FireWise CONSULTING LEARNING ACADEMY

CHAPTER 17 PART 2
MARINE FIRE INVESTIGATION

TYPES OF MARINE

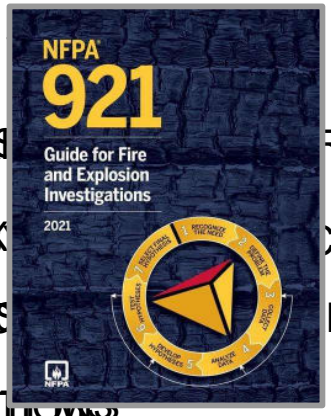
SAFETY CONCERNS

IDENTIFYING THE SYSTEMS

MARINE VESSEL CONSTRUCTION

PROPULSION SYSTEMS

SOURCES OF IGNITION



CH. 29

RE SCENES

CTIONS

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Welcome to **Part 2 of Chapter 17, Automobile, Marine and Equipment Fires which will cover** Marine Fire Investigations.
If you are following use in NFPA 921, 2021 edition we are covering Chapter 29 Marine Fire Investigations

In this chapter we will discuss:

- The different types of marine vessels,
- Safety concerns that are unique to marine fire investigations,
- The importance of identifying the different systems and functions at work on the vessel, as well as
- The importance of knowing the basics of marine vessel construction,
- The types of propulsion systems commonly found on marine vessels and how they relate to marine fire investigations,
- The potential sources of ignition,
- How cargo issues relate to marine fire investigations,
- How to document marine vessel fire scenes, and
- How to go about marine vessel examinations, as well as
- The additional considerations of marine vessels in structures and finally,
- The specific legal considerations surrounding marine fire investigations.

CASE STUDY

Hundreds evacuated in ship fire

By Roger Stonehewer and Norman Gidney

Photo cour

Why is it important for a fire investigator to know about the considerations surrounding a marine fire incident? To answer this let's look at a case history.

The following is a news report:

A stubborn fire aboard a Russian factory ship being worked on in a Canadian dry dock forced the evacuation of hundreds of nearby residents.

A huge cloud of black smoke covered the City after the 345-foot (105-meter) Gijon caught fire. The Gijon, built in 1993 and owned by the Vladivostok Based Trawling & Refrigerator Fleet, was in for what officials called cosmetic repairs.
Police said the blaze began Thursday when a spark from a welder's torch went into an oil tank, sparking a small fire that spread rapidly.

Crew members and shipwrights working on the refit were evacuated safely, and later, explosions rocked the vessel, sending flames into the sky.

Police evacuated 400 nearby residents, concerned about the potentially toxic fumes from ammonia stored aboard the trawler for fish processing.

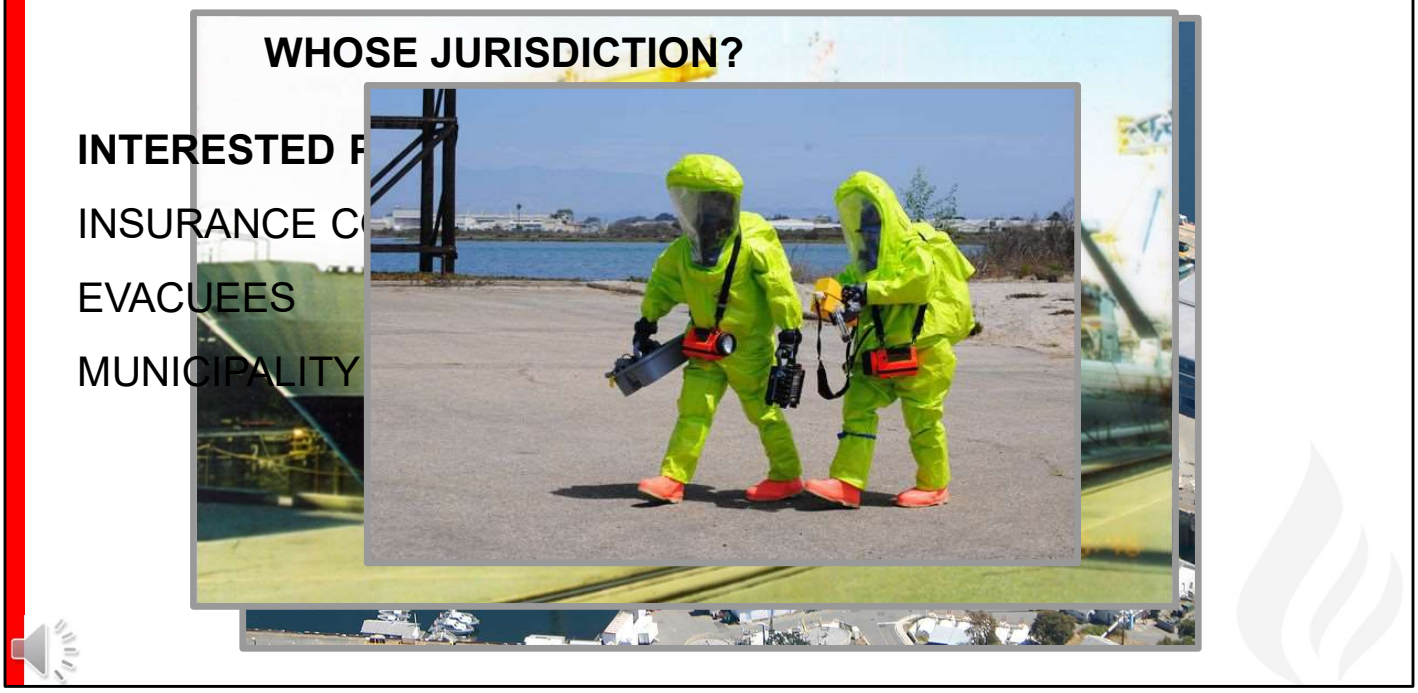
The thick smoke was caused by a polyvinyl chloride pipe stored for the refit, and 30 hours after the fire began, it was still smoldering.

At its height, some 100 firefighters tackled the blaze.

By Monday, the fire was declared under control and residents had returned to their homes, but two crews of firefighters continued to go through the vessel, compartment by compartment, extinguishing small pockets of fire.

No injuries were reported.

CASE STUDY



The ship in this photo is a sister ship to the Gijon.

At the time, it was estimated that the loss would be in the neighborhood of 115 million dollars.

The municipality contacted the Office of the Fire Commissioners on the Sunday after the fire requesting assistance with the investigation and to see if the OFC could recommend an expert in shipboard fire fighting and fire investigation. The OFC called Dr. DeHaan who said he did not have the expertise required in this area but he did recommend five or six experts from around the world. The OFC contacted the experts only to find that all of them were already on retainer by other interested parties in the investigation.

As with many large dollar loss fires, numerous insurance companies had vested interests in the outcome of the fire. The people that were evacuated also had a stake in the outcome as did the municipality.

Hazardous materials were a significant issue for the fire investigation team and haz-mat teams had to constantly monitor the situation for the investigators.

Jurisdiction was also an issue investigators needed to deal with. The ship was on federal land so was the Federal government or the Province responsible for the

investigation? The provincial fire commissioner assumed jurisdiction with the agreement of the feds.

The site investigation went on for several weeks with the final report taking several months and legal actions were pending for years.

One of the fire investigators quipped that “On the day of the fire everyone could speak English but the day after the fire nobody could speak English.”

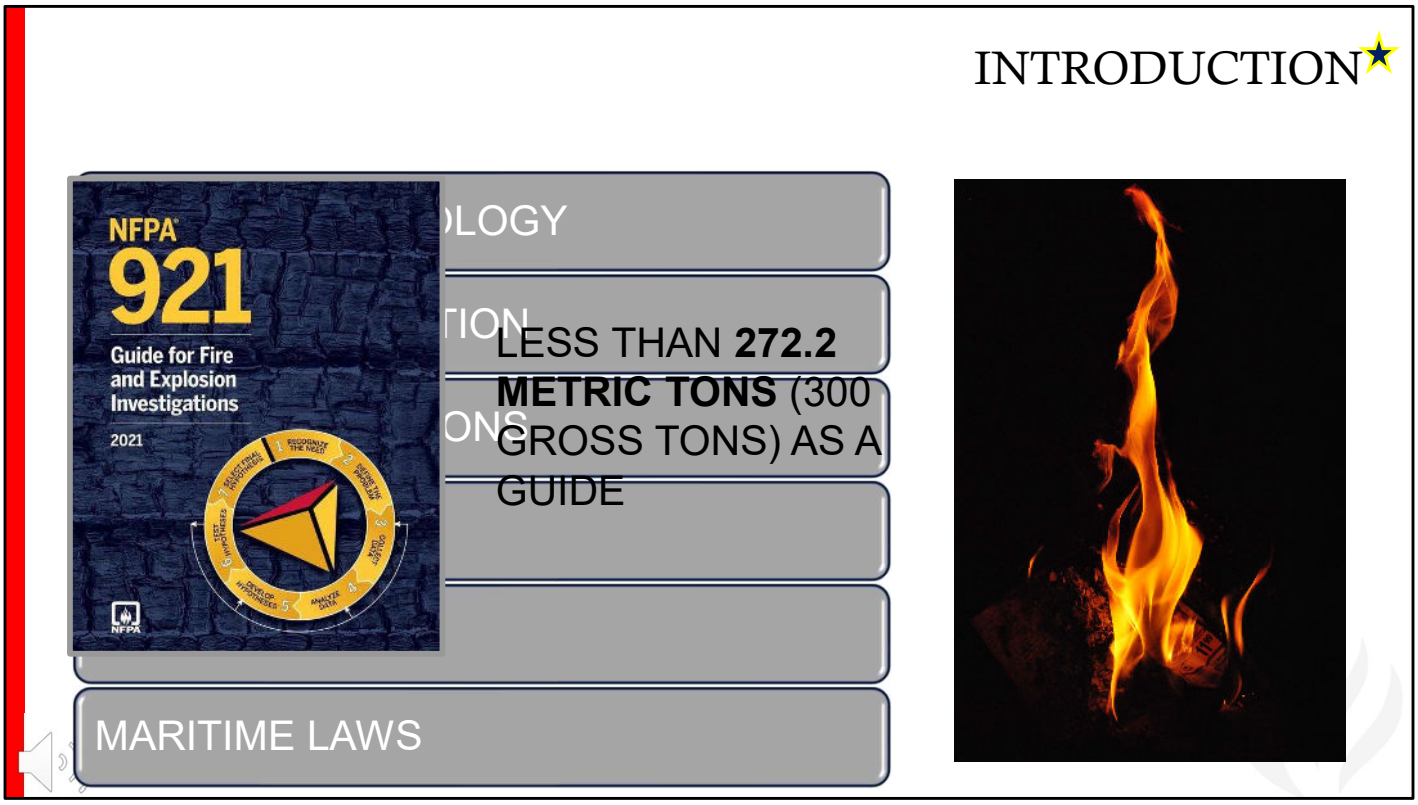
INTRODUCTION

COMPARTMENT FIRES

VEHICLE FIRES

INDUSTRIAL FIRES

Marine fire investigations are some of the most challenging in the field, as they require knowledge of so many different kinds of fires. On a marine vessel you can have compartment fires, vehicle fires or even industrial fires. In addition to the different kinds of fires, the definition of a marine vessel can range from a small recreational boat less than 20 ft long to an enormous carrier thousands of times larger…And then there is the variable locations a fire incident can occur- on the water, thousands of miles offshore, at a dock or even on land.



When investigating marine fires, you must have a good grasp of fire dynamics, but you also need to be familiar with marine terminology, ship construction, the operations of a vessel, marine safety and fire protection regulations as well as the local and international maritime laws.

Because of the wide range of vessels, NFPA 921, *Guide for Fire and Explosion Investigations* was written using boats that are less than 272.2 metric tons (300 gross tons) as a guide. Most marine fires occur on these boats of which there are hundreds of thousands.

