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

# **REPORTS AND STUDIES**

No. 14

Report of the twelfth session  
Geneva, 22-29 October 1981



World Meteorological Organization



Reports and Studies No. 14

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WORLD METEOROLOGICAL ORGANIZATION 1981



## Notes

1. GESAMP is an advisory body consisting of specialized experts nominated by the Sponsoring Agencies (IMCO, FAO, UNESCO, WMO, WHO, IAEA, UN, UNEP). Its principal task is to provide scientific advice on marine pollution problems to the Sponsoring Agencies and to the Intergovernmental Oceanographic Commission (IOC).
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## Definition of Marine Pollution by GESAMP

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

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## 1. OPENING OF THE MEETING

- 1.1 The Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) held its twelfth session at WMO Headquarters, Geneva, from 22 to 28 October 1981, under the Chairmanship of Mr. V. Pravdic. Mr. A. McIntyre was Vice-Chairman.
- 1.2 At the opening of the session, Mr. R. Czelnai, Director of Scientific and Technical Programmes, welcomed the participants on behalf of the Secretary-General of WMO, and emphasized the importance of GESAMP as a multi-disciplinary advisory body which brought a wide range of expertise. The WMO from the very beginning in 1969 supported the idea of a Joint Group composed of scientists acting in their individual capacities. The WMO, recognizing the atmosphere/ocean interface as one of the major factors controlling and modifying the climate, and both a source and a sink of atmospheric pollutants, appreciates, in particular, the work carried out by the Group in this respect. The WMO will also in future promote the activities of this Group, however, due to financial stringencies it may be difficult to maintain the same level of support. In conclusion Mr. R. Czelnai wished GESAMP every success in the performance of its tasks.
- 1.3 The Chairman of GESAMP thanked the WMO Secretary-General's representative on behalf of the participants for the good wishes for the success of the session and for the facilities that were provided. He also introduced the new members of the Group.
- 1.4 The agenda for the session as adopted by the Group is given in Annex I. A list of documents submitted to the session, including information papers relating to the activities of the sponsoring organizations and substantive papers relating to particular items of the agenda, is given in Annex II.
- 1.5 A list of participants is given as Annex III. The Group noted with regret that several members of the Group were unable to attend the session.

## 2. REVIEW OF THE HEALTH OF THE OCEANS

- 2.1 The Chairman of the Working Group reviewed the intersessional activities of the Working Group which included, besides several meetings of various Task Groups and Task Group Leaders, two meetings of the full membership of the Working Group. These meetings were held from 8 to 18 July 1980 in Kristineberg (Sweden) and from 9 to 14 February 1981 at FAO Headquarters in Rome (Italy). In addition, the Editorial Group had met on two occasions at UNEP/RSPAC in Geneva on 10 to 12 June and 10 to 13 September 1981, to edit the draft reports on the basis of comments received from Working Group members, outside reviewers and GESAMP members.

- 2.2 As a result of these activities a Draft Report was prepared and distributed to the members of GESAMP in advance to the twelfth session of GESAMP. The Group's members were asked to comment on it and to participate in a final meeting of the Working Group which was held from 19 to 21 October 1981, at WMO Headquarters in Geneva, at which a revised version of the final Draft Report was prepared for forwarding to the twelfth session of GESAMP.
- 2.3 The Chairman introduced this revised draft to the Session. With only a few editorial changes, the Group unanimously approved the Report of the Working Group on a Review of the Health of the Oceans. The Group expressed its appreciation to the Chairman and all members of the Working Group for the report which they had prepared.
- 2.4 With regard to publication, the Group decided that Unesco should publish the report as No. 15 of the GESAMP series "Reports and Studies", a summary of which and table of contents are given in Annex IV. The Group was informed by the UNEP Technical Secretary of GESAMP that UNEP intends to publish the report additionally in the form of a book with clear reference to the above Unesco publication in the GESAMP series.
- 2.5 The Group strongly recommended that the Technical Annexes to the report of the Working Group containing the background scientific information used for the preparation of the report be published by Unesco as "Resource Information Used in the Preparation of the GESAMP Reports and Studies No. 15", in a suitable form with an indication that as the papers were not reviewed by the Working Group the contents are the responsibility of the individual authors.
- 2.6 The Group decided that the GESAMP Working Group on the Review of the Health of the Oceans continue its work with the following modified terms of reference :
- (i) To prepare, by the end of 1985, a report consisting of a succinct critical review (up to 30 pages) of the state of the marine environment, supported by the necessary technical annexes, using the UNSCEAR report as a model, and making maximal use of the results obtained through other GESAMP Working Groups;
  - (ii) To cover in its report :
    - the present state (level) of pollution in the various components of the marine environment (sediments, water, biota) and its impact on human health, living resources and amenities, including climate;
    - the analysis of trends which led to the present situation and considerations of prognosis, where possible;

- the generalized mass balance of all major marine pollutants (inputs, pathways, sinks);
- the examination of the waste receiving capacity of the oceans, with special attention to coastal waters, enclosed and semi-enclosed seas, and the possible use of the critical pathway or alternative approaches in determining the waste receiving capacity;
- the analysis of oceanic processes influenced by or influencing global pollution;
- the assessment of the problems which may face the oceans in the future.

(iii) To report regularly to the forthcoming GESAMP sessions on the progress of work, specifically to submit to GESAMP XIII an annotated outline of the envisaged structure of the final report and information on the method planned to be used in accomplishing the task.

2.7 The Group also decided that during the next inter-sessional period, the Working Group continues as a small Steering Committee composed of R. Chesselet, G. Kullenberg and V. Pravdic, with the addition of a fourth member, a biologist, to prepare an annotated outline as suggested in item iii of the proposed terms of reference. The biologist will be nominated by Unesco as the Lead Agency of the Working Group in consultation with collaborating organizations, Chairman of GESAMP and the members of the Steering Committee. The final terms of reference will be determined at GESAMP XIII. The Chairman of the Working Group and members selected from the GESAMP experts will be nominated at GESAMP XIII, on the recommendation of Unesco. Additional members from outside experts will be designated by Unesco in consultation with the collaborating organizations, the Chairman of Gesamp and the Chairman of the Working Group. Recognizing that this would mean that the real Working Group activities could not commence until March or April 1983, at the earliest, it was agreed that the proposed target date for completion of the report should be open to amendment at GESAMP XIII if the Steering Committee or the Group felt this be advisable.

### 3. OCEANOGRAPHIC MODEL FOR THE DISPERSION OF WASTE DISPOSED OF IN DEEP SEA

3.1 The Working Group sponsored by IAEA in cooperation with IMCO, UNEP and UNESCO, created at the last GESAMP session (GESAMP XI), met twice during the last inter-sessional period. The first of these meetings was held at IAEA Headquarters in Vienna, Austria (December 8-12, 1980) and the second at Woods Hole, Massachusetts, USA (June 1-5, 1981).

3.2 The Chairman of the Working Group introduced the reports of these two meetings (see summary in Annex V). During the two meetings much effort was spent planning the Working Group's approach to the problem and in examining certain limiting situations regarding the transport of material from a deep-sea dump site. This has led to a number of working papers which are being considered and supplemented during the present intersessional

period. As a result of the diversity of half lives and interaction rates of pollutants with the physical, geochemical and biological oceanic systems, the development of a variety of specialized models will be required.

