SHIPPING AND HANDLING OF PESTICIDE CARGOES: ACCIDENTS WILL HAPPEN, PRACTICE MUST CHANGE

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Presented at:

Transport of Dangerous Goods by Sea and Inland Waterways
12th International Symposium
Manchester, England, 7-9 November 1994

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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. Although precise statistics are not available, it appears that incidents involving pesticides are an appreciable component of the total incidents arising from the carriage of dangerous goods. The various incidents for which information is readily available indicate that there is an urgent need to "fast track" the provisions of the IMDG Code. Given the fact that many pesticides which are exported are not registered in the country of origin, there is a good case for tying the provisions of the Code to the registration process and to the provisions of the FAO/UNEP Prior Informed Consent procedure.

INTRODUCTION

The transport of pesticides is an inherently risky undertaking. Pesticides are designed specifically to interfere with biological systems, often at very low concentration (See: Hassall 1990). Consequently, if spilled or released they pose very real dangers to aquatic ecosystems and to those handling or transporting them. The magnitude of this threat can be gauged from the fire which took place in a warehouse in Switzerland in 1986, which released large quantities of pesticide contaminated firewater. The whole eel population in the River was killed from the point of discharge at kilometre mark 159 to kilometre mark 560, with effects on more sensitive organisms recorded at kilometre 640. The "slug" of water containing the pesticides Disulfoton, Thiometon and Etrimphos could be traced using analytical instruments as far as the Netherlands (Malle 1994). 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 (Wanner *et al.*1989; Ackermann-Liebrich *et al.* 1992).

This accident was only indirectly related to the transport of these commodities. The pesticides lost in this particular accident, however, represent only a small fraction of such toxic chemicals transported by sea and river annually. Exports of pesticides from the United States alone are

estimated at between 400 and 600 million pounds *per annum* (GAO 1989). The trade is equally highly developed in Europe. 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.

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. Even subsequent to the amendment of the IMDG Code, accidents have continued. The potential costs are illustrated by a consignment of pesticides sent to Albania in 1991 and 1992 by the EU to help boost crop production. The part consignment from Germany, however, consisted of materials from the former East Germany which were banned in EU countries or which had expired and which were packed in barrels which subsequently began to leak. Overall 465 tonnes of pesticides were involved and the repackaging operation involved in returning them to Germany and their disposal is estimated to cost around US$ 6 million. 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. When preparing this paper it quickly became evident that even in those cases which attracted public concern, documentation was incomplete or did not appear to be readily accessible. 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. There is apparently no centralised record of cargoes and no systematic approach to the listing of hazardous cargoes.

There are other drawbacks even when incidents are formally reported and recorded on a national or regional basis. Lindgaard-Jorgensen & Bender (1994) report that one literature review of five hundred major industrial accidents showed that only five of these references mentioned the environment and only three discussed wider environmental effects. Other reviews 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. Of these, 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 those due to accidental spills from industrial installations (van Hengel & Kruitwagen 1994). This conclusion, however, 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.). The Emergency Response Notification System (ERNS) is a multi-agency national US database which complies data on release notifications of oil and hazardous substances. Recorded incidents have risen from 28,677 in 1987 to reach 35,653 by 1991 (EPA 1992). 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 these databases is that they can apparently only be interrogated with respect to specific chemicals. The current European Agrochemicals Directory (RSC 1991) 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 MHIDAS database in the UK is described in a comprehensive review of information sources concerning ecological impact of industrial chemical accidents (Meharg 1994). 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. Meharg (1994) indicates that just under 50% of incidents involved PCBs and bulk chemicals. The contribution of pesticides to the category designated by him as "Other" 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 (CEC 1982) 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 (Meharg 1994) irrespective of how the release occurs. Nonetheless, these are domestic legislative instruments and do not apply outside of the US.

The lack of a centralised information database is a considerable impediment to assessing the risks posed by pesticide transport. As noted by Meharg (1994) 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. Clearly 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 hazardous pesticide cargoes. Most of these cargoes have been lost in standard steel containers following heavy weather. The incidents 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.

a) The MV Perintis

On March 13th 1989, the Icelandic registered MV Perintis sank 25 miles south east of Brixham in the English Channel. Bound ultimately for Jakarta, 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 (Law & Allchin in press). The lost pesticide was packaged in polythene bags contained in fibreboard containers. This was carried as deck cargo in a standard 20 foot steel container. At one stage after the loss of the vessel, this container was taken in tow by a French naval tug but the tow subsequently parted in high winds and heavy seas.

There are substantial fishery and shell fishery resources in the area where the vessel was lost and accordingly both the French authorities and the UK Ministry of Agriculture Fisheries and Food have monitored the area regularly since the vessel and its cargo were lost. Between 1989 and 1993, some 117 samples have been taken. To date, although some slightly elevated values of lindane have been detected on occasion, there is no evidence that the missing container has leaked. Clearly, however, a major release in the future cannot be ruled out, and the implications of a major release are far from clear.

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 in the area to assure that marine resources remain marketable. It seems, too, at this stage that the container is unlikely to be recovered unless it can be detected as a result of leakage. In the event of such a leak, it could remain undetected for a considerable period of time since monitoring takes place only on an annual basis. Conceivably, it may be that release of this lost and sunken cargo may first become obvious as a result of contaminated fish reaching the market as opposed to prompt detection of elevated water levels of the pesticide.

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 (USCG 1992). 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 which were later located using ROV. Drums were found to be loose on the sea floor and 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.

