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MARPOL - DOES IT WORK?

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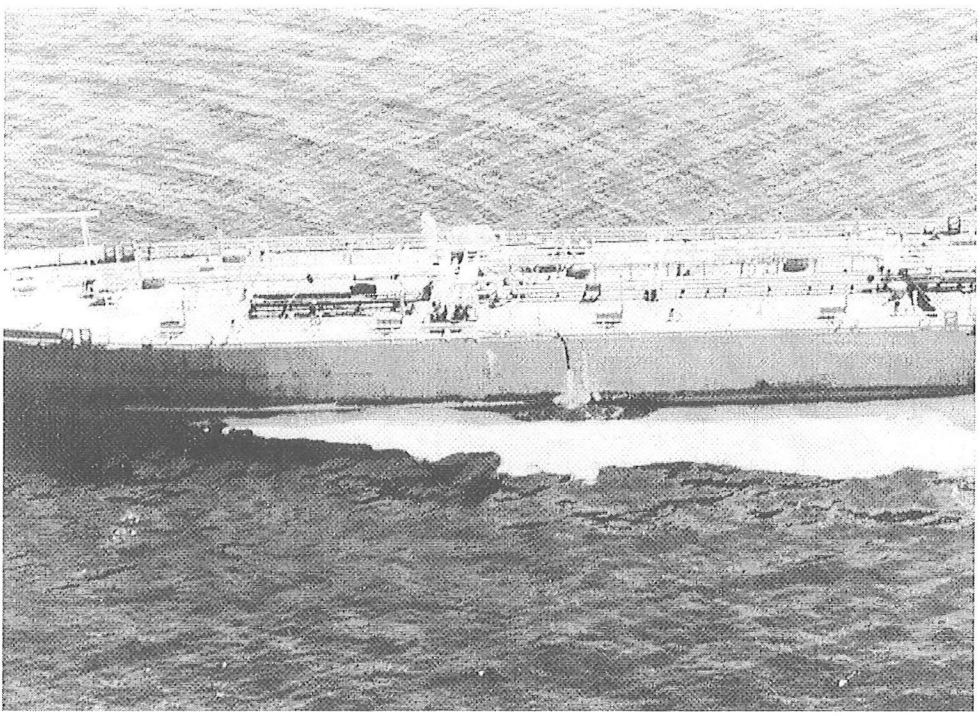
Abstract

The operation of ships gives rise to the potential for the pollution of the marine environment. The potential is reduced if there are adequate facilities on board to manage waste effectively and adequate and convenient facilities ashore to receive the waste when the ship reaches port. Adequate and practical waste management systems will only be implemented if suitable regulation and control measures exist. Developed under the auspices of the International Maritime Organisation, the MARPOL Regulations are recognised as the most comprehensive initiative to regulate and minimise pollution from ships. But are the regulations effective, are they workable and are more regulations necessary? Under the EU 4th Framework Programme the EMARC Consortium, comprising partners drawn from port authorities, shipping companies, ship builders and the waste industry, was set up to address these questions. The paper provides some answers and sets out recommendations for future work.

THE PROBLEM

All transport operations produce waste. Ships are no exception. The crew produces waste, as does the operation of the engines and cargo handling. In other words, ships are just like trucks, trains or aircraft. Where ships differ is frequently in their size and certainly in their operating environment. Unlike other modes of transport they are often out of touch for days or even weeks with the sort of services, like waste collection, which the rest of us take for granted. What happens to the waste they produce? The historical solution has been to dump it into that infinite waste amenity site, the sea - as in Photograph 1. In today's justifiable atmosphere of environmental concern this solution is no longer acceptable.



Courtesy of UK Maritime & Coastguard Agency

Photograph 1 Pollution at sea

Nevertheless, pollution due to shipping has to be put into context. It is estimated that shipping accounts only for some 25% of marine oil pollution, Table 1, and various studies have estimated that between 20% and 35% of marine pollution due to garbage originates from ships. As with all statistics these figures can be challenged, but the fact remains that the operation of ships is a significant source of marine pollution.

Table 1 - Sources of Oil Pollution

Source	Share (%)	Million Tonnes
Industrial waste, etc	60.8	1.48
Natural sources	10.3	0.25
Offshore production	2.1	0.05
Tanker operations	6.6	0.16
Tanker accidents	4.7	0.11
Other shipping	14.4	0.35
Refineries/terminals	1.2	0.03
Total	100.0	2.43

Source: Intertanko, Oslo 1977

THE SOLUTION?

