

# **UNDERSTANDING METAL CORROSION IN BOATS**



**A GUIDE TO WHAT'S GOING  
ON BELOW THE WATERLINE**

**& HOW TO COMBAT IT**

## WILL MY BOAT ROT?

From the moment your boat enters the water it starts to rot, corrode or rust. This process will continue relentlessly and your boats hull, or any metal components under the waterline, will never be in as good a condition again.

## WHAT CAN I DO?

What you can do as a responsible boat owner is monitor the condition of your Hull at certain intervals and take some remedial measures at the appropriate time to prolong your vessels serviceable life.

**To learn how to do this please read on.**

## OH NO ! THE SCIENCE BIT

### WHY DOES METAL CORRODE IN WATER?

Metals are strong. The metal atoms are arranged in rigid structures and they are surrounded by electrons which are relatively fluid. This allows metal to conduct electricity which is fundamentally the flow of electrons.

Your Hull and any other Metals in contact with the water therefore has a ready supply of electrons which are negatively charged. Unfortunately the water that your Craft is floating in has a positive charge and is permanently looking for sources of electrons to become more stable. Any metal in water is a perfect target.

Not all water is the same. If the water is slightly acidic, more Salty or has more Oxygen (fast flowing or white water) it will be more positive and able to steal electrons more readily from your Boat.

**Removal of electrons is a process called Oxidation other words for this include corrosion or rotting. See diagram below.**

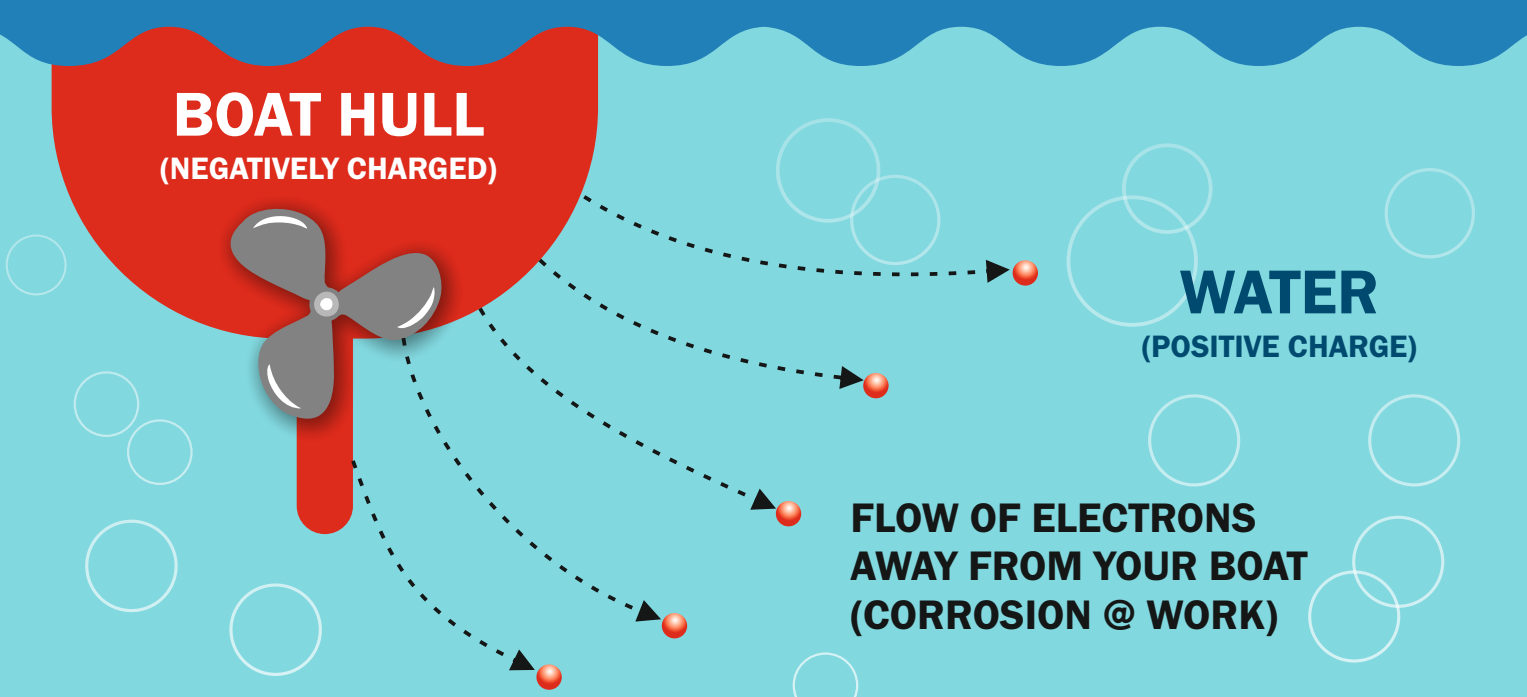
Fortunately, you can measure both the availability of electrons in your Hull and the corrosive potential of the water and take appropriate action!!

