless there is no other reasonable alternative. If more than one apparatus is carried, they must not be lashed to each other since this limits carrying capacity in the water.

The information contained in this manual is very basic and extremely limited. You can find additional information in the following references:

References:
46 CFR Part 180
33 CFR Part 175
http://www.uscgboating.org/alerts/pdf/TypeIPFDAlert.pdf
http://www.uscgboating.org/index.aspx
http://www.safeboating.org.au/Boating/Go_boating_safely/Emergency_Equipment.asp
NVIC 1-83
NVIC 14-92 Suitability of Extended size and certain adult PFDs for some children
NVIC 1-94 Marking of Life Preservers and PFD's

Chapter

6

Fire Fighting Systems

The risk of fires is always present onboard boats. As such it's vital that all vessels be equipped with adequate firefighting capabilities. Small passenger vessels often have many different accommodations spaces, some contain cooking equipment while others may store alcohol or other ships stores, and therefore it is crucial that inspectors carefully examine the vessel to ensure it presents no risk to the passengers or crew. Additionally, all passive and active firefighting systems should be closely examined to ensure they remain suitable for service.

Risks can come in many forms. They may be loose electrical connections, fuel leaks, oil in the bilge, or the crew not being familiar with the vessel's equipment, or having an understanding how to properly use that equipment.

As with many things, the best defense is a good offense and in this case it starts with prevention. Fire prevention starts with good house keeping, maintaining the vessel's machinery plant and reducing risks in those areas of the vessel more susceptible to fire than others. It includes understanding basic firefighting and systematic procedures for combating a fire regardless of size.

There are two general approaches to firefighting on vessels, passive and active. The act of passive firefighting really means to resist or slow the spread of fire while establishing escape routes and maintaining their integrity. Active firefighting is to physically attack a fire with a extinguishing medium such as a portable fire extinguisher, fire party, or a fixed fire extinguishing system.

Structural Fire Protection.

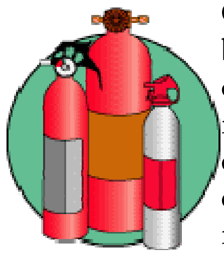
The goal of structural fire protection is passive in nature. It is designed to resist or slow the spread of fire while establishing escape routes and maintaining their integrity. This goal is achieved through the following basic principles.

- Use of materials which are resistant to ignition/flame spread
- Use of materials which minimize the products of combustion
- Arrangement of structures so as to resist fire spread
- Arrangement of structures so as to separate people from fire and the products of combustion.

To increase reliability, structural fire protection (SFP) is designed to be passive in nature and thus eliminate the need for personnel action to make it effective. This eliminates the possibility of human error affecting the performance of the SFP system. The result is that SFP is assumed to be extremely reliable.

Most small passenger vessels < 100GT and carrying < 149 passenger are not required to meet any structural fire protection requirements and are generally intended for the larger capacity vessels.

Portable Fire Extinguishers



Coast Guard approved fire extinguishers are required on boats where a fire hazard could be expected from the motors or the fuel system. Extinguishers are classified by a letter and number symbol. The letter indicates the type fire the unit is designed to extinguish (Type B for example are designed to extinguish flammable liquids such as gasoline, oil and grease fires). The number indicates the relative size of the extinguisher. The higher the number, the larger the extinguisher.

Coast Guard approved extinguishers required for boats are hand portable, either B-I or B-II classification and have a specific marine type mounting bracket. It is recommended the extinguishers be mounted in a readily accessible position, away from the areas where a fire could likely start such as the galley or the engine compartment.

Extinguisher markings can be confusing because extinguishers can be approved for several different types of hazards. For instance, an extinguisher marked "Type A, Size II, Type B:C, Size I" is a B-I extinguisher.

Classes	Foam (Gals)	C02(lbs)	Dry Chemical (lbs)	Halon (lbs)
B-I(Type B, Size I)	1.25	4	2	2.5
B-I(Type B, Size II)	2.5	15	10	10

Required Number of Fire Extinguishers

As a comparison, table II shows the USCG requirement for the number of fire extinguishers required on a recreational boat. The basis for this number is the overall length of the vessel; however, small passenger vessels use a different criterion. The following chart lists the number of extinguishers that are required on a recreational vessel.

Minimum number of hand portable fire extinguishers required		
Vessel Length	**No Fixed System**	**With approved Fixed Systems**
Less than 26'	1 B-1	0
26' to less than 40'	2 B-1 or 1 B-II	1 B-I
40' to 65'	3 B-I or 1 B-II and 1 B-1	2 B-1 or 1 B-II

Table II

For certificated small passenger vessels the number of required hand portable fire extinguishers are listed on table III below and also in 46 CFR Table 181.500 (a) and may be reduced slightly when a Coast Guard approved fixed fire extinguishing system is installed for the protection of the engine compartment. Note the differences between the recreation and commercial standards:

Table 181.500(a)				
Space Protected	Minimum No. Req.	Type Extinguisher permitted		
		CG Class	Medium	Min size
Operating Station	1	B1,C1	Halon CO2 Dry Chemical	2.5 lb 4 lb 2 lb
Machinery Space	1	B-II,C-II located just outside space	CO2 Dry Chemical	15 lb 10 lb
Open Vehicle Space	1 for every 10 vehicles	B-II	Foam Halon CO2 Dry Chemical	2.5 Gal 10 lb 15 lb 10 lb
Accommodation Space	1 for each 2,500 sq ft or fraction thereof	A-II	Foam Dry Chemical	2.5 Gal 10 lb
Galley, Pantry, Concession Stand	1	A-II, B-II	Foam Dry Chemical	2.5 Gal 10 lb

Table III

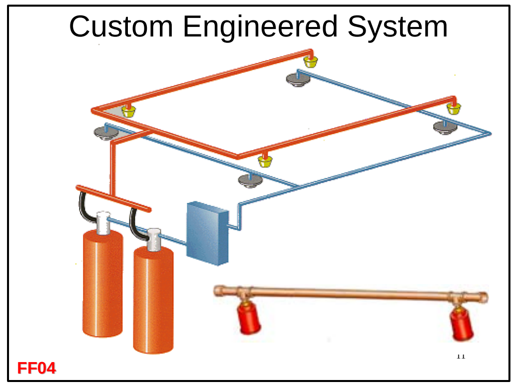
Note: The pressure gauge alone is not an accurate indicator that Halon extinguishers are full. The weight of the units should be checked regularly. It is recommended that portable extinguishers be mounted in a readily accessible position.

Fixed Fire Extinguishing Systems

Fixed fire extinguishing systems are a combination of passive and active fire fighting systems. They are passive when the system is designed to automatically activate after sensing a fire or a rapid heat rise. They maybe totally active systems if they must be manually activated. Typically there are two different types of fixed fire extinguishing systems.

Custom Engineered Systems

These are type approved systems originally intended for manned spaces on large vessels, but include scaled-down systems suitable for installation in unmanned small passenger vessel spaces such as engine compartments. They include carbon dioxide systems (approval category 162.038), new clean fire extinguishing agents such as FM200 (approval category 162.161), and halon (approval category 162.035) although there are no new halon systems being manufactured because halon is a ozone depleting substance and has been outlawed by the Montréal protocol.



Pre-Engineered Systems

These systems are type approved after initial testing by an independent testing lab (Underwriters Laboratories) and are described in the manufacturer's approved design, installation, operation and maintenance manual. They are called "engineered" or "pre engineered" because they are specifically designed for use in almost any space based on the volume of the space protected. They are “turn-key” systems that you can purchase off the shelve and come ready out of the box.

Carbon Dioxide

Carbon dioxide as an extinguishing agent has many desirable properties. It will not damage machinery and leaves no residue to be cleaned up after a fire. Even if the boat is without power a charged CO2 system can be released. Since it is a gas, CO2 will penetrate and spread to all parts of the space. It does not conduct electricity and therefore can be used on live electrical equipment and can be effectively used on most combustible materials.

There are two disadvantages to carbon dioxide. It has little cooling effect on materials that have been heated by the fire, and the quantity available in a system is limited.

Carbon dioxide extinguishes fires by reducing the oxygen concentration to a point where the atmosphere will no longer support combustion. The CO2 concentration must be maintained for a sufficient period to allow the maximum temperature to be reduced below the autoignition temperature of the burning material. Carbon dioxide is most effective against flammable liquid fires. In enclosed spaces, burning class A combustible (wood, paper, etc.) fires may not be completely extinguished but may be controlled. For most flammable liquids, reduction of the oxygen concentration to 15% (from the normal 21%) will be sufficient to extinguish the fire. For class A combustibles, a reduction to 15% will control the fire.

FM 200®

Effective on Class A, B, and C fires, FM-200® extinguishes fires quickly through a combination of chemical interaction and physical heat removal. It does not smother flames by removing oxygen. FM-200® removes heat energy from fire, not oxygen from the environment. FM-200® absorbs heat from the flame zone and interrupts the chemical chain reaction of the combustion process.

Stored as a liquid in pressurized cylinders, FM-200® flows through a piping network to a discharge nozzle where it is deployed as a gas. The amount of FM-200® delivered to each nozzle is carefully calculated to ensure the appropriate concentration level.

The primary objective of an FM-200® system is to detect and extinguish a fire in its incipient stage long before smoke generation causes damage. Fire often begins before you see smoke or fire or feel intense heat. This is the incipient stage of fire development. When fires are stopped at the incipient stage, the risk of explosion, production of toxic combustion byproducts, and extensive damage are eliminated. Delays usually result in loss of lives, increased damage and downtime.

How to Inspect Portable Fire Extinguishers

Inspecting fire extinguishers is not difficult. Essentially you are examining the extinguisher and its components to ensure they are all suitable for continued service. For hand portable fire extinguishers this consists of the following:

- ➢ Ensure the extinguisher is approved. (see definitions)
- ➢ Ensure the extinguisher is clearly visible and readily accessible from the space being protected
- ➢ Ensure the pressure and weight are within the manufacturers recommendations.
- ➢ Examine the nozzle to ensure it is free from obstructions or physical damage
- ➢ Examine hoses to ensure they are free from all physical damage or defects such as dry rot, UV damage etc...
- ➢ Examine the pin and tamper seal to ensure they remain intact.
- ➢ Examine the exterior of the extinguisher to ensure it is free from defects, rust and is within its hydrostatic date requirement.
- ➢ Examine the vessel's logs to see if the master is recording monthly maintenance to the extinguishers.

