Forster (1971) 3rd Session

GESAMP III/19

13 May 1971

Original: ENGLISH

IMCO/FAO/UNESCO/WMO/WHO/IAEA/UN

JOINT GROUP OF EXPERTS ON THE SCIENTIFIC ASPECTS OF MARINE POLLUTION (GESAMP)

REPORT OF THE THIRD SESSION

held at
FAO Headquarters, Rome
22-27 February 1971

MR/B6422/6.71/E/1/2250

N O T E S

1. This Report is available in English, French, Russian and Spanish from each of the sponsoring Agencies and appears in the following documentation series:

IMCO	-	Marine Pollution Circular (OPS/Circ . . .)
FAO	-	Fishery Reports
UNESCO	-	UNESCO Technical Papers on Marine Science
WMO	-	WMO Reports on Marine Science Affairs
WHO	-	WHO Water Pollution Series (WHO/W/POLL/ . .)

2. The Report contains views expressed by experts acting in their individual capacities which do not necessarily correspond with the views of the sponsoring Agencies.

3. Permission may be granted by any one of the sponsoring Agencies for the Report to be wholly or partly reproduced in publications, provided that the source of the extract and the condition mentioned in 2 above are indicated.

CONTENTS

GESAMP III/19
1 March 1971

Original: ENGLISH

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

REPORT OF THE THIRD SESSION

(Rome, 22-27 February 1971)

Opening of the Meeting

1. The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its Third Session at FAO Headquarters, Rome, 22-27 February 1971. The Chairman (Dr. M. Waldichuk) opened the session with a special welcome to new members and to the representatives of the United Nations which had recently joined IMCO, FAO, UNESCO, WMO, WHO, and IAEA in sponsoring GESAMP.

2. Mr. F.E. Popper, Director of Programme Coordination and Operations of the FAO Department of Fisheries, gave a welcoming address on behalf of the Director-General of FAO, stressing the service that the Group had already provided to FAO, particularly in connection with its recently convened Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing. He noted that FAO and other Agencies would be seeking further advice from GESAMP on various matters related to water pollution, particularly in the development of the Long-Term and Expanded Programme of Oceanic Research, on the global monitoring system which will have to be designed, and in the preparations for the forthcoming UN Conference on the Human Environment.

3. The Agenda of the Third Session, as adopted by the Group, is attached as Annex I and a list of documents is shown as Annex II. A full list of participants, comprising experts, representatives, observers and members of the Secretariat, is attached as Annex III.

Inter-sessional activities, particularly on the state of preparation of reviews on technical matters requested from members

4. The Administrative Secretary informed the Group of inter-sessional meetings of the representatives of the Sponsoring Agencies. These discussions had resulted *inter alia* in the preparation of an "Updated Memorandum on the Joint Group of Experts on the Scientific Aspects of Marine Pollution", which was subsequently approved by the Executive Heads of the Sponsoring Agencies and put into effect on 27 July 1970.

5. The Group noted that with reference to the Report of the Second Session (GESAMP II/11) follow-up action had been taken as follows:

(a) The material prepared by the Group on Marine Pollution which may result from the Exploration and Exploitation of the Sea-bed and Ocean Floor and its Subsoil beyond the limits of National Jurisdiction (paragraph 15 and Annex IV), was forwarded to the UN Secretary-General on 24 March 1970. This information, together with certain papers submitted to the Group, was utilized by the UN Secretariat in preparing the Report of the UN Secretary-General, as called for by UN Resolution 2467 B (XXIII).

(b) The preliminary Review of Harmful Chemical Substances shown as Annex V was also brought to the attention of the UN Secretary-General. This material had been utilized as part of a report being prepared by the UN Secretary-General in implementation of UN Resolution 2566 (XXIV), and in connection with the preparation for the UN Conference on the Human Environment in 1972.

6. The representative of the UN informed the Group that the United Nations was now formally a sponsor of GESAMP and made a statement on the Organization's activities relating to marine pollution. The Technical Secretary of each Sponsoring Agency also informed the Group of activities undertaken during the inter-sessional period which were of interest or related to the work of the Group.

Implementation of Operative Paragraph 1(a) of UN General Assembly Resolution 2566 (XXIV)

7. As indicated in the Report of its Second Session (GESAMP II/11, paragraph 19), the Group had continued, in the inter-sessional period, studies related to the future development of the preliminary Review of Harmful Chemical Substances called for by General Assembly Resolution 2566 (XXIV). These studies, together with further information which had become available, enabled a considerable enlargement and revision of the Review to be made by a panel of experts which met during the Third Session under the chairmanship of Dr. H.A. Cole. The Group agreed that the revised version of the Review, attached as Annex IV to this Report, should now be substituted for the preliminary version (GESAMP II/11, Annex V). It was also agreed that, during the next inter-sessional period, the panel should carry out further work for incorporation in the Review:

(a) to elaborate Table 2 with respect to organic compounds and wastes; and

(b) to prepare a summary describing the treatment of certain pollutants before they are discharged, with a view to reducing pollution.

Identification of Noxious and Hazardous Cargoes

8. In continuation of its work on the identification of noxious and hazardous cargoes as requested by IMCO, a panel of experts set up in the United Kingdom consisting of Mr. J. Wardley Smith (Chairman), Dr. J.E. Portmann, Mr. A.R. Agg and Dr. P.S. Elias, carried out a detailed study of the problem. The Group at this session received a report from the panel, which contained a draft document showing lists of selected substances under two main categories, together with a descriptive preamble drawing attention to important matters which had been taken into account when compiling the lists. After making appropriate amendments, the Group approved the document as shown in Annex V.

9. It was agreed that, subject to the limitations specified in the preamble, the lists should provide a useful guide for the development of further international measures to prevent and control marine pollution emanating from ships. Nevertheless in reaching this decision, the Group felt that it would be advisable to keep the lists under review, so as to take full account of future research and developments, particularly with regard to the possible long-term effects of some of the pollutants concerned, and the introduction of new substances which may call for similar control measures.

Marine Pollution Problems in relation to the Long-term and Expanded Programme of Oceanic Exploration and Research (LEPOR)

10. The section on Marine Pollution in the Report of the First Session of the IOC Group of Experts on Long-term Scientific Policy and Planning (GELTSPAP I/17 issued under cover of GESAMP III/11) was brought before GESAMP for review and advice. A panel under the chairmanship of Dr. Joseph, considered this Report in the light of other information available, such as the conclusion and recommendations of the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing. The panel noted the various projects proposed in the GELTSPAP document, and commented on each according to feasibility, possible further elaboration, modification and additions. The report of this panel, as adopted by the Group, is attached as Annex VI. The Group also generally endorsed the steps being

taken to establish cooperative exercises related to marine pollution.

11. A panel, under the chairmanship of Dr. Goldberg, considered the scientific basis for a monitoring system for marine pollution. It was noted that the second aspect of this agenda item, "registration of deliberate or accidental discharges into the marine environment", was a subject that should have separate consideration by carefully selected experts, not necessarily from within the Group itself. With regard to monitoring, the panel prepared a report outlining a plan for a baseline monitoring programme in three regions, each having unique characteristics: Baltic Sea, North Sea and Puget Sound. The measurement of five sets of chemical constituents were detailed, i.e., halogenated hydrocarbons, petroleum, heavy metals, radioactive nuclides and nutrients. Examples of laboratories which appeared to be potentially capable of carrying out sampling and measurements for the constituents in each of the three regions were listed. The Group adopted this report as attached (Annex VII).

Dispersion and movement of Pollutants in the sea by natural physical processes

12. Dr. Simonov gave a brief progress report relating to studies in the USSR pertaining to physical dispersion processes which would affect wastes discharged into the sea. He indicated that some real mathematical difficulties were encountered, but a report now under preparation would be made available. Mr. Tendron also distributed for information a note giving some results of the "Messages at Sea Programme", which had earlier been submitted to IMCO.

"LDC"

13. A brief account of some work in progress was given concerning the factors affecting the dispersal of wastes in containers dumped into relatively shallow water. Mention was made of the recent Norwegian report at the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing stating that containers were being recovered by Norwegian fishermen. It was pointed out that this phenomenon is an isolated one, and that such recoveries of waste containers have not been reported regularly by other nations fishing in the North Sea. It also seemed apparent, however, that much was still unknown about the dispersal of containers in shallow water and of factors such as currents, and transport induced by surface waves of sufficient size and period, acting perhaps in coordination with currents. It was suggested that studies related to the movements of objects on the bottom would be useful for prediction purposes.

14. A brief account was also given of U.S. modelling studies of pipeline diffusers and dispersion of effluents from pipelines under varying environmental conditions. The complexities of the problem were emphasized. For example density stratification effects are still not entirely understood and efforts to develop a multilayer circulation model on a high speed digital computer are in progress. In addition, models which fully take into account the dispersal of particulate matter discharged from submerged pipelines are still under early development.

15. A summary statement was made of the state of the art regarding dispersal and diffusion processes pertaining to surface and sub-surface pollutants. In general, it seems that it is possible to predict surface movement in the open sea in offshore areas with reasonable precision. There is, however, still insufficient knowledge about estuarine and shallow water dispersion. It was also pointed out that at present there is no adequate technique available for studies of deep sea diffusion, especially in relation to dispersal of toxic wastes.

16. It was suggested that studies of dispersion phenomena might be classed into three categories, namely: (1) estuaries, (2) shallow water coastal areas and (3) deep water studies. With reference to estuaries, the complexities of sedimentation effects and the multilayer nature of the system were pointed out. For coastal studies it was stated that some experimental work permits calculation of the zone of maximum current velocity based on the distance from shore and other physical factors. In general, the group was of the opinion that considerably more field observational work is needed, especially in the deep

seas and in coastal areas where multilayer systems are involved.

Pollution of the Sea through the Atmosphere

17. Under this heading, the Group examined a report prepared by Dr. K.O. Münnich, which contained a preliminary review of the various complex problems involved. Transport mechanisms of only lead and DDT were discussed as typical examples of different behaviour of substances in the atmosphere, particularly in terms of the vapour pressure of these substances. The vapour pressure of DDT, although over 1 000 times less than that of mercury, is sufficient to hold substantial amounts of DDT as a vapour in the atmosphere. A substance like DDT, even if introduced in solid or liquid form, has enough time, at least partially, to evaporate; the atmosphere is still far from saturated with this vapour as it can held around 10^7 tons of DDT in vapour form, i.e. nearly 10 to 100 times the estimated yearly input into the atmosphere.

18. Lead and DDT are introduced into the atmosphere from the continents. From this source, the yearly global input has been estimated to be 1.5×10^5 tons. They then enter the oceans either incorporated in the precipitation as aerosol particles or by direct molecular impact on the sea surface. With regard to lead, the main source is automobile exhaust, which takes aerosol form. Thus, the total amount of lead introduced into the atmosphere is precipitated by rain. With the residence time assumed (ten days), the total atmospheric lead inventory should be about 4 000 tons. Contrary to lead, however, DDT once introduced into the atmosphere in particle form, will evaporate to a considerable extent during its rain-scavenging residence time of ten days. This means that DDT reaches the sea both in aerosol particle form and primarily by direct molecular impact. In this connection, reference was made to a study by Dr. E.D. Goldberg, et al., which assumed, on the basis of British measurements of DDT in rain, that about 2.4×10^4 tons of DDT are transported yearly to the oceans by rainfall. The Group was further informed that at least half of the total amount of DDT utilized enters the sea through the atmosphere. Possibly an even higher percentage of lead enters the sea by the same path.

19. The Group was well aware of the fact that many marine pollutants reach the ocean in significant quantities via the atmosphere and, for some materials, this is the principal pathway. In view of this and other points arising in discussion, the Group:

(a) Recommended the evaluation of the atmospheric fall-out of other pollutants such as mercury, etc., along the same lines as developed for lead and DDT.

(b) Concurred with the suggestion of Dr. Goldberg to direct attention to the combustion of fossil fuels as a major source of a significant number of atmospheric pollutants such as mercury, which will enter the ocean by various mechanisms.

(c) Recommended monitoring of pollutants both in the atmosphere over the ocean and in the surface water to corroborate the conclusions drawn theoretically regarding the transfer of pollutants. This might be done by ocean weather ships to some extent, but any kind of additional studies by research vessels of pollutants and other suitable trace substances, in both the surface water and the atmosphere above it, should be encouraged.

(d) Supported the suggestion made by Dr. Münnich to evaluate the existing information on the vertical mixing in the ocean, based on the measured vertical distribution of tritium produced by the nuclear weapons tests of the last decade. These data provide a useful basis for estimates of the vertical spread of pollutants by bulk transport. This is also of help as a baseline information in cases where there exists additional gravitational transport by incorporation or adsorption to micro-organisms. Further trace studies as with environmental tritium or with the radon for the near-bottom mixing processes should be encouraged.

Other Special Scientific Problems related to LEPOR

20. The Group had before it a Draft Report on "Principles for limiting the introduction of radioactive waste into the sea" produced by the IAEA Panel on Procedures for Establishing Limits for Radionuclides in the Sea and expected to be published under co-sponsorship of IAEA and WHO (GESAMP III/3). The Report sets out basic principles concerning the marine disposal of radioactive wastes and indicates how these principles can be applied in practice.

21. The Group considered that these principles could be taken as an example of an approach toward the establishment of limits of disposal of other harmful substances into the sea. The Group endorsed the Draft Report in its present form. The members were invited to study and comment upon it during the inter-sessional period for further consideration at its next session. The Group requested the co-sponsors to circulate the Final Report to members as soon as it becomes available.

Microbiological and Toxicological Aspects of Marine Pollution with particular reference to Public Health

22. The Group considered and discussed papers submitted by some experts concerning microbiological and toxicological problems arising from discharge of pollutants in the marine environment, as well as technical aspects of coastal pollution control. These documents are referred to in some detail in Annex VIII.

Microbiological aspects

23. The Group reviewed a number of pathogenic agents, and their significance in relation to bathing and to shellfish production. It was considered important to improve the efficiency of retention of virus and bacteria by sewage treatment plants, and also to use cholimetry in addition to biological and chemical analyses for surveillance and control of the function of such plants.

24. The experts expressed the desirability of protecting those waters where shellfish are cultivated from pollution. The ideal solution would be to cease discharging waste in their vicinity. If this were impossible, only discharge of wastewaters adequately purified to meet the necessary criteria should be allowed. However, some members of the Group stressed the technical difficulties of total purification.

Toxicological aspects

25. At the Second Session of GESAMP, the WHO Technical Secretary indicated that his Agency would seek further advice concerning the toxicological aspects of marine pollution. The Group, using the word "toxicology" in a broad sense, considered general aspects of toxicology of pollutants in relation to marine organisms and (indirectly) to man.

26. The Group emphasized the need for establishment of "toxicity profiles" based on physiological, histological and other effects of toxic agents on a range of selected marine species or organisms, and at different stages of development. As for toxicity standards in human and domestic animal foods the current standards and techniques should be employed. It was recognized that there is an enormous lack of toxicological data on marine food products containing toxic agents.

27. (a) The Group recommended that long-term toxicity experiments be conducted on selected heavy metals, chlorinated hydrocarbons and other persistent intoxicants which may accumulate in marine organisms, in order to establish the levels at which there are no detectable effects.

(b) Joint groups of international experts convened by WHO and FAO have already studied and recommended limits in daily intake levels and tolerances for a number of toxic compounds. It is recommended that in the future work of these committees, they take into consideration the persistence of these toxic agents in the environment and their bio-accumulative characteristics. The Group also recommended that a joint FAO/WHO committee establish practical residue limits for persistent compounds such as mercury, PCBs, organochlorine insecticides, etc., in marine food products which are being consumed by man and domestic animals.

(c) The Group recommended that further epidemiological field studies be conducted on marine biotoxins as they may affect the future economic development of marine resources with special reference to tropical regions of the world. There is also a need for additional information on the chemical, toxicological, and pharmacological properties of these poisons from the above-mentioned regions. The Group noted in this regard the establishment of an FAO/WHO Biotoxicological Centre in Colton, U.S.A.

(d) The Group endorsed the recommendations made regarding the toxicological problems as presented in the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing, 9-18 December 1970.

(e) Observations of cancerous growths, skin ulcerations, and other pathological changes in marine organisms were brought to the attention of the Group. These conditions have been reported to occur in the Baltic Sea, New York Bight, Puget Sound, and along the Southern California coast (Los Angeles and Orange Counties) involving a variety of species of fish. The Group recommended that the occurrence of such changes in marine organisms be investigated in order to determine the causal relationships to toxic pollutants, if any, as well as any potential bearing on public health.

28. The Group reviewed the scope of the Long-term and Expanded Programme of Oceanic Exploration and Research, and it was felt that in conjunction with further development of the LEPOR programme, the aforementioned recommendations regarding toxicological research should be taken into account.

Pollution control

29. The Group also discussed scientific and technical questions for the control of coastal pollution, from land-based industrial and domestic sources, and pointed out the problems related to regulation of industrial waste discharges into a municipal sewer system (see Annex VIII). In considering the factors which might influence the development of a policy for prevention of marine pollution, prevention of pollution at its source was felt to be the ideal longterm approach although it could involve political, as well as economic and land-use management implications. This matter was suggested to be brought to the attention of the UN Conference on Problems of the Human Environment (Stockholm 1972).

30. The application of existing knowledge with regard to treatment of domestic and industrial waste permits the control of pollution locally in most cases. The Group felt, however, that international encouragement and support for a policy of application of known methods of control would be helpful, particularly for countries which have not yet started to control pollution, or are in the process of doing so.

31. The Group discussed the possibility of elaborating quality criteria on an international level, as a guide for the discharge of effluents into coastal waters.

FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing

The Secretary of the FAO Conference, Dr. M. Ruivo, described the main results of the Conference, referring to the section reports and recommendations.

Of particular interest to the work of the Group were a number of recommendations dealing with the scientific basis for a monitoring system, dumping, standardisation and intercalibration of methods; dispersion and transport of pollutants; prediction of fate and effects; technical assistance in various forms; vulnerable regions or ecosystems; and effects of pollution on organisms.

It was noted that the relevant recommendations had been of value in the discussion of several agenda items, especially items 5.1, 5.2 and 6.

Information System concerning Marine Pollution

The development of an exchange service for data related to marine pollution was considered to be premature. The FAO Fishery Data Centre was requested to pay special attention to such data, in close communication with the IOC and SCOR/ACMRR working groups on the subject.

Mr. Akyüz reported on the FAO scientific information system on aquatic sciences (GESAMP III/9), noting particularly that a new publication, "Aquatic Sciences and Fisheries Abstracts", will appear in July 1971 as a merger of "Current Bibliography for Aquatic Sciences and Fisheries" and "Aquatic Biology Abstracts". A panel of experts, with Professor Clark acting as Chairman, examined the problem of information during the Session.

The panel prepared a report which emphasized the need for an abstracting service giving all literature with relevance to marine pollution in a single journal. /The need was also noted for abstracts of publications in non-European languages./

The Group accepted the panel's final report (Annex IX), and it was agreed that this report should be brought forward at the next meeting of the FAO Advisory Committee on Marine Resources Research (ACMRR).

Future Work Programme

In considering the incompleted items in its work programme, the Group recognized that the following were main tasks which would need to be pursued during the coming intersessional period:

(a) In respect of the Review of Harmful Chemical Substances (Annex IV), further elaboration of Table 2 with respect to organic substances, and preparation of a summary describing possible means of treatment of certain pollutants before discharge and reduction of pollution levels.

(b) Depending on the response of the IOC Bureau and Consultative Council to the Report of the First Meeting of GELTSPAP (GELTSPAP 1/17), development of the programme elements of the Global Investigation of Pollution in the Marine Environment and other related matters arising in connection with LEPOR, including recommendations of the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing.

This task is to be pursued in cooperation with the scientific advisory bodies of the IOC (SCOR, ACMRR, ACOMR) and it will probably be necessary in the near future for the Chairman of GESAMP to meet the officers of these bodies, and representatives of the IOC and of the Agencies supporting the IOC, to work out appropriate arrangements for shaping this task, and acting jointly where necessary.

GESAMP III/19

In connection with the new tasks of the Group the representatives of IOC and FAO (ACMRR) indicated that as a result of the meeting of the IOC Working Group on Education and Training in Marine Science recently held in Malta, the Group would be called upon to advise on curricula, programming and other aspects of special education and training arrangements particularly with a view to training specialists in chemical methods and increasing public awareness of pollution problems.

