Focus on IMO

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Anti-fouling systems

Introduction

Ships travel faster through water and consume less fuel when their hulls are clean and smooth - free from fouling organisms, such as barnacles, algae or molluscs.

In the early days of sailing ships, lime and later arsenical and mercurial compounds and pesticides were used to coat ships' hulls to act as anti-fouling systems. During the 1960s the chemicals industry developed efficacious and cost-effective anti-fouling paints using metallic compounds, in particular the organotin compound tributylin (TBT). By the 1970s, most seagoing vessels had TBT painted on their hulls.

However, it soon became clear there was a price to pay for the efficient anti-fouling paints containing TBT. Environmental studies provided evidence that organotin compounds persist in the water and in sediments, killing sealife other than that attached to the hulls of ships and possibly entering the food chain. Specifically, TBT was shown to cause shell deformations in oysters; sex changes (imposex) in whelks; and immune response, neurotoxic and genetic affects in other marine species.

In the 1970s-1980s, high concentrations of TBT in shellfish on the coast of France caused the collapse of commercial shellfisheries in at least one area, and this prompted many States to act and enforce some restrictions on the use of TBT in anti-fouling paints.

In 1988, the problem was brought to the attention of the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO), the United Nations Agency concerned with the safety of shipping and the prevention of marine pollution.

As a result, IMO in 1990 adopted a resolution recommending governments to adopt measures to eliminate anti-fouling paints containing TBT. In the 1990s, the MEPC continued to review the environmental issues surrounding anti-fouling systems, and in November 1999, IMO adopted an Assembly resolution that called on the MEPC to develop an instrument, legally binding throughout the world, to address the harmful effects of anti-fouling systems used on ships. The resolution called for a global prohibition on the application of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2003, and a complete prohibition by 1 January 2008.

In October 2001, IMO adopted a new **International Convention on the Control of Harmful Anti-fouling Systems on Ships, which** will prohibit the use of harmful organotins in anti-fouling paints used on ships and will establish a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems.

The convention will enter into force 12 months after 25 States representing 25% of the world's merchant shipping tonnage have ratified it.

Fouling explained	
What is fouling?	Fouling is an unwanted growth of biological material - such as barnacles and algae - on a surface immersed in water.
How much fouling does an unprotected ship get?	Vessel bottoms not protected by anti-fouling systems may gather 150 kg of fouling per square metre in less than six months of being at sea. On a Very Large Crude Carrier with 40,000 square metre underwater areas, this would add up to 6,000 tonnes of fouling.
Why do ships need anti-fouling systems?	Just a small amount of fouling can lead to an increase of fuel consumption of up to 40%, and possibly as much as 50%, since the resistance to movement will be increased. A clean ship can sail faster and with less energy.
How do anti-fouling systems save a shipowner money?	An effective anti-fouling system can save a shipowner money in a number of ways: • Direct fuel savings by keeping the hull free of fouling organisms; • Extended dry-docking interval, when the anti-fouling system provides several years of use; • Increased vessel availability - since it does not have to spend so much time in dry dock.
What makes a good biocide in an anti-fouling system?	A good biocide for use in an anti-fouling system has the following characteristics: • Broad spectrum activity; • Low mammalian toxicity; • Low water solubility; • No bioaccumulation in the food chain; • Not persistent in the environment; • Compatible with paint raw materials; • Favourable price/performance.

Ref: Lectures 2 and 3 from proceedings of: The Present Status of TBT-Copolymer Anti-fouling Paints, International One Day Symposium on Anti-Fouling Paints for Ocean-Going Vessels, the Hague, the Netherlands, April 1996. Proceedings presented to MEPC, 38th Session.

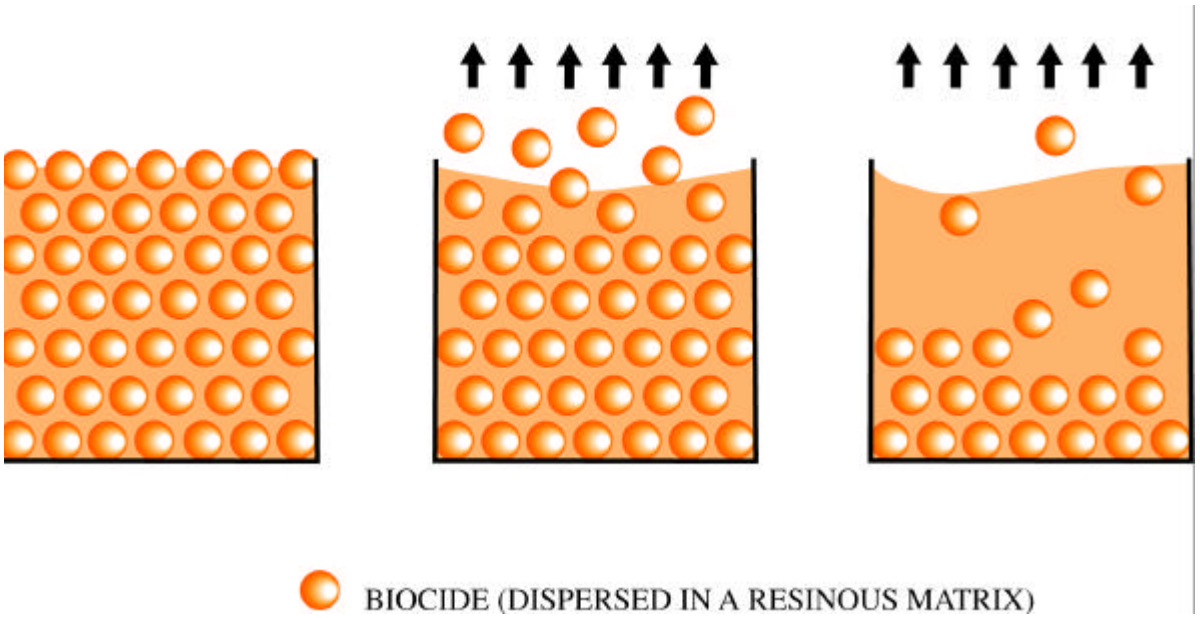
Development of Anti-fouling systems

In the early days of sailing ships, lime and later arsenical and mercurial compounds and DDT[1] were used to coat ships' hulls to act as anti-fouling systems. During the 1960s the chemicals industry developed efficacious and cost-effective anti-fouling paints using metallic compounds, in particular the organotin compound tributyltin (TBT). By the 1970s, most seagoing vessels had TBT painted on their hulls

With the early organotin-based anti-fouling paints, the active ingredients were dispersed in the resinous matrix - the "paint" - from which they "leached" into the sea water, killing barnacles and other marine life that had attached to the ship. But the release rate for the biocide in these "free association" paints was uncontrolled and tended to be rapid initially, with the effect wearing off in 18 to 24 months as the biocide leached out of the paint.

[1] DDT - dichloro dithenyl trichloroethane: a pesticide, banned from agricultural use in United States since 1973 and also prohibited in most other countries.