**BOAT HULL**  
(NEGATIVELY CHARGED)



**WATER**  
(POSITIVE CHARGE)

**FLOW OF ELECTRONS**  
**AWAY FROM YOUR BOAT**  
**(CORROSION @ WORK)**



## THE SCIENCE BIT (CONT.)

### UNDERSTANDING HULL POTENTIAL

To fully understand what is happening with your hull and/or anodes you have to measure the potential of your hull and other metal parts that are submerged.

**Measuring Hull Potential is very simple and quick.**

Using our [Boat Meter Kit](#) simply connect the Hull to the positive terminal and place the electrode in the water near the hull.

The readings for new boats will be as follows e.g.

**Aluminium Hulls**     **-900mv**  
**Steel Hulls**         **-600mV**

The results are negative as electrons are negatively charged. The more negative the result is the more electrons you have locked up in the Hull. This is a good thing.

As the water steals electrons and corrosion occurs this result will become less negative.

**Allow us to demonstrate with a graph.**

### LOSS OF ELECTRONS WITHOUT ANODES (STEEL HULL)

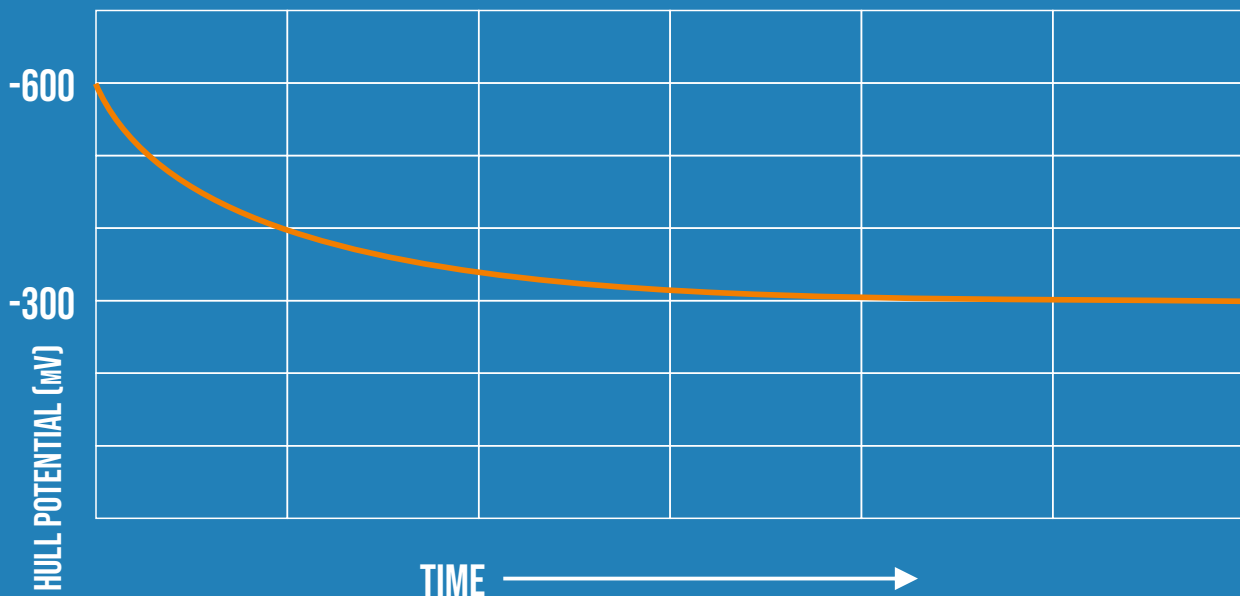


Figure Showing the Hull Potential decreasing over time as it loses electrons

### WATER POTENTIAL (REDOX)

Otherwise known as REDOX (Reduction-Oxidation) Potential. This is even easier to measure just connect the two electrodes up to our [Boat Meter](#) and place them in the water and take a reading.

## WATER POTENTIAL (CONT.)

Normal river water for instance will be around +200mV. **Notice that this is positive!!!** The water is therefore looking to take electrons from anywhere it can. The more positive the result the more corrosive the water is.