The Group, whilst recognizing that its future work programme would depend upon the Agenda for the next session which had yet to be determined by the sponsoring agencies, considered it useful to undertake inter-sessional work on the following new tasks, the need for which appeared likely to arise as a consequence of work done so far:

(a) development of criteria for intercalibration of methods of chemical analysis of pollutants, particularly oil products;

(b) consideration of methods of sewage and industrial waste treatment, with a view to minimizing pollution from this source;

(c) examination of wastes from chemical processes which may constitute new sources of pollution;

(d) compilation of information on available bioassay techniques;

(e) development of quality criteria, as a guide for the discharge of effluents into coastal waters.

Date and place of next Session

The Group was informed that WMO would act as host agency for the Fourth Session which was tentatively scheduled to be held in Geneva from 6 to 10 March 1972. It was envisaged that the Fifth Session in 1973 would be held in Vienna at the invitation of IAEA.

Preparations for the UN Conference on Human Environment

The Group was informed by Mr. P. Thacher, Senior Programme Officer of the UN Secretariat for the Conference on Human Environment, of the decisions reached at the Second Session of the Preparatory Committee for the Conference which was held in Geneva from 8 to 19 February 1971. The Committee had taken particular note of the Report of the Group's Second Session (GESAMP II/11) and had decided to establish inter-governmental working groups inter alia on marine pollution and on environmental monitoring. These groups are expected to meet during the summer of 1971 to consider possible areas for action by the Conference. It was intended that the Working Group on Pollution would meet first so that its views could be passed to the Group on Monitoring which would also be considering the feasibility of establishing possible release limits for very harmful pollutants. The terms of reference of these groups were noted. The Group considered that the final report of the present session, containing the Revised Review of Harmful Chemical Substances, would make a significant contribution to the preparatory work for the Conference, and invited the sponsoring agencies to make the report available to these Working Groups. The Group expressed its readiness to carry out any further tasks in this field which might be brought to its attention by the sponsoring agencies.

Other matters

The representative of ILO brought to the attention of the Group a resolution concerning Seamen's Welfare on Board Vessels (Sewage Disposal) adopted by the 55th (Maritime) Conference of ILO, which requested collaboration between ILO and IMCO with the object of considering the possibility of improving methods of sewage disposal from vessels.

The observer from IAMS suggested that the information on microbiological aspects of marine pollution would be useful for the work of the Group. The Group invited IAMS to prepare a paper in this field for consideration at its next session.

It was suggested by Dr. J. Ui that it would be useful if a small "floating panel" of experts could be set up to investigate special problems (i.e. pollution by heavy metals, biotoxins, other biocides, the effectiveness of quality standards for effluents and sea-water conditions, public awareness of pollution problems, etc.) by travelling and visiting actual and possible sites of pollution. This could perhaps be done either by a national or an international arrangement. The Group felt that the establishment of such a panel would undoubtedly be useful and any such project was to be encouraged provided the necessary financial and other arrangements could be made. In this connection the Group recalled the suggestions made at its first session (GESAMP I/11, para. 50) with reference to the possibility of arranging for "on the spot" investigations and advice in the event of major accidents involving pollution.

Election of Chairman for next inter-sessional period and for the Fourth Session

The Group unanimously re-elected Dr. M. Waldichuk as Chairman for the next inter-sessional period and for the Fourth Session. The Group also elected Dr. H.A. Cole as Vice-Chairman.

ANNEX I

AGENDA

1. Opening of the meeting.
   Adoption of the agenda.

2. Progress reports on inter-sessional activities, particularly on the state of preparation of reviews on technical matters requested from members.

3. Preparation of review of harmful chemical substances in implementation of operative paragraph 1(a) of UN General Assembly Resolution 2566 (XXIV).

4. Identification of noxious and hazardous cargoes.

5. Marine Pollution Problems in relation to the Long-term and Expanded Programme of Oceanic Exploration and Research (LEPOR).

   5.1 General discussion, including advice to IOC and its Group of Experts on Long-term Scientific Policy and Planning.

   5.2 Scientific basis for a monitoring system for marine pollution, including registration of deliberate or accidental discharges into the marine environment.

   5.3 Dispersion and movement of surface and sub-surface pollutants by natural physical processes.

   5.4 Pollution of the sea through the atmosphere.

   5.5 Other special scientific problems.

6. Health aspects of marine pollution.

   6.1 Microbiological pollutants.

   6.2 Toxicological problems.

   6.3 Technical and scientific aspects of coastal pollution control.

7. Follow-up of the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing (Rome, December 1970).

8. Information system concerning marine pollution and its effects, including storage, retrieval and exchange.

9. Future work programme.

10. Date and place of next session.

11. Other matters.

12. Election of Chairman for next inter-sessional period and for the fourth session.

13. Consideration and approval of the Report.

ANNEX II

LIST OF DOCUMENTS

	Title	Submitted by
GESAMP III/1	Provisional Agenda	
GESAMP III/2	Progress report on inter-sessional activities, particularly on the state of preparation of reviews on technical matters requested from members	Administrative Secretary
GESAMP III/3	Principles for limiting the introduction of radioactive waste into the sea (Draft) The IAEA Panel on Procedures for Establishing Limits for Radionuclides in the Sea (IAEA, Vienna, 9-13 November 1970)	IAEA Secretariat
GESAMP III/4	Identification of noxious and hazardous cargoes - Report of a Panel of United Kingdom Experts	IMCO Secretariat
GESAMP III/5	Progress report on inter-sessional activities, particularly on the state of preparation of reviews on technical matters requested from members	IMCO Secretariat
GESAMP III/6	Activities of FAO in the field of marine pollution	FAO Secretariat
GESAMP III/7	Final Report of the Seminar on Methods of Detection, Measurement and Monitoring of Pollutants in the Marine Environment, organized by FAO with the support of Unesco, IAEA, SCOR and WMO, and held in Rome, 4-10 December 1970 (FIR: TPME/70/6 Rev., Rome, 9 Dec. 1970)	FAO Secretariat
GESAMP III/7 Add. 1	Summary Report of the Seminar on Methods of Detection, Measurement and Monitoring of Pollutants in the Marine Environment	FAO Secretariat
GESAMP III/8	FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing: Conclusions and Recommendations as approved (FIR: MP/70/Rec.Rev.1, Rome, 17 Feb. 1971)	FAO Secretariat
GESAMP III/9	Scientific information system on aquatic science with special reference to marine pollution	FAO Secretariat

GESAMP III/10	Progress report on inter-sessional activities	WMO Secretariat
GESAMP III/11	Report of the first session of the Unesco/IOC Group of Experts on Long-Term Scientific Policy and Planning (GELTSPAP), Monaco, 16-25 Nov. 1970 (IOC/B-76, Paris, 23 Dec. 1970)	Unesco Secretariat
GESAMP III/12	Report on the pollution of the sea through the atmosphere (K.O. Münnich)	WMO Secretariat
GESAMP III/13	Summary of WHO activities in marine science and its application in 1970	WHO Secretariat
GESAMP III/14	La pollution des mers par les microorganismes (J. Brisou)	WHO Secretariat
GESAMP III/15	Toxicological aspects of marine pollution (B. Halstead)	WHO Secretariat
GESAMP III/16	Marine pollution and public health problems (G.D. van Esch)	WHO Secretariat
GESAMP III/17	Aspects scientifiques et techniques du contrôle de la pollution côtiére (L. Mendia)	WHO Secretariat
GESAMP III/18	Statement of IAEA relevant activities during the period March 1970-February 1971	IAEA Secretariat
GESAMP III/19	Report of the Third Session	

<u>Background documents</u>

GESAMP/21/Add.1	Oil pollution of the marine environment	J. Wardley-Smith
GESAMP/35	Some forthcoming meetings related to marine pollution	FAO Secretariat
GESAMP/36	A list of experts on marine pollution	FAO Secretariat
GESAMP/37	Questionnaire on pollution of the marine environment	IMCO Secretariat
GESAMP/38	Summary of relevant parts of resolutions adopted by the UN General Assembly, dealing with marine pollution	FAO Secretariat
GESAMP/39	The Preparatory Committee for the UN Conference on the Human Environment: Extracts from the draft report of the Second Session, (Geneva, 8-19 Feb. 1971)	FAO Secretariat
GESAMP/40	Summary progress report on results of Operation Message à la Mer	G. Tendron

ANNEX III

LIST OF PARTICIPANTS

MEMBERS OF GESAMP

BAUMGARTNER, Dr. D.J.
Chief, National Coastal Pollution Research Program, Water Quality Office
200 SW 35th Street, Corvallis
Oregon 97330, U.S.A.

BRISOU, Prof. J.
Faculté de Médecine
Poitiers, France

COLE, Dr. H.A.*
Director of Fisheries Research
Ministry of Agriculture, Fisheries and Food
Fisheries Laboratory, Lowestoft
Suffolk, England

FONTAINE, Prof. M.A.
Laboratoire de Physiologie Générale
Muséum National d'Histoire Naturelle
7, rue Cuvier
Paris 5e, France

FØYN, Prof. E.
Institute for Marine Biology
University of Oslo
Frederiksgt. 3
Oslo, Norway

GOLDBERG, Prof. E.D.
Scripps Institution of Oceanography
La Jolla
California 92037, U.S.A.

HALSTEAD, Dr. B.W.
Director, International Biotoxicological Center, World Life Research Institute
23000 Grand Terrace Road, Colton
California 92327, U.S.A.

JOSEPH, Dr. J.
Director, IAEA International Laboratory
Musée Océanographique
Principality of Monaco

MENDIA, Prof. L.
Centro Studi e Ricerche d'Ingegneria Sanitaria
Universitá di Napoli, Piazzale Tecchio
80125 Naples, Italy

MÜNNICH, Prof. K.O.
Zweites Physikalisches Institut der Universität Heidelberg
C-14 Laboratorium
12, Philosophenweg, 69-Heidelberg
Federal Republic of Germany

NESTEROVA, Dr. Maria
Laboratoria d'Analitik
Krjijanovskiy 15, Korp 4
Moscow B-218, U.S.S.R.

PORTMANN, Dr. J.E.
Fisheries Laboratory
Ministry of Agriculture, Fisheries and Food
Burnham-on-Crouch
Essex, England

SIMONOV, Prof. A.I.
Oceanographic Institute
6 Kropotkinsky Pereulok
Moscow G-34, U.S.S.R.

TENDRON, Mr. G.
Sous-Directeur
Muséum National d'Histoire Naturelle
57, rue Cuvier
Paris 5e, France

UI, Mr. J.
Faculty Assistant, Department of Urban Engineering, Faculty of Engineering
University of Tokyo, Bunkyo-ku
Tokyo, Japan

* also functioning as observer for the International Council for the Exploration of the Sea (ICES)

VAN ESCH, Dr. G.J.
Head, Laboratory of Toxicology
National Institute of Public Health
Bilthoven, Netherlands

WALDICHUK, Dr. M.
Program Head, Pacific Environment Institute
Fisheries Research Board of Canada
4160 Marine Drive, West Vancouver
British Columbia, Canada

WARDLEY SMITH, Mr. J.
Warren Spring Laboratory
Gunnelswood Road, Stevenage
Herts., England

WEICHART, Dr. G.F.
Deutsches Hydrographische Institut
Bernhard-Nocht-Str. 78
2000 Hamburg 4
Federal Republic of Germany

REPRESENTATIVES AND SECRETARIAT FROM UN ORGANIZATIONS

United Nations (UN)

DOLLINGER, Mr. A.*
UN Special Representative in Europe for Coordination
Palais des Nations
Geneva, Switzerland

MATTHEWS, Miss G. (GESAMP Tech. Secretary)
Ocean Economics and Technology Branch
Department of Economic and Social Affairs
UN, New York
N.Y., U.S.A.

THACHER, Mr. P.*
Senior Programme Officer
Secretariat of the United Nations Conference on the Human Environment
Palais des Nations
Geneva, Switzerland

International Labour Organization (ILO)

FANO, Dr. P.P.*
Director, ILO Branch Office
Via Panisperna 28
Rome, Italy

Food and Agriculture Organization of the United Nations (FAO)

AKYÜZ, Mr. E.*
Senior Fishery Officer
Fishery Resources Division
Department of Fisheries, FAO
Rome, Italy

ANDRÉN, Dr. L. (GESAMP Tech. Secretary)
Fishery Biologist (Marine Pollution)
Marine Biology and Environment Branch
Fishery Resources Division
Department of Fisheries, FAO
Rome, Italy

RUIVO, Dr. M.**
Director, Fishery Resources Division
Department of Fisheries, FAO
Rome, Italy

TOMCZAK, Dr. G.*
Chief, Marine Environment Section
Marine Biology and Environment Branch
Fishery Resources Division
Department of Fisheries, FAO
Rome, Italy

United Nations Educational, Scientific and Cultural Organization (Unesco)

HOLT, Dr. S.J.*
Director, Office of Oceanography
Unesco, Place de Fontenoy
Paris 7e, France

SAILA, Dr. S.
Marine Sciences Officer, IOC Secretariat
Unesco, Place de Fontenoy
Paris 7e, France

World Health Organization (WHO)

PAVANELLO, Dr. R. (GESAMP Tech. Secretary)
Chief, Environmental Pollution
Division of Environmental Health
WHO, Avenue Appia
1211 Geneva, Switzerland

* parttime only
** also representing ACMRR and IABO

World Meteorological Organization (WMO)

MIZUNO, Mr. S. (GESAMP Tech. Secretary)
Technical Officer, Applied Meteorology Division, Scientific and Technical Department, WMO
41 avenue G. Motta
Geneva, Switzerland

International Atomic Energy Agency (IAEA)

KLIMOV, Dr. A. (GESAMP Tech. Secretary)
Division of Health, Safety and Waste Management, IAEA
Kärntner Ring 11
A1010 Vienna, Austria

Intergovernmental Maritime Consultative Organization (IMCO)

YOUNG, Mr. S.L.D. (GESAMP Tech. Secretary)
Head, Marine Science Section
IMCO, 101-104 Piccadilly
London, W1V,OAE, England

SASAMURA, Mr. Y. (GESAMP Admin. Secretary)
Head, Marine Science and Technology Division
IMCO, 101-104 Piccadilly
London, W1V OAE, England

United Nations Institute for Training and Research (UNITAR)

SERWER, Mr. D.P.*
Assistant Research Fellow
UNITAR, 801 UN Plaza
New York, N.Y. 10017, U.S.A.

OBSERVERS FROM INTERNATIONAL ORGANIZATIONS

International Association of Microbiological Societies (IAMS)

FLOODGATE, Dr. G.D.
Marine Science Laboratories
University College of North Wales
Menai Bridge
Anglesey, England

International Association for Water Pollution Research (IAWPR)

CASPERS, Prof. H.
Institut für Hydrobiologie
Palmaille 55, 2 Hamburg-50
Federal Republic of Germany

International Biological Programme (IBP)

CLARK, Prof. R.B.
Department of Zoology
University of Newcastle-upon-Tyne
Newcastle-upon-Tyne, NE 1 7RU
England

International Council of Scientific Unions (ICSU)

BAKER, Mr. F.W.G.*
Executive Secretary, ICSU
Via Cornelio Celso 7
00161 Rome, Italy

GRASSHOFF, Prof. K.M.
Institut für Meereskunde an der Universität Kiel
Niemannsweg 11, 23 Kiel
Federal Republic of Germany

Scientific Committee on Oceanic Research (SCOR)

POSTMA, Prof. H.
Nederlands Instituut voor Onderzoek der Zee (Netherlands Institute for Sea Research), P.O. Box 59
Texel, Netherlands

* parttime only

ANNEX IV

REVISED REVIEW OF HARMFUL CHEMICAL SUBSTANCES

(as called for by UN Resolution 2566(XXIV) - Promoting effective measures for the prevention and control of marine pollution)

1. INTRODUCTION

1.1 UN General Assembly Resolution 2566(XXIV) called for a review of harmful chemical substances, radioactive materials and other noxious agents and waste which may dangerously affect man's health and his economic and cultural activities in the marine environment and coastal areas. The terms of the Resolution further indicated that this review had special reference to the preparations for the UN Conference on the Human Environment to be held in Stockholm in 1972 and would thus provide guidelines for deliberations related to the desirability and feasibility of an international treaty or treaties on the subject.

1.2 With a view to illustrating the comparative importance of substances causing pollution a table was compiled at the Second Session of GESAMP showing major categories of pollutants and their relative effect in terms of:

(a) harm to living resources

(b) hazards to human health

(c) hindrance to maritime activities

(d) reduction of amenities

The categories of pollutants used are essentially those drawn up by the IOC Working Group on Marine Pollution, modified in the light of the decisions of the First Session of GESAMP (GESAMP I/11 para. 13-38 incl.). This table has now been extended by sub-division of certain of the more important categories of pollutants into their major constituents. The resulting Table 1 replaces the similar table included in the Report of the Second Session of GESAMP. It must be emphasized that this table can only be regarded as a general guide, since some categories are made up of many substances, some of which may have more pronounced effects than others. Consideration will be given later to the need for providing an additional column relating to the impairment of quality of the sea water as mentioned in the basic definition of marine pollution (GESAMP I/11 para. 12).

1.3 The Group at its Second Session gave some thought to the sources from which pollutants originate, as it is generally agreed that this is where measures of prevention or control can be most effectively applied. To facilitate further consideration of the desirability and feasibility of international treaties, a broad illustration of the main sources of marine pollution together with examples of potential pollutants arising from them is set out in diagrammatic form in Diagram I. This is further elaborated in Table 2.

1.4 Attention is also drawn to the fact that the cargoes carried by ships include a wide variety of noxious substances, falling within the categories listed in Table 1, which may be discharged into the sea either by accident (such as in collision or stranding of a vessel) or deliberately, such as in the tank cleaning and ballasting operations of a tanker or bulk carrying vessel. A particular pollutant may therefore be subject to control under separate regimes, one associated with transport by sea (e.g. IMCO) and the other with its use or production ashore. For this reason, in assessing the potential hazards of noxious and hazardous cargoes carried by ships (see para. 8 and Annex V to this report), the Group has applied the same basic principles as were used in preparing Table 1 of this Review. The lists shown in Annex V may therefore also serve as an indication of some specific substances which would warrant the application of special measures to prevent their discharge into the marine environment from sources other than ships.

1.5 The Group (is not aware of any situation) in which the release of radioactive materials to the sea by the nuclear energy industry has produced adverse effects, i.e. pollution. This situation has resulted from the very firm control imposed by national governments over this industry since its beginning. The work done on the study of the dispersion effects and fate of radioactive materials in the marine environment has been, and continues to be, extensive. It has had the result that the status of radioactive materials as potential pollutants of the marine environment is more clearly defined than that of most other materials recognized as serious pollutants.

1.6 The routes by which marine pollutants enter the sea were examined by the Group at its Second Session and it was decided that the main headings should be:

(a) disposal of manufactured and industrial products or of the waste resulting from them by direct outfall or via rivers;

(b) disposal of domestic sewage by direct outfall or via rivers;

(c) run-off from the land of materials used in Forestry, Agriculture or Public Health activities;

(d) deliberate dumping of material from ships;

(e) operational discharge of polluting materials by ships in the course of their normal tasks;

(f) accidental release of material from ships or submarine pipelines;

(g) exploitation of sea bed for mineral resources;

(h) discharge or dumping of materials during military activities;

(i) transfer of pollutants to the ocean from the atmosphere.

These descriptions are included in Table 2 and the importance of each of them as a route by which the different categories of pollutants enter the sea has been shown by the use of a number of symbols. To aid in the study of Table 2 each category of pollutant is the subject of an explanatory note which gives, where appropriate, further information on principal sources and pathways to the marine environment, mode of occurence and distribution, toxicity, degree of persistence and accumulation in biological materials and known effects.

1.7 Attention is called to the fact that there is an increasing number of toxic substances that may appear in effluents discharged into the marine environment. These substances are present in both industrial and military wastes as a result of complex manufacturing processes. The present list of toxic materials is only tentative and will

THE ORIGIN OF MARINE POLLUTION

THE LAND			MARINE ACTIVITIES				THE AIR
RIVER DISCHARGES	DISCHARGE THROUGH COASTAL PIPELINES	AGRICULTURAL RUN OFF	DUMPING BY SHIPS AND BARGES	DELIBERATE POLLUTION BY SHIPS	ACCIDENTAL POLUTION BY SHIPS	EXPLOITATION OF SEABED MINERAL RESOURCES	VOLATILE COMPOUNDS AND PARTICULATES
e.g. 1) sewage 2) industrial waste products	e.g. 1) sewage 2) food processing waste 3) industrial waste products	e.g. 1) pesticides 2) fertilizers	e.g. 1) sewage 2) food process-ing waste 3) indust-rial waste products 4) dredged mater-ials	e.g. cargo tank washings such as oil	e.g. oil and other noxious cargoes	e.g. 1) oil and gas 2) minerals 3) gravel	e.g. 1) combustion products from vehicles 2) pesticides

DIAGRAM I

undoubtedly be extended as further investigations are made. In addition, some chemical substances may be altered by marine organisms or they may produce a synergistic effect, resulting in acute or low-level chronic toxicity. Little is known about the mechanism by which some of these processes take place. There is evidence that in some instances trace elements may trigger toxicity cycles in marine organisms; further information about ecological conditions leading to the production of biotoxins is highly desirable.

