SHIPPING AND HANDLING OF PESTICIDE CARGOES: THE NEED FOR CHANGE

Paul Johnston BSc. PhD.,[1] Sandra Marquardt B.A., [2] Jane Keys B.A., Topsy Jewell BSc. [3]

[1] Greenpeace Research Laboratory, University of Exeter, UK. [2] Greenpeace USA, Washington DC, USA. [3] Greenpeace International, Amsterdam, Netherlands

ABSTRACT

Of all the dangerous goods carried at sea, pesticide cargoes are unique in the dangers that they pose to the environment. In 1991 the UN International Maritime Organisation International Maritime Goods (IMDG) Code was amended to require that specified chemicals be labelled as "marine pollutants". In addition packaging must now allow for immersion in seawater and allow attempts at salvage.

The potential hazards of pesticide cargoes have been illustrated by a number of accidents involving shipping. There is an urgent need to "fast track" the provisions of the IMDG Code. In addition many pesticides which are exported are not registered for use in the country of origin. A good case exists for linking the provisions of the IMDG Code to the registration process and to the FAO/UNEP Prior Informed Consent procedure and the developing PIC Convention.

KEYWORDS: accidents, pesticides, prior informed consent, registration, shipping, transport

INTRODUCTION

Pesticides are designed specifically to interfere with biological systems, often at very low concentration [1]. Consequently, if spilled or released they pose very real dangers to humans and to natural ecosystems. The magnitude of this threat can be gauged from a fire in a Swiss pesticide warehouse in 1986, which released pesticide contaminated firewater into the River Rhine. The eel population was killed over a 400km length of the river and effects on more sensitive organisms were recorded 480km downstream. The

"slug" of water contaminated with Disulfoton, Thiometon and Etrimphos could be traced using analytical instruments as far as the Netherlands [2]. Closure of water abstraction points helped prevent exposure of the general population. Extensive contamination of the Rhine Delta area was only avoided by careful routing of the contaminated water through a single channel to the North Sea [3,4].

In relation to the potential environmental impacts of a pesticide cargo lost at sea, the UK Ministry of Agriculture Fisheries and Food (MAFF) [5] have predicted the likely impacts of a spill of 10t of the organophosphate insecticide pirimphos-ethyl into the English Channel. Based on the dilution necessary to achieve a "safe" concentration of 20ng/l for a water dispersible emulsifiable concentrate, then the theoretical impacts upon shellfisheries could extend over an area of 10,000 square kilometres. This scenario is illustrated in Figure 1 where the potential impact area is superimposed upon the areas actively fished for crustaceans in the English Channel.

The MAFF analysis notes that eradication or severe depletion of the crustacean stock over such a wide area would have major effects on the fishery. This could take up to five years to recover and regenerate in some cases. The financial and social costs of such an incident could run to tens of millions of pounds sterling. Every incident involving the loss of hazardous cargoes into the marine environment will have some economic impact notwithstanding demonstrable harm to the marine environment. These impacts can flow from disruption to fishing activity, loss of

consumer confidence in the quality of marine resources as well as from the costs associated with monitoring, control and clean-up.

The quantities of pesticides lost in the Rhine accident or in the simulated scenario outlined above represent only a small fraction of such toxic chemicals transported by sea and river annually. Between 1977 and 1987, worldwide pesticide sales dramatically increased and the agrochemical market doubled in size to more than $US17 billion [6]. US pesticide export sales currently represent around one quarter of the world market and exports are estimated at between 400 and 600 million pounds per annum. The trade is equally highly developed in Europe. Table 1 shows pesticide exports from Germany, a major pesticide exporting nation, as compared to the domestic market, broken down by category. The export tonnages are almost 2.5 times the domestic consumption [7].

Quite rightly, therefore, pesticides are regulated by the United Nations International Maritime Organisation Maritime Dangerous Goods code (IMDG Code). In 1991 the Maritime Safety Committee adopted amendment 26-91 to the Code which as part of its wide ranging provisions specified chemicals to be labelled as "marine pollutant". In addition specifications were made that such materials should be adequately packaged to withstand immersion in seawater and to allow attempts at salvage. As is common with International Conventions, the provisions of the code require incorporation into the national law of signatory nations to become effective. Further changes in transport conditions will result from the provisions of the 27th Amendment to the IMDG code which entered into force on January 1 1995.