Slightly acidic water is often +300mv or more.

Swimming pool water for example is around +700mV

## HOW TO PROTECT YOUR HULL (SACRIFICIAL ANODES)

To protect your Hull, you need to prevent the loss of electrons. Outside of applying coatings this is not usually possible on small boats. The Hull is highly negative and the water is strongly positive so it is going to happen!!

You can however use Sacrificial Anodes. The principle is simple. You bolt a piece of metal to your Hull under the waterline made of a material that has more available electrons than the Hull metal.

For river Boats this would be Magnesium. Magnesium has a potential of -1800mV. Zinc is also commonly used and has a potential of -1200mV. Basically when the water takes electrons from the Hull it takes the path of least resistance. The electrons in these sacrificial Anodes are more readily available and are therefore removed thereby saving the electrons in the Hull.

Electrons are removed more readily at Sea so it is not practical to use Magnesium or Zinc in many cases as they would disappear too quickly. It is therefore more common to use Aluminium or even Steel. This will depend on the metal you are protecting.

## LOSS OF ELECTRONS WITH ANODES (STEEL HULL)

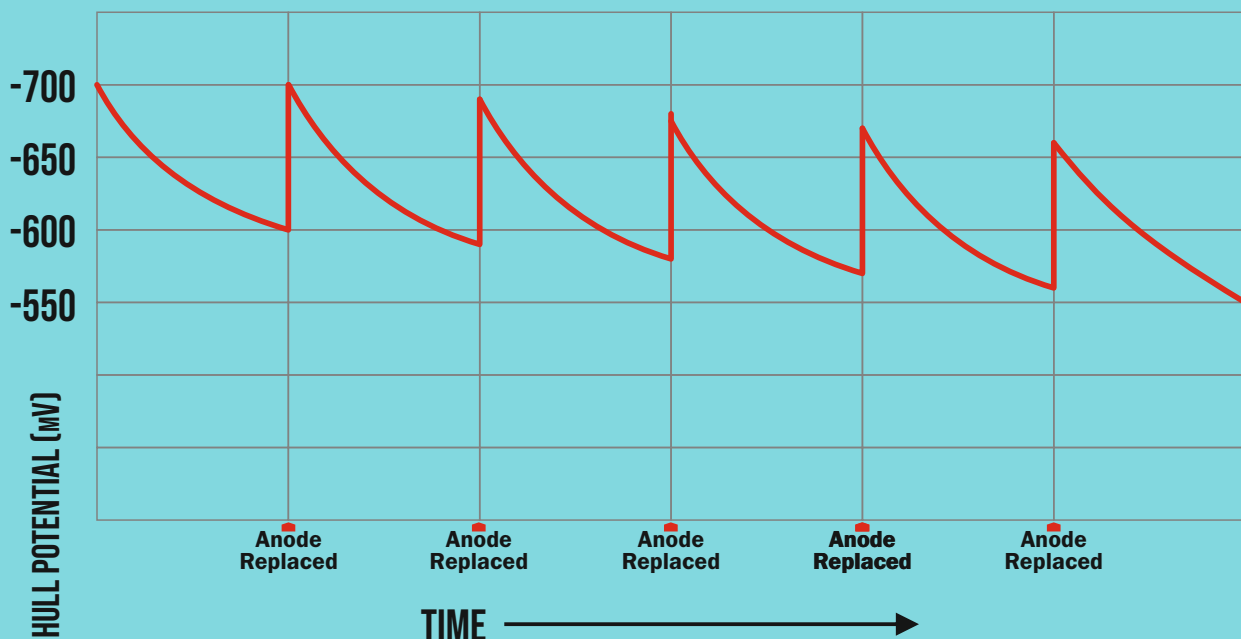


Figure Showing the protective effect of Sacrificial Anodes on Hull Potential

## MONITORING THE HULL OR DRIVES.

Once you have installed Sacrificial anodes you should measure the Hull potential. The reading will be more negative with the right size and number of anodes. e.g., a Steel hulls potential may change from -600mV to say -700mV.

The reading should be taken weekly or monthly. It will become more positive. Before the reading reaches the value it was before anodes were added they should be replaced. At this point the anodes are no longer effective and need replacing before the water starts taking electrons from the hull.

Drives and any other metal under the waterline should be monitored and protected in the same way.

