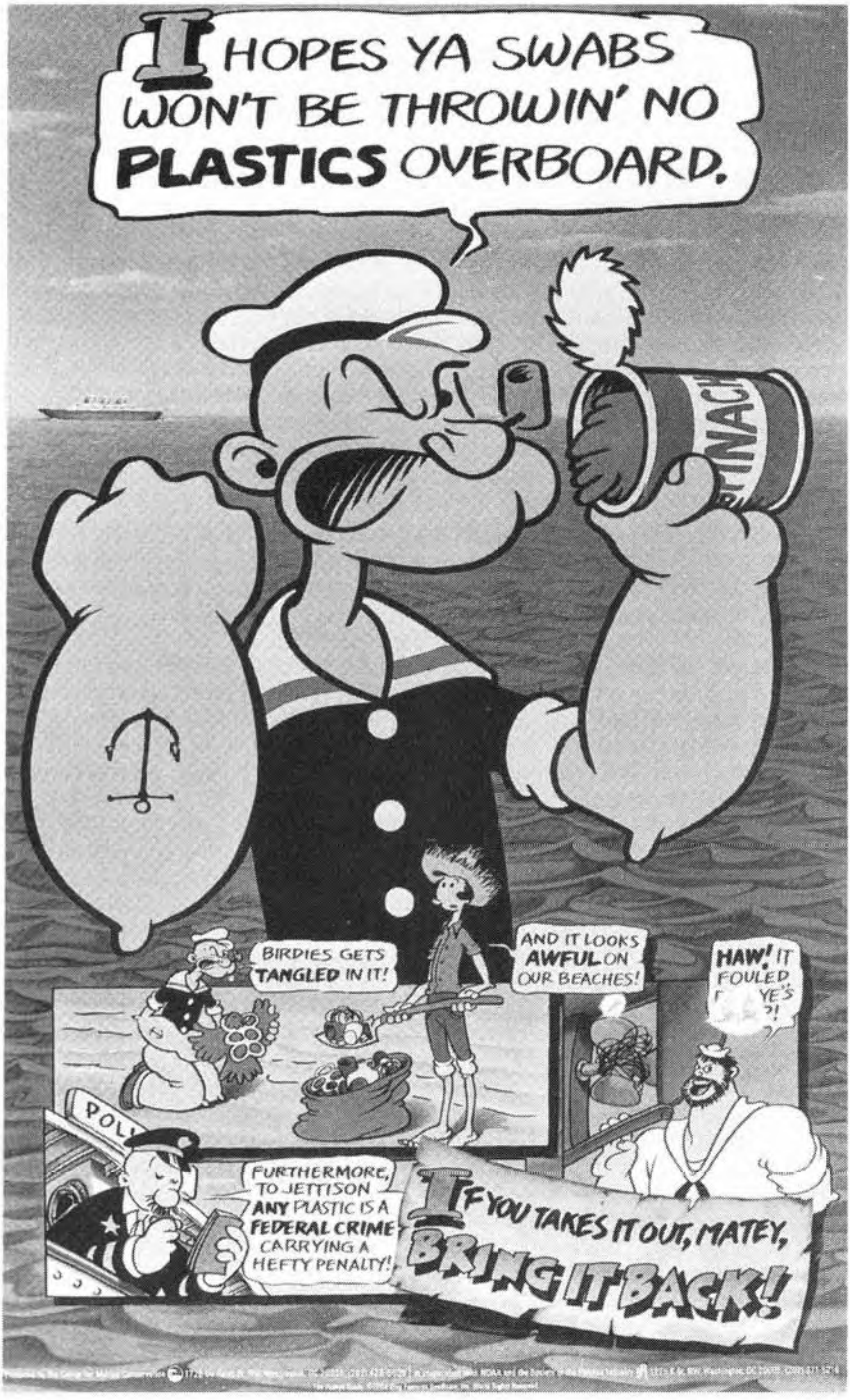
I HOPES YA SWABS WON'T BE THROWIN' NO PLASTICS OVERBOARD.
BIRDIES GETS TANGLED IN IT!
AND IT LOOKS AWFUL ON OUR BEACHES!
HAW! IT FOULED
FURTHERMORE, TO JETTISON ANY PLASTIC IS A FEDERAL CRIME CARRYING A HEFTY PENALTY!
IF YOU TAKES IT OUT, MATEY, BRING IT BACK!