The necessity for these regulations and more particularly their implementation is underlined by a number of incidents involving the loss or spillage of cargoes at sea in recent years. This paper documents some of the accidents which have occurred involving pesticide cargoes and explores some of the informational, regulatory and legislative issues highlighted by these incidents.

SOURCES OF INFORMATION

One extremely disturbing aspect of accidents involving pesticide cargoes is the apparent lack of an adequate database documenting them. Lloyds Intelligence which monitors the activities of some 30,000 ships worldwide estimates that around 4000 shipping incidents are reported annually while the UK National Union of Seamen has stated that cargo ship losses occur at the rate of around 4 per week worldwide. Table 2 provides a breakdown of shipping casualties compiled by Lloyds for 1995 [8]. Overall, this source reports the total loss of 188 ships in 1995 with an aggregated 0.9 million tons gross weight. Since 1990, a total of 1461 ships have been lost totaling 8.2 million tons gross weight. Cargo vessels are a particularly high risk category. There is apparently no centralised record of cargoes and no systematic approach to the listing of hazardous cargoes. The Lloyds figures total only actual and constructive total losses. Hence, it may be expected that the occurrence of incidents where total loss does not occur, and the statistics are, therefore not reported, will be very much higher.

Even when incidents are formally reported and recorded on a national or regional basis, environmental effects may not be

detailed. One literature review of five hundred major industrial accidents reported that only five of these references mentioned the environment and only three discussed wider environmental effects [9]. Other reviews noted in this study provide data which suggest that in the case of 87% of accidents, no information is available on environmental effects.

The Rhine Commission reported 250 accidents between 1985 and 1991 involving the release of chemicals to the Rhine River. These were from a variety of sources. Of these incidents, only eight described the ecological consequences. Further, in most cases, studies tend to report only fish kills or vegetation damage with little work carried out on longer term impacts. Despite the numbers of reported incidents, the calculated risks of inland water transport on the Rhine are considered low in relation to those due to accidental spills from industrial installations although environmental risks overall are considered to be dominated by the bulk transport of liquid materials [10]. This conclusion is based upon a probabilistic modelling exercise rather than an analysis of actual accident statistics.

Some databases which record releases of dangerous substances have been discontinued. The Pesticide Incidents Monitoring System (PIMS) database is no longer being maintained in the US for example (McNamara pers, comm.). Some local programmes still exist, such as the Washington State Department of Health Pesticide Incident Reporting and Tracking Review Panel. This body, however, does not specifically record transport related incidents unless human exposure takes place [11].

The Emergency Response Notification System (ERNS) is a multi-agency national US database which compiles data on release notifications of oil and hazardous substances. On an annual basis, incidents rose from the 28,677 recorded in 1987 to reach 35,653 recorded in 1991 [12]. The USEPA Acute Hazardous Events Database also provides information on releases of toxic chemicals. As at March 1994, this database contained 6,190 records representing 10,993 separate substance release incidents (Kampen pers. comm.). A major limitation of the above databases is that they can apparently only be interrogated with respect to specific chemicals. The current European Agrochemicals Directory [13] contains details of some 850 pesticides registered for use in the various European countries. Clearly, a complete search of these databases on a substance by substance basis would be extremely costly and unlikely to provide a great deal of information on the ecological effects of any given spill or leakage.

The Major Hazard Incident Database Service (MHIDAS) database in the UK is described in a comprehensive review of information sources concerning ecological impact of industrial chemical accidents [14]. This UK database has been assembled from reliable news information sources and showed that between 1981 and 1986 on average 28% of accidents involving hazardous chemicals took place during transport operations. This accords with the records of the United States AHE database which attributes 25% of incidents to transport activities. No syntheses of these data appear to have been made to evaluate the contribution of pesticides to the overall problem. 23% of the total number of incidents reported involved PCBs. Bulk chemicals were involved in 25% of incidents

[14]. The contribution of pesticides to the category designated as "Other" in this review is not known.

The availability of information is not helped either by the failure of key European legislation to regulate transport related chemical accidents. The Seveso Directive [15] excludes transport accidents in its provisions and in this sense is inferior to the US RCRA, CERCLA and SARA legislation which sets reportable quantities of designated hazardous substances which in some cases are as low as 2.2kg irrespective of how the release occurs [14]. These domestic legislative instruments and do not apply outside of the US.