How to Inspect Pre-Engineered Fixed Fire Fighting Systems

Inspecting a pre-engineered fire extinguishing system is very similar to conducting an inspection on a fire extinguisher. That being said, there are some important differences. For a pre-engineered system to truly function properly the space must be fume tight, the internal combustion engines and ventilation serving the space must shut down when activated, the storage bottle must be weighed annually, and the pressure gauge inspected periodically to ensure it remains within specifications.

- ➢ Ensure the extinguisher is approved. (see definitions)
- ➢ Ensure the pressure and weight are within the manufacturer's recommendations.
- ➢ Ensure the space protected is fume tight.

- Examine the pin and tamper seal to ensure they remain intact.
- Examine the exterior of the extinguisher to ensure it is free from defects, rust and is within its hydrostatic date requirement.
- Test the system's ability to secure all engines and power ventilation within the space protected using the manufacturer's directions.
- Test the system's come-home device.
- Inspect the system's directions and labeling for manual usage.
- Examine the vessel's logs to see if the master is recording monthly maintenance to the extinguishers.

Conclusion

There are numerous additional references regarding fire prevention and fire suppression available. The information in this chapter was designed to give the reader some basic information on this subject but due to the size limitations of this manual could in no way be completely comprehensive.

References:

1. NFPA 302 (no link available)
2. http://www.uscg.mil/hq/g-m/mse4/firefixedtboat.htm
3. http://www.uscg.mil/hq/msc/fixedff/links.htm
4. http://www2.dupont.com/FE/en_US/tech_info/index.html
5. NVIC 7-70
6. NVIC 6-72
7. NVIC 13-86
8. NVIC 9-97
9. http://www.universalsafetydept.com/Training/Fire_Safety/page_001.htm
10.

Chapter

7

Vessel Construction

There are numerous methods and styles used when constructing boats and they are completed by the most sophisticated boat manufactures or simple backyard boat builders. Where a vessel is constructed is important; however, the more important factor is what standard the vessel is constructed to and what materials are used in that construction process. These factors give us that warm and comfortable feeling because we know that those standards have stood the test of time. Hull strength of a boat is essentially an arrangement of plating and framing, which together form a structure that is designed to keep the water out and to resist a lateral load on its surface. In a boat, the lateral load is from the water pressure on the outside of the hull.

Recreational boats are governed by 33 Code of Federal Regulations parts 181 but are not required to meet any Federal construction design standards. The American Boat and Yacht Counsel (ABYC) has published the "Standards and Recommended Practices for Small Craft." This standard is *"the product of a consensus of representative of government, industry and public sectors. It is intended solely as a guide to aid the manufacture, the consumer and the general public in the design, construction, equipage and maintenance of small craft."* However, ABYC's standards do not address design or structural scantling requirements. The ABYC standards are extremely well written and cover engine, electrical, ventilation systems to name a few but they are silent on the construction front. This does not mean that recreational vessels are not well constructed or are not able to stand up to the loads imposed by the elements while in recreational service. It does however bring into question if these vessels can handle the same elements when carrying numerous passengers and when seeing an increase in their cyclic usage.

Since public safety is our overriding concern, we hold commercial vessels to a stricter standard; a standard that will afford a greater margin of safety. That being said, there are some alternatives to a vessel that was designed and built for recreational service but is now entering into commercial service. The Five Year Rule was designed to give some latitude for operators whose vessels were not constructed specifically for small passenger service but have a history of safe operation in similar service. This would also include a vessel of similar design and construction that has been in satisfactory service showing the vessel in question is also able to operate safely in a similar manner. The burden of proof in these cases always rests on the designer or vessel owner. He or she would be required to show the similarities between the proposed vessel and an existing vessel. This would include the similarities in size, power, displacement and scantlings. Additionally, the proposed route should be reviewed, as an inner harbor tour boats experiences is vastly different from a deep-sea fishing boat.

As an inspector it's important to understand these different construction methods and the many different construction materials so you can evaluate a vessel's hull and structure during your inspection. Knowing the material and how the vessel is put together as well as understanding the design requirements will give you a better understanding of how to inspect a boat. It will also give you the power to converse with a vessel owner when he or she is proposing modifications and will help you to quickly determine if that proposal is acceptable.

STEEL VESSELS

Certificated small passenger vessels constructed of steel are required to meet the design standards of ABS or Lloyd's rules. For the Coast Guard we have incorporated the 1983 Rules for Building and Classing Steel Vessels Under 200 Feet in Length and the Lloyd's Rules and Classifications of Yachts and Small Craft by reference. This means these rules have the effect of law, and since the ABS rules are less stringent than the Lloyd's rules in most cases you'll find vessel designers and Naval Architects prefer using the ABS standards.

What is interesting with the ABS rules is that the Coast Guard has only incorporated the design requirements by reference. Section 3 of the ABS rules in question discusses Materials, Workmanship and then Design. For us the only portion we can enforce is 3.5 or Design. This doesn't mean we are not concerned about workmanship; however, there are no specific regulations that state a small passenger vessel will be welded in accordance with any specific rule; therefore we must exercise common sense, which typically means "good marine practice" as we oversee the construction of a vessel.

Material selection for hull construction is extremely important. If a vessel is required to meet certain structural scantlings required by ABS or Lloyd's then the materials used in the structure need to be of certain strength, just looking at steel plate is not enough. We need to understand its physical properties to know if it will work in our structure and meet the sectional modulus (strength) requirements not to mention being able to withstand the dynamic forces vessels are exposed to.

Steel vessels operating in sole state waters should be expected to last a long time. Without the corrosive conditions present in salt or brackish water the effects of galvanic corrosion are minimized. This doesn't mean a vessel will not deteriorate or corrode when in fresh water, just that these issues are not accelerated by an electrically conductive electrolyte like salt water. Provided the vessel has no problems with its electrical system and there is no voltage shorted to the hull, steel vessels in fresh water should last a long time which equates to an easy evaluation for the inspector, at least in most cases.

ALUMINUM VESSELS

As with steel vessels there is a specific standard for the design calculations of a vessel constructed of aluminum. 46 CFR 177.300 stipulates that the Lloyd's Rules and Regulations for the Classification of Yachts and small Craft may be used. If the vessel is over 100ft use the 1975 ABS rules for Building and Classing Aluminum Vessels. For vessels less than 100ft the ABS Rules for Classing and Building Steel Vessels Under 200ft with the appropriate conversions from the ABS rules for Building and Classing Aluminum Vessels can be used. Another indispensable resource when reviewing aluminum vessels is Navigation and Inspection Circular (NVIC) 11-80 published on October 8th, 1980. This reference is the Coast Guard's structural plan review guidelines for aluminum small passenger vessels. It is a comprehensive document that explains the why and how of structural plan review and walks the reader through the entire process. While NVIC 11-80 is not really applicable to vessels under 60ft in length it is still a valuable tool when inspecting or reviewing aluminum boats.

BASIC WELDING

Since welding applies to both aluminum and steels vessels equally it stands to reason that a small section on welding is appropriate.

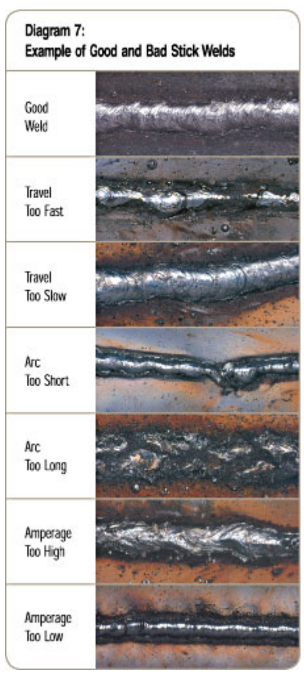


Figure 5

Welding is the process of joining two pieces of metal together. There are a number of ways to accomplish this but in the marine environment typically we see the SMAW and GMAW (MIG) process. SMAW or Shielded Metal Arc Welding is more commonly referred to as stick welding. SMAW is one of the oldest, simplest, and most versatile arc welding processes. The arc is generated by touching the tip of a coated electrode to the workpiece and withdrawing it quickly to an appropriate distance to maintain the arc. The heat generated melts a portion of the electrode tip, its coating, and the base metal in the immediate area. The weld forms out of the alloy of these materials as they solidify in the weld area. Slag formed to protect the weld against forming oxides, nitrides, and inclusions must be removed after each pass to ensure a good weld. The SMAW process has the advantage of being relatively simple, only requiring a power supply, power cables, and electrode holder. It is commonly used in construction, shipbuilding, and pipeline work, especially in remote locations."[1] Figure 5 on the left shows how travel speed, amperage and arc distance can affect the outcome of a weld. A good weld will have more strength than the surrounding metal so if the structure is designed correctly it should never fail in the weld area. The problem with this of course is welds often are the cause of failures in structures. When this does occur it is usually poor workmanship or a faulty design that causes the problem.

Gas Metal-Arc Welding (GMAW), also called Metal Inert Gas (MIG) welding, shields the weld zone with an external gas such as argon, helium, carbon dioxide, or gas mixtures. Deoxidizers present in the electrode can completely prevent oxidation in the weld puddle, making multiple weld layers possible at the joint. GMAW is a relatively simple, versatile, and economical welding apparatus to use. This is due to the factor of 2 welding productivity over SMAW processes. In addition, the temperatures involved in GMAW are relatively low and are therefore suitable when welding thin materials[2].

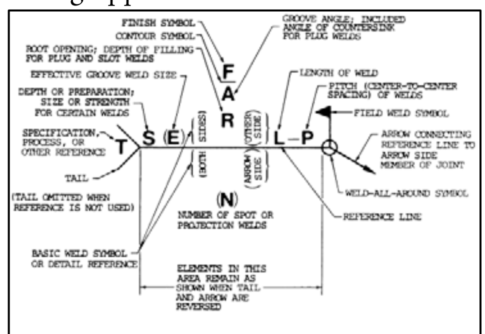


Figure 3-2. Standard locations of elements of a welding symbol.

