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## **PURPOSE**

This section provides an overview on corrosion prevention of underwater hulls including: general problems; types of hull substrates – steel and aluminium, and stray currents.

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## **UNDERWATER HULLS AND CORROSION**

Preventing attack from marine organisms and corrosion is essential for the protection of an underwater hull. General painting principles apply, however, the marine environment is unlike any typical painting situation and specialised knowledge and planning is essential for success.

Surface waters of the sea contain immense numbers of floating microscopic animal and plant life.

All sea vessels are bathed in this soup of living particles, a great many of which will settle on hulls and grow into marine fouling. Fouling is obstructive to speed, destructive to hulls and costly to remove. Fouling is thickest in coastal water and comparatively sparse in mid ocean. It is densest in harbours and estuaries which contain fresh water, where river and harbour effluent provide a rich supply of food on which marine organisms thrive.

The problem is a function of two factors:

- The prevention of corrosion in a very corrosive environment.
- The prevention of fouling in an ideal fouling environment.

These factors are inter-related – poor corrosion resistance leads to paint film disruption, and consequent loss of antifouling effectiveness as paint detaches by flaking, blistering, etc.

Poor antifouling resistance leads to corrosion, as barnacles cut their way down to the substrate and severely disrupt the film.

Design is important in addressing this problem – substrate selection and coating selection. The following sections outline issues concerned with substrate and coating selection in order to prevent corrosion and fouling.

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## **TYPES OF HULL SUBSTRATE**

### **Steel**

Corrosion is severe when dissimilar metals are used in the construction of steel boats e.g. phosphor bronze propellers. This dissimilar metal corrosion is electrical in nature and requires specialised treatment.

All owners of steel hulled craft must be constantly alert to outside influences including the above which may cause varying degrees of damage to below the waterline paint systems.

### **Stray Currents**

Corrosion can be accelerated by the action of electrical currents entering a metal from some external source such as a generator or storage battery and leaving the metal to continue its flow, in whole or in part through the seawater electrolyte. Damage results only when there is some high resistance interruption of the more favourable lower resistance metallic path.

Stray current corrosion frequently referred to incorrectly by the general term “electrolysis” can be caused by short circuiting of electrical connections in boat equipment.

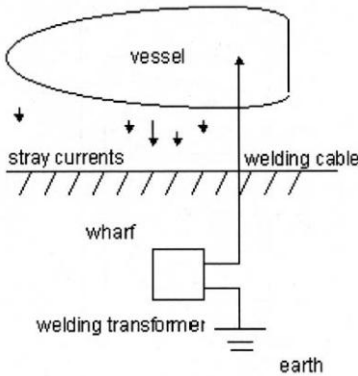
There could also be some stray current problem in marinas if there is a difference in the polarity of the ground of the electrical systems of adjacent boats, one with a positive ground and the other with a negative ground. The electrical circuit between boats could be completed by their common use of an onshore source of current while moored. The propeller and shaft and other grounded outboard metallic components of the boat with the positive grounding would suffer stray current corrosion. The proper practice would be not use negative grounding. To avoid electrical interference between adjacent boats it would be desirable to install a one to one isolation transformer in the circuit from the onshore source of the current.

Stray current corrosion can occur when welding on board a ship from a source of current onshore, and if the return leads to the onshore generator do not have ample current carrying capacity. This forces some of the current to return to the source onshore through discontinuities in the paint on the submerged hull.

In a ship that is being fitted-out, stray currents can be generated by operations such as welding, particularly if the welding equipment is not correctly earthed or if cables are defective. These stray currents are much stronger than the cathodic protection current and will therefore cause severe corrosion in areas where they leave the ship's hull, or cause damage to the paint where they enter the hull. The voltmeter should be connected to a recorder. If stray currents are detected, cables of welding equipment and temporary lighting should be inspected for leaks and defective earthing. Equipment that has already been installed and is running should be checked.

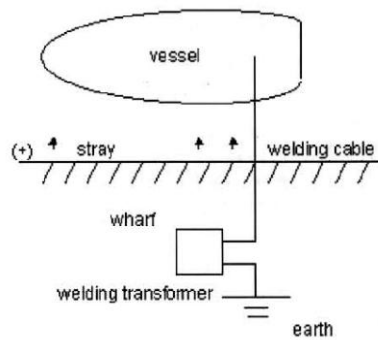
The following diagrams provide a pictorial guide to typical stray current situations.

**WELDING CONNECTIONS - SINGLE CURRENT SUPPL - ONE SHIP**



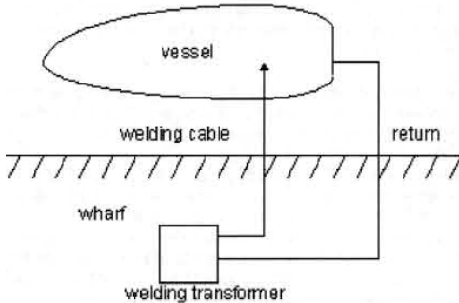
**Incorrect!**

Where welding with a positive electrode and without a return cable, the vessel's hull will become an anode, and stray current will cause severe corrosion in positions where it leaves the hull.