FIG. 1

GARBAGE POLLUTION
A GREEN OR NAVY BLUE ISSUE ?

BY

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ABSTRACT

The Ministry of Defence has recently endorsed a policy to comply with international discharge of garbage at sea legislation which came into force on 31 December 1988. This article gives a brief overview of the considerable problem facing the Fleet in complying with these regulations and outlines the development efforts under way within MOD.

Garbage Pollution

A study carried out more than a decade ago[1] estimated that vessels at sea dumped 6,360,795 tonnes of garbage into the sea every year—more than 726 tonnes per hour. This figure includes all solid cargo and crew waste material (paper, glass, metal, rubber and plastics) that was assumed to be disposed of by the world's commercial fishing and merchant shipping fleets, passenger cruise liners, military vessels, oil rigs and recreational craft.

This overall quantity is known to have increased over the last decade, with plastics gradually forming a greater percentage of the waste. The U.S. Navy estimates that plastics form approximately 11% by weight of the total dry waste—that is over 2000 tonnes a day at today's figures of which 4 tonnes are attributable to them. The Royal Navy's share is around 0.5 tonnes a day.

Garbage dumped at sea is a potential security risk from a military viewpoint, a hazard to navigation, a possible health hazard when washed up ashore, unsightly, but most widely of all is harmful to marine life. It is estimated that 1,000,000 sea birds, 100,000 marine mammals and 50,000 northern fur seals die each year either from plastics ingestion or entanglement. Plastics are therefore the greatest threat to the marine environment; examples of the harm they cause can be seen in FIGS. 2 and 3.

Garbage Pollution Regulations

The regulations relating to garbage pollution are contained in the International Maritime Organisation's (IMO) MARPOL 73/78 Annex V regulations, which came into force on 31 December 1988. Details of these garbage regulations are given in FIG. 4 (note that the shaded areas indicate regions where the discharge of garbage is banned altogether), but the most significant discharge restrictions may be summarized as follows:

(*a*) The discharge of synthetic waste is prohibited in all areas.

(*b*) The discharge of all non-food waste is totally prohibited in Special Areas. These are defined as the Mediterranean, the Baltic Sea, the Black Sea, the Red Sea and the Gulf. (There are moves to classify the North Sea as a Special Area).

(*c*) The discharge of food waste is totally prohibited within 3 nautical miles (nm) of the coast (or 12 nm in Special Areas).

MARPOL 73/78 Annex V is a Protocol and not an enforceable law; therefore national laws must be introduced and enforced in line with the Protocol. As a signatory, the U.K. introduced The Merchant Shipping

FIG. 2—'SIX-PACK' PLASTIC STRANGLING A SEAL

(Prevention of Pollution by Garbage) Regulations 1988 on 31 December 1988, but its regulations do not apply to warships.

Marine pollution is a visible political issue in the U.K. and is likely to become more so in the future. The Fleet is already having some operational difficulties in certain areas, notably the West Indies and Baltic, and these restrictions are likely to become more widespread if no action is taken for the Royal Navy to comply with the Protocol. The Fleet Effectiveness Committee (FEC) therefore recently (April 1989) endorsed a policy for MOD vessels to comply where operationally practicable with MARPOL 73/78 Annex V regulations and gave authority to identify and adapt suitable equipment.

