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**IMO/FAO/UNESCO/WMO/WHO/IAEA/UN/UNEP
JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS
OF MARINE POLLUTION
- GESAMP -**

REPORTS AND STUDIES

No. 35

**The Evaluation of the Hazards of
Harmful Substances Carried by Ships:
Revision of GESAMP Reports and Studies No. 17**



INTERNATIONAL MARITIME ORGANIZATION

IMO/FAO/Unesco/WMO/WHO/IAEA/UN/UNEP Joint Group of Experts
on the Scientific Aspects of Marine Pollution (GESAMP):

THE EVALUATION OF THE HAZARDS OF HARMFUL
SUBSTANCES CARRIED BY SHIPS:
REVISION OF GESAMP REPORTS AND STUDIES NO.17

IMO, 1989

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This report is an updated and revised version of an earlier report on the evaluation of the hazards of harmful substances carried by ships (GESAMP Reports and Studies No.17) which was published by IMO in 1982.

NOTES

- 1 GESAMP is an advisory body consisting of specialized experts nominated by the sponsoring agencies (IMO, FAO, Unesco, WMO, WHO, IAEA, UN, UNEP). Its principal task is to provide scientific advice on marine pollution problems to the sponsoring agencies and to the Intergovernmental Oceanographic Commission (IOC).
- 2 This report is available in English from any of the sponsoring agencies.
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* * *

Definition of marine pollution by GESAMP:

"POLLUTION MEANS THE INTRODUCTION BY MAN, DIRECTLY OR INDIRECTLY, OF SUBSTANCES OR ENERGY INTO THE MARINE ENVIRONMENT (INCLUDING ESTUARIES) RESULTING IN SUCH DELETERIOUS EFFECTS AS HARM TO LIVING RESOURCES, HAZARDS TO HUMAN HEALTH, HINDRANCE TO MARINE ACTIVITIES INCLUDING FISHING, IMPAIRMENT OF QUALITY FOR USE OF SEAWATER AND REDUCTION OF AMENITIES."

* * *

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NOTE

GESAMP wishes to draw attention to the fact that the hazard evaluation rationale was developed for the particular purpose of the development of the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto (MARPOL 73/78). As a consequence, the hazard profiles are intended to be used solely for that purpose. Information should not be extracted from the text or from the tables and used out of context unless the limitations and restrictions imposed upon it by the hazard assessment rationale are fully appreciated.

THE EVALUATION OF THE HAZARDS OF HARMFUL
SUBSTANCES CARRIED BY SHIPS

(Composite report)

FOREWORD

The assessment of environmental hazards of substances carried by ships started in 1972, initially as preparatory work for the development of the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73). This was in response to a request made by the Sub-Committee on Marine Pollution* of the International Maritime Organization (IMO) with regard to questions on hazards which might arise through the operational discharge at sea of tank washings by chemicals or through the accidental spillage of substances carried either in bulk or in packaged form. Originally, it was envisaged that this might include major inland waterways, e.g. St. Lawrence Seaway and Houston Ship Channel. The procedures were therefore initially developed to cover certain forms of fresh water pollution. Following signature of MARPOL 73** which deals only with marine pollution, this aspect has been given no further attention.

Work has continued throughout the intervening period and reports have been prepared of individual meetings of the GESAMP Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships. These reports have been available to GESAMP members and to the relevant IMO committees and sub-committees. Bearing in mind that the original working procedures*** have been progressively clarified, GESAMP in 1981 considered it desirable that the entire package of separate reports be drawn together and

* The Sub-Committee on Marine Pollution was the predecessor of the Marine Environment Protection Committee (MEPC), established by the IMO Assembly in 1973 (resolution A.297(VIII)).

