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REDUCING NAVY MARINE PLASTIC POLLUTION

A REPORT BY THE KEYSTONE CENTER

TO THE ASSISTANT SECRETARY OF THE NAVY
FOR SHIPBUILDING AND LOGISTICS

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TABLE OF CONTENTS

		Page
I.	Introduction	1
II.	Supply	6
III.	Technology	16
IV.	Operations	23
V.	Education	36

Appendix A - Individuals Consulted in Report Preparation

Appendix B - Glossary of Terms

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I. INTRODUCTION

Background

Over the last two decades, the United States and other nations have become increasingly aware of the impacts of human activity on the marine environment. In recent years, no environmental issue involving the oceans has engendered as much public attention and concern as marine plastics pollution. Plastic debris from ships is littering beaches, and killing and debilitating fish and wildlife because they are ingesting plastic, or because they are becoming entangled in plastic debris. While no one is purposefully causing these impacts, the effects are becoming more pronounced. In the United States and throughout much of the world, the use of plastics has grown exponentially. Plastic products are often more economical than non-plastic substitutes and present many attractive characteristics. Plastics enhance the shelf life and storage of products, provide ease in handling and use, and are durable and long lasting. As a consequence, the use of plastic products for food storage and packaging, and as a component of many everyday products, has increased significantly. The result is readily apparent in the increase in plastic use at home, in commercial use, and on board commercial and military ships.

Unfortunately, some of the characteristics that make the use of plastics so desirable create adverse environmental effects, particularly when disposed of in the marine environment. The proliferation of plastic products disposed of at sea is evident in the alarming increase in plastic beach litter worldwide. Plastic products are now found washing ashore in such remote places as Antarctica. Everyday solid wastes disposed of at sea now contain an increasing percentage of plastic products that do not degrade (ranging from plastic garbage bags, to styrofoam coffee cups, to plastic shrink wrap). These wastes are finding their way into the marine ecosystem and affecting (and oftentimes killing) marine life which have eaten or become entangled in six-pack rings, plastic strapping bands, or other plastic material.

Over the last several years, the international community has actively begun to address the problem of plastic pollution in the marine environment. In 1973, under the auspices of the International Maritime Organization in London, the United States and other maritime nations signed the International Convention for the Prevention of Pollution from Ships, known as MARPOL (which stands for Marine Pollution). MARPOL was developed to begin regulating pollution from ships resulting from operational and accidental discharges of oil, chemicals, sewage and garbage. Annex V of MARPOL focuses on the discharge of garbage from ships; including a ban on the disposal of plastics at sea. Annex V comes into effect for signatory nations one year from the date that it was signed by countries representing 50% of the world's

shipping tonnage (one year from December 30, 1987). MARPOL exempts military vessels from its provisions, including the prohibitions in Annex V, but requires that military vessels be operated in a manner consistent with MARPOL to the extent practicable. In implementing Annex V of MARPOL, the United States Congress, in Public Law 100-220 (Title II, the Marine Plastic Pollution Research and Control Act of 1987), required that military vessels comply with the provisions of Annex V in five years (including the ban on plastics disposal at sea) and develop a plan outlining how the Navy would approach compliance. Congress provided that this effort should not interfere with operations during wartime or during a national emergency. Congress also indicated that if the Navy believed it could not comply with the five year ban on plastics disposal, it would have three years to report back to Congress on the progress made and develop an alternative schedule.

During preliminary discussions regarding the implementation of Annex V, the U.S. Navy expressed concern that it faced a potentially insurmountable challenge in complying with the five year marine plastics disposal provision. However, in September 1987 during Congressional hearings on this issue, Everett Pyatt, Assistant Secretary for Shipbuilding and Logistics indicated that the Navy would make every effort to comply with the United States' commitment to Annex V of MARPOL. Shortly after that hearing, before the eventual enactment of the legislation by Congress, the Assistant Secretary asked The Keystone Center to develop strategies the Navy might consider to help address the problem of marine plastics pollution.

In developing this report, The Keystone Center consulted extensively with Navy personnel actively involved in Navy research and development, procurement and supply, operations, and shipboard environmental planning in developing its recommendations. Representatives from the David Taylor Research Center; Chief of Naval Operations; Commander in Chief, Atlantic Fleet; Naval Supply Systems Command; Naval Sea Systems Command; Navy Judge Advocate General's Corps International Law Division; Office of Navy Legislative Affairs; and the Office of the Assistant Secretary of the Navy for Shipbuilding and Logistics were actively consulted in developing the recommendations in this report. The Keystone Center also consulted with representatives from citizen and environmental organizations as well as congressional staff actively involved with and knowledgeable about the marine plastics pollution problem. This included representatives from the Cetacean Society; the Animal Protection Institute of America; the Oceanic Society; the Defenders of Wildlife; the Center for Environmental Education; the Texas Environmental Coalition; the National Audubon Society; the National Fish and Wildlife Foundation; the Monitor Consortium and Greenpeace U.S.A.; as well as Congressional staff from the Senate Commerce, Science and Transportation Committee; House Merchant

Marine and Fisheries Committee; Senator Chafee's Office; and Representative Schneider's Office.

During the early stages of its work, The Keystone Center focused on establishing a common framework for understanding the nature of the problem, the special challenges faced by the Navy, and the nature of existing information and programs currently being used by the Navy to address the plastics problem. During this early phase, Keystone staff reviewed data regarding the types and quantity of plastics used on board ship; the effects of ship size and type of operations on the generation of plastic waste and on the ability to store and dispose of plastics; as well as existing and planned technological innovations that might contribute to resolving the problem. Keystone staff visited the David Taylor Research Center in Annapolis, Maryland to learn about technology options; spent two days with the Commander in Chief of the Atlantic Fleet and his staff; and spent time on board several ships at the Norfolk Naval Station in Virginia to learn more about Navy supply systems, operations, and planning processes. A Keystone staff member also spent two days on board an aircraft carrier at sea working with Navy staff to better understand shipboard life and the nature of the plastics problem on board a large ship with five thousand crew. During the carrier visit, Keystone staff had an opportunity to meet with Navy personnel who would be directly affected by The Center's recommendations and to exchange thoughts about possible solutions.

After a substantial commitment of time and energy devoted to understanding the nature and extent of the problem for the Navy, The Keystone Center concluded that no single easy solution could eliminate the problem. At that point, Keystone began to realize that addressing the marine plastic pollution problem would require a combination of approaches, each contributing to the reduction and elimination of the disposal of plastics at sea.

The Report

The attached report represents six months of effort and is separated into four sections: supply, technology, operations, and education. In developing recommendations, Keystone attempted to take the Navy's primary mission into account, as well as the realities of shipboard life, and the challenge of affecting change in a large organization. Keystone also tried to take into account unique opportunities presented by the realities of the Navy including the Navy's historic pride in leadership as a Service; the level of pride found on each ship; the Service's substantial research and development capability; the "can do" attitude found throughout the Navy; unique aspects of the supply and operations systems; and the environmental sensitivity found on shipboard visits.

The supply recommendations, discussed first in the report, are considered to be of the highest priority. The reduction in the amount of plastics coming on board a ship will greatly reduce the need for expensive technologies intended to facilitate storage and disposal. Keystone believes that the reduction of plastics in the Navy supply system is the most direct and cost effective solution to the marine plastics problem and can significantly reduce the discharge of plastic at sea. The Keystone Center worked very closely with the Naval Supply Systems Command and communicated with the Defense Logistics Agency and the General Services Administration in developing this section of the report. The recommendations included in this section attempt to reflect the realities of the Navy supply system and on board use of materials. They range from identifying high volume food items for which non-plastic packaging is now available, to conducting waste stream surveys on ships at sea, to reviewing existing supply specifications with an eye toward procuring the same items in non-plastic packaging. The remaining sections of the report are not prioritized.

The second set of recommendations presented in the report addresses technology options. Keystone worked closely with representatives from the David Taylor Research Center, Naval Sea Systems Command, Chief of Naval Operations, and Atlantic Fleet Command to draw upon emerging technologies being developed by the Navy or considered elsewhere. The Keystone Center also worked with the Navy to identify potential new areas of research that might provide technological solutions to the plastic marine pollution problem. The trash compactor and the plastic waste processor discussed in this section of the report present very viable alternatives that could contribute to Navy compliance with the plastics disposal provision in the legislation. While the costs associated with research and development, production and installation might seem high, the extent of the problem and the relative contribution to solving the problem appear to justify the expenditure and appear consistent with other Navy innovations. The recommendations in this section encourage the development of technologies to handle and dispose of plastics and call for the development of new materials with the properties of plastic that will degrade rapidly in the marine environment.