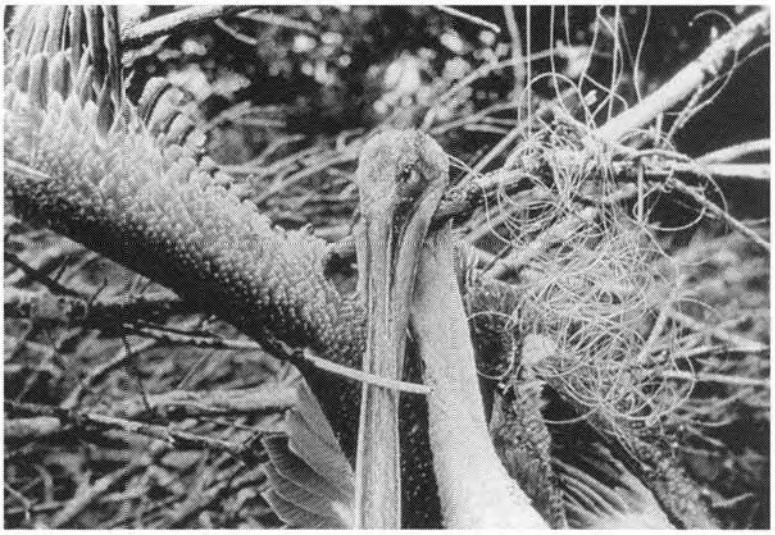

FIG. 3—A PELICAN TRAPPED BY OLD FISHING LINE

Current Shipboard Problems

It is estimated that the garbage generated in warships is about 0·85 kg/man/day of general waste (11% of which is synthetic waste) plus 0·58 kg/man/day of food waste. Hence a vessel with a complement of 200 men will generate 170 kg of general waste and 116 kg of food waste daily; the majority of the latter will be disposed of through Garbage Disposal Units (GDUs) which at present are the only widely fitted equipment for garbage processing.

Some existing vessels and major vessels now under construction are fitted with a range of commercial equipment. This equipment is not entirely satisfactory, being generally unreliable, labour intensive and difficult to operate and maintain. Much of it is also of insufficient capacity and, where the volume of garbage is high as in the CVS, the solution has been to provide several of the same standard equipment. This places additional demands on already limited manpower resources. Such equipment also does little for morale since much sorting of the garbage is necessary before being fed into the appropriate garbage processing equipment.

	OUTSIDE SPECIAL AREAS				SPECIAL AREAS (BALTIC, RED SEA, BLACK SEA, MEDITERRANEAN, GULF AREA)	
	Distance from Land in Nautical Miles					
	< 3	3–12	> 12	> 25	<	>
DUNNAGE, PACKING, ETC., WHICH WILL FLOAT	PROHIBITED	PROHIBITED	PROHIBITED	PERMITTED	PROHIBITED	PROHIBITED
FOOD WASTE	PROHIBITED	*	PERMITTED	PERMITTED	PROHIBITED	PERMITTED
PAPER PRODUCTS, RAGS, GLASS, METAL, BOTTLES, CROCKERY	PROHIBITED	*	PERMITTED	PERMITTED	PROHIBITED	PROHIBITED
PLASTICS INCLUDING SYNTHETIC ROPES, FISHING NETS, PLASTIC GARBAGE BAGS	PROHIBITED					

FIG. 4—GARBAGE DISPOSAL REGULATIONS, SUMMARIZED FROM MARPOL 73/78
*permitted when put through a comminutor or grinder and capable of passing through a screen with openings no greater than 25 mm

Processes Available

The processing equipment must provide simplicity of operation, low operator requirements, low maintenance, be easy to clean, economical with space, and minimize any health hazards. Development of such equipment as standard throughout the Fleet would reduce costs and simplify operating procedures, training time and the quantity of replacement spares.

Compliance with the regulations dictates that dumping at sea is unacceptable in many areas, so, in many instances volume reduction of garbage on board becomes essential. Many different forms of garbage processing equipment have been fitted to R.N. vessels in the past or trialled ashore with mixed results. The practical methods of achieving a volume reduction are:

- compaction;
- shredding or maceration;
- incineration.