Free Association paint

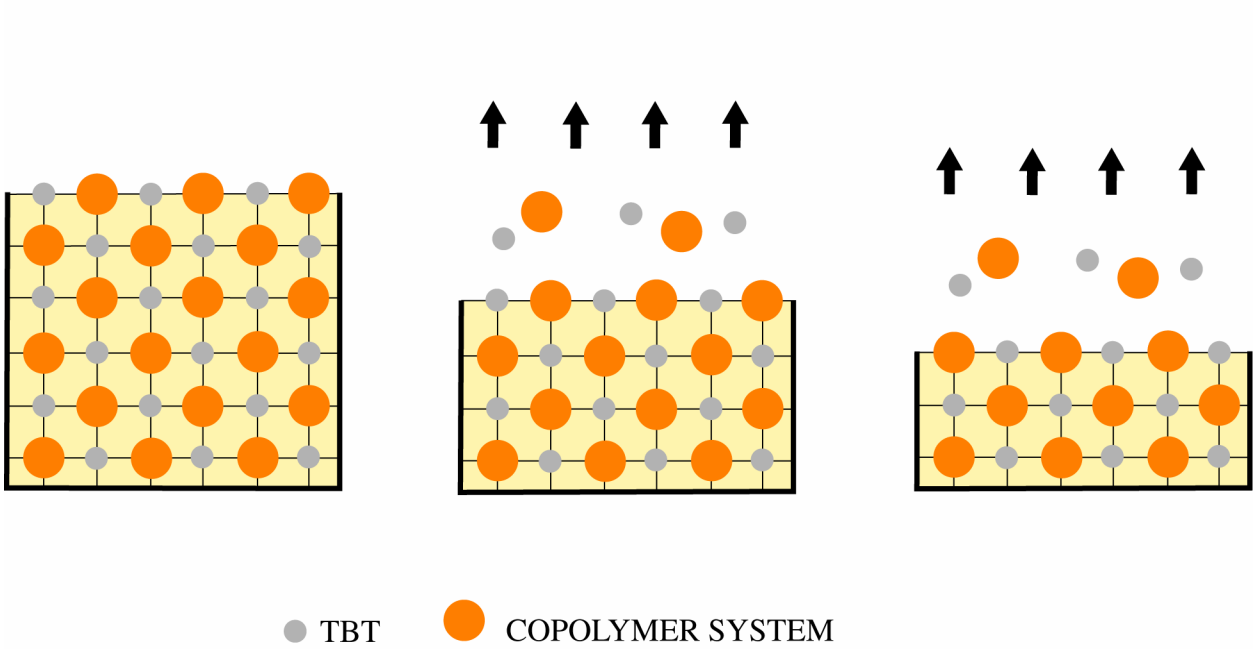


Biocide leaches freely from resinous matrix. Initial release is rapid, subsequent release declines so anti-fouling performance of paint diminishes over time. *Source*: European Chemical Industry Council (CEFIC).

Self-polishing paints

A particular breakthrough in anti-fouling paints came in the late 1960s, with the development of so-called self-polishing paints, in which the organotin compounds are chemically bonded to the polymer base. The leaching rate of these paints is controlled because the biocide is released when seawater reacts with the surface layer of the paint. Once the surface layer is worn off, the reaction to release the biocide begins again with the next layer. In this way, the leaching rate is the same throughout the life of the paint - and it became possible for ships to go up to 60 months without repainting.

Self-Polishing Copolymer System



Sea water hydrolyses the TBT copolymer bond and the TBT biocide and copolymer resin is slowly released at a controlled rate. Uniform anti-fouling performance is achieved throughout the lifetime of the paint. *Source*: CEFIC.

Naturally, the self-polishing paints containing TBT were a huge success with the shipping industry. [2]

But success came at a price – paid for by the environment.

TBT - the problem

TBT has been described as the most toxic substance ever deliberately introduced into the marine environment.[3] Used as a fungicide, bactericide, insecticide and wood preservative, it is known to be harmful to a range of aquatic organism, including microalgae, molluscs and crustaceans, fish and some invertebrates.

As a biocide in anti-fouling paint, it proved extremely effective at keeping smooth and clean the hulls of ships and boats. And when it was introduced into anti-fouling paints, it was considered less harmful than biocides used in anti-fouling systems at the time: such as DDT and arsenic. As a biocide, TBT needed to be toxic to be effective in killing off the organisms that would attach to the ship's hull. The main problem was its persistence in the marine environment.

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[2] The TBT-based self-polishing anti-fouling paints were also used for small vessels such as yachts and pleasure boats, until many countries in the 1980s banned their use for vessels under 25 metres in length.

[3] S.M.Evans, T.Leksono and P.D.McKinnell. *Tributyltin Pollution:A diminisihing problem following legislation limiting the use of TBT-based anti-fouling paints.* Marine Pollution Bulletin, Vol 30,No.1, pp 14-21,1995.

As TBT began to be widely used in anti-fouling paints, scientists began to find increasingly high concentrations of TBT in areas with high concentrations of boats and ships, such as marinas, ports and harbours. In the open seas and oceanic waters, TBT contamination was seen as less of a problem, although later studies showed evidence of TBT accumulation in fish and mammals.[4] Scientists first found evidence of TBT contamination in oysters. In Arcachon Bay, on the west coast of France, TBT contamination from boats was linked in the 1970s to high mortalities of oyster larvae and such severe malformations of the shells of adults that they were unmarketable. [5]

In south-west England, TBT poisoning was linked to the decline of the population of the dog whelk (*Nucella lapillus)* in the 1980s. Studies showed that female dogwhelks develop the condition known as imposex in response to TBT poisoning: females develop male sexual organs and the female can become sterile.

In the 1980s, high concentrations of TBT were reported in coastal areas around the world.[6] As a result, a number of countries introduced controls to limit the use of TBT in anti-fouling paint on small vessels. France prohibited the use of TBT-based paints on vessels less than 25 metres in length in 1982 and other countries followed suit, including Japan, which imposed strict regulations on the use of TBT in anti-fouling paints in1990 and prohibited the production of such paints in 1997.[7]

Developing international regulations on TBT

The pollution problems caused by TBT in anti-fouling paints were first raised at IMO's Marine Environment Protection Committee (MEPC) in 1988, when the Paris Commission[8] requested IMO to consider the need for measures under relevant legal instruments to restrict the use of TBT compounds on seagoing vessels.

By this time there was unequivocal evidence worldwide that TBT and other organotin compounds were harmful to aquatic organisms - and several countries had already, individually or under regional agreements, adopted measures to reduce the harmful effects of the use of TBT based anti-fouling paints.[9]

It was clear, however, that international measures to regulate the use of anti-fouling systems would need to be developed and in April 1990, the Third International Organotin Symposium held in Monaco recognized that the IMO was the appropriate body to do this.

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[4] TBT in antifouling paints: National Institute for Coastal and Marine Management/RIKZ, Netherlands. MEPC 42/Inf.10

[5] S.M. Evans, T. Leksono and P.D. McKinnell. *Tributyltin Pollution: A diminisihing problem following legislation limiting the use of TBT-based anti-fouling paints.* Marine Pollution Bulletin, Vol 30, No.1,pp14-21, 1995.

[6] Including Atlantic coast of France, Mediterranean Sea, Bahrain, North Sea off United Kingdom, Canada, United States, New Zealand and Australia

[7] Similar bans on use of TBT paints were imposed in the United Kingdom (1987), United States (1988), New Zealand (1988), Australia (1989) and Norway (1989), as well as other countries.

[8] The Paris Commission (PARCOM) is an international organisation established by Treaty and concerned with the prevention of pollution of the North East Atlantic. It is now part of the OSPAR (Oslo and Paris) Commission.