The third section of the report focuses on operations. This section focuses on opportunities for change in shipboard procedures that could be made in the short term to assist in: reducing the amount of plastic used; enhancing storage possibilities while at sea; and developing disposal restrictions. Again, the Keystone Center worked closely with Navy staff and drew upon the group's shipboard experience to develop recommendations that could be implemented in a cost efficient manner. The recommendations in this section include suggestions to off-load unnecessary plastic wrapping and trash before leaving

port, separate and store plastic trash, and initiate conservation and recycling policies on a fleetwide basis.

The fourth and final section of this report focuses on education. If the Navy is to implement an ongoing strategy to manage, reduce, and eliminate plastics at sea, it will need to inform its personnel about the nature of the problem; communicate the Navy's commitment to solving the problem; encourage new ideas; and generate support for shipboard and service-wide activities. The recommendations in this section call for disseminating information about the plastic debris problem and distributing the Navy's plan to all Navy personnel, developing educational materials for naval supply centers and procurement offices, utilizing special awards for ships, and developing a shipboard education package. The Keystone Center is pleased to report that many of the education recommendations already have begun to be implemented as part of the Ship Waste Plastics Control Demonstration Project by the David Taylor Research Center and Atlantic Fleet Command.

In each section of the report, Keystone summarizes the recommendations generated in that section followed by a narrative explaining the justification for each recommendation (i.e., the problem it will address). This is followed by a brief discussion of what is currently being done by the Navy regarding that particular recommendation as well as what needs to be done in the future. A time frame is then outlined for completion of the proposed recommendation, identifies responsibility for the next steps within the Navy, estimates the costs for the recommendation (in 1988 dollars), and ranks the relative priority of the recommendation within that section. Keystone wishes to underline that the cost estimates are just that, estimates. Keystone staff attempted to draw upon the expertise of Navy staff as well as prior examples of Navy work to develop the cost estimates. In some areas, this neatly fell into a fairly predictable dollar category. In others, such as the supply and operations sections, the costs include human resource costs which are difficult to measure. Where hard dollar estimates were not readily available, The Center depended exclusively on estimating the cost as high, medium or low. This represents a ranking of recommendations relative to each other within a section of the report to communicate the perceived relative expense of each recommendation. Finally, it should be noted that each recommendation is prioritized (i.e., high, medium, low) relative to the other recommendations within that section of the report. The recommendations are presented in the order of perceived importance within each section.

II. SUPPLY

The Navy supply system is the first point at which the Navy can reduce or eliminate its use of plastic and is considered the highest priority for action. The elimination or reduction of plastic packaging in the supply system can have a significant impact on other points in the waste stream. If less plastic packaging is purchased, less plastic will need to be handled and stored on ships for off-loading later. Less plastic which has to be stored means less wear and tear on shipboard equipment such as compactors, processors or thermal destruction devices.

The intent of this section of the report is to help the Navy identify plastic in the supply system, evaluate the use of plastic on board ship and develop strategies to help prevent its purchase and deployment to Navy vessels where possible.

One need only look at the shelves of the local grocery store to see how pervasive plastic packaging is in our society. Special needs of the Navy, such as long periods of time spent away from port, the rolling movements of ships at sea, high humidity on board ships, and the corrosive nature of salt air and spray make plastics even more attractive for use on ships than in ordinary household environments.

Most of the recommendations in this section deal with plastic food packaging. Although quantitative studies have not yet been completed, available data indicate that packaging of these food items constitute the largest part of the plastics on board Navy ships. These items are used on board all vessels in the Navy and make up a large part of stores which must be replenished periodically. In addition, shipboard storage of plastic which has contained food may pose a sanitation problem. For these reasons, the supply system, in general, and plastic food packaging, in particular, were considered a high priority area. The Keystone Center based its determination of priorities for the supply recommendations on the contribution to reduction in plastic use, time required for implementation, and financial costs involved.

A. SUMMARY OF SUPPLY RECOMMENDATIONS

1. Identify high volume food items for which non-plastic packaging is now available.

2. Conduct waste stream surveys on ships at sea.

3. Select and order non-plastic packaging alternatives for test runs on demonstration ships based on results of waste stream surveys.

4. Review all existing supply specifications for possibile procurement of items in non-plastic packaging. Change to non-plastic packaging where possible.

5. Identify and implement use of alternatives to plastic repackaging and over-pack materials at Naval Supply Centers throughout the United States and the Naval Supply Depots overseas.

6. Work with the General Services Administration (GSA) and the Defense Logistics Agency (DLA) to gain their cooperation in identifying non-plastic packaging for items they order for the Navy. Secure ongoing support and assistance from the Office of the Secretary of Defense (OSD) and other military services.

7. Review ships stores to identify plastic packaging which can be eliminated.

8. Establish within the Naval Supply Systems Command (NAVSUP) a Plastic Program Manager Office to plan, manage and coordinate NAVSUP's efforts to reduce plastics going on board ships.

9. Change supply/specification policy to include steps to investigate availability of non-plastic or reusable packaging.

10. Review Department of Defense (DOD) research on alternate non-plastic packaging and other DOD projects for applicability to the plastic disposal problem.

11. Review military, government and commercial data bases for research projects having possible impact on the plastic disposal problem. Particular attention should be paid to those projects dealing with non-plastic packaging. Investigate promising projects.

12. Poll scientific organizations, industry groups, trade associations and individuals to find projects contemplated or underway which affect the plastic disposal problem. Test promising proposals.

B. NARRATIVE DISCUSSION OF RECOMMENDATIONS

1. **Identify high volume food items for which non-plastic packaging is now available.**

Justification: There are food items on the Navy's supply list for which non-plastic packaging may be

available. The switch to alternative packaging for these items may be made relatively quickly, providing the Navy with a definitive early success in its efforts to reduce plastic waste.

What has been done: Lists of all food items ordered by the Navy have been reviewed. Approximately 30 high-volume items with plastic packaging have been selected for evaluation. Letters have been written to the Defense Logistics Agency and General Services Administration inquiring whether non-plastic packaging is available for these items. The U.S. Army Research Development and Engineering Center in Natick, Massachusetts has been asked to develop specifications for non-plastic alternative packaging (see Recommendation 10). These 30 items were used as examples of products needing alternative non-plastic packaging.

What needs to be done: Other food items will be identified to DLA for possible change in packaging. For those items that have already been identified, it must be determined whether non-plastic packaging is suitable for Navy vessels. Changes in procurement will be phased in as appropriate.

Time frame for completion: 6-12 months.

Responsibility: Navy Fleet Commands and Naval Supply Systems Command.

Cost Estimate: Low administrative cost (could be part of the Plastic Program Manager Office's responsibility discussed in Recommendation #8). Product cost may be higher, however, for non-plastic, non-commercial packaging).

Priority: High.

2. **Conduct waste stream surveys on ships at sea.**

In these studies of shipboard trash, the test vessel keeps all trash on board ship for a specified period of time. The plastic waste is then analyzed to determine the type, weight and volume of plastic.

Justification: Waste stream surveys will identify types of plastic waste that contribute most to the weight or volume of plastics on ships. These "worst offenders" can be targeted for elimination or reduction sooner than other items which might not contribute as much to the plastic disposal problem.

What has been done: Statements of work have been provided to the David Taylor Research Center by the Atlantic Fleet, Naval Supply Systems Command, and Naval Sea Systems Command.

What needs to be done: Proceed as quickly as possible with the studies.

Time frame for completion: Baseline studies - 1988; continuing studies - 1989.

Responsibility: Chief of Naval Operations, Fleet Commands, and David Taylor Research Center.

Cost Estimate: Low (approximately $350,000 for Recommendations 2 and 3).

Priority: High.

3. **Select and order non-plastic packaging alternatives for test runs on demonstration ships based on results of waste stream surveys.**

Changes in supply and operational procedures will be tested on demonstration ships to ascertain their impact.

Justification: Results of the waste stream studies will identify high volume items whose change to non-plastic packaging will theoretically lessen the amount of plastic to be disposed, but verification of the results on board actual ships is necessary. These trial runs will allow evaluation of a significant dollar investment in hardware, including development and deployment of shipboard compactors, pulpers and plastic waste processors, and will provide a blueprint for the success of the entire plastics reduction program.

What has been done: Chief of Naval Operations has tasked (i.e., requested) fleets to plan demonstration projects. David Taylor Research Center has been tasked as project manager.