- 3.3 The Chairman of the Working Group estimates that if its proposed level of effort (two meetings a year with inter-sessional exchanges of views) is maintained, the Working Group could submit its reports for the next GESAMP session (GESAMP XIII), in February/March 1983.
- 3.4 The IAEA Technical Secretary recalled that the Working Group was created on the IAEA's request to GESAMP for recommendations regarding the most appropriate oceanographic model for the prediction of the transport of pollutants (especially radionuclides) from the deep ocean. He reiterated that, although the IAEA is requested by the London Convention on the Prevention of Marine Pollution by Dumping of Waste and other Matter at Sea (1972) to prepare recommendations for the dumping of low-level radioactive wastes at sea, the IAEA's position is not to promote such practices.
- 3.5 The IAEA Technical Secretary had informed the Working Group that IAEA may commence the revision of its radiological assessment model for deep-sea dumping by mid-1982. For this activity it will require knowledge of the likely form of the oceanographic model. The Working Group agreed that it could inform the IAEA of the direction being taken and give an indication of the probable content of its Final Report, but estimated that the task of the Working Group could not be completed before late 1982 and would not be approved by GESAMP before its session in February/March 1983.
- 3.6 The Chairman of the Working Group noted that because of the nature of its work and the need to draw on as wide a range of scientific expertise as possible, the Working Group has (1) held meetings at venues where expertise is readily available; (2) invited the attendance of a limited number of knowledgeable "participating observers"; (3) taken steps to have an oceanographer from the USSR to join the Working Group. Noting the comments of GESAMP, the Chairman of the Group agreed that it would be appropriate to have its work reviewed by both the scientific community at large and the relevant national and international agencies.
- 3.7 The Technical Secretary of IMCO drew the attention of the Group to the fact that there was also interest in the model from the standpoint of non-radioactive containerised wastes which are dumped at deep sea (at water depths of less than 4000 metres).
- 3.8 GESAMP approved the Working Group's request that the terms of reference be modified so that (1) it could consider the aspect of wastes dumped at deep-ocean sites shallower than 4 kilometres, in keeping with the terms of international conventions; and (2) it be allowed to suggest programmes which could lead to better oceanographic models in the future. The terms of reference were therefore modified as follows:

- (i) to review the present knowledge of pathways by which substances might be transferred from a deep-ocean dumping area to man;
- (ii) where possible, to recommend methods for calculating the concentration of substances, arising from containers deposited on the deep-ocean floor, in the water column throughout an ocean basin;
- (iii) to assess the reliability of the calculated concentrations and where possible to recommend ways and means by which these might be improved.

#### 4. SEA DISPOSAL STUDIES

- 4.1 The IMCO Technical Secretary informed the Group of the activities carried out at the two intersessional meetings of the Working Group on Sea Disposal Studies. It was recalled that the Working Group had been requested by GESAMP XI to:
- (i) review and update GESAMP Reports and Studies No. 3 - "Scientific Criteria for the Selection of Sites for Dumping of Wastes into the Sea" - ;
  - (ii) compile a bibliography of relevant material on dumping at sea; and
  - (iii) consider a detailed approach for the development of criteria which may be used for the preparation of guidelines for the identification of sea areas particularly vulnerable to marine pollution from a wide range of sources.
- 4.2 The Chairman of the Working Group introduced the draft Final Report "Scientific Criteria for the Selection of Sites for the Disposal of Wastes at Sea", which was the result of updating and reviewing Rep. Stud. GESAMP (3), proposing that this should be considered for approval and publication. The Chairman put particular emphasis on the fact that the Working Group had agreed to follow, in general, the layout and structure of the previous report, but to update and rearrange certain sections and to add new material on recently developed waste disposal methods, such as incineration of wastes at sea and capping and burial of contaminated solid wastes. It was also agreed to consider in an additional section of the report, the application of remote sensing methods.
- 4.3 In an extensive discussion the report was considered a valuable contribution in assisting in the interpretation and clarification of criteria and conditions set out in the Annexes to the Dumping Conventions. It was felt, however, that certain aspects need further clarification and that therefore some editorial efforts were necessary, to take account, in particular, of the effect on the control of dumping operations of record keeping, the frequency of dumping operations carried out at one site and the input of amount and types of wastes in a certain area. Other comments and suggestions referred in particular to the views expressed in the report on the application of modelling methods and on the assimilative capacity of the oceans to receive wastes.

- 4.4 The Group considered the proposal of the Working Group to annex a set of five case studies to the report. Recognizing that many details described in the case studies had already been incorporated in the text of the report, the Group did not see the necessity for the publication of these studies as a part of the report. It was also felt that some further effort was required in editing the studies so that a more uniform level of presentation could be achieved. The Group agreed, however, that reference should be made in the report to these studies, as well as to other background material which had been presented by members of the Working Group during the course of preparing the report. This material should be made available by the IMCO Technical Secretary upon request.
- 4.5 With regard to the second task of the Working Group, the compilation of a bibliography of relevant material, the Group endorsed the view of the Working Group that a fully comprehensive compilation of all relevant material would be a major task and one more appropriate to an abstracting or indexing service. It was noted that the Working Group had considered that its most useful contribution would be to produce a selective list containing references which were judged to be of particular importance. The Group agreed that the list of selected material prepared by the Working Group should be handled in the same way as the case studies described in paragraph 4.4 above.
- 4.6 The Group noted that the Working Group has had a general discussion on the development of criteria which may lead to guidelines for identifying particularly sensitive sea areas. The Group agreed to the view expressed by the Working Group that many aspects considered in its report and also many items covered in the report on the Review of the Health of the Oceans, could provide basic material for such a task, but that specific emphasis would have to be given also to other features, the consideration of which would require additional expertise from outside the Working Group.
- 4.7 The Group recalled that the request to initiate the preparation of an inventory of sea areas which are particularly sensitive to pollution caused by dumping of waste and by maritime transport had been brought forward by the International Conference on Tanker Safety and Pollution Prevention, 1978 (TSPP). The Group endorsed the view expressed by the Working Group that any geographical inventory must be left to national authorities. With regard to the preparation of criteria and guidelines for the development of such an inventory, the Group agreed that the outcome of the consideration held so far, on this matter by the Group together with the basic material mentioned above, should be submitted to the relevant IMCO bodies, inviting them, if they still wished to do so, to confirm their continued need and to clarify the request of the TSPP Conference.



- 4.8 The Group, in the light of the above decision, deferred the question as to whether further and more detailed consideration should be made by GESAMP on the principles and criteria for the selection of particular sensitive sea areas, to a future session.
- 4.9 The Group approved the report of the Working Group on Scientific Criteria for the Selection of Sites for the Disposal of Wastes at Sea for publication as the GESAMP series "Reports and Studies No. 16", on the understanding that the Chairman of the Working Group would make certain editorial improvements, taking into account the comments and suggestions made by the Group. A summary of the report and the table of contents are given in Annex VI.

## 5. REVIEW OF POTENTIALLY HARMFUL SUBSTANCES

- 5.1 The report on the intersessional activities of the Working Group was introduced by the WHO Technical Secretary, a summary is attached as Annex VII. A small planning meeting had been held in Copenhagen, in September 1980, which was attended by the Chairman of this Working Group and the Chairman of the Working Group on a Review of the Health of the Oceans, the WHO Technical Secretary and a UNEP Representative. This led to the preparation of data profiles on some selected metals.
- 5.2 As outlined by the Director of the UNEP's International Register of Potentially Toxic Chemicals (IRPTC), the data profiles on tin and cadmium presented to this session cover only the marine aspects, whereas other data fields will be added later, including human health effects, production figures and legal control measures. Such completed data profiles will be available on tin, cadmium and lead by the end of 1981. Separate documents have already been issued on methyl-mercury.
- 5.3 The Chairman of the Working Group proposed to reconstitute this Working Group with Mr. Friberg as the new Chairman and some selected outside experts, in addition to the GESAMP members of the Working Group. He noted that the substance-by-substance approach chosen would be in line with one of the work methods adopted by the Working Group on the Review of the Health of the Oceans.
- 5.4 According to its terms of reference, the task of the Working Group was identified as being two-fold :
- (i) to prepare short referenced reviews on selected substances;
  - (ii) to produce a scientific evaluation of their harmful effects. It was understood that the first task would be assisted through UNEP's IRPTC data profiles.
- 5.5 However, as it was recognized that the task according to the terms of reference could be an extensive one, and there were some doubts expressed as to the validity of some of the analytical data that formed the base for selecting of elements, a two-step approach was recommended.