1.8 Although some measures of prevention and control, both national and international, are known to be in force for certain pollutants, the Group recommends that serious consideration be given especially to those categories shown in the tables as 'important' or 'significant' with a view to improving the effectiveness of existing legislation and, where necessary taking further action nationally and, where appropriate, internationally to limit or control their discharge into the sea. Where lack of knowledge is indicated (?) further research is desirable.

2. CONCLUSIONS AND RECOMMENDATIONS

2.1 The tables prepared listing the principal categories of marine pollutants are based upon an assessment of published data and the personal experience of the Group members, with an indication of the nature and seriousness of their effects and the pathways by which they reach the marine environment. The Group believes that they have value in showing where the main problems lie and the nature of the action needed to reduce or prevent damage to the marine environment and its living resources.

2.2 The Group is conscious of the need to deal separately with the principal organic compounds and organic wastes discharged into the sea and hopes to give attention to this task during the coming inter-sessional period so as to be able to report further at its next meeting.

2.3 Further, the Group agreed that, to assist in reducing the damage caused by the major categories of pollution, a summary should be prepared of the technical methods of treating pollutants before discharge.

3. NOTES ON MAJOR CATEGORIES OF MARINE POLLUTION (TABLES 1 and 2)

3.1 Domestic Sewage, including Food Processing Wastes

When discharged untreated, domestic sewage has five major polluting characteristics:

(a) a high bacterial content, parasites and possibly presence of virus concentrations, contaminating molluscan shellfish (necessitating purification or heat sterilization) and limiting the use of bathing areas;

(b) dissolved organic and suspended constituents which give it a high biochemical oxygen demand;

(c) settling solids (organic and inorganic) depositing on the bottom to undergo decay with consequent oxygen depletion;

(d) high nutrient concentrations (mainly phosphorus and nitrogen compounds) leading to enrichment of receiving waters and potential eutrophication;

(e) floatables, which may be organic or inorganic materials on the surface or in suspension, constituting a serious amenity problem and interfering with primary production and self-purification processes.

By reason of these characteristics sewage affects recreation, utilization of seafood, public health and general amenities. The production characteristics of the receiving waters may be altered and there is a possible connection with the production of toxic blooms of algae.

One of the reasons for the need to control pollution by sewage is the maintenance of shellfish quality. The standards of treatment and/or dilution required for this purpose are somewhat higher than those presently demanded for other public health or amenity purposes. Filter-feeding molluscan shellfish concentrate bacteria and viruses along with other particulate materials and the consumption of contaminated shellfish may give rise to enteric infections. The transmission of the viral disease, infectious hepatitis, by consumption of raw shellfish contaminated by sewage is well documented. Methods of purifying shellfish from the effects of bacterial contamination are available and are extensively used in many countries but are not yet fully acceptable in all situations.

Various degrees of treatment of domestic sewage eliminate or reduce some of the foregoing polluting characteristics: primary - normally eliminates the settleable solids and floatables and proportionally reduces the microflora; secondary - clarifies the effluent from the finer colloidal suspensions, mineralizes organic substances (reducing the biochemical oxygen demand) and disinfection can provide a further removal of pathogenic forms; tertiary - removes the plant nutrients by biological or chemical action, or by a combination of the two, and reduces the suspended solids still present as well as decolorising the effluent. Much coastally discharged sewage receives no treatment beyond comminution or maceration; this accelerates breakdown and is an improvement from the amenity standpoint but only marginally reduces bacterial or viral contamination. Where practicable, separation of storm water and sewage systems is desirable.

Other household wastes which enter the municipal sewer, including detergents and optical whiteners (dealt with in another section of this report), pharmaceuticals, house and garden pesticides and incidental chemicals, and oily and other discharges from small businesses and garages may also be important. However, apart from the considerations mentioned above, the major problems of municipal sewage disposal arise from the inclusion of industrial wastes with materials discharged from municipal sewers. The tendency to replace sewage treatment works by long outfalls, discharging well away from the shore into deeper water, has led to the inclusion of greater quantities of industrial wastes with domestic sewage. Such wastes may contain toxic and persistent materials (e.g. metallic wastes) in concentrations which, if they were accepted by a treatment plant would reduce its efficiency. Related pipeline discharges may adversely affect marine resources, particularly shellfish and young fish on coastal nursery grounds. Pre-treatment at source of industrial wastes before discharge to sewers should become standard practice. There has been a similar tendency to replace estuarine discharges by long trunk sewers leading to marine outfalls. Careful siting of all such outfalls in relation to dilution characteristics of receiving waters, other existing or projected outfalls, and presence of exploitable marine resources is essential.

The practice of disposing of sludge from coastal sewage treatment works by dumping at sea may be harmful because such wastes may contain substantial amounts of adsorbed metals e.g. zinc, and also pesticide residues and other persistent chlorinated hydrocarbons. These factors and probable biological effects e.g. interference with benthic fauna, need to be considered in deciding disposal procedures for sewage sludges and the selection of dumping zones.

3.2 Pesticides

The term "pesticides" covers a wide range of substances of differing chemical composition and class of target organism. They are considered here under seven headings, organochlorine compounds, organophosphorus compounds, carbamate compounds, herbicides, mercurial compounds, miscellaneous metal-containing compounds and polychlorinated biphenyls. The latter are not pesticides, but are widely used in industry and can conveniently be discussed in the same group as organochlorine pesticides.

3.2.1 Organochlorine compounds

Much information is available on this group of pesticides, some of which have been in use for about 30 years. The most commonly used are probably DDT, BHC, Dieldrin, Endrin, Aldrin and Endosulfan; all are used as insecticides, either for agricultural or public health pest control. Use is frequently on a fairly large scale and spraying from the air is a common means of application in some areas. Not all the material sprayed will reach the target area (less than 50% in some instances) and some will inevitably be lost to the atmosphere. Of this, a proportion will reach the sea by exchange with the atmosphere, in rain or adsorbed on air-borne particulate matter. Since organochlorine compounds are strongly adsorbed on particulate matter and are relatively insoluble in water, it is unlikely that they will reach river systems except under flood conditions where soil particles are washed into rivers. Although comparatively non-volatile, organochlorine compounds may be lost from the soil by evaporation and particularly by codistillation with water. In addition, soil erosion by wind may carry a proportion of the applied chemical into the sea. Aerial transport accounts for at least 50% of the material reaching the sea.

Mothproofing of wools and woollen garments may lead to discharge of insecticidal formulations (e.g. dieldrin) directly to rivers and hence to the sea. Recent analyses of sewage and sewage sludges suggest that these may also be an important route of entry of pesticides to the sea.

Estimates of the proportion of the annual production of organochlorine pesticides reaching the sea have ranged as high as 90% but a more accurate estimate may be 40-60 %.

Once in the sea, organochlorine pesticides may be concentrated either in surface slicks or by marine organisms. Some will be carried to the sea bed on particulate material, and a certain amount will remain dissolved in the sea water at a very low concentration. From analyses of marine animals, some of the organochlorine pesticides, particularly DDT, are known to be distributed on a world-wide basis. Concentrations in coastal waters can be determined, but oceanic waters contain levels below the normally accepted detectable level, i.e. 1 part in 10^{12}. Owing to the lipophilic/hydrophobic character of organochlorine pesticides, they are particularly likely to be concentrated in any oily material, eg fish oils. They are, therefore, found in appreciable concentrations in many marine organisms, especially those with a high lipid content and those organisms highest in the food chain. Their half life residence time in the environment has not been accurately determined but it is probably of the order of years rather than months.

Although used for up to 30 years, the precise mode of action of organochlorine pesticides is not fully understood. It is, however, generally accepted that they affect the transmission of impulses in the central nervous system. Recently, sub-lethal subtle side effects have been recognised, e.g. on calcium deposition in birds' eggs. Their acute toxicity to marine organisms is now fairly well documented. Crustacea are particularly sensitive; water concentrations as low as 0.003 ppm have been shown to be lethal to shrimps, but fish can tolerate concentrations up to two orders of magnitude higher - at least for a short time.

There is no evidence that the proper use of organochlorine pesticides has directly affected human health, nor have there been any incidents where humans have been affected by eating fish contaminated with organochlorine pesticide residues. Effects on fish and shellfish populations have been demonstrated in certain estuarine environments, particularly in America. Most of the incidents have been kills as a result of spray operations, but at least two instances have been reported where reduced breeding success of estuarine fish has been attributable to organochlorine pesticide residues arising from routine usage on the land.

3.2.2 PCB's

Polychlorinated biphenyl compounds (PCB's) are sold under a variety of brand names. There is a variety of formulations depending upon the degree of chlorination of the biphenyl molecule; the greater the degree of chlorination, the higher the viscosity. PCB's have a wide range of possible industrial uses, the major usage probably being in the electrical industry. They are unlikely to be sprayed over wide areas except in very special circumstances where a formulation may be used in association with a pesticide. The routes of entry to the marine environment are at present under investigation, but industrial use involves some losses which may reach the sea. Analysis of sewage sludges has revealed that most sewage contains some PCB's. The dumping of waste materials containing PCB's is probably largely on land tips but, since PCB's are highly resistant to burning, unless incineration is properly carried out (a temperature of over 800°C is required), burning of materials containing PCB's will simply release them to the atmosphere for subsequent rain out into the sea.

In occurrence and distribution, as well as persistence and accumulation, PCB's behave in much the same way as organochlorines and all that has been said above for these compounds will apply to PCB's. They have been in use for a slightly longer period and, at least in the marine environment, are just as widely spread as DDT and their persistence is, if anything, greater rather than less than that of DDT.

The mode of action of PCB's is not well understood but may be similar to that of organochlorine insecticides. Certainly PCB's have been implicated in egg-shell thinning incidents in birds' eggs. The acute toxicity of PCB's is in general lower than that of organochlorine pesticides. However, there is some evidence to suggest that they have a high chronic toxicity, i.e. it may take a matter of weeks before a short-term low-level exposure takes effect.

In incidents of gross industrial exposure, illness and even death have been reported in humans, but there are no known ill effects on man which can be associated with levels of PCB's in marine products. Even in estuarine environments, PCB's have not been implicated in any damage to marine life, although in some areas quite high levels have been reported in fish. The presence of high concentrations of PCB's in the livers of sea birds was suggested as a possible contributory cause in a large-scale bird kill off the U.K. coast in 1969, but it is now generally accepted that natural causes played the major role in causing this bird mortality.

3.2.3 Organophosphorus compounds

This group of compounds includes malathion, parathion, azinphos-methyl and chlorfenvinphos and, with the carbamate compounds, is to some extent replacing the organochlorine insecticides. In chemical terms, they are more varied than the organochlorines, although they all contain phosphorus. They are relatively soluble in water, and may be carried into rivers, and hence the sea, in substantial amounts, by run-off from land. Spray losses and evaporation of sprayed material followed by rain out over the sea is a second probable route of entry to the marine environment. Industrial usage is probably small and therefore an insignificant source of pollution.

Most organophosphorus compounds are chemically less stable than the organochlorine type and they are therefore much less persistent in the environment. Most are hydrolysed slowly on contact with water and they are much less hydrophobic than organochlorines. As a result bio-accumulation is likely to be comparatively unimportant.

Because they are less persistent and non-accumulative, not much effort has been exerted in studying the role of organophosphorus compounds in the sea. They are likely to be present in true solution and, since they are not particularly lipophilic, they are unlikely to be found concentrated in surface slicks. Because they are not persistent, it seems unlikely that they will be found in ocean waters and there appear to be no reports of their occurrence in waters other than estuaries.

Organophosphorus compounds act on the nervous system by inhibition of cholinesterase activity. Their acute toxicity to marine animals is reasonably well documented and appears to differ widely according to the particular compound used, e.g. Azinphos-methyl was lethal to Crangon crangon at a concentration of 0.0003 ppm but Morphothion had no effect on the same species at 0.3 ppm. The mammalian toxicity of some organophosphorus compounds is high but residues have not so far been detected in marine organisms other than a few estuarine species and no cases of poisoning through the eating of organophosphorus pesticide contaminated fish have been reported or indeed, seem likely to occur.

3.2.4 Carbamate compounds

These compounds, which are based on carbamic acid, are of two basic types, the N-dimethylcarbamates e.g. Isolan and dimetan, and the N-methylcarbamates e.g. carbaryl and zectran. In general, they are less soluble in water than the organophosphorus compounds but more so than the organochlorines. Some of these materials, particularly carbaryl (Sevin), are now in fairly widespread use. They are likely to reach the sea by all the routes quoted for organophosphorus compounds. The main usage of carbamates is in agriculture but carbaryl is to some extent replacing DDT and may be used in future malaria control operations. It also has a small-scale role in mariculture as a means of controlling crustacean pests in shellfish cultivation programmes. This provides a direct route of entry to the marine environment.

None of the carbamate compounds is particularly stable; they are attacked by acids and alkalis and it is probable that slow hydrolysis will occur once they reach the sea. They can be relatively easily metabolised and the data available for marine animals suggest that, once taken in by, for example, a bivalve, they can be completely metabolised and/or excreted within about 2-3 weeks. They are therefore unlikely to pose much of a hazard as a result of persistence or accumulation. Carbamate compounds have not been detected on a wide scale in sea waters or marine animals but they are known to be readily adsorbed on silt and small concentrations may be found in estuarine sediments following local use on land and in mariculture.

Carbamate compounds are cholinesterase inhibitors; a few also show activity against other enzyme systems. A few of these compounds are also used as herbicides and they might be expected to have minor effects on the phytoplankton in local areas. The toxicity of carbamate compounds to marine animals follows the same highly variable pattern, depending on compound and species, which they exhibit in the terrestrial environment. Carbaryl is moderately toxic to crustacea but not to fish or molluscs. With the exception of Isolan, all the carbamate compounds are of low mammalian toxicity, and harm to human health, either directly or indirectly, through eating fish or shellfish, seems improbable. Isolan is of a lower mammalian toxicity than the organophosphorus compounds.

3.2.5 <u>Herbicides</u>

Herbicides are a mixed group of compounds, most of which have water solubilities of the order of tens of ppm or more. They include urea-based compounds such as linuron, dipyridyl compounds such as diquat, and acid ester hormone type compounds such as MCPA and 2,4-D. The major routes to the marine environment are probably direct water transport from the land or spray drift and subsequent rain out over the sea. Most of these compounds are likely to be found in dissolved form but a few, e.g. diquat, are strongly adsorbed by particulate matter and will be largely associated with sediments or suspended material. Very little attention has been paid to herbicide compounds to date and the extent of their distribution in the marine environment is a matter of speculation. Most are comparatively short-lived but a few, e.g. 2,4,5-T and picloram, have half lives up to 5 years.

Few of the herbicides are particularly toxic to fish and it seems unlikely that appreciable effects would be noticed. The main effect of herbicides in the marine environment, might be expected to be on the phytoplankton but very few data appear to be available on this subject. Tests with unialgal cultures at the U.K. Fisheries Laboratory, Burnham-on-Crouch with 2,4-D, dalapon and two triazine compounds suggest that at least some herbicidal compounds tend to stimulate growth of algae rather than to kill them. Dalapon is used in Spartina grass control in salt marsh areas but does not seem to cause mortality of marine creatures.

3.2.6 <u>Mercurial compounds</u>

A variety of organic mercurial compounds are used in agriculture and horticulture for the control of seed-borne and fungal diseases. They have been used extensively in the past as slimicides in the paper industry. Calomel is used in some areas as a fungicide and insecticide.

Most of the mercury compounds used have a low water solubility and in addition are strongly adsorbed on to soil particles. They are therefore only likely to find their way into the aquatic environment in times of flood. Mercury compounds are readily converted under anaerobic conditions to methyl mercury . There is some evidence to suggest that dimethyl mercury is readily volatilised and could subsequently find its way into the sea. The importance of this and other routes has still to be established and modes of entry into the marine environment are the subject of study at the present time.

Mercury occurs naturally in the marine environment as a result of the normal processes of weathering of mercury-bearing rocks. The data available at present suggest a concentration of ionic mercury in sea water in the range 0.03 to 0.3 g/l. Methyl mercury concentrations are probably about 1/1000 of this level. Locally higher concentrations have been recorded in coastal waters and are attributed to industrial pollution. Most mercury compounds decompose to the inorganic form which is then available for methylation. Mercury as an element is a highly conservative and persistent substance in the marine environment. Although the ionic form does not pose much of an accumulation hazard, methyl mercury is very readily taken up by marine organisms and accumulated in the food chain.

Methyl mercury has a high mammalian toxicity and produces nervous disorders and death at low levels of dietary intake. One ppm of mercury is considered by many national governments to be an unacceptably high level for food fish. However, such levels appear to have no ill effects on the fish and in certain species are even considered to be the norm by some authorities. Only in instances of extremely high mercury pollution have definite ill effects been observed in marine organisms. Normal levels of mercury in fish are probably in the range 0.01 to 0.2 ppm and it can thus be seen that only small increases in mercury levels as a result of pollution are likely to lead to health hazards in man. There have in fact already been two instances of mortalities as a result of eating mercury-polluted fish and shellfish.

3.2.7 Miscellaneous metal-containing pesticides

In addition to the compounds already discussed, there are a small number of metal salts and organo-metal compounds which are used as pesticides, e.g. Bordeaux mixture (copper salt), lead arsenate and fentin acetate. These compounds have appreciable solubilities in water and are likely to be transported to the sea by land run-off and drainage. Their contribution in terms of quantity of metal ions or compounds added to the sea is negligible compared to those from other sources, e.g. lead from automobile fuels, copper from industrial wastes. It therefore seems unlikely that harmful effects, in the marine environment, would arise from their use on the land. Most of the metal-containing pesticides are toxic to fish and improper use has caused fish kills in inland waters. It is therefore conceivable that local damage may occur, e.g. in estuaries, but the risk to humans is negligible.

3.3 Inorganic Wastes

Most of the elements listed in the periodic table are present in sea water in at least one form of ion or complex and their introduction does not necessarily constitute pollution, although similar amounts discharged to fresh water areas might do so. In addition, because sea water is a relatively strong solution when compared to fresh water it is able to absorb some inorganic pollutants, e.g. acids, with relatively little change in its overall chemical nature. These are two important factors which must be borne in mind when considering inorganic substances as marine pollutants.

Of the various inorganic compounds or ions which are likely to enter the marine environment a number can be selected as potential pollutants in certain circumstances - the remainder might, at the worst, be defined as contaminants.

3.3.1 Acids and Alkalis

The production of many inorganic chemicals and some organic chemicals may give rise to large quantities of waste acid or alkali which may be discharged to the marine environment. Sulphuric and hydrochloric acids are most likely to be discharged with smaller quantities of nitric acid. The effects of nitrate and sulphate are considered below but chloride, already present in large amounts in the sea, cannot be considered as a pollutant. The alkalis involved are sodium and to a lesser extent potassium hydroxide and ammonia. The ammonium cation is considered separately below but sodium and potassium fall into the same category as chloride.

Sea water has a considerable buffering capacity, i.e. it can absorb relatively large amounts of acid or alkali with comparatively small changes in pH. Discharges of un-neutralised acid or alkaline effluents are frequently made into estuaries and quantities of waste acids are dumped by barge away from the shore. A second major source of acid is the burning of fossil fuels which releases quantities of sulphur dioxide and acid oxides of nitrogen into the atmosphere (50-80 million tons annually). These may subsequently be rained out over the sea, but although rainfall containing sulphur dioxide (i.e. acidic) is believed to have affected the pH of some Swedish lakes, a similar effect on the sea seems unlikely (The buffering capacity of sea water is equivalent to 130 x 10^{12} tons of SO_3 and SO_3 is rapidly oxidised to SO_4). Burning of chlorine containing compounds, particularly substances such PVC, gives rise to HCl gas, which on dissolution, e.g. in rainwater, is a further source of acid which may grow in importance.

Although the effect on the pH of sea water of acids from the atmosphere cannot be detected, pH changes can be detected over relatively small areas in the proximity of discharges of acid or alkaline wastes both in estuaries and in the open sea in the wake of a discharging barge. It must therefore be concluded that the discharge of acids or alkalis can only have a local effect and that their distribution, although occurring possibly on a world wide scale, is completely accommodated by the carbon dioxide buffer system and has no effect.