** In 1978 MARPOL 73 was extended by parts of the Protocol on Tanker Safety and Pollution Prevention (TSPP 78). Since that time the official title of the Convention is "International Convention for the Prevention of Pollution from Ships, as modified by the Protocol of 1978 relating thereto" (MARPOL 73/78)

*** The very early work had been made available to particularly interested parties as copies of document GESAMP IV/19/Supp.1, but was not published.

published as a single entity, together with all the hazard profiles developed at that time. Accordingly, GESAMP adopted a composite report, Reports and Studies No.17, which was published by IMO in 1982. It should be emphasized that since that time the original working procedures have not been substantively altered; to do so would require changes to the MARPOL 73/78 Convention. However, taking into account the progress of work carried out since 1982 and the considerable number of clarifications and advisory components prepared by the GESAMP Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships, GESAMP in 1987 agreed that an updated and revised version of GESAMP Reports and Studies No.17 be published by IMO. Since 1984 the United Nations Environment Programme (UNEP) has co-sponsored the work of the Working Group. IMO acts as lead agency. The updated and revised version of GESAMP Reports and Studies No.17 was approved for publication by GESAMP as Reports and Studies No.35 at its eighteenth session (Paris, 11-15 April 1988).

In making this report widely available, GESAMP wishes to draw attention to the fact that the hazard profile rationale was developed for the particular purpose of the development of MARPOL 73/78. As a consequence, the hazard profiles were intended to be used solely for that purpose. Accordingly, information should not be extracted from the text nor from the tables and used out of context unless the limitations and restrictions imposed upon it by the hazard assessment rationale are fully appreciated.

The lists of hazard profiles included in this composite report are accurate as of August 1988; however, they are continuously being reviewed as new data become available. In this connection it should be recognized that GESAMP has continually been faced with the problem of limited data availability. This has meant that in many cases extrapolations have had to be made. As more information becomes available, hazard profiles are reviewed and, if necessary, revised. It is recognized that the consequent change of hazard profiles may cause operational problems, but until Governments and the chemical industry supply the data necessary for GESAMP to carry out a complete hazard assessment this problem will remain. Being aware that in many cases such data have been prepared for restricted distribution only, GESAMP pointed out that such information might, if necessary, be provided to GESAMP on an "In Confidence" basis.

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1 INTRODUCTION

1.1 Historical background

In 1969 the Assembly of the International Maritime Organization (IMO) decided to convene an International Conference for the purpose of preparing a suitable international agreement for placing restraints on the contamination of the sea, land and air by ships and other equipment operating in the marine environment.

Late in 1971, in the course of preparing for the International Conference on Marine Pollution, which was held in 1973, the Sub-Committee on Marine Pollution of IMO experienced considerable difficulty in categorizing pollution hazards of substances carried by ships in a way which could be utilized in the development of control measures. As a means of solving the problem the Sub-Committee on Marine Pollution prepared a detailed enquiry requesting GESAMP to examine a number of lists of chemicals and products and to consider the hazards which these substances might pose to the aquatic environment. A copy of the enquiry is attached to this report as Annex 1. At that time (late 1971) it was the intention that the International Convention, which was to be developed in 1973, should contain regulations for the prevention of pollution by oil, noxious liquid substances carried in bulk, dangerous goods carried in packages, portable tanks, freight containers or road or rail tank wagons, as well as sewage and garbage from ships. It was originally also planned to include in the Convention not only measures for the control and prevention of the marine environment, but also of inland waters used by seagoing vessels, as well as of air (e.g. emissions from vessels), hence the title "International Convention for Prevention of Pollution from Ships". The inclusion of provisions for the prevention of pollution that might be caused by emissions from ships into the air is currently (1988) being discussed by IMO.

Due to the urgency of the problems related to evaluating the hazards of all the substances carried by ships, the then Chairman of GESAMP, Dr. M. Waldichuk (Canada), agreed that an Ad Hoc Panel of IMO and GESAMP experts should be established. A list of members of the Ad Hoc Panel is given

in Annex 2. The panel met on three occasions prior to the International Conference on Marine Pollution and, following the second meeting of the Ad Hoc Panel, the proposed methods for assessing the hazards likely to be posed were approved by GESAMP at its fourth session (18-23 September 1972). The outcome of the Ad Hoc Panel was set out in document GESAMP IV/19/Supp.1 which was not published, although it has been made available to interested parties on request and has, as a consequence, been widely distributed. In 1982 GESAMP Reports and Studies No.17 was published, which updated and replaced both the Rationale and Hazard Profile List included in the original report, GESAMP IV/19/Supp.1. The present document, Reports and Studies No.35, is a further update and supersedes all the earlier documents.