Figure 6

So how exactly does the inspector know that the weld being performed is correct, or that it will function as the designer has intended. Welding is a complex process made more difficult when you consider the average inspector, sole state or Coast Guard, has very little experience welding. A proper weld that is completed under all the right conditions will usually last the life of the vessel. While you may never see a vessel under new construction it is still important to understand these concepts as collisions, allisions and corrosion are inevitable on a boat. That means repairs will most certainly needed from time to time. The symbol in figure 6 above is an industry standard welding symbol. It tells the fabricator and welder the type of welding process used and includes all of the information that is needed to perform the weld. But what if there are no drawings or weld symbols to review against. In these cases we have to fall back on good marine practice. If we know the material being welding then we can do some basic research to determine if the process is acceptable. By reviewing the mil specification sheet on the steel or aluminum we should be able to determine the tensile strength. For example the required tensile strength for ordinary strength steels that meet ASTM A 131/A 131M is 58 to 71 ksi. Knowing this you would never allow a welding rod (filler metal) that had a lesser tensile strength value. To determine the strength of a filler metal you should consult the manufactures data sheet.

NON DESTRUCTIVE TESTING

A discussion about welding would not be complete without talking about non destructive testing. A good as a finished weld may look it may have defects that could affect the integrity of its structure. We are very concerned about the scantlings used to construct a boat and have very specific standards that apply when determining strength but how do we determine if the complete structure when assembled is satisfactory? This is where weld inspection come into play. Welding a repair or completing new construction is not complete until the welds have been accepted as satisfactory. This is because if the welds are substandard then the overall structure may not be able to handle the operating environment or the loads placed on it. There are two common methods to determine the quality of a weld. They are destructive and nondestructive testing.

Nondestructive testing is a method of testing a weld without destroying its usefulness. The most common type of nondestructive test is simply conducting a visual examination of the weld. When we do this we are looking for size and distribution, cracks, inclusions and porosity to name a few defects. The other types of nondestructive testing include x-ray, magnetic particle, liquid dye penetrant, eddy current, and air leak with soap test.

Destructive Testing is usually not performed in the field. In most cases these tests are performed to either qualify a weld process or a welder. Since qualified welders are not required on small passenger vessels you may never see a destructive test on a weld; however, there are times when you may question welder's capability. When this happens you can always require him or her to weld a test piece in the position of the production weld and then perform a bend test on it. This will tell you a lot about the welders capabilities and if the welds in production will be acceptable.

There is a plethora of information on the subject of welding and weld inspection. The American Welding Society (AWS) has a certification for just weld inspectors. This is a highly technical field that one cannot cover in several short paragraphs. There are many resources available to individuals interested in this subject and if you find yourself overseeing a lot of vessel repairs you may consider furthering your knowledge in this area.

FIBERGLASS REINFORCED PLASTIC VESSELS

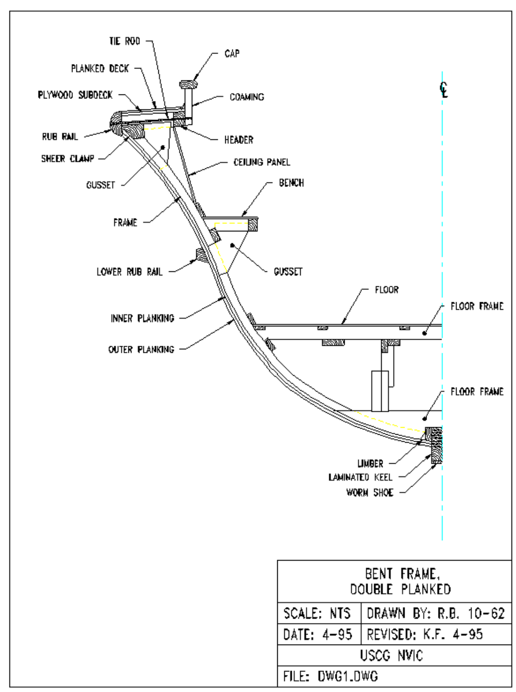
Fiberglass reinforced plastic is basically a composite of materials used to create a structure. It consists of a combination of glass fibers or strands bound together with a plastic. The plastic materials are typically polyester, epoxy and vinylester, compounds that when mixed correctly and cured form a composite that has very known structural properties. In the boating world FRP has been a primary construction method since the early 60s. One of its greatest strengths is the ability to mold and create shapes and forms with relative ease. FRP's durability also make it an excellent choice for boat building.

There are many methods by which a fiber reinforced plastic (FRP) vessel can become Coast Guard certificated. The American Bureau of Shipping (ABS) Rules for Building and Classing Reinforced Plastic Vessels, 1978 (ABS Rules) apply to vessels up to 200 feet in length of normal form, and require special consideration for vessels of unusual form or design features. Lloyd's Register of Shipping Rules and Regulations for the Classification of Yachts and Small Craft (Lloyd's Rules), Part 2, Chapter 2, Glass Reinforced Plastics, apply to vessels of not more than 30 meters (100 feet) in length. NVIC 8-87 addresses the use of these and other acceptable design methods.

Keep in mind that while your state may not have regulations or standards that can be applied to these or other vessels, good marine practice is a good term to use when overseeing the construction or repair of vessels. There are hundreds of books on construction and repairing boats, the Coast Guard has numerous resources for these topics that can be used in many different circumstances and while they may not be enforceable under state law they certainly hold up under the scrutiny of "good marine practice".

WOOD VESSELS

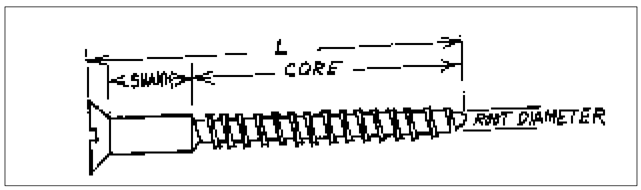
Wood as a boat building material is still used in many parts of the world as the most readily available, easy to work, repairable material for marine applications. Even with the advent of composites, fiber reinforced plastic (FRP) and lightweight metals, wood will for many years to come, continue to be a major factor in the design of boats. No single publication contains all the innovations found in the design of wooden vessels. NVIC 7-95 and the readings referenced in Annex R of that document form a basis of good marine practices from which owners, designers, builders, inspectors and surveyors can, along with experience, maintain the highest level of small passenger vessel safety.



C-2

Lloyd's Register of Shipping Rules and Regulations for the Classification of Yachts and Small Craft is the standard adopted by reference in Subchapter T for the design and construction of wooden small passenger vessels. Direct reference to the Lloyd's Rules is based on the familiarity that Coast Guard inspectors and technical personnel have with reviewing a vessel designed to this standard. In general, all wooden small passenger vessels must be built to the Lloyd's Rules. These Rules specifically address carvel, cold molded, double, lapstrake, single skin plywood, and strip planked vessels. Since wood has seen such a decrease in its popularity and use, however, Lloyd's Register no longer publishes this standard. The fact that a standard is no longer published does not prevent it from being used to demonstrate regulatory compliance.

Similar to all types of vessel construction there has to be a way to keep things together. For wood vessels this is the fasteners, fasteners hold the planking, frames and other structural components together to create a composite structure. That is, a structure of wood and screws, bolts or other means that keeps the structure intact. Mechanical fastenings should be of material suitable for the service intended. Ferrous fastenings should be hot-dipped galvanized. Among the usual non-ferrous types brass is not acceptable in salt water applications as it will corrode from de-zincification and is inherently soft and weak.



Caution should be used in selecting fastening material because of the problem of galvanic action which can arise if dissimilar metals are used close to one another. A bronze washer used with a steel bolt will result in the eating away of the steel. Proper selection of fastening materials will significantly prevent corrosion and thereby extend their service life.

Marine applications of stainless steel alloys (chromium-nickel) are subject to a phenomenon known as contact corrosion or more commonly, crevice corrosion. Stainless steels which are in contact with each other or placed in tight joints (nuts and bolts), swage connections (standing rigging), or used to fasten wood planking below the waterline, may corrode at an alarming rate under certain circumstances. The vehicle of crevice corrosion is electrolytic cell formation. If the stainless steel is unable to naturally form a thin film of chromium oxide to shield the material from attack, corrosive liquids such as salt water are able to establish electrolytic cells with chloride ions and rapid corrosion may take place. In short, stainless steel depends on oxygen to provide protection against crevice corrosion.

Grade 316 L (passive) stainless steel is the most accepted material for marine applications due to the introduction of molybdenum to the alloy. For example: grade 304 stainless steel has 18% chromium and 8% nickel in the alloy while grade 316 L has 18% chromium and 10% nickel and 3% molybdenum. Grade 304 is quite susceptible to crevice corrosion when employed in tight spaces and unable to generate chromium oxide. The 316 L material will last longer in the same application. As a rule, stainless steel fastenings are generally not recommended to be used below the waterline, particularly in salt water. Some degree of longevity has been experienced with stainless steel in fresh water when used below the waterline because the propensity to go from passive to active is less.

It is safe to say that when you start getting involved with a wood vessel you need to educate yourself on the different types of wooden boat construction. Indeed there are far too many types of wooden boats to list in this guide. In chapter 12 there is an extensive reading list that will help you with this process. If all else fails the use of NVIC 7-95 will be a good starting point.

REPAIRS

Eventually all boats need structural repairs and this is where things get interesting. Usually the repair yard has one idea about a repair, the owner another and then when you mix in the regulatory agency you undoubtedly get conflict. Often the best approach is to find common ground amongst all of the different parties of interest. I have often found the best common ground is passenger safety. Nobody wants a marine casualty, least of all the vessel owner, and since there is a plethora of information on how to repair boats the issue is often not black and white. One thing to avoid, though, is telling the vessel owner or repair facility **how-to** make repairs. As inspectors we often know what we're willing to accept so it is easy to sometimes take the shortcut and just tell the repair facility. This is bad for a number of reasons; first we are not ship or boat repair experts, and second we become liable if we tell the owner how to repair his or her boat. If those repairs do not stand the test of time or worse, are later revealed to be a casual factor in a marine casualty we'll have a hard time explaining how we or our organization are not personally liable. It is always best to have the owner or owner's representative submit a repair proposal to us. We can review this against our regulations and industry guidance and make a determination if that repair proposal is acceptable. For repairs to steel and aluminum vessels we use NVIC 7-68 and NVIC 11-80, 11-80 for aluminum and 7-68 for both. For wood vessels we use NVIC 7-95. For amphibious vessels we use NVIC 1-01, which at the time of this writing is being updated to reflect the newer amphibious vessels being operated throughout the United States. For FRP vessels we use NVIC 8-87. I have not included any information on cement vessels as they are rare although there has been some recent interest in this construction method. Should you need additional information on this you should contact the Coast Guard's Marine Safety Center and ask for the small passenger vessel branch (H-1).