The lack of a centralised information database, therefore, is a considerable impediment to full assessment of the risks posed by pesticide transport. Many accidents are likely to go unreported or may generate little media concern. What does attract media attention may not be subsequently followed up in depth and any ecological or other effects may also remain unreported. There is a need to generate a record system capable of tracking pesticide cargoes from source to final destination and collating information on accidents.

EXAMPLES OF ACCIDENTS INVOLVING PESTICIDE CARGOES

1) Deck cargoes

The carriage of dangerous goods as deck cargo has led to a number of losses of pesticide cargoes, mostly in standard steel containers following heavy weather. The incidents detailed below have generated a great deal of publicity and therefore the facts

are relatively easy to ascertain. In the absence of a complete database, it is impossible to estimate the true numbers of such incidents in any one year. Nonetheless, a wide range of chemicals have been lost in waters around the UK including acrylonitrile, o-cresol, xylene, uranium hexafluoride together with the pesticides dinoseb and nemagon [5].

Even when considering well managed operations using weather routing services, losses still occur due to adverse weather. Over an eighteen month period from Jan 1995 one such operator recorded 18 lost containers out of a total number of 2.5 million carried (Johnson, pers. comm.). This admittedly low figure must be contrasted with the 88 containers lost in a single incident during heavy weather from the MV Sherbro (see below). At present it is not possible to gauge the magnitude of the problem and assess differences between operators.

a) The MV Perintis

On March 13th 1989, the Icelandic registered MV Perintis sank 25 miles south east of Brixham in the English Channel. Her deck cargo included 0.6 tonnes of cypermethrin, 1.0 tonne of permethrin and almost 6.0 tonnes of lindane (gamma-HCH). Although the cypermethrin and most (80%) of the permethrin was recovered, the location of the lindane remains unknown [16]. The lost pesticide was packaged in polythene bags contained in fibreboard containers packed in a standard 20 foot steel container. Although this container was taken in tow by a French naval tug, the tow subsequently parted in high winds and heavy seas.

There are substantial fishery and shell fishery resources in the

area concerned. Accordingly both the French authorities and the UK Ministry of Agriculture Fisheries and Food have subsequently monitored the area regularly. To date, there is no evidence that the missing container has leaked but a major release in the future cannot be ruled out. Indeed, the possibility exists that any leakage may not be detected in the wider environment, but might only come to light through the landing of contaminated marine food resources from the area since marine organisms are able to accumulate this pesticide to concentrations much higher than those present in the water in which they live.

Two things are apparent from this transport accident. Firstly that notwithstanding the provisions of IMDG Code, salvage attempts may not succeed. Secondly, the failure of salvage attempts then implies a long term commitment to monitoring activities. At this stage the container is unlikely to be recovered unless leakage is detected. Even so, it could remain undetected for a considerable period of time since monitoring takes place only on an annual basis.

b) Mecoprop in the River Rhine

In April 1989, some 800 25kg sacks of the pesticide Mecoprop were lost in the River Rhine after the transporting barge ran into difficulties. The material was in transit from the UK to Ludwigshaven in Germany. According to news reports from Reuters at the time the majority of the packages were quickly recovered after which the incident slipped out of the news. The clean-up was handled by Dutch Authorities, although the costs of this remain unknown.

c) The MV Capitaine Tasman

On July 5th 1989 13 pails of the insecticide Orthene were lost overboard from the MV Capitaine Tasman in bad weather on a passage from New Zealand to Papua New Guinea. In this case the chemicals were palletised and secured to the deck. Subsequently, six pails and over 200 loose sachets of the chemical were washed ashore on recreational beaches in the North Island of New Zealand. According to media reports on this incident, seven pails of Orthene containing 1400 sachets of the chemical were never recovered. Clean-up costs in this case exceeded $5000.