MARINE VESSEL TERMINOLOGY

GLOSSARY OF TERMS

AFT – REAR OF VESSEL

ASHORE – ON LAND

BEAM – WIDEST PART OF VESSEL

BELOW – BENEATH THE DECK

CABIN – COMPARTMENT FOR CREW

CAPSIZE – TURN OVER

CHAIN PLATE – USED TO FASTEN SHROUDS/STAYS

Before beginning a marine fire investigation, it is important the investigator understand the proper terminology to use when speaking of a marine vessel. Here is a quick glossary of terms you are likely to encounter when investigating a marine fire:

- *Aft* refers to the rear of the vessel.
- *Aground* means touching the bottom, as in run aground.
- The *beam* is the widest part of the vessel,
- *Below* refers to beneath the deck,
- A *cabin* is a compartment for passengers and crew,
- *To capsize* means to turn over,
- A *chain plate* is a metal plate used to fasten the shrouds or stays, or in other words, the ropes or wires used to stabilize the masts.

MARINE VESSEL TERMINOLOGY

GLOSSARY OF TERMS

DOCK – WHERE BOATS ARE MOORED
FREEBOARD – VERTICAL DISTANCE BETWEEN WATERLINE & GUNWALE
DORADE VENT – ALLOWS AIR TO PASS BUT NOT WATER
GALLEY - KITCHEN
FENDER – BUFFER BETWEEN VESSEL & PIER
GEAR – MARINE EQUIPMENT
FORWARD – FRONT OF SHIP

- A *dock* is a protected water area where people moor their boats. This is usually a pier or a wharf.
- A *dorade* vent is a deck box that allows air to pass through the cabin or engine room while keeping the wet stuff such as rain, spray and sea wash out.
- A *fender* on a boat serves the same purpose as one on a car: it is there as a buffer zone between the vessel and the pier.
- *Forward* means the front of the ship,
- The *Freeboard* is the vertical distance between the waterline and the gunwale, which is
- the upper edge of a marine vessel's side
- The *galley* is the kitchen,
- *Gear* refers to marine equipment such as ropes, blocks and tackle,

MARINE VESSEL TERMINOLOGY

GLOSSARY OF TERMS

PORT – LEFT SIDE

STARBOARD – RIGHT SIDE

RUB RAIL – BUMPER RAIL ON SIDES OF VESSEL

WATERLINE – PAINTED LINE ON HULL INDICATING THE POINT TO WHICH A VESSEL
VESSEL WILL SINK WHEN IT IS PROPERLY TRIMMED

SOLE – CABIN FLOOR, TIMBER EXTENSIONS UNDER RUDDER, OR MOLDED FIBERGLASS DECK OF COCKPIT

- *Port* means the left side in nautical speak.
- The *Rub rail* is the bumper, made out of either rubber or metal that runs along both sides of the vessel usually just below the gunwales,
- *Sole* refers to either the cabin floor, the timber extensions under the rudder, or the molded fiberglass deck of a cockpit,
- *Starboard* means the right side of the boat and finally,
- The *waterline* is the line painted on the hull indicating the point to which a boat sinks when it is properly trimmed.

TYPES OF VESSELS

COMMERCIAL

- FISHING BOATS
- CONTAINER SHIPS
- FERRIES
- RECOVERY VESSELS
- OIL TANKERS
- SPEED BOATS

There are a great many types of marine vessels, each of them with their own specific use. The recreational or personal vessels include but are not limited to:

- Jet skis,
- Wave runners,
- Runabouts,
- Catamarans,
- Sailboats and
- Speedboats.

On the commercial vessel side, you would find vessels such as:

- Fishing boats,
- Container ships,
- Ferries,
- Recovery vessels, and
- Oil tankers.

MARINE FIRE BURN PATTERNS

DIFFERENCES IN FIRE PATTERNS

Fire investigators have to be aware of the differences between the way a fire has been fought at sea as opposed to one that has been fought on land as it might affect fire pattern development. Although some people argue that a fire pattern is a fire pattern no matter where, the way marine crafts are constructed and the way they operate can be the cause of differences in the interpretation of fire ignition, in the fire growth and pattern development.

- (U.S. Coast Guard photo courtesy Station Coos Bay)
- National park service photo

MARINE FIRE BURN PATTERNS

DIFFERENCES IN FIRE PATTERNS

- COMMON INSTANCES OF FLAMMABLE ATMOSPHERES
- HEAVY SEAS
- VENTILATION EFFECTS OF WATERTIGHT INTEGRITY
- HIDDEN SPACES
- BOUNDARY COOLING
- HIGHLY CONDUCTIVE STEEL BULKHEADS

Some of the factors that may cause these differences include:

- Common instances of flammable atmospheres,
- The ventilation effects caused by maintaining water tight integrity at the time of or after a fire has been started,
- The highly conductive property of steel bulkheads,
- Six-way heat transfer to surrounding spaces,
- Hidden spaces or those that are rarely accessed,
- The subsurface effects of boundary cooling,
- The way the shipboard moves during heavy seas,
- The panoply of hazardous materials found on a ship,
- The effects of wind,
- Air in the fire compartment,
- Using saltwater for firefighting, and finally,
- The different ways one would fight a shipboard fire as opposed to a land-based one.

MARINE FIRE INVESTIGATION SAFETY

MAKE SURE IT'S SAFE & STABLE

WEAR PPE

RELY ON SKILLED DIVERS

DE-ENERGIZE ELECTRICAL

DEWATER THE CRAFT

Fire investigation safety takes on unique importance when dealing with marine vessels, especially if they are afloat. You need to be aware of a vessel having taken on too much water and vessel instability.

Here are some important rules of thumb to keep in mind when conducting a marine fire investigation:

- Before investigating a marine vessel, always make sure it is safe and stable enough to board and that it will remain so during the investigation,
- Always wear the appropriate level of personal protective equipment while conducting the investigation,
- Marine crafts still afloat might be in danger of falling over or capsizing due to taking on too much water- if this is the case, make sure to remove the water (dewater) the craft and stabilize it before proceeding,
- If you can't take the boat out of the water, a personal flotation device should be worn.
- If the boat has sunk, you might have to rely on skilled divers and finally,
- De-energize any electrical service, whether it be shore-based or from an onboard battery system to avoid being shocked or electrocuted.

MARINE FIRE INVESTIGATION SAFETY

Marine vessels are usually compartmentalized in order to contain the water in the event of a flood. These spaces are small and can only be accessed one way, posing some unique safety risks.

Before entering such a space, an investigator should make sure the air is safe to breathe by monitoring for any hazardous levels of ignitable gases, toxic vapors or oxygen rich or oxygen deficient environments. Always use the same procedures you would for any other confined space entry.

Remember to use an appropriate level of PPE and to make sure that any lighting or equipment is using the “intrinsically safe” protection feature.

Many boats are made out of fiberglass. When fiberglass burns, the resin is consumed and small particles of glass fibre are left in the air, which can be very harmful to a person’s respiratory function. Make sure to use appropriate respiratory protection during an investigation such as a self-contained breathing apparatus (SCBA) or a particulate filter mask and always monitor the air, especially if you arrive right after the fire has been extinguished.

MARINE FIRE INVESTIGATION SAFETY

LOCATE & DISABLE ALL ELECTRICAL SOURCES

ATMOSPHERIC MONITORING

PHOTOGRAPH & DIAGRAM

DE-ENERGIZE SHORELINE, THEN DISCONNECT

There are many possible different sources of electrical power on boats. Before the investigation can begin, it's important for the investigator to locate and disable them not only for personal protection but to make sure to prevent another fire from occurring.

All electrical sources should be photographed and diagrammed before being touched.

Batteries are a common source of electrical power on board marine vessels. Because there is a possibility of an electrical arc occurring when a cable is disconnected from a battery, the investigator has to make sure the conditions for an explosion are not present by conducting atmospheric monitoring before disconnecting anything. Remember that hydrogen gas can be located in battery compartments and that electrical arcs and static charge need to be prepared for in advance before disconnection.

If there is an inverter present, disconnect the DC input.

Shore lines may be a possibility, especially if the boat is docked. De-energize the shore line and then disconnect it from the boat.

MARINE FIRE INVESTIGATION SAFETY

MARINE FLUIDS, LUBRICANTS & OIL

- HYDRAULIC FLUIDS
- ANTIFREEZE
- ENGINE OIL

Marine vessels can also have a lot of different fuels and gases aboard, all with different purposes, such as fuels that are used for cooking and heating and fuels to propel the boat. It is important for the investigator to be aware of all these systems because a leak in one of them can pose significant fire or explosion risks, especially if the gas migrates to an unsuspected area of the vessel.

In addition to fuels, a vessel can contain various fluids, lubricants and oil that are not only fire hazards, but also dangerous to the environment. These can include:

- Hydraulic fluids,
- Antifreeze,
- Engine oil, as well as
- Many other lubricants.

If these leak, in addition to the hazards mentioned above, they can also cause a slippery, dangerous walking surface for the investigator.

Some marine vessels may also contain sewage holding tanks, where methane gas will be present. The investigator must make sure there is proper ventilation to reduce the risk of explosion. They should also be aware that there might also be biohazards present.

MARINE FIRE INVESTIGATION SAFETY

INSPECT THE DECK AND WALKWAYS

Structural concerns take on new meaning when speaking of a marine vessel, especially if it is still on the water. Either through the act of fighting the fire or because of the damage caused by the fire itself, water may have flooded the bilges, or lower sections of the boat, making it extremely unstable. This is one of the greatest risks to the marine fire investigator making it essential that they ensure the vessel is stable before beginning their investigation. Because if it lists or capsizes, there is a very real danger of the investigator being trapped inside the vessel.

In addition to water filing up the bilges, just like any other fire, there can also be other structural damage that come with their own hazards. After the investigator has determined the vessel to be stable, they should inspect and sound the deck and other walkways to make sure they won't collapse. This is done the way an investigator would do it in a regular structure, by using a tool to test the integrity of the surface in front of them.

The vessel might also have vertical or horizontal openings that allow access to different parts of the vessel. Though some of these might be visible, others might be hidden behind hatches, doors and covers. If there is flooding and they are indeed hidden, these concealed, unprotected openings can pose a great risk to the investigator.

MARINE FIRE INVESTIGATION SAFETY

[illegible] TO REMOVAL

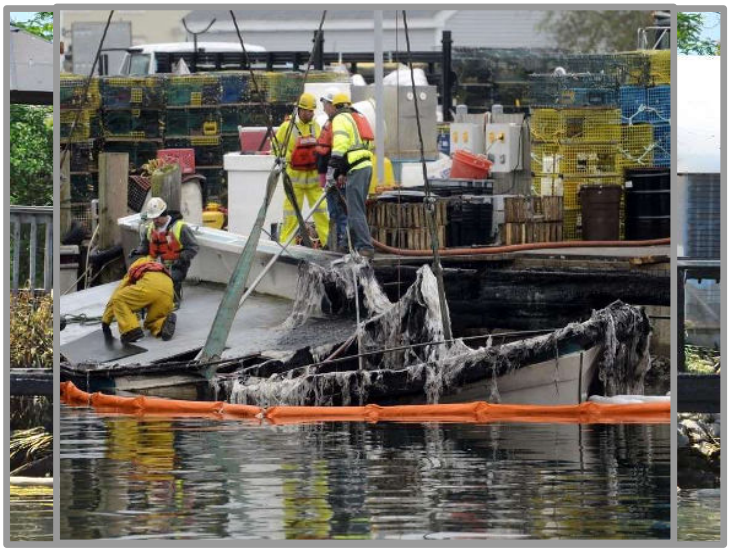
MONITOR & MANAGE

Remember that wharves, docks and jetties are often slippery due to water constantly sloshing on them. They may also be structurally unsound due to disrepair or because of damage from the fire. The investigator should exercise caution when navigating these surfaces, especially when boarding and disembarking from the marine vessel.

In the case of submerged marine vessels, the vessel should be thoroughly documented and photographed before being taken out of the water. However these are unique kinds of investigations and require specialized personnel. The investigator's responsibilities during the recovery is to monitor and manage the operations. Like in all investigations, care should be taken to minimize damage or alter as little as possible. As well, the investigator should be aware of any fuel or other fluids leaking into the water.