- 5.6 The first step would involve (i) to determine the approximate concentration of selected substances in edible marine organisms which would give rise to concern from a toxicological point of view; (ii) to assess accuracy of such reported concentration data. The second step would involve a more detailed scientific evaluation according to the terms of reference. It is understood that during the next intersessional period only step one will be dealt with.  
On the basis of the report from the Working Group to GESAMP XIII, a decision can be taken on the possibility of a further evaluation of these elements.
- 5.7 In concurrence with the requirements of the organizations sponsoring the Working Group and as a possible contribution to the Working Group on a Review of the Health of the Oceans, several substances were selected by the Groups. During the inter-sessional period GESAMP XII-XIII, cadmium, lead and tin will be considered and if time and resources permit, also arsenic and mercury. Subsequently, toxaphenes, phthalates, organosilicons, chlorinated and brominated aromatics, PNAHs and nutrients (phosphorus, etc.) should be considered; relevant data profiles will be commissioned in due course.
- 5.8 The Group appointed Mr. L. Friberg as the Chairman of the Working Group. The Working Group would be jointly sponsored by WHO, FAO, and UNEP, with WHO acting as lead agency. The offer of UNEP to support this Working Group substantively and with funds, was considered essential for successful implementation.
6. THE EVALUATION OF THE HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS
- 6.1 The IMCO Technical Secretary informed the Group that the Working Group on the Evaluation of the Hazards of Harmful Substances Carried by Ships had met on three occasions during the intersessional period. He indicated that the work of producing hazard profiles had been continued but that the major activity of the Working Group had been to produce a composite report on the hazard profile rationale according to the instructions given by the Group at its twelfth session at Dubrovnik.
- 6.2 The Group was further informed of a number of questions which had been raised by the relevant IMCO bodies. In particular, questions had been raised by the Sub-Committees on Bulk Chemicals, relating to carcinogenicity and to the environmental assessment of phthalates. Finally, the attention of the Group was drawn to the question raised by the Marine Environment Protection Committee (MEPC) as to whether there was a need to control the disposal of ashes from coal-fired boilers of ships and the response proposed by the Working Group on behalf of GESAMP. A summary of the reports of the Working Group is set out in Annex VIII.
- 6.3 The Chairman of the Working Group introduced the draft composite report on the evaluation of the hazards of harmful substances carried by ships. In so doing he reminded the Group that the procedure followed by the Working Group had to a very large extent been embodied in the text of the International Convention for the Prevention of Marine Pollution from Ships, 1973

(MARPOL 73/78) and as such could not be substantially altered. The procedures adopted by the Working Group were therefore essentially unchanged from those approved at the fourth session of the Group. However, as the state of knowledge and experience had improved and the work had progressed, a number of clarifications had been made and certain minor additions and changes had been included in the hazard profile rationale. Nevertheless much of the bulk of the material in the report had already been approved by previous sessions of GESAMP. The Chairman of the Working Group then briefly described the content of the report and invited the Group to comment upon and approve the report for publication in the GESAMP Reports and Studies series, No. 17.

- 6.4 The Group agreed that the composite report, which represented the examination of activities of one of the longest serving Working Groups should be published as proposed, subject to the inclusion of a few editorial changes. Attention was drawn particularly to the need to highlight the cautionary remark in the Foreword to the effect that the rationale and hazard profiles had been developed with a particular purpose in mind and should not be used for other purposes without a realisation of the restrictions this might impose on the validity of the data reflected in the hazard profile. The Group also agreed that part of the material originally prepared for the International Conference on Marine Pollution in 1973 and which was contained in the original unpublished report prepared in 1972 by an ad hoc panel of GESAMP/IMCO experts (GESAMP IV/19 Supp.1(Annex V)), was out of date and irrelevant to the main subject matter of the report and should not therefore be included. The Group however felt that it was appropriate to include as an Annex to the report the Guidelines for the Categorization of Noxious Liquid Substances which are contained in the Marine Pollution Convention (MARPOL 73/78, Annex II, Appendix I) and which describe the way in which the hazard profiles are utilized to categorize the chemicals. (Details of how chemicals are permitted to be discharged at sea as tank washings are assigned according to this Categorization.)
- 6.5 The Group expressed some concern that the UN Group of Rapporteurs on the Carriage of Dangerous Goods might proceed along parallel lines in the evaluation of the aquatic pollution potential of chemicals. The UN and IMCO Technical Secretaries were asked to make every effort to ensure that the UN Group was fully informed of the work undertaken by the GESAMP Working Group so that it should be aware of the danger of confusion among those concerned with transport regulations. It was agreed that the procedures adopted by the Working Group had a certain relevance to freshwater pollution but that it would probably be unwise to apply them directly to such problems.
- 6.6 The Group strongly endorsed the inclusion of remarks on carcinogenicity in the hazard profile rationale prepared by the Working Group. Several members of the Group were of the opinion that the approach actually used tended to err on the side of caution to the advantage of certain industrial interests.

It was however pointed out that the objective was only to identify substances over which there is little doubt as to their carcinogenic properties. This explanation was accepted by the Group, but it was emphasized that the matter should be kept under review and that if evidence arose which would allow extension of the carcinogenicity ratings this should be undertaken especially in relation to marine biota or Ames test results.

6.7 The Group took note of the approach used by the Working Group in relation to biodegradability. It was pointed out that problems could arise as a result of low biodegradability especially in cold climates and that the entire question should be reviewed from time to time in the future. Finally the Group endorsed the response prepared on its behalf by the Working Group in relation to disposal of ash from ships using coal-fired boilers - viz that there should be little serious environmental damage as a result of such disposals.

6.8 The Group welcomed the information that links have been established with IRPTC of UNEP. It is hoped that when the Working Group encounters difficulties in obtaining data, IRPTC will be able to provide background material. The Group also asked IRPTC to avail itself to the maximum amount feasible of all the information produced by the Working Group, and make it available through its computerized retrieval system.

6.9 The Group agreed that the Working Group should continue with its task and thanked the Chairman and all the members of the Working Group for their achievements in the past and the preparation of their report.

## 7. BIOLOGICAL EFFECTS OF THERMAL DISCHARGES IN THE MARINE ENVIRONMENT

7.1 The FAO Technical Secretary informed the Group that the Working Group on Biological Effects of Thermal Discharges in the Marine Environment had held its first session in Dubrovnik, from 21 to 25 September 1981. The Chairman of the Working Group introduced the report, a summary of which is given in Annex IX.

7.2 The Group noted that the Working Group had largely fulfilled the task of its first session, to selectively review available information on the effects of thermal discharges in coastal waters and to evaluate direct and indirect adverse effects of thermal discharges on marine life, particularly fishery resources. The Group proposed that although the Working Group had been instructed to concentrate on tropical and sub-tropical environments, it should also consider the inclusion of examples of effects of thermal discharges in cold waters, such as altered species succession and increased survival of parasites during the winter season. It was further proposed that additional information on effects on fisheries should be collected, particularly in tropical shallow waters.

