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# PROVISIONS FOR THE CONTROL AND MANAGEMENT OF BALLAST WATER TO MINIMIZE THE TRANSFER OF HARMFUL AQUATIC ORGANISMS AND PATHOGENS

by



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## INTRODUCTION

The International Maritime Organization (IMO) is a specialized agency of the United Nations dealing with maritime affairs, i.e. to improve safety of life at sea and to prevent marine pollution from shipping. In 1973, during preparation of the Convention of Pollution from Ships (MARPOL), the International Conference on Marine Pollution requested the World Health Organization, by resolution, to initiate studies and research concerning the effects of discharge of ballast water containing bacteria of epidemic diseases, on the basis of any evidence that may be submitted by any Government. In those days concern focused primarily on the transfer of pathogens through ballast water. It might be of interest to note that until very recently no Government has found it worthwhile to actually ask WHO to carry out such research. It has now been included in the work programme of WHO.

The role of ballast water discharges for the introduction and establishment of non-indigenous aquatic organisms was already known early in this century, but from single data published in the mid 1970s, the list of organisms that have survived ballast water transfer today contains several hundred species, including bacteria, e.g., *Chlostridium botulinum* and *Vibrio cholerae*.

It seems that the number of cases that have been reported in regard to the survival of organisms transported with ballast water and associated sediments have increased considerably since the mid 1970s. This could be due to increasing research activities on the one side, and, and on the other side, due to larger ships and faster voyages.

A number of the introduced non-native species have caused severe effects upon the ecology of their new habitats, and from the many examples that are known to have caused catastrophic effects, I should mention those four cases that did convince a number of IMO Member States that action was needed to reduce opportunities for the transfer of aquatic organisms through ballast water. These are:

- the European zebra mussel *Dreissena polymorpha* in the North American Great Lakes, causing severe damage to underwater constructions and pipes;

- the American comb jelly *Mnemiopsis leidyi*, causing near extinction of anchovy and sprat fisheries in the Black and Azov Seas;

- the South-east Asian brown kelp *Undaria pinnatifida*, having detrimental impact on the Tasmanian abalone industry; and

- the South-east Asian dinoflagellates of the *Gynodiniuum* and *Alexandrium* species into Australian waters contaminating shellfish and producing toxins that are harmful to humans.

The countries that had been particularly affected by these events or feel threatened by the introduction of alien organisms in their waters have been in the forefront of IMO Member States requesting that action should be taken by IMO. These were Australia, Canada, New Zealand and the United States. They are currently supported by States bordering the Baltic Sea, after realizing that about fifty species had been introduced from elsewhere, and noting the catastrophe caused in the Black Sea by *Mnemiopsis*. These countries realized that this was an issue that could not be solved solely on the basis of national or regional regulations, but needed international action, which could then be complemented by domestic provisions.

**Ballast water**

Water is used as ballast in ships to ensure that the propeller and bow are submerged to an acceptable depth. Large ships, particularly bulk carriers, tend to spend 40 to 50 per cent of their sea time in ballast. Total water ballast tonnage can range from a few hundred up to about 80,000 tonnes.

**Ballast Water Guidelines developed by IMO's Marine Environment Protection Committee (MEPC)**

After several years of preparation, the Marine Environment Protection Committee (MEPC) of IMO in 1991 adopted **Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships' Ballast Waters and Sediment Discharge**. These Guidelines contained advice to IMO Member States on how they might introduce relatively simple basic ballast water management controls.. They were based on national control measures taken at that time by Australia, Canada and the United States. The MEP Committee emphasized that the adoption of these voluntary guidelines should be a first step in addressing the problem and that in the longer term the Committee would have to evaluate whether legally binding provisions, either as amendments to MARPOL 73/78 or as a new annex to the MARPOL Convention might be appropriate. The attention of IMO Member States was also drawn to the fact that efficient treatment processes for ballast water on board ships still need to be developed

Then in 1992, the United Nations Conference on Environment and Development (UNCED) included in its Agenda 21, Chapter 17 on the Protection of the Oceans and All Kinds of Seas ..., a request for IMO to consider "the adoption of appropriate rules on ballast water discharge to prevent the spread of non-indigenous organisms" (paragraph 17.30(a)(vi)).