The potential for marine pollution from shipping activity is reduced if there are adequate facilities on board to manage waste effectively and adequate and convenient facilities ashore to receive the waste when the ship reaches port. Adequate and practical waste management systems will only be implemented if suitable regulation and control measures exist.

Table 2 - MARPOL Regulations relating to Reception Facilities

Annex	Category of Waste	Annex in Force?	Reception Facilities Required?	Types of Waste for Reception
I	Oil	✓	✓	Covers all types of wastes from the carriage of oil: as fuel, engine room slops, cargo (tank washings) or dirty ballast water
II	Noxious liquid substances in bulk	✓	✓	Chemical wastes derived from bulk chemical transportation, including residues and mixtures containing noxious substances
III	Harmful substances in packaged form	✓	×	-
IV	Sewage	×	✓ When in force	Raw sewage – retained in holding tanks for disposal in port or outside 12nm Partially treated sewage – retained in holding tanks for disposal in port or outside 4nm
V	Garbage	✓	✓	Garbage includes domestic (food and packaging) and operational (maintenance, cargo and miscellaneous) wastes
VI	Air pollution from ships	×	×	-

The necessary regulations and controls have been developed over a number of years. A convention adopted as long ago as 1973 and modified by a 1978 protocol has become known as the MARPOL Regulations. These regulations are recognised as the most comprehensive initiative to regulate and minimise pollution from ships and continue to be vigorously monitored, amended and augmented under the auspices of the International Maritime Organisation (IMO).

A series of Annexes (I – VI), Table 2, to the Regulations set out the details for the prevention of pollution in the maritime environment by oil, noxious liquids, harmful substances in packaged form,

sewage and garbage respectively. A further annex, Annex VI, is being developed to extend MARPOL 73/78 to cover air pollution from ships. Annex III is mainly a cargo handling problem and does not need special waste reception facilities, only the ability to access them in the event of (an accidental) spillage. The harmful substances concerned are covered by the International Maritime Dangerous Goods Code. Therefore it is Annexes I, II, IV and V with which the maritime world is primarily concerned.

It is important to note that MARPOL not only regulates what can not be discharged overboard but also what is permitted to be discharged into the sea under strict control and outside clearly specified areas. Although the controls and areas become ever more extensive with each amendment of the regulations, ships are able, quite legally, to discharge considerable quantities of waste to the sea.

THE RESEARCH PROGRAMME

Under the EU 4th Framework Programme for Research and Technological Development the EMARC Consortium, a group of twelve environmentally conscious commercial and research organisations from France, The Netherlands and the United Kingdom, was formed to assess the effects of the MARPOL Regulations on the port environment throughout Europe and to investigate present and future systems for the management of ships' waste both ashore and afloat.

With partners drawn from Port Authorities, shipping companies, ship builders and the waste industry the EMARC Consortium attempted to assess the problem even handedly. The nature of the problem is the translation of the MARPOL Regulations into practical, but not punitive, systems of ships' waste management ashore and afloat under an evolving legislative framework. The aims of the research therefore were to provide answers to specific questions:

- what sorts of shore based waste management systems are currently in operation?
- what are the perceived waste management needs of vessels?
- are there improvements that could be made to either, or both, of the above?
- what constraints prevent waste management systems operating effectively, afloat and ashore?
- is the interface between ship and shore effective?
- is the environment benefiting?

This paper presents some of the findings and conclusions of the Consortium.

METHODOLOGY

The first task of the EMARC team was the collation of baseline data and information about the implementation and operation of MARPOL both on ships and in ports. What the Consortium discovered was that there is an apparent wealth of literature available on the subject of ships' air and sea pollution giving an illusion of comfort with current research effort. On closer examination the result was a broad, but fragmented, picture of the impact of ships' waste on operators - ships and ports - and the possible beneficial effects of the MARPOL Regulations on the environment. Further, more specific, information was needed.

In this respect there seems to be a constant stream of research programmes, mostly gathering data from questionnaires, aimed at establishing that either ports or ships are, or are not, playing their part in the reduction of pollution. Alternatively the research concentrates purely on the environmental effects of maritime pollution, not necessarily solely from ships. Primary research on environmental indicators was

beyond the scope of the project and the interpretation of work carried out by others had to suffice. However, new information from operators could be obtained.

The EMARC Consortium therefore added to the plethora of questionnaires by sending out two of its own: one to ship owners and operators and one to ports. The response was gratifyingly large although throughout the two year programme it was evident that those sections of the industry that had nothing to hide responded fully and willingly. It may not be entirely fair to draw the converse conclusion

The main parts of the EMARC methodology can be described as follows:

- comparing primary data from the questionnaires on the types of shore based waste management systems currently in operation in ports with secondary research carried out in individual ports
- asking specific questions of ships' masters on a rolling basis and comparing the results with secondary data available in the rest of Europe
- examining the economic, technical and legislative situation throughout Europe
- conducting limited trials on specific vessels
- attempting to identify trends in the improvement or otherwise of the port environment.