All of these Navigation and Inspection Circulars have been provided to help you as you work with these and other complex repair issues. One final note on repairs; it is always a good idea to seek a second opinion when reviewing a repair proposal. A second set of eyes usually not only helps you as an inspector but can sometime help the vessel owner in reducing their repair costs.

References:

NVIC-8-87
NVIC 7-95
NVIC 7-68
NVIC 11-80
ABS Guide for the Nondestructive testing of hull welds 2002
ABS Rules for Building and Classing Reinforced Plastic Vessels, 1978
ABS Rules for Building and Classing Aluminum Vessels, 1975
Marine Composites
American Welding Society

Chapter

8

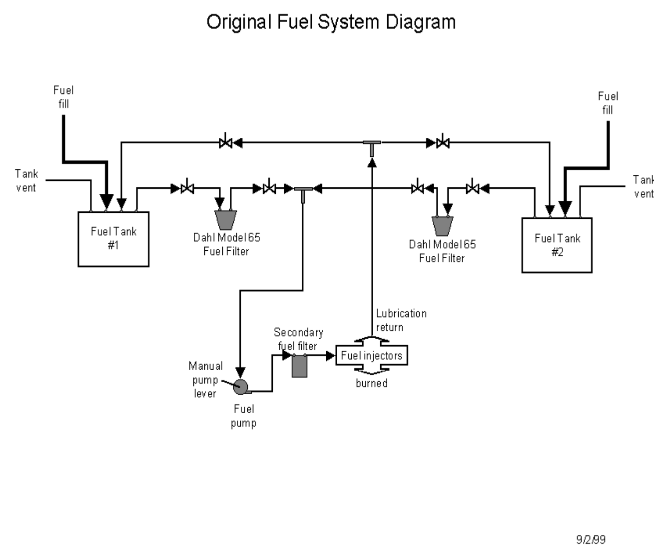
Machinery Systems

Propulsion systems on small passenger vessel can be as simple as a common recreational vessel or as complex as a high speed ferry vessel equipped with the latest machinery technology. As with the other portions of this pamphlet a systems approach to machinery systems always helps. For ease of use, this section will be centered on some of the more common engineering systems and will not delve into the modern or the complex machinery systems found on newer vessels. It's assumed that a majority of vessels operating on sole state waters are smaller in nature and do not contain complex machinery systems.

When we look at a machinery system we need to understand that, like your car, it requires a number of things working in unison to operate. The fuel delivery system needs to be able to supply fuel at all speeds, the cooling system needs to maintain the engine at the optimum operating temperature and prevent overheating, the lubricating system needs to be able to lubricate the internal engine components to prevent premature engine wear or failure, the electrical system needs to be capable of starting and stopping the engine when desired and of course the control system needs to allow the operator to control the speed and direction of the boat. All of these are sub-systems of the propulsion, steering & control systems. So considering there are hundreds of manufacturers that provide engines, reduction gears, jets drives and all of the ancillary equipment found on a boat, how does one attempt to inspect, let alone approve, the installation of a component on a small passenger vessel?

We could spend days on this subject and there are literally hundreds of books on the subject. Rather than bore you with the specific details from a hundred different manufactures lets break things down into the major systems.

Fuel Systems: The common fuel system consists of a fuel storage tank, a supply line, a filter, a carburetor (or injection system if using diesel) and usually a return line. Interlaced within this system you find vent lines, fill hoses, bonding wires, flex hoses to absorb vibration and usually a couple of valves.

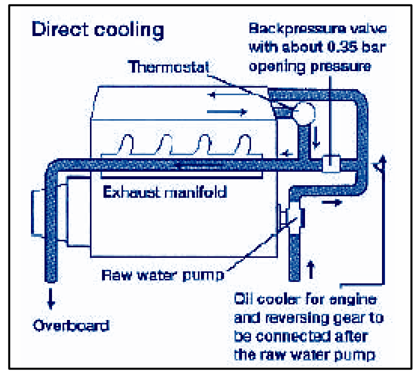


Inspecting a fuel system usually starts in the bilge. Lets face it, if a fuel system is leaking is will undoubtedly end up in the bilges. If there is no fuel in the bilges then a quick examination of the tank should be done next. While looking at the tank take a look at any fuel lines attached and the straps that hold the tank in place. In some cases the tanks are not accessible because they are foamed in place. In this case you must rely on the absence of leaks to determine the overall condition. Fuel lines attached to the tank should be made through a securing valve that can be operated from the main deck. Many times this is accomplished through the use of a cable or reach rod. In either case this is considered crucial for fire safety, as it provides a second means for securing the engines and a means for securing fuel to a fire should a hose or fuel line leak.

Fuel piping should meet the requirements found in 46 CFR 182.455 and fuel hoses must exceed the recreation fuel system requirements found in 33 CFR 183.540. The reason for this is the hoses for recreational vessels do not have the same pressure, fire or permeability rating as we require on commercial small passenger vessels. This may seem like overkill but hoses that do not meet the strict standards required by the Society of Automotive

Engineers (SAE) J-1942 will not hold up to the excessive service and do not afford the appropriate safety factors desired for commercial vessels.

<u>**Cooling systems**</u> are exactly that, a system designed to maintain the engine at a specific temperature. Cooling systems can be direct or open or indirect or closed and, in some cases, air cooled, although air cooled systems are not very efficient on boats and therefore seldom used. Depending on whether the boat operates in salt or fresh water will sometimes determine which system is employed. The inspection of a cooling system is relatively easy and like the fuel systems starts in the bilge. If the bilges are clean and free of water or antifreeze that is a good indication that the system is at least intact. The next is the engine, ideally an examination of the engine's cooling system is completed while the engine is running up to speed and temperature. This shows us if the cooling system is leaking and if it is maintaining the engine at the correct temperature. Most marine engines run between 170° to 200° F. Stains or salt build up on the cooling lines or hoses may be an indication of an ongoing problem that should be investigated.

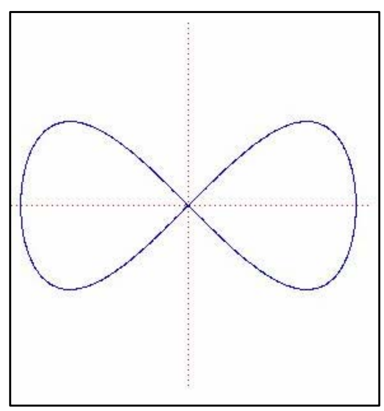


If the vessel has multiple engines and is having difficulties with on engine's cooling system you should always ensure that both engines are operating correctly before allowing continued operation of the vessel with passengers. Allowing a vessel to operate in a reduced capacity is always a recipe for disaster and should be avoided. Most operators are accustomed to running the boat with all of the equipment working. When only one engine is running in a multi engine boat the boat's maneuvering characteristics change and could increase the chance of an accident. A great additional source of information on the vessel's particular cooling system can be found in the engine manufactures operating instruction manual. If you have a particular concern, ask the owner/operator if you can look at the repair manual.

As with fuel lines the use of certain non-metallic hoses should be avoided. Hoses that are not impervious to hydrocarbons have a tendency to break down and prematurely fail, a condition that could result in a marine casualty. When there is a lack of regulatory guidance on the use of non-metallic hoses you should remember that all of the components that were originally supplied by the manufacture are acceptable as they are approved as part of the "package". However when there is a specific interface with the boat and the engine's cooling system the use of SAE J1942 non-metallic hose should be used. SAE J1942 hose is pressure rated, compatible with hydrocarbons and is fire rated.

Control systems come in many shapes and sizes but all of them have one thing in common, they allow the operator to control speed and direction. Probably the most common control system in the marine environment is the mechanical control system. The mechanical control system is a combination of control cables and a control head similar to the control head pictured at the left. The control head when moved forces a cable to move with it placing the boat in gear and allowing for precise control of the engine speed. These systems are widely used as they can be adapted to almost any engine and marine gear application. Another method that is seeing more use these days is electric controls commonly called fly-by-wire. Fly-by-wire is an electrical means for controlling engine speed and marine gear direction. This type system is often found on newer engines with computer controlled fuel injection systems. Either system should be inspected while the vessel is operating underway. If you are unable to witness the vessel underway then a dockside evaluation can be made by running the controls through the gears while the vessel is at idle. Always have the operator perform the function and just witness the outcome. Never take control of the vessel or attempt any tests or operations of the vessel on your own accord as this puts you and the state agency you represent at risk in the event something goes wrong.

Steering systems like control systems also come in many shapes and sizes. I have seen everything from semi truck steering boxes to highly sophisticated electro-hydraulic systems on small passenger vessels. For sole state water boats I would expect the steering systems to be an off the shelf item like the steering systems manufactured by Teleflex®. These systems are relatively easy to inspect and will show most common problems by just visually examining the system. Another way to determine if the system as a whole is standing up to the elements is to conduct a figure eight operation test of the boat at max speed. This test should be conducted in open water and while there is little or no boat traffic in the immediate area. While the boat is at speed and turning check the steering system and its foundations to ensure they are working as intended, are tight and, most importantly, turn the boat safely.



Chapter
9

Electrical Systems

Electrical systems are complex and to become really a good inspector one must acquire a basic understanding of electrical theory. A simple electrical circuit usually consists of a power source like a battery a conductor or wire and the load the light, radio or other device. Since electrical systems that are not designed properly can cause fires and be electrocution hazards we need to ensure that those items making up a circuit are capable of handling the demands being placed on them as well as being safe for the vessel's crew and passengers. Most of us have seen the effects of a poorly designed electrical system. The wires are charred and in some cases the insulation is gone completely, similar to the wires pictured on the left. In the worst case scenario an electrical fire leads to a total constructive loss of the vessel in best case, maybe its just the loss of one circuit. As inspectors we are in the job of risk assessment. We need to be able to look at things quickly and determine if a problem exists or if the potential for a problem is present. With a basic understanding of how to design an electrical circuit and some understanding of electrical components we can increase our overall effectiveness and help vessel owners operate safer.