Compactors

Commercially available compactors may provide the best solution for smaller vessels with limited space that spend the greatest part of their operational time in restricted waters. Several are being evaluated.

Advantages

(*a*) Volume reduction of approximately 5:1.
(*b*) Quick and simple operation.
(*c*) There are no restrictions on composition of garbage.
(*d*) The processes are clean.
(*e*) Low maintenance.
(*f*) Easy to keep clean.

Disadvantages

(*a*) Commercial compactors do not achieve good volume reduction.

Shredders and Macerators

Modern high capacity shredders and macerators provide operational flexibility for all forms of dry garbage. In shredded or macerated form, the garbage is reduced in volume by 80% and is amenable to automatic handling methods. Processed waste, other than plastics, may be discharged directly beyond 3 nm of the coast and the shreddings will sink in a few minutes. Alternatively the shreddings may be stored temporarily in order to meet particular operational requirements; e.g. plastics, or when at flying stations or in Special Areas.

Advantages

(*a*) Average volume reduction of 5:1.
(*b*) Glass, cans and most soft materials can be handled.

Disadvantages

(*a*) Cloth, non-rigid plastic sheet, and wet materials can clog the equipment, especially if a 25 mm grid is inserted beneath the cutters allowing discharge between 3 and 12 nm.
(*b*) Large metal objects, tools, etc., can jam the mechanism.
(*c*) Can be extremely difficult to keep clean.
(*d*) Relatively complex machinery.

Incinerators

Incineration provides the most effective means of reducing the volume and weight of garbage. Incineration leaves ash and clinker which can be stored on board for disposal ashore or at sea. The combination of shredders and incinerators provides a viable solution for large ships such as the CVS and future major warships. Such a combined system would give improved incineration rates and allow a high degree of automation in both the garbage feed and ash extraction systems. There are however problems with burning certain materials such as plastics which burn at high temperatures and can give off toxic gases.

Advantages

(*a*) High volume reduction (approx 20:1) assuming pre-shredding of cans, etc., is carried out.
(*b*) No pre-sorting required.
(*c*) Can be fully automated.

Disadvantages

(*a*) Labour-intensive to operate and maintain unless incorporated into fully automated systems which are relatively complex.
(*b*) Aerosol cans, food cans and glass require shredding before incineration.
(*c*) Bulky in construction.
(*d*) Dust and smoke are created within the compartment.
(*e*) The incinerator must be sited adjacent to a main flue.
(*f*) Maintenance requirements can be high.
(*g*) The incineration of synthetic materials at sea may be banned in future international agreements.
(*h*) Wild heat generation.
(*i*) NBCD considerations.

Neither incineration nor shredding/maceration on their own are ideal for surface ships, but combined together into fully automated systems may be practicable for larger ships. A system based on a Hamworthy Neptune incinerator and a Metal Box shredder is currently undergoing trials for subsequent fitting to H.M.S. *Illustrious* in her forthcoming refit. Existing pulping machines for paper and card, which are already fitted to larger ships, may be modified to be less susceptible to blockage in line with results obtained by the United States Navy during extensive trials. For ships of frigate and destroyer size or smaller, compaction is being evaluated. It is envisaged that garbage compacted using purpose-built high density machines achieves a volume reduction in the order of 8:1 or better. MOD assessments indicate that a standard rugged compactor system will provide significant savings on training, maintenance, spares holdings and number of installations, when compared with incinerator-based systems.

Garbage Handling Policy in the R.N.

The flow diagram in FIG. 5 forms the basis for garbage handling equipment policy. The aim is to produce some equipment that can be fitted to most ships at reasonable cost and which minimizes complexity and the manpower requirement, and is easy to install. If vessels are to comply with MARPOL 73/78 Annex V, dry garbage will have to be retained when operating within the 12 nm limit (3 nm if shredded) or in Special Areas, and synthetic waste will have to be retained at all times.