What needs to be done: Demonstration projects should be completed and evaluated.

Time frame for completion: Tasking calls for preliminary reports on the first two ships by 30 June, 1988. Final report of demonstration projects is due 30 March, 1989.

Responsibility: Chief of Naval Operations.

Cost: Low ($350,000 for this program and waste stream studies in Recommendation 2).

Priority: High.

4. Review all existing supply specifications for possibile procurement of items in non-plastic packaging. Change to non-plastic packaging where possible.

Specifications will be chosen for review based on results of waste stream studies. Where alternate non-plastic packaging is now available, it should be ordered. Suppliers should be asked to determine whether they would supply products in non-plastic packaging if requested by the Navy. Where specifications require plastic packaging, it should be determined if plastic packaging is functionally necessary. If it is determined that non-plastic packaging would suffice and the supplier will offer it, the alternate packaging should be ordered.

Justification: There may be opportunities to reduce the amount of plastic taken on board ships by simply reviewing existing procurement specifications or asking vendors for non-plastic packaging.

What has been done: Project description and budget for contracted work have been developed.

What needs to be done: Conduct complete analysis of packaging specifications. Change specifications where appropriate. To insure the greatest benefit of review, specifications for high volume items should be targeted, (e.g., food items first, high volume items from waste stream study second, those packing specifications that have application to the greatest number of end items, such as those which have similar packaging needs, third).

Time frame for completion: Analysis - 12 months for food items, 24 months for other high volume items; change in procurement - 2-3 years from identification.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Medium ($200,000 a year for five years).

Priority: High.

5. Identify and implement use of alternatives to plastic repackaging and over-pack materials at Naval Supply Centers throughout the United States and the Naval Supply Depots overseas.

Justification: Personnel will be responsible for removing plastic from ships before deploying and repackaging items to eliminate plastic. Example: under current procedures, supply centers and depots repackage material in plastic shrink wrap, stretch wrap, bubble wrap, and micro foam. This procedure should be changed where possible. Changing the procedure may require new equipment and personnel.

What has been done: A recommendation to add packing/packaging personnel at Naval Supply Centers and Naval Supply Depots has been approved by the Assistant Secretary of the Navy for Shipbuilding and Logistics.

What needs to be done: The Naval Supply Systems Command should identify alternative pre-packaging materials and methods and implement new procedures.

Time frame for completion: 1989.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Medium (approximately $1.4 million annually).

Priority: High.

6. Work with the General Services Administration (GSA) and the Defense Logistics Agency (DLA) to gain their cooperation in identifying non-plastic packaging for items they order for the Navy. Secure ongoing support and assistance from the Office of the Secretary of Defense (OSD) and other military services.

Justification: The Naval Supply Systems Command is in control of the purchase of only 20-25% of the items taken on board Navy ships. Other government procurement organizations control the remainder. The Navy should attempt to educate these other organizations about the problem of marine plastic pollution and obtain their cooperation in solving it.

What has been done: Points of contact at GSA and DLA have been established. The Armed Forces Product

Evaluation Committee has also been advised of the problem.

What needs to be done: The Navy should identify offices in other military services, such as the DOD Food Planning Board and other DOD groups, and begin discussions with them.

Time frame for completion: 1988.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Low (could be part of the Plastic Program Manager Office's responsibility outlined in Recommendation #8).

Priority: High.

7. **Review ships stores to identify plastic packaging which can be eliminated.**

Justification. Ships stores often contain items which are unnecessarily packaged in plastic.

What has been done: A contract for 11 million plastic shopping bags destined for ships stores has been cancelled. Six-pack rings and plastic over-wrap for soft drink containers have been targeted for elimination. Letters have been written to suppliers announcing the change. Other items are being reviewed for possible change.

What needs to be done: Review should continue.

Time frame for completion: Ongoing.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Unknown (may result in increased cost to individual sailors for ship stores items).

Priority: High.

8. **Establish within the Naval Supply Systems Command (NAVSUP) a Plastic Program Manager Office to plan, manage and coordinate NAVSUP's efforts to reduce plastics going on board ships.**

Justification: This Office will be responsible for executing the Naval Supply Systems Command plan of action and establishing Navy policy through

coordination with NAVSUP, field activities, other Navy activities, military services and federal agencies.

What has been done: A recommendation to establish a Plastics Program Manager Office has been provided to the Assistant Secretary of the Navy for Shipbuilding and Logistics.

What needs to be done: Naval Supply Systems Command must obtain funding and establish the program office.

Time frame for completion: 1989.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Medium (approximately $200,000 annually).

Priority: High.

9. **Change supply/specification policy to include steps to investigate availability of non-plastic or reusable packaging.**

Justification: The search for non-plastic or reusable packaging should be an on-going process in the supply system.

What has been done: No action.

What needs to be done: Naval Supply Systems Command should initiate a proposed change in the procurement process for evaluating the availability of the non-plastic or reusable plastic packaging in all procurement activities.

Time frame for completion: 6 months.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Unknown (cost of product may be higher due to use of non-commercial packaging).

Priority: High.

10. **Review Department of Defense (DOD) research on alternate non-plastic packaging and other DOD projects for applicability to the plastic disposal problem.**

Justification: Some research is already underway at U.S. Army Research Development and Engineering Center, in Natick, Massachusetts (Natrick Laboratories), which

will help reduce the amount of plastics on board ships. Possibilities include projects which have a direct impact on Navy efforts, such as development of a non-plastic food container. Others, such as research into ambient temperature washing capability (washing dishes with room temperature water), will have an indirect impact on the disposal of plastic. If it is successfully implemented, plastic utensils will not be necessary when a ship loses steam power.

What has been done: Natick Laboratories has been requested to develop non-plastic food packaging that achieves the desirable characteristics of plastic packaging such as storage life and sanitation. Research on ambient temperature washing capability has been completed.

What needs to be done: Specifications should be developed for non-plastic packaging for circulation to vendors as an example of possible future packaging requirements.

Time frame for completion: 1989 - 1992.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Medium ($100,000 - $500,000 per year).

Priority: High.

11. **Review military, government, and commercial data bases for research projects having possible impact on the plastic disposal problem. Particular attention should be paid to those projects dealing with non-plastic packaging. Investigate promising projects.**

Possibilities include Defense Logistics Studies, Information Exchange Search, Defense Technical Information Center, and National Technical Information Service (Commerce Department).

Justification: The Navy should take advantage of work already completed, or in progress, which would have an effect on the plastics disposal problem.

What has been done: The Navy has received initial products from Defense Logistics Studies Information Exchange Search and Defense Technical Information Center.

What needs to be done: The National Technical

Information Service should be contacted. Analysis of products already received should be done.

Time frame for completion: Searches - 1988; investigation of projects - 1989.

Responsibility: Naval Supply Systems Command.

Cost Estimate: Low.

Priority: Low.

12. Poll scientific organizations, industry groups, trade associations and individuals to find projects contemplated or underway which affect the plastic disposal problem. Test promising proposals.

Possibilities include placing advertisements in Commerce Business Daily, talking to industry groups such as the National Paper Institute, and discussions with scientific organizations such as the National Research Council/ National Science Foundation.

Justification: The Navy should encourage other organizations to get involved in research which pertains to solutions to the plastic pollution problem and should take advantage of research which is already underway.

What has been done: Commerce Business Daily Request for Information has been published.

What needs to be done: Other organizations, such as those mentioned above, should be contacted and analysis done on information received.

Time frame for completion: Review - 1988; test - 1989-1990.

Responsibility: Contacting Commerce Business Daily, industry groups - Naval Supply Systems Command; liaison with National Research Council - Assistant Secretary of the Navy for Shipbuilding and Logistics.

Cost Estimate: Low.

Priority: Low.

III. TECHNOLOGY

Although some solutions to the Navy's plastic waste problem can be implemented immediately and are fiscally inexpensive, others will require highly technical and somewhat expensive hardware. Some of this equipment is now undergoing field testing, with fleetwide installation of the equipment imminent. Other equipment will require design, prototype construction, testing, and evaluation before installation and use can occur. Although the estimated cost for all of the hardware is significant, The Keystone Center believes that the overall benefits will far outweigh the costs. Benefits derived from the use of this equipment and these technologies will not only help the Navy deal with its plastics problems, but will assist the Navy in addressing the overall waste management challenge presented by other solid wastes such as paper, cardboard, metal, and glass. Some of the recommended technologies described below, not targeted exclusively at plastics, will provide more space, save more time, and utilize less labor, and will thereby contribute to solving the marine plastic pollution problem. Although some technological solutions will require years of development, The Keystone Center recommends that the Navy consider all options for dealing with the management of plastic waste.