The acute toxicity of both acids and alkalis to some marine animals is documented and, presumably because of the buffering capacity of the sea water, moderately high concentrations - several hundreds of ppm - have no effect. Fish and small crustacea can detect concentrations of acids and alkalis below the acutely toxic level and will avoid such concentrations. The toxic action of both acids and alkalis is probably mainly associated with the effect that they have on the oxygen - carbon dioxide transfer across the gill surface. At higher concentrations their corrosive action would undoubtedly be lethal.

3.3.2 Nutrients and Ammonia

Phosphate enters the sea via rivers and directly from outfalls via sewage where its origin is largely in the form of polyphosphate builders in detergent formulations. Small amounts may also be discharged by industry and some will enter as run-off from agricultural land. Nitrate will be introduced from fossil fuel burning, by rainfall over the sea, and large amounts reach the sea annually as a result of nitrate fertiliser usage on land. Sewage effluents contain nitrate and ammonia + nitrite both of which are oxidised by bacteria to nitrate. Ammonia may reach the marine environment in sewage effluents and as a result of its use in industrial processes. In addition large quantities of ammonium sulphate are produced as by-products in certain industrial processes. Some of this is considered waste and is discharged to the sea.

The concentration of ammonium ion in sea water is low (generally of the order of 5-50 μg/l) although locally it may be high near a discharge of nitrogen-containing waste. It is one of the intermediates in the bacterial decomposition of nitrogen-containing compounds which eventually terminates at nitrate. Ammonia is not therefore a persistent substance and large-scale distribution of high concentration is unlikely. Nitrate and phosphate are essential nutrients in the productivity of the marine environment. Over-abundance of these ions in freshwaters can lead to eutrophication with blooms of phytoplankton followed by deoxygenation, and anaerobic decay. Such phenomena have been recorded in the marine environment in fjord and estuarine areas (e.g. Oslo fjord). Both nitrate and phosphate are adsorbed on particulate matter and the sediments provide a reservoir and means of storage of excess nutrients. Although persistent, neither nitrate nor phosphate constitute accumulation hazards within marine animals and there is no evidence to suggest that concentrations less than grossly excessive would be toxic.

3.3.3 Cyanide

Wastes containing cyanide are discharged to rivers, estuaries and on open coasts from a variety of industrial premises, e.g. metal-plating plants, gas works and coke ovens, and from the scrubbing of steel works gases as well as a number of chemical processes. Direct discharges such as these account for most of the cyanide entering the marine environment. Whatever the form in which the cyanide is discharged, i.e. HCN, NaCN, etc. it readily takes the form of HCN with some dissociation to H^+ and CN^-. It is now generally accepted that HCN is much more toxic to aquatic life than CN^- and at pH 8 only about 7-10% of the HCN is dissociated. Cyanide is readily biodegradable and treatment methods are available which can eliminate the need to discharge cyanides. The biodegradability of cyanide and the readiness with which it forms complexes with certain metal ions, e.g. copper and iron, means that large scale distribution of cyanide is unlikely and that any detrimental effects would be local in nature.

3.3.4 Sulphite

Sulphite may enter the marine environment in wastes from certain industrial processes e.g. the pulp industry and rayon manufacture. Partially oxidixed sulphur dioxide produced from the burning of fossil fuels will also enter the sea as sulphite from the atmosphere. The sulphite ion is not stable in sea water, under normal aerobic conditions it will be oxidized to sulphate. Under anaerobic conditions sulphite and sulphate may be reduced by bacteria to sulphide which is toxic and obnoxious on amenity grounds. Sulphite is also toxic to marine life and, although not stable in the marine environment, is known to have caused damage to marine life near effluent discharges. Sulphate is not toxic to marine life and is present naturally in sea water in relatively high concentration (2.76 g/l); it cannot therefore be considered to be a pollutant.

3.3.5 Phosphorus

Phosphorus is normally found in the sea in the form of phosphate, either particulate, organic or inorganic. If discharged in elemental form, however, it remains largely in that state and is potentially highly toxic. The only known instances of elemental phosphorus being discharged to the marine environment are from factories producing phosphorus from phosphate ores. Much of the phosphorus becomes locked in the sediments where it remains virtually unchanged for a considerable period; the fraction remaining in the water is slowly oxidized to phosphate.

One large scale incidence of toxicity arose off the coast of Newfoundland from such a discharge. Large numbers of herring and smaller numbers of cod and other species were killed. The precise mode of action of the elemental yellow phosphorus has not been established, since, although in some species extensive haemolysis and reduction of haematocrits was observed, this did not apply to all species.

3.3.6 Titanium dioxide wastes

The industrial production of titanium dioxide from titanium ores can give rise to large volumes of a waste which is characterised by its high proportion of acid and ferrous sulphate. This particular waste is considered worthy of special attention since in many instances the waste is discharged, completely untreated, into the sea either from a pipeline or from barges.

The ferrous ion is very rapidly oxidized to ferric ion which precipitates in colloidal form as the hydrated hydroxide over a considerable area in the locality of the discharge or dumping. Although the effect of the acid is lost relatively rapidly, ferric hydroxide is persistent and remains in, or on, the sea bed for considerable periods. No ill effects on human health or living resources, except in the immediate vicinity of the discharge, have been reported but amenities might be affected in coastal areas due to deposition of ferric hydroxide in the intertidal region. The production of this waste is likely to decline rather than increase in the future since new methods are replacing the old sulphuric acid process.

3.3.7 Mercury

The mode of occurrence, toxicity, distribution, etc., of mercury are discussed in Section 3.2. Agricultural usage of pesticides is, however, a relatively minor source of mercury to the environment although their industrial usage as slimicides has had an important effect on the environment in some areas, e.g. Sweden and Canada.

The annual world production of mercury is approximately 9,000 tons, the majority of which is used by industry, the most important single usage being in the chlor-alkali industry. In theory no losses of mercury should occur but in fact typically 250 gm of mercury are lost per ton of chlorine produced. Much of this finds its way into the marine environment either via rivers or from the atmosphere. Other industrial usages of mercury are in the electrical industry in mercury switches and batteries and in the production of high grade antifouling paints. Mercury is also used as a catalyst in the production of acetaldehyde and vinyl chloride. It was this latter usage which led to the deaths of 41 people at Minamata in Japan.

In addition to these sources of mercury, which between them probably account for 4-5,000 tons added to the sea per year, an amount possibly equivalent or greater is derived from the burning of oils and coal much of which may contain some mercury albeit very low concentrations. This mercury is carried in the atmosphere and may be rained out over the sea.

Mercury is accumulated to a similar degree in both bivalve molluscs and fish, in contrast to other metals such as zinc and copper.

3.3.8 Lead

The annual world production of lead is approximately 3 million tons and the supply of lead to the marine environment as a result of man's activities must now be greatly in excess of the natural supply. Over 10 percent of the present annual production of lead is used in leaded motor fuels where it functions as an 'anti-knock' agent. Much of the lead is released to the atmosphere in exhaust fumes and subsequently finds its way into the sea. Use of lead in this way is believed to introduce 2×10^5 tons of lead into the marine environment annually and is believed to be the cause of the elevated lead concentrations found in sea waters adjacent to industrial and populated coasts. Lead is also introduced in the effluents of many chemical factories and natural processes of weathering probably contribute a further 2×10^5 tons annually. The concentration of lead found in the surface layers of near-shore sediments is now considerably higher than that in sub-surface layers.

Lead accumulates in animal tissues and is only very slowly excreted. It is an enzyme inhibitor and impairs cell metabolism. In marine animals it is probable that, at least in acute exposures, lead acts by damaging gill surfaces and hence inhibits oxygen-carbon dioxide transfer. Lead is persistent in the marine environment and marine sediments are probably the main storage point. In common with other 'heavy metals' (except mercury) lead is specially prone to accumulate in bivalve molluscs and the elevated levels of lead found in near shore sediments are causing high lead concentrations in these shellfish. However, no ill effects have so far been recorded either in fish or shellfish and there appear to be no recorded instances of human poisoning by eating marine products with high lead contamination. The rapid increase on the level of lead in the marine environment in recent years must, however, be viewed with concern.

3.3.9 Other Metals

A number of other metals besides lead and mercury are considered as potentially hazardous in a marine pollution context. These are copper and zinc both of which are produced on a very large scale annually (5 million tons), chromium (annual production 2 million tons) and cadmium. Arsenic, antimony, bismuth and selenium may also be of interest in view of their toxicity to man.

Chromium is likely to enter the marine environment largely as a result of its use in the metal-plating industry. In addition, small quantities are used in pest control and in paints. Recently, large quantities have been used in road marking materials some of which must reach the marine environment via rivers. Copper and zinc are used in large quantities for water pipes and water for plating of storage tanks respectively; zinc plating, galvanising etc. is commonly used as a rust preventative and quantities of copper and lead must be dissolved and run into rivers and sewers from all large towns. Sewage sludges, particularly from industrial areas, contain measurable amounts of both copper and zinc. In addition, both copper and zinc salts are used in a variety of industries and are found in many industrial waste discharges. Copper finds a small-scale usage in pesticide formulations. Cadmium is used largely in the plating and metallurgical industry in certain electrolytic processes. It is also a useful catalyst in some industrial processes; in addition cadmium compounds are used as pigments. Probably the most important route to the marine environment for all four of these metals is via rivers and sewage or industrial outfalls.

All four elements are found in sea water and some will be in the simple ionic form. The main forms in which they are found are probably as follows:

Copper - Ca^{2+} $CuOH^{+}$ $CuHCO_3^{+}$ $\underline{\underline{CuCO_3}}$ $CuCl^{-}$

Zinc - Zn^{2+} $ZnOH^{+}$ $ZnCO_3$ $ZnSO_4$ $\underline{\underline{ZnCl^{+}}}$

Cadmium - $CdCl^{+}$ $\underline{CdCl_2}$ $\underline{CdCl_3}$

Chromium - $\underline{Cr(OH)_3}$

(Underlining indicates the main form of occurrence in the sea.) Levels of all four elements appear to be higher near to the land, probably partly due to natural weathering of rocks but also due to man's usage of these elements.

Some of the forms in which the elements occur in sea water are insoluble and it seems likely that a proportion of the annual loss to the marine environment enters the sediments. There is definite evidence of accumulation by bivalves of very high concentrations of both copper and zinc, but marine fish appear to be less likely to accumulate these two elements. Cadmium is known to be accumulated by certain marine animals but data for chromium are lacking. There is evidence that cadmium, once in the human body, is only very slowly excreted. As with many other substances, the problems of synergism need to be borne in mind, for example nickel, which is of low toxicity to marine animals, can increase the toxicity of copper by a factor of 10.

3.4 Radioactive Materials

Although as a result of fallout from nuclear explosions or weapon testing, radioactive materials may reach the marine environment in uncontrolled amounts, the development of the civil uses of nuclear energy is strictly controlled, usually by special legislation so as to minimize the hazard to public health or damage to marine resources. The disposal of solid radioactive waste to the deep oceans is similarly controlled. There are no known effects on the natural environment on marine resources except in the immediate vicinity of nuclear test sites.

3.5 Oil and Oil Dispersants

The great increase in oil based technology has led to a corresponding rise both in the transport of oil by tankers and in the search for and exploitation of oil wells on the shallower parts of the ocean floor. This increase has also led to a corresponding increase in oil pollution.

Oils and oil products can enter the marine environment from submarine seeps, from shipping operations and marine accidents, both on the high seas and in port (up to 1m tons per annum) and by discharge to rivers, sewers, and so finally to the sea (up to 5m tons per annum).

In general, oil is lighter than water and tends to spread fairly rapidly, forming a thin layer which moves over the surface under the influence of winds and tides. Though found widely over the oceans it is most frequent around the main routes by which oil is carried from producing areas to the refineries and along trade routes and near the population centres they connect.

In temperate and tropical zones oils are biodegraded and also polymerized, under the action of light and oxygen, density increases and the particles become dense enough to sink to the sea floor. A fresh crude oil can lose up to 30 percent by evaporation in 30 hours. A much smaller amount can dissolve in the water. These effects tend to increase the density to the sinking point.

Oils with a high wax content or which are very viscous do not degrade so rapidly and are frequently found on beaches as lumps of so-called "tar".

In general terms: oil has a low toxicity to marine life, the types most at risk are those living in the littoral zone where oil may be deposited on a falling tide. In such circumstances, shellfish have become tainted and edible seaweeds both reduced in growth and made unsaleable. Experiments in temperate zones have shown that a single heavy contamination of the flora and fauna of the intertidal zone has a negligible effect though repeated applications (every tide) of a much smaller amount - a hardly visible film - eventually leads to a reduction in the number of species and in some cases, absence of life. In tropical areas marine life may be more sensitive to damage by oil.

In inland estuarine waters or enclosed bays or similar situations, accumulation of the more toxic aromatic fractions, together with the reduction in dissolved oxygen resulting from biodegradation, can produce more marked mortality of many species.

It is believed that traces of hydrocarbons may affect fish behaviour such as the return of salmon to the "home" river. Some oils contain carcinogens and the reported accumulation in the food chain could, if proven, lead to some risk to man as the ultimate consumer.

Oil pollution is always listed as an important contaminant of the ocean very largely because it is visible, and is a great despoiler of coastal amenities. It also kills sea birds, particularly the diving birds, which, being washed ashore in an oiled condition, arouse great concern.

Oil is difficult to remove from the sea surface, particularly in open water, consequently at present the only satisfactory methods of dealing with oil pollution while it is on the open sea are either to sink the oil by the application of a dense oleophilic powder, such as treated sand, or to disperse it in the sea by applying a suitable dispersing agent of low toxicity and then giving sufficient agitation to disperse the oil in the upper layers of the sea.

Neither of these methods removes the oil from the environment but no evidence of damage to oceanic resources has been observed. Methods suitable for use in the very cold waters of the Arctic and Antarctic are still to be developed.

3.6 Petrochemicals - Organic chemicals

The number of organic chemicals known at the present time exceeds 1 million and it has proved beyond the capacity of the present Working Group to do more than outline the major sources and general behaviour, fate and toxicity of organic chemicals and to draw attention to particular hazards that may be posed by certain substances.

The major sources of organic pollutants are the effluents from chemical factories and refineries, in many cases these are discharged directly to rivers, estuaries or the sea. In some circumstances quantities of organic chemical by-products are dumped at sea either in containers or as bulk effluents, e.g. wastes from PVC manufacture. An additional potential source of importance to particular areas is that posed by the shipping of bulk cargoes of such organic chemicals as solvents, or intermediates such as ethylene oxide vinyl acetate and vinyl chloride.

Biological treatment methods are available for many organic chemicals, e.g. phenols, and such compounds are unlikely to accumulate in the sea. Many others, e.g. polycyclic aromatics, are not so readily open to bacteriological degradation and might be expected to persist in the marine environment. Data on the distribution of organic chemicals in the sea is, on the whole, sparse, but a few chemicals, particularly those derived from oil and possibly PVC production, are likely to be found on a world-wide scale.

Very few of the large number of organic chemicals have been examined for toxicity and accumulation by marine animals, although such data are available for the more widely used substances such as the commoner aliphatic and aromatic solvents. It is also known that some substances are taken up by marine animals, e.g. phenols, and there have been several instances of tainting of food fish. A number of organic chemicals are known or suspected carcinogens in mammals, e.g. benzene and alpha-naphthylamine, and may have the same effect on fish.

3.7 <u>Organic industrial wastes - including Pulp and Paper Mill waste</u>

In general, these wastes can be harmful to receiving waters for four reasons:

(a) toxicity
(b) biochemical oxygen demand (BOD)
(c) suspended solids
(d) colour

A variety of compounds in organic wastes are toxic to marine organisms. In pulp mill wastes, for example, these are usually sulphur-containing compounds, arising from the wood digestion process, and chlorinated phenolic compounds created by bleaching the pulp and paper.

High BOD is a characteristic of untreated sulphite pulp effluents, as well as of any other biodegradable organic wastes. Many fish kills have occurred because of oxygen depletion in waters receiving high-BOD wastes. Stabilization ponds with aeration, and activated sludge systems are common forms of treatment.

The solid organic wastes from industry accumulate in sludge beds to produce local nuisances. These undergo decomposition and remove dissolved oxygen from water. They often form noxious gases. In addition, large areas of the bottom of receiving bodies of water may be covered with a thin layer of settled organic material having undesirable effects on benthic communities. Improved in-plant facilities, more efficient screening and better retention in clarifiers and/or ponds are helping to reduce solids losses.

The effects of industrial organic wastes are often of a subtle long-term nature. They may interfere with various trophic levels in the food chain which ultimately lead to degradation of the coastal environment. These problems may be of particular significance to tropical insular areas. The effects on the higher forms of marine flora and fauna are often sub-lethal rather than acute. For example, oyster quality is known to have declined in many pulp mill areas, although there is little documentation on actual mortality. The food supply of these sedentary organisms can be markedly altered owing decline of phytoplankton caused by turbidity and colour.

3.8 Military wastes

The dumping of military wastes is a significant factor in the pollution of national and international waters. These wastes may consist of organic materials, biological and chemical warfare agents, heavy metals, petrochemicals, out-dated explosives, defoliating agents, pesticides, solid objects, dredging spoils and other miscellaneous inorganic materials peculiar to the military establishment. Because of the classified aspect of military operations, the exact chemical and toxicological nature of these materials is frequently unknown. Moreover, details concerning the dumping of these materials are not generally available. Nevertheless, it should be pointed out that the dumping of many of these materials may be contrary to sound conservation practice.

3.9 Heat

Thermal pollution has specific economic associations since many industrial activities are developing in coastal areas partly because of the availability of cheap cooling water.

Increase in temperature arising from thermal pollution may cause two main types of undesirable effects; it decreases oxygen solubility in water and increases metabolic activities of microflora and fauna generally, which in turn may result in higher BOD and eutrophication. When pollution from domestic sources is accompanied by thermal pollution a local environmental degradation may result affecting natural self-purification capacity. Fluctuating water temperatures may produce changes in biological communities. The effects of this form of pollution naturally depend on the recipient sea water temperature and that of the effluents.

In certain circumstances thermal pollution has made estuaries and enclosed reef areas unsuitable for various commercial species of fish and shellfish and, on the other hand, may lead to the introduction and establishment of undesirable forms such as timber boring organisms. Special care is needed in siting power stations employing seawater for cooling in tropical areas where animals and plants may have a rather narrow range of temperature tolerance.

3.10 Detergents

Pollution qualities of detergents have been related to:

(1) non-biodegradability, resulting in foaming of receiving waters; and

(2) phosphate content, leading to enrichment of receiving waters.

Virtually all domestic detergents on the world markets today are biodegradable, as a result of conversion by manufacturers from the "hard" alkyl benzene sulfonate (ABS) to the "soft" linear alkyl sulfonate (LAS) form. The former are, however, still widely used in industry. Sodium tripolyphosphate remains as a major constituent (20-60%) in detergents. Because it performs vital functions related to cleaning efficiency and no generally acceptable substitute is available, manufacturers are reluctant to eliminate or even reduce the amount of phosphate in detergents. NTA (sodium salt of nitrilotriacetate) has been used as a substitute for phosphate in detergents but recently some doubts have been expressed as to the wisdom of this; its environmental effects are not fully known. Optical whiteners, added to most detergents, appear to persist in the environment and their effects should be studied.

3.11 Solid objects

Pollution of the sea by solid objects takes the form of floating and sunken articles such as wrecked ships, drums, wire, bottles, timbers, unwanted vehicles and plastic articles, including ropes and fishing nets made of synthetic fibres. Many of these are virtually indestructible. Their main effect is that they are a nuisance in that they interfere with navigation and fishing operations and when washed up on shores reduce amenities. For example, pieces of synthetic ropes and fishing nets are commonly found floating in areas of intense fishing activity, such as the North Sea, and they can immobilize vessels by getting wound round propeller shafts. Again, plastic bottles and containers thrown overboard and washed ashore are a common feature of beaches in many parts of the world. There is also increasing evidence of damage to sea birds due to their getting entangled in pieces of floating fishing net. Sunken objects may also interfere with fishing operations and some areas have been reported as being unfishable after offshore oil drilling operations on account of the rubbish left behind. In some cases, the dumping of objects has been on such a scale as to affect the habitat of bottom-living animals.

Various types of waste, some very poisonous, are dumped into the sea in containers, which gradually deteriorate. The waste then escapes and may contaminate marine life or be a hazard to human health, if the containers have been deposited on the continental shelf.

3.12 Dredging spoil and inert wastes

Inert wastes are introduced into the marine environment via rivers and pipelines, by dredging and mining operations and from barges. In shallow coastal seas dispersal away from the coast may be seriously hampered by various types of sediment traps. Frequently, solid matter discharged into the sea returns to neighbouring shores or estuarine waters, thus threatening areas where important marine, plant and animal populations are located.

