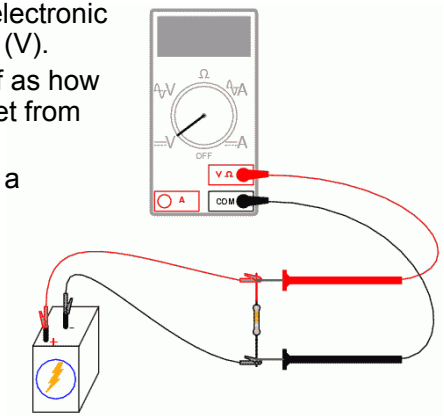
Ship's Systems

Electricity

- Electricity is a general term that encompasses a variety of phenomena resulting from the presence and flow of electric charge.
- Ship's depend on electricity for many vital functions including lighting, engine starting, and communications.

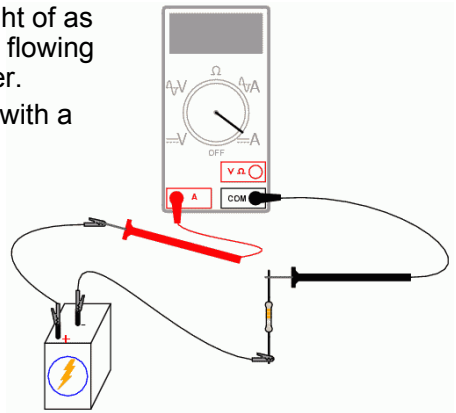
Voltage (V)

- Voltage is the difference of electrical potential between two points of an electrical or electronic circuit, expressed in volts (V).
- Voltage can be thought of as how badly electrelectrons want to get from one point to another.
- Voltage is measured with a voltmeter.



Amperage (I)

- Amperage is the flow of electric charge, expressed in amps (I).
- Amperage can be thought of as how many electrons are flowing from one point to another.
- Amperage is measured with a ammeter.

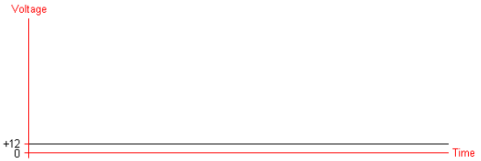


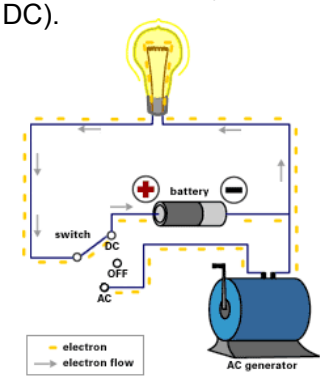
Circuit Protection

- Circuit breakers and fuses are used to protect electrical circuits from over-current.
- Circuit breakers:
  - Easily resettable,
  - More costly,
  - Slower acting.
- Fuses:
  - Must be discarded when “blown”
  - Cheap
  - Fast acting

Direct Current (DC)

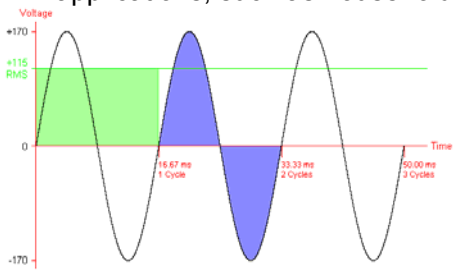
- Direct current is the unidirectional flow of electric charge.
- Direct current is commonly found in low-voltage applications, especially where these are powered by batteries (which can only produce DC).

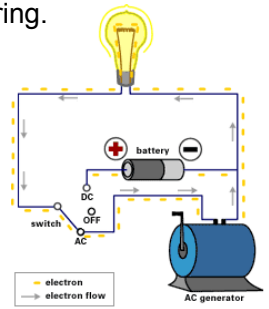




Alternating Current (AC)

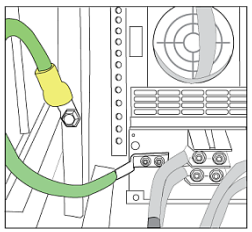
- Alternating current is an electric current whose direction reverses cyclically.
- The usual waveform of an AC power circuit is a sine wave, however in certain applications different waveforms are used, such as square waves.
- Alternating current is commonly found in higher-voltage applications, such as household wiring.





Ground (Earth)

- Ground is the reference point in an electrical circuit from which other absolute voltages are measured.
- The ground in a steel ship’s electrical system is usually the hull.
- In a DC system the negative side is usually connected to ground.
- In an AC system a wire that is connected to ground is called the “neutral”.
- The ground connection on electrical equipment provides a safe path for any “leaked” electricity to dissipate.