The development of legally binding rules on ballast water management is, from the technical point of view, not as easy as it may seem: there is at this stage still a lack of efficient ballast water treatment techniques, and the basic advice provided in the Guidelines that ships should exchange ballast water during voyages in deep sea areas is not without problems in relation to safety and stability aspects of the ships concerned, nor is the advice that Port Authorities may set up port reception facilities for ballast water, and facilities for treating sediments from ballast tanks.

The Marine Environment Protection Committee in 1993, when considering action to be taken in response to UNCED's request, therefore agreed that at this stage the Ballast Water Guidelines should remain voluntary due to the lack of any major advance in ballast water management and treatment processes. However, in light of the apparent lack of IMO Member States implementing or observing the Guidelines, MEPC requested the IMO Assembly to adopt by Resolution these Guidelines for Preventing the Introduction of Unwanted Aquatic Organisms and Pathogens from Ships' Ballast Waters and Sediment Discharge. Through this measure members of the MEPC expected that more weight would be given to the recommendations set out in these Guidelines.

In its submission of the Guidelines to the IMO Assembly, MEPC proposed that the Assembly should request IMO's Maritime Safety Committee to consider the safety aspects, particularly with regard to stability and structural integrity of ships exchanging ballast water at high seas. The Assembly further requested IMO bodies to liaise with other relevant organizations such as WHO, UNEP, IOC, ICES and the IAPH[1] with a view to seeking their participation in resolving the issue of harmful aquatic organisms in ballast water.

Finally, in 1993 the IMO Assembly confirmed that the Marine Environment Protection Committee should keep the ballast water issue and the application of the IMO Guidelines under review with a view to developing legally binding provisions for inclusion in MARPOL 73/78.

Since 1994 a Ballast Water Working Group established by the MEPC has been considering form and contents of possible regulations for the "Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens". These might be presented through a set of a number of legally binding provisions, accompanied by implementation guidelines. Such guidelines would only have the status of recommendations and as such could be easily reviewed, updated and amended in light of experience gained with them and of new research and technical developments. The combination of small sets of legally binding rules with more detailed guidance for their interpretation and effective implementation has been a very successful mechanism used by IMO, particularly if complemented by technical co-operation and assistance programmes for less developed countries.

## THE GUIDELINES

The Guidelines in an **introduction** emphasize the purpose of their development and application, namely, "to provide Administrations and Port State Authorities with guidance on procedures that will minimize the risk from the introduction of unwanted aquatic organisms and pathogens from ships' ballast water and sediment. The selection of an appropriate procedure will depend upon several factors, including the type or types of organisms being targeted, the level of risks involved, its environmental acceptability, and the economic and ecological costs involved".

In this connection it should be noted that throughout the Guidelines mention is made of their aim to minimize the risk of introducing non-native organisms. This is somewhat more modest but also more realistic that their title referring to "preventing the introduction of unwanted organisms".

Under a section "**General principles**", it is pointed out that the ability of aquatic organisms and pathogens to survive, after transportation in ballast water, can be reduced if significant differences in ambient conditions prevail, e.g., salinity, temperature, nutrients and light intensity. The probability of organisms survival under different conditions of salinity are considered in a matrix

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[1] The International Association of Ports and Harbors

comparing fresh water, brackish water and fully saline waters of ballast water uptake areas with those of the receiving waters.