Finally, pyrotechnic signal flares, or visual distress signals, might also be present on the vessel and constitute a high risk of explosion. If discovered, they should be immediately secured to prevent activation.

IDENTIFYING SYSTEMS & FUNCTIONS



As we have already seen above, marine vessel fires pose unique challenges to the safety of investigators. But it doesn't stop there. There are many different systems and components at work on marine vessels— the investigator needs to be able to recognize and identify if they had a role in the cause of the fire, which means they must be familiar with the systems and components themselves. But it isn't as easy as it sounds; the wide spread use of combustible materials such as foam, plastics and wood can make the identification process of components difficult. The plus side is that the non-combustible items will usually survive and therefore be examinable.

FUEL SYSTEMS: PROPULSION & AUXILIARY

MOST COMMON ARE **GAS OR DIESEL ENGINES**

SAFETY FEATURES:

BACKFIRE FLAME ARRESTORS

SPECIALIZED GASKET TO STOP FUEL ESCAPING

MILITARY VESSELS - DIRECT DRIVE **DIESEL** OR **NUCLEAR** POWER PLANTS

Depending on the type of propulsion system and vessel, the investigator could encounter many different kinds of fuels. The most common type of propulsion systems use gas or diesel engines. Military vessels are propelled by direct drive diesel engines or nuclear power plants that generate heat to operate the steam boilers.

Here are a few aspects to consider when thinking of engines designed for marine propulsion:

- The Vacuum/Low Pressure Carbureted inboard/outboard engines found on boats have a certain safety feature in case flooding occurs: these types of engines all must have back flame arrestors and a specialized gasket that will stop fuel from escaping the Venturi opening.

FUEL SYSTEMS: PROPULSION & AUXILIARY

HIGH PRESSURE, MARINE FUEL INJECTION SYSTEMS

- THROTTLE BODY
- PLENUM
- FUEL RAIL ASSEMBLY
- KNOCK SENSOR
- ENGINE CONTROL MODULE

TAKE DOWN THE SERIAL # MAKE & MODEL

- High pressure/Marine fuel Injection Systems: These operate at high pressure (like their name suggests) and vary from manufacturer to manufacturer. However they all have in common the following features:
    - Throttle body,
    - Plenum,
    - Fuel rail assembly,
    - Knock sensor and
    - Engine control module.

To identify the specific design of the engine, the investigator should take down the serial number as well as the make and model.

FUEL SYSTEMS: COOKING & HEATING

- LP SYSTEMS
- COMPRESSED NATURAL GAS
- NOT AS POPULAR
- STORED IN SPACE **<100 FT³**
- COOKING
- HEATING

Because people tend to live on their boats, at least for a period of time, you will also commonly find systems on the boat for cooking and heating similar to those used on recreational vehicles. An investigator must find and identify these systems and determine whether they had anything to do with the fire's development or spread.

Here are a few types of gases commonly used for cooking and heating purposes:

Liquefied-Petroleum gas systems or LP systems, are used for both cooking and heating purposes and come in cylinders which are stored in compartments that vent directly to the outside of the vessel. When LP systems are used, other sources of ignition must be controlled. Appliances that use the LP fuel cylinders of less than 16 ounces are controlled by the American Boat and Yacht council (ABYC) A-30, Cooking Appliances with Integral LPG Cylinders.

These days, the use of compressed natural gas is not as popular as it once was but still may be encountered from time to time. These cylinders are usually stored in an accommodation space of less than 100ft$^{3.}$

FUEL SYSTEMS: COOKING & HEATING

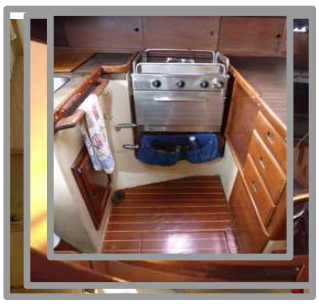
ALCOHOL AS A FUEL SOURCE

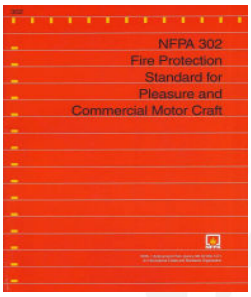
- IN TANKS INTEGRATED WITH APPLIANCE
- IN INDEPENDENT CONTAINER PRESSURIZED BY HAND PUMP

SOLID FUELS GOVERNED BY NFPA 302

DIESEL AND KEROSENE FUELS FOR HEATING AND COOKING

- REPLACE PROPANE TANKS
- REDUCE VAPORS
- DRAW COMBUSTION AIR FROM INSIDE COMPARTMENT
- EXPEL EXHAUST OUTSIDE VESSEL
- RISK OF CARBON MONOXIDE POISONING OR FIRE IGNITION





Frequently, galley ranges will use alcohol as a fuel source. This can be stored two ways:

- In tanks that are integrated with the appliance, or
- In an independent container and pressurized by a hand pump.

Solid fuels, including the use of charcoal and wood, are governed by the NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, which also provides design and installation requirements.

NFPA 302 also provides design and installation requirements for the use of diesel and kerosene fuels for heating and cooking. For instance, stoves powered by this kind of fuel are used most often to replace propane tanks thus reducing the vapors. They work by drawing the combustion air from inside the compartment and expelling the exhaust outside the vessel. If they are not working properly, there is a risk of carbon monoxide poisoning or fire ignition.

EXHAUST SYSTEMS

TURBOCHARGERS HOT EXHAUST GASES

SUPERCHARGERS USE DRIVE BELT

MIGHT USE OIL TO LUBRICATE OR COOL DEVICES

WATER JACKETS, HEAT BLANKETS OR SHIELDS

It is important to keep in mind that some diesel or gas engines might have turbochargers or superchargers installed on them. Like their names suggest, they help to “charge” or improve the amount of horsepower for an engine. Turbochargers work on hot exhaust gases while superchargers use the drive belt of the engine. Because they function at very high temperatures, they might also be using oil to lubricate or cool them. To protect the surrounding materials from the intense heat, these units are often fitted with water jackets, heat blankets or shields.

EXHAUST SYSTEMS

2 KINDS OF EXHAUST SYSTEMS

WET TAKES IN WATER AROUND BOAT INTO SYSTEM

THE WATER MAKES ITS WAY THROUGH THE MUFFLER AND HOSES UNTIL IT IS EXPELLED FROM THE VESSEL

DRY VENTS COMBUSTION GASES THROUGH VERTICAL PIPES COVERED WITH INSULATED MATERIALS

DRY

ABYC P-1

NFPA 302

All combustion engines used for propulsion produce hot gases or exhaust. There are two kinds of exhaust systems: wet and dry. A wet system takes in the water around the boat into the system. The water makes its way through the muffler and hoses until it is expelled from the vessel. There can also be a dewatered system where the water and the exhaust gases are separated at the muffler. The water is then expelled through the transom and the gases through the bottom of the vessel. Both of these systems must conform to the ABYC P-1, *Installation of exhaust systems*, as well as NFPA 302.

Dry exhaust systems on the other hand, vent combustion gases through vertical pipes covered with insulated materials. However, these systems are not commonly found on recreational vessels.

ELECTRICAL SYSTEMS

CORROSION

FIRES CAN HAPPEN **ANYWHERE** IN THE CIRCUIT

Corrosion is a significant problem on board marine vessels. Not only can the metal structure corrode and become unsound, but wiring, connectors and electrical distribution equipment can as well. Once the copper conductors begin to corrode due to constant exposure to saltwater, there can be an increased resistance in the electrical circuits.

Although electrical fires on land usually happen at the connection area, because saltwater can seep under wire or cable insulation, fires can happen anywhere in the circuit.

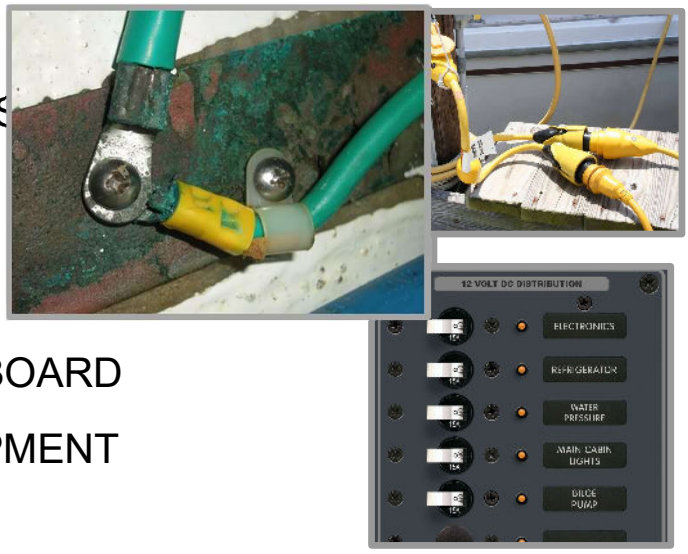
Corrosion can especially be a problem when it comes to AC power supplied through shore-tie connections. If theses systems are exposed for too long to saltwater and/or not properly maintained, the result can be high resistance connections. If a system partially shorts, the overcurrent protection might not kick in and the electrical power will continue to flow, resulting in fires at the plastic or rubberized boots of the shore to vessel connection.

ELECTRICAL SYSTEMS

AC POWER

SUPPLIED BY A S

GENERATORS &



DC POWER

BATTERIES ONBOARD

LIGHTS & EQUIPMENT

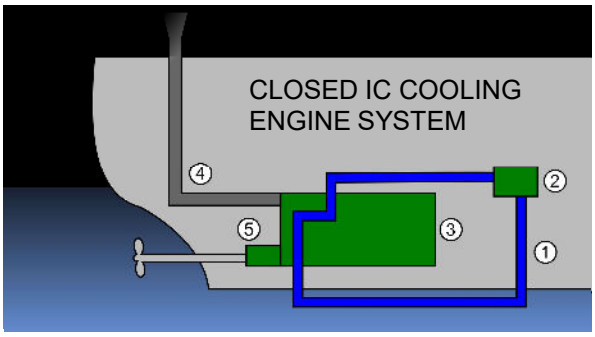
Although topside, or above deck, connections are usually shielded from sea spray and protected against saltwater seepage, it can still happen. Here is another instance, where high resistance connection can occur, causing unequal heating and sometimes fires.

It is important to remember that there can be both AC power and DC power on a marine vessel, supplied by various sources. For example, AC power is often supplied by a shoreline, though generators and inverters can be used for onboard sources of AC electricity. Battery systems on board will provide direct current, usually for supplying power to lights and equipment.

ENGINE COOLING & VENTILATION SYSTEMS

TWO WAYS MARINE VESSELS COOL THEIR ENGINES

1. DRAW WATER IN, CIRCULATE, & EXPEL IT BACK
2. CLOSED COOLANT, 50/50 BLEND OF GLYCOL ANTIFREEZE.
   WATER CIRCULATES THROUGH THEN OUT THROUGH EXHAUST



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There are two ways marine vessels cool their engines:

1. One way is to draw seawater into the engine with a pump, circulate it through the engine and then expel it back from whence it came or,
2. Through a closed coolant system, which uses a 50/50 blend of glycol antifreeze contained in a heat exchanger. Seawater circulates through the heat exchanger and is then expelled through the exhaust system.

ENGINE COOLING & VENTILATION SYSTEMS

GAS TANKS ARE
NATURALLY VENTILATED

COMPARTMENTS ARE
POWER VENTILATED

FLAME ARRESTORS

There are several different ventilation systems that can be found on marine vessels. Many of them have a fuel tank that is permanently mounted and hidden either in the accommodation space or a compartment designed specifically for it. These fuel tanks are obligated to have flame arrestors which are vented through the top of the tank via a hose that leads overboard, or out of the vessel.

Gas tanks are naturally ventilated (that is, not forced), but compartments and associated bilges need to be power ventilated.

As well, most marine vessels have hatches and portholes that, when open, provide natural ventilation to the accommodation space. There may also be dorade and cowl vents which allow for continuous ventilation.

