REPORT OF THE WORKING GROUP ON TECHNOLOGY

(William G. Gordon, Chair)

INTRODUCTION

The Working Group on Technology, while recognizing that further work is required to quantify the types and volumes of ship-generated debris, strongly believes that technology/methodology currently exists to address management of the majority of the wastes generated at sea. The group recognizes that a considerable portion of debris originates from such terrestrial sources as careless transportation of garbage, combined storm/sewage outfalls, storm and street drains, industrial activities, beach-goers, and at-sea disposal, and that management of these sources requires application of somewhat different technologies and methodologies. However, a large measure of the ship-generated debris ultimately will be transported ashore. Thus, satisfactory resolution of much of the marine debris issue will require rational resolution of many of the terrestrial waste management issues and problems.

SHIP-GENERATED DEBRIS

Ship-generated debris and sources are categorized in Table 1, Sources and types of ship-generated debris.

SHIP WASTE MANAGEMENT

Technology and/or methodologies for dealing with ship-generated wastes, and their potential application, are shown in the Table 2, available technology and methodology for handling ship-generated waste.

As displayed above, there are currently available a number of techniques for addressing ship-generated wastes. However, all ultimately require some degree of transportation of the waste ashore for disposition. On-land facilities for handling such wastes may not exist, and thus at-sea disposition will continue.

The group stressed that there is no single methodology or technology which will resolve the issue. Regardless of the size of the vessel or craft, a variety of practices will undoubtedly be employed. Brief descriptions follow.

Source Reduction

Source reduction is the use of materials on board the vessels which will reduce both quantity and volume of waste. Such practices will vary with segments of the industry and should be encouraged for all.

In R. S. Shomura and M. L. Godfrey (editors), Proceedings of the Second International Conference on Marine Debris, 2-7 April 1989, Honolulu, Hawaii. U.S. Dep. Commer., NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFSC-154. 1990.

Table 1.--Sources and types of ship-generated debris.

Sources	Clean plastic	Contaminated plastic	Fishing gear	Paper	Metal and glass	Oils	Food wastes
Merchant marine	Large	Small	--	Medium	Small	Large	Small
Naval vessels	Large	Large	--	Large	Large	Medium	Large
Commercial fishing	Small	Medium	Large	Small	Small	Medium	Small
Recreational craft	Medium	Large	Small	Small	Medium	Small	Medium
Cruise ships	Large	Large	--	Large	Large	Medium	Large
Oil and gas operations	Large	Large	--	Large	Large	Large	Large

Alternate Materials

The use of alternative materials is a simple but effective strategy for plastic waste management at sea. This may involve the replacement of a given plastic product with either a different plastic product or a nonplastic product which is more disposable. This simple approach can have a significant impact on solid waste management options for shipboard use.

Effectiveness and feasibility of incineration of waste on board a vessel can be increased by the selection of plastics which can be safely burned for use at sea. Exclusion of chlorine-containing plastics and, perhaps, the use of compounds with high factions of fillers (to reduce BTU's per pound) are possible examples.

Recycling of plastics carried to shore is viewed as a plausible means of disposal. Plastics to be used aboard vessels might then be selected to ensure optimum blend compatibility of the disposed plastic waste stream. Alternatively, the plastics can be coded to allow easy separation into the different chemical types. Replacement of nonrecyclable material such as glass and metal (usually disposed of at sea) with recyclable material such as paper and plastic is also feasible.

Reducing the plastic content of a given product can lean to substantial improvements in disposability with minimal loss of performance. Plastic films, plates, and cups, for instance, can be replaced with plastic-coated or composite materials that are more disposable. At the extreme is the replacement of plastics and glass with paper, which can be more easily

Table 2.--Available technology and methodology of disposition of debris generated at sea.

Type of debris	Type of disposal							
	Incineration	Disposal at sea	Separation	Compaction	Recycle	Degradation	Alternate	Source reduction
Plastic	X	--	X	X	X	X	X	X
Foamed plastic	X	--	X	X	--	--	X	X
Fishing gear	X	--	X	--	X	--	--	X
Paper	X	X	X	X	X	--	--	X
Metal and glass	--	X	X	X	X	--	X	X
Oils	X	X	X	--	X	--	--	--
Food wastes	X	X	X	X	--	--	--	--

disposed of. In doing so, of course, the economic factors must be taken into account to make sure that the proposed substitution of materials is realistic. Substitution of materials that are easily compacted and stored on board is stressed by the working group.