[9] MEPC 42/5 para 2

Tributyltin (TBT) - harmful effects on the environment	
Water and sediments	Tributyltin - organotin compound (TBT) is a broad spectrum algicide, fungicide, insecticide and miticide used in anti-fouling paints since the 1960s. TBT is toxic to humans. TBT can be broken down in water under the influence of light (photolysis) and micro-organisms (biodegradation) into less toxic di- and monobutyltin. Half-life varies from a few days to a few weeks, but decomposition is slower when TBT has accumulated in sediment - if oxygen is completely excluded, TBT half-life maybe several years. Therefore waters with heavily sedimented bottoms - such as harbours, ports, estuaries - are at risk of being contaminated with TBT for several years.
Shell malformations	TBT causes thickening of shells in sea oysters, caused by disturbance of calcium metabolism.
Imposex	Recorded in marine snails: females develop male sexual characteristics. Imposex has been recorded in 72 marine species. Concentration of just 2.4 nanograms of TBT per litre needed to produce sexual changes in dog-whelks, leading to sterility.
Marine mammals	Traces of TBT have been found in whales, dolphins and members of the seal family in the United States, south-east Asia, the Adriatic Sea and the Black Sea. The TBT is absorbed via the food chain.
Reduced resistance to infection	Research has shown TBT reduces resistance to infection in fish such as flounder and other flatfish which live on seabed and are exposed to relatively high levels of TBT, especially around areas with silty sediment like harbours and estuaries.

Ref: TBT in antifouling paints: National Institute for Coastal and Marine Management/RIKZ, Netherlands. MEPC 42/Inf.10

MEPC Resolution adopted 1990

In1990, at its 30th session, the MEPC adopted Resolution MEPC 46(30) on ***Measures to Control Potential Adverse Impacts Associated with Use of Tributyl Tin Compounds in Anti-Fouling Paints***.

This resolution recommends that Governments adopt measures to eliminate the use of antifouling paint containing TBT on non-aluminium hulled vessels of less than 25 metres in length and eliminate the use of anti-fouling paints with an average leaching rate of more than 4 microgrammes of TBT per cm^2 per day.

These recommendations were intended to be interim measures until IMO could consider a possible total prohibition of TBT compounds in anti-fouling paints for ships.

RESOLUTION MEPC.46(30) (adopted on 16 November 1990)

Measures to control potential adverse impacts associated with use of tributyl tin compounds in anti-fouling paints

THE MARINE ENVIRONMENT PROTECTION COMMITTEE,

NOTING that scientific studies and investigations by Members and other competent international organizations have shown that tributyl tin compounds can pose substantial risk of toxicity and other chronic impacts to ecologically and economically important marine organisms,

NOTING ALSO that use of tributyl tin compounds in anti-fouling paints for vessels is a significant source of tributyl tin found in the marine environment,

NOTING FURTHER that the existing scientific studies and investigations indicate that adverse impacts associated with tributyl tin compounds are of greatest concern in coastal waters, which by their nature can serve as important habitat and breeding grounds for marine organisms and are subject to concentrated shipping activities,

BEING AWARE that measures to control the use of tributyl tin compounds in anti-fouling paints have been adopted by a number of Governments and competent international organizations,

RECOGNIZING that there is a need for action to control the use of tributyl tin compounds in anti-fouling paints in order to reduce or eliminate potential adverse impacts to the marine environment,

RECOGNIZING ALSO that there are a number of different measures and approaches which can be used to reduce the potential for such adverse impacts,

AGREES:

(a) to recommend that Governments adopt and promote effective measures within their jurisdiction to control the potential for adverse impacts to the marine environment associated with the use of tributyl tin compounds in anti-fouling paints, and as an interim measure specifically consider action as follows:

- (i) to eliminate the use of anti-fouling paints containing tributyl tin compounds on non-aluminium hulled vessels of less that 25m in length,
- (ii) to eliminate the use of anti-fouling paints containing tributyl tin compounds which have an average release rate of more than 4 microgrammes of organotin per square centimetre per day,
- (iii) to develop sound management practice guidance applicable to ship maintenance and construction facilities to eliminate the introduction of tributyl tin compounds into the marine environment as a result of painting, paint removal, cleaning, sandblasting or waste disposal operations, or run-off from such facilities,
- (iv) to encourage development of alternatives to anti-founding paints containing tributyl tin compounds, giving due regard to any potential environmental hazards which might be posed by such alternative formulations, and
- (v) to engage in monitoring to evaluate the effectiveness of control measures adopted and provide for sharing such data with other interested parties;

(b) to consider appropriate ways towards the possible total prohibition in the future on the use of tributyl tin compounds in anti-fouling paints for ships.

Effectiveness of legislation banning TBT

In areas where a ban on TBT-based anti-fouling paints was imposed on smaller vessels, there was evidence of a decline in TBT contamination, including recovery from abnormal shell growth in oysters and a decline in imposex in dogwhelks. [10]

UNCED 1992

The need for IMO to work on the anti-fouling issue was highlighted at the 1992 Rio Conference on Environment and Development. Chapter 17 of Agenda 21 developed by the Conference called on States to take measures to reduce pollution caused by organotins compounds used in anti-fouling systems.

MEPC continues work on TBT

From 1990 onwards, IMO's MEPC was presented with TBT monitoring study results which reconfirmed the toxicity of TBT compounds to marine organisms. The Committee was also presented with information on existing alternative anti-fouling systems, including their effectiveness and the risk posed to the aquatic environment by these systems.

The MEPC in 1996, at its 38th session, established a Correspondence Group to look at the issues involved. The main conclusions, based on comments from the 12 countries and four non-governmental organizations which participated, were reported back to MEPC at its 41st session in April1998[11]:

- Most supported the application of the "precautionary approach" - based on the idea that if there is doubt about harm to the environment from a particular product or action, it should not be done. The onus should be on proving something is completely harmless.

- Further research on harmful effects of anti-fouling systems on the marine environment are necessary to focus attention and increase awareness, though many countries saw no need for further evidence of harmful effects of TBT.

- Development of alternative less harmful anti-fouling systems should be encouraged - biological anti-fouling, non-stick mechanisms, electrochemical anti-fouling systems and cleaning methods.

- Alternative systems should be shown to be considerably less harmful to the marine environment than TBT.

- Criteria for substances and/or methods used as anti-fouling systems should be developed - such as toxicity, effectiveness, release rate of toxins.

- Industry has its own methods for deciding whether or not to produce and market a product, taking into account existing national and international health, safety and environmental regulations.

- Interim measures would be needed ahead of a total ban on TBT anti-fouling systems. Interim measures could include limiting TBT anti-fouling systems to larger vessels initially; prohibiting TBT systems on ships with docking interval of 2.5 years or less; restrictions on specific vessel categories such as fishing vessels, dredging equipment, offshore equipment, ships operating in particularly sensitive sea areas.

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[10] MEPC 42/5 para 2

[11] MEPC\41\10

- Long-term measures need to be developed to bring about a complete ban of TBT and preclude other harmful anti-fouling systems from entering the market.

- Mandatory measures are required to reduce and eventually eliminate the use of anti-fouling systems containing organotin compounds or other harmful substances or anti-fouling systems which are harmful to the environment in any other way. Measures should be mandatory to prevent unfair competition and should be supported as widely as possible.

- An instrument containing mandatory measures for anti-fouling systems should be developed as a matter of urgency, taking into account enforcement and enforceability of such measures. Control and enforcement can partly be established by certification of approved anti-fouling systems and on the basis of product specifications.

After discussion, the MEPC agreed at its 41st session in April 1998 to establish a Working Group at its 42nd session, later the same year, to begin work on drafting mandatory regulations to phase out and eventually prohibit the use of toxic anti-fouling systems containing organotin compounds such as TBT.