## LOSS OF ELECTRONS (CORROSION COMPARISON)

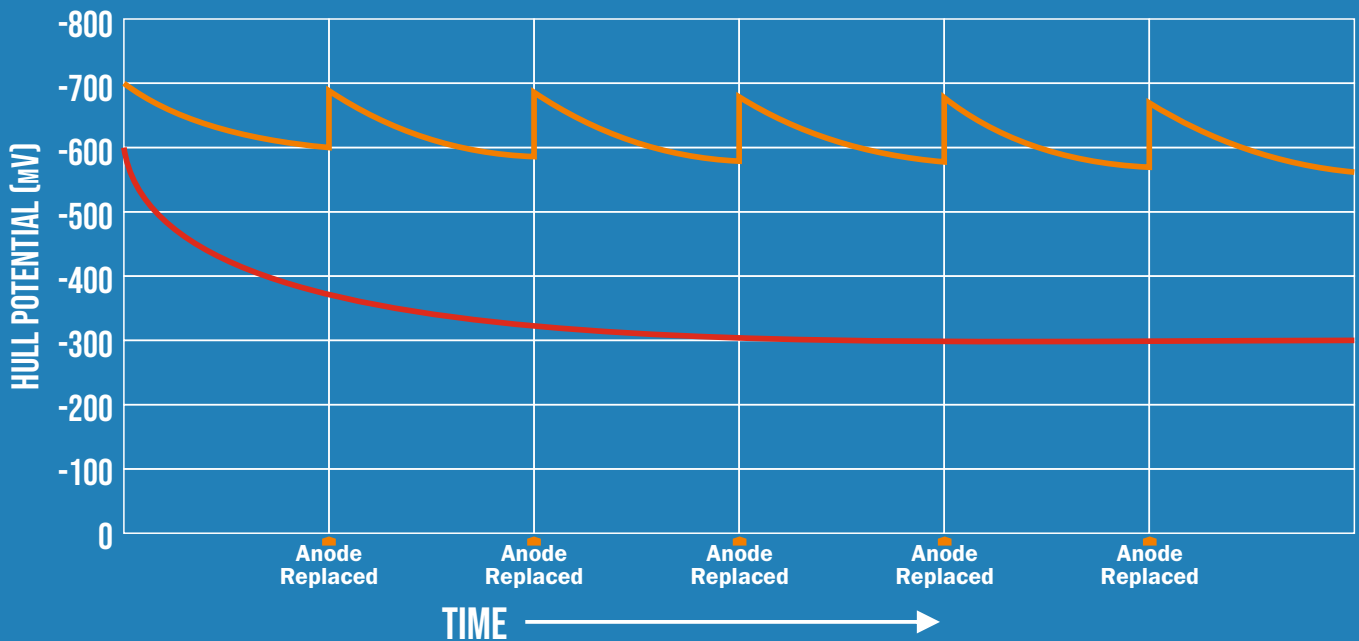


Figure Showing the Effect of sacrificial Anodes on Hull Potential

## MEASURING THE WATER,

The REDOX potential of water shouldn't change much but remember you can measure this potential and decide, within reason to moor your boat in the least corrosive location.