The small passenger vessel electrical Regulations, 46 CFR subpart 183, are, in many areas, complex and difficult to understand. The CFR is limited to telling what must or must not be done. Regulatory intent, explanation, policy, equivalency information, requirement derivation, inspection aids, and examples are not provided. Sometimes, the preamble to a regulation can provide useful information, but this is a one-time issue in the Federal Register, and is usually lost over time. NVIC 2-89 should be used to fill the void caused by the limitations of the regulations as they apply to electrical equipment and systems on commercial vessels. It also promulgates information on equipment, systems, materials and methods that have been determined by the Coast Guard to provide an equivalent level of safety. Further, it describes how electrical reviews and inspections are typically performed, and provides useful training information for novice designers, marine and electrical engineers, naval architects, or inspectors.

The Marine Inspection Program uses plan review and on-site inspection to ensure that electrical installations are designed, built and maintained in a manner to promote the safety of the vessel, its crew and passengers. The small passenger vessel regulations provide uniform minimum requirements for electrical equipment. These requirements are intended to ensure electrical installations aboard vessels provide services necessary to protect passengers, crew members and other persons from electrical hazards.

Electrical safety on ships includes the prevention of shock, fire and panic. On a steel hulled vessel, a person is usually walking on or touching ground at all times, and is usually within reach of power cables or electrical equipment containing lethal voltages. The currents that can flow from an energized conductor to ground can be very large, even in an ungrounded system. Currents as low as twenty-five thousandths of an ampere (25 milliamps) that pass through the heart can cause death. Currents of a non-fatal magnitude, or currents having a path to ground through other parts of the body can cause severe burns and injury. Minor shocks can also create severe secondary injuries when muscles contract involuntarily.

Fire is the greatest dread of seamen, and electricity is one of the most frequent causes of fire. A fire hazard can exist wherever electrical potential is present, and on a ship, the electrical installation covers a far greater area than any other type of installation. How can electricity start a fire? Current flowing through a conductor encounters resistance. This resistance generates heat. If the conductor is properly sized, the heat is harmlessly dissipated. Where the conductor is not adequate sized for the current, or where the heat generated by the current is prevented from properly dissipating, whether it is the normal current, an overload current, or a fault (high or low impedance) current, the heat can become excessive, and can start a fire in nearby combustible materials, such as cable insulation. Electrically-caused fires most often involve wire and cable. Most vessels have many miles of cable run throughout the entire vessel, spreading their risks to all locations. Whenever the protective insulation of a wire or cable is damaged by heat, moisture, oils, corrosive materials, vibration, abrasion, or impact, or where faulty installation or operating conditions result in loose connections, the threat of fire exists.

Proper shipboard electrical installations also help reduce or prevent panic during an emergency. Put an individual, such as a vessel passenger, in the dark, in a strange place, in threatening circumstances, and the stage is set for panic. Electrical installations are designed to keep the lights on, power vital equipment, and allow needed information to be passed to passengers and crew.

While I'm sure there are AC electrical systems on vessels operating in sole state for the purpose of this pamphlet I will be concentrating on DC electrical systems. AC systems differ from DC in that they are running alternating current and involve greater voltages.

Before I get started through I will have to define a couple of the items for this discussion:

Wire - A wire is a conductor with functional insulation only, for use inside an enclosure. A cable consists of one or more insulated conductors provided with a protective covering of either a watertight metallic sheath or an impervious non-metallic sheath compatible with the insulation. Most shipboard wiring is accomplished using multiconductor cable.

Ampacity -The ampacity of a cable is the maximum current-carrying capacity of the cable, based on the cross-sectional area of the conductors, maximum allowable conductor temperature for the insulation used, and the ambient temperature. The temperature rating of a conductor is the maximum temperature, anywhere along its length, that the conductor can withstand for a prolonged period without serious degradation of its insulation. Ampacities for many common conductor sizes and insulation types have been calculated, using procedures such as the Neher-McGrath method, and tabulated for ease of reference and consistency. Conductors with a temperature rating above the maximum ambient temperature must be used. Tabulated ampacities should be corrected for the anticipated ambient temperature and method of cable installation (banking of cables) using the ampacity correction factors applicable to that table. Adjacent or closely-spaced cables both raise the ambient temperature and impede heat dissipation.

Voltage is the difference of electrical potential between two points of an electrical network, expressed in volts [2]. It is a measure of the capacity of an electric field to cause an electric current in an electrical conductor.

Circular Mil is a means for measuring a wires cross-sectional size. A circular mil is the equivalent are of a circle whose diameter is 0.0001 inch.

So now that we have some of the definitions out of the way, let's look at a basic electrical circuit.

Figure 7 below shows a basic electrical circuit. The circuit is the feeder cable for a 5 amp solenoid switch. What we want to do with this circuit is determine if the wiring is sized correctly. The drawing has all of the required information except the voltage required. For this illustration assume the voltage to be 12 volts DC.

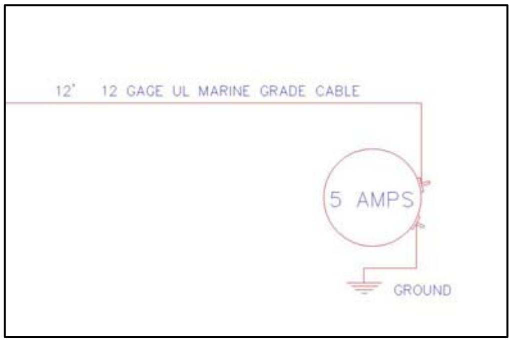


Figure 7

To determine the wiring size of a circuit we can reference 46 CFR subpart 183.340 or ABYC E-11 11.16. Both of these standards use the following formula top determine wiring size. K x I x L / E = CM. Ok so lets break this down. K is a constant of 10.75 which represents the resistivity of copper. I equals the load current measure in amps, L is the length of run. The length of run is from the power source and back so often this will be seen as L x 2, and lastly E, which equals the voltage drop. The voltage drop here differs depending on what standard you use. The federal regulations call for a maximum of 10%; however, ABYC calls for a 10% voltage drop for all non-vital systems and no more than 3% voltage drop for any vital load. In the example above we can use the formula provided to see if the 12 gage UL Marine Cable is satisfactory.

Example: $\frac{10.75 * 5 * 24'}{1.2} = 1075$ cm

So now we know that the minimum size wire should be 1075 circular mils, right? Next we need to convert circular mils to American Wire Gage or AWG. Using table IV chart on the next page you can see that 1075 cm is larger than 22 AWG but smaller than 18 AWG. Thus a correctly sized conductor for this circuit is 18 AWG right? Well almost, Coast Guard regulations go on to state that at no times should a conductor be sized under 14 AWG therefore the federal requirements on this circuit would be 14 AWG. Now we are almost done, we also want to ensure the circuit wiring is protected from over current and that the wire insulation can handle the environment it's placed into. Conductors are designed to carry current but when the circuit is in operation a by-product of that current flow is heat. The insulation on a wire not only prevents electrical shorts but also contains the heat from that current flow. Additionally the more conductors bundled together the more heat generated and less current capacity of the wire. Another way to look at this is the higher the temperature rating on the conductor's insulation the higher the current carrying capacity. Why this is important is the wire's maximum current carrying capacity is generally the number used to determine the size of over current protection required. Using the same chart you can see the over current protection for our circuit is 30 AMPS if the circuit is inside a hot machinery space or 35 AMPS if outside a machinery space.

Obviously electrical systems can be much more complex than this easy explanation. The goal here is to give you some insight into a boats electrical system along with some basic theory. If you are interested in pursuing this field further a great source of training can be found at ABYC.com

American Wire Gauge (AWG)	Circular Mil (CM)	Ampacity Outside of Engine Spaces	Ampacity Inside of Engine Spaces
0000	211,600	445	378
000	167,800	385	327
00	133,100	330	280
0	105,600	285	242
1	83,690	245	208
2	66,360	210	178
3	52,633	180	153
4	41,740	160	136
6	26,240	120	102
8	16,509	80	68
10	10,380	60	51
12	6,530	45	38
14	4,110	35	30
16	2,580	25	21
18	1,620	20	17

Table IV

References:

ABYC
ABYC Education Programs
Ancor Marine Grade Products
NVIC 2-89

Chapter

10

Operations & Safety Systems

The Coast Guard regularly reviews operations and safety systems for inspected passenger vessels, and an underway exam is part of each inspection for certification. The underway exam verifies the proper operation of propulsion and steering systems, and gives the inspector an opportunity to witness the performance of the crew. Sole state vessels should comply with applicable State standards for passenger vessel operations, or in accordance with prudent seamanship.

Marine Casualties: There are specific federal and state requirements for the reporting of marine casualties including groundings, bridge strikings, loss of steering, propulsion, or seaworthiness, loss of life or injury that requires professional medical treatment, or an occurrence resulting in property damage in excess of $25,000. Immediate and follow-up written reporting, requirements for post-incident drug and alcohol testing, and retention of voyage records are all elements of the marine casualty investigation. Sole State vessels should comply with the reporting requirements for their state and municipality.

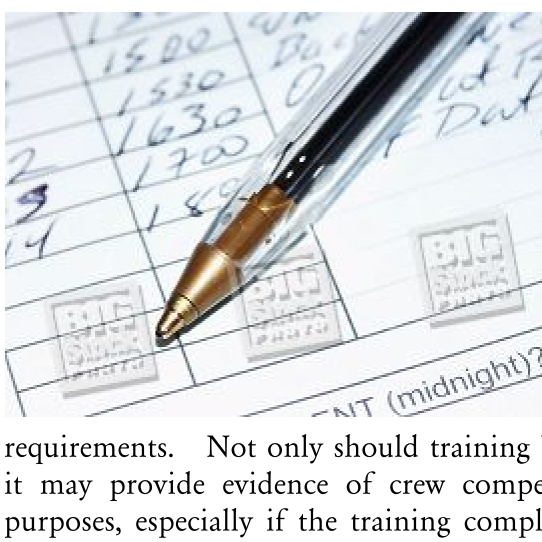
Navigation underway: A commercial vessel should be operated by a qualified individual. For vessels operating on federal waters the Coast Guard requires passenger vessels to be operated by a licensed master at all times. It is the master's responsibility to take all action necessary to prevent a casualty. Prudent seamanship dictates special attention to the following:

- Tides and currents, prevailing and forecasted weather conditions, density of marine traffic, handling characteristics of the vessel, condition and use of installed navigation equipment, potential danger of each contact detected visually or electronically, and potential damage caused by the vessel's wake.