- 7.3 The Group endorsed the report of the Working Group and recommended that it continue to deal with its second term of reference, as defined by GESAMP XI, to develop guidelines for the siting of discharges of heated water, with a view to minimizing harmful effects on living marine resources. In this connexion, it was suggested that the Working Group consider alternative technologies for power plant cooling in situations where environmentally sound siting of conventional power plants would not be feasible.
8. INTERCHANGE OF POLLUTANTS BETWEEN THE ATMOSPHERE AND THE OCEANS
- 8.1 The Chairman of the Working Group reviewed its activities during the inter-sessional period which included, (1) the third session held in October 1980 in Miami; and (2) an ad hoc session held in Tallinn from 19 to 23 May 1981. One of the principal goals of the ad hoc meeting was to review the progress of the Working Group on a Review of the Health of the Oceans in the area of air-sea pollutant exchange and develop additional information on this subject. A summary of the reports is attached as Annex X.
- 8.2 It was noted that the report of the ad hoc meeting was not in the usual GESAMP format and that the reports of both meetings were in draft form and were not as yet being presented for adoption of the Group. A suggestion was made to discuss the information contained in the report of the ad hoc meeting at the next regular meeting of the Working Group. The Chairman indicated that this would be put on the agenda for the next meeting.
- 8.3 The Chairman of the Working Group and the GESAMP Technical Secretaries of WMO and UNEP proposed the continuation of the Working Group under modified terms of reference. This proposal was made bearing in mind the work accomplished until now by the Working Group and the explicit request of the Contracting Parties to the Barcelona Convention addressed to UNEP and the relevant organizations of the UN system to provide them with advice on the best possible way to curb and control the input of atmospheric pollutants into the Mediterranean Sea. A similar request may be expected to be addressed also to the UN system from the Governments of other regions. This proposal and the following terms of reference were agreed upon by the Group :
- (i) to describe transport processes towards and into specific regions, using the Mediterranean as the first example, including :
    - horizontal atmospheric transport affecting the region;
    - vertical atmospheric transport to the air-water interface;
    - air-water interchange, and
  - (ii) to review the scientific literature and assess the pathways and fluxes of important pollutants into particular regions, using the Mediterranean as the first example, and to differentiate between natural and pollutant sources.

9. MARINE POLLUTION IMPLICATIONS OF OCEAN ENERGY DEVELOPMENT

- 9.1 The UN Technical Secretary informed the Group that the Working Group on the Marine Pollution Implications of Ocean Energy Development had held one meeting since the eleventh session of GESAMP. It had, however, also received a working paper produced by an expert group of U.S. scientists on the impact of ocean thermal energy conversion (OTEC) and had concentrated on OTEC principally because it held the greatest promise for deployment in the near future.
- 9.2 The report of the Working Group was introduced by its Chairman who characterized it as preliminary in nature. He noted the importance of the need to provide advice to developing countries on the environmental effects of ocean energy plants and their multiple uses as well as on the studies needed to make impact assessments. A summary of the report is given in Annex XI.
- 9.3 Despite the considerable work done by a limited number of industrial countries, consideration of legal and socio-economic impacts as well as other local conditions should reflect the situation in developing countries.
- 9.4 Among several technical issues mentioned, the consideration of effects of thermal discharges and chlorination were seen to overlap to some extent with those of the Working Group on the Biological Effects of Thermal Discharges in the Marine Environment. As a result, close communication between these groups was recommended. Trace metal enrichment caused by power plants was felt to pose a potentially serious problem with respect to impacts on coastal systems and should be considered.
- 9.5 Bearing in mind that the Working Group would continue to focus upon ocean energy sources expected to be significant in the near future, the Group recommended that the work be continued with Dr. J. Roney as Chairman and the UN as lead agency. The UNEP Technical Secretary expressed its agency's interest in the subject and its desire to co-operate in the work.

10. FUTURE WORK PROGRAMME

- 10.1 The Group noted that inter-sessional work would continue on the subjects listed below. The sponsoring Organizations responsible for organizing the inter-sessional work and the GESAMP members assigned to the Working Group are indicated. Additional members from outside GESAMP are selected by the Chairmen in consultation with the Organizations sponsoring the respective Working Groups.

- (a) Review on the Health of the Oceans
- |                       |   |
|-----------------------|---|
| Lead Agency           | : UNESCO                                      |
| Co-operating Agencies | : All other GESAMP sponsors                   |
| Steering Committee    | : R. Chesselet<br>G. Kullenberg<br>V. Pravdic |
- (b) Oceanographic Model for the Dispersion of Waste Disposed of in Deep Sea
- |                       |                            |
|-----------------------|----------------------------|
| Lead Agency           | : IAEA                     |
| Co-operating Agencies | : IMCO, UNESCO and UNEP    |
| Chairman              | : G.T. Needler             |
| Members               | : G. Kullenberg<br>G. Rowe |
- (c) Review of Potential Harmful Substances
- |                       |                           |
|-----------------------|---------------------------|
| Lead Agency           | : WHO                     |
| Co-operating Agencies | : FAO and UNEP            |
| Chairman              | : L. Friberg              |
| Members               | : L. Magos<br>A. Jernelov |
- (d) Evaluation of the Hazards of Harmful Substances Carried by Ships
- |                     |               |
|---------------------|---------------|
| Lead Agency         | : IMCO        |
| Co-operating Agency | : UNEP        |
| Chairman            | : J. Portmann |
- (e) Biological Effects of Thermal Discharges in the Marine Environment
- |                       |                        |
|-----------------------|------------------------|
| Lead Agency           | : FAO                  |
| Co-operating Agencies | : UNESCO and UNEP      |
| Chairman              | : V. Pravdic           |
| Members               | : J. Roney<br>E. Gomez |
- (f) Interchange of Pollutants Between the Atmosphere and the Oceans
- |                       |   |
|-----------------------|---|
| Lead Agency           | : WMO   |
| Co-operating Agencies | : UNEP and IAEA*                                      |
| Chairman              | : W.D. Garret   |
| Members               | : R. Chesselet<br>V. Pravdic<br>R. Fukai<br>A. Tsyban |

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\* Subject to approval by Headquarters

(g) Marine Pollution Implications of Ocean Energy Development

|                     |   |  |
|---------------------|---|--|
| Lead Agency         | : | UN   |
| Co-operating Agency | : | UNEP   |
| Chairman            | : | J. Roney<br>A. Jernelov<br>G. Kullenberg<br>E. Gomez |

11. DATE AND PLACE OF NEXT SESSION

- 11.1 The Group noted that the next (thirteenth) session of GESAMP would be held at WHO Headquarters in Geneva, from 28 February to 4 March 1983. It was agreed that the deadline for distribution to GESAMP members of documents for consideration at that session shall be 31 December 1982.

12. OTHER MATTERS

- 12.1 The Group noted the proposal of WMO to amend the definition of marine pollution by adding the following wording :

"and altering ocean-related physical processes including climate"

- 12.2 The Group felt that this proposal together with the background information submitted by WMO (GESAMP XII/INF 4/1) would need careful consideration by all its members. The Group invited its members to submit comments and additional suggestions to the Chairman of the Group by 30 November 1982. The Chairman would compile the views expressed by the members and report to the next session. Accordingly it was agreed that this subject should be included in the list of items to be considered at the next session of the Group.