It is important to remember all these ventilation points and how they affect fire movement when conducting a marine fire investigation.

TRANSMISSIONS, ACCESSORIES & HYDRAULIC SYSTEMS

OTHER SYSTEMS TRANSMISSIONS

MECHANICAL TRANSMISSION

POWER STEERING PUMP

REFRIGERATION UNITS HYDRAULIC-GEARED TRANSMISSION

- IN BOARD & HIGH PERFORMANCE ENGINES
- OWN LUBRICATING OIL & COOLER

There are two types of transmissions a marine vessel will typically be equipped with:

- A mechanical transmission or a
- Hydraulic-geared transmission.

In general, hydraulic-geared transmissions will be found in inboard and some high performance inboard/outboard, or IO, engines. If they are using a hydraulic transmission, they will have their own lubricating oil and cooler. However most IO and outboard engines will use mechanical transmissions.

Other systems you may find on a marine vessel include:

- Air conditioners, which use a heat exchanger to circulate seawater through the coils and are usually found in lower accommodation spaces or engine rooms,
- A power steering pump, where a belt-driven pump is attached to the propulsion engine and,
- Refrigeration units which may be powered by AC or DC current, LP gas or a combination of both.

HYDRAULIC SYSTEMS

If LP gas is used in an accommodation space, it must conform to UL 1500 *Standard for Safety Ignition Protection Test for Marine Products.*

EITHER STEER OR ADJUST THE TRIM SETTINGS

A PUMP MOTOR POWERS THE TRIM TABS

STEERING SYSTEMS PUMP-DRIVEN OR MECHANICAL

CLOSED SYSTEMS

RISK IF HYDRAULIC FLUID LEAKS ON ELECTRICAL

Remember that if LP gas is used in an accommodation space, it must conform to UL 1500, *Standard for Safety Ignition Protection Test for Marine Products*.

Finally hydraulic systems can be used to either steer or adjust the trim settings on a marine vessel.
In terms of adjusting the trim settings, a pump motor powers the trim tabs. However, hydraulic steering systems may be either pump-driven or mechanical.

Both are closed systems and do not pose a huge danger of ignition. However, there is a risk if there is a release of hydraulic fluid on any of the electrical components that happen to be near a hot surface.

EXTERIOR CONSTRUCTION

LARGE VESSELS ARE CONSTRUCTED OUT OF HIGH-TENSILE STEEL

SMALLER COMMERCIAL VESSELS CAN BE MADE OF:

STEEL, WOOD, FRP, ALUMINUM, FERRO-CEMENT

IS THE FRP MADE OF BALSA OR HIGH-DENSITY FOAM?

Knowing how and with what materials marine vessels are built and how this applies to fire dynamic principles is essential for investigators of marine fires.

The materials used for exterior construction differs depending on the size of the vessel. Most large sea-going vessels will be almost always constructed out of high-tensile steel. The hulls of smaller commercial vessels or recreational boats, however, can be made of a variety of different materials. They may use steel as well, but they also might be made of wood, fiberglass-reinforced plastic (FRP), aluminum or even ferro-cement.

It is important to remember the impact on the fire load if a boat is made of wood or FRP. And in the case of FRP it is doubly important to know if the FRP is made of balsa or high-density foam core as these can act as heat insulators during a fire.

EXTERIOR CONSTRUCTION

WHAT TYPE OF MATERIALS WERE THE ACCESSORIES MADE OF?

ACCESSORIES MAY INCLUDE
COMMUNICATION EQUIPMENT, MARKERS, NAVIGATION LIGHTS, SPOTLIGHTS, & RAILINGS

Another important question to ask is what type of materials were the accessories either attached or within the vessel made of because they might be combustible and add to the fire load. For example, these accessories may include:

- Communication equipment
- Markers, navigation lights, spotlights and railings,
- Decking, masts and booms and other wooden components,
- Interior finishes and fixtures and
- Other combustible items such as sails, PFDs, life rafts and seat cushions.

EXTERIOR CONSTRUCTION

BULKHEADS – VERTICAL PARTITION THAT RUNS PERPENDICULAR TO THE LENGTH OF THE VESSEL

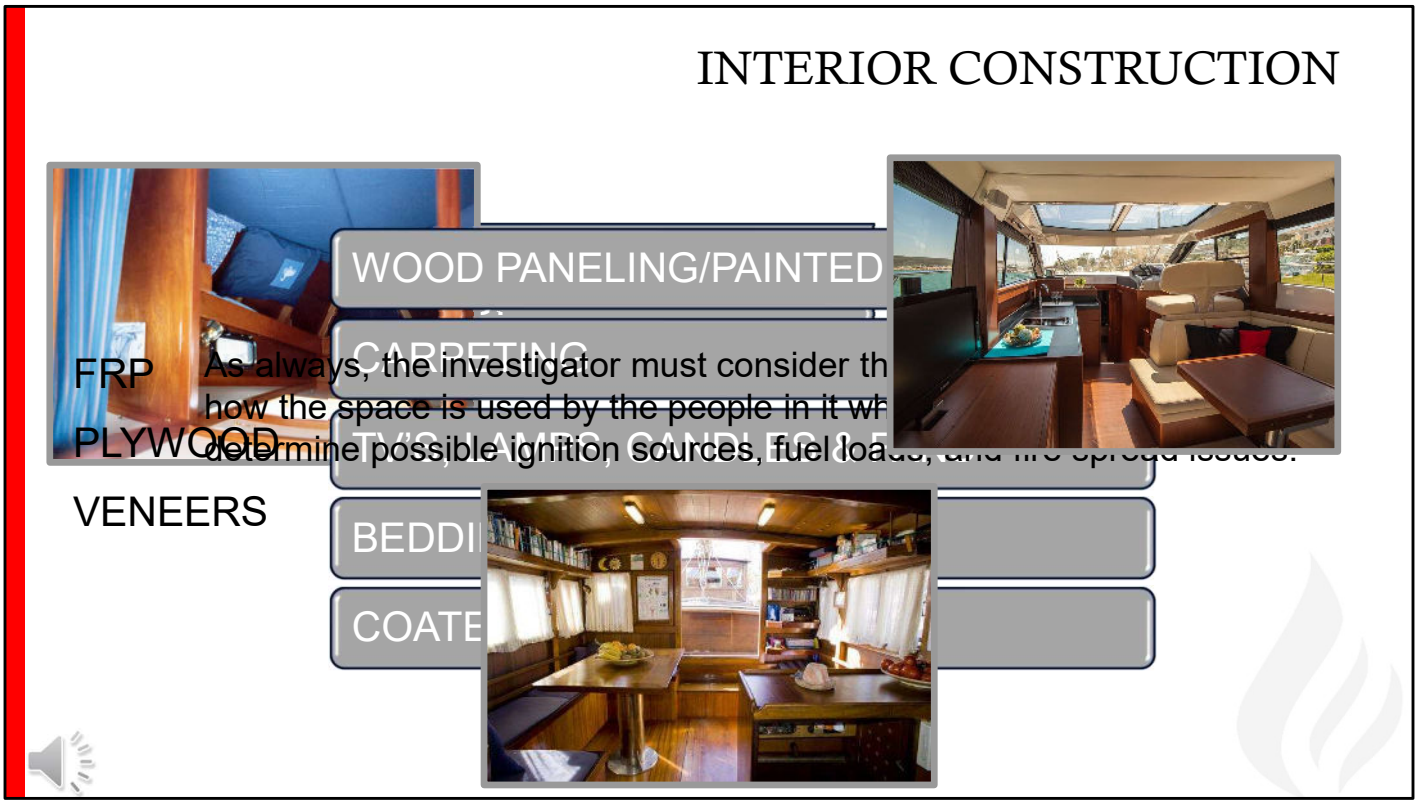
SUPERSTRUCTURE – CABIN OR STRUCTURE ABOVE DECK

DECKS – HORIZONTAL PARTITIONS THAT FORM THE TOPS AND BOTTOMS OF COMPARTMENTS

The term superstructure refers to any cabin or other structure found above deck. The term “deck” refers to the horizontal partitions that form the tops and bottoms of compartments. Both the superstructures and the decks are usually made out of the same material as the hull.

A bulkhead is a vertical partition that runs perpendicular to the length of the vessel. They provide the basic compartmentation of the inside of the vessel. They can be either structural or non-structural. The structural bulkheads connect decks, frames, and hull plating and are built to withstand extreme fluid dynamic pressures of the sea and/or liquid cargo. They can also provide a certain degree of passive fire protection.

The non-structural bulkheads serve the same purpose as walls in a house: to create separate living or accommodation spaces.



Many smaller vessels use the same construction materials for their interiors as those found in houses and automobiles. In general, recreational boats use:

- FRP,
- Plywood and
- Veneers.

As mentioned above, steel and aluminum, used mainly for bulkheads and support structures are noncombustible.

Just as you can have houses ranging from trailer parks to mansions, the interiors of boats also demonstrate the same range. These can include:

- Finished wood paneling or painted walls,
- Carpeting,
- Items such as TVs, lamps, candles and fans,
- Bedding and furniture constructed of fabric-covered foam padding and
- Wood items that may be coated with organic oils and varnishes as a finish.

As always, the investigator must consider these aspects as well as how the space is used by the people in it when attempting to determine possible ignition sources, fuel loads, and fire spread issues.

ENGINE & MACHINE COMPARTMENTS WITH COMPONENTS INCLUDING:

BATTERIES

AC & DC SYSTEMS

GENERATORS

INVERTERS

STORAGE UNITS FOR:
WASTE, WATER,
HYDRAULIC FLUIDS, & FUEL

Other factors to consider are the engine and machine compartments where all the components needed to propel the boat forward are held. These compartments include:

- Batteries,
- Generators,
- Inverters, and
- Storage units for:
    - Waste,
    - Water,
    - Hydraulic fluids and
    - Fuel.

In terms of power- both AC and DC systems might be present, with a variety of electrical circuits needed to power all the different kinds of systems on the boat.

MATERIALS USED FOR FUEL TANKS:

ALUMINUM
STEEL
METAL
POLYETHYLENE
FIBERGLASS

EXAMINE:

MATERIALS USED FOR FITTINGS & HOSES:

NEOPRENE
SYNTHETIC RUBBER
METAL
NYLON

Materials used for fuel tanks include:

- Aluminum,
- steel,
- Polyethylene and
- Fiberglass.

Materials used for fittings and hoses include:

- Neoprene,
- Synthetic rubber,
- Metal and
- Nylon.

All of the above need to strictly adhere to design requirements. The investigator should examine the tanks, fittings and hoses to determine whether they are suitable for marine use as leakage may result if there is any damage, deterioration or corrosion due to water contact.

INTERIOR CONSTRUCTION

WERE VAPOR DETECTORS ON BOARD?
WERE THE STORAGE TANKS AND HOLDS PROPERLY?
COMBUSTIBLE?
ENSURE SUPPRESSION SYSTEMS ARE DISABLED

The engine and machine compartments are usually equipped with vapor detectors to alert those on board of any vapors due to a leak or a spill. The investigator should examine these to make sure they were working properly at the time of the fire.

There might also be fire protection and suppression systems in place in these compartments. One way they suppress fire is by cutting off the oxygen to a space. It is important the investigator ensures these systems are disabled before entering the space.

The lower part of the marine vessel usually contains the storage tanks and holds. As you can imagine, the materials stored in these tanks are more often than not combustible. The investigator needs to know what exactly were the items held in storage or holding tanks. Of important consideration is whether or not the items were properly stored; as an improperly stored material could have come into contact with an ignition source or, in the case of volatile organics such as those used for maintenance and cleaning, spontaneously ignited.

PROPULSION SYSTEMS

PROPULSION SYSTEMS CAN BE:

ELECTRIC
LIQUID FUEL
FUEL GAS

How a vessel is used and how it is operated often determine the type of propulsion system present, which can include:

- Electric,
- Liquid fuel
- Fuel gas or
- A combination of the above.

