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

**REPORTS AND STUDIES**

**No. 17  
The Evaluation of the Hazards of  
Harmful Substances Carried by Ships**



**INTER-GOVERNMENTAL MARITIME CONSULTATIVE ORGANIZATION**

IMCO/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

IMCO, 1982

船舶有害物質運送危險性評估調查報告

## NOTES

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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 SEA WATER AND REDUCTION OF AMENITIES."

\* \* \*

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#### NOTE

GESAMP wishes to draw attention to the fact that the hazard rationale was developed for the particular purpose of the development of the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73). 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.

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\* International Convention for the Prevention of Pollution from Ships, 1973

THE EVALUATION OF THE HAZARDS OF  
HARMFUL SUBSTANCES CARRIED BY SHIPS  
(Composite Report)

FOREWORD

This report is being published almost ten years after work started on the assessment of the environmental hazards of substances carried by ships. This work was undertaken initially as preparatory work for the development of the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73). A request was made by the Sub-Committee on Marine Pollution\* of the Inter-Governmental Maritime Consultative Organization (IMCO) with regard to questions related to the consideration of hazards which might arise through the accidental spillage of substances carried either in bulk or in packaged form, or through the operational discharge of tank washings by chemical tankers, whenever such discharges might take place. Originally it was envisaged that this might include major inland water-ways, e.g. St. Lawrence Sea Way and Houston Ship Channel. The procedures were therefore initially developed to cover certain forms of fresh water pollution. Following signature of the Convention 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.

Hitherto these reports have only been available to GESAMP members and to the relevant IMCO Committees and Sub-Committees. However, bearing in mind that the original working procedures\*\* have been progressively clarified, GESAMP considered it desirable that the entire package of separate reports be drawn together and published as a single entity, together with all the hazard profiles evaluated to date; at its twelfth session (22-28 October 1981) GESAMP adopted the composite report for publication. It should however be emphasized

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

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

that the original working procedures have not been substantively altered. To do so would require changes of the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73) which at the time of preparing this report has not yet entered into force.

In making this report more 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 the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73). As a consequence the hazard profiles are intended to be used solely for that purpose. 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 late 1981 and will certainly remain valid until 1983. It should however 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 a hazard profile may cause operational problems, but until Governments supply the data necessary for GESAMP to carry out a complete hazard profile assessment the 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.

## 1 INTRODUCTION

### 1.1 Historical background

In 1969 the Assembly of the Inter-Governmental Maritime Consultative Organization (IMCO) 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 IMCO 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 and solid dangerous chemicals carried in bulk, harmful substances carried in packages, portable tanks, freight containers or road or rail tank wagons, as well as sewage and garbage from ships.

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, agreed that an Ad Hoc Panel of IMCO 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. This report updates and replaces both the Rationale and Hazard Profile List included in that original report.



The International Conference on Marine Pollution in 1973 adopted the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73)\*. The Convention in its Annex II contains detailed requirements for the discharge criteria and measures for control of pollution by noxious liquid substances carried in bulk. For this purpose noxious liquid substances are divided into four categories depending upon their hazard to marine resources, human health, amenities and other legitimate uses of the sea as evaluated by the Ad Hoc Panel. Some 250 substances had been categorized and were included in the list appended to Annex II to the Convention.

Following the conclusion of the Convention, GESAMP agreed to undertake the on-going task of evaluating the environmental hazards of additional substances carried by ships, and a Working Group was established. This met for the first time in 1974 and has since met on ten more 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 continuity in membership. A list of those experts who have been members of the Working Group is given at Annex 3. The two sets of terms of reference are shown at Annex 4. Under the earlier and wider terms of reference the Working Group was also asked by GESAMP to deal with questions which were not directly related to the main task of assessing, through the development of hazard profiles, the environmental hazards of substances carried by ships. Such questions were about the quantities of dangerous goods which might be carried in packaged form without the need to

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\* MARPOL 73 covers all the technical aspects of pollution from ships, except disposal of land-generated waste into the sea by dumping and the discharge of substances directly arising out of 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 hereafter as MARPOL 73/78.

consider pollution prevention measures. Others were 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 IMCO and non-IMCO bodies in subsequent deliberations.

## 1.2 Factors taken into account in developing the Hazard Evaluation Rationale

As mentioned above, the Ad Hoc Panel of IMCO and GESAMP Experts was 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 in appreciating the scale and nature of the problem, a report was made available by the Government of Norway on pollution caused by the normal operational procedures of ships engaged in 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 agreed to consider all shipborne substances with the exception of:

- (1) oil, as then defined by the 1954 Pollution Convention\*; and
- (2) radioactive substances.