The Keystone Center based its determination of priorities in this section of the report on the following criteria: feasibility; proven nature of the technology; level of significance in reducing the plastics waste stream; level of significance in reducing the non-plastics waste stream; short-term versus long-term nature of the solution; potential for greatest impact; need for a technology; and cost.

Please note that food waste disposers/grinders were not considered as part of this analysis because their use does not contribute to reduction or elimination of plastic disposal, or other non-food-related wastes.

A. SUMMARY OF TECHNOLOGICAL RECOMMENDATIONS

1. Trash Compactor
2. Plastic Waste Processor
3. Enhanced Degradable Packaging Materials
4. Solid Waste Pulper
5. Thermal Destruction Device
6. Dedicated Garbage Barge

B. NARRATIVE DISCUSSION OF RECOMMENDATIONS

1. Trash Compactor

Justification: Use of a trash compactor will greatly facilitate storage of plastic and other garbage (e.g., paper, cardboard, metal, and glass) on board ship. It will provide tremendous space-savings, with easier handling and off-loading of compacted trash. Installation and use of the vertical trash compactor fleetwide would implement a feasible, proven technology. Its use is applicable to all ships in the Navy, regardless of size. The compactor is fully automated and is designed to take many types of trash, including plastics.

If, in the future, trash is separated -- glass, metal, paper, and cardboard -- recycling efforts, if developed, could be expedited. In addition, compaction of non-plastic waste will result in greater available space for dealing with plastic waste. It will also facilitate easier overboard disposal of these wastes due to their compact characteristics, and it will enable better storage of wastes which cannot be dumped overboard while ships are in no dumping areas.

The trash compactor is designed to be a breakdown model and, thus, can be taken piecemeal onto each ship, eliminating the need to cut and reweld the hull to bring the compactor on board. Since ships are normally in a shipyard for three-month periods, installation can easily be completed during that time. Any industrial shipyard can accomplish the fitting.

What has been done: A prototype has been built and tested at the David Taylor Research Center in Annapolis, Maryland. The prototype is now being tested on a destroyer class vessel.

What needs to be done: The prototype, already installed on the USS O'Bannon (a destroyer), is being field/sea tested for six months. This will be followed by six months of technical evaluation, plus an additional six months of operational evaluation. Procurement will require an additional year resulting in initial installation during the fall of 1990 (these are best case time estimates for this and the following analyses; times could likely be shortened somewhat, but probably at far greater costs). Destroyers will be outfitted first, with installation dependent on ship availability.

Time frame: Five years to completely outfit all Naval vessels once the unit is mass produced.

Responsibility: Naval Sea Systems Command (NAVSEA).

Cost Estimate:

Research and Development:	$ 1 million to complete.
Acquisition:	$62 million
Installation:	$68 million

Priority: High

2. **Plastic Waste Processor**

Justification: The Plastic Waste Processor (PWP) will deal specifically with all plastic waste. It will function much like a trash compactor containing a built-in heating/melting unit. Compressed plastic will be melted, then cooled into small, solid, sterile plastic bricks for later land-based disposal or possible recycling. The sterile bricks of plastic will result in easier storage, handling, and off-loading. There is a need for this machine, especially on board large combatants, tenders, and carriers because of the large volume of waste generated and limited storage space. Use of the PWP will result in tremendous volume reduction of plastic -- a major problem with such items as bubble wrap. The processor will also sterilize plastic food wrap, eliminating a major health hazard and over-riding health concern.

What has been done: Engineering and design of a prototype has begun.

What needs to be done: After the design of a processor that will accept all plastic, a prototype will be built with testing, evaluation, production, and installation. The PWP should be fully automated.

Time frame:
Research and Development: 3-4 years Five additional years to completely outfit all large surface ships once the unit is mass produced.

Responsibility: Naval Sea Systems Command (NAVSEA)

Cost Estimate:

Research and Development	$11 million
Acquisition	$50 million
Installation	$46 million

Priority: High

3. **Enhanced Degradable Packing Materials**

Justification: Since the physical qualities of plastics are extremely desirable -- durable, waterproof, lightweight, bacteria-resistent, etc. -- if non-plastic alternatives can be developed which possess similar qualities and are not persistent, but will allow overboard disposal, then part of the plastics problem will be solved.

Development of enhanced degradable packing materials (EDPM) could help solve much of the Navy's plastic waste stream problem if the Navy can convince industry to adopt alternative packaging practices. Work in this area could actually enhance the Navy's ability to leverage industry to develop and use EDPM's.

What has been done: The Navy recently signed a contract with Research Triangle Institute (RTI), North Carolira to continue work on developing degradable plastics, and to test commercially available products which may be of use to the Navy (e.g., 100% biodegradable cellulose cellophane, cardboards).

What needs to be done: RTI should continue testing existing commercially available products, and should attempt to develop a degradable plastic-like product which may be used on board ships as a substitute for conventional plastics.

Time frame:
Research and Development phase: 2-7 years (because of the many unknowns with this type of exploratory development program).

Responsibility: Office of Naval Technology.

Cost Estimate: $2 million over 2-7 years.

Priority: High

4. **Solid Waste Pulper**

Justification: The solid waste pulper (SWP) will deal primarily with the paper waste stream, acting as a cost and labor-saving device for eliminating paper. Incidental to its operation, the SWP will separate plastic from paper, allowing for removal of plastic from the pulper (e.g., plastic liners in paper bags,

accidental plastic disposal). Paper waste will be directly discharged into the ocean eliminating the need to hand-carry some paper to the compactor and/or fantail. The paper plugs generated by the pulper will be small, easily biodegradable, wet, and negatively or neutrally buoyant. In this form, the waste is expected to deteriorate quickly in the marine environment.

The SWP will deal specifically with the paper waste stream, acting as a tremendous labor-saving device. Environmental deterioration/degradation of the paper will be greatly enhanced by size reduction and the wetting of paper waste. Crew involvement in waste elimination should be considerably lessened.

What has been done: A development contract has been awarded to Somat Corporation, Pomeroy, Pennsylvania. A demonstration model has been developed.

What needs to be done: Development should be carried out in four phases:

1. Field/sea testing and evaluation of the pulper.

2. Construction of a preproduction model.

3. Construction of a production model to be installed, tested, evaluated, and readied for commercial production.

4. Commercial manufacture and installation on all larger surface ships.

Time frame:
Research and Development: 3-4 years.
Production and installation - onto larger surface ships: 5-7 years. (Production and installation are budget driven. Research and development can be accelerated, installation cannot.)

Responsibility: Naval Sea Systems Command (NAVSEA).

Cost Estimate:

Research and Development	$ 4 million
Production/acquisition	$20 million
Installation	$48 million

Priority: Medium

5. **Thermal Destruction Device**

Justification: The thermal destruction device (TDD), as it presently exists, is a large, but trailerable, plasma-arc heating unit which produces temperatures through electrical arc generation greater than 5,000 degrees Fahrenheit. Large quantities of electricity are needed to create temperatures high enough to vaporize waste products. Existing equipment is now being used for soil pyrolysis decontamination.

Newly emerging thermal destruction devices have a potential to solve part of the Navy's plastic waste problem particularly on larger ships with crews of more than 600 people. Some emerging TDD's hold promise in providing safe destruction of trash; however, none have been fully tested to demonstrate environmental acceptability, particularly for burning plastic trash. The TDD would be particularly useful at foreign ports where countries are not willing to accept Navy waste. Use of the TDD would remove Navy dependence on inshore waste facilities, at least on larger ships in which it would be installed. Any TDD technology must meet all of the requirements of the Ocean Dumping Act. All TDD systems should meet Clean Air Act standards for similar land based systems to maintain high environmental and human health standards.

What has been done: An available technical assessment has been completed by the Navy. The Navy continues to identify pyrolysis and plasmolysis technologies which may be potentially scaled down.

What needs to be done: Industry should be contacted to determine possible interest in the project. Analyses of engineering and feasibility should to be conducted. A scaled down model should be designed and built. This would lead to the design and production of a full-scale model. The Navy needs to scale down such a machine; although, scaling them down will reduce the throughput capacity (pounds per hour of burnables). Design and construction of a TDD is a highly technical issue, requiring answers to a number of technical issues including: materials issues, heat expansion, corrosion, weight, available energy, and exhaust emissions.

Time frame:

Research and Development: 5-7 years

Installation: 5-7 additional years to completely outfit all larger surface ships once unit is mass produced.