Degradation

Deep-sea disposal of many materials remains acceptable. Waste food biodegrades, paper (unless plastic-coated) degrades, metal cans (if punctured) sink, and glass bottles (if broken or if caps are removed) sink. However, plastic materials regardless of form cannot be dealt with in this way as their rate of degradation is unacceptable for at-sea disposal.

Some common plastic and fibers can be made to photooxidize and biodegrade in a controlled fashion. In both film and fiber forms they are already in use in agriculture and some packaging applications. Olefins are among those polymers which can be engineered to degrade. Nylon and polyesters presently available do not degrade in an acceptable time. Nylon can be made to photodegrade, but photodegradable nylon is not yet commercially available. The products of degradation of most polymers are environmentally innocuous.

Photodegradable plastics are compatible with other technologies. Degradable plastics can be burned normally or can be recycled to secondary products. Degradable products can cause environmental problems in landfills, as many cease to degrade under anaerobic conditions.

Degradable plastics have potential disadvantages. For example, few of the existing degradable materials have been cleared by the Food and Drug Administration for contact with food. Some degradable plastics perform differently on land than in the marine environment, and require further evolution. Thus, industry is not yet prepared to supply economically feasible plastics which can be counted on for degradability at sea.

Recycling

Recycling of plastics is a process by which used plastic objects are collected, identified, separated (if necessary), and melt-processed into useful items. Recycling of plastic soda bottles, fishing nets, and general plastics waste is currently being done on a commercial basis. At present, probably less than 10% by weight of the annual production of plastics is being recycled. The impetus brought about by factors such as the increasing costs of dumping at landfills, the influence of environmentally concerned groups, the inherent value of the plastics themselves, which continue to increase in cost, and the profit motive for value-added products made of recycled plastics could well increase the use of recycling to as much as 50% of yearly production.

Except perhaps aboard very large vessels, recycling at sea does not appear to be a viable solution for dealing with plastics waste. A more practical approach is the establishment of recycling centers at ports receiving large volumes of plastic debris. Unless information on how much, what type, and when will it be landed is made available, industry is

unlikely to move. Accordingly there is a need to acquire much more information on the issue in order to encourage the private sector toward a positive response.

Another aspect of recycling is the reuse of plastic items for different purposes. An example of this is the use of fishing nets for decorative or recreational applications.

Recycling of various plastics together (commingling) will result in some difficulties. Commingling will reduce the value of the resultant product as it results in characteristics that are less desirable to most users. This problem must be addressed, particularly in view of the move toward laminated products of various plastics.

Compaction

Compaction technology as wide application for resolution of waste issues within the maritime industry. For many, compaction may be the most appropriate, as all solid waste may be reduced through compaction and stored readily aboard those craft where trips are of short duration. This would include virtually all recreational boats, coastal commercial fishery operations, and coastal maritime shippers. Obviously, on-land disposal must be economical and efficient in order to encourage the practice.

For recreational and small fishing vessels, the initial problem created by the need to retain all wastes aboard ship is that none of these vessels are designed with waste retention compartments. However, they are designed with water and fuel tanks, sleeping compartments, cargo and provision compartments, and most recently with sewage holding tanks. These vessels are designed with these various compartments because either laws require them or they are necessary for the operation of the vessel. Therefore, in a way similar to sewage holding tanks, waste retention compartments could become a necessary requirement of all vessels.

One suggestion for a type of shipboard waste retention compartment might be a "shipboard waste compactor." One could be designed to run off the ship electrical system or be hand-operated. If owner-installation were possible, then some of the burden of cost to the vessel owner would be lessened. Such a device could provide for improved sanitation as well as make transfer of wastes easier. For example, the ports could store compacted wastes more neatly and securely than "untreated wastes," which are often unsightly, cause odors, and are cumbersome to store.

Separation

Separation of all wastes by type will become part of all successful waste management practices within the maritime industries. This methodology must be fully integrated into customary practice in combination with others. All practices must be at reasonable cost and effective.

Combustion

Combustion includes low technology burning and incineration.