The International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL)* was adopted in 1973 by the International Conference on Marine Pollution. Annex II of the Convention contains detailed requirements for the discharge criteria and measures for control of pollution by noxious liquid substances carried in bulk. It also refers to the need to develop specific requirements for the prevention of accidental spillages from chemical tankers. For the purpose of developing discharge requirements, noxious liquid substances were divided into four pollution categories depending upon their

* MARPOL covers all the technical aspects of pollution that might be caused by discharges into the sea of substances from ships, except for the disposal of land-generated waste by dumping from ships and the discharge of substances directly arising from the exploration and exploitation of sea-bed mineral resources. It consists of articles, two protocols dealing respectively with reports on incidents involving harmful substances and arbitration, and five Annexes which contain regulations for the prevention and control of marine pollution by:

- (1) oil;
- (2) noxious liquid substances carried in bulk;
- (3) harmful substances carried in packages, portable tanks, freight containers, or road or rail tank wagons, etc.;
- (4) sewage from ships; and
- (5) garbage from ships.

The International Conference on Tanker Safety and Pollution Prevention, 1978, by adopting the "1978 MARPOL Protocol" modified the provisions of the Convention, referred to thereafter as MARPOL 73/78.

hazards to marine resources, human health, amenities and other legitimate uses of the sea as evaluated by the Ad Hoc Panel. Guidelines for the categorization of noxious liquid substances were set out in Appendix I to Annex II to MARPOL 73/78 together with some 250 substances that had then been categorized at that time.

Following the conclusion of the Convention, GESAMP agreed to undertake the ongoing task of evaluating the environmental hazards of additional substances proposed for carriage by ships, and a Working Group was established. This met for the first time in 1974 and has since met on 22 further occasions. Both the terms of reference and the membership of the Working Group have changed over the years, although an effort has always been made to maintain reasonable continuity in membership. A list of those experts who have been members of the Working Group is given in Annex 3. The two sets of terms of reference are shown in Annex 4. Under the earlier and wider terms of reference the Working Group was asked by GESAMP to not only deal with questions which were directly related to the main task of assessing the environmental hazards of substances carried by ships (through the development of hazard profiles), but also to consider such questions as quantities of dangerous goods which might be carried in packaged form without the need to consider pollution prevention measures. The Working Group was also asked to advise on questions related to the interpretation of the expression "rapidly rendered harmless at sea" as used in various international legal agreements on the prevention of marine pollution by dumping of wastes at sea. The results of the considerations of the Working Group were used by IMO and non-IMO bodies in subsequent deliberations. After the establishment of specific scientific advisory bodies under a number of international conventions (e.g. the Scientific Group on Dumping under the London Dumping Convention), the Working Group now solely evaluates hazards of harmful substances transported by ships and does not evaluate wastes carried by dumping vessels for the purpose of disposal at sea. In this context it should be noted that the Marine Environment Protection Committee (MEPC) of IMO had agreed that liquid chemical wastes transported for dumping at sea should be classified as pollution category A substances, i.e. tank washings would have to be discharged at the dumping site designated by the responsible national authority, together with the cargo of wastes, or to a shore reception facility.

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1.2 Factors taken into account by the Ad Hoc IMO/GESAMP Panel in 1972 when developing the hazard evaluation rationale

As mentioned above, an Ad Hoc Panel of IMO and GESAMP Experts had been requested to develop a means by which substances carried by ships could be classified according to the hazards they might pose if released to the environment. In order to assist the Panel concerning the scale and nature of the problems, a report had been made available by the Government of Norway regarding the pollution that might be caused by the normal operational procedures of ships engaged in chemical bulk transport. Further information was made available by representatives of the International Chamber of Shipping (ICS). A list of substances reported to be carried in bulk was also provided, as was a list of dangerous goods carried in packages.

In the light of this information, the Ad Hoc Panel in 1972 agreed to consider all shipborne substances with the exception of:

- .1 oil, as then defined by the International Convention for the Prevention of Pollution of the Sea by Oil, 1954 (OILPOL 1954); and
- .2 radioactive substances (transported as packaged goods).