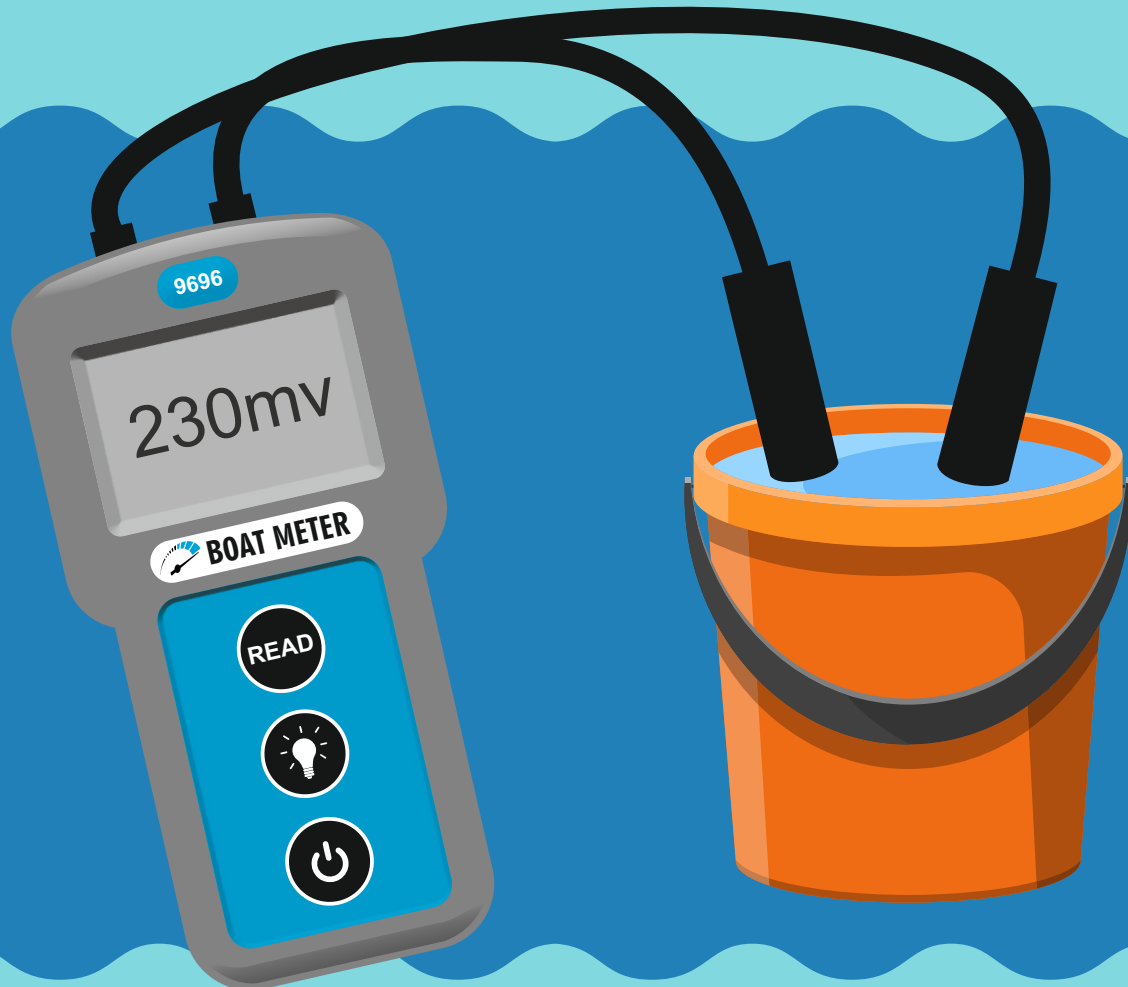
In a Marina these are usually in more stagnant water. If the reading is say +200mV near the boathouse and say +260mV near the entrance (where the water moves faster) that equates to being 10 times more corrosive.

Every +60mv equates to 10 X the corrosive power! So if the result is +320mV that means 100 times as corrosive and so on.

## STRAY DC AND WHY IT INCREASES CORROSION

The best reason to measure the REDOX potential of water is to pick up catastrophic stray DC (direct Current) or Oxidizing conditions brought about by faulty ground or earth contacts on nearby boats or in the Marinas grounding set up. (We have Used Stray DC generally as a term to cover all of these issues as they are varied and complex)

DC accelerates the movement of electrons and provides clearer paths to the Anodes. The good news is that it is pretty easy to locate the source of the problem.



All you need do is measure the REDOX potential of the water where you believe there is a problem.

If there is stray DC the REDOX result will be High (typically over +300mV) and may be variable. In some cases, depending on the source, it can be negative this will depend on the proximity of the REDOX probe to an active Anode or Cathode. Make a note of this reading and then remove a bucket of water taken from the same place the reading was taken. If you take a reading in the bucket it will be the base reading of the Marina water with no Stray DC. The difference in the result shows the extent of the Stray DC. **The bigger the difference the bigger the problem.**

Don't forget every 60mV increase is a 10 times more corrosive power. It is common to see 1000 and 10,000 times more corrosive activity with stray DC.

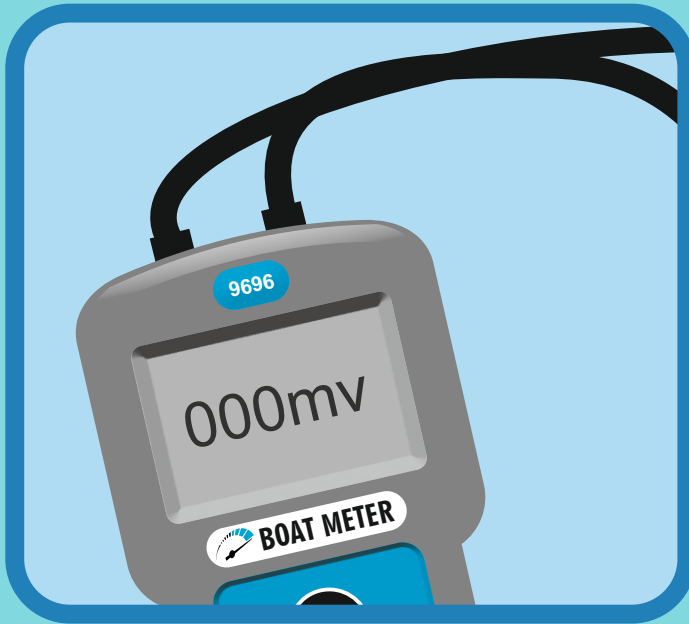
The first course of action is to isolate the issue by disconnecting the shore power on the suspected source and then re-test the water.