Dredging and mining operations can create an excessively high sedimentation factor which can reduce the supply of light for plants, smother fish eggs, larvae, invertebrates, and micro-organisms, thereby interfering with the normal bottom component of biological energy cycling. These effects may be particularly disastrous in tropical reef areas where many reef organisms such as corals, sponges and coelenterates are especially sensitive to increased sedimentation. There is a need for accurate quantative data regarding the effects of increased sedimentation on marine fauna and flora.

In addition to sand and silt dredged from navigable channels and harbours, and dumped at sea, there are industrial activities which result in a large volume of inert waste which may either reach the sea by pipeline as a slurry, be dumped from barges, or merely tipped on the shore. Examples are china clay, gypsum, "red mud" from bauxite reduction, fly-ash from power stations and colliery waste. These materials are usually inert and non-toxic but may affect marine life by settling on the sea bed, and so modifying the ecosystem, or by creating turbid conditions and reducing light penetration. Primary production may be decreased, fish spawning grounds may be destroyed and the settlement of molluscs prevented. The bottom may be rendered unsuitable for crustacea such as lobsters, crabs and prawns, but new communities of bottom animals may be produced which may provide additional food for fish. Where dredging includes a substantial quantity of organic material an additional BOD may be created locally and nutrients may be added.

Table 1

MAJOR CATEGORIES OF MARINE POLLUTION

Category	Harm to living resources	Hazards to human health	Hindrance to maritime activities	Reduction of amenities
1) Domestic sewage including food processing wastes	++	++	(+)	++
2) Pesticides				
Organochlorine compounds	++	(+)	-	-
Organophosphorus compounds	+	+	-	-
Carbamate compounds	+	(+)	-	-
Herbicides	+	(+)	-	-
Mercurial compounds	++	++	-	-
Miscellaneous metal-based cpds.	+	+	-	-
PCBs	+	(+)	-	-
3) Inorganic wastes				
Acids and alkalis	(+)	-	+	-
Nutrients and Ammonia	(+)	(+)	-	(+)
Cyanide	(+)	(+)	-	-
Sulphite	+	-	-	(+)
Titanium dioxide wastes	(+)	-	-	(+)
Mercury	++	++	-	-
Lead	+	+	-	-
Copper	+	?	-	-
Zinc	+	-	-	-
Chromium	+	?	-	-
Cadmium	+	?	-	-
Arsenic	+	?	-	-
4) Radioactive materials	-	+	-	-
5) Oil and oil dispersants	+	?	+	++
6) Petrochemicals and organic chemicals				
Aromatic solvents	+	?	-	(+)
Aliphatic solvents	+	?	-	(+)
Phenols	+	+	-	(+)
Plastic intermediates and by-products	+	?	-	-
Plastics	(+)	-	+	+
Amines	+	?	-	-
Polycyclic aromatics	+	+	-	-
7) Organic wastes including pulp and paper wastes	++	?	(+)	+
8) Military wastes	+	?	+	?
9) Heat	+	-	-	-

cont'd ....

Table 1 (cont'd)

Category	Harm to living resources	Hazards to human health	Hindrance to maritime activities	Reduction of amenities
10) Detergents	+	–	–	(+)
11) Solid objects	+	–	+	++
12) Dredging spoil and inert wastes	+	–	+	+

Key to symbols:

++ important

\+ significant

(+) slight

? uncertain

– negligible

Table 2

PRINCIPAL SOURCES OF MARINE POLLUTION

Category of pollutant	(a) Manufacture and use of industrial products – disposal via direct outfalls and rivers	(b) Domestic wastes. Disposal via direct outfalls and rivers	(c) Agriculture Forestry Public Health via run-off from land	(d) Deliberate dumping from ships	(e) Operational discharge from ships in course of duties	(f) Accidental release from ships and submarine pipelines	(g) Exploitation of sea bed mineral resources	(h) Military activities	(i) Transfer from the atmosphere
1. Domestic Sewage including food processing wastes	+	++	–	+	(+)	–	–	–	–
2. Pesticides									
Organo-chlorine compounds	+	+	++	(+)	–	0	–	?	++
Organophosphorus compounds	+	(+)	+	–	–	0	–	?	+
Carbamate compounds	+	–	(+)	–	–	0	–	–	–
Herbicides	+	(+)	+	–	–	0	–	+	+
Mercurial compounds	+	–	++	–	–	0	–	?	?
Miscellaneous metal-containing compounds	+	(+)	(+)	–	–	0	–	–	?
PCB's	++	(+)	–	(+)	–	–	?	–	+
3. Inorganic Wastes									
Acids and Alkalis	+	–	–	+	–	+	–	–	–
Sulphite	+	–	–	–	–	–	–	–	(+)
Titanium dioxide wastes	0	–	–	0	–	–	–	–	–
Mercury	++	+	–	+	–	0	–	?	++
Lead	+	(+)	–	?	–	(+)	–	–	++
Copper	++	(+)	(+)	(+)	–	(+)	–	–	–
Zinc	+	–	–	+	–	(+)	–	–	–
Chromium	+	–	–	?	–	0	–	?	–
Cadmium	++	–	–	–	–	0	–	?	–
Arsenic	+	–	(+)	+	–	0	–	?	?
4. Radioactive materials	++	–	–	(+)	–	0	–	(+)	0*

Cont'd ....

Table 2 (cont'd)

Category of pollutant	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
5. Oil and oil dispersants	++	(+)	-	+	+	++	+	+	-
6. Petrochemicals and Organic chemicals									
Aromatic solvents	++	-	-	(+)	-	(+)	-	?	?
Aliphatic solvents	+	-	-	(+)	-	(+)	-	?	?
Plastic intermediates and by-products	++	-	-	+	-	(+)	-	-	?
Phenols	++	(+)	(+)	+	-	0	-	(+)	-
Amines	+	-	-	(+)	-	0	-	-	-
Polycylic aromatics	++	-	-	+	-	0	?	-	-
7. Organic Wastes including pulp and paper wastes	++	++	+	+	-	-	-	-	-
8. Military Wastes	?	-	-	?	?	?	-	?	-
9. Heat	++	-	-	-	-	-	-	-	-
10. Detergents	+	++	(+)	-	-	-	-	-	-
11. Solid Objects	+	+	-	++	++	(+)	(+)	+	-
12. Dredging spoil and inert wastes	+	-	-	+	-	-	++	-	-

Key to Symbols

++ important
\+ significant
(+) slight
? uncertain
\- negligible
0 potentially harmful
* dependent on extent of weapons testing

INDICATION FOR CONTROL

In relation to the prevention and control of marine pollution, the symbols in Tables 1 and 2 would generally imply the following:

++	- restrictive or preventive measures recommended
+	- restrictive or preventive measures should be considered
0	- measures to assess potential harm advisable
?	- further investigations required pending which caution is recommended
(+)	- no special action indicated
-	- no special action indicated.

****

ANNEX V

IDENTIFICATION OF NOXIOUS AND HAZARDOUS CARGOES WHICH MAY CAUSE SERIOUS MARINE POLLUTION

1. With a view to facilitating the effective implementation of future international agreements or other measures for the prevention and control of marine pollution, GESAMP was requested by IMCO to identify the noxious and hazardous cargoes other than oil which are currently being carried by ships and which could, therefore, be accidentally released into the sea as a result of a maritime casualty. In carrying out this task, reference has been made to the following documentation:

(a) The International Maritime Dangerous Goods Code, in respect of substance carried in packages[1/]; and

(b) Information, made available to IMCO by its Member Governments, on dangerous substances which are at present being carried in bulk by ships.

2. The Group felt that there was first a need to identify those substances which are highly toxic, very persistent or subject to bioaccumulation and which can, therefore, be expected to cause extensive, long-term or permanent damage to the marine environment as a whole. Additionally, the Group has identified other substances which are toxic or otherwise harmful but which can be expected to have less extensive and/or less persistent effects but which nevertheless can produce severe damage in certain localities or under certain circumstances. The substances are, therefore, listed in two main categories as follows:

(a) Category I - Substances which on release into the sea present a major hazard to either human health or marine resources or cause serious harm to amenities and, therefore, justify the application of special measures to prevent their escape into the marine environment. This category includes pesticides, compounds of fluorine, arsenic, antimony or mercury and persistent oils. These substances are listed in Appendix I.

(b) Category II - Substances which, on release into the sea may present a hazard to either human health or marine life or are harmful to amenities but which, because of their short-term or strictly localized effect, require special anti-pollution measures only in certain circumstances or localities - i.e., if a large shipment is involved or if the release is likely to take place in the proximity of susceptible marine resources or in an enclosed area such as a bay, canal or dock. This category includes compounds of lead, zinc or chromium or concentrated acids or alkalis. These substances are listed in Appendix II.

3. In accordance with the request made to it, the Group has confined the present study to the identification of pollutants other than oil, as defined in Article I of the International Convention for the Prevention of Pollution of the Sea by Oil, 1954. Other persistent oils, carried as cargo, however, can give rise to serious pollution if released into the sea and should, therefore, be included in Category I.

1/ In this context the term "packages" includes a wide range of receptacles for transporting solid, liquid or gaseous dangerous substances including large containers such as portable tanks. The Code contains provisions covering the construction and testing of all types of packagings together with other conditions for their safe carriage such as stowage, segregation, fire and spillage procedures, medical first-aid, etc.

4. The Group noted that radioactive substances, which are listed in Class 7 of the Code, are transported under special conditions and/or are contained in packages which have been specially designed and tested to ensure that radiation leakage does not exceed a safe value under specific accident conditions (see IAEA Safety Series No. 6 - "Regulations for the Safe Transport of Radioactive Materials"). Furthermore, special provisions have been formulated for the control of radioactive pollution of the sea (see IAEA Safety Series No. 5 - "Radioactive Waste Disposal into the Sea"). For these reasons, such cargoes have not been included in either Category I or Category II.

5. The lists should not be regarded as exhaustive since ships may well carry other cargoes, not classed as dangerous, which could cause serious pollution if released into the sea and, furthermore, new dangerous substances, not listed in the Code, may be expected to be offered for shipment in the future. In such cases, the lists may be taken as an indication of the types of cargoes for which special preventive measures may be considered necessary; nevertheless, it should be noted that continuing research on the effects of pollutants in the marine environment may indicate the need for some revision of the lists from time to time. For this reason, the Group recommends that the Organization should arrange for their periodical review in the future both to re-examine the status of materials already listed and to add new materials to the appropriate category.

6. Thus each list contains essentially certain main groups of chemicals of a similar chemical nature, which have been considered worthy of inclusion in Category I or II respectively, according to the kind of hazard they present either to human interests or marine life. New chemicals of a similar composition to those listed, can be given the same categorization as other compounds of that type, e.g. compounds containing fluorine would be included in Category I.

Appendix 1

CATEGORY I

Substances which on release into the sea present a major hazard to either human health or marine resources or cause serious harm to amenities and therefore justify the application of special measures to prevent their escape into the marine environment.

NOTE - This category includes substances such as:

(i) pesticides

(ii) compounds containing fluorine, arsenic, antimony or mercury

(iii) persistent oils (see paragraph 3 above).

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI- FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
ACETONE CYANOHYDRIN, stabilized	6120	1541	Packages/Bulk
ACID MIXTURES, hydrofluoric and sulphuric	8105	1786	Packages
ACROLEIN, inhibited	3103	1092	Packages/Bulk
ACRYLONITRILE, inhibited	3104	1093	Packages/Bulk
ALDRIN	6121	1542	Packages
ALDRIN, mixtures, dry and liquid	6122	1543	Packages
ALKALI METAL AMALGAMS, not otherwise specified	4320	1389	Packages
ALKALINE EARTH METAL AMALGAMS, not otherwise specified	4323	1392	Packages
ALKALOIDS, poisonous and their salts, not otherwise specified	6123	1544	Packages
AMMONIUM ARSENATE	6126	1546	Packages
AMMONIUM HYDROGEN FLUORIDE	8115	1727	Packages

GESAMP III/19
ANNEX V

CATEGORY I

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN INDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
AMYL MERCAPTAN	3214	1111	Packages
ANILINE	6127	1093	Packages/Bulk
ANTIMONY COMPOUNDS, inorganic, not otherwise specified	6129	1549	Packages
ANTIMONY LACTATE	6130	1550	Packages
ANTIMONY PENTACHLORIDE, liquid	8119	1730	Packages
ANTIMONY PENTACHLORIDE, solutions	8120	1731	Packages
ANTIMONY PENTAFLUORIDE	8121	1732	Packages
ANTIMONY POTASSIUM TARTRATE	6131	1551	Packages
ANTIMONY TRICHLORIDE, (a) solid	8122	1733	Packages
ANTIMONY TRICHLORIDE, (b) liquid	8123	1733	Packages
ARSENIC ACID (a) liquid	6133	1553	Packages
ARSENIC ACID (b) solid	6134	1554	Packages
ARSENIC BROMIDE	6135	1555	Packages
ARSENIC COMPOUNDS, (a) liquid, not otherwise specified	6136	1556	Packages
ARSENIC COMPOUNDS, (b) solid, not otherwise specified	6137	1557	Packages
ARSENIC PENTOXIDE	6138	1559	Packages
ARSENIC TRICHLORIDE	6139	1560	Packages
ARSENIC TRIOXIDE	6140	1561	Packages
ARSENICAL DUST	6141	1562	Packages
BIFLUORIDES, not otherwise specified	8132	1740	Packages
BORON TRIFLUORIDE	2107	1008	Packages
BORON TRIFLUORIDE ACETIC ACID COMPLEX	8134	1742	Packages

CATEGORY I

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
BORON TRIFLUORIDE PROPIONIC ACID COMPLEX	8135	1743	Packages
BROMINE PENTAFLUORIDE	8137	1745	Packages
BROMINE TRIFLUORIDE	8138	1746	Packages
BRUCINE	6153	1570	Packages
CALCIUM ARSENATE	6155	1573	Packages
CALCIUM ARSENATE AND ARSENITE, solid mixtures	6156	1574	Packages
CHLORINE	2114	1017	Packages/Bulk
CHLORINE TRIFLUORIDE	8142	1749	Packages
CHLOROPHENATES, CHLOROPHENOLS, solid	6164	2020	Packages
CHLOROPHENATES CHLOROPHENOLS, liquid	6165	2021	Packages
CHROMIC FLUORIDE, solid	8149	1756	Packages
CHROMIC FLUORIDE, solution	8150	1757	Packages
COAL TAR OIL	-	-	Bulk
COPPER ACETOARSENITE	6172	1585	Packages
COPPER ARSENITE	6173	1586	Packages
CREOSOTE COAL TAR	-	-	Bulk
CREOSOTE OIL	-	-	Bulk
CRESOL	-	-	Bulk
CROTONALDEHYDE	3224	1143	Packages
CUT-BACKS, asphalt or bitumen	3225 3230	1116	Packages/Bulk
CYANOGEN	2126	1026	Packages
CYANOGEN CHLORIDE	2127	1589	Packages
1.1 - DIFLUOROETHANE	2133	1030	Packages
1.1 - DIFLUOROETHYLENE	2134	1959	Packages

CATEGORY I

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
DIFLUOROPHOSPHORIC ACID, anhydrous	8161	1768	Packages
ENDRIN, mixtures, dry and liquid	6191-1	-	Packages
ETHYLENEIMINE, inhibited	3236	1185	Packages/Bulk
FERRIC ARSENATE	6197	1606	Packages
FERRIC ARSENITE	6198	1607	Packages
FERROUS ARSENATE	6199	1608	Packages
FLUOBORIC ACID	8169	1775	Packages
FLUORINE	2151	1045	Packages
FLUOROPHOSPHORIC ACID, anhydrous	8170	1776	Packages
FLUOROSULPHONIC ACID	8171	1777	Packages
FLUOSILICIC ACID	8172	1778	Packages
HEXAETHYL TETRAPHOSPHATE	6202	1611	Packages
HEXAETHYL TETRAPHOSPHATE and compressed gas mixture	6203	1612	Packages
HEXAFLUOROPHOSPHORIC ACID	8176	1782	Packages
HEXAFLUOROPROPYLENE	2154	1858	Packages
HYDROFLUORIC ACID, solution	8183	1790	Packages/Bulk
HYDROGEN CYANIDE, anhydrous, stabilized	2160	1051	Packages
HYDROGEN FLUORIDE, anhydrous	2161	1052	Packages/Bulk
HYDROGEN SULPHIDE	2163	1053	Packages
INSECTICIDE GASES, toxic, not otherwise specified	2164	1967	Packages
INSECTICIDE GASES, non-toxic, not otherwise specified	2165	1968	Packages
INSECTICIDES	9032	1615	Packages
INSECTICIDES, liquid, toxic, not otherwise specified	3241 3334-1	1995	Packages

CATEGORY I

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
LEAD ARSENATES	6208	1617	Packages
LEAD ARSENITES	6209	1618	Packages
MAGNESIUM ARSENATE	6212	1622	Packages
MERCAPTANS AND MIXTURES, liquid	3118	1228	Packages
MERCURIC ARSENATE	6213	1623	Packages
MERCURIC CHLORIDE	6214	1624	Packages
MERCURIC NITRATE	6215	1625	Packages
MERCURIC POTASSIUM CYANIDE	6216	1626	Packages
MERCUROUS NITRATE	6217	1627	Packages
MERCUROUS SULPHATE	6218	1628	Packages
MERCURY ACETATE	6219	1629	Packages
MERCURY AMMONIUM CHLORIDE	6220	1630	Packages
MERCURY BENZOATE	6221	1631	Packages
MERCURY BISULPHATE	6222	1633	Packages
MERCURY BROMIDES	6223	1634	Packages
MERCURY COMPOUNDS, inorganic, not otherwise specified	6224	2024	Packages
MERCURY COMPOUNDS, organic, not otherwise specified	6225	2025	Packages
MERCURY CYANIDE	6226	1636	Packages
MERCURY FULMINATE, containing by weight, at least 20% water	-	0135	Packages
MERCURY GLUCONATE	6227	1637	Packages
MERCURY IODIDE	6228	1638	Packages
MERCURY NUCLEATE	6229	1639	Packages
MERCURY OLEATE	6230	1640	Packages
MERCURY OXIDE	6231	1641	Packages

GESAMP III/19
ANNEX V

CATEGORY I

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
MERCURY OXYCYANIDE	6232	1642	Packages
MERCURY POTASSIUM IODIDE	6233	1643	Packages
MERCURY SALICYLATE	6234	1644	Packages
MERCURY SULPHATE	6235	1645	Packages
MERCURY THIOCYANATE	6236	1646	Packages
NICOTINE	6244	1654	Packages
NICOTINE, compounds and preparations, not otherwise specified	6245	1655	Packages
NICOTINE HYDROCHLORIDE, and solutions	6246	1656	Packages
NICOTINE SALICYLATE	6247	1657	Packages
NICOTINE SULPHATE, solid or solution	6248	1658	Packages
NICOTINE TARTRATE	6249	1659	Packages
NITROSYL CHLORIDE	2185	1069	Packages
ORGANOPHOSPHATES, poisonous, not otherwise specified	6255	1893	Packages
OXYGEN DIFLUORIDE	-	-	Bulk
PARATHION and mixtures, solid, liquid or under compressed gas	6256	1668	Packages
PENTACHLOROETHANE	6257	1669	Packages
PERCHLOROMETHYLMERCAPTAN	6258	1670	Packages
PESTICIDES, high hazard (a) solid	6258-1	-	Packages
PESTICIDES, high hazard (b) liquid	6258-2	-	Packages

CATEGORY I

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
PESTICIDES, high hazard, such as:	6258-3 6258-4	-	Packages
Organophosphorus Compounds			
Organochlorine Compounds			
Carbamates			
Substituted Nitrophenols			
Alkaloids			
Organomercury Compounds			
Organotin Compounds			
Miscellaneous Compounds			
PESTICIDES, low hazard, such as:	9036-1 -2 -3 -4	-	Packages
Organophosphorus Compounds			
Organochlorine Compounds			
Carbamates and derivatives of Urea			
Substituted Nitrophenols			
Alkaloids			
Miscellaneous Compounds			
PHENYLMERCURIC ACETATE	6261	1674	Packages
PHENYLMERCURIC COMPOUNDS	6262	2026	Packages
PHENYLMERCURIC HYDROXIDE	6263	1894	Packages
PHENYLMERCURIC NITRATE	6264	1895	Packages
PHOSGENE	2191	1076	Packages
PHOSPHORUS, amorphous	4158	1338	Packages
PHOSPHORUS, white or yellow (a) dry	4257	1381	Packages
PHOSPHORUS, white or yellow (b) in water	4258	1381	Packages/Bulk
POTASSIUM ARSENATE	6266	1677	Packages
POTASSIUM ARSENITE	6267	1678	Packages
POTASSIUM BIFLUORIDE, (a) solid	8202	1811	Packages

CATEGORY I

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
POTASSIUM BIFLUORIDE, (b) solution	8203	1811	Packages
POTASSIUM FLUORIDE, (b) solution	8204	1812	Packages
POTASSIUM FLUORIDE, (a) solid	6270	1812	Packages
SILICON TETRAFLUORIDE	2196	1859	Packages
SILVER ARSENITE	6273	1683	Packages
SODIUM AMALGAM	4362	1424	Packages
SODIUM ARSENATE	6275	1685	Packages
SODIUM ARSENITE, aoqueous solutions	6276	1686	Packages
SODIUM ARSENITE, solid	6276-1	2027	Packages
SODIUM FLUORIDE, solid	6280	1690	Packages
SODIUM FLUORIDE, solution	8218	1820	Packages
STRONTIUM ARSENITE	6281	1691	Packages
STRYCHNINE, and salts	6282	1692	Packages
SULPHUR HEXAFLUORIDE	2198	1080	Packages
TETRAETHYL PYROPHOSPHATE, and compressed gas mixture	6288	1705	Packages
THALLIUM COMPOUNDS	6289	1707	Packages
ZINC ARSENATE and ARSENITE, solid mixtures	6294	1712	Packages

Appendix 2

CATEGORY II

Substances which on release into the sea may present a hazard to either human health or marine life or are harmful to amenities but which, because of their short-term or strictly localized effect require special anti-pollution measures only in certain circumstances or localities - i.e., if a large shipment is involved or if the release is likely to take place in the proximity of susceptible marine resources or in an enclosed area such as a bay, canal or dock.