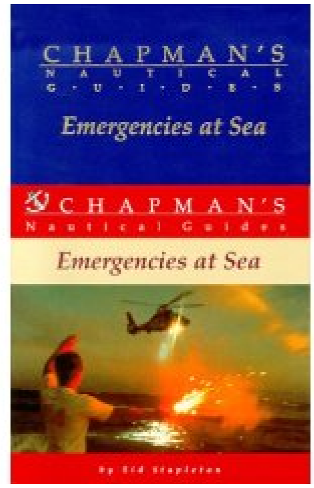
Sole state vessels should comply with the manning requirements for their State; vessel examinations should include checks to verify the validity of all licenses and documents required by the State, as well as proper operation of navigation equipment and posting of vessel handling characteristics.

Operations underway: The Coast Guard charges masters of passenger vessels with the responsibility for certain operating systems underway. This includes verification that the vessel has been loaded in accordance with its stability restrictions; testing of steering, propulsion, and navigation equipment prior to getting underway; appropriate closure of watertight and loading doors, safe stowage of vehicles on vessels designed to carry them; precautions for vessels with gasoline machinery spaces, and safe usage of auto pilot. These guidelines should be reviewed against applicable sole state regulations and the tenets of prudent seamanship. Some test information may be reviewed in logbooks, while other tests, particularly steering and propulsion, may be witnessed underway in accordance with the state inspection protocol.

Crew requirements and training: The Coast Guard requires that for each crew member required to be licensed, that the license be onboard and available at all times when the vessel is operating. The master of each passenger vessel is further required to carry enough crew members to provide a roving patrol during the nighttime while passengers are onboard, whether underway or not. The master must also provide each crew member with sufficient training to prepare them to respond in the event of an emergency. Training must be logged, and should be reviewed during an inspection. Similar reviews of crew credentials, manning, and emergency training should be conducted in accordance with state requirements. Not only should training be logged to comply with the law, but it may provide evidence of crew competency for insurance or post-accident purposes, especially if the training complied with a text or manual that could reasonably be considered as a best practice or good standard.



As a minimum, the master and crew should be familiar with the emergency procedures to be taken in the event of fire, heavy weather, or a man overboard situation. Different procedures and fire fighting techniques apply to fires in the engine room, galley, accommodation spaces, on deck, or for an electrical fire. Training and fire drills should focus on all aspects of marine firefighting so that the crew is familiar with the equipment, including the operation of any fire pumps, and can respond quickly and effectively in the event of a real fire.

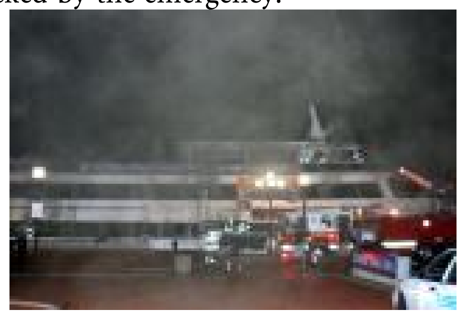


Though a prudent passenger vessel master is expected to review marine weather conditions prior to operations, crews may encounter unexpected heavy weather and be forced to respond. Each crew member should be familiar with procedures to secure the vessel (e.g., dog all hatches and watertight doors, take in sport fishing gear, etc.) and don lifejackets if appropriate. In the unlikely event that heavy weather swamps the vessel and it must be abandoned, all crew members should be very familiar with all primary lifesaving devices carried onboard, such as life rafts and buoyant apparatus. Proper operations of primary lifesaving equipment should be reviewed and the training sessions logged on a regular basis.

Particularly in cold waters, it is vital that all crew members be very familiar with the procedures for responding to a man overboard situation. Actions to keep the person in sight, deploying life rings or other lifesaving equipment, and returning to the scene and actually affecting the recovery should be regularly practiced and the training logged.

On larger vessels or vessels with crews over 4 persons the vessel shall post a station bill on the bridge/pilothouse and in each accommodation space. This document lists the duties for each crew member in the event of an emergency. Even if not required by State regulations, a station bill that is thoughtfully prepared and regularly exercised can greatly reduce confusion during a real emergency. It will help avoid duplication of effort, or oversight of a needed action. For example, if each crew member thought that another person was responsible for closing ventilation dampers before deploying an installed fire suppression system, it might get overlooked, with the subsequent use of the system rendered nearly worthless. Even if there are only two crew members, including the master, it is vital that each person clearly understand their duties in an emergency.

The Coast Guard also requires that placards be posted containing instructions for the proper donning and use of life jackets, deployment of primary lifesaving systems, such as life rafts, and operation of all fire protection equipment. Such prominently displayed "ticklers" can give potentially life-saving guidance to a passenger or crew member who may be panicked by the emergency.



Large (greater than 100 gross tons capacity) passenger vessels, and those small passenger vessels that carry more than 150 passengers, are required by the Coast Guard to comply with a number of security measures put in place by the 2002 Maritime Transportation Security Act of 2002 (MTSA). MTSA regulations require submission of a Vessel Security Plan, designation of a Company and Vessel Security Officer and actions to prevent the introduction of dangerous devices or substances, including access control, baggage screening, and the like. In this era of heightened security and awareness of potential terrorist threats, State vessels should consider the adoption of security measures to minimize the risk to their passengers, crew, and property. For purposes of review, the Coast Guard has established a MTSA Helpdesk at http://cgweb.comdt.uscg.mil/g-mp/helpdesk.htm

Miscellaneous equipment and systems

Most passenger-carrying sole state vessels will not be of such a size and complexity to require inspection of their miscellaneous systems; however, this guidance is presented for the occasional need to inspect such larger vessels. The following inspection criteria are described for passenger vessels required to be inspected by the Coast Guard. Except where noted, sole state vessels should comply with applicable state standards for workmanship and marine engineering, or in accordance with good marine practice.

Lifeboat winches: Electric winches used to raise and lower lifeboats on Coast Guard inspected passenger vessels must comply with certain specifications found in 46 CFR 160.015 (winch construction, capacity, inspection and testing, etc.), and 46 CFR 111.95 (electric components, wiring, etc.)

Hazardous Areas: Hazardous areas on Coast Guard inspected passenger vessels generally include those areas containing machinery, gasoline or other fuel (110º

F or lower flashpoint) tanks, and paint lockers. Electrical equipment in those spaces must be explosion-proof, or part of an intrinsically safe system. Intrinsically safe systems must meet the requirements of 46 CFR 111.105 (Hazardous Locations)

Elevators: Elevators installed on Coast Guard inspected passenger vessels must comply with the requirements of American National Standards (ANSI) A17.1, "Safety Code for Elevators and Escalators."

General Alarm System: All vessels with overnight accommodations must be equipped with a general alarm system. An installed PA system may be used for the general alarm.

Cooking and Heating: All cooking and heating equipment must be suitable for marine use. 46 CFR 184.200 lists several sources for appropriate equipment design and installation, including American Boat and Yacht Council (ABYC) A-3, "Galley Stoves," and A-7, "Boat Heating Systems," and National Fire Protection Association (NFPA) 302, "Pleasure and Commercial Motor Craft." In general, passenger vessels inspected by the Coast Guard may not use gasoline for cooking or heating, may not use installed fireplaces or space heaters with open flames, and must provide for the safe operation of heating equipment; e.g., no contact with combustible materials, overheat protection, and proper material. Cooking equipment must be sufficiently secured to prevent its movement while underway, and the use of liquefied and non-liquefied fuels is further regulated by 46 CFR 184.420.

Ground Tackle: A vessel must be fitted with ground tackle and mooring lines necessary for the vessel to be safely anchored and moored. This is typically examined, but not deployed, during a Coast Guard inspection for certification.

Navigation Equipment: Most navigation equipment required for inspected passenger vessels may not be applicable to state inspected vessels. Equipment includes a working compass except for those operating on restricted routes (rivers, lakes, bays, and sounds), an FCC-approved radar for vessels that carry more than 49 passengers, charts, and nautical publications.

Marine Sanitation Device: A vessel with installed toilet facilities must have a Marine Sanitation Device (MSD) that complies with 33 CFR 159. This requirement applies to all vessels operating on U.S. waters, and ensures that the standards of the Environmental Protection Agency are met. For most State inspected vessels, the most practical MSD will be the Type III device, a holding tank. Vessels that operate on lakes capable of interstate navigation may use Type I or II systems that treat waste and discharge it overboard. Please note that this requirement does not compel a vessel operator to install toilet facilities if not previously installed, but it does apply to the waste collected.

<u>First-aid Kits</u>: All Coast Guard inspected vessels are required to carry a first-aid kit or equivalent materials.

Reference material

46 CFR 184-185
Chapman's *Emergencies at Sea*
MTSA Helpdesk site

Chapter

11

Crew Proficiency & Drills

Commercial vessel passengers rely on their professional crewmembers to provide them with an enjoyable boating experience. Separate from these "good business" responsibilities, the master or deckhand may be called upon at any point to assist in an emergency involving the vessel or a particular passenger; it only makes sense to ensure that basic levels of qualification and training are in place. After due consideration, the Coast Guard determined that the most effective way to promote crew competency was to allow marine employers to develop a voluntary training program, given the industry's vested interest in passenger safety. To assist in developing such training programs, the Coast Guard has provided marine employers with recommendations for enhancing the safety of their passenger vessel operations with crew qualifications and training. Although the guidance does not require marine employers to undergo a formal review process, unless it is a high speed vessel (>30 knots) the Coast Guard retains the responsibility of ensuring that passenger vessels are manned with competent crews, and each local Officer in Charge, Marine Inspection (OCMI) has the discretion to determine if a given company's training program is sufficient for that purpose. While sole state vessels should comply with the requirements for their particular state, due consideration should be given to the Coast Guard recommendations for vessels of similar size and usage.

The Coast Guard-published Navigation and Vessel Inspection Circular (NVIC) 1-91 which recommends that deckhands serving on small passenger vessels be at least 16 years of age, physically able to perform deckhand duties, and also be physically able to perform duties relating to the protection and assistance of passengers during emergency situations. Specifically, deckhands should be familiar with procedures for the following emergencies: man overboard, fire, abandon ship, foul weather, collision (including dewatering), and medical emergency. At the discretion of the OCMI, the deckhand may also serve in certain other service capacities, such as waiter or concessionaire, but the individual must be able to immediately undertake their safety-related duties if needed. Because of the nature of their work, however, cooks and food handlers would not normally be allowed to perform deckhand duties.