Responsibility: Naval Sea Systems Command (NAVSEA)

Cost Estimate:

Research and Development:	$10 million
Acquisition:	Cannot estimate
Installation:	Cannot estimate

Priority: Medium

6. **Dedicated Garbage Barge**

Justification: The dedicated garbage barge would serve as a ship-towed barge specifically designed to haul plastic and other wastes in special use areas (e.g., the Antarctic, near-shore operations).

What has been done: No action. Creation of a fleet of dedicated garbage ships is feasible. However, there may be problems in obtaining acceptance of waste by these ships in foreign countries. Economic incentives -- separated waste (metal, glass, paper) for recycling -- may increase the likelihood of foreign acceptance of Navy waste.

What needs to be done: Evaluate the cost of developing a fleet. Identify where there may be a need for this service. Explore land-based disposal options in one fleet to determine the feasibility. Compare costs of this option with other alternatives in the long term.

Time frame: Long term.

Responsibility: Fleet Command.

Cost Estimate: $10's of millions.

Priority: Low

IV. OPERATIONS

Operational responses to the plastic problem on board Navy ships focus primarily on altering routine practices for dealing with plastic trash to facilitate: (1) reductions in the amount of plastic used and brought on board the ships; and (2) separation and stowage of plastic for proper offloading.

In most cases, operational responses do not require the development of new technology or changes in procurement practices. For that reason, many of the operations recommendations can be instituted immediately and will result in an immediate reduction in the amount of plastic discharged at sea. The cost estimates associated with each recommendation are approximate because many of the recommended actions regarding operations primarily involve human resource costs. Although these costs may be quantified in hours of labor expended, other human resource costs (e.g., morale) are virtually impossible to quantify.

Recommendations in this section are prioritized based on the contribution each recommended action will have on reducing the amount of plastic brought on board ship and the extent to which each recommended action will facilitate elimination of the need for plastic discharge. Generally, success in achieving the first three recommendations in this section will determine the degree to which all other recommendations in the Operations section of the report will need to be pursued.

A. SUMMARY OF OPERATIONS RECOMMENDATIONS

1. Prior to leaving port, the maximum amount of packing materials and other plastic trash should be offloaded from ships.

2. Separate plastic trash.

3. Store plastic trash for offloading.

4. Consider storage of used plastic wrapping from foods in closed container in freezer.

5. Locate plastic waste receptacle on fantail of ship or other trash discharge location.

6. Until full compliance is achieved, determine "no plastic discharge zones" for each class of ship.

7. Initiate conservation and reuse/recycling policies on a shipwide basis, especially target shipping and receiving areas.

8. Eliminate plastic liner in trash can.

9. All Commanding Officers should require that, wherever possible, plastic items (e.g., coffee cups, coffee stirrers) be replaced with non-plastic items and that disposable items used on board ship be replaced with reusable items (e.g., disposable aprons, gloves, dry cleaning bags).

10. Designate Environmental Officer (on collateral duty) for each ship to integrate responsibility for all environmental systems, including collection, holding and transfer (sewage) system, hazardous materials/hazardous waste systems and trash disposal.

11. Determine capacity for storage of plastic trash for each class of ship, beginning with demonstration ship.

12. Evaluate the feasibility of sanitizing plastic trash and subsequent storage on board ship.

13. Until full compliance is achieved and the Act takes effect for Navy vessels, each vessel should maintain a ship's log for recording all discharges of trash. The Navy should develop a system for using this data to measure progress in achieving compliance with the legislation.

14. Evaluate storeroom designs and operating procedures to facilitate storage of plastic trash.

15. Evaluate use of supply ship for offloading of certain plastic trash, pallets and reusable items or materials (e.g., sonabuoy cases).

16. On ships equipped with compactors, consider compacting plastic material separate from all other waste.

17. Provide bulk dispensers for commonly used products packaged in personal sized plastic containers.

18. Study the feasibility of hiring a private contractor to collect trash at sea from Navy vessels operating in selected areas.

B. NARRATIVE DISCUSSION OF RECOMMENDATIONS

1. <u>Prior to leaving port, the maximum amount of packing materials and other plastic trash should be offloaded from ships.</u>

Justification: This will minimize the amount of plastic generated for disposal. The degree to which the Navy can minimize the amount of plastic brought on board the ship will have a significant effect on its ability to eliminate the discharge of plastic waste at sea.

What has been done: In some instances, this practice already exists. In addition, Atlantic Fleet ships have already been instructed to attempt to institute this practice.

What needs to be done: Issue an instruction to implement this practice in all instances.

Time frame: Institute immediately.

Responsibility: Navy chain of command.

Cost Estimate: Low

Priority: High

2. **Separate plastic trash**.

Separate plastic trash from other trash at source on mess decks and other main collection sites. Keep plastic trash, which is contaminated with food residue, separate from plastic trash which is not contaminated. Achieve through use of dual trash receptacles or multi-compartmented trash receptacle.

Justification: This will provide a basic first step for separate handling and disposal of plastic trash without added labor cost. It will reinforce awareness of the problem at all levels.

What has been done: Atlantic Fleet ships have already been instructed to attempt to institute this practice.

What needs to be done: Equip collection sites with suitable receptacles. Institute instruction to separate plastic trash.

Time frame: Institute immediately.

Responsibility: Navy chain of command down through the individual level.

Cost Estimate: Low

Priority: High

3. Store plastic trash for offloading.

Store for offloading plastic trash which is not contaminated with food residues. Until full compliance can be achieved, to greatest extent practicable, store for offloading plastic trash which is contaminated with food residue.

Justification: This will facilitate the ultimate goal of land disposal of plastic trash. The larger the amount of plastic that can be stored, the less the need to manage the plastic in some other way or discharge.

What has been done: Atlantic Fleet ships have already been instructed to attempt to institute this practice.

What needs to be done: Issue instructions to store plastic trash in designated areas.

Time frame: Institute immediately.

Responsibility: Navy chain of command.

Cost Estimate: Low - Medium.

Priority: High

4. Consider storage of used plastic wrapping from foods in closed container in freezer.

Justification: Re-freezing of plastic trash contaminated with food residue will eliminate health hazards and provide sanitary storage until the plastic can be offloaded for proper disposal. Management of plastic contaminated with food residue is expected to be a major concern because a large percentage of the plastic brought on board ship is used as food packaging.

What has been done: No action.

What needs to be done: Determine safety of such storage from public health perspective. Issue instruction to food preparation personnel to re-freeze used plastic from foods products.

Time frame: Make determination prior to initiating

demonstration ship program and, if appropriate, test on demonstration ship.

Responsibility: Approval by Navy Environmental and Preventive Medicine Command. Implement through Navy chain of command.

Cost Estimate: Low

Priority: High

5. **Locate plastic waste receptacle on fantail of ship or other trash discharge location.**

Justification: This will facilitate retention of plastic trash by providing last opportunity for collection.

What has been done: No action.

What needs to be done: Provide ships with receptacles. Issue instruction to retain plastic at point of discharge.

Time frame: Institute immediately.

Responsibility: Navy chain of command down through the individual level.

Cost Estimate: Low

Priority: High

6. **Until full compliance is achieved, determine "no plastic discharge zones" for each class of ship.**

Such zones would be areas in which no plastic trash could be discharged. The boundaries of the zones would be determined by the storage capacity of each class of ship within a time frame that enables that class of ship to travel from the offshore edge of the zone to port. Since Navy vessels are currently prohibited from discharging trash within 25 miles of the coast, a "no plastic discharge zone" would extend that prohibition for plastics to a greater distance from shore for those ships with additional storage capacity.

Justification: This will facilitate the retention on board of a larger quantity of plastic than might otherwise be maintained. Minimizes to a limited extent the shoreline impact of discharged plastic.

What has been done: Atlantic Fleet ships have already been instructed to attempt to institute this practice.

What needs to be done: Determine the appropriate "no plastic discharge zone" for each class of vessel. Zones could be defined by "hours from port" or "distance from port" (whichever is further from shore). Issue an instruction to implement the "no plastic discharge zone".

Time frame: Determine "no plastic discharge zone" for each class of vessel within three months; implement immediately thereafter.

Responsibility: Chief of Naval Operations and/or Fleet Command.

Cost Estimate: Low

Priority: High

7. **Initiate conservation and reuse/recycling policies on a shipwide basis, especially target shipping and receiving areas.**

Includes requirement that plastic be stored in work area for purposes of reuse or recycling.

Justification: This will ensure that reuse or recycling efforts are carried out wherever feasible and will minimize the amount of plastic trash that must be offloaded for land disposal.