Assembly resolution

At its 42nd session, in November 1998, the MEPC approved a draft Assembly resolution which includes a deadline of 2008 for the complete prohibition on the presence of organotin compounds acting as biocides in anti-fouling systems on ships.

The Working Group also began looking at the basic structure of the proposed legal instrument as well as how alternative anti-fouling systems should be assessed.

The Group agreed that the global legal instrument developed by IMO should be legally binding and global in scope to ensure an equitable solution that avoids creating competitive distortions in the global shipping, shipbuilding and shiprepair market. In discussing the methodology for assessing alternative anti-fouling systems, the Group recognized the need for assessing alternatives to be based on environmental factors and it concluded that it would be inappropriate to develop performance or efficacy criteria for anti-fouling systems through IMO as this issue is best handled as a function of market pressures.

The resolution developed by the Working Group that met during MEPC 42, was subsequently adopted by the 21st IMO Assembly in November 1999. The resolution A.895 (21) **Anti-fouling systems used on ships** states that IMO "urges the Marine Environment Protection Committee to work towards the expeditious development of a global legally-binding instrument to address the harmful effects of anti-fouling systems used on ships".

The Resolution adds that IMO "agrees that the global instrument to be developed by the Marine Environment Protection Committee should ensure a global prohibition on the application of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2003, and a complete prohibition on the presence of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2008".

The Assembly in November 1999 also approved the holding of a diplomatic conference in 2001 to adopt the proposed instrument.

Perceived obstacles in banning organotin compounds

Adopting a mandatory instrument in 2001 to phase out organotin compounds which act as biocides in anti-fouling systems was seen as a realistic goal for IMO. However, there were a number of issues

which needed to be resolved or clarified in order to obtain full agreement from all IMO Member States.

The main concerns, expressed during a one-day symposium on Anti-Fouling Paints for Ocean-Going Vessels, held in the Netherlands in 1996, were as follows:[12]**:**

A general organotin phase out for ocean-going vessels **when no acceptable alternatives exist,** *would have severe economic and ecological consequences:*

- **Premature, uncontrollable hull fouling** *and reduced paint film structural integrity leading to potential corrosion and safety hazard.*
- *Trans-global contamination of ecosystems with exotic organisms as a consequence of* **failed anti-fouling protection.**
- *Major reduction of* **drydocking service intervals** *for ocean going vessels*
- **Unknown environmental risks** *due to an increased usage of alternative biocides and their metabolites.*
- **Accumulation potential of organic biocides** *may become more severe.*
- **Acceleration of green house and acid rain effects** *due to higher heavy oil consumption.*
- *If unilateral measures are introduced [in the EU], operators will assign dry dockings to yards outside the EU, which will result in drastic* **losses of business** *and possible closures of European yards.*

These points have been raised at the Marine Environment Protection Committee (MEPC) and some viewpoints are listed below:

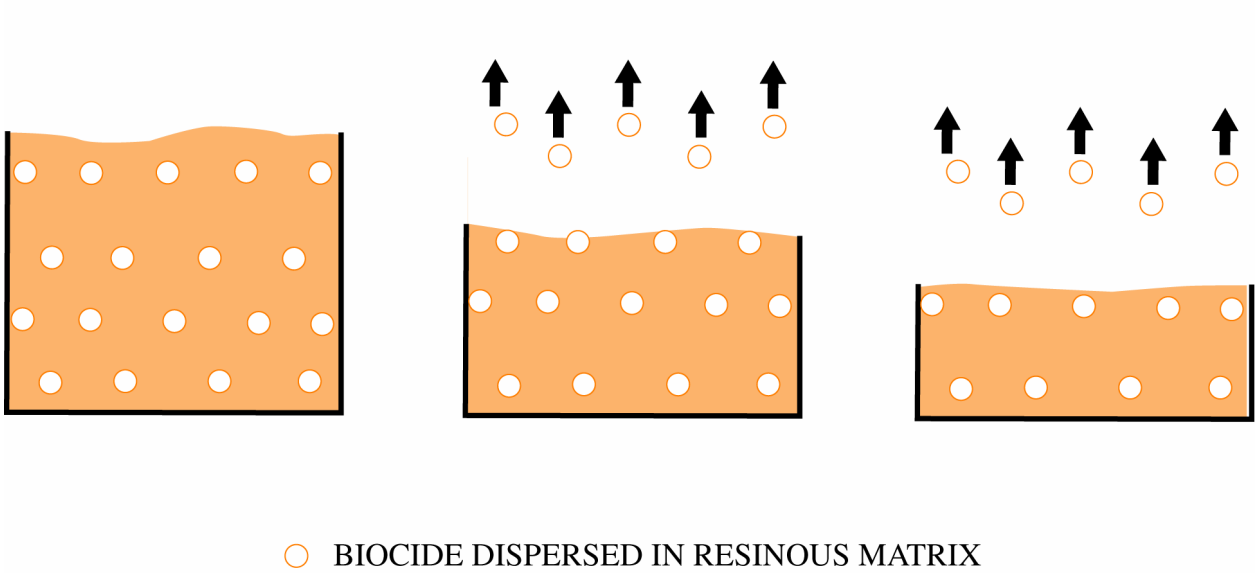
1 There are not enough efficient alternative products around

Alternatives to organotin compounds are already available. The Japanese merchant fleet has coped with a Japanese ban on TBT use on non-aluminium hulls since 1990. Several companies are already selling TBT-free anti-fouling systems. The generalised ban on TBT-paint for small vessels has forced paint producers to look into other products, while the prospect of a total prohibition on organotin compounds in anti-fouling systems is encouraging the development of more new products.

As more such new products become available, it becomes more and more likely that performance will improve and prices will drop.

[12] Executive summary, proceedings of: The Present Status of TBT-Copolymer Anti-fouling Paints, nternational One Day Symp osium on Anti-Fouling Paints for Ocean-Going Vessels, the Hague, the Netherlands, April 1996. Proceedings presented to MEPC, 38th Session.

TBT Free Systems



TBT free anti-fouling systems may be composed of seawater soluble matrices containing tin-free biologically active ingredients. The biocides are dispersed and contained throughout the matrix, but not necessarily chemically bonded to it. At the seawater/paint interface, the biocide leaches at a controlled rate. The matrix dissolves, revealing freshly available biocide, enabling a predictable performance to be achieved. *Source:* CEFIC

2 Uncontrollable hull fouling will lead to potential corrosion and safety hazard

Hull fouling can be controlled with the organotin alternatives already available. Ship operators who manage their ships properly - with appropriate dry-docking - will be unlikely to suffer these problems.

In any case, anti-fouling systems are generally applied on top of an anti-corrosive paint system. The anti-corrosive paint would still be applied even where alternative anti-fouling systems were used.

3 Increased drydocking for ocean going vessels

Some of the new alternative anti-fouling systems claim to be equally effective as organotin-based systems - allowing drydocking intervals of up to five years. Other systems will require increased frequency of dry-docking, perhaps every 2.5 or three years. But for many ships this could fit in with routine surveys or general maintenance. Paint manufacturers are likely to increase research efforts to produce efficient organotin-free systems with the prospect of a ban.

In terms of extra costs resulting from increased dry-docking intervals, some delegations argue that the "polluter pays" principle should apply - so the shipping industry should pay the cost of not polluting the marine environment. In any case, any costs are likely to be passed on to the consumer. A ban will apply equally on all vessels so there will be no market distortion. Figures suggest that increased costs would be small compared to total costs of sea transport. One survey suggests the increase in costs for a Panamax size vessel is 1% over 20 years.[13]

4 Unknown environmental risks due to an increased usage of alternative biocides and their metabolites

The MEPC looked at how alternative anti-fouling systems should be assessed, as well as developing regulations to prohibit the use of organotin compounds which act as biocides in anti-fouling systems. Environmental requirements are likely to be included, to avoid one harmful substance being replaced with another.