d) MV Santa Clara I

The incident involving the above Panamanian registered vessel in US waters in January 1992 is particularly well documented as a result of the subsequent Report from the Board of Inquiry into the incident [17]. The materials involved in the incident were arsenic trioxide and magnesium phosphide. During heavy weather, twenty one containers were lost from the deck including four containing arsenic trioxide. Each container held 108 drums containing 375 pounds each. Drums were photographed by remotely operated vehicle loose on the sea floor but were not subsequently salvaged. In addition ten palletised drums of magnesium phosphide also broke loose below decks and were breached, releasing poisonous phosphine gas. This affected two crew members. Although categorised as dangerous cargo, the magnesium phosphide did not appear as such on the ships manifest. As a result of this failure to declare the fumigants as dangerous cargo, workers in the port of entry were unaware of the hazards. 37 were taken to hospital for observation and it took 32 days to clear-up and decontaminate over 400kg of

the spilled phosphide [18].

The Board of Inquiry noted the similarities to other past incidents but considered the broad combination of failures seen in this case as unusual. The Board considered that the cargo had been improperly stowed in the first place. The loading of the ship had taken place improperly so that the ship left harbour with an excessive metacentric height. This would have increased the forces acting on the cargo and lashing gear. In addition, the seamanship of the ships master was questioned in relation to his tracking of the storm centre. Finally when the ship began reacting severely in the weather, his shiphandling was not adequate.

e) MV Sherbro

The MV Sherbro, a French container ship, lost a total of 88 containers in heavy weather in the English Channel in early December 1993. Ten of these containers were carrying dangerous goods, including two containing 3.6t of a seed treatment chemical. Subsequently, around 130,000 sachets of the fungicide Apron+ 50DS were washed ashore in the Netherlands and also threatened German coastal islands [5]. Each bag contained around 10 grams of the pesticide which in powder form is relatively water insoluble and adheres strongly to sand. The clean up operation was estimated to have cost around 5 million Dutch guilders and the incident provoked a great deal of concern about likely effects upon ecosystems. A high level international governmental meeting was called to discuss the incident and ways in which a repeat could be avoided.

2) Below-deck cargoes

Losses of dangerous goods from deck cargoes could of course be eliminated by stowage below decks. In this case, materials would only be lost in the event that the ship itself foundered. This is a much less common occurrence than the loss of cargo. Part of the rationale, however, for carrying dangerous cargoes on deck is to minimise the danger to the crew and in particular to prevent losses into the internal spaces of the ship where remediation often poses extreme logistic difficulties. In some cases, cargoes are carried where they can be easily jettisoned in case of fire. Shippers and handlers are particularly at risk since during an accident due to potentially high exposures and lack of availability of remedial treatment for such exposure.

a) Fumigants

The United States Coastguard (Eldridge pers comm.) have kept partial records of accidents involving fumigants where human casualties occurred or where life was endangered. In 1978, the use of aluminium phosphide which liberates phosphine gas in contact with moisture, was responsible for the death of a child on board the Greek registered MV Thermopylai. The gas leaked into the living quarters from the cargo space. In 1979, a crew member was killed on board the Greek registered MV Theanto after a leak of phosphine into crew quarters. On 27th July 1984 an explosion occurred aboard the Argentinean vessel MV Rio Neuquen. The explosion was seated in a 20 foot steel container loaded with around ten tons of aluminium phosphide and was thought to be due to the ignition of phosphine gas in the container. The most likely cause of the problem was poor sealing of the chemical containers

allowing the ingress of moisture and air. Problems arose during discharge of a grain cargo in Rotterdam in early 1986 after fumigant bags were placed on a wet deck. These and other reported incidents led eventually to US interim regulations and more importantly, the International Maritime Organisation Recommendations on the Safe Usage of Pesticides in Ships. Nonetheless, as the incident with the MV Santa Clara I has shown, incidents involving fumigants continue to occur.

b) Other Pesticides

Incidents involving pesticides carried as deck cargo appear to be relatively common but no centralised records are available to confirm this. In January of 1994 a fire took place aboard the Liberian vessel MV Astra Peak in the cargo of safety matches. The hold also contained a shipment of the pesticides fenproathin, fenvalerate and esfenvalerate. Although the fire did not spread to this cargo, leakage of around 35 gallons of the insecticide terbuphos from a drum which had ruptured during heavy weather took place onto the deck. The US Coastguards only became aware of the problem following a request for new wiring aboard the vessel.