Low Technology Burning (e.g., Use of Burners)

Low technology burning has important practicabilities and benefits:

1. It can be an attractive option for compliance with Annex V.

2. It is low in cost.

3. It needs relatively little deck space.

It also has some potential pitfalls:

1. Some separation of hazardous materials is necessary.

2. Products of incomplete combustion (e.g., dioxin, furans) of a wide range of materials (including salt from the marine environment) are environmentally hazardous. Potential hazards include toxic air emissions.

3. There are current problems concerning disposal of toxic ash (which may be resolved in the near future as a result of manufacturing modifications by the plastics industry).

4. The regulatory climate concerning air pollution emissions could change in the future.

Incineration (e.g., Insulated Combustion Chambers With Mechanical Air Control)

Incineration also has important practical aspects and benefits:

1. It is an attractive option for compliance with Annex V for ships such as cruise ships, merchant vessels, and tankers.

2. It provides operational flexibility, given the variable availability of port reception facilities.

It, too, has potential pitfalls:

1. Trained skilled personnel are necessary for proper operation.

2. It is more costly than low technology burning or overboard dumping.

3. Combustion of plastics, salt, and other materials produces air pollution emissions.

4. There are current problems concerning disposal of hazardous ash (which may be resolved in the future as a result of manufacturing changes).

5. Regulatory climate concerning air pollution emissions at sea could worsen in the future.

LAND DISPOSAL

The working group recognizes that ultimately ship-generated debris, particularly plastics, will be transported ashore for disposition. Land facilities, therefore, must be expanded or developed to accommodate the increased volume of such materials. Shoreside receivers must be cost effective and convenient in order to encourage maximum use. Shore-based industries should be encouraged to recycle such materials; they will require considerable information on the types, quantities, and location of the materials. Governments should implement policies and incentives permitting and encouraging such initiatives, but this, too, requires a much greater level of knowledge than is currently available.

The group stressed that marine debris is clearly linked to the land and that all efforts to encourage rational waste management must be extended globally.

RECOMMENDATIONS

Data

More information should be obtained about types, quantities, and distribution of the plastic materials which, under MARPOL regulations, will be brought ashore for disposal. Such information should be disseminated throughout the plastics industry to encourage reuse of such material.

Technology

Research and development of new technologies should be encouraged.

Low Technology Burning

1. Research on environmental impacts of air emissions.

2. Research and development of guidelines concerning materials separation and operations.

3. Research concerning environmental implications of ash and methods of disposal.

Incineration

1. Research on environmental impacts of air emissions.

2. Research concerning environmental implications of ash and methods of disposal.

3. Research concerning hydrogen chloride corrosion of incinerator units and accompanying potential effects on durability. Measures to address problems, if necessary.

Ship Design

1. New design should accommodate waste management strategies.

2. New construction should include facilities and space accommodations for waste management.

Plastics

1. Development or identification of the more desirable plastic mix streams for commingled plastics.

2. Development of performance standards for alternative materials used for specific product applications.

3. Development of trade-off studies on performance versus disposability.

Policy

No single methodology or technology will ensure compliance with waste management regulations. Accordingly, no policy should be established which prohibits technologies which have potential--keep all options open.

Governments should work together to create incentives for on-land disposal wherever feasible. Recycling, for example, will be feasible only where economic conditions are ideal for such practices. Governments should take the lead to assure that new and complementary technologies are created.

Education

Manufacturers of items such as packaging, fiber, and netting, are not aware of the capabilities and potential of programmable degradable plastics. Efforts should be undertaken to achieve broad dissemination of such information. The working group suggests that the plastics industry undertake such efforts.

There is need for a global network to disseminate information on the impact of marine debris widely and to uniformly encourage development of modern technologies or methodologies everywhere.

There is need for education throughout the private sector, aboard all classes of ships as well as shoreside, to encourage good waste management practices.

General Views

The working group strongly endorses the need to conduct global workshops on the issue of marine debris periodically. Sessions should include technical aspects of present and emerging technology for shipboard application. Invitees should include those potentially interested in land-based use of materials.

LIST OF PARTICIPANTS

Terrill J. Chang, SCS Engineers
Paul G. Kelleher, Polymer Processing Institute, Stevens Institute of Technology
Lissa A. Martinez, Takoma Park, MD
Cathy L. P. Palmer, Mote Marine Laboratory
Bruce Perlson, Quantum Chemical Corporation
Alan Reichman, Greenpeace USA
Akinori Satou, N.S. Environmental Science Consultant