**Incorrect!**

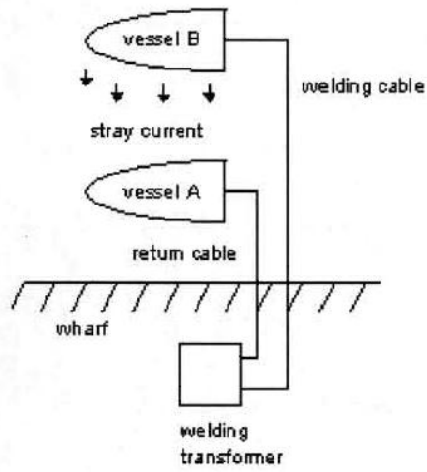
Where welding with a negative electrode and without a return cable, the vessel's hull becomes a cathode; the paint will be damaged in places where alkalinity is high; bare spots will subsequently corrode.



**Correct!**

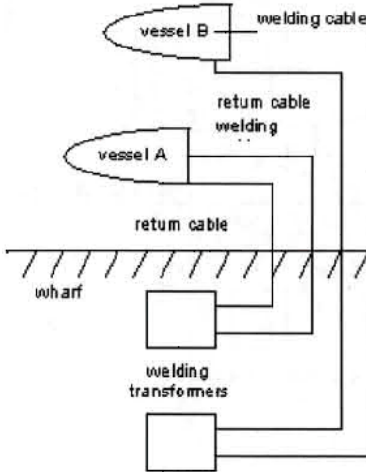
The welding transformer is not earthed; the return cable has a large diameter (low resistance), so the seawater and the wharf do not act as conductors for the return current. **NOTE:** Welding must not take place on the wharf, since this would cause earth contact.

**WELDING CONNECTIONS- SINGLE CURRENT SUPPLY - TWO SHIPS**



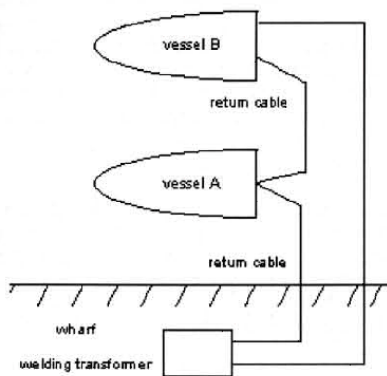
**Incorrect!**

One welding transformer for two vessels and no return cable. The return current from vessel B will pass to vessel A. The hull of vessel B will corrode and paint on the hull of vessel A will be damaged.



**Correct!**

Each vessel has its own welding transformer with separate return cable.



**Correct!**

Both vessels are connected electrically by a return cable to the welding transformer

**Aluminium**

There are a number of distinct advantages of using aluminium as a construction material – lightweight, strong and durable. Aluminium has a number of disadvantages that need to be clearly understood to avoid future problems.

1. The excellent durability of aluminium when uncoated is due to an oxide layer that resists further corrosive attack in the marine environment. However, this oxide layer is of little use. In immersed situations as aluminium is subjected to pitting and corrosion upon continuous immersion in seawater, particularly at welded joints.
2. Aluminium needs to be adequately protected from its environment in marine situations. Furthermore, aluminium is a difficult material on which to apply surface coatings and obtain satisfactory adhesion. Special surface preparation steps are essential – the oxide film needs to be removed by abrasive disc sanding or whip blasting so that the primer will adhere satisfactorily. **NOTE:** Do not use wire brushes.
3. Aluminium cannot be coated with any cuprous oxide containing-antifouling. An extremely severe electrolytic corrosion reaction occurs between copper (and its salts) and aluminium. This reaction is so severe that the boat owner should never be convinced that sufficiently thick primer coatings will insulate the aluminium from the copper.
4. Any minor damage or scratch mark has the potential to sink the vessel, and quite quickly.
5. Aluminium appendages should not be employed on a boat coated with a cuprous oxide based antifouling.
6. When repainting aluminium, old coatings may need to be removed and the surface prepared.

DO NOT burn off the old paint with blow lamps etc.  
DO NOT use caustic based paint strippers.  
DO NOT use steel wool or wire brushes.

**OSMOSIS**

Each coat of paint must be an even film of the required dry film thickness. The reason for this is that all organic paint coatings transmit water vapour through a semi permeable membrane (paint coating) from a solution of smaller concentration to a solution of greater concentration – this is called osmosis.

The osmosis effect is manifested in the form of blisters on the underwater surfaces. This effect can be greatly increased at low film thickness under cathodic protection, or induced by stray current flowing through the hull. This reduces the corrosion protection benefit of the coating system.

To minimise this possibility, it is essential that an anti-corrosive paint system of consistently 225-250 microns minimum be applied to a steel hull before antifouling.



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