Power (W)

- Electric power is the rate at which electrical energy is transferred by an electric circuit, measured in Watts (W).
- Power = Voltage x Amperage or W = V•I

Wires

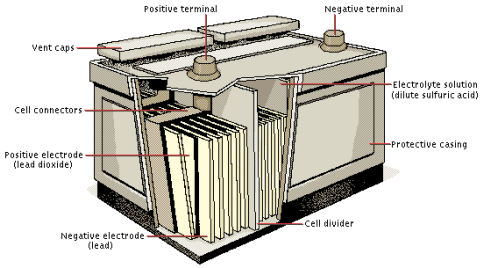
- A wire is a length of conductor surrounded by an insulator.
- The larger (or better quality) the conductor, the greater the amperage that can safely pass through the wire.
- The thicker (or better quality) the insulation, the greater the voltage that can safely pass through the wire.
- Cables are made up of multiple wires.

Sources of AC Power

- AC Power on a ship can come from:
  - Shore-power,
  - Generators,
  - DC→AC Inverters.
- Without specialized equipment, only one AC source can power a circuit at a time.
- Transfer switches are used to select the source of AC power.

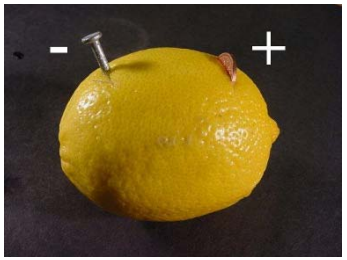
Sources of DC Power

- DC Power on a ship can come from:
  - Batteries,
  - Alternators,
  - AC→DC Rectifiers (power supplies & battery chargers).
- Multiple DC sources can be connected to a circuit at one time.



Batteries

- Batteries are used to store electrical energy.
- Care must be taken when working with or near batteries:
  - Batteries may contain acid.
  - Batteries may contain explosive gasses.



Power Underway

- While underway a smaller vessel will use power stored in her batteries. The batteries may be recharged through the use of generators, alternators, solar, or wind power.
- Inverters can be used to convert DC (battery) power into AC power while underway.
- Large vessels with greater power requirements will usually run generators continuously, but will have emergency batteries to supply critical systems should a generator fail.

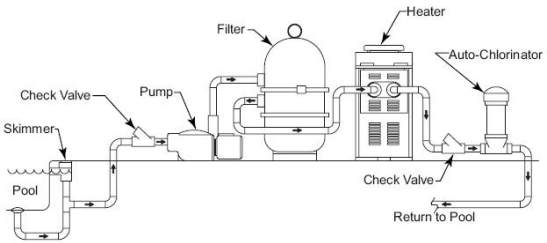
Power Alongside

- When alongside, a smaller vessel will use shore-power to charge her batteries (by means of a rectifier or battery charger), as well as provide power for general use.
- Large vessels with greater power requirements will usually run generators continuously even when alongside, because the available shore-power is not great enough to supply their needs.

Multi-Function Equipment

- Often things such as inverters, battery chargers, and transfer switches are combined into one piece of equipment.
- This is done in order to simplify wiring, save space, and automate operation.

Pumps & Plumbing

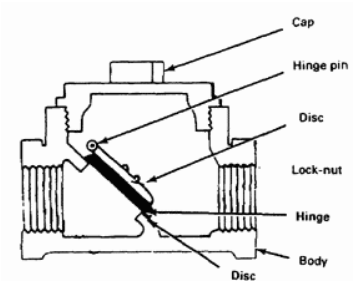


Pumps

- A pump is a device used to move fluids, such as gases, liquids or slurries.
- Pumps may be power or hand operated.

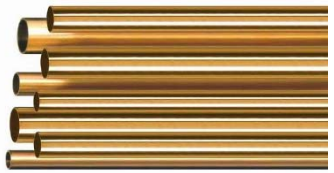
Valves

- A valve is a device that regulates the flow of fluids, such as gases, liquids or slurries, by opening, closing, or partially obstructing various passageways.



Piping

- A pipe is a tube or hollow cylinder used to convey fluids, such as gases, liquids or slurries.
- The terms pipe and tube are almost interchangeable. A pipe is generally specified by the internal diameter (ID) whereas a tube is usually defined by the outside diameter (OD).



Seacocks

- Seacocks are plumbing fittings that penetrate the hull below the water-line.
- Seacocks should be:
  - Strong,
  - Easily closed,
  - Easily winterized.