The basic range of equipment which will be engineered will probably centre around a 200 man compactor or baler. It is envisaged that larger ships with a greater garbage problem could still use incinerators for the disposal of the majority of waste, even if the burning of synthetic waste is ultimately banned, with sorting at source, as in the rest of the Fleet, and compacting or baling plastics separately. Commercial compactors will be provided for minor vessels. Submarines will continue to be fitted with small compaction and ejection systems and will claim exemption from MARPOL 73/78 Annex V Garbage Regulations.

There is of course a manpower burden as operators and maintainers of the equipment will be required, but this can be minimized by engineering equipment of good design to meet R.N. requirements. In the majority of vessels a system will be introduced whereby garbage is sorted at source into plastic waste and non-plastic waste—two sacks in appropriate holders at each collection point (one plastic sack and one paper sack). The sacks are taken to the garbage processing equipment where the plastic sack containing plastic waste is placed in the collecting/waiting area, whilst the other is placed into the garbage equipment hopper, the button pressed and the garbage processed

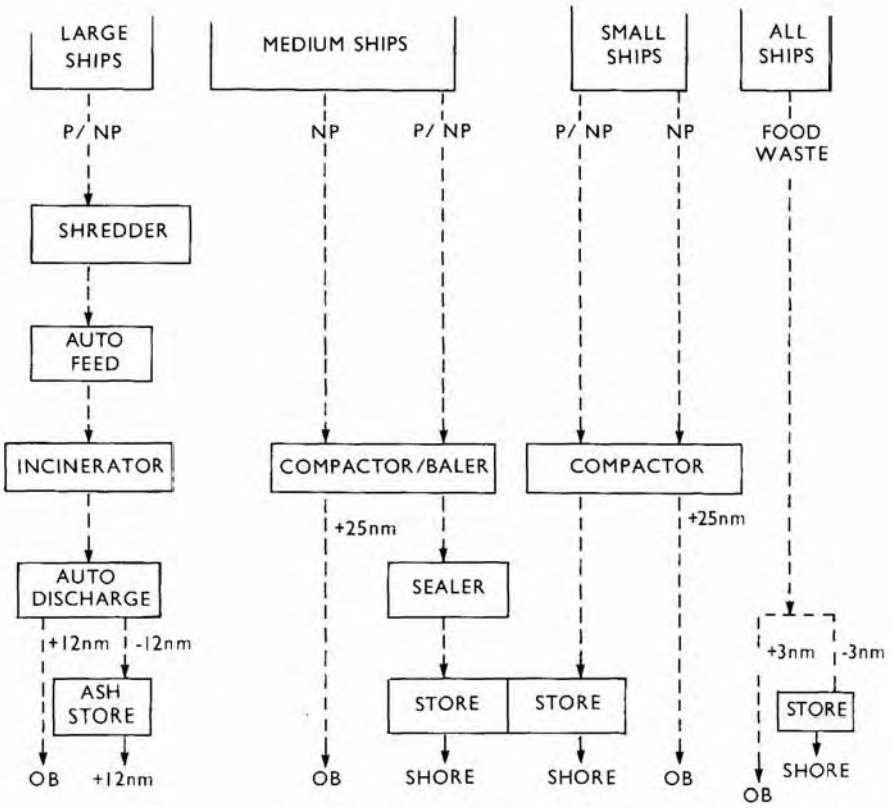

FIG. 5—OPTIONS FOR DISPOSAL OF GARBAGE OUTSIDE SPECIAL AREAS
nm: NAUTICAL MILES
NP: NON PLASTICS
OB: OVERBOARD
P: PLASTICS

and temporarily stored. The plastic garbage would be processed by a dutyman once a day. The non-plastic processed garbage would be ditched at sea where appropriate or temporarily stored.