What has been done: No action.

What needs to be done: Issue instruction to recycle plastic waste wherever possible.

Time frame: Institute immediately.

Responsibility: Navy chain of command.

Cost Estimate: Low

Priority: High

8. **Eliminate plastic liner in trash can.**

If necessary, replace metal trash cans with specially coated receptacles to facilitate ease of disposal and cleaning; install specially coated trash chute on

fantail or other discharge location to facilitate discharge of trash without use of plastic.

Justification: Minimize discharge of plastic or other waste material into the sea.

What has been done: No action.

What needs to be done: Investigate feasibility of using receptacles without liners -- if only in selected areas. If necessary, procure new or additional receptacles.

Time frame: Evaluate feasibility on demonstration ship.

Responsibility: Navy chain of command.

Cost Estimate: Low - Medium

Priority: High

9. All Commanding Officers should require that, wherever possible, plastic items (e.g., coffee cups, coffee stirrers) be replaced with non-plastic items and that disposable items used on board ship be replaced with reusable items (e.g., disposable aprons, gloves, dry cleaning bags).

Justification: This will minimize the amount of plastic trash generated on board ship.

What has been done: Atlantic Fleet ships have already been instructed to attempt to institute aspects of this practice.

What needs to be done: Complete evaluation and, on that basis, Navy should notify suppliers of needs and institute use on board ship.

Time frame: Begin evaluation immediately for testing on demonstration ships.

Responsibility: Naval Supply Systems Command and Commanding Officers.

Cost Estimate: Low - Medium (depending on item)

Priority: High

10. **Designate Environmental Officer (on collateral duty) for each ship to integrate responsibility for all environmental systems, including collection, holding and transfer (sewage) system, hazardous materials/hazardous waste systems and trash disposal.**

Justification: Effective pollution control can best be achieved if an officer is delegated responsibility for that task. The importance of pollution control will be greatly enhanced by the designation of such an officer. Dedicated effort to address pollution systems in a more comprehensive way is necessitated by increasing legislative requirements over the years for all waste disposal activities. The technology applied to these systems is more advanced and complex and crosses many disciplines. A high level of expertise and coordination is required to comply with legislative mandates.

What has been done: No action.

What needs to be done: Concept paper drafted by the Chief of Naval Operations staff.

Time frame: Submit concept paper within three months. Process within one year.

Responsibility: Chief of Naval Operations.

Cost Estimate: Medium

Priority: High

11. **Determine capacity for storage of plastic trash for each class of ship, beginning with demonstration ship.**

Justification: This will provide a basis for determining the ability of the ship to store plastic trash for offloading, and the consequent need to further minimize onloading of plastic, or the need for special equipment. Sets a standard to be achieved by each ship.

What has been done: No action.

What needs to be done: Each class of ship must be surveyed to identify potentially available storage space. Such space should be allocated for storage of plastics on board demonstration ships to evaluate its suitability for storage.

Time frame: Begin survey immediately for application to demonstration ships.

Responsibility: David Taylor Naval Research Center (as part of the Ship Waste Plastics Control Demonstration Project).

Cost Estimate: Medium

Priority: High

12. **Evaluate the feasibility of sanitizing plastic trash and subsequent storage on board ship.**

Explore possibilities for sanitizing plastic trash on board ship (e.g., steam cleaning, flushing with seawater).

Justification: Long-term storage of plastic contaminated with food residue poses potential health problems and such plastic, therefore, requires special treatment or handling. The benefits of implementing this recommendation will be proportional to the percentage of plastic trash contaminated with food residue. Since this percentage is expected to be quite high, the benefit of pursuing this course of action is also expected to be high. The Keystone Center acknowledges that this approach may be labor intensive, but believes it presents an important opportunity to reduce marine plastic pollution and deserves the Navy's attention.

What has been done: The feasibility of sanitizing plastic trash is currently being evaluated as part of the Ship Waste Plastics Control Demonstration Project conducted by the David Taylor Naval Research Center.

What needs to be done: Data should be gathered to determine: (1) the extent of the need (volume of plastic) for special equipment or measures; (2) the feasibility of instituting operational measures or installing equipment; (3) the effectiveness of such measures or equipment.

Time frame: Initiate efforts immediately and identify any suitable operational measures within one year. If special equipment is needed, adjust time frame in accordance with the nature of the equipment.

Responsibility: David Taylor Research Center for Ship Waste Plastics Control Demonstration Project on sanitization.

Cost Estimate: Low capital cost; potentially high costs depending on labor requirements and the need for special equipment.

Priority: High

13. **Until full compliance is achieved and the Act takes effect for Navy vessels, each vessel should maintain a ship's log for recording all discharges of trash. The Navy should develop a system for using this data to measure progress in achieving compliance with the legislation.**

Record of all discharge of trash should include an annotation as to whether plastic waste was discharged. The Navy should develop a data collection system and a regular reporting mechanism to utilize the information collected and integrate information in the Navy's annual report to Congress.

Justification: This provides the basis for measuring progress in achieving compliance with the legislation. Currently, the Navy has no system to collect such data and report on progress made to Congress. This will provide valuable information about plastic trash generated on board Navy vessels.

What has been done: No action.

What needs to be done: Commanding Officers should issue instructions to maintain a log of plastic waste discharge and the Navy should establish a system for measuring compliance with the legislation.

Time frame: Institute immediately.

Responsibility: Navy chain of command.

Cost Estimate: Low

Priority: High

14. **Evaluate storeroom designs and operating procedures to facilitate storage of plastic trash.**

Evaluate storeroom designs and operating procedures (such as the potential for more effective use of ceiling spaces and storage in shipping/receiving areas; backfilling plastics behind active stock; the use of mechanical shelving units for storage of supplies

and/or plastic trash, etc.) to determine whether the current system can be altered.

Justification: This facilitates efficient use of space for storage of plastic trash without impeding access that might otherwise remain unused.

What has been done: No action.

What needs to be done: Initiate evaluation.

Time frame: Initiate evaluation immediately.

Responsibility: Naval Supply Systems Command (Fitting Out and Supply Support Assistance Center).

Cost Estimate: Medium

Priority: Medium (depends on storage capacity)

15. Evaluate use of supply ship for offloading of certain plastic trash, pallets and reusable items or materials (e.g., sonabuoy cases).

Justification: Using supply ships to offload plastic trash has limitations. However, they may provide a useful option in selected situations -- especially for classes of ships where there is minimal storage capacity for plastics or reclamation of reusables. The benefits of implementing this recommendation will vary greatly by class of ship.

What has been done: The Navy has undertaken an evaluation of the use of supply ships for offloading all plastic trash.

What needs to be done: Evaluate the use of supply ships for offloading of limited kinds/quantities of plastic trash, or offloading plastic trash under certain specified circumstances (e.g., ship has been at sea for extended period of time, to service ships which have minimal storage capacity). Identify target items for potential offloading to supply ships (e.g., sonabuoy cases).

Time frame: One year for completion of evaluation.

Responsibility: Type Commanders Combat Logistics Force Staff.

Cost Estimate: Medium - High

Priority: Medium

16. **On ships equipped with compactors, consider compacting plastic material separate from all other waste.**

Justification: Compactor will reduce the volume of plastic for storage. Plastic trash contaminated with food residue poses a potential health hazard requiring special storage considerations.

What has been done: No action.

What needs to be done: Once compactor has been installed, issue appropriate instructions.

Time frame: Immediately for demonstration ship and immediately upon installation of compactor for all other vessels.

Responsibility: Operators of compactors.

Cost Estimate: Medium

Priority: Medium.

17. **Provide bulk dispensers for commonly used products packaged in personal sized plastic containers.**

Justification: This will eliminate the overall number and variety of small plastic items in need of disposal.

What has been done: No action.

What needs to be done: Identify items that may be dispensed in bulk; investigate bulk procurement of identified items; test on demonstration ship.

Time frame: Immediately for testing on demonstration ships.

Responsibility: Naval Supply Systems Command (Navy Resale and Services Support Office)

Cost Estimate: Medium - High

Priority: Medium

18. **Study the feasibility of hiring a private contractor to collect trash at sea from Navy vessels operating in selected areas.**

Specifically investigate the use of private contractor for collecting recyclable materials and plastic trash in selected areas (e.g., offshore of the U.S., Europe).

Justification: In the long term, the Navy may benefit from contracting out for collection of trash, especially recyclables such as aluminum and glass that may substantially increase in value in the future.

What has been done: No action.

What needs to be done: Feasibility study.

Time frame: Feasibility study completed in three years.