RESULTS

Operators

Included in the wealth of information provided by ports there is confirmation of the wide range of operational methods in use and the different criteria used for record keeping (assuming this is regarded as a priority) and thus the assessment of efficiency. Although each port complex may have effective and efficient systems at its various terminals, the diverse systems often causes their perception to be less than adequate, especially to vessels calling infrequently. Table 3 shows the range of methods for the provision of garbage reception facilities adopted by the 116 ports responding to the questionnaire.

Table 3 - Garbage Reception Facilities in Ports (%)

Port Size by Vessel Movements/Annum	<100	<250	<500	<1,000	>1,000	All Ports
Facilities available	100.0	83.8	92.3	90.0	97.1	94.8
Arranged by ship/agent	71.5	16.6	38.0	15.0	18.5	23.3
Arranged by port/terminal	28.5	83.3	61.5	70.0	58.5	60.3
Arranged by contractor	0	16.6	92.0	5.0	18.5	14.6
Disposal by incineration	0	16.7	15.4	5.0	5.7	7.0
Disposal by skip	100.0	66.7	77.0	85.0	84.3	83.0
Disposal by barge	0	0	0	0	7.1	4.0
Other methods of disposal	0	16.7	7.0	5.0	4.3	6.0
Fees included in port dues	29.0	83.0	54.0	65.0	42.0	49.0

(Some ports completed more than one category in their responses)

Ships may therefore experience a different system in every port they visit. The implication of this is that communications - an essential element in achieving good waste control - could be serious problem and there is an urgent need both for the standardisation of recording and reporting, afloat and ashore (if the full impact of the MARPOL Regulations is to be assessed accurately).

There is also a problem with the perception of the quality and cost of reception facilities provided. A total of 198 shipping companies responded to the questionnaire and their perceptions of cost and adequacy of facilities are set out in Tables 4 and 5 respectively.

Table 4 - Perception of Cost of Waste Disposal (%)

Perceived Cost	Shipping Company View
Inexpensive / free	2.0
About right	21.2
Dear	49.5
Very dear	15.7
No reply	11.6

Table 5 - Ratings of Port Waste Reception Facilities by Ships (%)

Rating	Garbage	Oil
Poor	35.4	38.9
Adequate	32.8	27.8
Good	12.1	13.9
Very good	4.6	5.6
No reply	15.2	13.9

Environment

The Consortium also set out to assess whether the marine environment is benefiting from the operation of MARPOL. Only a brief examination of the problem is given here and it is not possible to give justice to the quantity of information and data examined during the course of the project.

Generally, there are no systematic comparable data available to determine the effects of MARPOL regulations on the amounts of waste entering the marine environment in European waters because of the many different methods employed. Results from national litter/debris collecting programmes generally provide useful information on amounts of ship generated litter recorded along the coasts of many European countries. However, information on the different sources of debris collected from individual sites is not readily available, so determining the amount of ship generated debris in specific ports is not possible. Although it is known that this level of information is available for certain areas, it is uncertain whether detailed data is available Europe-wide.

Data that does exist from such surveys is rarely reliable or comparable due to methodological shortcomings and inconsistencies. Thus there is a need for the standardisation of techniques if such sources of data are to be utilised further. Presently, however, the general consensus appears to be that beach observations provide the most suitable basis for intensive assessment surveys, although naturally these too are subject to a number of limitations. Many national surveys rely on volunteers to collect and record the amounts of litter found along a particular stretch of the coast. Volunteers may comprise of a number of different groups of people ranging from environmental groups and universities to primary schools, which will influence the accuracy of the results and the consistency of the survey.

Table 6 - Estimates of inputs of oil per year into the world's oceans from shipping (in million tonnes) [adapted from GESAMP, 1993]

Shipping	1981	1985[1]	1988[2]	1989
Bilge and fuel oil discharges	0.3	0.3	0.283	0.253
Tanker operations	0.7	0.7	0.398	0.159
Tanker accidents	0.4	0.4	0.089	0.114
Non-tanker accidents	0.02	0.02	-	0.007
Marine terminals	0.022	0.02	0.022	0.03
Dry docking	0.03	0.03	0.024	0.004
Scrapping of ships	-	-	-	0.003
Total	1.472	1.47	0.816	0.57

[1] 1985 Data adapted from US Nat. Acad. Sci., 1985 cited in UNEP/IOC, 1988: Assessment of the state of pollution of the Mediterranean Sea by Petroleum Hydrocarbons, Table I, p.11

[2] 1988 Data adapted from Blake, G.C. (1990): Conference presentation from "Tanker 90", London, March 1990; 'The world tanker fleet - still going strong or cause for concern?'