### SUMMARY

Monitoring and logging your hull potential will ensure Sacrificial Anodes are replaced at the right time. Not too soon and not too late. Either way you save time and money and prolong the life of your valuable boat.

Checking the water for optimum moorings and detection of Stray DC or other Oxidation issues will prevent more rapid and catastrophic damage.

# MEASURING HULL POTENTIAL WITH BOAT METER KIT



## CONNECT THE CABLES TO THE METER

When measuring the hull potential you must use

1. Boat Meter
2. Cathodic Protection Reference Electrode
3. The Crocodile Clip Cable

Firstly connect the cathodic protection reference electrode and the crocodile clip cable to the meter terminals on top of the meter. The Hull is the positive terminal. (RED)

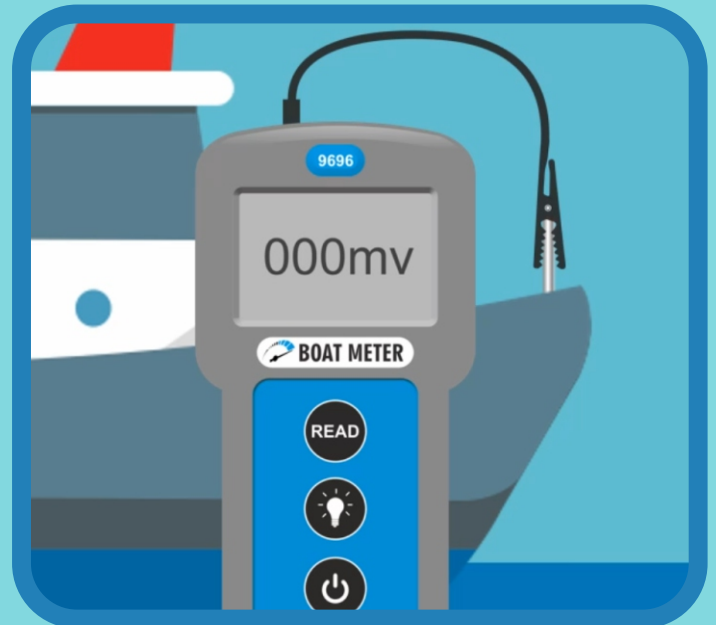
The Reference Electrode is the Negative terminal. (BLACK)

## CONNECT CROCODILE CLIP

Connect the Clip to a clean metal contact which is directly part of, or welded to the Hull.

If the area is corroded make sure you remove as much rust as possible and expose some clean metal.

Fender loops are often ideal for this purpose. Avoid connecting to hanging chains though they may be loosely connected to loops and fittings.



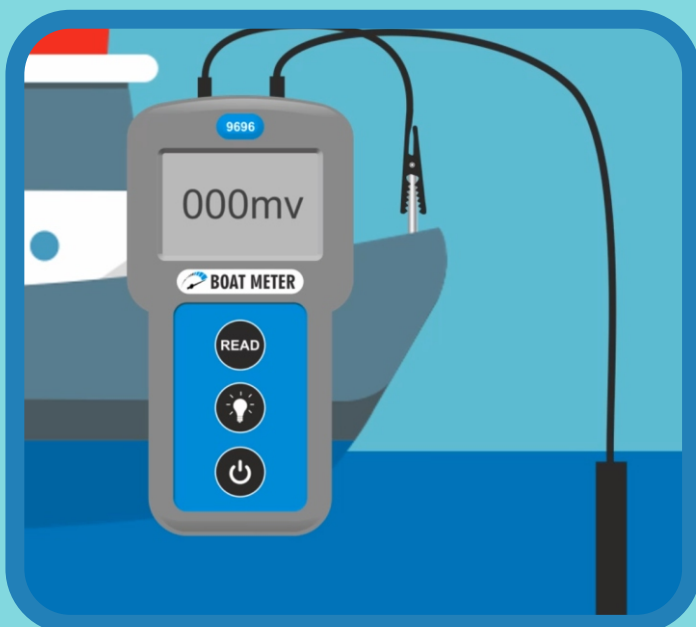
## LOWER ELECTRODE INTO WATER

Turn the Boat Meter on by pressing the READ button.