5 Accumulation potential of organic biocides may become more severe

This is unlikely to happen if alternative systems are controlled and the criteria drawn up for anti-fouling systems include environmental risks.

Some people argue that certain alternative anti-fouling systems - for example copper - may prove equally harmful to the environment, so the development of criteria for anti-fouling systems is an important element in drafting mandatory regulations.

In the case of copper-based coatings, one study suggests copper is 1,000 times less harmful that TBT - so even if other alternatives are not considered, a change to copper-based products would benefit the marine environment.

6 Acceleration of greenhouse and acid rain effects due to higher heavy oil consumption

One survey suggests carbon dioxide emissions would rise by just 0.03%[14] with a switch from TBT to TBT-free anti-fouling systems. Furthermore, excess fuel consumption is only likely to be a problem if ship operators allow their ships to get excessively fouled.

Environmentalist groups argue that releasing a toxic chemical into the marine environment cannot be justified by the fact it may help in reducing greenhouse gas emissions.

New IMO regulations on Air Pollution by Ships have been adopted, which set limits on the sulphur content of fuel and nitrogen oxide emissions. IMO is also looking at whether controls are needed on carbon dioxide emissions from ships. Theoretically, the use of TBT anti-fouling systems reduces the production of greenhouse gases which contribute to global warming because ships use less fuel than if they used no anti-fouling system. But the availability of alternative anti-fouling systems means the difference in fuel consumption and therefore production of extra greenhouse gases is less than it would have been some years ago, had a ban on TBT come into force then.

Furthermore, a ban on TBT is likely to lead to manufacturers working harder to develop better and more effective TBT-free systems.

7 Unilateral measures could result in losses of business and possible closures of certain shipyards

The development of international, legally binding measures to phase-out organotin compounds acting as biocides in anti-fouling systems is in part aimed at ensuring that measures are applied universally, so that they do not benefit any one area or market.

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[13] Referred to in MEPC 40/11/1

[14] Japanese submission to Correspondence Group on anti-fouling systems, as referred to in Marine Environment Protection Committee (MEPC) 40/11/1

Working towards the proposed new convention

During 2000-2001, the Marine Environment Protection Committee (MEPC) Working Group on anti-fouling systems continued developing the draft convention text.

The MEPC's 44th session in March 2000 clarified a number of issues and at the 45th session in October 2000 the MEPC considered the draft text of the convention on an article by article basis and was able to approve it "in principle". A number of issues remained open for discussion, such as entry-into-force criteria.

At its 46th session in April 2001, the MEPC reviewed a number of issues and prepared a revised draft convention. A number of articles were still to be finalised by the Conference, including entry into force criteria and whether ships should be allowed to over-paint existing TBT coatings with a sealer or be required to sandblast back to bare steel in order to comply with the Convention's requirements.

Diplomatic Conference 1-5 October 2001

The Conference successfully adopted of the new International **Convention on the Control of Harmful Anti-fouling Systems on Ships**, after ironing out the final details of a number of articles.

The convention will prohibit the use of harmful organotins in anti-fouling paints used on ships and will establish a mechanism to prevent the potential future use of other harmful substances in anti-fouling systems.

Under the terms of the new Convention, Parties to the Convention are required to prohibit and/or restrict the use of harmful anti-fouling systems on ships flying their flag, as well as ships not entitled to fly their flag but which operate under their authority and all ships that enter a port, shipyard or offshore terminal of a Party.

Ships of above 400 gross tonnage and above engaged in international voyages (excluding fixed or floating platforms, FSUs and FPSOs) will be required to undergo an initial survey before the ship is put into service or before the International Anti-fouling System Certificate is issued for the first time; and a survey when the anti-fouling systems are changed or replaced.

Ships of 24 metres or more in length but less than 400 gross tonnage engaged in international voyages (excluding fixed or floating platforms, FSUs and FPSOs) will have to carry a Declaration on Anti-fouling Systems signed by the owner or authorized agent. The Declaration will have to be accompanied by appropriate documentation such as a paint receipt or contractor invoice.

Anti-fouling systems to be prohibited or controlled will be listed in an annex (Annex 1) to the Convention, which will be updated as and when necessary.

As recommended by the 21st session of the IMO Assembly, the Conference agreed to an effective implementation date of 1 January 2003 for a ban on the application of organotin-based systems.

Conference Resolution 1, on Early and Effective Application of the Convention, invites Member States of the Organization to do their utmost to prepare for implementing the Convention as a matter of urgency. It also urges the relevant industries to refrain from marketing, sale and application of the substances controlled by the Convention.

The new convention will enter into force 12 months after 25 States representing 25% of the world's merchant shipping tonnage have ratified it.

Annex I attached to the Convention and adopted by the Conference states that by an effective date of 1 January 2003, all ships shall not apply or re-apply organotins compounds which act as biocides in anti-fouling systems.

By 1 January 2008 (effective date), ships either:

(a) shall not bear such compounds on their hulls or external parts or surfaces; or
(b) shall bear a coating that forms a barrier to such compounds leaching from the underlying non-compliant anti-fouling systems.

This applies to all ships (including fixed and floating platforms, floating storage units (FSUs), and Floating Production Storage and Offtake units (FPSOs).

The Convention includes a clause in Article 12 which states that a ship shall be entitled to compensation if it is unduly detained or delayed while undergoing inspection for possible violations of the Convention.

The Convention provides for the establishment of a "technical group", to include people with relevant expertise, to review proposals for other substances used in anti-fouling systems to be prohibited or restricted. Article 6 on Process for Proposing Amendments to controls on Anti-fouling systems sets out how the evaluation of an anti-fouling system should be carried out.

Resolutions adopted by the Conference

The Conference adopted four resolutions:

Resolution 2 Future work of the Organization pertaining to the Convention – The resolution invites IMO to develop guidelines for brief sampling of anti-fouling systems; guidelines for inspection of ships; and guidelines for surveys of ships. The guidelines are needed in order to ensure global and uniform application of the articles of the Convention which require sampling, inspection and surveys.

Resolution 3 Approval and Test Methodologies for Anti-Fouling Systems on Ships – This resolution invites States to approve, register or license anti-fouling systems applied in their territories. It also urges States to continue the work, in appropriate international fora, for the harmonization of test methods and performance standards for anti-fouling systems containing biocides.

Resolution 4 Promotion of Technical Co-operation – The resolution requests IMO Member States, in co-operation with IMO, other interested States, competent international or regional organizations and industry programmes, to promote and provide directly, or through IMO, support to States in particular developing States that request technical assistance for:

(a) the assessment of the implications of ratifying, accepting, approving, or acceding to and complying with the Convention;
(b) the development of national legislation to give effect to the Convention; and
(c) the introduction of other measures, including the training of personnel, for the effective implementation and enforcement of the Convention.

It also requests Member States, in co-operation with IMO, other interested States, competent international and regional organisation and industry programmes, to promote co-operation for scientific and technical research on the effects of anti-fouling systems as well as monitoring these effects.

The conference was attended by representatives of 75 Member States of IMO and one Associate Member; as well as by representatives of two intergovernmental organizations that hold agreements of co-operation with IMO and representatives of 23 non-governmental organizations in consultative status with IMO.