NOTE: This category includes substances such as:

(i) compounds of lead, zinc or chromium

(ii) concentrated acids or alkalis

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
ACETALDEHYDE	3101	1089	Packages/Bulk
ACETONE	3102	1090	Packages
ACRYLIC ACID, inhibited	-	-	Bulk
ADIPONITRILE	-	-	Bulk
ALLYL ALCOHOL	3211	1098	Packages/Bulk
ALLYL BROMIDE	3211	1099	Packages
ALLYL CHLORIDE	3105	1100	Packages
ALLYL isoTHIOCYANATE, stabilized	6124	1545	Packages
ALUMINIUM PHOSPHIDE	6125	1397	Packages
ALUMINIUM TRIETHYL	4224	1102	Packages/Bulk

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
AMMONIA, anhydrous	2103	1005	Packages/Bulk
AMMONIA, solutions	2104	1005	Packages/Bulk
AMMONIUM DICHROMATE	5121	1439	Packages
AMMUNITION, tear producing, non-explosive, with neither burster nor expelling charge, non-fused	6126-1	2017	Packages
AMMUNITION, toxic, explosive, with burster or expelling charge, fuzed or non-fuzed	-	0020	Packages
AMMUNITION, toxic, explosive, with neither burster nor expelling charge, fuzed or non-fuzed	-	0021	Packages
AMMUNITION, toxic, non-explosive, with neither burster nor expelling charge, non-fuzed	6126-2	2016	Packages
AMYL ACETATE	3212 3310	1104	Packages/Bulk
ANILINE HYDROCHLORIDE	6128	1548	Packages
BARIUM AZIDE, dry or containing, by weight, less than 50% water or alcohol	-	0024	Packages
BARIUM AZIDE, containing at least 50% water or alcohol	6142	1571	Packages
BARIUM COMPOUNDS, not otherwise specified	6143	1564	Packages
BARIUM CYANIDE	6144	1565	Packages
BARIUM OXIDE	6145	1884	Packages
BENZENE	3214	1114	Packages/Bulk
BENZIDINE	6146	1855	Packages
BENZYLIDENE CHLORIDE	6147	1886	Packages
BERYLLIUM, metal powder	6148	1567	Packages
BERYLLIUM COMPOUNDS	6149	1566	Packages

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
BORDEAUX ARSENITES, liquid or solid	6150	1568	Packages
BROMOACETONE	6151	1569	Packages
BROMOBENZYLCYANIDE	6152	1694	Packages
BUTYRALDEHYDE	3220	1129	Packages/Bulk
isoBUTYRALDEHYDE	-	-	Bulk
CACODYLIC ACID	6154	1572	Packages
CALCIUM CYANIDE	6157	1575	Packages
CARBON DISULPHIDE	3107	1131	Packages/Bulk
CHLOROACETONE, stabilized	6158	1695	Packages
CHLOROACETOPHENONE	6159	1657	Packages
CHLOROANILINES, (a) liquid	6160	1576	Packages
CHLOROANILINES, (b) solids	6161	1576	Packages
CHLOROBENZENE	3317	1134	Packages/Bulk
CHLORODINITROBENZENE	6162	1577	Packages
2-CHLOROETHANOL	3318	1135	Packages
CHLOROHYDRINS, crude	-	-	Bulk
CHLORONITROBENZENES	6163	1578	Packages
CHLOROPICRIN	6166	1580	Packages
CHLOROPICRIN and METHYL BROMIDE, mixtures	6167	1581	Packages
CHLOROPICRIN and METHYL CHLORIDE, mixtures	6168	1582	Packages
CHLOROPICRIN, mixtures, not otherwise specified	6169	1583	Packages
CHLOROSULPHONIC ACID	8147	1754	Packages/Bulk
4-CHLORO-ortho-TOLUIDINE HYDROCHLORIDE	6170	1573	Packages
CHROMIC ACID, solution	8148	1755	Packages

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
CHROMIUM OXYCHLORIDE	8151	1758	Packages
CHROMIUM TRIOXIDE, anhydrous	5146	1463	Packages
COAL TAR DISTILLATE, containing BENZENE or HOMOLOGUES	3318 3221	1136	Packages
COAL TAR LIGHT OIL	3319 3222	1137	Packages
COBALT NAPHTHENATES, powder	4127	2001	Packages
COCCULUS, solid	6171	1584	Packages
COPPER CYANIDE	6174	1587	Packages
CROTONALDEHYDE	3224	1143	Packages/Bulk
CUMENE	3340	1918	Packages/Bulk
CYANIDES, solutions	6175	1935	Packages
CYANIDES, inorganic, not otherwise specified	6176	1588	Packages
CYANOGEN BROMIDE	6177	1889	Packages
CYANOGEN CHLORIDE	6178	1589	Packages
CYCLOHEXANOL	-	-	Bulk
CYCLOHEXANONE	3321	1915	Packages/Bulk
DECABORANE	4129	1868	Packages
isoDECALDEHYDE	-	-	Bulk
DICHLOROANILINES	6179	1590	Packages
DICHLOROBENZENES	6180	1591	Packages
Di-(4-CHLOROBENZOYL) PEROXIDE (a) dry or containing less than 10% water or less than 30% phlegmatizer	-	0149	Packages
Di-(4-CHLOROBENZOYL) PEROXIDE (b) containing at least 10% water	5245	1531	Packages

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
Di-(4-CHLOROBENZOYL) PEROXIDE (c) containing at least 30% phlegmatizer	5246	1531	Packages
DICHLOROETHYL ETHER	3323	1916	Packages/Bulk
1-2 DICHLOROPROPANE	-	-	Bulk
DICHLOROPROPANE	-	-	Bulk
DICHROMATES, inorganic, not otherwise specified	5147	1464	Packages
DIETHYLAMINE	3109	1154	Packages
DIETHYLBENZENE	-	-	Bulk
DIETHYLENE GLYCOL MONOBUTYL ETHER	-	-	Bulk
DIETHYLENE GLYCOL MONOETHYL ETHER	-	-	Bulk
DIETHYLENE GLYCOL MONOMETHYL ETHER	-	-	Bulk
DIETHYLENE TRIAMINE	3221	1160	Packages/Bulk
DIETHYL SULPHATE	6181	1594	Packages
DIETHYLZINC	4236	1366	Packages
DIMETHYLAMINE, anhydrous	2136	1032	Packages/Bulk
DIMETHYLAMINE, solution	3227	1160	Packages
DIMETHYLDICHLOROSILANE	3228	1162	Packages
DIMETHYLHYDRAZINE, unsymmetrical	3228	1163	Packages
DIMETHYL SULPHATE	6182	1595	Packages
DIMETHYLZINC	4239	1370	Packages
DINITROANILINES	6183	1596	Packages
DINITROBENZENES	6184	1597	Packages
4, 6-DINITROorthoCRESOL	6185	1598	Packages
DINITROPHENOLS, (a) dry, insufficiently wetted	-	0076	Packages
DINITROPHENOLS, (b) wetted with not less than 15% water	4130	1320	Packages

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
DINITROPHENOLS, (c) solution in water or inflammable liquid	6186	1599	Packages
DINITROPHENOLATES, (a) dry, or insufficiently wetted	-	0077	Packages
DINITROPHENOLATES, (b) wetted with not less than 33% of water	4131	1321	Packages
DINITRORESSORCINOLS, dry or containing, by weight, less than 15% water	-	0078	Packages
DINITRORESORCINOLS, wetted with not less than 33 1/3% of water	4132	1322	Packages
DINITROTOLUENES liquid; or solid and wetted with not less than 10% of water	6187	1600	Packages
DIPHENYLAMINE CHLOROARSINE	6188	1698	Packages
DIPHENYLCHLOROARSINE	6189	1699	Packages
DODECYL BENZENE, commercial	-	-	Bulk
DYE INTERMEDIATES, poisonous, liquid or solid, not otherwise specified	6191	1602	Packages
EPICHLOROHYDRIN	6192	2023	Packages/Bulk
ETHYL ACRYLATE, inhibited	3232	1917	Packages
ETHYLBENZENE	3327	1175	Packages/Bulk
ETHYL BROMOACETATE	6193	1603	Packages
ETHYL CHLOROACETATE	3328	1181	Packages
ETHYL CHLOROFORMATE	3234	1182	Packages
EPICHLOROHYDRIN	6192	2023	Packages/Bulk
ETHYLDICHLOROSILANE	3235	1183	Packages
ETHYL DICHLOARSINE	6194	1892	Packages
ETHYLENEDIAMINE	6195	1604	Packages/Bulk
ETHYLENE DIBROMIDE	6196	1605	Packages

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
ETHYLENE DICHLORIDE	3236	1184	Packages/Bulk
ETHYLENE GLYCOL	-	-	Bulk
ETHYLENE OXIDE, containing not more than 0.2% of nitrogen	2145	1040	Packages/Bulk
ETHYLTRICHLOROSILANE	3238	1196	Packages
FORMALDEHYDE, solutions containing 37% to 50%	3331	1198	Packages/Bulk
FORMIC ACID	8173	1779	Packages/Bulk
FURFURAL	3332	1199	Packages/Bulk
FURFURYL ALCOHOL	-	-	Bulk
HALOGENATED IRRITATING LIQUIDS, not otherwise specified	6201	1610	Packages
HYDROCYANIC ACID, aqueous solution of not more than 20% of hydrogen cyanide	6204	1613	Packages
HYDROGEN CYANIDE, anhydrous, stabilised, absorbed in a porous inert material	6205	1614	Packages
IRON CARBONYL	3116	1994	Packages
ISOPHORONE	-	-	Bulk
JET FUEL	-	-	Bulk
KEROSENE	3339	1123	Packages/Bulk
LEAD ACETATE	9033	1616	Packages
LEAD AZIDE, containing by weight at least 20% water	-	0129	Packages
LEAD CHROMATE	9034	1619	Packages
LEAD CYANIDE	6210	1620	Packages
LEAD DIOXIDE	5153	1872	Packages
LEAD NITRATE	5154	1469	Packages
LEAD ORES or CONCENTRATES	-	-	Bulk
LEAD PERCHLORATE	5155	1470	Packages

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
LEAD STYPHNATE, containing by weight, at least 20% water	-	0130	Packages
LEAD SULPHATE, containing more than 3% of free acid	8186	1794	Packages
LONDON PURPLE	6211	1621	Packages
MESITYL OXIDE	3335	1229	Packages/Bulk
METHYLAMINE, aqueous solution	3120	1235	Packages
METHYL BROMIDE and ETHYLENE DIBROMIDE, liquid mixtures	6237	1647	Packages
METHYL CHLOROFORMATE	3246	1238	Packages
METHYL BUTYRALDEHYDE	-	-	Bulk
METHYLCHOROMETHYL ETHER	3121	1239	Packages
METHYL CYANIDE	6238	1648	Packages/Bulk
METHYLDICHLOROSILANE	3246	1242	Packages
METHYLTRICHLOROSILANE	3249	1250	Packages
MOTOR FUEL ANTI-KNOCK COMPOUNDS	6239	1649	Packages/Bulk
NAPHTHALENE	4152	1334	Packages/Bulk
NAPHTHYLAMINE	6240	1650	Packages
NAPHTHYLTHIOUREA	6241	1651	Packages
NAPHTHYLUREA	6242	1652	Packages
NICKEL CARBONYL	3124	1259	Packages
NICKEL CYANIDE	6243	1653	Packages
NITRIC ACID, other than red fuming, all concentrations	8187	2131	Packages/Bulk
NITRIC ACID, red fuming	8188	2032	Packages/Bulk
NITROANILINES	6250	1661	Packages
NITROBENZENE	6251	1662	Packages
NITROPHENOLS	6252	1663	Packages
2-NITROPROPANE	-	-	Bulk
NITROTOLUENES	6253	1664	Packages
NITROXYLENES	6254	1665	Packages
NONYL ALCOHOL	-	-	Bulk

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
NONYL PHENOL	-	-	Bulk
isoOCTANOL	-	-	Bulk
PHENOLS	9037	1617	Packages/Bulk
PHENYLCARBYLAMINE CHLORIDE	6259	1672	Packages
PHENYLENEDIAMINES	6260	1673	Packages
orthoPHOSPHORIC ACID, liquid	9030	1805	Packages/Bulk
POTASSIUM CUPROCYANIDE	6268	1679	Packages
POTASSIUM CYANIDE	6269	1680	Packages
POTASSIUM DICHROMATE	9039-1	1874	Packages
POTASSIUM HYDROXIDE, solution up to about 50% concentration	8206	1814	Packages/Bulk
β PROPIOLACTONE	-	-	Bulk
PROPIONIC ANHYDRIDE	-	-	Bulk
PYRIDINE	3259	1282	Packages
SELENIC ACID	8212	1905	Packages
SILVER CYANIDE	6274	1684	Packages
SODIUM AZIDE	6277	1687	Packages
SODIUM CACODYLATE	6278	1688	Packages
SODIUM CYANIDE	6279	1689	Packages
SODIUM DICHROMATE	9041-1	1497	Packages
SODIUM DINITROorthoCRESOLATE, (a) dry or containing, by weight, less than 15% water	-	0234	Packages
SODIUM DINITROorthoCRESOLATE, (b) wetted with not less than 10% of water	4167	1348	Packages
SODIUM DINITROorthoCRESOLATE, (c) wetted with not less than 30% of water	4168	1348	Packages
SODIUM HYDROXIDE, solution up to about 50% concentration	8223	1824	Packages/Bulk

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
STYRENE MONOMER, inhibited	-	-	Bulk
SULFOLANE	-	-	Bulk
SULPHURIC ACID, fuming or containing more than 95% of acid	8229	1831	Packages/Bulk
TEAR GAS, irritating substances liquid or solid, not otherwise specified	6283	1693	Packages
TEAR GAS CANDLES, non-explosive	6284	1700	Packages
1, 1, 2, 2-TETRACHLOROETHANE	6285	1702	Packages
TETRAETHYL DITHIOPYROPHOSPHATE, and compressed gas mixture	6286	1703	Packages
TETRAETHYL DITHIOPYROPHOSPHATE, liquid and mixtures	6287	1704	Packages
TETRACHLOROETHYLENE	9043	1897	Packages/Bulk
TETRAHYDRONAPHTHALENE	-	-	Bulk
1, 2, 4-TRICHLOROBENZENE	-	-	Bulk
1, 1, 1-TRICHLOROETHANE	-	-	Bulk
TRIDECANOL	-	-	Bulk
TRIETHYLENE TETRAMINE	-	-	Bulk
TRIMETHYLCHLOROSILANE	3264	1298	Packages
TOLUENE	3263	1294	Packages/Bulk
TOLUIDINES	6290	1708	Packages
2, 4-TOLUYLENEDIAMINE	6291	1709	Packages
TURPENTINE	3344	1299	Packages/Bulk
VALERALDEHYDE	-	-	Bulk
VINYL ACETATE, inhibited	3265	1301	Packages
VINYL TOLUENE (Meta and para, mixed)	-	-	Bulk
VINYLTRICHLOROSILANE, inhibited	3266	1305	Packages
XYLENE	3267 3345	1307	Packages/Bulk

CATEGORY II

NAME OF SUBSTANCE	IMDG CODE PAGE NO. (if listed)	UN IDENTI-FICATION NO. (if listed)	METHOD OF CARRIAGE ABOARD SHIP (as indicated by present information)
XYLIDINES	6292	1711	Packages
XYLYL BROMIDE	6293	1701	Packages
ZINC, powder or dust, non-pyrophoric	4373	1436	Packages
ZINC, powder or dust pyrophoric	4262	1383	Packages
ZINC ASHES	4374	1435	Packages
ZINC CHLORATE	5199	1513	Packages
ZINC CHLORIDE, solution	8240	1840	Packages
ZINC CYANIDE	6295	1713	Packages
ZINC DITHIONITE	4271	1931	Packages
ZINC NITRATE	5200	1514	Packages
ZINC PERMANGANATE	5201	1515	Packages
ZINC PEROXIDE	5202	1516	Packages
ZINC PHOSPHIDE	6296	1714	Packages

ANNEX VI

COMMENTS TO IOC AND ITS GROUP OF EXPERTS ON LONG-TERM SCIENTIFIC POLICY AND PLANNING (GELTSPAP) REGARDING MARINE POLLUTION PROBLEMS OUTLINED IN LEPOR

The Group noted with satisfaction the recognition in the GELTSPAP proposals that research related to marine pollution problems must have an important place in the Long-term and Expanded Programme (LEPOR), and the implication that it be given high priority. Pertinent parts of the Report of the First Session of GELTSPAP (GELTSPAP I/17) are appended (Appendix 1). In examining the conclusions and recommendations of the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing, a high degree of correspondence between these Conference recommendations (Appendix 2) and elements of the marine pollution proposals of LEPOR was noted. This was considered desirable and the Group endorsed the steps being taken to establish active cooperative exercises related to marine pollution and grouped under the heading Global Investigation of Pollution in the Marine Environment (GIPME).

The following comments and suggestions are submitted on paragraphs 48 through 59 of the report of the Group of Experts on Long-term Scientific Policy and Planning (GELTSPAP I/17). Some suggestions for additional investigations related to marine pollution are also offered.

48. International Seminars, Workshops and Panels on Specific Analytical Problems

It was the opinion of the Group that panels similar to those conducted by IAEA for intercalibration and for establishing minimum permissible concentrations for radio-isotopes be organized, taking into account the comprehensive report and recommendations of the Seminar on Methods of Detection, Measurement and Monitoring of Pollutants in the Marine Environment organized by FAO (Rome, 1970).

It was suggested that SCOR be invited to establish a working group to consider the problems connected with the preparation of reliable standard solutions and intercalibration procedures for the most significant marine pollutants.

It was proposed that a working paper be prepared for the next session of GESAMP on the use of remote sensing equipment from satellites for the purpose of pollution monitoring. The great amount of lead time necessary between a proposal for satellite use and its operational stages prompts the suggestion at this time.

49. Laboratory Network and Scientific Collaboration

The Group agreed with the suggestions made in paragraph 49 and recommended urgent action with respect to their implementation.

50. Monitoring Programme

This paragraph is related to 1.9, Monitoring Pollution and its Effects, of the FAO Conference recommendations. It has been considered under paragraph 10 of the Report of the Third Session of GESAMP, and detailed in its Annex VII.

51. Oil Pollution Research and Control

This paragraph is related to FAO Conference recommendation 1.5, Oil Pollution. The Group strongly recommended the early development of research programmes concerning short and long-term ecological effects of oil pollution in both arctic and tropical regions. It was the opinion of the Group that a considerable amount of research was already in progress concerning the oil pollution problem with the exception of the types of location mentioned above.

52. Regional Investigations of Marine Pollution

The Group noted that this paragraph was related to items 2.3 and 2.6 of the FAO Conference recommendations. It suggested that the development of a regional cooperative exercise relating to oceanography and marine ecology in a tropical and sub-tropical region be given very high priority. Reasons for this are the fact that funding for such an exercise is not easily available, because such regions are in proximity to developing nations, and that the tropical ecosystems are believed to be especially vulnerable to pollution effects.

This recommendation is made in addition to complete endorsement of recommendation 2.5 and other related Conference recommendations.