The identification of the source of marine debris is a complicated process and it is impossible precisely to identify the amount generated by shipping, as many items originate from a variety of sources, such as plastic bottles, and are recorded simply as "non-sourced". Other items which are classed at typical shipping wastes, may in fact derive from other sources, such as rivers, sewage systems, and loss from coastal landfill sites. In order for litter surveys to provide a useful indication of the efficiency of MARPOL rules, more reliable methods of determining a source for items and a more systematic basis for generating litter statistics needs to be developed. This problem is now receiving urgent attention from a number of researchers.

The most recent estimate of spillage from tanker accidents of 114 000 tonnes (above in Table 6) demonstrates a marked reduction from the nearly 1.5 million tonnes spilled annually from tanker operations and accidents between the late 1970s and early 1980s (National Research Council : Tanker Spills: Prevention by Design, cited in The Motor Ship, December 1991). This is an impressive reduction, especially when one considers the fact that the average 1990 ship is 40% larger than its 1970 counterpart (Suzuki, S: INTERTANKO, 1990). In a study of 9,276 marine accidents, conducted by Lloyd's Register, only 6% resulted in oil spills that caused pollution.

The National Research Council report concludes that the decrease in oil spilled can be attributed to international co-operation in development and execution of rules for tanker design, clean ballasting and vessel operations. Many other data sources were considered not all of which demonstrated so clearly that oil pollution is decreasing – the picture in some areas is less encouraging.

DISCUSSION

Communications between operators was found to play a pivotal role in the implementation of MARPOL. Co-operation of everyone concerned with the waste management chain - ship, agent, terminal operator, competent harbour authority, waste contractor, local regulatory and environmental agencies, is essential if the system is to work efficiently and cost effectively. Port waste management plans certainly contribute to this process.

One example from EMARC research demonstrates this principle. Initial results had shown that the perception of shore based waste reception facilities at one major United Kingdom port (an EMARC partner) was no better than adequate. A conscious decision was therefore taken by the Port Authority to comply with the then voluntary system of self-regulation in terms of port waste management planning.

The port introduced a port waste management plan, which, to large degree, formalised the existing structure and established a procedure whereby the method of accessing facilities was explained to a ship's master prior to arrival and, conversely, the master was asked to specify his requirements in advance. No changes to equipment or facilities were undertaken. When the survey was repeated, an increased proportion of respondents said that the facilities were excellent, demonstrating the power of perception and the importance of communications.

Protection of the environment requires investment and compliance with the Regulations which implies committing time, money and personnel. In the case of ports, this means physical and organisational infrastructure, and, for ship operators, investing in equipment to control and to prevent pollution occurring. The project team found that, contrary to expectations compliance with the Regulations is not dependent on geography, but rather on management or individual attitudes.

Where ports and ship operators expend effort and commitment on environmental and safety policies, MARPOL is one of several issues considered. Those companies which are at the forefront in the implementation of environmental policies can provide benchmarks for others. There is an element of self-interest in this: public awareness in environmental matters has increased and organisations are therefore conscious of bad publicity and loss of standing. For shipping companies, direct compliance may be seen as enhancing their ability to attract business. These companies usually make investment ahead of legislation whilst at the other end of the scale, some companies will wait until the last minute and install just enough equipment to comply with the letter of the law.

There are difficulties in forecasting the actual amount of waste which will be discharged, rather than produced, by a particular ship. Waste 'factors' are normally used in these calculations, for example, the weight of garbage produced per person per day, often quoted as 2.5kg. However, these do not normally take into account treatment or disposal which is carried out on board the vessel.

Thus, remembering that large quantities of treated waste can be discharged, legally, into the sea, consideration must also be given to on-board equipment, Table 7. assuming that it is actually used and (There is some evidence to indicate that although fitted, equipment is not always used.) Processing can be defined as any mechanical process or chemical treatment (or combination) performed on ship generated waste to either reduce its volume, change its physical form or reduce its toxicity/hazard level. Techniques vary, but equipment includes pulpers, shredders, grinders, comminuters, macerators, compactors, coalescers and filter/strainers.