Radioactive substances were excluded on the grounds that:

- (1) 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;
- (2) the matter would be reviewed by the IMCO Sub-Committee on the Carriage of Dangerous Goods (CDG) in co-operation with the International Atomic Energy Agency (IAEA)\*\*; and
- (3) the matter could only properly be assessed by a group of specially selected experts.

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\* International Convention for the Prevention of Pollution of the Sea by Oil, 1954.

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

It was recognized that the definition of oil as laid down in the 1954 Oil Pollution Convention might well be extended to include some of the substances listed as being carried in bulk.

The Ad Hoc Panel concluded 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 on to a beach. Substances carried in bulk might escape to the environment as a result of collisions or of ships sinking. 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 tank 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 (1971/72) 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 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 possible hazard to human health.

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 might enter waters which 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 freshwater problems has subsequently been dropped.

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

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) damage to living resources;
- (2) 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 dangerous substances; rather a conscious attempt was 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. 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. It was therefore essential that the Hazard Profile Procedure remain in basically the same structure as conceived. Since the 1973 Conference the procedure has not been changed except to modify certain definitions 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 (see Section 2.3).

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\*\* The working definition of marine pollution adopted for the purposes of 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 sea water and reduction of amenities".

## 2 THE HAZARD EVALUATION PROCEDURE

### 2.1 Outline

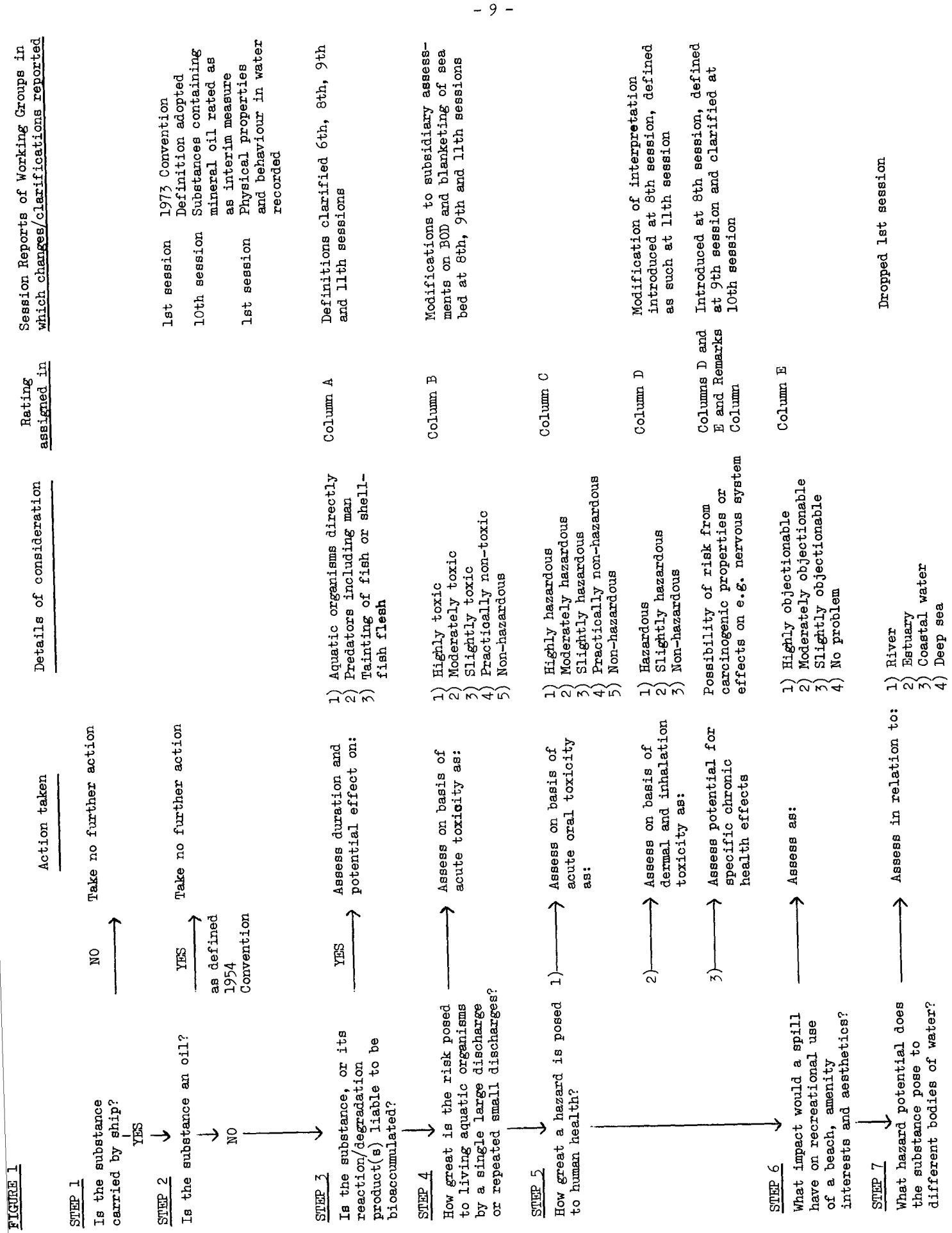
Figure 1 illustrates the originally developed procedure and its subsequent modifications. This version includes the additions and amendments introduced subsequently by the GESAMP Working Group (with dates). No further mention of the dates of change is made and all the Hazard Profiles set out in Annex 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. These substances were already covered by the 1954 Oil Pollution Convention. A somewhat extended range of oils is listed in Appendix I to 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 and differ in several respects from those laid down for oil (e.g. rates of discharge and position of the outlet for the discharge).