PROBABILITY OF ORGANISMS SURVIVAL AND REPRODUCTION

| Discharged Ballast / Receiving Waters | Fresh water | Brackish water | Fully saline water |
|---|---|---|---|
| Fresh water | HIGH | MEDIUM | LOW |
| Brackish water | MEDIUM | HIGH | HIGH |
| Fully saline water | LOW | HIGH | HIGH |

Under "**Strategies**", the Guidelines introduce seven different options that may be effective in minimizing the incidence and introduction of unwanted aquatic organisms and pathogens, as follows:

- the non-release of ballast water;
- ballast water exchange and sediment removal at sea, or in areas designated as acceptable for this purpose by the Port State Authority;
- ballast water management practices aimed at preventing or minimizing the **uptake** of contaminated water or sediment during **ballasting** operations;
- ballast water management practices aimed at preventing or minimizing the **discharge** of contaminated water or sediment during **deballasting** operations;
- discharge of ballast water into shore-based facilities for treatment or controlled disposal;
- ballast water and sediment treatment processes acceptable to Port State Authorities; and
- testing and certification, acceptable to the receiving Port State Authority, that ballast water and sediment from the ballasting port are free of unwanted aquatic organisms and pathogens.

**Ballast water exchange and sediment removal**

The Guidelines recommend that in the absence of more scientifically based and technically approved efficient means of ballast water treatment and control, an exchange of ballast water in deep ocean areas or open seas offers a good possibility of limiting the transfer of fresh water species or coastal species with ballast water.

The probability of transferring unwanted organisms, through ballast water discharges, can indeed be greatly reduced by ocean or open sea ballast exchanges, preferably in recommended water depths of 2,000 m or more. This is currently the option most often used to minimize the risk of transfer and introduction of non-indigenous organisms. In those cases where ships do not encounter water depths of at least 2,000 m, the Guidelines recommend that an exchange of ballast water should occur well

clear of coastal and estuarine influences. There is evidence to suggest that, despite contact with water of high salinity, the cysts of some organisms can survive for protracted periods in the sediment within ballast tanks and elsewhere on a ship. Hence, where ballast water exchange is being used as a control measure, care should be taken to slush out ballast tanks, chain lockers and other locations where sediments may accumulate, to dislodge and remove such accumulations, wherever practicable.

Pursuant to recognized maritime practices, the responsibility for deciding on ballast water exchange in open seas must rest with the Master of the vessel, taking account of the following safety requirements:

- stability has to be maintained at all times to values not less than those recommended by the Organization (or required by the national Administrations);

- longitudinal stress values shall not exceed those permitted by the ship's classification society with regard to prevailing sea conditions; and

- exchange of ballast in tanks or holds where significant structural loads may be generated by sloshing action in the partially filled tank or hold shall be carried out in favourable sea and swell conditions only such that the risk of structural damage is minimized.

Where a Master, due to weather, sea conditions or operational impracticability, is unable to comply with the management option of "at sea" exchange of ballast water which may be required by a Port State, the Master should report this fact to the Port State as early as possible prior to entering port. This is to allow for appropriate alternative action to be arranged.

Port State Authorities may take and analyse ballast water and sediment samples. Where ballast water or sediment sampling for compliance or effectiveness monitoring is being undertaken, Port State Authorities should ensure that there is no undue delay to ships when taking such samples.

**Ship operational and safety aspects of ballast water exchange at sea**

Three typical commercial ships - a dry-bulk carrier, a tanker, and a container ship - were investigated by the University of Michigan[2] to determine the level of potential hazards when exchanging ballast water at high seas. The at-sea investigations for hull bending moment, shear, and rate of slamming for these ships have shown that for a 10-foot significant wave height, the bending movement and shear values were far below the design values required by current (1991) American Bureau of Shipping rules, and slamming was very infrequent. For 20-foot significant wave height, and a ship moving at its design speed, the bending movement and shear magnitudes are greater, but still well below allowed values. However, groups of peak waves occurring approximately one-in-300 among the 20-footers produce shear and movement values near or above the allowed values. Rate of slamming, even at the significant height, reaches what may be an intolerable level at the higher ship speeds.

Somewhere between the 10- and 20-foot significant wave heights must lie a threshold sea state below which it is safe for any typical ocean-going ship to exchange ballast.