With regard to the prevention of marine pollution by oil, it was recognized that the definition of oil as laid down in OILPOL 1954 might well be extended to include some of the chemicals listed as being carried in bulk. Later on, for the purposes of MARPOL 73/78, Annex I, which "superseded" OILPOL 1954, a definition of "oil" was developed as follows:

"Oil means petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products (other than petrochemicals which are subject to the provisions of Annex II of the present Convention) and, without limiting the generality of the foregoing, includes the substances listed in Appendix I to this Annex".

The list of oils in Appendix I to Annex I in fact includes "Naphtha Solvent" which under various different names is also contained in the list of noxious liquid substances contained in Annex II to the Convention.

Radioactive substances were excluded on the grounds that the requirements laid down by the International Maritime Dangerous Goods Code (class 7) involve a high degree of containment to avoid exposure to individuals; this should be sufficient to minimize accidental spillage and should therefore be adequate to take account of environmental hazards. It was also recognized that the safety aspects related to the loading and handling of radioactive substances is continuously being reviewed by the IMO Sub-Committee on the Carriage of Dangerous Goods (CDG) in co-operation with the International Atomic Energy Agency (IAEA)*. The hazard assessment of radioactive materials would also need very specific expertise and could only properly be assessed by a group of experts specially selected with that expertise.

The Ad Hoc Panel considered that there were a number of circumstances in which substances carried by ships might escape to the environment. For example, packaged goods could be swept overboard as a result of bad weather or be released as a direct result of a collision. As a result the contents of these packages may be released either where they are lost (for example, on the high seas or in the coastal zone) or during or subsequent to being swept onto a beach. Substances carried in bulk might escape to the environment as a result of collisions or of ships sinking and grounding. Such releases would occur in the vicinity of the accident.

Shipping experts advised the Ad Hoc Panel that it was rarely possible to unload the entire contents of a chemical tanker in a port, and that in most cases the vessel involved would be expected to carry different substances in its tanks on its next voyage. As a result the tanks had to be washed out and the normal practice at that time (1971/1972) was to discharge the wash and rinse waters overboard, either in or close to the port of unloading or loading, or en route between ports. The amount of tank washings discharged would be dependent on the product involved and on the design of the tank.

The Ad Hoc Panel agreed it should not consider questions relating to the effects of substances on either the vessel or its crew. Such matters were

* IAEA Regulations for the Safe Transport of Radioactive Materials, 1973, Revised Edition - IAEA Safety Series No.6

considered to involve aspects of occupational safety which were covered by other Conventions* and were therefore outside the scope of the Panel. However, since people might come into contact with the substance, its solution or its reaction products after its release into the environment, the Panel believed it necessary to consider these wider aspects of hazards to human health, in particular with regard to the possible reduction of public amenities.

At that time it was noted that the scope of the proposed Marine Pollution Convention was not clear and that ships involved in sea passages might also travel considerable distances via inland waterways, and almost invariably enter river estuaries. Accordingly, it was concluded that any of the substances could enter waters that might be abstracted and used as a source of potable water supplies. However, the Convention did not include inland waterways in its provisions and the consideration of fresh-water problems has subsequently been discontinued.

Using the definition of pollution adopted by GESAMP**, the Ad Hoc Panel was asked to evaluate substances according to the hazards they might pose when released into the sea for the following four considerations:

- .1 short-term and long-term hazards to living resources;
- .2 short-term and long-term hazards to human health;
- .3 reduction of amenities; and
- .4 interference with other uses of the sea.

Recognizing that the evaluation of hazards would eventually be required for all substances carried by ships, the Ad Hoc Panel made no attempt to select particularly hazardous substances; rather, a conscious attempt was

* e.g. the International Convention for the Safety of Life at Sea, 1974 (SOLAS 74).

** The definition of marine pollution adopted by GESAMP is "Introduction by man, directly or indirectly, of substances or energy into the marine environment (including estuaries) resulting in such deleterious effects as harm to living resources, hazard to human health, hindrance to marine activities including fishing, impairing of quality for use of seawater and reduction of amenities".

made to cover examples from the full range of substances which might be carried in the form of bulk liquid or dry cargoes or as packaged goods.

Note: In 1987 Parties to MARPOL 73/78 agreed that specific requirements for the prevention and control of marine pollution by bulk solid cargoes be developed and eventually added to the Convention.

The Ad Hoc Panel noted that guidance was required on the potential scales of problems which might be involved in terms of the bodies of waters which might be affected, e.g. a river, an estuary, coastal waters or deep sea.