Responsibility: Naval Facilities Engineering Command.

Cost Estimate: Medium - High

Priority: Low (in the short term).

V. EDUCATION

In the next few months, the U.S. Navy will test new equipment and shipboard practices to prevent the disposal of plastic trash at sea. Ultimately, such procedures and equipment will come into use throughout the fleet. For these efforts to be successful, crew members and others must understand the basis for these actions. They must be made aware of the fact that the Navy has a Congressional mandate to comply with the provisions of Annex V of the MARPOL Treaty within the next five years, and more importantly, they need to understand the reasons for this mandate. Navy crew members and others need to learn about the problems caused by the disposal of plastics in the marine environment, including the threat plastics pose to marine wildlife and must be informed about how they can become part of the solution.

A program that explains these and other aspects of the marine debris problem are essential to the success of the Navy's plan to reduce the disposal of plastic trash in the marine environment. Changes in attitudes and behaviors of naval personnel will determine whether the Navy's plan will be successful, and such changes can only be achieved through a well coordinated education plan.

The development of education programs must evolve relative to changes in supply, operations and technology. Therefore, although a general time frame has been assigned to the recommendations in this section, education activities should be developed along with the Navy's general plan to address this problem. Ideally, all of the following recommendations, particularly those pertaining to ships, should be applied fleetwide by 1993. However, all educational materials and methods developed for the Navy should be periodically reviewed and updated to maintain their effectiveness.

At this time, it is also difficult to estimate costs for many of the following recommendations. Many activities will only involve the costs of time spent by Navy personnel. In addition, the benefits of such recommendations, in terms of overall plastic waste reduction, cannot be measured at this time. However, as noted above, without some attempt to inform and educate naval personnel about the plastic debris problem and the Navy's plan to address this problem, their cooperation cannot be fully achieved.

The following recommendations suggest ways the Navy can incorporate education into its plan to reduce the disposal of plastics in the marine environment. Priority has been assigned to each recommendation based on the order in which each task should be addressed and the importance of each task relative to other recommendations in this section.

A. SUMMARY OF EDUCATION RECOMMENDATIONS

1. Information on the plastic debris problem and the Navy's plan to address this problem should be disseminated to all levels of the Navy.

2. Educational materials on the plastic debris problem and the Navy's plan to address this problem should be developed for ships, naval supply centers, and offices involved in procurement.

3. Every Navy vessel should use an education package composed of several key elements.

4. The effectiveness of education efforts on ships should be assessed through a survey.

5. The Navy should use the Environmental Award as a means to recognize ships that are outstanding in their efforts to reduce plastic wastes.

6. Naval vessels should consider sponsoring shipboard contests on plastics reduction methods.

B. NARRATIVE DISCUSSION OF RECOMMENDATIONS

1. ***Information on the plastic debris problem and the Navy's plan to address this problem should be disseminated to all levels of the Navy.***

   Justification: Cooperation at all levels will be needed if the Navy's plan to reduce plastic debris is to be successful. For example, those who must begin procedures to minimize the amount of plastics in supply, those who must take precautions in separating plastic wastes from the ship's waste stream, and those who will be in charge of supervising these efforts and allocating funds for these projects need to know why such measures are important. The initial process of sensitizing Navy personnel to the issue of plastic debris will facilitate the acceptance of later steps taken by the Navy to address this problem. Regular updates on the Navy's progress will help maintain interest. The eventual development of programs to be incorporated in training programs will help to prepare Navy personnel about what they will be required to do to reduce plastic waste disposal at sea.

   What has been done: Only a small segment of the Navy, including personnel who have been involved with the

development of this report, have been introduced to the plastic debris issue. Broad-based information and education activities have not yet taken place.

What needs to be done:

Phase I: The Navy must begin to disseminate information on the plastic debris issue through various media including the Navy Times, Navy News This Week, the Armed Forces Information Service and other general avenues. These efforts should emphasize that: 1) plastics pose a threat in the marine environment; 2) Congress has directed the Navy to come into compliance with Annex V within the next five years, and; 3) the Navy has made a commitment to reduce plastic disposal at sea and is developing a plan to carry this out, and intends to pursue this effort with Navy pride in leadership. In addition, information should be provided on what other marine user groups, such as the commercial fishing and merchant shipping industries, are doing to reduce plastic disposal at sea.

Phase II: Information on the results of test ships, technological developments, and other progress to reduce plastic disposal at sea should be disseminated to Navy personnel, through the media discussed above.

Phase III: Information on the plastic debris problem and what the Navy has done to address this problem should be included in boot camp training, Officer's Candidate School, Navy ROTC programs, the Navy Academy and other avenues.

Time frame: The above information/education process should commence immediately and be a continuing process thereafter.

Responsibility: Chief of Naval Operation, Chief of Naval Education and Training, Fleet Commander and Chiefs.

Cost Estimate: Staff time to write articles for distribution to Navy media.

Priority: High

2. **Educational materials on the plastic debris problem and the Navy's plan to address this problem should be developed for ships, Naval Supply Centers and offices involved in procurement.**

Justification: Navy ships, supply centers and offices involved in procurement will be most affected by the Navy's plan. Therefore, educational materials should be developed specifically for these groups.

What has been done: The development of an education program for Navy vessels, supply offices and offices involved with procurement began in May, 1988.

What needs to be done:

Phase I: Since the Navy will be using several ships to test new supply, operation and technological strategies to address the plastic debris problem, these ships should also test educational efforts for crew members. Any form of education would have to coincide with other matters being tested on the ship so that sailors are not confused by suggestions that are beyond their control or the ability of the test ship. In addition, emphasis should be given to promoting plastics awareness with those officers who will be overseeing plastic waste reduction programs.

Education efforts should include information on the problem, what is being done to address the problem, and what individual ships and their crew members can do to help. Information on entanglement in and ingestion of plastics by marine life should be included in addition to other problems caused by plastics such as aesthetic degradation and vessel disablement. Materials should convey that this is a global problem (include examples of plastics accumulating even in remote areas of Antarctica, etc.). (See Recommendation #3 for list of specific educational materials to be used on board ships.)

The Naval Supply Centers and offices involved with procurement for these test ships should also be used as models for the development of educational materials. In this case, informative and attractive posters would be useful. It is suggested that the poster "Our Ocean. It's Drowning.", developed by the National Marine Fisheries Service Marine Entanglement Research Program, be used. This poster could be framed and permanently mounted. However, an alternative poster should be developed for these offices.

All materials should be low-keyed, professional and sincere. The primary purpose of education is to explain why it is important to prevent the disposal of plastics in the marine environment and what an individual can do to become part of the solution.

Phase II: Once educational materials have proved to be successful on test ships and model Navy supply and procurement offices (see recommendation #4), these materials should be produced for fleetwide distribution.

Time frame: By December 1988, the Navy should finalize development of materials that will be used for widespread distribution and begin production of these materials.

Responsibility: Chief of Naval Operations, Systems Commands, Fleet Commander and Chiefs.

Cost Estimate: Printing and staff time to oversee development and implementation of education plan.

Priority: High

3. Every Navy vessel should use an education package composed of several elements.

Justification: Navy vessels are a direct source of plastic wastes. Therefore, the greatest amount of effort in terms of education should be placed on educating crew members. Educational materials should inform crew members about the problem and what they are required to do on board. Materials, such as video announcements, posters, bumper stickers, and placards provide a long-term mechanism for reinforcement of these ideas.

What has been done: No action.

What needs to be done: The following materials should be developed for inclusion in an education package, listed in order of priority:

a. **Fact Sheet** -- It is important to prepare a fact sheet (2-3 pages in length) on the problem for those that will have to answer questions from crew members, or for those that just want to know more.

b. **"Plan of the Day" Announcements** -- Each ship prints and posts its own "Plan of the Day" which is a type of newsletter. When a ship is at sea, this is often one of the only forms of outside information available to a sailor. The Navy should distribute information on plastics to all ships and request that it be printed in the "Plan of the Day". This should consist of a series of very brief articles on the

subject that should be printed in the Plan at regular intervals. This information would have to be short (2-5 lines per issue), informative and interesting. These can easily be taken from the above fact sheet or articles produced in Recommendation #1.

c. **Video** -- A video program (8-10 minutes) should be shown before full-length movies, or incorporated into short training sessions. Such a video would give information on the problems caused by the disposal of plastics in the marine environment followed by an explanation of what their ship is doing to reduce the disposal of plastics at sea and what individual crew members should do as part of these efforts.