Similarly, in Montevideo on September 14 1994, the container vessel MV Zim Argentina reported a leaking dry cargo container in the hold. This contained 400 drums (12 180 kilos) of Metamidophos pesticide which although categorised as IMDG class 6.1 UN NO 2784, had not been declared as dangerous cargo. No documents were received from the port of lading. A long delay was caused in discharging the ship since the stevedores refused to handle the container and it was ultimately unloaded under the supervision of the fire brigade.

3) Overview

From the limited overview of incidents outlined above it is apparent that while reliable statistics are not available, pesticides are involved in an appreciable number of accidents. The examples given were found predominantly through scrutiny of reliable news sources rather than through a centralised information source dedicated to such matters. In some cases, accidents have involved substantial remediation and clean-up efforts and in the case of fumigants have caused loss of life. A common factor appears to be loss or damage resulting from adverse weather conditions, usually involving deck-stowed containerised cargoes. On the basis of fully documented cases such as the MV Santa Clara I, human factors can also play a part in these incidents.

The provisions of IMDG Code amendment 26 need to be urgently implemented. In particular the practice of deck stowage of these materials needs to be fully evaluated. If such cargoes cannot be shipped in any other way, consideration must be given to preventing their export entirely. This is not without precedent. In 1992, the United Nations Conference on Environment and Development (UNCED) recommended that Governments, through the cooperation of international organisations, should phase out or ban "toxic chemicals that pose an unreasonable and otherwise unmanageable risk to the environment or human health [19].

Generally considered, the appropriate packaging and adequate containerisation of dangerous pesticide cargoes could address some of the risks. Surveys of containerised hazardous cargoes have

revealed numerous failings. A survey of 15 ports was carried out by the US Coastguard in 1985. 25% of a sample of 1287 containers opened for inspection were found to have one or more deficiencies relating to labelling, packaging or stowage of hazardous materials[18] In 1990 a similar survey carried out cooperatively by the Dutch, German and Belgian authorities found deficiencies in 50% of the containers opened for examination. As a basic minimum, the container itself must carry a valid safety approval plate under the terms of the IMO Container Safety Convention. The container should not be overloaded and should be adequately stowed and secured. The packaging of materials within the container should conform to IMDG requirements.

Various suggestions have been made to facilitate the recovery of containers carrying dangerous goods. The most intuitively attractive suggestion has been to attach an immersion activated radio-location buoy to dangerous cargoes containerised on deck. These are carried by ships and the life saving craft which they carry. Shipowners and regulatory authorities alike, however, have resisted this. They cite the high frequency of false alarms likely to result and the attendant danger that the primary role of these devices in life-saving will be compromised. This issue remains unresolved. It appears, therefore, that the best way of dealing with these incidents is adequate prevention of accidents and container losses.

PESTICIDE EXPORT IN RELATION TO REGISTRATION

A large scale release of pesticide to marine waters would obviously fall outside the conditions of use and application

assessed through the registration procedure. In many cases however licences for exported pesticides have been withdrawn or not sought in the country of origin. Around one quarter of US exports are of products which are not registered for use in the United States. Some of these unregistered exports are pesticides that have been cancelled or suspended for US use on environmental or human health grounds. Others have been voluntarily taken off the market by the manufacturer because of economic considerations or because of concern about potential adverse effects [6].

As an example, chlordane and heptachlor are no longer registered for use in the US. They are persistent and bioaccumulative pesticides and the problems that they pose to natural ecosystems led to severe restrictions on use in 1987, and they were later banned. The US manufacturer of these chemicals nonetheless continues to export both of these pesticides, primarily to developing countries [20]. In 1993 exports of heptachlor were around 2.8 million pounds. 48 nations currently have full or partial bans on chlordane and heptachlor usage.

In some cases, pesticides for which registration has been refused in the US are regularly exported. Carbosulfan is a carbamate pesticide which has never been registered due to concerns about toxicity to wildlife [21]. In September 1992, several gallons of this pesticide were released onto the dockside following puncture of a drum during forklift operations. While an emergency response crew from the manufacturers arrived within one and a half hours, this incident raises the question of realistic response times in the event of an accident at the destination port. The pesticides butachlor, nuarimol, prothiophos and haloxyfop all fall into the

same category: registration for use in the US has never been granted yet they are exported in substantial quantities [22]. Denmark produces a substantial proportion of the pesticides parathion-ethyl and parathion-methyl used globally [23]. Parathion-ethyl has been voluntarily withdrawn by the manufacturer while parathion-methyl is not registered for use in Denmark. Both pesticides are acutely toxic and have been responsible for numerous recorded lethal poisonings [24]. A UK example is that of furathiocarb, a carbamate insecticide. This is not licensed for use in the UK, but may still be transported through its waters [5].