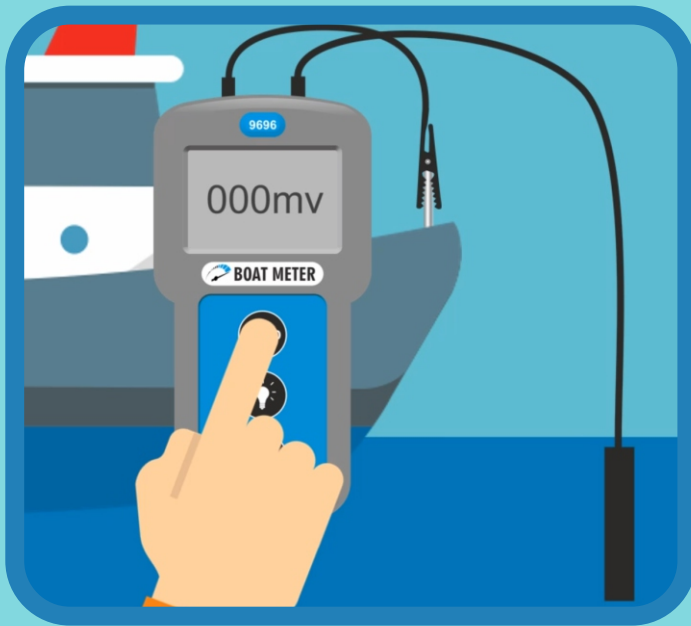
You are in the Hull potential Mode.

Lower the Cathodic protection Reference electrode into the water at a point close to where the Crocodile clip is connected.

For best results keep the top of the electrode above the waterline if possible. Do not throw or drop the Electrode in the water as it may contact the bottom or become snagged



# MEASURING HULL POTENTIAL WITH BOAT METER KIT (CONT.)



## PRESSING THE READ BUTTON

The electrode is waterproof so submersion is not damaging.

The display will immediately read the Hull potential in millivolts (mV).

The reading will take approximately 30 seconds to stabilize. The closer the electrode is to the hull the more stable the result.

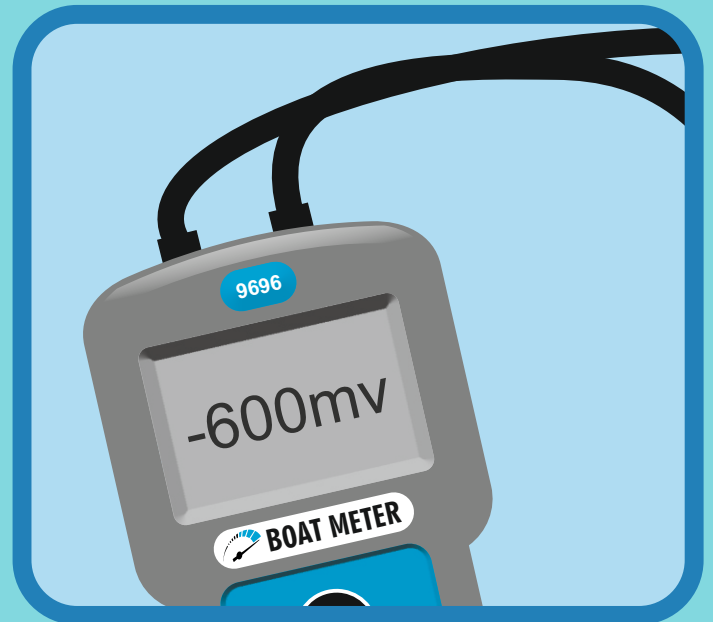
Both the electrode and Hull connection have 5 meter cables to enable measurements to be made from the boat deck or the pontoon or dock.

## TAKING THE READING

When the reading is stable press read to store the result in the Boat Meters memory. This will be automatically dated and will serve as a record as you monitor the rate of corrosion of the hull.

It will also track the effectiveness of your sacrificial anodes and provide a guide as to when they need replacing.

You should read your Hull potential regularly particularly when you are in a Marina as that is where most corrosion is likely to occur.



## RECORD THE DATA FOR FUTURE REF.

The Boat Meter will not only store your Hull and Water (REDOX) Potential readings but it has a Micro USB connector which allows the results to be downloaded directly into an Excel spreadsheet.