IMO 22nd Assembly November 2001

The 22nd Assembly adopted resolution **A.928(22) Early and effective application of the Convention on the Control of Harmful Anti-fouling Systems on Ships.** The resolution notes that the International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001, was adopted by a diplomatic conference on 5 October 2001 and that Resolution 1 adopted by the conference requests Member States to do the utmost to prepare for consent to be bound by the Convention as a matter of urgency, observing the effective date of 1 January 2003 for phase-out of application of anti-fouling systems containing organotins.

The resolution urges Governments to provide any information available regarding any anti-fouling systems they have approved, restricted or prohibited under domestic law as soon as possible and request the IMO Secretary-General to make this information available.

Anti-fouling systems time line		
Anti-fouling systems		**Environmental impacts /measures taken**
Resin or pitch used on ship hulls.	**1900**	
Copper-based paints containing mercury oxide, arsenic halogen compounds.	**1960s**	Long-life anti-fouling paints provide protection to hulls for up to 24 months.
Introduction of free association TBT-based anti-fouling paints	**1970s**	Self-polishing anti-fouling paints containing TBT hailed by shipping industry. Anti-fouling toxin is partly released by a reaction with seawater and paint polishes away layer by layer, continuously exposing new layer to seawater. Biocide delivery rate is more or less constant. Ships can now drydock just once every five years.
Introduction of self-polishing co-polymer TBT-based anti-fouling paints.	**1980s**	Worrying side-effects of TBT on oysters (deformities) identified in France. TBT-related imposex recorded in English coastal waters. Various countries ban TBT on boats less than 25 metres long.
Introduction of non-stick coating for small vessels. Various tin-free alternatives developed.	**Early 1990s**	IMO Resolution recommends Governments ban TBT on vessels less than 25 metres in length; TBT leaching from paint should be less than 4 microgrammes per cm square per day. Japan, New Zealand, Australia ban use of anti-foulants containing TBT. Imposex found in dog whelks, attributed to TBT. United States, Canada, Australia, Sweden, the Netherlands impose TBT release rate restrictions.
.	**1995**	IMO creates MEPC working group on harmful effects of anti-fouling paints.
	1997	Japan bans production of TBT-based anti-fouling paints.
	1998	MEPC agrees to draft mandatory regulations to ban organotins used in anti-fouling systems; MEPC approves draft Assembly Resolution setting out time scale to do so.
	1999	IMO 21st Assembly adopts Resolution on phasing out organotin compounds acting as biocides in anti-fouling systems.
	2001	Diplomatic conference adopts **International Convention on the Control of Harmful Anti-fouling Systems on Ships**
	2003	Date for prohibiting application of organotin compounds acting as biocide in anti-fouling systems
	2008	Date for complete prohibition on organotin compounds acting as biocides in anti-fouling systems

Alternative anti-fouling systems	
Product/method	**Advantages/disadvantages**
Copper-based anti-fouling paints	Already exist and less toxic than TBT in aquatic environment. Only effective against marine fauna - to combat weed growth, herbicides are added which may pose new threats to environment.
Tin-free anti-fouling paints	Have proved adequate on passenger ferries in North Sea. Work best on vessels that go to dry dock every three and a half years or more frequently because some fouling does occur. Works on special purpose vessels such as tugs, pilot boats, lifeboats, research vessels if these are used at least 100 days per year and go into dry dock at least every three years. When use is not as frequent they run more risk of fouling and will need dry dock every year.
Non-stick coatings	Contain no biocide but have extremely slippery surface - preventing fouling occurring and making it easier to clean when it does. Most suitable for vessels with minimum speed of 30 knots. Damage to coating difficult to repair. Light fouling occurs but easily removed with high-pressure hose in annual dry dock visits.
Cleaning	Periodic cleaning of hull is most appropriate for ships operating in both sea and fresh water and in areas where few organisms attach to hull. Cleaning of merchant ships involved divers using rotating brushes or high-pressure hoses.
Natural resistance, natural biocides	Substance produced in nature which prevent fouling or hinder fouling process - based on capacity of marine organisms such as corals and sponges to remain free of fouling. Research on use of natural compounds is in early stages, but active metabolites (for example ceratinamine and mauritiamine) have been identified and new biocides have been synthesised. E**nzymes** can break the sticking of bacteria (the first phase of fouling's growth) to the hull; while the concept of **hydrophilic coating** has been inspired by the preference of fouling to stick to hydrophobic surfaces, such as rocks and vessels. The organisms have no grip on hydrophilic 'wettish' surfaces. Paint industry and research institutes are involved in Camellia project (running 1996-2000), subsidised by EU, to research use of natural compounds
Electricity	Creating a difference in electrical charge between the hull and sea water unleashes chemical process which prevents fouling. This technology shown to be more effective than tin-free paint in preventing fouling, but system is easily damaged and expensive. Also creates increased corrosion risk and higher energy consumption.
Prickly coatings	Includes coatings with microscopic prickles. Effectiveness depends on length and distribution of prickles, but have been shown to prevent attachment of barnacles and algae with no harm to environment. However, prickles could increase water resistance of vessel. Use of prickly surfaces on static objects such as buoys and cooling water inlets seen as realistic option in near future.

Ref: TBT in antifouling paints: National Institute for Coastal and Marine Management/RIKZ, Netherlands. MEPC 42/Inf.10

RECENT PROGRESS IN ANTIFOULING/RECENTE ONTWIKKELINGEN IN ANTIFOULING

Maarten Plesman; Chemistry Shop, University of Groningen; 1997, report C 78 (in Dutch) MEPC/42/Inf.7

Regulations of use of organotin-based antifoulants in various countries											
Regulations	**USA**	**Canada**	**Australia**	**New Zealand**	**France**	**UK**	**Holland Ireland**	**other EU countries**	**Sweden ***	**other non-EU**	**South Africa**
Vessels <25m: all organotin-based antifouling coatings prohibited; exemptions for aluminum structures.	○	○			○						
Vessels <25m: all organotin-based antifouling coatings prohibited; no exemptions for aluminum structures.			○								
Vessels <25m: TBT-based antifouling coatings prohibited; no exemptions for aluminum structures.							○	○	○	○	○
All antifouling products containing triorganotins banned on vessels <25m, and on fish-farming equipment.						○					
Vessels >25m: TBT antifouling available only in 20l containers.							○	○			○
Vessels >25m: low release rate(<4µg TBT/cm^2/day) permitted.	○	○							○		
Vessels >25m: low release rate(<5µg TBT/cm^2/day) permitted.			○	○							
All antifoulants must be registered.	○	○	○	○		○	○		○		○
TBT paints can only be applied by certified operator.	○										
All antifoulants registered as pesticides, sale and use must be approved by Advisory Committee on pesticides.						○					
Triorganotin paints only sold In drums of 20l or more; must contain <7.5% total tin in copolymers or 2.5% total tin as free tin.						○					

*Organotin-based antifouling coatings are totally prohibited in certain water.

Source: Paper submitted by Japan to MEPC, MEPC 41/INF.3

Japan: TBT in anti-fouling paints banned since 1990; production banned since 1997.