53. Deep-sea Diffusion Studies

It was noted with satisfaction that this paragraph is covered by FAO Conference recommendations 1.3, 3.2 and 6.5. The paragraph and the Conference recommendations were strongly endorsed.

Deep trenches, especially those extending through continental shelves and terminating near the coast-line, are being considered as possible disposal sites for barge dumping and pipeline discharges.

However, little is known about the transport and dispersion characteristics of trench waters, chemical exchange properties and accumulation rates of the sediments, and the transient or permanent biological properties of trenches. This information is required in order to evaluate the potential of trench systems for waste disposal. A regional cooperative exercise relating to the above studies is suggested.

54. Laboratory Research on Mode of Uptake and Route of Marine Contaminants

The Group considered this item to be clearly related to paragraph 49, which pertains to a laboratory network and scientific collaboration and recommended that the items covered by the two paragraphs be developed simultaneously. This paragraph is also related to FAO Conference recommendation 1.4.

The Group recommended that a list of priorities for pollutants and organisms to be investigated be established within the general frame-work of the laboratory research programme.

The Group also recommended that the title of paragraph 54 be amended to include "Metabolic transformations of the pollutant", due to the great importance of metabolic considerations in this work.

55. Pollution Analogues

The Group regarded research in this field to be only preliminary and considered it premature to include this item as an element of the LEPOR programme.

56. Varved Sediments as Indicators of Natural Effects

The Group agreed that several approaches (including varving) should be considered in attempting to separate natural fluctuations from pollution induced effects. However, studies of shorter term natural fluctuations in ecosystems should receive a higher priority than varved sediment studies.

57. Further Environmental Studies

The Group supported the suggestions made under this paragraph but recommended that it be viewed in a broader context. A variety of organisms, mostly from coastal waters in temperate regions, are known to be useful integrators and thus indicators of certain pollutants. An effort should be made to extend this list of organisms from a wider range of geographic areas as well as from the deep-sea benthos. This would facilitate global surveys of the distribution of pollutants as well as studies of the fate of materials reaching deep waters by dumping or natural means.

In interpreting the results it will be necessary to take into account biological transport (e.g. by fish migrations, motions of the deep scattering layer) deep-sea advection, diffusion and transient processes.

The Group also noted with interest and strongly endorsed the FAO Conference recommendation on "Pollution and Ecosystems" and further recommended that SCOR be invited to establish a working group to consider the present "state of the art" regarding the mathematical modelling of ecosystems of relevance to marine pollution studies, and to make suggestions regarding the nature of additional biological information requirements, in particular experimental ecosystems, as well as mathematical techniques of possible value for accelerated progress.

It was suggested that attention be given to the problems involved in the dynamics and exchange of pollutants between air, water, sediments and biota.

58. Anticipation of Future Pollution

The Group noted these suggestions with interest, and suggested that one or more highly qualified industrial chemists and sanitary engineers be invited to take part in any specific programme development related to anticipating future pollution.

59. International Centres for Pollution Information and Data Exchange

It seemed to the members of the Group that data exchange system development with special reference to marine pollution is premature, based on the information available. As a temporary measure, the Fisheries Data Centre of FAO should act as an interim depository for available data related to marine pollution and marine organisms, and should consider ways and means for developing an effective data exchange system.

NEW RECOMMENDATIONS

Microbiology - Micro-organisms play an important part in connection with pollution, not only as possible pathogens but as agents of change of substances. There is a great need for research into the role of marine bacteria in the biodegradation of pollutants in general, but in particular the following items should be investigated:

(a) factors affecting the role of degradation of certain pollutants (e.g. oil, detergents, etc.);

(b) a technique for measuring the degree of biodegradability (e.g. biodegradability index.) Note: this will involve a critical survey of various indices already in use (BOD, half-life, etc.) as well as devising new ones;

(c) changes in toxicity induced by bacteria;

(d) accumulation of pollutants by micro-organisms.

ANNEX VI

Appendix 1

Distribution: limited

IOC/B-76
(GELTSPAP I/17)
Paris, 23 December 1970
Original: English

UNITED NATIONS EDUCATIONAL,
SCIENTIFIC AND CULTURAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

GROUP OF EXPERTS ON LONG-TERM SCIENTIFIC POLICY
AND PLANNING

(First Session, Monaco, 16 to 25 November 1970)

EXTRACT OF REPORT

Marine Pollution

42. We were well aware of the importance of the marine pollution problem, as discussed in "Global Ocean Research" and later emphasized by the Commission in adopting the "Outline". Because of its potential impact on the welfare of man, the problem has attracted the attention of numerous organizations, including a number of bodies in the UN system, whose concern with the scientific aspects is focussed in GESAMP.

43. The IOC should, through the Expanded Programme, contribute to scientific understanding of the problem by promoting and coordinating joint action of its Member States in relevant scientific investigations. It should also sponsor, though not necessarily itself compile, the proposed periodic Review of the State of Health of the Ocean. The goal of IOC cooperative exercises in this field should be the development of the scientific basis for management action required to deal with marine pollution problems at national, regional and international levels. It is, however, a peculiarly difficult task to define appropriate exercises because of the interactions of most oceanic processes and phenomena in pollution problems. There is a clear need to promote and coordinate research in specific fields, and to arrange for systematic and regular communication among scientists and scientific institutions. Moreover, marine science must contribute to any broad marine pollution monitoring system that may be developed, and to the specialized training of scientists and technicians in fields related to it.

44. In one sense, pollutants in the ocean are perturbations, often minor in magnitude, of a natural system which itself is so poorly known, that few of its changes can unequivocally be ascribed to the effects of the pollutants. Discussion of marine pollution has sometimes been based on extrapolation and transplantation of terrestrial and fresh-water experience, even though the marine ecological systems are clearly different in some aspects of their behaviour from those on land. The IOC, through its connexions with marine scientists and governments concerned with marine science, should be able to develop a fundamentally ocean-oriented investigation of pollution in the marine environment.

45. We therefore propose (Pollution Exercise 3.1) that the Commission establish a Global Investigation of Pollution in the Marine Environment as a major exercise in the Expanded Programme, and that it take the following actions to this end:

(a) Invite GESAMP and the Commission's scientific advisory bodies, to develop the programme elements of this Investigation. In doing so, they should consider the proposals already made by the Commission and by GESAMP, the expanded and new proposals given below, and the results of the FAO Technical Conference on Marine Pollution and its Effects on Living Resources and Fishing, and the associated Seminar.

(b) Based on the recommendations of GESAMP and the scientific advisory bodies, establish an appropriate organizing committee for the Investigation. Under this committee, subsidiary bodies would be set up as necessary for specialized tasks (see, for example, para. 48 below).

(c) In accordance with recommendations of the organizing committee, propose to Member States of IOC and the Agencies concerned, the nature of their participation in all aspects of the Investigation, including participation in baseline sampling and monitoring activities and the designation of existing national and international laboratories to carry out specific international tasks.

(d) Accept a major responsibility for the exchange and dissemination of results of the Investigation, including the periodic convening of scientific conferences and publication of reports.

46. Within the major exercise specified above, we propose that arrangements should be made for further consideration of the following twelve suggestions for specific types of action. Seven of these (paras. 48 to 54 below) we have developed along the lines formulated in the Outline and later elaborated in the report of the second session of GESAMP. Pertinent extracts from this latter document, which we have annotated, are appended for convenience (Annex VIII). Reference should be made to the proposed Geo-science Exercise 4.4. We also propose five new suggestions (paras. 55 to 59 below).

47. We wish to stress that at our first session we had no time to prepare a well ordered, detailed and homogeneous set of proposed actions. The following paragraphs 48 to 59 should therefore be considered only as a draft to be examined in much more detail, with reference again to the suggestions in the Outline, "Global Ocean Research" and the second report of GESAMP. We suggest that under the arrangements specified above the relevant parts of all these documents, including this section of our present report and materials from the FAO Seminar on Methods of Detection, Measurement and Monitoring of Pollutants in the Marine Environment, and the Conference on Marine Pollution and its Effects on Living Resources and Fishing, should be integrated into a single, detailed working paper which would constitute the elaboration of Cooperative Exercise Pollution 3.1.

48. International Seminars, Workshops and Panels on Specific Analytical Problems

In support of a technical, preparatory phase for a monitoring system and of appraisal of the results, as need be, the Commission should convene international seminars, workshops and/or panels on specific problems related to scientific aspects of marine pollution. Such gatherings would be analogous to those convened by the International Atomic Energy Agency, concerning the detection of radionuclides and the establishment of maximum permissible concentrations in the sea. They would provide for an exchange of information, cross-fertilization of ideas and possibly development of techniques needed to assess certain pollution problems, as well as the development of environmental quality criteria. They would provide the personal contact for inter-laboratory collaboration. Suggestions in paragraphs 50 and 55 require the early convening of such bodies.

49. Laboratory Network and Scientific Collaboration

Arrangements should be made for linking existing laboratories and scientists concerned with marine pollution research, creating a flexible system for improving international co-operation. This would facilitate the conduct of experiments for development of analytical and sampling methods and for intercalibration and standardization. Temporary exchanges of scientists for joint work could be arranged. It would be desirable to broaden the scope of some existing laboratories, especially those already providing some international services, and to establish a few new centres, as suggested by GESAMP. An appropriate existing, or new laboratory, or perhaps several of them might be selected to act as a centre or centres for improving analytical methods and comparability of results, as well as to provide some study and training facilities in these methods for scientists from both technically advanced and developing countries. It was suggested that one such laboratory might be developed from the International Laboratory of Marine Radioactivity at Monaco and we suggest that the authorities concerned be approached to this end.

50. Monitoring Programme

A detailed study must be made to identify more precisely the elements of a desirable and feasible marine pollution monitoring system. It is necessary to establish what pollutants and marine materials are to be monitored, and how. The ways of incorporating some of these elements in IGOSS need to be worked out in detail. Chemical components in the sea water need to be monitored but more importantly, attention should be given to monitoring living organisms, including naturally resident organisms and selected "indicator" or "warning" organisms (like to coal miners' canaries) introduced for sampling purposes. The initial phase of this programme may be the establishment of guidelines by which future changes may be evaluated, through parallel analyses of selected pollutants and pollution analogues (para. 55 below).

A monitoring programme should be focussed on the physical, chemical or biological concentration mechanisms that facilitate detection as well as determine significance. Platforms of opportunity (including selected ships, scientific and navigational buoys, ocean station vessels, etc.) and existing monitoring programmes, should be used. Internal filtering, fouling and captive organisms may be most useful early means of concentration and broad sampling. Comparable methods of analysis and their improvement are essential.

With the aid of this coordinated monitoring programme, and with laboratory support, it also might be possible to give effect to the suggestion in "Global Ocean Research" that all information about changes in the marine environment be brought together, and an attempt made to ascertain which of these changes may have been influenced by man's actions.

In parallel with the marine monitoring programme, and starting even before it is established, there must be an initial survey and a system for compiling significant data and information from all sources as a major contribution to an annual Report on the State of Health of the Ocean.

51. Oil Pollution Research and Control

Liquid hydrocarbons are generally accepted as deserving high priority among specific pollutants needing research and control now. Some danger of accidental injections into the marine environment will persist so long as crude oil and oily products are transported in quantity over or under the sea, used as the main fuel of ships, and extracted from the sea-bed. A system for rapidly predicting the fate of spilt oil in any given instance, and the effects of attempting to dispose of it in various alternative ways could be devised. This would be useful even on the basis of our present very incomplete state of scientific knowledge. Later, such arrangements might be applied to spillages of other pollutants. We examined a draft proposal for such a system and concluded that this idea was worthy of further development. Financial means could come perhaps from non-governmental sources. They system would be of direct interest at least to some developing countries such as those near tanker routes. It might be operated by a separate specialized unit, but under the general technical guidance of the Commission and in close coordination with IMCO. To have rapid access to oceanographic and meteorological data in real-time, it would need to be linked to World Weather Watch and IGOSS. An accelerated programme of research, especially as related to the long-term effects of oil pollution, is considered highly desirable in conjunction with the above proposal.

52. Regional Investigations of Marine Pollution

Certain regions of the oceans are bordered by large populations and many industries of technically advanced nations. The waters of some of these regions are exhibiting symptoms of general pollution and are becoming a concern to the coastal States. Areas like the

Baltic Sea, the Mediterranean, the North Sea, the Gulf of Mexico and the Sea of Japan, have levels of pollution which could eventually reach serious proportions. Others, like the Arctic and waters round Indonesia, where there is a great potential for industrial development, could develop intensive pollution.

We propose that the following regions should be designated for international collaboration in the expansion of the marine scientific programme: (a) the Arctic Ocean, in the vicinity of oil and gas exploitation; and (b) tropical or sub-tropical regions where underwater mineral exploitation is practised or proposed, or where there are coral reefs, which are very sensitive to harmful effects from man's activities. In some areas, there is already under way, or is planned, bilateral or multilateral collaboration in such studies.

53. Deep-Sea Diffusion Studies

Ocean dumping and disposal of wastes from ordinary trash, radioactive processes, chemical wastes, ammunition and other explosives and military materials, are practised. More generally, detrital settlement conveys surface water pollutants to the sea floor. There is very little known about the processes of diffusion and advection, or about the transport and migration by organisms in the deep bottom waters which may convey these substances. In some cases, there could be a serious threat to marine resources as these toxic materials damage the benthic populations and enter the food chain. Appropriate research results could be used to define more precisely the areas where dumping might safely be practised, and the types of materials that could be disposed of in this way, the concentrations of various substances that might be permitted, and the rate of introduction of pollutants from the surface. We propose that experiments be designed and executed to elucidate diffusion and other physical and biological processes near the bottom in the deep sea. We were aware of the need also to develop the essential techniques for such experiments.

54. Laboratory Research on Mode of Entry, Uptake and Route of Marine Contaminants

The uptake by marine organisms of certain contaminants, such as pesticides, polychlorinated byphenyls and heavy metals, is extremely important. The biological accumulation of such materials through the different trophic levels can lead to damaging concentrations in the top predators and consumers. Uptake experiments should be made in parallel with tests of the validity of pollution analogues (see para. 55 below).

While we know that research on this problem is usually a responsibility of national laboratories, we wish to emphasize the urgent need for more information and better exchange of it. This would contribute to better development of a global monitoring programme by pin-pointing the processes of greatest biological significance.

55. Pollution Analogues

The potential vulnerability of various organisms to several large classes of important pollutants can, in some instances, be appraised by studying a limited number of carefully selected "pollution analogues" (i.e. minor natural components of sea water or phytoplankton that behave like such pollutants). After these analogues have been selected, a broad cooperative sampling programme is required. An existing or new national or international laboratory should undertake the responsibility for the necessary analyses.

56. Varved Sediments as Indicators of Natural Effects

The ocean and its biosphere undergo large natural fluctuations that are poorly known and thus difficult to distinguish from man-made effects. There are also natural inputs of pollutant-like materials (e.g. from erosion and run-off, glaciers, volcanism and geothermal activity, etc.) which must be appraised. The long-term characteristics of some natural fluctuations might be evaluated through examination of varved sediments, the upper layers of which may also reveal the effect of recent man-made inputs (see also para. 39).

57. Further Environmental Studies

Benthic organisms and benthic detritus, particularly in the deep sea, may be especially useful integrators, and thus indicators, of pollutants. Distributions need to be established and samples collected for analysis of various constituents. Biological transport (fish migration, scattering layer motion, etc.) must be taken into account. More knowledge of the dominant deep-sea advection and diffusion and/or transient processes is required to identify the physical effects as distinct from the biological processes (see also para. 53).

58. Anticipation of Future Pollution

It is necessary to examine the trends of potential pollution inputs resulting from advancing technology (e.g. juvenile hormone insecticides, residues of contraceptive pills, organo-metallic components, mitostatic agents; thermal, electrical, sonic and other energy additions; and "negative" pollution - that is to say, in the terms of the adopted definition of marine pollution, removals, rather than additions of substances). World production and use of products discharged in large quantities into air and/or water should be monitored and reported routinely. Methods for detection and analysis of these must be developed.

59. International Centres for Pollution Information and Data Exchange

Pollution research information through publications and various reports is growing rapidly. The large amount of data gathered from the international network of laboratories and from the global monitoring programme must have a suitable repository for archiving and rapid retrieval.

We stress the need for one or more international marine pollution data and information centres. We were aware of the existence of the World Data Centres (Oceanography) and realize that pollution data and information centres might appropriately be adjuncts of these. An alternative is for one of the pollution data and information centres to be associated with a central or coordinating laboratory of the laboratory network.

ANNEX VI

Appendix 2

SELECTED RECOMMENDATIONS FROM THE FAO TECHNICAL CONFERENCE
ON
MARINE POLLUTION AND ITS EFFECTS ON LIVING RESOURCES AND FISHING
(ROME, DECEMBER 1970)

1.3 Dumping

One particular instance of pollution concerned deliberate off-shore dumping in the high seas. This received special attention, as presenting problems not only in the general context of pollution, but also as presenting physical problems and even danger to fishermen, and indeed potential international problems in so far as such dumping is done extra-territorially. The Conference strongly recommended that deliberate dumping of toxic and solid wastes on recognized and potential fishing grounds and other shallow water areas be prohibited. It was also recognized that, even in respect of carefully controlled dumping in deep waters, much further information is still required on important aspects such as rates of degradation of the materials, and especially rates of transport and diffusion of toxic substances in such circumstances, both physically in the aquatic medium and biologically through the food-web. The use of dumping in deep trenches where in-folding may occur should be further investigated. The Conference recommended that FAO, in collaboration with IOC, be asked to encourage and speed up research in both fields as a matter of urgency.

1.4 Mercury pollution

The Conference was aware of the accumulation of mercury by aquatic organisms and of the tragic consequences of mercury pollution to human health, particularly as exemplified by the so-called "Minimata disease" in Japan. Moreover, because of the hazards of mercury poisoning and the banning of contaminated fish, the fishing industry in many parts of the world has suffered severe economic losses. The Conference was informed that technology is now available virtually to eliminate mercury losses from industries where this metal is used. Therefore, the Conference recommended that action be taken by governments to require advanced techniques be adopted for mercury recovery in all factories producing mercurial products or using mercury or its compounds as catalysts, cathodes or for other purposes in production. It further recommended that seed-dressings, slimicides and other mercurial compounds be replaced at the earliest possible time by other non-mercurial substitutes.

1.5 Oil pollution

The Conference recognized that there will be a continuous increase in the amount of petroleum and its products transported over and under the sea by ships and pipelines, and exploited from the sea bed, and recognized that in spite of measures taken by IMCO and industry concerned, it would be very difficult to eliminate all accidental or deliberate releases into the sea from these sources, and that releases from land-based installations and through the atmosphere are also taking place in substantial amounts; noted with concern the damage already done to water fowl and to some aquatic organisms; the potential hazards of the accumulation of dangerous chlorinated hydrocarbons, such as DDT and polychlorinated biphenyls, as well as other aromatic hydrocarbons in oil films and the possible toxicity to aquatic life and possibly to man; and potential damage by oil to sensitive ecosystems, such as those of coral reefs and of arctic waters and, therefore recommended an immediate increase in research at national or international laboratories, to examine more closely the scientific problems associated with oil pollution effects on the marine environment and its living organisms, so that action can be taken to avoid dangers that could arise, and furthermore, that FAO together with IOC, in consultation with their advisory bodies, including GESAMP, coordinate such research and, in cooperation with appropriate agencies, foster necessary action.

1.8 Pollution and ecosystems

Recognizing the urgent need for improved understanding of the marine ecosystems if the potential effects of pollutants are to be properly assessed, the Conference recommended that FAO, in cooperation with appropriate international organizations, encourage research in this field, by biologists, physicists, mathematicians and others in collaboration, with the object of establishing realistic models of natural conditions and especially those conditions for which predictions of the fate of pollutants and their effects on members of the food-web will be required.

1.9 Monitoring pollution and its effects

In considering a global system for marine pollution monitoring the first objective must be to provide data and information on the state and trends of pollution of the world oceans, with a view to facilitating management measures and their enforcement. The Conference noted and agreed with the suggestions made by the Seminar on Methods of Detection, Measurement and Monitoring of Pollutants in the Marine Environment (Rome, 4-10 December 1970), and recommended that, as a first step, existing national monitoring programmes, particularly in areas with a risk of heavy pollution should be encouraged to cooperate in pilot regional monitoring exercises, such as are being organized under ICES at present for the North and Baltic Seas. Such regional projects will provide valuable experience both in necessary techniques and in management of monitoring; they will at the same time facilitate contacts between the relevant laboratories regarding the essential basic research, the substances to be monitored, the sampling procedures and the analyses of pollutants.