Food waste causes particular problems because peelings from root vegetables cannot be discharged within 3 nm of the shore (12 nm in Special Areas) thus effectively rendering potato peelers inoperable close inshore and in harbour. Means of modifying existing potato peelers are being investigated to allow peelings to be collected onboard. Food-contaminated plastic garbage, for example from the wrappings of meat, is the most difficult problem because of the hygiene and health problem of the storage which may be necessary for many days or weeks or even months. Therefore this compacted garbage must be stored in hermetically sealed packages which will not be broken during storage or during disembarkation, or else this waste must be rendered sterile by some other process.

If all garbage in a 200 man frigate or destroyer is compacted or baled, 11 bales each weighing 15 kg are created daily, and if plastics only are compacted and stored (which will be the normal situation) only 1 such bale would be produced for storage every day because at present plastics account for no more than 11% of dry garbage generated. There are already studies in hand with Head of Victualling and DFSD to investigate ways and penalties (mostly cost) of reducing the amount of plastics entering a vessel, including those for NAAFI.

Garbage Handling Equipment Development

Development will be centred on reasonably proven processes in the short term, with new technology considered for the long term. The main development areas, in order of priority, are:

(*a*) Compactor system for most vessels.

(*b*) Incinerator system for large ships.

(*c*) Commercial compactors for minor vessels.

(*d*) New processes for sterilizing food-contaminated plastics, including thermal compaction and microwave technology.

(*e*) Modified pulping machine for large ships as an alternative to incinerators.

(*f*) Non-magnetic compactor for MCMVs.

The MOD is in close contact with NATO allies, but only the U.S. Navy is devoting substantial resources to the development of equipment. The U.S. Marine Plastic Pollution Research and Control Act of 1987 implemented Annex V of MARPOL. The Act goes beyond Annex V provisions by making the requirements applicable to the U.S. Navy, beginning 5 years after Annex V entered force (i.e. December 1993). The U.S. Navy has therefore expended over $20M on development of suitable equipment, including a powerful and elaborate compactor and a heat sealing device for plastics. They will be expending a further $400M on production and fitting costs.

Although commercial equipment is available, it is in most cases unsuitable for use in warships, being too large, manpower-intensive to use, and not sufficiently robust. A Statement of Technical Requirements is being prepared prior to commencing the procurement programme which will be initiated once a Marine Engineering Requirement has been approved by DOR(Sea).

FIG. 6—A U.S. NAVY WARNING POSTER

Education

It is clear that the U.S. Navy is heavily committed to MARPOL. Indeed it has already embarked on an expensive publicity and education drive with videos, 'adverts' to be added to shipboard film shows, posters, booklets, etc. (see FIGS. 1 and 6). It is clear that if the Royal Navy's equipment programme is to be a success MOD(N) must devote considerable time and resources in a similar course of action through 'Viewpoint RN' and other outlets in order to obtain the assistance of each and every sailor, and also to guide and support management in ships.

Conclusions

In these days of growing public awareness on 'green' issues it was unlikely that the Royal Navy could continue for many more years with its existing garbage disposal routines. The decision by the FEC in April 1989 to comply with MARPOL 73/78 Annex V regulations where operationally practicable has given MOD the authority to commence the identification and procurement of suitable equipment for MOD vessels. By providing high quality videotapes it is hoped to communicate effectively with shipboard audiences, providing details of the potential problems caused by plastics in the oceans and the new policies and procedures. Detailed guidance material on management details will have to accompany the videotapes.

Although a positive response is hoped for from the generally environmentally aware young sailors, active support is needed from the entire chain of command if the programme is to be a success.

Reference

1. U.S. National Academy of Sciences. 1975. Marine litter. Pp. 405–438 in *Assessing potential ocean pollutants*. A report of the study panel on assessing potential ocean pollutants to the Ocean Affairs Board, Commission on Natural Resources, National Research Council, National Academy of Sciences, Washington, D.C.