- 12.3 The Group, after expressing its concern over the late distribution of documentation to this session noted with satisfaction that the agencies have agreed on a deadline for distribution of papers to be presented at GESAMP XIII, and that the agenda should be distributed as soon as possible thereafter, suitably annotated as to the papers to be considered.

13. ELECTION OF CHAIRMAN AND VICE-CHAIRMAN FOR THE NEXT INTER-SESSIONAL PERIOD AND FOR THE THIRTEENTH SESSION

- 13.1 The Group unanimously elected Mr. A.D. McIntyre as Chairman and Mr. E.D. Gomez as Vice-Chairman for the next intersessional period and for the thirteenth session of GESAMP



14. CONSIDERATION AND APPROVAL OF THE REPORT OF THE SESSION

- 14.1 The report of the twelfth session of GESAMP was considered and approved by the Group on the final day of the session. The Group expressed its deep appreciation to Mr. V. Pravidic for his most able guidance during his period of office. Mr. A.D. McIntyre was welcomed as the new Chairman of GESAMP.

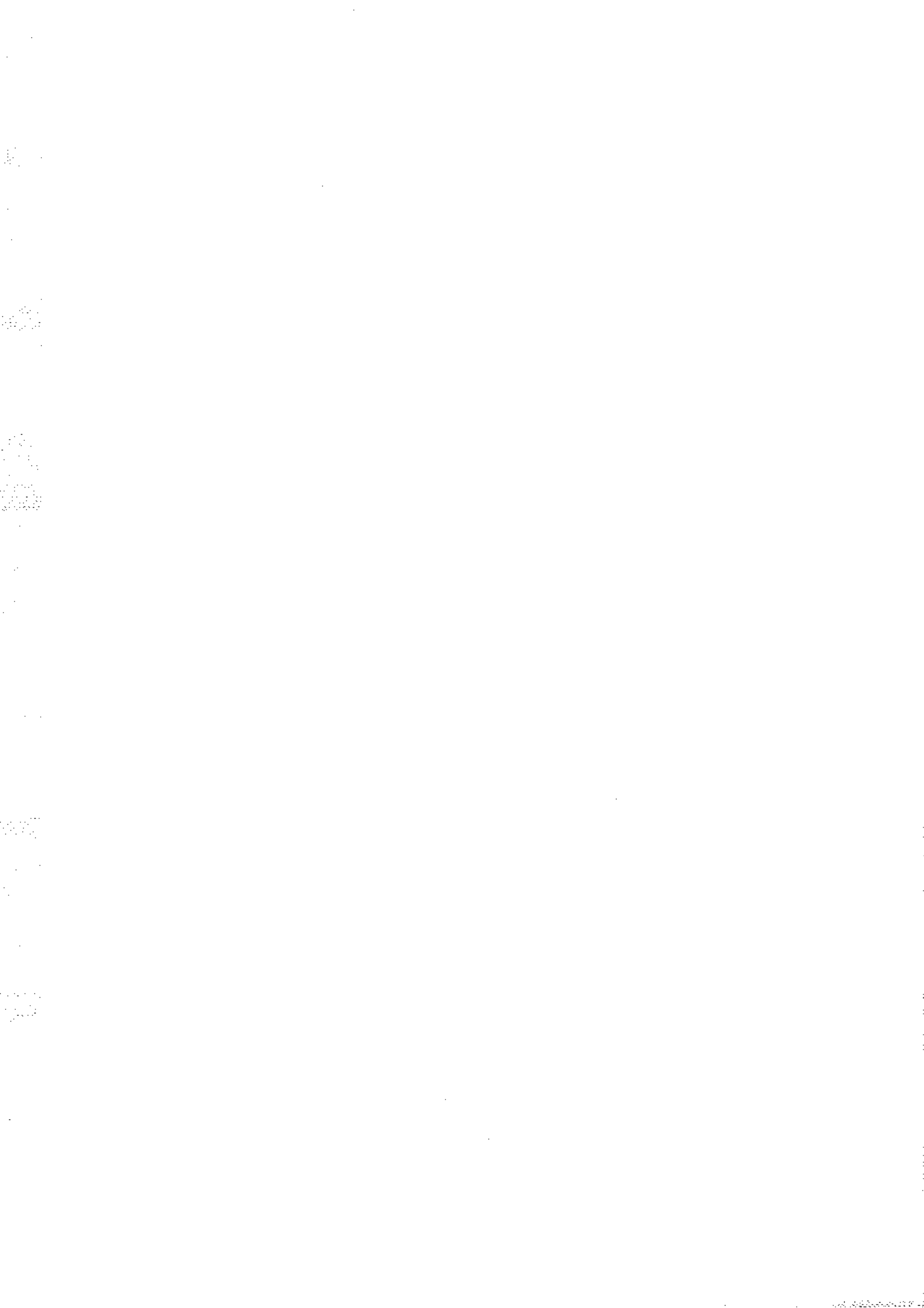


## Annex I

### AGENDA

Opening of the meeting

1. Adoption of the Agenda
2. Review of the health of the oceans
3. Oceanographic model for the dispersion of waste disposed of in deep sea
4. Sea disposal studies
5. Review of potentially harmful substances
6. Evaluation of the hazards of harmful substances carried by ships
7. Biological effects of thermal discharges in the marine environment
8. Interchange of pollutants between the atmosphere and the oceans
9. Marine pollution implications of ocean energy development
10. Future work programme
11. Date and place of next session
12. Other matters
13. Election of Chairman and Vice-Chairman for the next inter-sessional period and for the thirteenth session
14. Consideration and approval of the report of the meeting



## Annex II

## LIST OF DOCUMENTS

| GESAMP No.         | Agenda No. | Author, Source           | Title  |
|--------------------|------------|--------------------------|--|
| XII/1              | 1          | Administrative Secretary | Agenda for the twelfth session of GESAMP                             |
| XII/2              | 2          | Working Group            | Review of the Health of the Oceans                                   |
| XII/3              | 3          | Working Group            | Oceanographic Model for the Dispersion Waste Disposed of in Deep Sea |
| XII/4              | 4          | Working Group            | Sea Disposal Studies   |
| XII/4/Add.1        | 4          | Working Group            | Selected Case Studies on the Disposal of Wastes at Sea               |
| XII/4/Add.2        | 4          | Working Group            | Selected Bibliography on the Disposal of Wastes at Sea               |
| XII/5              | 5          | WHO                      | Review of Potentially Harmful Substances                             |
| XII/5/Add.1.       | 5          | WHO                      | Data Profile on Cadmium in the Marine & Estuarine Environment        |
| XII/5/Add.2        | 5          | WHO                      | Data Profile on Tin in the Marine & Estuarine Environment            |
| XII/6              | 6          | Working Group            | Evaluation of the Hazards of Harmful Substances carried by Ships     |
| XII/7              | 7          | Working Group            | Biological Effects of Thermal Discharges in the Marine Environment   |
| XII/8/1<br>XII/8/2 | 8          | Working Group            | Interchange of Pollutants between the Atmosphere and the Oceans      |
| XII/9              | 9          | Working Group            | Marine Pollution Implications of Ocean Energy Development            |
| XII/INF/1          |            | IMCO                     | Recent Activities of IMCO in the field of Marine Pollution           |

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| GESAMP No.  | Agenda No. | Author, Source | Title   |
|-------------|------------|----------------|---|
| XII/INF/2   |            | FAO            | Summary Report of Activities of FAO in the field of Marine Pollution                                      |
| XII/INF/3   |            | UNESCO/IOC     | Report on the Work of UNESCO and IOC in relation to Marine Pollution since the eleventh session of GESAMP |
| XII/INF/4   |            | WMO            | Report on the work of WMO in relation to marine pollution since the eleventh session of GESAMP            |
| XII/INF/4/1 |            | WMO            | WMO proposal to amend the GESAMP working definition of marine pollution                                   |
| XII/INF/8   |            | UNEP           | Information on UNEP's activities relevant to GESAMP   |

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Annex III

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## Annex IV

### SUMMARY OF THE REPORT OF THE WORKING GROUP ON A REVIEW OF THE HEALTH OF THE OCEANS

In assessing the health of the oceans four complementary approaches have been used :

- (i) Fundamental processes of the ocean system have been identified and described as a background against which further information should be evaluated.
- (ii) Examples have been given of biogeochemical cycles that many elements undergo and of the influence that human activities may have on the flux of elements between compartments in the ecosystem, or the pool of the element in a given compartment.
- (iii) Pollutants in the marine ecosystem have been identified and data have been gathered on present concentrations and trends in the concentrations so as to allow an evaluation of the hazard they pose.
- (iv) Physical, chemical and biological characteristics of selected geographical areas have been described and information has been collected on the situation with regard to marine pollution in those areas.