The Navy has a special unit that makes videos, the Naval Imaging Command. To expedite the production of this video, The Keystone Center is investigating the availability of video footage on the plastic debris problem from contractors of the National Marine Fisheries Service Marine Entanglement Research Program and local television stations. Such footage could be used and adapted to meet a Navy audience.

d. **Video Announcements** -- In addition to the video described above, short video announcements (30 seconds to one minute in duration) should be produced and shown at regular intervals on board ships. These announcements would explain a specific problem caused by plastics in the marine environment. Four such videos should be produced with the following messages:

(1) Plastic debris harms marine wildlife-- Describe the harmful effects of plastic debris on marine wildlife due to entanglement in and ingestion of plastics.

(2) Plastic debris is a persistent eyesore-- Describe the aesthetic degradation of shorelines and the open ocean caused by the accumulation of plastic debris. Emphasize the fact that plastics are different than other types of trash because of their light weight, strength and durability.

(3) Plastic debris poses a threat to navigation-- Describe the problems of vessel disablement caused by plastic debris such as ropes, lines, bags and sheeting that can foul props and clog cooling water intakes and evaporators. This is a problem for all seafarers (naval, commercial, recreational, etc.).

(4) Plastic debris is a matter of reputation and sailors should "take pride" in what they are doing to combat this problem -- The public and others are becoming increasingly aware of the specific sources of plastic debris and to what degree these sources are attempting to reduce their contribution to this problem. The Navy is taking a lead role in finding practical solutions to this problem -- solutions that are not just applicable to Navy, but solutions that will assist all marine vessels and user groups in finding ways to reduce plastic waste disposal at sea.

e. **Posters** - Posters should be placed in key areas of the ship where plastics are generated and discarded. These posters should be art work of an entangled animal with a short caption (i.e., Picture: of sea turtle with plastic bag in mouth. Caption: "A vessel tossed out some garbage and killed this turtle"). Four such posters should be developed with the following pictures:

(1) sea turtle with plastic bag in mouth
(2) seal with plastic strapping band around neck
(3) fish entangled in plastic six-pack ring
(4) bird either entangled or with plastic in stomach

It should be noted, however, that in certain areas such as dining halls, the posters described above may not be appropriate.

f. **Mounted Display** - A display using pictures with written captions should be developed and used on board larger ships. This display should show examples of the impact of plastics on marine wildlife and provide information on what is being done on board a ship to prevent plastic disposal at sea.

g. **Bumper Stickers on Operational Guidance**-- Stickers that remind sailors not to throw plastics overboard should be posted in prime areas of the ship such as on garbage cans, in the galley, mess halls and supply rooms.

h. **Placard** -- A placard, similar to those pertaining to oil discharges, should be posted at the station of the Duty Officer. This placard should notify the crew of the requirements of Annex V. The U.S. Coast Guard is presently designing such placards for commercial and recreational vessels.

Time frame: Educational materials should be used first on test ships. Materials for fleetwide distribution should be finalized and ready for production by December 1988.

Responsibility: Fleet Commander and Chiefs

Cost Estimate: Development and production of materials and staff time.

Priority: High

4. **The effectiveness of education efforts on ships should be assessed through a survey.**

Justification: Well written surveys will indicate whether educational efforts are effective and help in the development of a strong education plan.

What has been done: No action.

What needs to be done:

Phase I: Crew members on board test ships should be given a "pre-test" survey before educational materials are used to determine the level of awareness of the problems caused by plastic debris and general feelings toward preventing the disposal of plastics at sea (e.g., do they think it is a problem to dispose of plastics at sea, how would they respond if asked to separate and store plastic trash on board for disposal in port). The results of this survey would be evaluated against a "post-test" survey to determine whether attitudes and behaviors were changed due to educational efforts. In addition, crew members would be encouraged to evaluate the materials used (what did they like, dislike, need more of, need less of, etc.).

Phase II: Once educational efforts are applied fleetwide, spot check surveys should be conducted periodically to provide a regular check on the effectiveness of educational materials and methods in order to determine where changes are necessary.

Time frame: Begin development of surveys for test ships immediately. Surveys for distribution fleetwide should be completed by December 1993.

Responsibility: Chief of Naval Operations, Chief of Naval Education and Training, Fleet Commander and Chiefs.

Cost Estimate: Staff time to design survey and compile and analyze results.

Priority: High

5. **The Navy should use the Environmental Award as a means to recognize ships that are outstanding in their efforts to reduce plastic wastes.**

Justification: Awards offer an additional incentive to comply with the task of reducing plastic disposal at sea. For very little cost and effort, the Environmental Award will provide the Navy a means to reward ships that are outstanding in their efforts to reduce plastic debris and will offer the Navy an additional opportunity to assess its efforts to address the problem. In addition, it will provide means for the Navy to publicize its success both within the Navy and to outside groups.

What has been done: Each year, the Navy gives an Environmental Award to one small ship and one large ship. Winning ships fly the white and green environmental flag.

What needs to be done: Preventing discharges of plastic waste should become a criterion for the Environmental Award, and ships that are outstanding in their efforts should be rewarded.

Time frame: To be implemented in 1990.

Responsibility: Chief of Naval Operations.

Cost Estimate: Staff time of those who administer the Environmental Award.

Priority: Medium

6. **Naval vessels should consider sponsoring shipboard contests on plastics reduction methods.**

Justification: Contests offer an additional means of education and help to create incentives for sailors to reduce plastic waste disposal at sea.

What has been done: No action.

What needs to be done: Each ship should consider conducting a contest on plastic reduction methods among all departments of the ship. Contests could also be

conducted between different ships of the same class. The group or ship that is most outstanding in their efforts could be given a suitable reward to be determined by Navy staff.

Time frame: Contests could begin on test ships in 1988. By 1990, this should be encouraged fleetwide.

Responsibility: Fleet Commander and Chiefs

Cost Estimate: Staff time

Priority: Medium

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APPENDIX A

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APPENDIX B

GLOSSARY OF TERMS

1. **Armed Forces Information Service** - the public information service for the armed forces.

2. **Chief of Naval Education and Training** - the officer responsible for administering the Navy's education and training programs.

3. **Chief of Naval Operations** - senior military officer in the Navy.

4. **David Taylor Research Laboratory** - a Navy laboratory researching and developing technologies for various Navy areas of interest.

5. **Defense Logistics Agency** - the organization that oversees purchasing and distribution of items common to all United States Armed Forces, not exclusively single service (like, Navy) use items.

6. **Duty Officer** - a generic title for an officer in the execution of responsibilities to further the command's mission in a role other than the officer's specific administrative assignment, such as the officer representing the commanding officer after the work day is over and the commanding officer has gone home.

7. **Natick Laboratory** - military research and development laboratory related to food and clothing.

8. **Naval Environmental and Preventive Medicine Command** - the Navy's equivalent to a public health agency.

9. **Naval Facilities Engineering Command** - the systems command responsible for facilities and military construction engineering and also some environmental issues.

10. **Naval Fleet Command** - there are two fleet commands. One is the Pacific and the other is the Atlantic Fleet Command. The two commands divide responsibility for Navy ships and aircraft based on the location of the ships or aircraft within the geographic area of responsibility of either the Commander of the Pacific or Atlantic Fleet Commands. The Fleet Commanders are the intermediary administrative command between the Chief of Naval Operations (CNO) and the Type Commanders (TYCOM).

11. **Naval ROTC Program** - a Navy training program for future officers enrolled in colleges and universities.

12. **Naval Supply Centers** - regional purchasing and distribution centers located in the United States.

13. **Naval Supply Depots** - overseas purchasing and distribution centers.

14. **Naval Sea Systems Command** - the organization that designs and builds ships and submarines and subsystems, like propulsion or weapons systems, for the ships and submarines.

15. **Naval Supply System Command (NAVSUP)** - the organization that oversees purchasing and distribution of supplies for the Navy.

16. **NAVSUP FOSSAC** - subordinate command under Naval Supply Systems Command (NAVSUP) and responsible for storeroom and warehouse design and distribution systems.

17. **NAVSUP NAVRESSO** - subordinate command under NAVSUP responsible for retailing personal convenience items.

18. **OPNAV** - the organization that carries out the mission of the Office of the Chief of Naval Operations.

19. **Systems Command** - other systems commands provide the management for aircraft and research laboratories.

20. **TYCOM** - the administrative commander of a single type of Naval unit (e.g., aircraft carriers, submarines, or other surface vessels). The officer responsible for administrative rules, training and maintenance for all Naval units of the type, e.g., all aircraft carriers. Works for and under the respective Fleet Commanders.