Common Pipe Fittings

- Nipples
- Elbows – 90° and 45°
- Tees
- Crosses
- Couplings
- Unions
- Bushings

Manifolds

- A manifold is a section of plumbing with multiple inlets and/or outlets.
- A manifold simplifies the distribution and/or combination of fluids

Pipe Joints

- Thread
- Flange
- Glue
- Weld
- Clamp
- Solder

Plumbing with Dissimilar Metals

- Two dissimilar metals react when placed in an electrolyte.
- One metal will usually corrode away, while the other may experience a build-up of new material.
- When two pipes of dissimilar metal are joined an insulating joint, such as a dielectric union, should be used.

Winterizing

- Unlike other fluids, water expands when it freezes.
- If a plumbing system full of water freezes it will often crack or split.
- Plumbing systems should be drained of all water whenever freezing temperatures can be expected.
- When designing and/or installing a plumbing system, it is important to add drains in the lowest points of each section.

Steering Systems

Steering Types

- There are many types of steering systems including:
  - Mechanical (gear/chain/direct)
  - Hydraulic
  - Electrical
- All vessels must have a backup steering system.
- It is important to know:
  - What kind of system your vessel is equipped with so that you can maintain and troubleshoot it,
  - How to quickly switch to the backup system in the event that the main steering system fails.

Engines

- Among other things, engines can be used for:
  - Propulsion,
  - Power generation,
  - Pumping.

Engine Starting

- Most small vessel engines are started electrically, either by a key switch or by push buttons.
- Some engines are equipped with pre-heaters to assist starting in cold weather.
- Before starting an engine make sure that the area around the engine is clear of personnel, tools, equipment, and is not in gear.
- If an engine turns over but does not start, do not run down the battery trying to start it.
- After starting it is good to let the engine warm up for one or two minutes before using it. Prolonged idling should be avoided as this will damage the engine over time.

Engine Stopping

- Most small vessel engines are stopped electrically, either by a key switch or by push buttons.
- Most engines also have a mechanical shut-down, which can be used to stop the engine in the event of an electrical fault.
- Before shutting down an engine, it is good to let the engine cool down for one or two minutes.

Engine Lubrication

- Engines use oil for lubrication.
- Proper lubrication is vital to the operation of an engine. A failure in the lubrication system can destroy an engine in seconds.
- All engines will have oil pressure gauges and/or alarms to notify you in the event of a lubrication problem.
- Often auxiliary equipment such as transmissions or gearboxes will have their own lubrication systems.

Engine Cooling

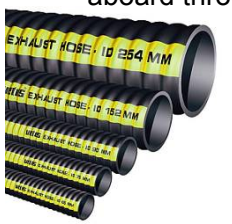
- Most engines are liquid (water) cooled, although some small engines are air cooled.
- Proper cooling is vital to the operation of an engine. A failure in the cooling system can destroy an engine in minutes.
- All engines will have temperature gauges and/or alarms to notify you in the event of a cooling problem.
- Often auxiliary equipment such as transmissions or gearboxes will have their own cooling systems.
- Liquid cooled engines may either be raw water cooled, heat exchanger cooled, or keel cooled:
  - In a raw water cooled engine seawater is pumped directly through the engine block.
  - In a heat exchanger cooled engine coolant is circulated through the engine block and then passed through a heat exchanger where it is cooled by seawater.
  - In a keel cooled engine coolant is circulated through the engine block and then pumped through a series of pipes on the exterior of the hull where it is cooled by the seawater.

Engine Ventilation

- Engines require air for both combustion and cooling.
- An engine requires large quantities of air for combustion alone – approximately 1 litre per second for every 1 horsepower.
- It is important to make sure that all vents are opened and blowers turned on before using an engine.
- If a vent must be closed because of heavy weather it may be necessary to run the engine at a reduced speed and/or load.

Engine Exhaust

- Engine exhausts may be either “dry” or “wet” (water cooled).
- An obstruction or restriction in the exhaust will cause poor engine performance.
- It is important to keep water from flowing backwards up the exhaust into the engine when the engine is not in use.
- Engine exhaust gasses are poisonous and care should be taken that they are not allowed to be blown back aboard through open scuttles, skylights, or vents.



Engine Fuel

- Nearly all commercial engines use diesel fuel, as it is both cheaper and much safer then gasoline.
- Clean fuel is very important as the fuel injection equipment is easily damaged and/or clogged by foreign matter.
- On most engines fuel is sucked from the tank, through a primary filter, pumped through a lift pump, through a secondary filter into the injection pump.
- Many primary filters have a vacuum gauge that indicates when it is necessary to change the primary fuel filter.

Engine Winterization

- Raw water cooled engines and heat exchanged engines must be completely drained of all seawater if freezing temperatures can be expected.
- Engine coolant in heat exchanged and keel cooled engines must have an adequate concentration of anti-freeze mixed in.