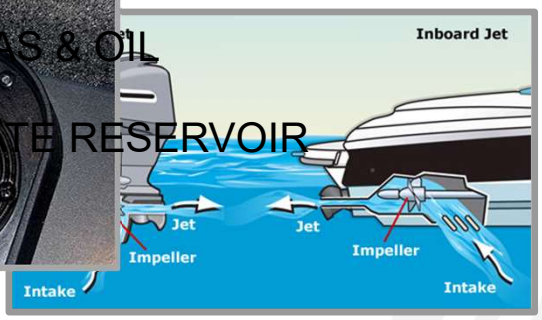
Determining what kind of propulsion system is present will go a long way in identifying the components that could have contributed to the fire's cause and spread.

You will mostly find electric systems on small, recreational boats in the form of a trolling motor which is a small electrical motor attached to a battery used primarily for maneuvering. However, electric systems for main propulsion are not generally used.

PROPULSION SYSTEMS

FUEL GAS FOR PROPULSION

1. OUTBOARD ENG PORTABLE)
2. 2 CYCLE ENGINE – M OF GAS & OIL
3. 4 CYCLE ENGINES – OIL IN SEPARATE RESERVOIR



What is way more common are motorized propulsion systems that use fuel. As we have already mentioned above, fuel systems have multiple uses on boats, from propulsion to appliances to generating electricity. In terms of propulsion however, there are 3 general categories:

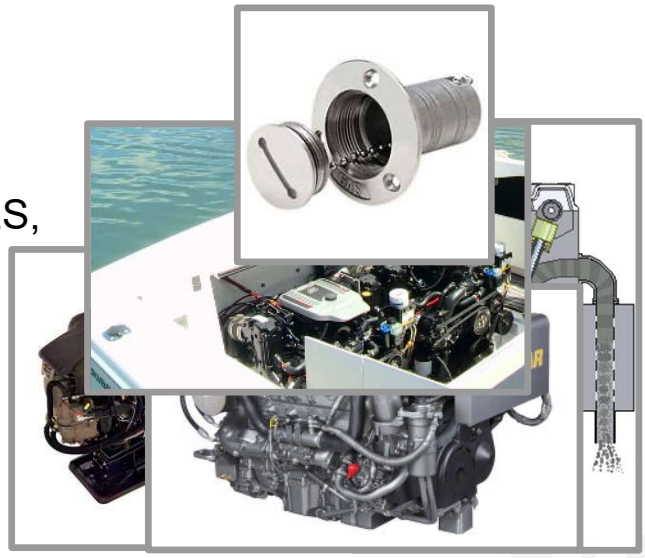
1. Outboard engines with their own fuel tanks which are either self-contained or portable,
2. Inboard gasoline engines and
3. Inboard diesel engines.

Outboard motors come in either the two-or four-cycle variety with a carburetor or a fuel-injected fuel delivery system. A two-cycle engine works on a mixture of gas and oil which lubricates the motor. The four-cycle engines, however, work pretty much the same way as an automobile, where the oil is kept in a separate reservoir. The fuel is run through the system through either a low-pressure delivery pump or a high-pressure, engine mounted fuel pump which is used in fuel-injection systems.

PROPULSION SYSTEMS

INBOARD DIESEL ENGINES:

- 4-CYCLE ENGINES
- HIGH-PRESSURE SYSTEM DELIVERS FUEL
- VENTED
- BUILT-IN FUEL TANKS, FUEL LINES, FUEL FILTERS & FUEL PUMPS EQUIPPED WITH FILL PLATE



Inboard motors are usually 4-cycle engines. The fuel tanks, fuel lines, fuel filters and fuel pumps are all built-in. It is important to remember there can be more than one tank. If that's the case, the tanks will be connected by a manifold, or an equalizing line, to make sure there is an equal weight distribution. All the tanks are vented and all the connections, fittings and valves are placed on top to prevent draining or leakage. They are also equipped with a fill plate, which is located on top of the fill port, connected to the vessel's ground which will stop fuel from leaking into the hull and reduces the risk of a static discharge while fueling.

The inboard diesel engines also work a lot like a car engine: a high-pressure system delivers the fuels. There will however likely be a low-pressure return line to the tank as well.

PROPULSION SYSTEMS

FUEL SYSTEMS FOR
TAKE SAMPLES OF ENGINE FLUIDS
COOKING, HEATING & GENERATORS

LP MOST COMMON - POOL AT BOTTOM OF VESSEL
RARE: STEAM-DRIVEN ENGINES
WOOD, CHARCOAL, COAL OR PARRAFIN
GENERATORS - **DIFFERENT** FUEL LINE

Remember once again that other fuel systems may also be present and used for such things as cooking, heating and generators. LP gas being the most common form one would encounter for heating, cooking and refrigeration systems. If LP gases leak, they will pool at the bottom of the vessel. Another thing to remember is that generators are often supplied by a different fuel line than the vessel's fuel tank.

The investigator should take samples of all engine fluids including fuel, hydraulic, and lubricating fluids to analyze their prefire condition.

Although it is rare, an investigator might also encounter old-fashion vessels propelled by steam-driven engines. These are usually powered by wood, charcoal, coal or paraffin.

IGNITION SOURCES

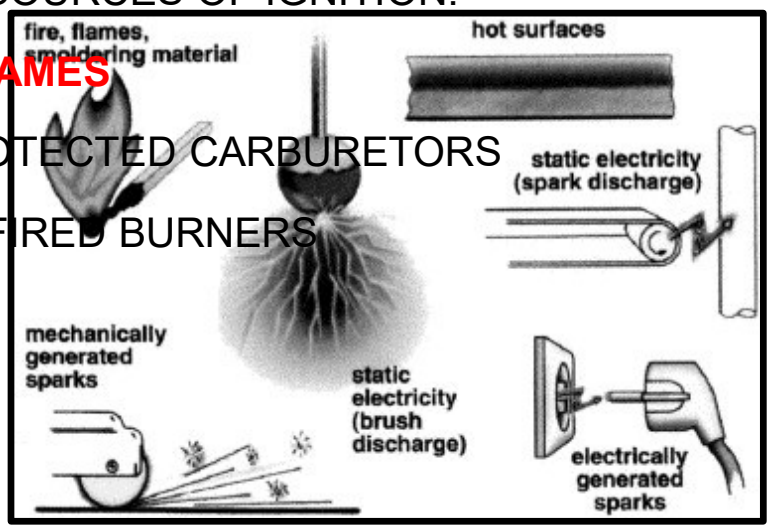
TURBOCHARGERS & EXHAUST MANIFOLDS…

POSSIBLE SOURCES OF IGNITION:

1. OPEN FLAMES

UNPROTECTED CARBURETORS

FUEL-FIRED BURNERS

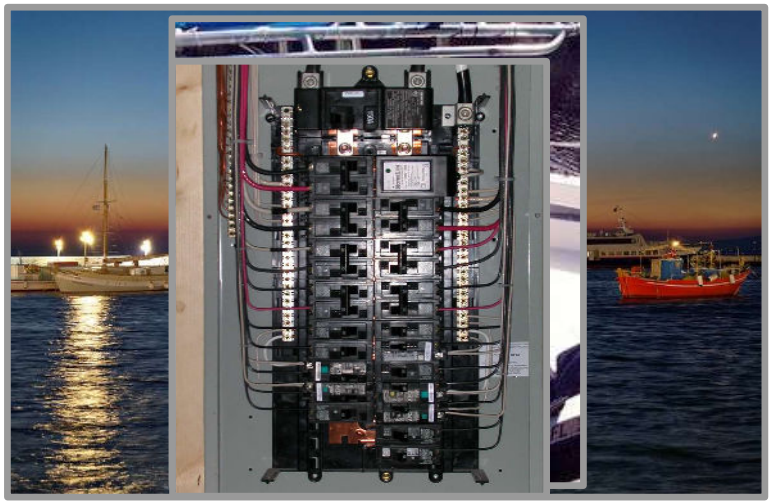


In addition to the unique set of ignition sources such as turbochargers and exhaust manifolds, the same kind of ignition sources present in structural or vehicular fires will also be present in marine vessel fires. A thorough understanding of the vessel's mechanical and electrical systems is essential to make sure that possible sources of ignition are identified and examined.

Here are a few possible sources of ignition on board a marine vessel:

1. Open flames caused by unprotected carburetors. Although all inboard and I/O vessels are required to have a backfire flame arrestor approved by the US coast guard and compliant with the Society of Automotive engineers Standard SAE J-1928 attached to the air intake, fires can still happen as a result of the owner not cleaning it properly or keeping it in good condition. Another source of open flames are fuel-fired burners for cooking. However, these are more and more rare as appliances with pilot flames have been prohibited since 1977 on gas-fueled marine vessels…

2. ELECTRICAL SOURCES



2. Electrical sources. Almost all marine vessels have some type of electrical system: to power lights or operate auxiliary lighting, to start the engine or to provide the conveniences you would find in a home. And just as in a house, any source of electricity is also a potential source of ignition and must be examined and assessed.

For instance, batteries onboard marine vessels may have several circuits energized even if the engine is not running and the ignition switch says “off”. For example, the bilge pump and the primary wiring circuits to the alternator, ignition switch and battery cables will almost always be energized. When the marine vessel is in operation however, all accessory items should be considered as potential sources of ignition.

ELECTRICAL SOURCES

OVERLOAD WIRING

Another factor that could contribute to an electrical system being the source of ignition is overloaded wiring. There may be components present that are not supposed to be used on boats. Which means that overcurrent devices may have been replaced with oversized fuses and breakers and accessory items might be overloading the system. In this case, the conductor may start to heat up, which will then in turn degrade and ignite the protective insulation. Because a lot of the wiring is concealed within the structure of the boat (the bulkheads for example), heat isn't easily dissipated. Which means a significant fire can occur without tripping the overcurrent devices. It is important for the investigator to identify and interview the right person who can speak to any prefire deficiencies that might have played a role in starting the fire.

ELECTRICAL SOURCES

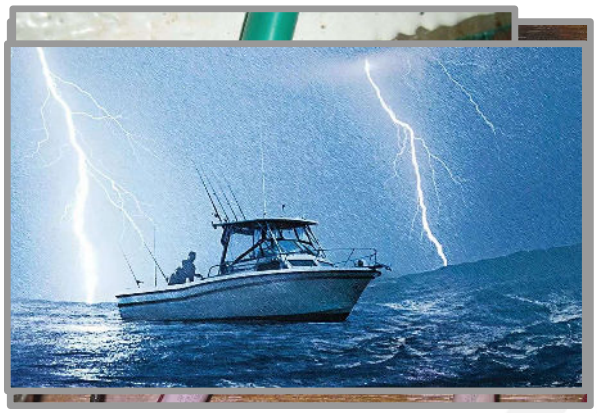
AC/DC SYSTEMS

Marine vessels usually have both AC and DC systems present and both must be examined. Any components below the water level will be grounded or bonded to the vessel's electrical system to prevent electrical shock and also as a form of lightning protection.

Just as in a car, the negative or ground side of the battery is bonded to the engine block while the positive side, or hot side, supplies power to the fuses, accessories and equipment that function on the DC electric system. The dangers of this system lies in the potential ignition risk if the positive side of the battery becomes grounded to another object. As well, the AC systems that are supplying power from either a generator or an inverter may also pose potential ignition risks throughout the circuit, connections and appliances it is powering.

ELECTRICAL SOURCES

- SHORT CIRCUITS AND ARCS
- CORRODED CONNECTIONS



Short circuits and Arcs. This can happen if the wiring is worn, brittle, or damaged or if exposed conductors come in contact with a grounded surface. That is why it is important for the investigator to examine all electrical wiring: if large circuits short or arc this can easily have ignited the engine oil, any ignitable vapors or even the insulation or wiring itself.

Another thing to look for are corroded connections due to a high-resistance connection or exposure to water and salt. These high-resistance connections easily ignite surrounding combustible items.

If lightning strikes near or on the vessel itself, the high-energy discharge can make its way through the vessel's structure and electrical system, which will in turn heat it up and ignite surrounding combustible items as well.