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[2] Structural integrity of ships engaged in ballast water exchange (resolution a.774(18)); Submitted by the United States. Document DE 38/INF.2; International Maritime Organization, London, 1994.

**Research on ballast water treatment options**

With regard to on-board treatment of ballast water and associated sediments, the Guidelines draw attention to the need to carry out research of or developing future techniques, including:

- treatment with chemicals and biocides;
- heat treatment;
- oxygen deprivation controls;
- tank coatings
- filtering systems; and
- ultraviolet light disinfection.

Member States are being encouraged to carry out or to commission research studies into these and other relevant areas of ballast treatment techniques, and to provide information on results of such research to IMO.

In reviewing the various treatment options that are being investigated, it is apparent that no single treatment process has yet been found that is likely to achieve the required inactivation or removal of unwanted organisms. This is likely to consist of an initial preliminary mechanical treatment process, e.g., filtering or cyclonic separation, followed by disinfection or physical treatment processes, e.g., ultraviolet radiation, thermal processes and ultrasound.

With regard to chemical treatment options, the use of chlorine, chlorine dioxide, chloroamines, sodium and calcium hypochlorites and ozone, as well as bromine, potassium permanganate and hydrogen peroxide, have been investigated. Tests have further been carried out with organic biocides but their application would involve the use of detoxification agents. Electrolytically generated silver and copper ions have shown success in treating certain types of organisms but result in environmental concerns on the discharge of ballast water containing relatively high copper and silver ion concentrations in coastal or estuarine waters.

Treatment methods entailing salinity adjustments, i.e., the addition of fresh water to salt water or salt water to fresh water in order to disturb the osmo regulatory processes of the salt or fresh water organisms which are present in the ballast water have shown to be most effective and relatively simple. This is one of the options used by ships entering the North American Great Lakes.

**FUTURE DEVELOPMENT**

The Ballast Water Guidelines adopted by the IMO Assembly in 1993 (resolution A.774(18) have so far been applied in only a few IMO Member States, and in light of growing worldwide concern in relation to the introduction of non-indigenous organisms, disease bacteria and viruses through discharges of ballast water, and their effects on human health, the marine environment, fisheries, aquaculture and amenities, IMO has repeatedly drawn the attention of its Member States to the importance of this issue, urging all Governments to apply the Guidelines. Other Organizations, such as FAO, likewise requested its Member States to apply the Guidelines, as did regional bodies such as the Helsinki Commission.

During the thirty-seventh session of MEPC in September 1995 a first attempt was made to develop a set of legally binding regulations which could form a new Annex to MARPOL 73/78. These requirements shall be complemented by guidelines.

This seems to be a major breakthrough in reaching worldwide applicable legal provisions. However, the various management and control options that are available are still those referred to in the current recommendatory IMO Guidelines which are based on deep ocean exchange of ballast water.

The draft Regulations that are in development will contain:

- **General obligations**

  requesting all Parties to promote measures "to control the spreading of non-indigenous organisms through ships' ballast water and associated sediments".

- **Definitions**

  listing terms, such as :

  harmful aquatic organisms
  unwanted species
  pathogens
  clean ballast water
  non-indigenous, alien

- **Application**

  "shall apply to all ships"
  [... on international voyages] only

- **Force majeure**

  due to stress of weather

[- **Exceptions**

  for specific trade patterns]

- **Operational requirements**

  containing references to Guidelines on Ships' Ballast Water Control and Management

- **Safety requirements**

  are under development, taking into account ongoing work within several IMO Sub-Committees

- **Role of national authorities**

  on implementation in districts and regional [uniform and co-ordinated?] and distribution of information on outbreaks of diseases, surveillance requirements, treatment techniques, compliance.

Another task that IMO was requested to carry out in the near future is the preparation of packages containing education and awareness material, and the establishment of clearing house functions for ballast water research, including a data bank on technical developments and setting up links with other related information centres, e.g., on toxic algae blooms.

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