As all nations should, in the long run, participate in monitoring of marine pollution, the Conference recommended that FAO, together with IOC, and their relevant advisory bodies should use all possible means to promote the development, and adoption of intercalibration and suitable methods for monitoring, and should further assist in establishing national marine pollution programmes in developing countries, especially in training scientists and technicians, in expanding existing specialized laboratories or, when necessary, setting up of new laboratories performing international functions, and in intercalibrating and/or standardizing sampling and analytical equipment.

In order to facilitate the establishment of a marine pollution monitoring programme on a world-wide basis, the Conference further strongly recommended that a preliminary exploratory survey for evaluation of the state of pollution of the world ocean should be made by international cooperation at the earliest possible date, in order to establish the levels of various substances (natural and artificially introduced) in the water column, together with their accumulation in the plankton, the benthos, the fish and the sediments. Special attention would need to be paid to the coastal zone. Substances that should be surveyed include especially metals (mercury, lead, cadmium, copper and zinc), petroleum-derived halogenated hydrocarbons, including polychlorinated biphenyls, and some other aromatic hydrocarbons. The survey designed by the Study Group on Critical Environmental Problems (SCEP) may serve as an example for the planning of such a survey, but it would need to be extended and repeated as facilities and information develop.

In recommending this preliminary assessment, to be followed by further surveys of the state and health of the ocean, the Conference recognized that the initiating and developing of a global system for marine pollution monitoring must take place through close coordination and collaboration among the international agencies responsible for monitoring of the marine, terrestrial and atmospheric components of the earth's environment. Only through such close cooperation can all the information essential for man's further evolution on the planet earth - in equilibrium with the remainder of the ecosystem - be provided..

With these important matters in mind, especially the need for a greater understanding of the scientific basis for rational management of living marine resources as a matter of urgency, the Conference recommended that FAO should strengthen its work and capability in the field of ecology in the closest collaboration with intergovernmental and non-governmental scientific organizations. Recognizing the need for the establishment of closer contacts between workers in the field of research and control of marine pollution, the Conference also recommended that FAO, in collaboration with other relevant international organizations, should continue and increase its activities in the exchange and retrieval of marine scientific information in general, but concerning pollution in particular, including registers and tabulations of marine pollutants and the compilation of lists of experts and institutions active in this field. The Conference recommended further the encouragement and support of arrangements for the production of manuals on monitoring and minimizing pollution. Such manuals should be issued in various languages for the use by marine scientists and engineers and in relevant training courses.

2.3 The Conference recommended that, in enclosed and semi-enclosed seas (such as the Baltic, North Sea and Mediterranean); in sea areas spanning national boundaries; and where large river systems draining several countries discharge, pollution control should be organized on a regional cooperative basis, based on joint scientific evaluation. Subsequent monitoring on the effects of measures adopted to control pollution should also be arranged cooperatively employing standardized methods.

2.5 Where large areas are being considered in pollution surveys, it is useful to classify them into regions according to biophysical or ecological characteristics as was done in the survey of estuarine and coastal pollution in the U.S.A.

2.6 The Conference recognized the serious lack of the ecological information needed to make assessments of pollution effects in tropical areas, e.g., in relation to such sensitive ecosystems as coral reefs, mangrove areas and coastal lagoons. There is also a serious lack of such information in the Arctic, therefore, it is recommended that additional research should be encouraged.

3.2 In view of the lack of knowledge of physical, chemical and biological processes in the deep water zones and the increasing interest in the use of these areas for waste disposal, FAO should be requested to encourage and bring to the attention of other organizations concerned, particularly IOC, the need for investigations into these matters by member nations and interested scientific and technical organizations and laboratories.

6.5 FAO should cooperate with appropriate agencies in working toward the eventual curtailing of the widespread practice of dumping wastes especially persistent toxic substances in the oceans. In the interim one step could be to encourage international studies of existing and selected dumping sites and make a scientific evaluation of both the short and long-term effects of such practices.

ANNEX VII

SCIENTIFIC BASIS FOR A MONITORING SYSTEM FOR MARINE POLLUTION, INCLUDING REGISTRATION OF DELIBERATE OR ACCIDENTAL DISCHARGES INTO THE MARINE ENVIRONMENT

The marine science community is ready to prescribe actions to measure the impact of man's activities upon the chemical characteristics of the oceans. Over the past several years assemblages of scientists have attempted to identify the principal pollutants and the most reliable methods of analyses for them (Seminar on Methods of Detection, Measurement and Monitoring of Pollutants in the Marine Environment, FAO, Rome, December 1970) and to design a sampling system (Study Group on Critical Environmental Problems, Williamstown, Massachusetts, July, 1970). Several concepts have emerged from these meetings to guide future actions:

(1) The initial programme should be made at a regional level, i.e. the Gulf of Mexico, the North Sea, the Adriatic Sea, rather than globally. Regional studies will provide patterns which can be applied to other areas and can act as springboards for global efforts.

(2) Baseline studies, exploratory surveys of the levels of various substances in the water column, atmosphere, organisms and sediments, are a necessary prelude to monitoring programmes. They provide not only the background levels for relatively unpolluted areas but also benchmarks to study changes with time in the polluted zones.

We recognize that there are completely adequate scientific resources, laboratories, investigators and ships equipped with collecting devices, to mount regional baseline studies today and strongly urge that they be implemented in every possible way. Inasmuch as planning such baseline studies may require periods of a year or two after agreement is reached to carry them out, we propose without reservation that immediate action be taken to initiate them.

We propose, as a first step, that experts be assembled from each of three regions named below to detail sampling programmes and to identify and to recruit the laboratories that can collect samples, perform analyses and analyse the data and that the step by step formulation of a baseline survey with total costs be prepared and be submitted to the appropriate international agency for funding. Such experts should include laboratory directors who are aware of their abilities in the collection of samples, laboratory personnel who can prescribe the amounts of sample, handling and packaging techniques, and methods of inter-laboratory comparisons of results, and scientists who can interpret and appraise the data.

We propose three regions for the first baseline studies - each possessing a unique set of characteristics*:

Baltic Sea: The Baltic Sea is a semi-enclosed basin with very limited water exchange and a marked stratification. The salinities range from almost zero to thirty parts per thousand. In some of its deeper basins anoxic conditions are found. The residence time of deep water is between ten and twenty years and there can result high accumulations of pollutants. The Baltic Sea has inputs from 250 rivers. There are already high levels of pollution with respect to halogenated hydrocarbons, including DDT and PCB's, mercury, and petroleum.

*(All three of these regions are in the northern temperate latitudes. Clearly, tropical and polar areas will require similar regional studies. Priority was given to those areas receiving high and varied material inputs of man)

North Sea: The North Sea is a shallow sea with high tidal mixing and only seasonal stratification in some areas.

The present state of knowledge of the physical processes for both of these seas is fairly well developed. Mathematical models of water exchange and transport are available or at least in advanced states of development.

Both seas are recipients of wastes from about 50 million people and are surrounded by highly industrialized countries. The international collaboration of their marine scientific communities is well established and organized. Both seas are exposed to an ever-increasing input of wastes of man.

Puget Sound: Puget Sound is a relatively unpolluted area providing a marine resource to the United States and Canada. A pilot study for fjords could be carried out within this relatively unpolluted area. It will be a receptacle for increasing discharges under the pressures of increasing populations and of increasing industrial activities. It has both well-flushed and stagnant zones. Primary production is one of the highest in the marine environment. The area offers the opportunity to document water quality changes that may be quite prominent.

We propose that the following materials* (methods of analyses are given in parantheses) be involved in the baseline study:

(a) Halogenated hydrocarbons including DDT and its metabolites, dieldrin, PCBs, (gas chromatography).

(b) Petroleum, (gas chromatography).

(c) Heavy metals - mercury, copper, chromium, and perhaps several others, depending upon the analytical method available, (activation analysis or atomic absorption).

(d) Radioactive nuclides: Sr-90; Zn-65; Cs-137; Pu-239 and H-3, (low level alpha, beta and gamma counting).

(e) Nutrients and potential nutrients: NH_3, NO_3^-, NO_2^-, PO_4^{---}, $Si(OH)_4$, and total phosphorus (spectrometry). Dissolved organic carbon and particulate organic carbon, (manometry),

For identification of water masses, state of mixing, and stability of the water column, the hydrographical parameters should be measured. This will also allow a comparison of the baseline study with the results of on-going and past investigations.

The Group recommends as a guiding principle that there should be a close sampling, both in time and space near the suspected points of major injections of materials and a rather limited number of observations covered once or twice a month in the key areas of the sea. At least one observation point should be located in the cleanest area of the seas. A synoptic sampling programme does not seem to be necessary. Sampling should include water, representative organisms, detritus and other particulate material, surface sediments and atmospheric precipitation.

In addition to sea water assays, analyses upon the river waters draining into the system provide necessary data for mass balance studies.

*(Bacteria and virus monitoring programmes were considered. However, since different laboratories are involved, the analyses were limited to chemicals).

In proposing laboratories, as examples, for involvement in such programmes, we were led to the desirability of an international laboratory. We recognized that for the analyses of some pollutants, present laboratory facilities might not be able to assume any additional analytical burdens. The cost of the equipment is oftimes quite high. Many economies might be realized with a central facility which could carry out not only analyses but also be involved in intercalibration studies, method development and evaluation, and the data storage retrieval activities, and educational programmes.

In order to interpret the results from baseline studies, and to provide a base for future monitoring programmes, the necessary data on pollutants to allow mass balance calculations with some of the more sophisticated mathematical models must be available. We endorse the Recommendation of the FAO Technical Conference on Marine Pollution held in Rome, December 1970, that countries establish registration systems for the production and for the dumping of chemicals into the marine environment.

We propose that IOC be the body for the coordination of such baseline studies taking into account on-going programmes being carried out by such international organizations as ICES and WMO. IOC should cooperate closely with ICES and the Baltic Oceanographers with respect to the North Sea and Baltic Areas and with SCOR with respect to the Puget Sound Area. It is thought that a period of up to two years may be necessary for appropriate planning and organizational efforts.

We are convinced that the scientific and technical potentials of the nations adjacent to the three areas are sufficient to initiate the baseline studies within a very short time. We are aware of the existence of quite a number of laboratories already conducting continuing analyses upon the materials proposed for assay in the baseline study. We can, for example, detail the case of tritium, H-3, where there is extensive experience available in Stockholm, Heidelberg, and La Jolla, and more recently in Wantage, U.K., Copenhagen, Hanover, Munich, Krakow, Freiberg/DDR, and Groningen, Netherlands. Many of these laboratories may be able to contribute their facilities to the programme. Further, we are sure, that this list is by no means complete.

For the planning and organization of the sampling programmes, we suggest the following laboratories. Clearly, this list is only meant for illustrative purposes and can be modified readily by the concerned International Organizations and Governments:

Puget Sound Area:

- University of British Columbia
- Biological Station, Nanaimo
- Pacific Environment Institute, West Vancouver, B.C.
- University of Washington
- Oregon State University
- Pacific Northwest Water Laboratory, US EPA, Corvallis, Oregon

North Sea:

- Fisheries Laboratory, Lowestoft, Suffolk, United Kingdom
- National Institute of Oceanography, Godalming, United Kingdom
- Netherlands Institute of Marine Research, Texel, Netherlands

Deutsches Hydrographisches Institut, Hamburg, Federal Republic of Germany

Institute of Fisheries Research, Bergen, Norway

Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium

National Institute of Public Health, Bilthoven, Netherlands

Baltic:

State Oceanographic Institute, Leningrad, USSR

Institute of Marine Research, Helsinki, Finland

Board of Fisheries, Hydrographic Department, Göteborg Sweden

Institut für Meereskunde, Kiel, Federal Republic of Germany

Institut für Meereskunde, Warnemünde, DDR

Hydrographic and Meteorological Institute, Gdydnia, Poland

Oceanographic Institute of the Academy of Sciences USSR, Kaliningrad, USSR

We have tabulated examples of laboratories that are at present carrying out analyses on the pollutants in question. The choices came from the knowledge of a small group of participants at GESAMP III. Clearly, a larger or different group would have chosen other institutions. Such laboratories can be contacted to provide the names of other laboratories involved in similar analyses.

AREA	Halogenated Hydrocarbons	Petroleum	Heavy Metals	Radioactive Materials	Nutrients
PUGET SOUND	Canadian Wildlife Services Laboratory Ottawa	Woods Hole Oceanographic Institution Woods Hole Massachusetts, USA	Pacific Northwest Water Laboratory Corvallis, Oregon	Oregon State University	Pacific Environment Institute West Vancouver
NORTH SEA	Fisheries Laboratory Burnham-on-Crouch UK	Admiralty Oil Laboratory, UK	Isotopcentralen Akadmiet for de Tekniske Videnskaber Copenhagen	Deutsches Hydrographisches Institut Hamburg	Fisheries Laboratory Lowestoft, Suffolk UK
BALTIC SEA	State Oceanographic Institute, USSR	State Oceanographic Institute, USSR	Department of Analytical Chemistry University of Gothenburg Sweden	Institute for Marine Research Helsinki Finland	State Oceanographic Institute, USSR

EXAMPLES OF LABORATORIES ANALYSING MATERIALS PROPOSED FOR THE BASELINE STUDY

ANNEX VIII

MICROBIOLOGICAL AND TOXICOLOGICAL ASPECTS OF MARINE POLLUTION WITH PARTICULAR REFERENCE TO PUBLIC HEALTH

Microbiological aspects

A background paper submitted by Professor Brisou showed that the pathogenic agents responsible for outbreaks of epidemics and endemics are generally found both in near-shore coastal waters and in estuary and river waters. With very few exceptions (hemophilic bacteria and obligatory parasitic bacteria), all these micro-organisms live and survive in sewage water and sea water for a period of days and up to several weeks. This also applies when they are absorbed or ingested by plankton or deposited on sandy beaches and on bottom sediments. Furthermore, since these micro-organisms are continuously discharged, public health hazards may arise. The majority of pathogenic agents were reviewed, among them enterobacteria, human and animal tuberculosis bacilli, cholera vibrions, entero-viruses, parasites.

The difficulty of epidemiological surveys with regard to bathing in polluted water and its relation to disease was stressed.

In the light of present clinical and etiological knowledge concerning certain viruses, however, it is justifiable to assume that a certain number of summer/autumn diseases are contracted after bathing in polluted water or after a prolonged period spent on sands in which it has been demonstrated that pathogenic agents are retained. These diseases which include cutaneo-mucous mycosis and some bacterial infections, mainly affect children and young adolescents of city origin normally resident far from the coasts.

Enteroviruses and pathogenic bacteria are isolated from sewage treatment plant effluents. Therefore, it is important to accentuate technical efforts to improve their efficiency. In this particular field of control and surveillance of results, cholimetry and other biological parameters will assume their full significance. On the whole, these data remain valid for assessing the microbiological quality of water for health purposes and for deciding on the steps to be taken. Since the presence of *E. coli* is proof of close or relatively close fecal contamination, it would seem more economical to locate the source of contamination, i.e. the sewage outlets. A map of sewer outfalls on the coast would certainly be more significant than the identification of coli bacilli and *St. focalis* which require interpretation by specialists. In any case cholimetry and various biological and chemical measurements as well as acceptable health standards should be used for the surveillance and control of the efficiency of sewage treatment plants.

Toxicological aspects

The term "toxicology" is used in this report in its broadest possible sense. The term refers to the total effect of noxious agents on plants, and animals, regardless of the source or nature of the noxious substance.

(a) Acute toxicity is manifested by obvious signs, symptoms or lethalities that usually develop within a relatively short period of time, i.e. hours or days;

(b) Chronic toxicity may be brought about by relatively low levels of the noxious agent. Months or years of continual exposure to the intoxicant may take place before the signs and symptoms become manifest in the target organism. These toxic manifestations may consist of mutagenic, carcinogenic or other chronic organotropic changes.

An example of a biodegradable toxic substance is endosulfan which is capable of producing mass mortality of fish, but because of its nature, it is probable that this compound does not enter the food chain in its toxic form. Examples of long-term persistent compounds are heavy metals such as mercury, lead, and organo-chlorine compounds such as DDT and PCBs.

There are no set criteria for toxicity of any chemical substance in the marine eco-system because of the different specific sensitivity of different organisms and varying vulnerability during different stages of development. Eggs and juveniles are usually more sensitive than the adult.

The present overall marine environmental toxicological problem can be classified into the following categories:

(a) Marine biotoxins. A possible relationship to dumpings of war material, wreckage and discharges of industrial pollutants was pointed out.

(b) Naturally-occurring toxic inorganics, i.e. background substances such as mercury, copper, arsenic, lead, fluorine, etc. when at raised levels.

(c) Industrial wastes. These, taken in a wide sense, may include toxic agents derived from agricultural practices, domestic sources, industrial manufacturing, mining, military operations, etc.

It was felt that in the consideration of priorities of evaluation of toxic agents, man should be of first concern but the toxic effects on marine organisms are also of the utmost importance.

The Group agreed that the study of effects of the following groups of substances or compounds should be given priority: chlorinated hydrocarbons, heavy metals, persistent herbicides, detergents and marine biotoxins.

These groups of materials were selected because of their toxicity, persistence, bio-accumulative characteristics, and widespread involvement in the marine food web.

ANNEX IX

INFORMATION SERVICE CONCERNING MARINE POLLUTION AND ITS EFFECTS, INCLUDING STORAGE, RETRIEVAL AND EXCHANGE

All sciences have difficulty in providing for rapid and reliable access to information but the problem is accentuated in multidisciplinary, international programmes. There are two separate problems: valuable information may be widely scattered throughout the whole medico-scientific literature, and much research effort is wasted unless individual programmes are coordinated with one another on a continuing basis. Resolutions at both previous meetings of GESAMP, at the GELTSPAP meeting and the FAO Technical Conference on Marine Pollution emphasized the need for information services of various kinds. A valuable start has been made in response to these requests. It is recognized that at present, financial provision for this activity is sufficient for only a modest effort. It is nevertheless important to record what is necessary so that progress in the future can be directed towards these ends.

Several different types of scientific information are involved and each is treated in a different way and has its own problems.

1. Scientific Literature

Resolution 7.6 of the FAO Technical Conference emphasized the need for a multidisciplinary approach to marine pollution research, "embracing ecology, fishery biology, oceanography, chemistry, toxicology and the health sciences". An abstracting journal that will be of service to marine pollution research should therefore take into account the appropriate literature in all these fields, as well as in the engineering sciences. It would be useful to evaluate relevant abstracting journals in this connection.

Most medical and scientific literature is already abstracted in some journal or other, and the greatest benefit would accrue if abstracts of all literature with some pertinence to marine pollution could be placed in a single journal. FAO informed the Joint Group of a merger between its "Current Bibliography for Aquatic Sciences and Fisheries" and "Aquatic Biology Abstracts". This was welcomed, but unless the coverage of literature in the new abstracting journal is greater than that in its two predecessors, the effect of this merger will simply be to reduce by one, the number of abstracting journals that the researcher has to examine each month. The proposed new journal "Aquatic Biology and Fisheries Abstracts" would gain in value if arrangements were made to take advantage of abstracting carried out by other bodies. Thus it would be advantageous to arrange with WHO for the use of appropriate citations in MEDLARS (even though this provides "key words" rather than abstracts), with the Reference Centre in Marine Biotoxins for FAO, WHO, and IOC, for literature on marine biotoxicology and for the exchange of abstracts with other abstracting journals. A particular effort should be made to include abstracts of scientific papers in languages other than those normally covered in abstracting journals.

The Joint Group suggested that FAO bring these suggestions to the attention of ACMRR.

2. Scientists

The Joint Group is aware that FAO has published a List of Experts in Marine Pollution (Fisheries Technical Paper 99), and that a revised edition is promised by the end of 1971. It is noted that the use of the word "Experts" in the title of the present preliminary list is misleading and that, in fact, it consists simply of those people who have expressed an interest in the subject. While this is perhaps inevitable at this stage, the list should be refined in future editions. The abstracting service may help in this but the possibility should be examined of requesting appropriate national agencies to review the list, and suggest amendments.

3. Institutions

The abstracting service will also facilitate the compiling of a list of laboratories engaged in marine pollution research. The Joint Group would welcome the regular publication of such a list.

4. Research Programmes

It would be of great benefit to researchers to have, in outline, information about research programmes currently in progress. The difficulty of collecting this information is acknowledged and only incomplete coverage could be expected, but this information is so valuable to researchers that an attempt should be made to collect and circulate information of this kind.

The Joint Group has learned that FAO and Unesco are both willing to contribute to such an effort and also that IUCN is seeking substantial funds privately from non-governmental sources for this purpose in the context of a project for regular reporting of the State of the Health of the Ocean as a proposed element of LEPOR. The Joint Group recommends that these efforts be pursued vigorously and cooperatively.