IGNITION SOURCES

ELECTRICAL SOURCES

GASOLINE VAPORS SINK TO THE BOTTOM OF VESSEL

STATIC ELECTRICITY & INCENDIVE ARCS

IGNITABLE LIQUIDS **MUST NOT MIX**

GROUNDING BETWEEN TANK & NOZZLE

Piping and/or any other mechanical devices used for transferring cargo to and from the marine vessel must be properly grounded to reduce the risk of static electricity and discharge and thus reduce the risk of a fire or explosion.

Static electricity and incendive arcs pose an even greater threat if there are any ignitable vapors present. This is especially important to remember during refueling operations as there is a real possibility that both static electricity and ignitable vapors may be present. To avoid this, proper grounding is required between the fuel tank and the fuel nozzle.

The investigator also needs to be aware that gasoline vapors are heavier than air and therefore will sink to the bottom of the vessel where you'd find the accommodation space and bilge areas, the spaces where static electricity is bound to occur simply from the normal operations of the ship.

Finally, ship owners and operators must take care to make sure that dissimilar cargos, especially if they are ignitable liquids, are not mixed because when they do, it can result in an overall higher volatility where normal fire prevention precautions are no longer sufficient.

3. HOT SURFACES

3. Just like in a home or vehicle, cooking and heating appliances as well as exhaust systems can cause fires.

In the case of cooking and heating appliances, anything combustible kept too close to these objects can easily catch fire. The investigator should conduct interviews with the appropriate people to determine what was kept beside these appliances.

As for exhaust systems, their manifolds can easily generate temperatures that could ignite engine fluids. It is important to remember that they can be even hotter right after the engine is shut down because the cooling system is no longer circulating fluid through the engine.

IGNITION SOURCES

4. MECHANICAL FAILURES

INSPECT ENGINE FOR FRICTION DAMAGE TO THE BEARING

HEATING

4. Fires are not usually caused by main bearing failures. However, once again, it depends on what is nearby. If a bearing fails in the alternator, motor, a pulley or a pump, friction will cause excessive heating or even sparks to fly. If there are any combustible items near the area of failure, a fire may result. The investigator should inspect the inner and outer races of the bearing if they suspect there might have been a mechanical failure. Or if they suspect that a pulley, alternator or water pump seized, they should inspect the engine components for damage.

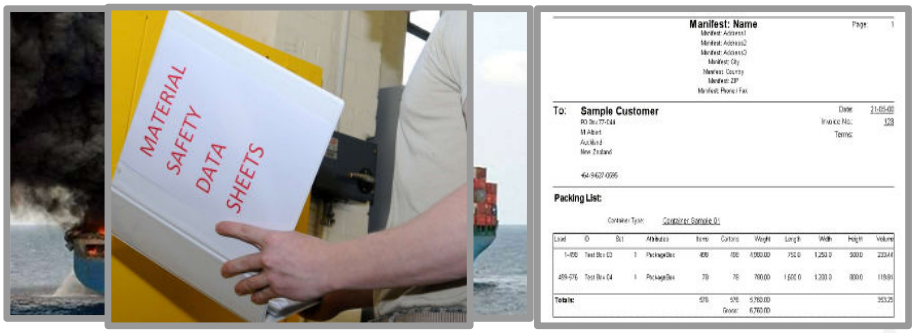
5. Finally, lit cigarettes are capable of starting a fire on a boat just as they are in any structure, particularly if it falls on the upholstery and other fabrics used on boats as they are very flammable and can cause the fire to spread quickly and intensely.

CARGO ISSUES

INCOMPATIBLE MATERIALS SHOULD BE SEPARATED

As mentioned above when speaking of storing ignitable liquids with dissimilar volatilities together, there are specific issues relating to fire prevention and cargo. A huge concern when shipping, is to make sure incompatible materials are always isolated from each other. For example, many thousands of tons of oxidizers and peroxides are shipped annually. It is imperative that these kinds of materials be isolated from any fuels that might combust in their presence. Even if they have a lot of packaging separating them, incompatible materials should be kept well away from each other – you never know when you are going to hit rough seas which could result in containers breaking or accidental mixing.

CARGO ISSUES



INTERNATIONAL MARITIME DANGEROUS GOODS (IMDG) CODE

An investigator should always review the vessel manifest to identify what exactly the boat was shipping at the time of the fire. To know more about hazardous products and cargo compatibility issues, the International Maritime Dangerous Goods (IMDG) Code can provide more information.

Another important point to remember is that in break bulk cargo ships and container vessels, if a fire breaks out in one of the middle stacks, it can either take a long time to detect or go unnoticed altogether. Because they are mounted with only about 18 inches of space between them laterally it can be very difficult to locate the seat of the fire, making the investigators job all that more difficult.

DOCUMENTING A MARINE VESSEL FIRE ON LAND

INSPECTIONS COMMONLY OCCUR IN A:

- SALVAGE YARD
- REPAIR FACILIT
- STORAGE LOT

A marine fire investigation should be inspected the way one would inspect any other type of fire. Although it is best to inspect a boat at the loss location before it is moved, this is rarely practical or safe. Most marine vessel inspections will have to be conducted in a salvage yard, repair facility or storage lot. This also allows the investigator to examine the entire vessel as any evidence of prefire damage or improper maintenance could be hiding below the water line.

If the marine vessel was on land at the time of the fire, the investigator must first of all determine whether the fire occurred at the location and whether or not the vessel was connected to any shore-based power-sources at the time.

DOCUMENTING A MARINE VESSEL FIRE ON LAND

SIGNS OF ABANDONMENT ARE:

- IMPROPERLY RESTING ON TRAILERS
- POOR LOCATION
- COVERED WITH DEBRIS

Once these aspects are determined the investigator should document and photograph the following:

- All power sources, shore lines and connection to the vessel,
- All potential ignition sources and fuels found in or around the vessel and
- How the vessel was stored and the area surrounding it.

The investigator should also look for any evidence of prefire vandalism or mechanical problems.

Signs that the vessel might have been abandoned are:

- If the vessel was improperly resting on its trailers,
- was covered with debris, and
- If its location was obscure, for instance surrounded by growing foliage.

DOCUMENTING A MARINE VESSEL FIRE IN WATER

WAS THE VESSEL FLOATING?

DOCUMENTATION REQUIREMENTS THE SAME

WITNESS INTERVIEWS WILL BE IMPORTANT

UNDERWATER INVESTIGATION?

GO BACK TO ORIGINAL LOCATION

NEED FOR UNDERWATER INVESTIGATION?

Marine Vessel fires that occur when in the water have many of the same documentation needs of those in a land-based investigation. The investigator needs to determine whether the vessel is floating at the location where the fire occurred. If the vessel was towed away, then the investigator needs to go back to the original location and determine if there is any valuable evidence still present. There may be a need for an underwater investigation of the original location as well as the underside of the vessel.

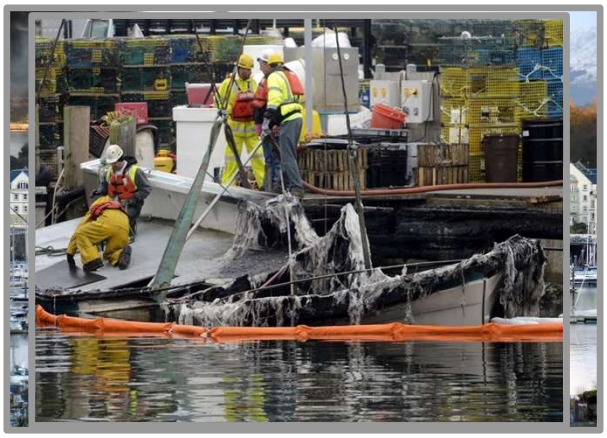
However, the documentation requirements for the vessels on land are the same: document and photograph any power sources, shore lines and connections to the vessel as well as an potential ignition sources and any potential fuels in or around the vessel.

Witness interviews will be important to determine whether the vessel was under way, moored or anchored at the time of the fire.

DOCUMENTING A MARINE VESSEL FIRE

EXAMINE DOCK, SLIP OR SEAWALL

WAS THE VESSEL UNDERWAY, ADRIFT OR AT ANCHOR?



If a vessel was moored, then the dock, slip or seawall should also be examined for potential ignition sources. It is also important to pay special attention to the construction materials of the above as they could possibly contribute to the fire's intensity or to the spread of the fire from one vessel to the next.

Because ignition sources will vary depending on if a vessel was underway, adrift or at anchor, it is important for the investigator to identify what the specific status of the vessel was at the time of the fire to determine which systems were in use.

If the vessel is submerged then specialized personnel should be called in to investigate it and the surrounding area for any valuable evidence including components of the vessel, dock or pier or items that could be potential ignition sources. Before the vessel is raised the orientation and condition of the vessel should be documented as the raising operation can damage or displace items.

DOCUMENTING A MARINE VESSEL FIRE

MARINE VESSEL IDENTIFICATION

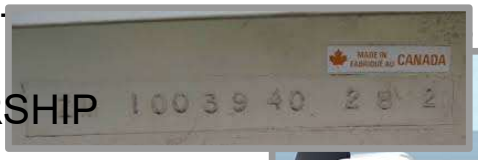
REGISTRATION NUMBER

HULL IDENTIFICATION NUMBER (HIN)

1. LOCATED ON THE STARBOARD, OR RIGHT REAR, SIDE OF THE TRANSOM, OR STERN CROSS-SECTION, BELOW THE RUB RAIL

2. VARIES

ESTABLISH OWNERSHIP



In general, a unique identifier is given to every vessel. However the practices will vary depending on local regulations and the vessel's manufacturers. A hull identification number, or HIN, is required for every vessel imported into the United States, including homemade vessels. These are permanently attached by either stamping or engraving them in two separate places on the vessel:

1. The first is usually at the starboard, or right rear, side of the transom, or stern cross-section, below the rub rail.
2. The second location varies depending on the manufacturer.

The first three letters of the HIN is the manufacturer's code.

Registration numbers are usually found underneath the bow of the vessel. These are used to establish ownership.

United States Coast Guard, or USCG, numbers may also be present, depending on the vessel. The investigator might also be able to find a hailing port and name usually on the transom, though this is not regulated.

DOCUMENTING A MARINE VESSEL FIRE

INTERVIEWS

SEEK INFO ON:

- HISTORY OF VESSEL
- ACTIVITIES BEFORE, DURING FIRE
- BYSTANDERS
- POLICE & F.D.

Witness interviews for marine vessel fires are much the same as those for any other type of fire. The investigator should always establish a basic scenario surrounding the incident.

They should identify, seek and interview:

- The owner of the vessel,
- The operator at the time of the fire,
- Any bystanders present, and the
- Police and fire department personnel who responded to the incident.

During the interview the investigator should seek information on:

- The history of the marine vessel, and
- Any specific activities that could be related to the fire, including those before, during and after the fire occurred.

DOCUMENTING A MARINE VESSEL FIRE

WITNESS INTERVIEW QUESTIONS

- WHAT WAS THE OPERATIONAL CONDITION?
- WHAT WERE THE WATER & WEATHER CONDITIONS?
- WHAT ACCESSORIES WERE IN USE & LOCATIONS?
- WHAT WAS HAPPENING ON THE VESSEL RIGHT BEFORE THE FIRE?
- HOW WAS THE FIRE DISCOVERED?
- WERE THERE ANY RECENT REPAIRS OR MODIFICATIONS?

Questions may include the following:

- What was the operational condition of the vessel?
- What accessories were in use and where were they located?
- Were there any recent repairs or modifications done?
- What were the water and weather conditions at the time of the fire?
- What was happening on the vessel right before the fire?
- How was the fire first discovered?

DOCUMENTING A MARINE VESSEL FIRE

WITNESS INTERVIEW QUESTIONS

WHAT ACTIONS WERE TAKEN AFTER DISCOVERY?

HOW WAS FIRE EXTINGUISHED?

WHERE WERE THE OCCUPANTS LOCATED?