In many of the cases studied it has been concluded that man has substantially altered the flux of elements and compounds to the ocean.

In no case has it been demonstrated that this has resulted in any large scale effects on populations of living organisms, or on large scale physical or chemical processes in the open ocean.

In coastal areas and semi-enclosed seas increased levels of pollutants have frequently been recorded in organisms, sediment and water. In some cases this has resulted in a threat to individuals and populations in reductions of fisheries or other uses of the sea.

For some substances it has been demonstrated that governmental regulations and international agreements have managed to reduce an existing threat (e.g. DDT) and for others have prevented a hazard to man from arising (e.g. radionuclides).

High levels of some contaminants (e.g. mercury) exist in both local areas and in certain fish species in the open sea. Regulations on discharges have prevented the local problems from becoming more numerous and the existing ones from getting more severe, while regulations of fish consumption have protected human health.

The high mercury levels in predatory fish species in the open sea are concluded to have resulted largely from natural processes.

For the vast majority of substances too little information is available to allow any assessment of present or future risks.

On the basis of the elaborations and studies a number of conclusions and suggestions are made which have been comprised into an Executive Summary.

Ten years after the Stockholm Conference it can be concluded that the health of the world oceans does not give cause for alarm but does require continuous attention. The work necessary for the collection of information on and control of pollution has barely started. Some of the pollutants that were initially given high priority now provide examples of how the problems that arise can be handled.

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Executive Summary

I Scope and purpose of the report

II Basic properties of the ocean system

III Biogeochemical cycling

IV Pollutants in the marine environment

V Implications for the use of the marine environment

VI Specific problems of regional significance

VII Methodology for the assessment and control of marine pollution

Glossary

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References

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## Annex V

### SUMMARY OF THE REPORTS OF THE WORKING GROUP ON THE OCEANOGRAPHIC MODEL FOR THE DISPERSION OF WATERS DISPOSED OF IN THE DEEP SEA

The Working Group met from 8 to 12 December 1980 and from 1 to 5 June 1981, with the following terms of reference :

- (i) to review the present knowledge of pathways by which substances might be transferred from a deep ocean (deeper than 4 kilometres) to man;
- (ii) where possible to recommend methods for calculating the concentration of substances, arising from containers deposited on the deep ocean floor, in the water column throughout an ocean basin;
- (iii) to assess the reliability of the calculated concentrations.

At the first meeting the Working Group reviewed its terms of reference and decided to recommend minor changes to GESAMP. The Working Group members noted that in various nations modelling efforts related to dumping activities are under way especially for the assessment of the disposal of radioactive wastes in the deep sea. They agreed that it would be desirable to establish co-operation with the other group working in this field and to incorporate the results in its work as they became available, if appropriate.

The Working Group considered various aspects of physical, geochemical and biological oceanography which are relevant to the understanding of the transfer of substances from the deep sea. Particularly instructive were the considerations of the benthic boundary layer, the large-scale geochemical balances of certain naturally occurring radionuclides, and the nature of the deep-sea biota. From these discussions it was apparent that estimates of transfer rates had to be approached with full recognition of the multi-disciplinary nature of the problem. In addition, the variety of time-scales involved in the important physical, chemical and biological processes made it clear that a detailed examination of the evolution in space and time of a release from a dump site is necessary. It is only by such an examination that one can obtain some understanding of which processes will be dominant in the transfer of material in various dumping scenarios.

The Working Group schematically mapped out the important transfer mechanisms for an idealized oceanographic model, considered some in more detail and outlined those problems to which members could give special attention, in the inter-sessional period.

At its second meeting (after reviewing its accomplishments), the Working Group decided that it would be more effective to first examine certain limiting situations. In this way it would be possible to develop a scientific framework upon which future work could be based, and to identify critical problems in this context. Accordingly, the Working Group decided to concentrate on the various aspects of concentration fields of pollutants to be found in both the near-field and far-field from a source, including the effects of physical transport and the interaction of contaminants with particulate matter, sediments and biota. While identifying these aspects, they agreed to also address somewhat separately particular relevant aspects of marine geochemistry and biology. After discussing further in plenary various aspects of the work to be carried out, the Working Group split into smaller groups which prepared working papers on the various topics. These reaffirmed that, as a result of the diversity of half-lives and interaction rates of pollutants with the physical, geochemical and biological oceanic systems, the development of a variety of specialized models would be required.

Recognizing that the details of the working papers could only be absorbed by the members of the group over a period of time, the Working Group decided that the first inter-sessional task should be the critical examination of these working papers and the serious attempt to evaluate their consistency, especially on interdisciplinary matters. Certain problems were, however, identified as clearly needing to be addressed at the next meeting. These included (a) the detailed examination of benthic boundary layers and their place in models of the release of pollutants from a dump site; (b) the extension of the steady-state ideas already being considered to time-dependent problems; (c) the identification of biological pathways and the integration of biological processes into the physical-geochemical models being developed; and (d) serious consideration of the nature of the detailed models that would ultimately be required if the Working Group is to meet its objectives concerning calculations of the concentration of pollutants throughout an ocean basin.

The Working Group also recognized that some of the above topics might be dealt with by various concerned parties in a number of countries during the intersessional period. Members of the Working Group will attempt to further develop contacts with other parties working in this field. It was considered not to necessary at this time to request help from outside the Working Group in the carrying out of detailed model computations although this might be desirable later. Additional expertise might be required at the next meeting in the introduction of descriptive oceanographic features into the models being developed and in biological uptake rates of critical substances.

The next meeting of the Working Group is to be held from 23 to 27 November 1981, after its programme is approved by GESAMP XII.



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## Annex VI

### SUMMARY OF THE REPORT OF THE WORKING GROUP ON SEA DISPOSAL STUDIES

1. The report is a result of two inter-sessional meetings held under the Chairmanship of A. McIntyre at IMCO Headquarters in London from 30 September to 2 October 1980, and from 27 to 30 April 1981.
2. The terms of reference of the Working Group as given at the eleventh session of GESAMP were reviewed by the Working Group. It was noted that the first and main task dealt with the review and updating of Rep. Stud. GESAMP (3) - Scientific Dumping of Wastes into the Sea. The Working Group agreed that since the report had been produced a number of advances had been made in several fields but that the document was a concise and comprehensive account of the situation as it had existed at that time, and that in terms of presentation and structure, major changes would not be required. The Working Group agreed to follow, in general, the existing layout of the report but to update and rearrange certain sections as necessary and to add new material as required.
3. The Working Group prepared a new report "Scientific Criteria for the Selection of Waste Disposal Sites at Sea". A list of contents of this report is set out below.
4. With regard to the second task, the compilation of a bibliography of relevant material, the Working Group recognized that several annotated lists already exist and that these could be obtained by interested parties if referenced in the updated report. The Working Group considered that its most useful contribution would be to produce a selective list containing such references which were judged to be of particular importance.
5. The Working Group also noted that GESAMP at its eleventh session had requested the Working Group to suggest a detailed approach to the development of criteria leading to guidelines for identifying sea areas particularly vulnerable to marine pollution. The Working Group felt that this task will need consideration of specific ecological features such as diversity, uniqueness, naturalness, integrity as a self-sustained ecological entity. This would however need the participation of experts e.g. socio-economists from outside the present membership of the Working Group.