The third step was introduced because it is very difficult to establish a safe limit of discharge for substances which are liable to bioaccumulation. 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 be rendered unpalatable. For these reasons it is felt that special measures are called for in order to restrict the input of such substances.

FIGURE 1



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 major spillages. These dangers are assessed by use of acute toxicity information. It was 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 spilt in large quantities, may blanket the sea-bed and render it unsuitable for marine fauna, and indication is given where such dangers are felt likely.

The fifth step provides for the ranking of potential short and longer term dangers to humans, other than ship or dock-side personnel, who might accidentally or unwittingly come into contact with the substance. These dangers are assessed by examination of published information on oral, skin and inhalation toxicity.

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 interests such as beach use 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 necessary in the pre-1973 Convention days 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 dangerous. The assessment proved useful in combining the previous hazard evaluations and in drawing attention to the protective measures needed. The step has not been used since 1973.

## 2.2 Detailed explanation of the hazard evaluation steps

Prior to the 1973 Conference, no records of the basis of decisions were kept by the Ad Hoc Panel. Subsequently it was recognized that from time to time questions would be raised as to the information used in the derivation of the hazard profiles. It was therefore agreed, at the first meeting of the GESAMP Working Group (1974), that a data sheet should be completed for each substance for which a hazard profile was assigned. These sheets are stored at IMCO for future reference and updated as necessary. A copy of a blank data sheet is included in this report as Annex 7. Most of the substances originally assessed by the Ad Hoc Panel have subsequently been re-examined by the GESAMP Working Group. Where this is the case, data sheets have been prepared. The data sheets are the property of GESAMP and as such are intended as working records. They are not made available to outside persons, although details can be made available on request through the IMCO Secretariat of GESAMP in consultation with the Chairman of the Working Group.

Each substance is listed under a commonly accepted chemical name. Where substances are commonly known by several such names, those names are listed but the hazard profile is given under one name and the reader is referred to that name and entry at each of the additional entries. It is recognized that various formal nomenclature systems exist but, as these are not universally adopted the Working Group has used these names of substances listed in the Bulk Chemicals\* and Dangerous Goods Codes\*\* developed by IMCO. Trade-names are listed in the Hazard Profiles only in exceptional circumstances (see section 5).

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\* Code for the Construction and Equipment of Ships Carrying Dangerous Chemicals in Bulk;

\*\* International Maritime Dangerous Goods Code.



Based on the procedure shown in Figure 1 each substance is given a hazard profile, an example of which is shown below:

	Bioaccumulation	Damage to living resources	Hazard to human health		Reduction of amenities	
			Oral intake	Skin contact and inhalation		
Substances	A	B	C	D	E	Remarks
Carbolic oil	T	3	2	I	XX	Rated as creosote (wood tar)

2.2.1 Column A - Bioaccumulation

Bioaccumulation occurs if an aquatic organism takes up a chemical to which it is exposed so that it contains a higher concentration of that substance than is present in the ambient water or its food. The process is usually reversible, although the rates of loss may be substantially slower than the rate of uptake. Where the rate of metabolism or elimination of the substance is high and the degree or period of exposure is small, bioaccumulation may be short-lived. Where the rates of metabolism or elimination are low or the degree or period of exposure great, bioaccumulation may be of long duration.

The hazard posed by a substance is increased if the substance is accumulated in aquatic organisms, since poisoning of the organisms may eventually ensue. The effect on the target organism in so far as the end result is concerned is the same whether the accumulation takes place directly from the water or via the consumption of food. Furthermore, once accumulated in an aquatic organism, predators, including man, may be adversely affected. In certain situations there may be no adverse health effect but the palatability of fish or shellfish may be adversely affected through tainting of their flesh.