Section 3: Low Voltage Batteries

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3.1 Safe handling of batteries

The dangers associated with batteries are often underestimated.

You should always exercise caution when handling batteries. Not only is the electrical charge a danger, but so are the corrosive materials which make up a battery.

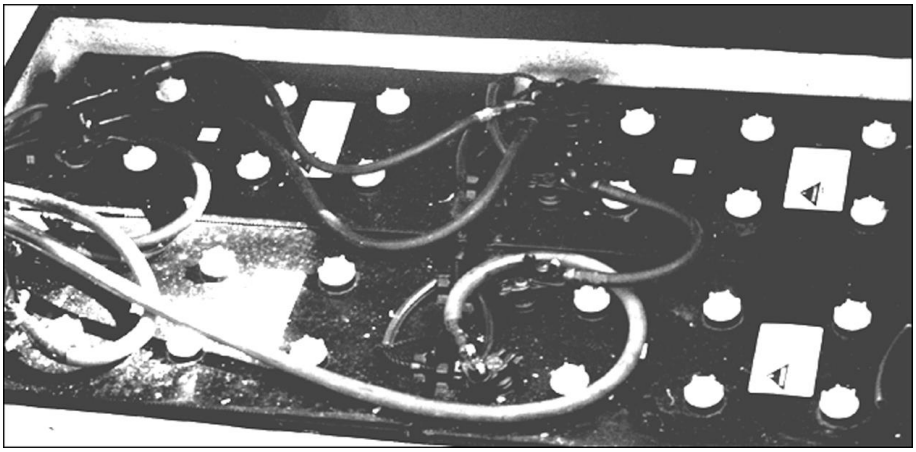

Figure 1: Battery bank

Follow these safety tips when handling batteries.

- Install batteries away from the motor. Heat given off by your motor may weaken or damage the battery housing. Therefore battery acids can leak and cause corrosion to other components. A faulty connection in your starter motor could cause a spark to jump and ignite gases escaping from battery cells.
- Have an appropriate Amp meter and Volt meter installed for the purposes of monitoring the condition of your battery.
- Fit ‘kill switches’ or circuit breakers to your wiring system.
- Ensure that the correct fuses are used when wiring additional electrical equipment to your vessel.
- When fully charged, batteries hold a great deal of electrical energy. If you are careless, you may experience severe shocks or burns.
- You should be extremely careful when handling battery acid (sulphuric acid) which is highly corrosive. This will burn through clothing and skin, and can even cause blindness if it comes in contact with eyes.

Wear safety goggles and rubber gloves when dealing with the battery electrolyte.

- Always wear protective glasses and remove any metal from your hands (eg jewellery and watches) when handling batteries because you can create a short circuit or sparks, and possibly receive severe burns. When working on the battery, use insulated tools.
- Gasses given off by batteries are highly volatile and toxic. Be aware of any leakages or fumes escaping. Wear a protective mask to minimise inhalation of any gases.
- Check to see there are no defects in the battery housing.
- Ensure that there are no naked flames in the vicinity when you are handling batteries (for example, when you are checking the water level as the fumes emitted by the batteries are flammable).
- When fitting batteries, ensure they are safely secured into position in a well constructed and ventilated space.
- When replacing an old battery ensure that the positive (+) terminal and the negative (-) terminals are placed at the correct poles.
- Ensure that the terminals are sufficiently tightened.
- Do not make sparks by touching leads on the battery terminals as this can cause the hydrogen oxygen gases in the battery to explode.
- Avoid electrolyte spillage. It can mix with salt water and create chlorine gas.
- Never place lead acid batteries and alkaline batteries in the same compartment as the acid fumes will contaminate the alkaline batteries causing permanent damage.

A solution of baking soda can be used to rinse clothes or neutralise acid if a spillage occurs.

A **short circuit** occurs when the positive side of the battery is connected directly across to the negative side, bypassing the equipment itself. This causes an excessive current flow, generating heat and causing fire to occur (usually at the smallest wire in the circuit), unless fuses or circuit breakers are fitted.

For instance, a short circuit will occur if you were to drop a metal tool onto your battery and it were to touch both battery poles at the same time.