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SCIENTIFIC CRITERIA FOR THE SELECTION OF WASTE DISPOSAL SITES AT SEA

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## Annex VII

### SUMMARY OF THE REPORT OF THE WORKING GROUP ON REVIEW OF POTENTIALLY HARMFUL SUBSTANCES

At GESAMP XI this Working Group was confirmed and A. Jernelöv appointed as the Chairman. Its terms of reference were retained as established at previous sessions of GESAMP, namely to prepare short referenced reviews on selected substances including an assessment of relevant environmental factors. Furthermore, to produce a scientific evaluation of the harmful effects of substances released into the marine environment on living resources, human health, amenities and other legitimate uses of the marine environment and adjacent coastal areas.

In following up GESAMP XI, a small planning meeting was held in Copenhagen on 30 September 1980, which was attended by the Chairman of this Working Group and that on the Review on the Health of the Oceans, the WHO Technical Secretary of GESAMP and UNEP. The investigation of alternative approaches to the task of the Working Group was discussed and the Chairman's proposal to start from the "effects" end was accepted, in principle. Candidate substances for hazard assessment were examined also in the light of the requirements of the Working Group on the Review of the Health of the Oceans.

As concerns heavy metals, it was recognized that substantive information has been collected and summarized already on methyl-mercury in connection with the Mediterranean Action Plan. Comprehensive compilations would, however, be needed to review and evaluate cadmium, tin and lead. The potential importance of titanium in relation to dumping practices was noted and the hazard evaluation proposed for the next intersessional period. Similarly, the organo-chlorine compounds were earmarked for discussion at GESAMP XII and actual work during subsequent inter-sessional periods.

In support of the Working Group's tasks, UNEP's International Register of Potentially Toxic Chemicals (IRPTC) and Regional Seas Programme Activity Centre (RS/PAC) commissioned the preparation of data profiles on cadmium, tin and lead in the marine and estuarine environment to the Library and Information Service of the Marine Biological Association of the United Kingdom, Plymouth, United Kingdom. The profiles for cadmium and tin are being submitted to GESAMP XII, whereas the one on lead will be completed before the end of 1981.

Consequently, the following tasks are submitted to GESAMP XII for consideration :

- (i) Re-constitution of the Working Group on a Review of Potentially Harmful Substances, including the appointment of its Chairman and members;
- (ii) Design of the workplan and time table of the Working Group for the inter-sessional period on the basis of existing documentation as described above;

- (iii) Selection of candidate substances for the preparation of data profiles thus allowing for their review at subsequent inter-sessional periods;
- (iv) Harmonization of this Working Group with the tasks undertaken by others and particularly with the Review on the Health of the Oceans.

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## Annex VIII

### SUMMARY OF THE REPORT OF THE WORKING GROUP ON THE EVALUATION OF THE HAZARDS OF HARMFUL SUBSTANCES CARRIED BY SHIPS

1. The report is the result of three sessions of the Working Group which met under the Chairmanship of Mr. John Portmann in London, from 2 to 6 June 1980 and from 21 to 25 September 1981, and in Houston (United States) from 15 to 19 December 1980.
2. The Working Group established new hazard profiles of substances and reviewed existing hazard profiles of substances for which members of the Working Group had undertaken to carry out work during the inter-sessional period. Results of tests on aquatic toxicity of certain substances which had been carried out by other institutions and which had been submitted to the IMCO Secretariat and/or Chairman were also used in the preparation of new or revised hazard profiles.
3. The Working Group considered at length possible effects of carcinogenic substances on the marine environment. The Working Group recommended that compounds allocated with carcinogenic remarks should be given special consideration by the relevant IMCO bodies with regard to the prevention of accidental spillages of large volumes of such substances and of packages containing such substances being washed up on beaches. The Working Group, noting in particular the enquiries made on this matter by the Chemical Industry, strongly reaffirmed its view that there is a need to indicate any specific hazardous risks of substances which may lead to interference regarding the use of beaches, with a view to drawing the attention of the authorities concerned to particular hazards.
4. The Working Group prepared a draft composite report on the evaluation procedure used by the Working Group together with a composite list of hazard profiles of more than 1000 substances established by the Working Group at twelve meetings. This document is a revised and updated version of the report of the ad hoc Panel of IMCO and GESAMP Experts to Review the Environmental Hazards of Noxious Substances other than Oil Transported by Ships (GESAMP IV/19/ Supp.1, 1973).

The draft composite report prepared by the Working Group describes in detail the criteria used and further developed by the Working Group for the evaluation of hazards of harmful substances, e.g. with regard to bio-accumulation, damage to living resources, ingestion of water containing these substances, the risk to human health via skin or inhalation and the reduction

of amenities. The report also presents the outcome of the consideration of the Working Group on carcinogenic properties of certain substances and the assessment of the possible effects of these substances on the marine environment.

Other parts of the draft comprehensive report refer to the sources and requirements for data which are necessary as basis for the evaluation process and to specific problems met in the evaluation of several classes of chemicals, such as alcohols, halogenated compounds and phthalates.

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## Annex IX

### SUMMARY OF THE REPORT OF THE WORKING GROUP ON BIOLOGICAL EFFECTS OF THERMAL DISCHARGES IN THE MARINE ENVIRONMENT

The Working Group met in Dubrovnik from 21 to 25 September 1981. For its first session it had the following terms of reference : to selectively review available information on the effects of thermal discharges on coastal waters, and subsequently to evaluate direct and indirect adverse effects of thermal discharges on marine life, particularly fishery resources.

A large body of information is available in the literature concerning the effects of thermal discharges. To understand these effects and their causes it will be necessary to distinguish the separate mechanical processes of cooling water use, and cooling water treatment. At cooling water intakes where large volumes of water are abstracted and passed through grids and screens, a substantial "catch" of fish and macroinvertebrates may be observed. This catch is variable and its relationship to the population from which it is drawn, and its wider ecological significance, is not clear. Any effects will be of local, rather than of regional or wider significance, but could be important to a coastal community dependent on exploitation of local marine resources. The analysis of entrainment conditions and mortality can be helpful in understanding the separate and combined effects of physical and chemical stresses imposed during passage of smaller organisms through the plant. Mortality is greater during chlorination, so that the possibly significant loss of fish eggs and larvae, and of larvae of important macroinvertebrates could be minimized by limiting periods of antifouling treatment.