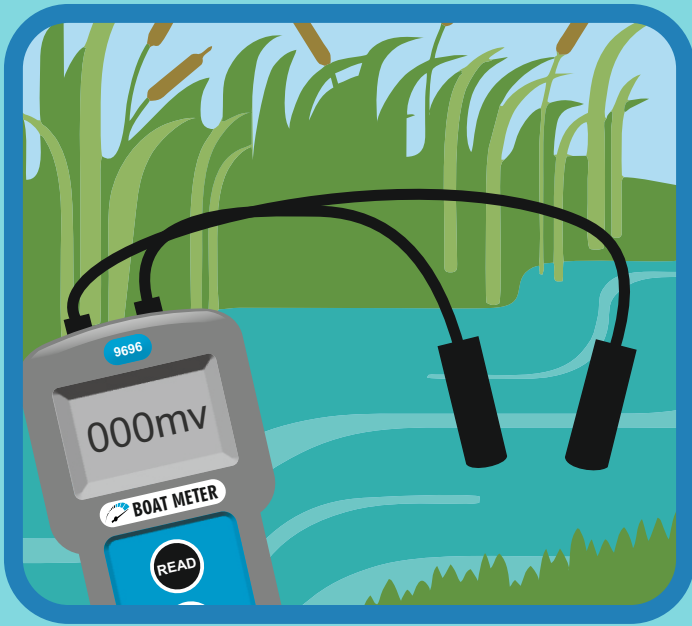
This will allow you to create graphs, tables and follow trends more easily. You can also locate when corrosion occurs and get an early warning should your anodes need replacing.

It can also save valuable time and money by confirming the good condition of anodes.





# MEASURING WATER POTENTIAL



## CONNECTING THE ELECTRODES

Measuring Water Potential (REDOX) tells you how corroding the water is and can identify the presence of damaging Stray DC.

You will need the following:

1. Boat Meter
2. Cathodic Protection Reference Electrode
3. Platinum Electrode

The measurement is the same as the Hull measurement except that a Platinum electrode is connected to the Positive terminal instead of the boat hull. The Reference and the Platinum Electrode are both placed in the water together.

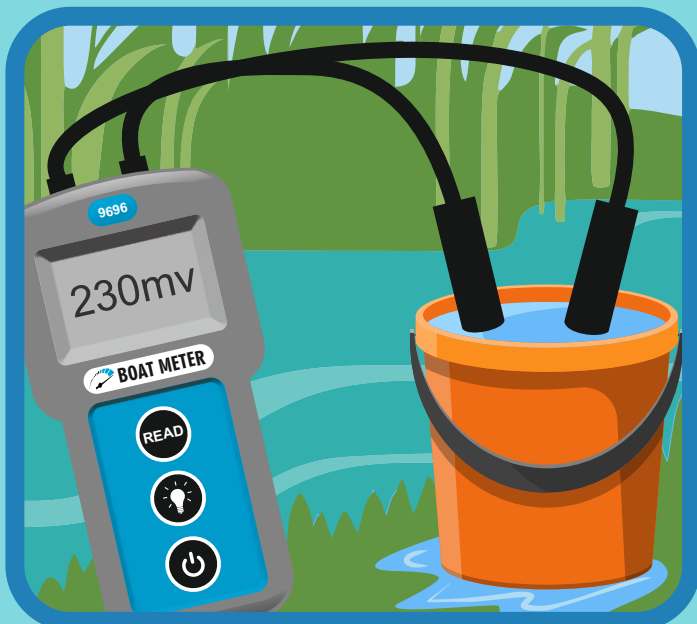
## TAKING THE READING

Best readings are taken near the surface so try and keep the tops of the electrodes just out of the water with the bodies submerged.

Water is most corrosive at the surface. Every 60mV increase means 10X more corrosion!!

Press the READ button then the MODE button to enter the Water (REDOX) mode. Allow 30 second for the reading in millivolts (mV) to stabilize.

Press READ to store the result in the Boat Meters memory.



## CHECKING FOR STRAY DC

Water (REDOX) readings will identify the presence of Stray DC. Normal water readings are around +200 to +250mV.

When Stray DC is present this result will rise dramatically and often be unstable. It is possible to track the readings to locate the source where the readings are highest.

When you have located the source of the stray DC remove a bucket of water and make a measurement in the bucket. The difference in the results is the extent of the Stray DC.

**PLEASE VISIT OUR WEBSITE**



**FOR MORE INFORMATION  
TIPS, TRICKS & TUTORIALS**

**INFO@SACRIFICIALANODE.CO.UK**

**[WWW.SACRIFICIALANODE.CO.UK](http://WWW.SACRIFICIALANODE.CO.UK)**

**+44 (0)1925 320310**