3.2 Lead and alkaline batteries

If two electrodes of dissimilar metals are immersed in an electrolyte a voltage will be produced across the electrodes.

In a lead acid battery, each cell produces 2.1 volts.

In an alkaline battery, each cell produces 1.22 volts.

Alkaline batteries are generally externally connected.

The main components of a lead acid battery are:

- the positive plate (lead dioxide)
- the negative plate (sponge lead)
- the electrolyte (sulphuric acid).

On the discharge cycle (battery on load) lead sulphate is deposited on both plates and water is formed due to chemical reaction. The water dilutes the electrolyte, lowering its specific gravity.

When charging, the lead sulphate is converted to lead dioxide on the positive plate and spongy lead on the negative plate at the same time ionised, sulphuric acid is formed, and hydrogen and oxygen are released from the water, causing electrolyte concentration and the specific gravity to increase.

Measuring the specific gravity of the electrolyte can determine the state of charge of the battery.

Alkaline batteries

The main components of an alkaline battery are:

- the positive plate (nickel hydroxide)
- the negative plate (Calcium Hydroxide and the electrolyte)
- Potassium Hydroxide.

They use alkaline instead of acid and the active materials do not dissolve in the electrolyte. The electrolyte transports ions between the positive and negative plates and the plates undergo changes in their oxidisation state.

The specific gravity does not change between charged and discharged condition so it is necessary to use the terminal voltage to determine the state of charge.

Alkaline batteries emit Hydrogen/Oxygen and care should be taken when dealing with these batteries.

Never allow any sparks of any type in the vicinity of these batteries. Even a tiny spark could cause an explosion.

3.3 Automotive and deep cycle batteries

In automotive batteries, the plates are thin and made of a porous loose active material so that maximum exposure to the electrolyte is obtained with a minimum internal resistance. This allows maximum chemical reaction to take place and allows maximum current availability.

Automotive batteries cannot withstand cycling and should be maintained at 95 per cent charge.

Deep cycle batteries

In deep cycle batteries, the plates are thicker and made of a denser active material and are separated by glass matting. They can withstand cycles of long continuous discharge and repeated recharging, hence the name ‘deep cycle’.

They are generally selected so that the discharge does not go below 50 per cent of battery capacity.

3.4 Battery testing

Lead acid batteries should be tested regularly, at least once a week.

You will need to test the condition of a battery using a hydrometer. Hydrometer is used to compare cells and indicate pending problems. A low reading in one cell compared to the others indicates battery deterioration.

A hydrometer measures electrolytes in the battery acid. As a battery discharges, the electrolyte becomes less dense, and the indicator in the hydrometer will sink.

Firstly, observe the normal safety precautions:

- before removing the caps situated over each cell ensure you have sufficient ventilation
- ensure there are no naked flames in the vicinity.

Using the hydrometer, insert it into each cell squeezing the sembler bulb drawing liquid into the chamber. Reading the scale at eye level will tell you the condition of the battery.

Do not try and test your battery immediately after topping the battery with distilled water or after removing the battery from the charger. Wait for at least 30 minutes. This will allow for cooling and settling to gain a more accurate reading.

Typical readings are as follows:

Charge%	*S.G.*	*Voltage*
100	1.25	12.75
90	1.235	12.65
80	1.22	12.55
70	1.205	12.45
60	1.19	12.35
50	1.175	12.25
40	1.16	12.1
30	1.145	11.95
20	1.13	11.85
10	1.113	11.75
0	1.1	11.65

Deep cycle batteries must be fully recharged or else their life span will be severely reduced and damage will be permanent. A charging voltage of approximately 14.5V will be required to achieve this.

Occasionally an equalising charge at a current rate of 5 per cent of the battery capacity can increase the life of the battery (check with manufacturer). Always top the water up to a level just above the plates or to the level marked on the side of the cells.

Alkaline batteries

Terminal voltage is the only way to determine the level of charge. 1.3 volts is fully charged down to 1.0 volts being fully discharged.

The charging voltage required for alkaline batteries is higher than that of acid batteries and is typically 15.5V to 16V for a 12V battery bank.

The normal alternator voltage regulation which is usually set at 14 volts will not deliver enough current to fully charge the battery, it will only deliver a float charge.