Following a thorough analysis of the range of problems which could be encountered in a broadly defined hazard assessment, the Ad Hoc Panel adopted a procedure consisting of a seven-step process which became known as the hazard evaluation procedure. By this procedure hazard profiles were established and were used in 1973 by the International Conference on Marine Pollution in the preparation of the Convention. The hazard rating system developed by GESAMP was included in the MARPOL 73/78 Convention (MARPOL 73/78, Annex II, Appendix I: Guidelines for the Categorization of Noxious Liquid Substances) and it was therefore essential that the procedures used for hazard profiling remain in basically the same structure as conceived, as the incorporation of any changes would require that the Convention be amended. However, since the 1973 Conference adopted the evaluation procedure, certain definitions have been modified in the light of difficulties encountered. Such modifications have been introduced by way of clarification and have not in any way changed the substance of the procedure except that in 1978 the question of carcinogenesis was introduced and subsequently other specific adverse health effects were considered.

2 THE HAZARD EVALUATION PROCEDURE

2.1 Outline

Figure 1 on page 12 illustrates the originally developed procedure and its subsequent modifications. All the hazard profiles set out in Annex 6 to this document have been assessed according to the procedure as it now stands.

It is important to recognize that in assigning a hazard profile to any particular substance it is essential that these steps are followed as summarized below.

The first step in the process of hazard evaluation is designed to ensure that the substance involved is carried by ships and that hazard profiles are not produced unnecessarily.

The second step is designed to eliminate oils from further consideration. Oils were already covered by the 1954 Oil Pollution Convention. A somewhat extended range of oils is listed in Annex I to MARPOL 73/78. Consequently, conditions for the carriage of noxious liquid substances other than oil, plus the procedures and arrangements for the discharge of their residues and tank washings, are covered by a different Annex of the Convention and differ in several respects from those laid down for oil (e.g. rates of discharge and position of the outlet for the discharge). However, since the development of MARPOL 73/78 there have been a number of cases where different views were expressed as to whether a certain substance from the regulatory viewpoint should be covered by Annex I or by Annex II (Liquid Noxious Substances). In this respect it has been agreed by the relevant IMO bodies to assign to a number of substances "dual status".

The third step was introduced because it is very difficult to establish a safe limit of discharge for substances which are liable to bioaccumulate. Even small discharges may be hazardous since very low concentrations of such substances in the water may be concentrated by marine life and as a result, pose a hazard, either to the organisms themselves or to their predators, including man. In the special context where the marine organism is commercially exploited, its flesh may also be rendered unpalatable. For these reasons it was felt that special measures are called for in order to restrict the input of such substances.

The fourth step is followed in order to give a ranking of the potential danger of marine organisms being killed in the short term, either as a result of operational discharges or as a result of spillages. These dangers are

assessed by use of acute toxicity information. It was also noted that certain substances may exert a very high oxygen demand as they degrade in the water and it was initially felt desirable to identify substances particularly likely to pose such problems. Similarly, certain substances, especially bulk solids, if spilled in large quantities, may blanket the sea-bed and seriously affect the marine benthos. An indication was given where such dangers were felt likely.

The fifth step provides for ranking on the basis of acute toxicity, primary irritancy and longer term specific adverse health hazards to humans, other than ship, salvage, or dock-side personnel, who might accidentally or unwittingly come into contact with the substance once released into marine waters. The dangers are assessed by review of published information on all relevant toxicology by oral, inhalation, cutaneous and ocular exposure.

The sixth step is a somewhat subjective one. It was introduced in the light of several actual incidents and is designed to make provision for the protection of amenity incidents such as beach uses and water sports, e.g. sailing. Aesthetic considerations such as discolouration of the water, objectionable smells and creation of scums or floating material are also taken into account.

The seventh step was useful, prior to the conference leading to the 1973 Convention, to provide some measure of the potential of a substance to create a hazard in particular water bodies. In order to illustrate this, hypothetical bodies of water were postulated in which the quantity of substance being carried could be shown to be potentially hazardous. The assessment proved useful in combining the previous hazard evaluations and in drawing attention to the protective measures needed. This step has not been used by GESAMP since 1973.