Efficacy of organotin regulations in various countries			
Nation	**Section**	**Improvement**	**No improvement**
France	water	TBT concentrations on the Atlantic coast decreased.	TBT concentrations on the Mediterranean coasts didn't decrease.
	sediment	Sediment core suggested improvement.	Surface still exhibited high concentrations of TBT in Arcachon Bay.
	organisms	Organotin concentrations and shell malformations in Pacific oysters decreased.	Some shell malformations existed.
United Kingdom	water	TBT concentrations decreased	The standards are sometimes exceeded.
	sediment	TBT concentrations decreased at a half of the sites.	TBT concentrations didn't decrease at a half of the sites.
	organisms	TBT concentrations in oysters decreased. Imposexed population declined in Scotland.	No recovery of recruitment in clams. Reduced growth, poor condition and onset of shell ticking remained in bivalves.
USA	water	TBT concentrations decreased in San Diego Bay.	
	sediment	TBT concentrations decreased in Boston Harbor.	TBT concentrations didn't decrease in San Diego Bay.
	organisms	Butyltin concentrations in molluscs decreased on the West Coast.	Butyltin concentrations in molluscs didn't decreased on the East Coast.
Canada	organisms	Imposex frequency and *vas deferens* formation frequency decreased.	
Australia	organisms	TBT concentrations in oysters decreased. Growth and condition in oyster improved.	Shell deformity remained in some oysters.
New Zealand	sediment	Sediment cores indicated declining inputs of TBT.	Recovery in breeding capacity of whelks was not observed.
The Netherlands	water		Decrease of butyltin concentrations were not observed.

Ref: Paper submitted by Japan to MEPC, MEPC/41/INF.3

Summary of discussions at MEPC sessions on anti-fouling paints	
Session and date	**Outcome**
MEPC 26 5-9 September 1988	MEPC considers anti-fouling paints for first time after Paris Commission requests IMO to consider the need for taking measures to restrict the use of TBT compounds on seagoing vessels to supplement the measures that had been taken in other fora to eliminate pollution from such compounds. Members were invited to submit information, where possible explaining the ecological effects that TBT compounds might be causing.
MEPC 27 13-17 March 1989	MEPC provided with information on research being carried out in Germany on the impact emission concentration by TBT, studies being carried out in Argentina on copper based anti-fouling paints, and activities undertaken within the framework of the Mediterranean Action Plan. MEPC agreed to add topic to its work programme.
MEPC 29 12-16 March 1990	Anti-fouling paints included in agenda for the first time. Consultative Meeting of the Contracting Parties to the London Dumping Convention gives details of effects of organotin compounds on the marine environment and human health. MEPC notes recommendations on organotin compounds adopted by the Contracting Parties to the Barcelona Convention; and monitoring results and measures taken by Japan on TBT and TBT compounds, including controlling their import and production. United States appointed lead country to collect more information.
MEPC 30 12-16 November 1990	MEPC informed of the outcome of the Third International Organotin Symposium held in Monaco in April 1990 where it was recognized that IMO was the appropriate body to regulate the use of TBT compounds internationally. Symposium asked IMO to establish: • a limit for release of TBT from ship hulls, including an agreement on a method for measuring this; • regulations for application, removal and disposal of organotin based anti-fouling paints; • public information leaflets to serve as self-regulatory information strategies for small boat owners; and, • an IMO record system to register and certify every vessel as to type of anti-fouling paint used. MEPC adopts Resolution MEPC.46(30) "Measures to Control Potential Adverse Impacts Associated with the Use of tributyl Tin Compounds in Anti-Fouling Paints"including recommendations to eliminate the use of TBT based anti-fouling paints with an average release rate of $\leq$ 4 µg/cm^2/day.
MEPC 31 1-5 July 1991	Japan presents monitoring study results.
MEPC 33 26-30 October 1992	CEFIC (European Chemical Industry Council) presents monitoring study results.
MEPC 35 7-11 March	MEPC reviews monitoring study results. Governments urged to: • co-operate towards the improvement of analytical monitoring

1994	procedures, including further efforts towards international validation and calibration of the analytical methods; • take appropriate steps to reduce the use of TBT paints on small ships and those operating in coastal waters; • develop Guidelines for sound dockyard practices; and, • continue efforts in developing environmentally less harmful anti-fouling alternatives. MEPC recognizes that the total ban of TBT could not be justified at the time on cost/benefit grounds and due to the lack of availability of alternative anti-fouling systems. MEPC instructs IMO Secretariat to contact International Standards Organization (ISO) and Organization for Economic Cooperation and Development (OECD) to enquire about the possibility of establishing an international standard method for measuring leaching rates of biocides from anti-fouling paints.
MEPC 38 1-10 July 1996	MEPC informed of ISO Working Group set up to generate test methods for determining leaching rates of biocides from anti-fouling paints. MEPC notes monitoring studies undertaken world-wide, the action taken by Japan to ban TBT based anti-fouling paints, and the progress made in development of alternative systems. Australia points out important role played by anti-fouling paints in preventing the transfer of unwanted aquatic organisms on hulls of ships. MEPC establishes Correspondence Group for the reduction of the harmful effects of the use of anti-fouling paints from ships including TBT, co-ordinated by the Netherlands.
MEPC 39 10-14 March 1997	Correspondence Group requests more time to consider issues relating to the nature of any measure, the way to legislate any measures, and enforcement matters.
MEPC 40 18-23 September & 25 September 1997	Interim report of the Correspondence Group gives conclusions expressed by the majority of the Members of the Group: • mandatory measures are required to reduce and eventually eliminate the use of anti-fouling systems containing organotin compounds; • an instrument enabling mandatory measures for anti-fouling systems should be developed as a matter of urgency; and • enforcement and enforceability of measures should be taken into account when developing such measures.
MEPC 41 30 March - 3 April 1998	Final report of correspondence group. MEPC agrees working Group at MEPC 42 should begin work on drafting regulations to phase out organotin compounds acting as biocides in anti-fouling systems.
MEPC 42 2-6 November 1998	MEPC approved a draft Assembly resolution which includes a deadline of 2008 for the complete prohibition on the presence of organotin compounds acting as biocides in anti-fouling systems on ships. The Working Group also began looking at the basic structure of the proposed legal instrument as well as how alternative anti-fouling systems should be assessed.

MEPC 43 28 June - 2 July 1999	MEPC requests to IMO Council (and Assembly) the holding of a Conference in the 2000-2001 biennium to adopt a legal instrument to regulate the use of shipboard anti-fouling systems, in particular to phase out those containing organotins such as tributyltin (TBT). Progress made on developing the basic structure of the proposed legal instrument.
IMO 21st Assembly November 1999	Assembly adopts resolution A.895 (21) **Anti-fouling systems used on ships** which states that IMO "urges the Marine Environment Protection Committee to work towards the expeditious development of a global legally-binding instrument to address the harmful effects of anti-fouling systems used on ships". The Resolution adds that IMO "agrees that the global instrument to be developed by the Marine Environment Protection Committee should ensure a global prohibition on the application of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2003, and a complete prohibition on the presence of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2008". The Assembly also approved the holding of a diplomatic conference in 2001 to adopt the proposed instrument.
MEPC 44 6-13 March 2000	MEPC Working Group clarified a number of issues and prepared draft text of the proposed convention.
MEPC 45 2-6 October 2000	MEPC considered the draft text of the convention on an article by article basis and was able to approve it “in principle”. A number of issues remained open for discussion, such as entry-into-force criteria.
MEPC 46 23-27 April 2001	MEPC reviewed a number of issues and prepared a revised draft convention. A number of articles were still to be finalised by the Conference, including entry into force criteria and whether ships should be allowed to over-paint existing TBT coatings with a sealer or be required to sandblast back to bare steel in order to comply with the Convention’s requirements.
Diplomatic Conference 1-5 October 2001	The Conference successfully adopted the new International **Convention on the Control of Harmful Anti-fouling Systems on Ships**
IMO 22nd Assembly 19-30 November 2001	Assembly adopts A.928(22) Early and effective application of the Convention on the Control of Harmful Anti-fouling Systems on Ships The resolution requests Member States to do the utmost to prepare for consent to be bound by the Convention as a matter of urgency, observing the effective date of 1 January 2003 for phase-out of application of anti-fouling systems containing organotins. The resolution urges Governments to provide any information available regarding any anti-fouling systems they have approved, restricted or prohibited under domestic law as soon as possible and request the IMO Secretary-General to make this information available.