The exact magnitude of this situation is impossible to quantify using present accounting and monitoring systems. It raises a number of important questions. Arguably, some pesticides are not registered in the country of manufacture since they are specifically designed for use under tropical conditions. This does not apply, however, to products which are banned or which have failed to gain registration after an application has been filed. In short, if a given pesticide is regarded as unacceptable for use in the country of manufacture it is difficult to justify its use elsewhere. In this regard, unregistered pesticides destined for export should be categorised on the basis of whether the pesticide would be likely to attract restriction if registration was to be sought. This should take into account any difficulties encountered during the domestic registration process and any failures on the part of the manufacturer to provide data to the process. There is a need to derive a list of internationally traded pesticides which are not registered for use in the country

of origin.

THE PRIOR INFORMED CONSENT PROCEDURE

The logistic problems of transport of both registered and unregistered pesticides covered by the IMDG Code are compounded by failings of the Prior Informed Consent (PIC) Procedure. In 1989 the United Nations Environment Program (UNEP) and the Food and Agriculture Organisation (FAO) adopted a voluntary Prior Informed Consent (PIC) procedure for the international trade in hazardous pesticides and industrial chemicals. This was designed to provide information to countries about pesticides whose use was banned or heavily restricted in other countries. In particular it was designed to allow informed regulation of pesticides in countries which have no regulatory or registration framework of their own. Developing countries particularly, tend to rely on registration procedures carried out elsewhere, having none of the expensive infrastructure which would enable this process to be carried out domestically.

In 1992, the European Community adopted new legislation concerning the export of banned products that incorporated the international PIC scheme. In practice, however, the PIC scheme is far from exhaustive and significant doubts attach to its aim of public health and environmental protection from hazards arising from trade in dangerous goods.

Principally, the FAO/UNEP PIC scheme is highly restricted, very slow in its application and a voluntary scheme. It applies only to chemicals banned or severely restricted by five or more

countries and by any one country after January 1992. It also applies to pesticides that are particularly hazardous under conditions of use in developing countries. So far there are 22 candidate substances. Only those substances that have Decision Guidance Documents circulated can be identified as in the PIC process. The international PIC procedure was adopted in 1989, yet only 17 pesticides and 5 industrial chemicals are covered by the PIC mechanism (i.e. have Decision Guidance Documents circulated). Overall, there are substantial delays in bringing new chemicals into the PIC procedure in spite of over 20 which have been identified in addition to the original candidate substances.

No new pesticides/chemicals banned by a country since January 1992 or any of the pesticides identified by the working group as particularly hazardous under certain conditions of use are yet covered by the PIC mechanism. Austria, for example banned over 60 pesticides in January 1992. It may be many years before banned pesticides like DBCP, carbosulfan or atrazine are included in the international PIC procedure and importing countries are given an opportunity to refuse their import. Pesticides that have never been registered or are ineligible for registration in the country of export fall completely outside the procedure unless they are actively banned or have been withdrawn from use for health or environmental reasons in a country.

Many of the problems which apply to the International PIC scheme are also evident in the US domestic legislation. This was reviewed and found to be deficient in a number of important areas

principally those concerned with documentation and the provision of information abroad [6]. The tightly defined circumstances under which the PIC procedure applies are likely to prove very limiting. The procedure, moreover, applies only to the country of destination and does not consider transport.

If, however, the PIC process were extended and made to apply to the carriers of pesticide cargoes, then considerable benefits might accrue: Cargoes would be carried under assured circumstances in ships inspected and found adequate for the purpose, crewed by personnel capable of dealing with any emergencies which might arise. Currently, a new legally binding PIC Convention is under negotiation to replace the voluntary scheme. Although transport and carriage of substances has been recognised as an issue, it remains to be seen whether the Convention will improve on current provisions [25].