The Board of Inquiry noted that the incident was similar to other incidents in the past, but what was considered unusual was the broad combination of failures all seen in one case. The Board considered that the cargo had been improperly stowed in the first place, and this is a known major contributor to container losses at sea. The loading of the ship had taken place improperly so that the ship left harbour with an excessive metacentric height. This mismanagement of the stability of the ship would have increased the forces acting on the cargo and lashing gear. In addition the seamanship of the ships master was called into question, particularly 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 three containers overboard in heavy weather in the English Channel in early December 1993. Subsequently, around 130,000 sachets of the fungicide Apron+ 50DS were washed ashore in the Netherlands and also threatened German coastal islands. 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. The dangers of toxic materials in cargo spaces are well illustrated by a considerable number of problems in the 1970s and 1980s involving fumigants aboard ship. Releases of other toxic chemicals into cargo spaces have also occurred. Shippers and handlers are particularly at risk since during an accident they are likely to be exposed at very much higher levels in the short term than even regular users of these toxic chemicals. In addition, remedial treatment for human or environmental exposure may not be routinely understood or practised in the receiving country and even if available may prove highly expensive.

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 IMO 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

Pesticides carried as cargo below decks have also given rise to incidents involving substantial remediation efforts and endangering life. These incidents appear to be relatively common but since no centralised records are kept actual statistics are hard to come by. 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. None of this was reported to the US Coastguards who 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 (12180 kilos) of Metamidophos pesticide which although categorised as IMDG class 6.1 UNNO 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 difficult to find, pesticides are involved in an appreciable proportion of accidents involving hazardous goods. In some cases, these 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. Given the potential hazard to human and environmental health it is clear that 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.

PESTICIDE EXPORT IN RELATION TO REGISTRATION

Quite apart from the safety aspects of shipping pesticides in bulk there is another important anomaly which relates to registration of these chemicals in the country of manufacture. According to GAO (1989) between 1977 and 1987, worldwide pesticide sales dramatically increased and the agrochemical market doubled in size to more than $US17 billion. US pesticide export sales currently represent around one quarter of the world market. In turn 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.

Chlordane and heptachlor are no longer registered for use in the United States (GAO 1989). They are persistent and bioaccumulative pesticides and the problems that they pose to natural ecosystems led to severe restrictions on use in the US in 1987, and they were later banned. The United States manufacturer of these chemicals nonetheless continues to export both of these pesticides, primarily to developing countries (Costner & Thornton 1989). 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 which have never been registered for use in the United States, despite attempts by manufacturers to do so, are regularly exported. Carbosulfan is a carbamate pesticide which due to concerns about toxicity to wildlife has never been registered (FDA 1994). It breaks down in the environment to the well known insecticide carbofuran. It is exported from the US under the trade name "Marshal". In September 1992, several gallons of this pesticide were released onto the dockside following puncture of a drum during forklift operations. An emergency response crew from the manufacturers arrived within one and a half hours. This raises the question of realistic response times in the event of an accident at the destination port. In addition 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 (Marquardt *et al.* 1992). Similarly Denmark produces a substantial proportion of the pesticides parathion-ethyl and parathion-methyl used globally (Jewell & Johnston 1991). 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 (Dinham 1993).

This phenomenon is widespread and 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, for example. This obviously 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.

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 and very slow in its application. 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 nearly four years later only 17 pesticides/chemicals are presently covered by the PIC mechanism (i.e. have Decision Guidance Documents circulated).

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 in some country.

Many of the problems which apply to the International PIC scheme are also evident in the US domestic legislation. This was reviewed (GAO 1989) and found to be deficient in a number of important areas principally those concerned with documentation and the provision of information abroad. 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 process were extended and made to apply to the carriers of pesticide cargoes, then considerable benefits might accrue: Cargoes would be carried under optimum circumstances in ships inspected and found adequate for the purpose, crewed by personnel capable of dealing with any emergencies which could arise.

CONCLUSIONS

Pesticides comprise a unique component of the dangerous goods which are transported by sea. They are designed to be extremely bioactive and as a result may exert various deleterious effects upon human and environmental health. While improvements in labelling and packaging may help to avoid problems in identifying and dealing with lost cargoes, it is inevitable that losses will occur at an unacceptable rate unless stowage and securing systems are specified and scrupulously enforced. 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. 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 (UNCED 1992).

There is a clear need for centralised information resources specifically covering accidents involving the shipping and handling of pesticide cargoes. There is also the need for a centralised information resource covering the shipment itself. 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. At a minimum, pesticides that are banned in one or more countries or classified by the WHO as extremely or highly hazardous (Class I) should be recorded and monitored.

In a number of reported incidents there have been failures to identify the goods carried as dangerous on the ships manifest. Many potential problems could be alleviated if exporting agents and authorities paid attention to the status of the pesticide cargoes which they carry. In particular the registration status of a given pesticide is an important consideration which may well give an indication of whether there are any special problems in handling and transport. In addition it is likely to indicate whether problems may arise at the destination port.

The IMDG Code, EC Export legislation and the UNEP/FAO PIC procedure currently operate in isolation of one another. In the light of the number of transport incidents involving pesticide cargoes there is an extremely good case for applying these various provisions through central national agencies. Indeed the pesticides as low volume but high risk goods would provide a good subject group for testing and refining national mechanisms. In particular, central oversight of pesticides traffic would allow observance of the PIC process to be confirmed while also ensuring that the provisions of the IMDG Code were enforced. In addition, this would facilitate the gathering of statistics and the collation of information relevant to the trade, particularly that relating to consistent problems or consistent "bad actors".

The problems of pesticide transport should not be underestimated simply because serious incidents seem to be rare. Accidents are taking place all the time which involve shipping and indeed other forms of transport. Until practices change and the pesticide trade is adequately controlled and overseen, a catastrophic release remains a real possibility.

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