Discharge conditions are often complex and site specific, depending on the temperature increment above ambient, the residual concentration of biocide, local topography and intertidal substrate. It is convenient to distinguish near field and far field areas and conditions. In the near field, the effects on plankton within the plume will not be distinguishable from those resulting from plant entrainment, and those consequent on plume entrainment, although their causes are different. In the far field the same problem occurs, with additional complexity. Some potential effects will be the result of acute exposure, but others, especially on the benthos or intertidal community, may be due to longer-term exposure. In subtropical and tropical areas, some habitats e.g. mangrove swamps and shallow weed beds are particularly sensitive. The observed greater incidence of parasites in heated waters, and the potential effect on fish stocks merits investigation. The long-term effects of chlorine residuals are not well understood - it is necessary to gain knowledge of the chemical pathways of chlorine decay and to develop instruments and methods for detection of the residuals and of their biological effects.

In general it can be noted that rejected heat can provide some benefit especially if it is harnessed to aquaculture systems. But the threshold between potentially valuable and potentially damaging effects of heat is not particularly well defined due to the range of sensitivity of species and the interaction

of heat with other water quality conditions.

It was understood that the Working Group should address its report mainly to environmental scientists and managers in developing countries. These countries, while exhibiting great need for increased power generation, do not always have the necessary experience to deal with ecological aspects of reject heat disposal and associated biological effects. Also, since most modern power plants and other processing industries are being built in heavily populated shore areas, the effects of combined discharge of heat and other substances, including sewage, warrant careful evaluation and recommendations regarding siting and long-term monitoring.

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## Annex X

### SUMMARY OF THE REPORTS OF THE WORKING GROUP ON THE INTERCHANGE OF POLLUTANTS BETWEEN THE ATMOSPHERE AND THE OCEANS

The Third Session of the GESAMP Working Group on the Interchange of Pollutants between the Atmosphere and the Oceans (INTERPOLL-III) was held at the National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratories, Miami, U.S.A., in October 1980.

In reviewing the status of high-molecular-weight halogenated hydrocarbons, the Working Group was made aware of the decline in the marine environment of the earlier pollutants, such as DDT and PCBs. At the same time it was noted that a shift might be occurring in the global distribution of DDT with increasing concentrations in the southern hemisphere.

Calculations based upon data analyzed by the Oceanographic Data Centre, Hamburg, from the IGOSS MAPMOPP (Marine Pollution (Petroleum) Monitoring Pilot Project) indicate that, in the areas monitored, oil slicks cover either 0.1 per cent or 0.05 per cent of the surface, depending on the approach used. Globally, considering both the monitored and unstudied regions of the world oceans, the oil slick coverage of the sea-surface by oil was estimated to be 0.015 per cent. It was generally agreed that this is an upper limit in film coverage and probably exaggerates the real situation.

The Working Group discussed processes involved in transferring substances from the sea to the atmosphere. Bubble and aerosol spectra produced by recent laboratory experiments with a simulated "breaking wave" showed that most of the aerosol particles originated from film drops, which can be as small as  $10^{-2}$  mm in diameter. About  $3 \times 10^5$  particles  $\text{sec}^{-1}$  were produced from the entire surface of the experimental tank, and about half of these had a diameter less than 1mm. The mass of particles, however, comes from jet drops.

The Working Group noted the importance of sea-surface micro-layer studies to the air-sea pollutant interchange problem. A number of ocean pollutants were considered in terms of their potential effect on tropospheric processes. These included: carbon dioxide and aerosols, which could have an impact on global climate, sulphur dioxide, leading to acid precipitation and an impact on terrestrial and freshwater ecosystems.

An ad hoc meeting of the Working Group on the Interchange of Pollutants between the Atmosphere and the Oceans was held in Tallinn, USSR, in May 1981. The Group reviewed the section "Air-sea Interface" for a report of the GESAMP Working Group on a Review of the Health of the Oceans. The Group has suggested some improvements and revisions in order to obtain a more accurate and up to date consideration of the work of INTERPOLL so far available.

The various values of CO<sub>2</sub> uptake by the oceans obtained by different investigators were discussed using data from specific areas and certain models for their evaluations. It was noted that the pCO<sub>2</sub> (partial pressure of CO<sub>2</sub>) of surface sea water is generally not in local equilibrium with the present global atmospheric CO<sub>2</sub> concentration of about 340 ppm. In discussion, it was estimated that 30-50 per cent of the manmade CO<sub>2</sub> is taken up by the ocean.

The importance of the bacterioneuston in the sea surface microlayer for biological degradation of pollutants in the surface film was discussed. Surface films have been shown to be particularly rich in microflora, the number of micro-organisms being 10-10,000 times higher there than in the lower layers. It has been found that the number of heterotrophic, saprophytic microflora in the sea foam exceeds by two or three orders of magnitude those in the lower layers. Several related topics were also discussed including the atmospheric input of sulphur to the oceans, models of the transfer of CO<sub>2</sub> and some organic pollutants across the air-sea interface, distribution and forms of petroleum hydrocarbons in boundary zones of the ocean and the atmosphere.

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## Annex XI

### SUMMARY OF THE REPORT OF THE WORKING GROUP ON MARINE POLLUTION IMPLICATIONS OF OCEAN ENERGY DEVELOPMENT

The Working Group met once during the intersessional period, from 29 June to 2 July 1981, at UNESCO Headquarters in Paris. It had the following terms of reference:

- (a) To review the current literature and results of ongoing research and describe marine pollution implications of the exploitation of the major sources of unconventional ocean energy with special reference to coastal areas and multiple-use concepts, particularly in developing countries;
- (b) To discuss the long-term environmental impacts to be expected from extensive ocean energy exploitation at the global level.

The intersessional work was undertaken by a selected number of experts involved with the environmental implications of ocean thermal energy conversion (OTEC). This focus was influenced by the Ocean Energy Technical Panel of the United Nations Conference on New and Renewable Sources of Energy which concluded that OTEC was the most promising form of ocean energy and held the greatest long-term potential for developing countries.

In the absence of commercially operational OTEC plants, current evaluations are based on anticipated inputs and studies of pilot plant operations. OTEC programmes are underway in the United States, France, the Netherlands, Sweden, Japan and India for sites in tropical ocean areas. It is anticipated that first generation plants, and the majority of those in developing countries, will be under 100 MWe and may be land- or shelf-based rather than moored or floating in deeper water.

The OTEC review was initiated using a working paper prepared by leading scientists in the United States OTEC environmental programme. A small working group was organized including scientists and engineers from France and the Netherlands to review this paper and supply additional information from projects within their experience.

The Working Group reviewed the U.S. working paper on environmental issues of OTEC. The Group considered that this report presented a very useful summary of the technology and resource characteristics which are pertinent to environmental concerns. An important factor in consideration is that the first number of OTEC power plants will be of relatively small size (1-50 MWe), in contrast, to later OTEC development which might result in large floating plants including sites offshore. Consequently, environmental concerns may divide into near-term matters related to coastal impacts locally, and long-term matters associated with increased numbers of plants having impacts on a regional or global basis.

The first category includes construction impacts, particularly if tropical reefs are involved, and operating impacts particularly associated with upwelling of nutrient rich water, or discharge of mixed effluents in coastal systems. The secondary category is primarily concerned with large volumes of ocean water flowing through the plants and consequent oceanic property redistribution.

A variety of studies and surveys are needed at potential OTEC sites to insure that the plans are scientifically and environmentally sound. These studies fall within two major categories.

1. Those associated with the engineering and construction of a practical plant.
2. Those associated with operating the plant and utilizing its products.

It was recognized that adverse environmental impacts can occur in the construction and operation phases of OTEC plants but that the risks can be reduced to acceptable levels through proper planning and design.

At this initial session, the Working Group felt that the engineering aspects of OTEC development were in good order and that the Working Group would review other major ocean energy sources and report in detail on biological impacts, long-term physical effects and multiple-uses associated with OTEC energy.

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