LIABILITY AND COMPENSATION

Recently, the Convention on Liability and Compensation for Damage in connection with the Carriage of Hazardous and Noxious Substances (the HNS Convention) was agreed in London. This complex Convention, subject to ratification, will provide for up to £250 million to be made available to be paid in compensation for maritime accidents involving hazardous cargoes [26]. While imposing strict liability on shipowners and a compulsory insurance regime, this liability will be shared by importers of HNS cargoes. Payments can be made for *inter alia* loss or damage resulting from contamination of the environment and the costs of remedial measures.

The ratification of this International Convention will be an important positive step insofar as it transfers the responsibility for the costs arising from incidents away from national and local authorities who previously had to meet such expenditure. Nonetheless, irrespective of compensation arrangements, the possibility of such incidents means that national authorities need to meet the set-up and stand-by costs of an appropriate response body, and these costs are not recoupable through the fund. In addition the fund does not address the inadequacies in the information base or in the mechanisms for tracking hazardous cargoes identified above. In order to be fully effective, such measures need to be coupled with robust mechanisms to track pesticides together with other hazardous cargoes.

CONCLUSIONS

1) Pesticides comprise a unique component of the dangerous goods which are transported by sea since they are designed to be extremely bioactive. The risks involving pesticide transport should not be underestimated simply because serious incidents seem to be rare. Frequent accidents take place which involve shipping and other forms of transport.

2) Given the vulnerability of deck cargoes to being swept overboard in bad weather, consideration should be given to restricting shipments of particularly hazardous substances, including banned, never-registered and acutely toxic substances such as the World Health Organisation Class I Pesticides.

3) Since the bulk of pesticide exports are made by relatively few

countries, the establishment of a database covering amounts exported and final intended destinations should be relatively easy to establish. As a minimum, pesticides that are banned in one or more countries, not registered for use in the country of manufacture or classified by the WHO as extremely or highly hazardous (Class I) should be recorded and monitored.

4) The IMDG Code, EC Export legislation and the UNEP/FAO PIC procedure currently operate in isolation of one another. An extremely good case exists for applying these various provisions through central national agencies. Pesticides as low volume but high risk goods would provide a good subject group for testing and refining national mechanisms. The provisions of the developing PIC Convention also need to address these issues.

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LEGEND TO FIGURE 1.

Figure 1: Map showing areas commercially exploited for crustaceans in the English Channel. The box superimposed over the area shows the 100km x 100km square maximum potential impact zone resulting from a spillage of 10t of the organphosphorous pesticide pirimphos-ethyl. Source: Reference (5).

TABLE 1: Domestic and export markets in tonnes for pesticide active ingredients manufactured in Germany. Figures refer to the year 1992. Source: Reference (7)

ACTIVE INGREDIENT	DOMESTIC MARKET	EXPORT MARKET
Herbicide	15707	34177
Fungicide	9368	26229
Insecticide/Acaricide/Synergist	4094	15596
Growth regulators/inhibitors	2931	2606
Other	1470	4929
TOTAL	33570	83537

TABLE 2: Loss rates per thousand registered ships resulting from various types of incident. Source: Reference (8).

Vessel Type	Foundered/ missing	Fire/ explosion	Collision/ contact	Overall
Liquefied gas	2.0			2.0
chemical	0.5	0.5		1.0
oil	0.1	0.3	0.6	1.0
bulk dry	0.4		1.0	1.7
bulk dry/oil			4.4	4.4
general cargo	2.6	0.5	1.3	4.4
refrigerated	2.1		0.7	2.8
ro-ro cargo	1.2		1.2	3.0
passenger	0.4	1.1		1.5
fish catching	1.2	0.6	0.5	2.6
Overall	1.2	0.3	0.7	2.3

PICTURE CAPTIONS

1. The MV Sherbro pictured in port after the incident in which 88 containers were lost in heavy weather. The stacking of containers on the open deck can be seen for and aft.

2. A container vessel loading at Tilbury Docks. The stowage of containers forward of the superstructure is typical of container vessels.

3. Containers stacked on the deck of a container vessel.

4. A leaking hazardous cargo stowed below decks. The confined space and close packing of the cargo combine to make clean-up operations a specialised, cost intensive task.