Resolution A.895(21)
adopted on 25 November 1999

ANTI-FOULING SYSTEMS USED ON SHIPS

THE ASSEMBLY,

NOTING that Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning prevention and control of marine pollution from ships,

NOTING ALSO that scientific studies and investigations by Member Governments and other competent international organizations have shown that some anti-fouling systems used on ships pose a substantial risk of adverse impacts on ecologically and economically important marine organisms,

RECOGNIZING that, due to the international nature of shipping and the need to avoid distortions in the global shipping, shipbuilding and shiprepair markets, actions to prohibit or otherwise control anti-fouling systems on ships are most effectively accomplished through a global, legally binding instrument,

NOTING IN PARTICULAR the serious concern regarding anti-fouling systems in which organotin compounds act as biocides, and being convinced that the introduction of such organotin compounds into the marine environment must be prevented,

RECALLING that chapter 17 of Agenda 21, adopted by the United Nations Conference on Environment and Development (UNCED), calls upon States to take measures to reduce pollution caused by organotin compounds used in anti-fouling systems,

RECALLING ALSO that the Marine Environment Protection Committee, by resolution MEPC.46(30), recommended that Governments, *inter alia*, consider appropriate ways to prohibit the use of tributyltin compounds in anti-fouling systems,

RECOGNIZING the importance of protecting the marine environment from the adverse effects of anti-fouling systems used on ships,

RECOGNIZING ALSO that the use of anti-fouling systems to prevent the build-up of organisms on the surface on ships is of critical importance to efficient commerce,

RECOGNIZING FURTHER the need to continue to develop anti-fouling systems which are effective and environmentally safe,

HAVING CONSIDERED the recommendation made by the Marine Environment Protection Committee at its forty-second session,

1. URGES the Marine Environment Protection Committee to work towards the expeditious development of a global legally binding instrument to address the harmful effects of anti-fouling systems used on ships as a matter of urgency;

2. AGREES that the legally binding instrument to be developed by the Marine Environment Protection Committee should ensure a global prohibition of the application of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2003, and a complete prohibition of the presence of organotin compounds which act as biocides in anti-fouling systems on ships by 1 January 2008;

3. URGES ALSO Member Governments to encourage industries to continue to develop, test, and use as a high priority anti-fouling systems which do not adversely impact on non-target species and otherwise degrade the marine environment;

4. CALLS UPON Governments to develop assessment procedures for evaluating anti-fouling systems and to consider their impact on the environment and society;

5. CALLS FURTHER UPON Governments to continue to promote scientific and technical research on the environmental impacts of anti-fouling systems.

Resolution A.928(22)

Adopted on 29 November 2001
(Agenda item 11)

RESOLUTION ON EARLY AND EFFECTIVE APPLICATION OF THE INTERNATIONAL CONVENTION ON THE CONTROL OF HARMFUL ANTI-FOULING SYSTEMS ON SHIPS

THE ASSEMBLY,

RECALLING Article 15(j) of the Convention on the International Maritime Organization concerning the functions of the Assembly in relation to regulations and guidelines concerning the prevention and control of marine pollution from ships and other matters concerning the effect of shipping on the marine environment,

NOTING that the International Conference on the Control of Harmful Anti-fouling Systems for Ships has adopted the International Convention on the Control of Harmful Anti-fouling Systems on Ships, 2001 (hereinafter referred to as "the Convention") on 5 October 2001,

NOTING ALSO that the said Conference adopted Resolution 1 requesting Member States of the Organization to do their utmost to prepare for consent to be bound by the Convention as a matter of urgency, observing the effective date of 1 January 2003 mentioned in Annex 1 thereto,

RECALLING that the Preamble of the Convention refers to the precautionary approach, as set out in Principle 15 of the Rio Declaration on Environment and Development,

MINDFUL of the importance of disseminating information regarding the measures taken by Governments as provided for in article 9 of the Convention,

1. URGES Governments to provide any information available regarding any anti-fouling systems they have approved, restricted or prohibited under domestic law as soon as possible, in accordance with the provisions of paragraph (1)(b) of article 9 of the Convention; and

2. REQUESTS the Secretary-General to make available, by any appropriate means, any information communicated to the Organization, when it is received, as provided for in paragraph (2) of article 9 of the Convention.

General marine environment websites:

SeaWeb a project designed to raise awareness of the world ocean and the life within it.
http://www.seaweb.org/home.shtml

Lycos Environment News Service http://ens.lycos.com/index.html

About.com Guide to the Environment
http://seawifs.gsfc.nasa.gov/OCEAN_PLANET/HTML/peril_polluti

Advisory Committee on Protection of the Sea (ACOPS)
http://www.acops.org

Bluewater Network
http://www.earthisland.org/bw/index.html

ERIN Marine and Coasts site
http://www.erin.gov.au/sea/sea.html

Friends of the Earth International
http://www.foei.org/

GEF/UNDP/IMO: Regional Programme on Partnerships in Environmental Management for the Seas of East Asia
http://www.pemsea.org

Global Investigation of Pollution in the Marine Environment (GIPME) Programme (The)
http://ioc.unesco.org/iocweb/activities/ocean_sciences/marpo

Greenpeace International
http://www.greenpeace.org

HELSINKI COMMISSION Baltic Marine Environment Protection Commission
http://www.helcom.fi/

International Union for the Conservation of Nature (IUCN)
http://iucn.org

Miller Associates, Inc - CQD - Journal for the Maritime Environment Industry
http://www.cqdjournal.com

National Oceanic and Atmospheric Administration (NOAA) US
- NOAA Central Library Wind and Sea - The Oceanic and Atmospheric Services Internet Locator
http://www.lib.noaa.gov/docs/windandsea.html

National Oceanic and Atmospheric Administration (NOAA) US
- Office of Response and Restoration

http://response.restoration.noaa.gov/index.html

Ocean Pollution Research Center (Rosenthiel School of Marine a nd Atmospheric Sciences)
http://www.rsmas.miami.edu/groups/oprc.html

Patricia Michael's Page (About.com - environment)
http://environment.about.com/

SEHN 'S (Science and Environmental Health Network - web pages on the precautionary principle)
http://www.sehn.org/index.htmll

UK/IMO Correspondence office WWF-UK
http://www.wwf-uk.org

World Resources Institute
http://www.wri.org/

World Wide Fund for Nature (WWF)
http://www.panda.org

Worldwatch Institute
http://www.worldwatch.org/

“On the Net” Listing key environmental internet sites
http://www.worldbank.org/nipr/onthenet.htm

Environment News Service
http://www.ens-news.com/features/

George Washington University Green University Initiative - Environmental Information Resources Also: International Environmental Resources by Country
http://www.gwu.edu/~greenu/inter.html

Virtual Library Environmental Page (The)
http://earthsystems.org/Environment.shtml

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http://environ.nosc.mil/Other/seligman_980327.htm

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