WHAT WAS THE TIMELINE FROM DISCOVERY ON?

WHAT SALVAGE OPERATIONS WERE IN PLACE?

ANY ACTIONS TAKEN BY GOV'T AGENCIES?

- What actions were taken after the fire was discovered?
- How was the fire extinguished?
- What was the timeline from the fire's discovery, to the raising of the alarm and getting help to the ultimate extinguishment?
- What kind of salvage operations were in place?
- Were there any actions taken by the Environmental Protection Agency (EPA) or any other agency?
- Where were the occupants of the vessel located? If there were any victims, where were they located?

DOCUMENTING A MARINE VESSEL FIRE

WITNESS INTERVIEW QUESTIONS

WHAT WERE THE ACTIONS TAKEN BY OCCUPANTS AND OFFICIALS?

ANY PREVIOUS INVESTIGATIONS?

LAST TIME THE VESSEL WAS OPERATED?

ANY OTHER QUESTIONS THAT COME UP

- What were the actions taken by the occupants or any public officials during and after the incident?
- Were there any previous investigations of the vessel? If so, what were the details of that investigation?
- If the vessel was not in operation at the time of the fire, when was it last used and by whom
- And finally
- Any other question that comes up as a result of the investigation.

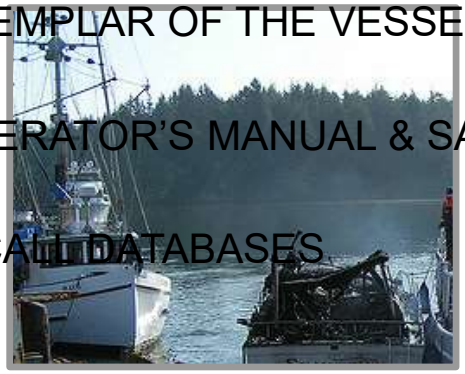
DOCUMENTING A MARINE VESSEL FIRE

MARINE VESSEL PARTICULARS

1.EXAMINE AN EXEMPLAR OF THE VESSEL

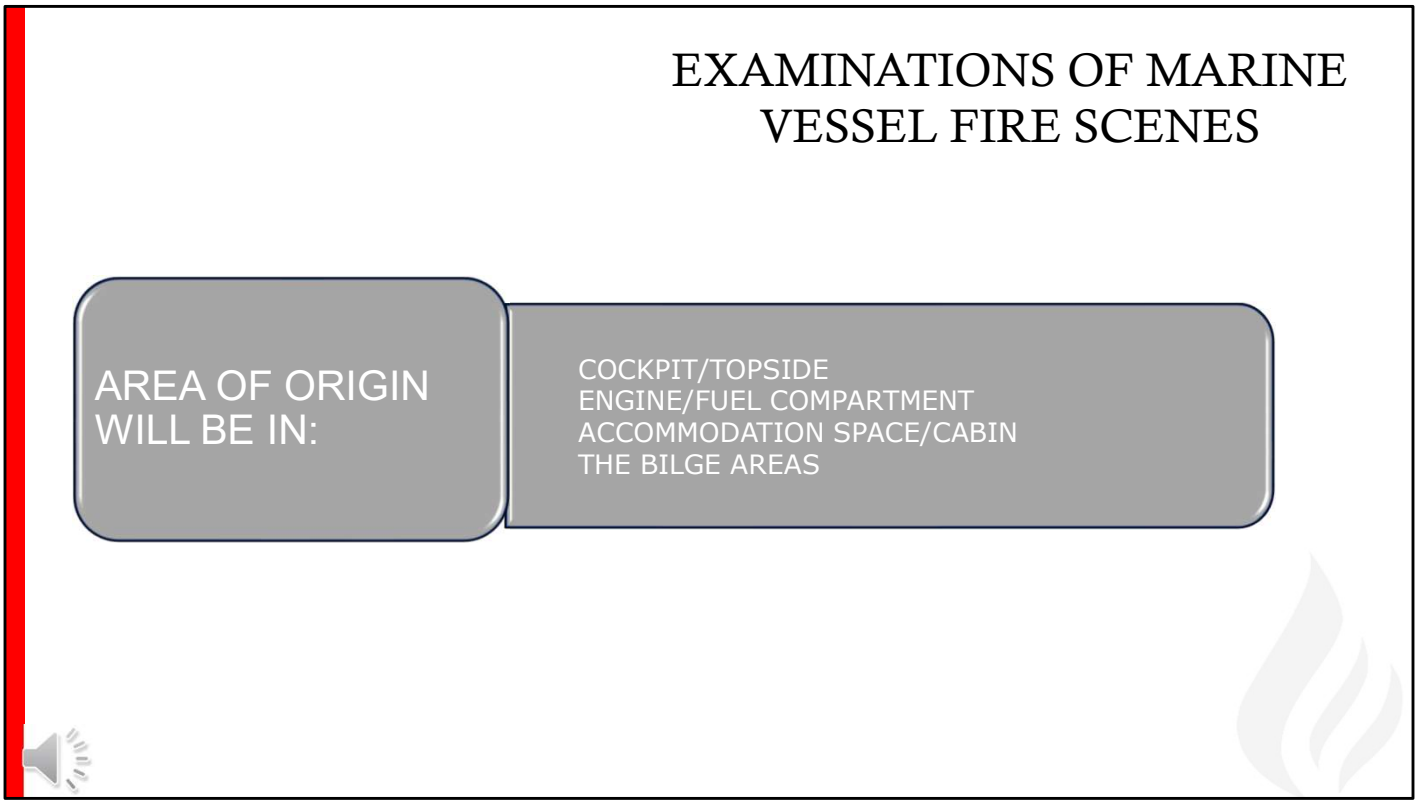
2.THE OWNER/OPERATOR'S MANUAL & SALES LITERATURE

3. SEARCH IN RECALL DATABASES



Another important aspect to determine once the type of vessel has been identified and all other information has been gathered is if the construction and design features affected the fire's development and growth. There are several ways to accomplish this:

1. An investigator can examine an exemplar of the vessel,
2. They could consult the owner/operator's manual as well as the sales literature associated with that make and model and
3. They could do a search in the recall databases compiled by the Consumer Product Safety commission as well as the USCG to determine whether any pre-existing issues with the vessel existed.



In a marine vessel examination the fire's area of origin will be in one of the following four locations:

- Cockpit/topside,
- Engine/fuel compartment
- Accommodation space or cabin or
- The bilge areas.

EXAMINATIONS OF MARINE VESSEL FIRE SCENES

INVESTIGATORS SHOULD USE A:

SYSTEMATIC PROCE

1. BEGIN WITH THE EXTERIOR
   CHECK FOR FIRE PATTERNS
   NOTE VENTS AND OPENINGS
   EVIDENCE OF PREFIRE DAMAGE
2. MOVE TO THE TOPSIDE
   CHECK THE MAST, DECKS, ACCESSORIES
   APPLICATIONS AND TRACES
   EVIDENCE OF REMOVAL

Just as in an investigation of a structure or a vehicle, the investigator should use a systematic process in the evaluation and examination of the vessel. Here is a recommended examination outline:

1. Begin with the exterior, paying special attention to any fire patterns that might give a clue to the area of origin. Note any vents, and openings around the engine and fuel compartments as these can affect fire patterns. As well check for any prefire damage.
2. Then move on to the topside checking the mast, the deck, what accessories items are present, any application patterns and/or any evidence that materials had been removed or replaced prior to the fire.

EXAMINATIONS OF MARINE VESSEL FIRE SCENES

3. MOVE TO THE INTERIOR

COCKPIT, SLEEPING BERTHS, STORAGE AREAS, GALLEYS & STATE ROOMS

EXAMINATION **NECESSARY** TO DETERMINE IGNITION SOURCE

EXAMINE FIRE PATTERNS PRESENT

3. Move on to the interior of the vessel and examine the cockpit, sleeping berths, storage areas, galleys and state rooms. Note that because they are usually airtight when closed, fires that occur in accommodation spaces may consume the space but not spread. They will also often self-extinguish. An examination of the items within the space is necessary to determine the ignition source and how the fire spread. Because the spaces are all used in different ways —for sleeping, cooking, or storage, for example—the issues surrounding ignition and spread will also be unique. It is also important to note that the way hulls are constructed give accommodation spaces sloped surfaces and limited vertical spaces which may alter the way a fire normally develops as well as the fire patterns the investigator might find. However, by examining the fire patterns present, it is possible to determine whether a fire originated outside or inside the accommodation space.

EXAMINATIONS OF MARINE VESSEL FIRE SCENES

4. EXAMINE THE MECHANICAL COMPARTMENTS

THOROUGHLY EXAMINE THE FOLLOWING:
INCLUDING: PROPULSION SYSTEM, BILGE ROOMS/COMPARTMENTS, OTHER ACCESSORY LOCATIONS

- CARBURETOR
- FUEL INJECTION SYSTEMS
- FUEL DELIVERY
- EXHAUST SYSTEM
- IGNITION

4. Finally, the mechanical compartments of the vessel must be examined, including the propulsion system, the bilge rooms/compartments and the other accessory locations. If the fire originated in an engine or fuel compartment, there is a good chance it will involve fuel vapors which cause extensive damage and will likely spread to the accommodation spaces. The investigator needs to thoroughly examine the following to determine what their role was in the fire's ignition and development:

- The carburetor,
- The fuel injection systems,
- The fuel delivery,
- The exhaust system and
- The ignition systems.

Though bilge areas are usually pretty safe if they are operating properly and are not a significant risk factor in themselves, there is a risk of them having amassed heavier-than-air fuel gases such as gasoline, diesel, or oil which can still be present after the fire.

EXAMINATIONS OF MARINE VESSEL FIRE SCENES

ONCE THE AREA OF ORIGIN IS LOCATED…

THIS INCLUDES…

DETAILED EXAMINATION OF COMPARTMENTS & ITS COMPONENTS

ANY INDIVIDUAL SYSTEMS

FUEL TANKS FOR FAILURES/CORROSION

FUEL FILL & VENT HOSES

Once the area of fire origin is located, a detailed examination of the compartment and its components to determine their role in the fire is the next step. These include an examination of:

- Any individual systems,
- Fuel tanks for any failures around the edges or any corrosion that might have allowed liquids or gases to escape. It is also important to note in the case of fuel tanks that when a tank is expose to heat, there may be a demarcation line where the fuel inside has auto-cooled the exterior surface. In the case of plastic tanks, they may still be intact and contain fuel as the container will often soften and fail where the level of fuel is.
- Fuel fill and vent hoses for chafing, corrosion and any other damage,

EXAMINATIONS OF MARINE VESSEL FIRE SCENES

TESTING FOR ELECTRICAL CONTINUITY &
GENERATOR, BATTERY, & SHORE-LINE &
POWER TRANSFER SWITCHES

- Testing the ground between the tank fill plate and the tank for electrical continuity,
- Switches and handles, portlights and hatches need to be examined and also have their position documented and photographed including:
    - Generator, battery and shore-line power transfer switches, and
    - If the ignition can be identified, determine whether or not a key is present and whether any damage or tampering occurred.

Unfortunately, most of the above is made of material that is easily consumed. However, there might still be identifiable components present after the fire.

MARINE VESSELS IN STRUCTURES

When examining a marine vessel in a garage or a carport, the investigator should treat it as if it is potentially the source of ignition. However, the vessel might just be an extra fuel package. That is why other potential sources of ignition within the storage unit must be examined.

If the vessel is afloat and moored under a shelter, the shelter itself needs to be considered as it may contain heat and fire gases that can influence the fire spread and patterns on the vessel.

Once again, any electrical service to and on the floating docks must be examined for damage caused by corrosion or because of dock movement.