NVIC 1-91 gives more detailed suggestions for emergency responses; in general, deckhands should be familiar with all of the emergency, lifesaving, and firefighting equipment onboard such that they can respond ably given a specific emergency; e.g., they know which type of fire extinguishing equipment to use on various types of fires, can render appropriate first aid, etc. Much of the training can be accomplished on the job, but marine employers may choose to provide their deckhands with a professional course in marine fire fighting, CPR/first aid, or emergency response, and there are a number of agencies offering such courses. NVIC 1-91 further discusses the concept of a Senior Deckhand, an individual that provides an increased level of experience on vessels where there is only one licensed officer required, with additional recommendations for practical experience expected of the Senior Deckhand.

A subsequent revision to NVIC 1-91, NVIC 1-91 Change 1, provides further guidelines for deckhands serving on high-speed small passenger vessels and introduces the concept of qualified deckhand (high-speed). Given the decreased available response time for some emergencies involving high-speed craft, qualified deckhands should demonstrate familiarity with a number of operational tasks in addition to the more general recommendations of NVIC 1-91. Some of these tasks include operation of all communication and navigation equipment such as VHF radios and radar/collision avoidance equipment, operation of all steering and propulsion systems in all modes, demonstrated familiarity with "rules of the road" for avoiding collisions between vessels, demonstrated knowledge of the local operating area, and night operations if applicable. As with the first publication, while the specific standards are provided as guidance and not regulation, the onus is on the marine employer to satisfy the OCMI of the adequacy of the qualification and training programs in place.

Specific recommendations regarding onboard fires were issued by the Coast Guard in NVIC 6-91, which endorsed International Maritime Organization (IMO) Circular #544, "Fire Drills and On-Board Training." The Circular recommended fire drills on at least a weekly basis for passenger vessels, with training on the use of fire extinguishing equipment given at the same interval. The Circular lists specific minimum standards for fire drills, onboard training, the availability of fire extinguishing equipment, and maintenance of drill and equipment records. As with other NVICs, failing to comply with the recommendations would likely require the vessel operator to prove an equivalent level of safety to the local OCMI.

The Coast Guard published further guidance for enhancing the safe operation of high-speed craft in NVIC 5-01 and NVIC 5-01 Change 1. These documents address manning, crew training, vessel operations and navigational safety equipment. For purposes of the guidance, high-speed vessels are those that operate at speeds of 30 knots or more. Again, while sole state high-speed craft vessels should be examined in accordance with the requirements for their particular state, due consideration should be given to the Coast Guard recommendations for these vessels. It is of particular note that NVIC 5-01 was developed as a joint work product of the Coast Guard and industry partners engaged in high-speed passenger vessel operations.

In general, NVIC 5-01 provides:

- Recommended guidelines for crew training including,
    - Position prerequisites for each individual crew position, addressing minimum requirements and essential duties/responsibilities.
    - Training methodology, clearly stating training objectives, qualification and evaluation criteria, who will conduct the training, where it will be held, documentation, refresher training, etc.
- Recommended content for a Vessel Operations Manual including,
    - Vessel-specific characteristics and critical system specifications
    - Routine operating procedures (e.g., startup/shutdown, loading, docking)
    - Service and maintenance procedures
    - Emergency procedures
    - Route-specific considerations and procedures (e.g., weather, regulated navigation areas, etc.)
- Minimum levels of bridge navigation and communications equipment

NVIC 5-01 Change 1 goes on to address manning issues for high-speed passenger vessel operations. Without a specific regulatory requirement for a two-person bridge team, many operators were already doing so, and "growing" the skill sets needed for operating high-speed craft. Clearly, there was a need to define the circumstances under which a two-person bridge team was warranted. As a basis, certain skill sets were identified for bridge manning, including:

- Collision avoidance
- Local knowledge
- Knowledge of piloting techniques
- Comprehensive knowledge of vessel characteristics and operating limitations
- A set of emergency preparedness and evacuation procedures that encompassed emergency response skills
- Multi-tasking skills
- Physical characteristics
- Crew endurance management
- Demonstrated night operations skills

To evaluate the challenges facing each particular vessel's bridge team, NVIC 5-01 Change 1 provided the Challenge Assessment Tool (CAT) and Manning Evaluation Matrix (MEM). These tools are designed to be used as part of an iterative process between the vessel's operator and the local OCMI, to ensure that all relevant issues are addressed and safety is optimized.

For further consideration, the Coast Guard's and Coast Guard Auxiliary's own Boat Crew Seamanship Manual lists best practices for boat operations, crew training, and certification. Team coordination is stressed, particularly as it relates to emergency response.

Reference material

NVIC 1-91 and 1-91 CH 1, Recommended Qualifications for Small Passenger Vessel Deckhand
NVIC 6-91, Fire Drills and On-Board Training
NVIC 5-01 and 5-01 CH 1, Guidance for Enhancing the Operational Safety of Domestic High-Speed Vessels
Commandant Instruction M 16114.5C, Boat Crew Seamanship Manual

Chapter

12

Stability & Subdivision

PRINCIPLES OF STABILITY:

An inspector should have a basic understanding of vessel stability. Since poor stability has been a causal factor in numerous marine casualties over the years understanding how boats react under different loading conditions is crucial. A marine inspector needs a good understanding of the principles of stability and how to apply the regulations to vessels operating in commercial service. Especially important is the understanding on how or when structural changes in a vessel effect vessel's stability/survivability; thereby, requiring a new stability test or submission of new calculations.

Equilibrium: A floating body is acted on by forces of gravity and forces of buoyancy. The algebraic sum of these forces must equal zero if equilibrium is to exist.

States of stability: Objects exist in three states of stability:

- Stable (positive stability)
- Neutral
- Unstable (negative stability).

A vessel's state of stability can be changed by adding or removing weights (solid or liquid), shifting weights or when the hull is breached allowing water to flood one or more compartments (adding weights).

PRINCIPLES OF STABILITY

DEFINITIONS:

Archimedes Principle: states that an object floating in a liquid will displace a volume of liquid equal in weight to the weight of the object.

Displacement: The weight of water that a vessel displaces expressed in long tons. It is designated by the symbol Δ .

- Since Δ is equal to weight of water displaced by the ship's underwater volume, it is possible to calculate Δ by using the following formula:

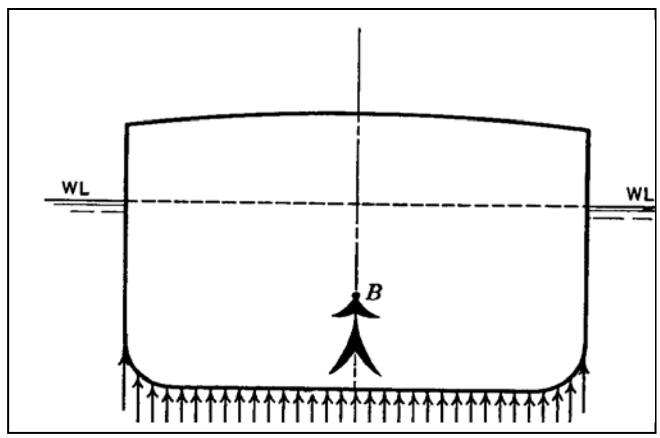
$$\Delta = V \text{ x } \frac{\text{vsl in long tons}}{35 \text{ feet}}$$

V = vessel underwater volume
(35 cubic feet of sea water = 1 long ton)

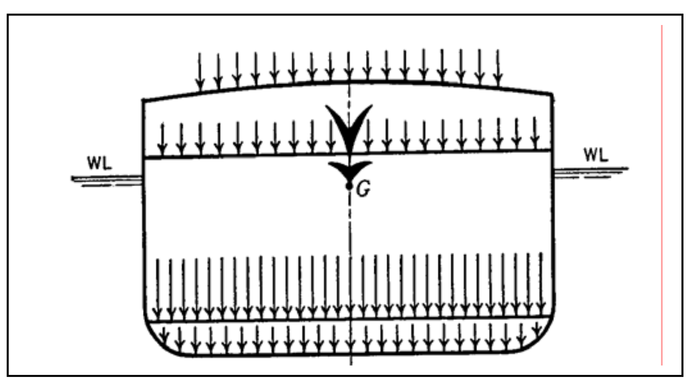
- The weight of a vessel is always expressed in long tons. A long ton equals 2240 pounds.

Buoyancy: The force, which supplies vertical support to a vessel. It is dependent upon the specific gravity of the liquid in which the vessel floats.

Center of buoyancy (B): The point at which all of the buoyant forces acting vertically upward are considered to be concentrated. It is located at the geometric center of the underwater portion of the vessel. Designated by the letter B.



Center of gravity (G): The point at which all forces of weight acting vertically downward are considered to be concentrated. It is the center of mass of the vessel, designated by the letter G.

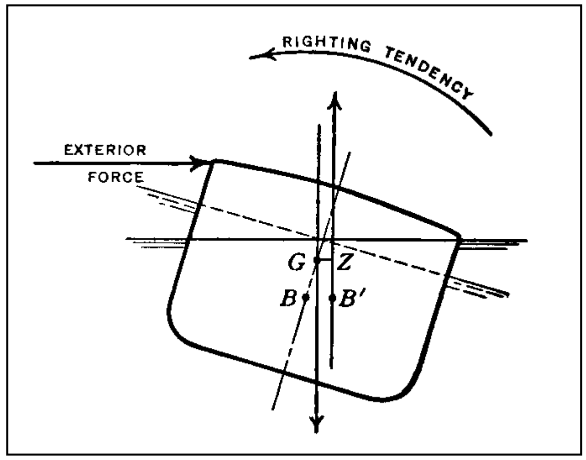


Metacenter (M): The

point at which a vertical line from the center of buoyancy during heel intersects a line from the keel through the original center of buoyancy when the vessel was upright, designated by the letter M.

Metacentric height (GM): The primary indicator of initial stability of a vessel. It is the distance between the center of gravity and the metacenter, designated by the letters GM.

Righting arm (GZ): The horizontal distance between the center of gravity and the center of buoyancy, designated by the letters GZ.



Positive stability: The condition of a vessel in which the forces of gravity and buoyancy act in such a manner to cause the vessel to return to the upright position after an inclining force has been applied.