Table 7 - Waste Management on Board Vessels

On Board Treatment	Percentage Fitted
Compactor	19.4
Incinerator	30.7
Food grinder	24.9
None of above	28.0
Sewage holding tanks	63.6
Sewage treatment plant	70.8
Pump to shore facilities for sewage	62.2

Generally, such equipment is found on ships generating large volumes of waste. Consideration has to be given to whether the benefits to the environment of reducing one hazard outweigh the new hazards introduced into the environment from, say, exhaust gases and suspended solids.

This leads on to waste minimisation - the prevention and reduction, reuse, recycling, separation and processing of waste before storage, discharge into reception facilities and discharge to sea. Perhaps the most important of these is prevention and reduction by the elimination of unnecessary products that produce waste and the use of on the board equipment provided. Others include the substitution of products that reduce the toxicity and/or amount of waste generated, improved maintenance and operating procedures and the implementation of purchasing practices which encourage waste minimisation. These principles have been successfully applied to cruise liners and ferries where very large amounts of waste are produced by, sometimes, thousands of passengers and crew

Evidence has emerged from research undertaken on cargo vessels in particular that, although the on-board equipment is in place, it is not always efficient in terms of either direct cost or manpower to use the equipment, and waste is therefore stored for disposal ashore. Were circumstances to change, that is, lack of shore facilities or facilities at excessive cost, the on-board equipment might well be adequate, but any changes in the Regulations regarding discharge overboard or emissions to air might require a revision of the on-board facilities.

Although shipping remains responsible for inputs into the marine environment through accidental, operational and illegal discharges, surveys of the industry have generally demonstrated a notable and improving environmental performance over the past few decades. The International Chamber of Shipping recorded an increase in seaborne trade of over 23% between 1985 and 1991 during which time it rose from 13 billion to 17 billion tonne miles (ICS, 1993). Over a similar period (1981-1989) the amount of oil entering the sea from waterborne transport was estimated to have fallen by over 60% (US National Academy of Sciences, 1990).

These improvements have been largely attributed to the measures required by environmental legislation and international conventions, most significant of which is the mandatory requirements of MARPOL 73/78. Improvements have been further facilitated by technological advances in safety and environmental protection, new ship designs, improved operational techniques and marine transportation activities.

CONCLUSIONS

The MARPOL Regulations are extensive and comprehensive and there is already sufficient effort being expended to keep them technically up to date and relevant in the current environmental climate. However, assessing their impact remains a matter for impressions rather than scientific fact. Information and data about waste quantities generated and landed is sparse and statistics from ports are required in a comprehensive and standardised form. Environmental data gathering on a long term, common, basis is essential.

However, notwithstanding the fragmentary nature of the available data, there are indications that MARPOL is having a positive effect. There is no doubt that if knowledge of the regulations themselves was used as an indicator MARPOL would be a considerable success.

Communications between the various parties in the waste management chain must be improved. This can be achieved relatively simply by ensuring that the ship reports its requirements, acknowledged by the port and the information is passed on to the waste contractor. The system and equipment can be simple but effective as in the Port of Bremerhaven, Photograph 2. The way in which each link operates will vary enormously in each port, but the links must be established. An authorised and proven Waste Management Plan for every port would set the framework for the communications system.

Courtesy of Nehlsen

Photograph 2 - Waste Management at the Port of Bremerhaven

A move towards the standardisation of what a ship's crew could expect to find in every port has considerable merit. Simple standard pictograms would be a start with, possibly, standardised containers for garbage much further along the waste management road.

Often overlooked in the quest for technological solutions is the crucial input from human resources. Staff training in the correct procedures backed up by the necessary management controls are essential.

Finally, adequate independent national and international monitoring is required not only to ensure that systems are in place but that properly implemented. Port State Control, through the various national marine agencies, has a major role to play in ensuring compliance with the regulations.

RECOMMENDATIONS

The European Commission's forthcoming Fifth RTD Framework Programme will provide an ideal opportunity to progress some of the recommendations made by the EMARC Consortium many of which have an element of standardisation of information interpretation and analysis.

- Establish criteria for the assessment of the environmental impact of the MARPOL Regulations and establish monitoring programmes.

- Monitor the implementation of Port Waste Management Plans (likely to become mandatory under the imminent European Directive).
- Establish waste factors based on waste actually landed by ships.
- Establish common standards for the reporting of quantities of ships' operational waste landed under the MARPOL Regulations.
- Establish common standards for marine debris surveys, beach monitoring campaigns and the definition of beach litter.
- Improve the accessibility of marine environmental data through centralised databases.
- Encourage increased intervention by Port State Control with regard to MARPOL.

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The partners in the EMARC Consortium are

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