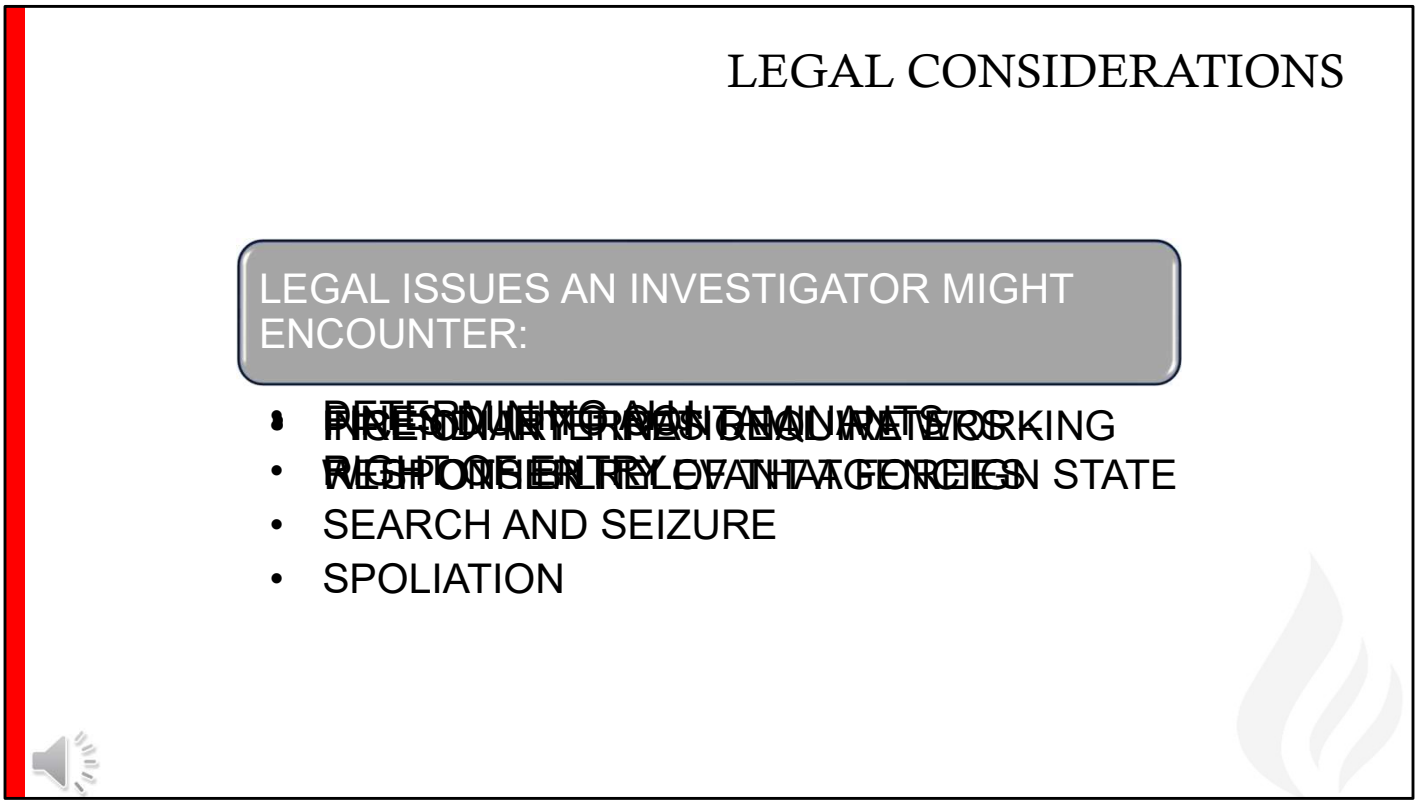
LEGAL CONSIDERATIONS

In the U.S. constitution, article III, Section II establishes maritime (or admiralty) law and gives jurisdiction over cases concerning marine commerce, marine navigation and shipping, sailors, and the transportation of passengers and goods by sea to the federal courts.

In Canada there are multiple agencies with jurisdiction depending on the location of the fire. Offshore fires will normally be the jurisdiction of the Federal Government through Fisheries and Oceans Canada, the Canadian Coastguard, Transport Canada and Port Authorities. The Provinces usually have authority on the foreshore which is the area between low and high tides and on non-tidal waters with the exception of fish spanning waterways. First Nations may also be the authority having jurisdiction.

The military will be the authority having jurisdiction for all their installations and equipment.

It is important for the fire investigator to determine who is the authority having jurisdiction before conducting the investigation.



Some of the legal issues an investigator might encounter in a marine vessel fire investigation are:

- Determining the authority having jurisdiction
- Right of entry
- Search and seizure,

And

- Spoliation of evidence which we have discussed at length in the Legal considerations chapter.

However, there also might be fines and other considerations related to the vessel's fuel and/or other contaminants leaking into the water from the vessel, which may involve environmental agencies both local, state or provincial and federal along with the Coastguard.

Another important thing to remember is though Federal, Provincial and local investigators may have authority over fires that happen on vessels in territorial waters, any fires that occur on international waters on foreign-owned ships will be the responsibility of that foreign state.

Like any other fires, people can set a marine vessel on fire for many reasons. If it is deemed incendiary, the investigator will in all probability have to work with local port

authorities, the coast guard or any other relevant agencies.

CHAPTER REVIEW

TYPES OF MARINE VESSELS

HAZARDOUS MATERIALS

METHANE GAS IN SEWAGE HOLDING TANKS

STRUCTURAL CONCERNS

SAFETY PRECAUTIONS

WHARVES, DOCKS, JETTIES

SUBMERGED VESSELS

VISUAL DISTRESS SIGNALS

ELECTRICAL POWER

In this chapter we discussed:

- The different types of marine vessels from recreational and personal vessels, to commercial and military vessels,
- The potential difference in fire patterns found in marine fire investigations,
- The safety precautions investigators need to take while examining a marine vessel fire, with special consideration given to:
    - Confined spaces,
    - airborne particulates,
    - The different sources of electrical power as well as
    - The hazardous materials found on marine vessels,
    - The issue of methane gas in sewage holding tanks,
    - Structural concerns of not only the vessel but
    - The wharves, docks and jetties surrounding it,
    - The unique issue of submerged marine vessels and finally
    - Visual distress signals.

CHAPTER REVIEW

FUEL SYSTEMS: PROPULSIONS, COOKING & HEATING

TURBOCHARGERS/SUPERCHARGERS

EXHAUST, ELECTRICAL & ENGINE COOLING SYSTEMS

VENTILATION SYSTEMS

TRANSMISSIONS

ACCESSORIES

We also discussed:

- The importance of identifying the different systems and functions at work on the vessel including:
    - Fuel systems for propulsion and those for cooking and heating,
    - The issue of turbochargers and superchargers,
    - The exhaust, electrical and engine cooling systems, as well as
    - Ventilation systems,
    - Transmissions and
    - The different accessories that may be present on the vessel,

CHAPTER REVIEW

MARINE VESSEL CONSTRUCTION

- EXTERIOR & INTERIOR
- PROPULSION SYSTEMS
- AREAS WHERE OPEN FLAMES OCCUR
- ELECTRICAL SOURCES
- HOT SURFACES
- MECHANICAL FAILURES
- SMOKING MATERIALS

- The importance of knowing the basics of marine vessel construction, both exterior and interior,
- The types of propulsion systems commonly found on marine vessels and how they relate to marine fire investigations,
- The different sources of ignition you may find during a marine investigation, including:
    - Areas where open flames occur,
    - Electrical sources,
    - Hot surfaces,
    - Mechanical failures and
    - Smoking materials

CHAPTER REVIEW

CARGO

EXAMINATION

- EXTERIOR

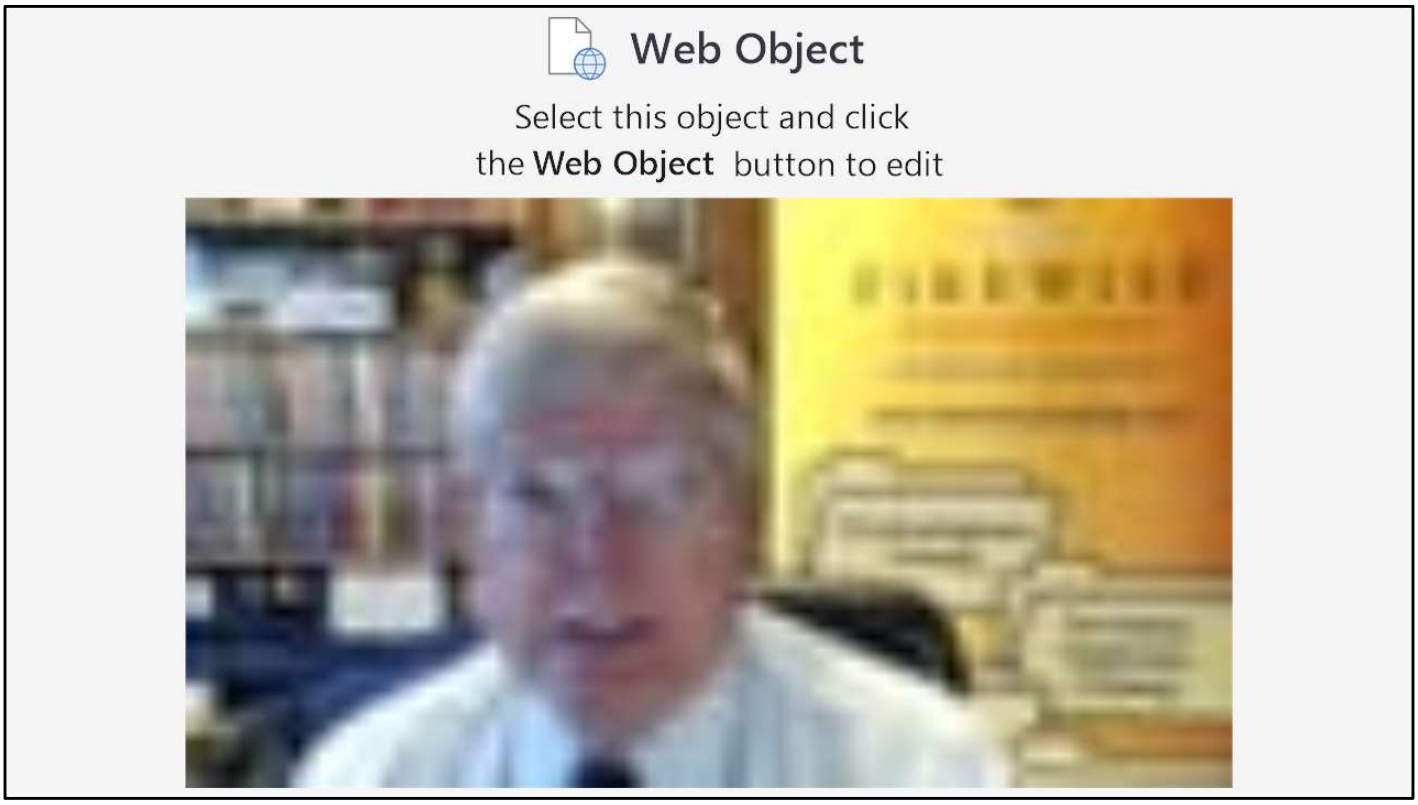
DOCUMENTING A MARINE VESSEL FIRE

- TOPSIDE THAN ON TO INTERIOR
- ON LAND
- MECHANICAL COMPARTMENTS
- IN WATER
- CONDUCTING INTERVIEWS

MARINE VESSELS IN STRUCTURES

LEGAL CONSIDERATIONS

- How cargo issues relate to marine fire investigations,
- How to document marine vessel fire scenes on land, in the water as well as aspects to consider when conducting interviews,
- How to go about marine vessel examinations, starting from:
    - The exterior, going to
    - Topside then moving on to the interior and
    - The mechanical compartments,
- The additional considerations of marine vessels in structures and finally,
- The specific legal considerations surrounding marine fire investigations.



DeHaan Congratulations video

END OF CHAPTER 17 PART 2

CONTACT
TRAINING@FIREWISECONSULTING.COM

That's the end of Part 2 of Chapter 17 Automobile, Marine, and Equipment Fires. You are now ready to move on to Part 1 of Chapter 18 which deals with Wildland Fires but please complete the quiz for this chapter first."

If you have any questions now is a good time to contact your teacher.