Negative stability: The condition existing when the force of gravity and the force of buoyancy act in such a manner to upset the vessel from the upright position after an inclining force has been applied.

ARCHIMEDES LAW:

An object floating or submerged in a liquid is buoyed up by forces equal to the weight of the liquid it displaces. The weight or displacement represents the effect of gravitational forces.

When a vessel is floated, it settles in the water until the weight of the liquid displaced by the underwater volume is equal to the weight of the vessel. At this point, the forces of gravity and buoyancy are equal; the vessel is in equilibrium.

We may regard the total forces of gravity as acting vertically downward. Likewise, the forces of buoyancy are regarded as acting vertically upward at one point located at the geometric center of the vessel's underwater body through the center of buoyancy (B).

EFFECTS ON THE CENTER OF BUOYANCY:

As the vessel's draft increases, the center of buoyancy rises with respect to the keel.

When a vessel is inclined due to some external force (winds, waves), the center of gravity remains the same (unless weights aboard are allowed to shift), but the center of buoyancy will move since it is the center of the volume of the underwater body which is changing.

- It is this movement of B off the centerline, which results in a tendency for the vessel to return to its original position. This tendency is caused by a "couple" or a "moment."

MOMENTS AND COUPLES:

A couple is formed whenever two equal forces are acting on a body in opposite directions and along parallel lines.

- In the case of a vessel, the equal forces are the forces of gravity and the forces of buoyancy.

- As B shifts off centerline and G remains fixed, the two forces are acting in opposite directions along parallel lines. A COUPLE is formed.

When the couple is expressed as a force, (weight) times a length, it is called a moment.

The greater the weight of the vessel, the greater the righting moment. The greater the distance between the lines of force of G and B, the greater the righting moment. Since in most cases displacement does not change, the size of the righting moment can be a relative indication of a vessel's stability.

When draft is increased, righting arms are reduced and righting moments are decreased as a result of the decreased righting arm.

INFLUENCES ON METACENTRIC HEIGHT (GM):

Metacentric height acts as a measure of the righting arm for angles of heel less than 7 degrees.

If M is above G, the metacentric height is positive. The moments that develop when the ship is inclined are righting moments.

If M is below G, the metacentric height is negative. The moments that develop are upsetting moments.

When the metacentric height is large, the righting arm at small angles of heel is also large. The ship will resist roll and is said to be stiff.

Smaller metacentric heights are sometimes desirable for slow, easy rolls.

Movement of the metacenter is dependent on the position of the center of buoyancy. The height of the metacenter above the keel increases as the draft of the vessel decreases.

EFFECTS OF WEIGHT SHIFTS:

If one weight in a system of weights is moved, the center of gravity of the whole system moves along a path parallel to the path of the weight that was moved.

If a weight is moved straight up a vertical distance on a small passenger vessel, the vessel's center of gravity will move straight up on the centerline and result in a decrease in the righting arm, thus lessening the vessel's stability.

If a weight is moved horizontally, the center of gravity will shift athwartships and parallel to the weight movement.

STABILITY REGULATIONS

The new T-boat regulations (46 CFR 178.115) apply only to vessels built on or after March 11, 1996. Vessels built before this date may comply with the regulations applicable to vessels on March 10, 1996, or the regulations of new Subchapter T. For the purposes of simplified stability tests, there is very little difference between the new and the old regulations.

INTACT STABILITY STANDARDS

There are two ways to verify intact stability. One is to conduct an inclining experiment and the other is to conduct a simplified stability proof test.

46 CFR 178.310:

Inclining experiments: Conducted on the following vessels:

- Vessels greater than 100 GT,

- Vessels greater than 65 feet in length,
- Vessels that carry more than 150 passengers on domestic voyages,
- Vessels that carry more than 12 passengers on an international voyage, and
- Vessels whose stability is questioned by the OCMI. This is usually a vessel that failed the simplified stability test and still wants to operate at that particular loading, or a vessel of unusual design.

Simplified stability tests: Conducted on the following vessels:

- Vessels less than 65 feet in length;
- Vessels that carry not more than 150 passengers on domestic voyages;
- Vessels that carry not more than 12 passengers on an international voyage; and
- Vessels that have not more than one deck above the bulkhead deck, exclusive of the pilothouse.
- Pontoon vessels

INCLINING EXPERIMENT PROCEDURES

The purpose of this test is to determine the lightship characteristics of the vessel.

NVIC 17-91 and 46 CFR 178.310:
The owner's naval architect conducts this test. The marine inspector is only there to witness the test and identify unacceptable conditions or procedures when they occur.

Events: The following is a brief description of the events that take place during an inclining experiment:

- All items/weights which need to be added, removed, or moved to reflect the actual lightship condition of the vessel are identified.
- The contents of all tanks are identified.

- Freeboard readings are taken to establish the waterline. This information will be used to calculate the displacement of the vessel.

- The specific gravity of the seawater is established. This information will also be used to calculate the displacement of the vessel.

- Once the displacement is calculated, the draft marks are verified.

- All this information is used to plot a line to indicate a hog or sag if any exists.

- Weights are then moved in increments and the degrees of inclination are recorded.

When the inclining is complete the naval architect will take all the data with him and calculate the lightship characteristics of the vessel. The naval architect's calculations are then reviewed and approved by the Coast Guard Marine Safety Center.

SIMPLIFIED STABILITY TESTS

PASSENGER CRITERIA (46 CFR 176.113):

Passenger allowance is determined by one of the following criteria:

Length of rail criteria: One passenger for each 30 inches of rail at the sides and stern.

Deck area criteria: One passenger per 10 square feet of deck area except in the following areas:

- Area where fixed seating is used;

- Concession stands;

- Toilets and washrooms;

- Companionways and stairways;

- Spaces for lifesaving gear;

- Spaces below deck unsuitable for passengers;

- Interior passageways less than 34 inches wide and open deck passageways less than 28 inches wide; and

- Aisle area provided in accordance with 46 CFR 177.820(d).

Fixed seating criteria:

- One passenger for each 18 inches of width of fixed seating.
- Each seating area must be calculated as a separate number. (no partial bottoms)

Seating and deck area can be combined for different areas on the same deck.

Note: If the stability test fails with the number of passengers calculated with the above criteria then the test may redone with fewer passengers. If the vessel passes the test in the second condition, the vessel's file must clearly indicate that the passenger capacity is limited due to stability considerations.

STABILITY TEST PROCEDURES AND CALCULATIONS:

Like the inclining procedure, the simplified stability test is conducted by the owner or his representative. The Coast Guard is there to verify the validity of the test. This is done by using form CG-4006, "Small Passenger Vessel Stability Test Procedure." The marine inspector is to fill the form out and take the measurements necessary to validate the test.

Events: The following is a brief description of the events that will take place during a simplified stability test (46 CFR 178.330):

- The vessel is checked for completeness in all respects and all of the required equipment is placed on board.

- The weight of the passengers to be carried is placed on board. The weight is to be simulated by equivalent deadweight.

- The wind's relative direction and velocity is noted so that the test can be conducted so as to create a worst case result.

- The vessel's mooring arrangement is noted and monitored to ensure that it does not interfere with the test.

- The vessel's dimensions are verified.

- All tank locations, capacities and contents are documented.
- All permanent ballast weights and locations are recorded.
- The test weight is distributed to ensure the vessel is on an even keel.
- A reference mark is placed on the hull to establish the maximum immersion that can take place during the test.
- The required heeling moment is calculated.
- The weight is moved in increments to achieve the required heeling moment. The reference mark must be checked after each movement of the weight.
- Pass/fail is determined by the position of the reference mark after the required heeling moment has been achieved.

STABILITY LETTERS (46 CFR 178.210)

Stability letters are issued by the OCMI following satisfactory completion of a simplified stability test. The OCMI or the MSC will issue the stability letter for vessels that pass a required inclining experiment.

CONCLUSION

We have seen how the effects of gravity and buoyancy determine the stability of a vessel. The addition or modification of vessel structures or equipment may add or detract from vessel safety. The regulations address stability, route and maximum number of passengers based on the type of vessel and the results of tests conducted by the marine inspector. It's imperative that you remember these principles and use them to evaluate the vessel's stability.

References:

G-MOC Policy Letter
http://www.uscg.mil/hq/g-m/nmc/pubs/msm/v4/c6.htm
http://www.tc.gc.ca/marinesafety/Tp/tp14070/11-vessel-stability.htm#11_more_info
http://www.brayyachtdesign.bc.ca/
NVIC 14-81
NVIC 17-82
NVIC 12-83
NVIC 3-89
NVIC 17-91 Guidelines for conducting stability tests

Chapter

12

Suggested Reading

1. International Marine/McGraw-Hill
   The Boatowners Guide to Corrosion
   Everett Collier
   P.O. Box 547, Blacklick, OH 43004
   1-800-262-4729
2. International Marine/Ragged Mountain Press
   Boatbuilding Manual
   Robert M. Steward
   P.O. Box 547, Blacklick, OH 43004
   1-800-262-4729
3. W.W. Norton & Company
   Details of Classic Boat Construction
   Larry Pardey
   500 5th Ave
   New York, NY 10110
4. Gulf Publishing Company
   The Boat Repair Manual
   George Buchanan
   P.O. Box 2608
   Houston, TX 77252-2608
5. McKay Press
   The Gougeon Brothers on Boat Construction Wood & West System
   Materials
   P.O. Box X908
   Bay City, MI 48707
6. Wooden Boat Publications
   Planking & Fastening
   Peter H. Spectre
   P.O. Box 78
   Brooklin, ME 04616-0078

7. Sheridan House Inc.
   Surveying of Small Craft Third Edition
   Ian Nicolson
   145 Palisade Street
   Dobbs Ferry, NY 10522
8. International Marine
   What Shape is She In? A Guide to the Surveying of Boats
   Allen H. Vaitses
   12 Elm Street
   Camden, ME 04843
9. International Marine
   Boatowners Mechanical and Electrical Manual
   Nigel Calder
   P.O. Box 547, Blacklick, OH 43004
   1-800-262-4729
10. International Marine
    The New Cold-Molded Boatbuilding
    Reuel B. Parker
    P.O. Box 547, Blacklick, OH 43004
    1-800-262-4729
11. Hearst Marine Books
    Chapmans Nautical Guides Emergencies at Sea
    Sid Stapelton
    9 West 19th Street
    New York, NY 10011

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