Practical Activity

Ask your facilitator to demonstrate battery testing and charging procedures on a battery. Observe the procedures and note down what you observe in the space below. Reverse roles and instruct your facilitator on what you have just learnt.

Steps for testing a battery	*Steps for charging a battery*

3.5 Charging batteries

It is always safer to remove the battery from a confined space before recharging for reasons mentioned in Section 8.3.

When connecting the battery to its charger, firstly remove the caps over each cell and ensure the liquid is above the cell plates to a height recommended by its manufacturer.

When connecting the wire coming from the charger, ensure that the positive wire and the negative wire are connected to the appropriate terminals before switching on the charger.

Ensure that the charger is set on its appropriate 6 volt or 12 volt charge, depending on which battery you are about to charge.

When the meter on the charger indicates that the battery is fully charged, let the battery sit for at least 30 minutes after disconnecting it and before testing with a hydrometer. This is because the battery temperature has increased whilst on the charger, so you need to allow cooling before getting an accurate reading.

Practical Activity

Ask to observe the procedure for charging a battery.

Write down the steps you observed here. This will help you as a reference later, and also for your assessment.

_____

_____

_____

How did you assess that the battery was fully charged?

_____

_____

3.6 Battery installation survey requirements

Provision must be made to electrically isolate batteries. They must be securely mounted to prevent movement during vessel motion. Lead acid must be installed in liquid trays lined with acid resisting material.

Alkaline batteries should be installed to prevent shorting between case to case and between case to the metal structure. They must be protected from mechanical damage and damage from water or short circuit.

Storage battery spaces must be ventilated.

Battery terminals must be electrolyte resistant and cable ends sealed to prevent electrolyte entry.

Motor starters and solenoids must be covered and protected to prevent sparks.

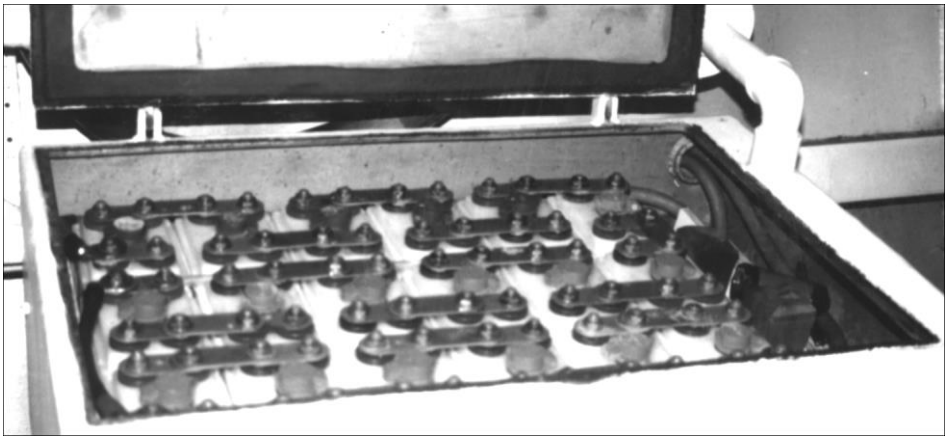

Figure 2: Alkaline batteries in battery compartment

Check your progress

1 When does a short Circuit occur and what is the consequence of short circuit?

_____

_____

_____

2 What should you do if battery acid spills ?

_____

_____

3 Lead Acid batteries should be tested regularly, at least once a _____?

4 Name two key safety precautions to be observed prior to testing batteries?

_____

_____

5 Name four key survey requirements for the installation of batteries?

_____

_____

_____

_____

Check your answers on the next page.

Answers to check your progress questions

1 A **short circuit** occurs when the positive side of the battery is connected directly across to the negative side, bypassing the equipment itself. This causes an excessive current flow, generating heat and causing fire to occur (usually at the smallest wire in the circuit), unless fuses or circuit breakers are fitted.

For instance, a short circuit will occur if you were to drop a metal tool onto your battery and it were to touch both battery poles at the same time.

2 A solution of baking soda can be used to rinse clothes or neutralise acid if a spillage occurs.

3 Once a week.

4 Before removing the caps situated over each cell ensure you have sufficient ventilation.

Ensure there are no naked flames in the vicinity.

5 Refer to Section 3.6.