

MARINE ECOTOXICOLOGICAL TESTING IN  
THE FRAMEWORK OF INTERNATIONAL CONVENTIONS

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**ABSTRACT**

This paper describes the role of ecotoxicological testing in the framework of the international conventions to prevent marine pollution. In particular, the paper summarises the chief principles of the tests for toxicity, biodegradation and bioaccumulation which have been adopted by the Oslo Commission for application prior to the dumping of chemical wastes containing "black listed" substances. It describes the comparable consultative procedures which have been agreed at global level under the London Dumping Convention. The paper also refers to the test procedures being developed under the auspices of the Bonn Agreement for the evaluation of dispersants to be used in combating oil spills and briefly to the hazardous assessment profiles developed under the MARPOL Convention. The paper concludes with a justification of the role of ecotoxicological testing at the international level.

**KEYWORDS**

Marine ecotoxicology, Conventions, Testing procedures, Regulations, Review.

## INTRODUCTION

As the announcement for this symposium makes clear, concern for the protection of marine ecosystems against pollution is relatively recent. It is only within the last ten years or so that concern at international level has expressed itself by the binding together of many states in international and regional conventions for the protection of the marine environment. For the most part, measures at national level have only been taken subsequently in order to implement these international commitments and obligations.

Subsequent papers to be presented to this symposium describe the state of the art of marine ecotoxicological testing in different countries as well as tests with different types of organisms. The objective of the first paper is to describe the developments in marine ecotoxicological testing in recent years at international level. It will attempt to justify the need for such testing at the international rather than the national level and will describe the development of the art up to the present day.

## THE OSLO CONVENTION

It is surely the case that the development of marine ecotoxicological testing at international level has developed to its fullest extent under the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, commonly called the Oslo Convention after the capital of Norway where the Convention was opened for signature on 15 February 1972. Prior to the Oslo Convention, the dumping of wastes at sea was an activity which was unregulated either at international or at national level.

Following the Stella Maris incident, however, when a Dutch coaster proposing to dump 650 tonnes of chlorinated hydrocarbons in the North sea was harried by different national authorities from one prospective dump site to another before finally returning to Rotterdam with its cargo intact, the maritime States of Europe decided that it was necessary to take joint action to prevent such incidents occurring in future. Thus it was that the diplomatic negotiations led in a relatively short space of time to the Oslo Convention.

The Oslo Convention has now been ratified by all its thirteen signatory States : Belgium, Denmark, Finland, France, the Federal Republic of Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom. As might be expected with so many contracting parties, the national policies towards dumping at sea among the members of the Oslo Commission vary. On the one hand, there are those states which would prefer to prohibit the dumping of wastes at sea entirely, with the possible exception of dredged spoils which need to be disposed of in order to maintain clear access to harbours and ports. On the other hand, there are those states which regard the sea as a resource to be used for the disposal of wastes where such disposal is considered to be economically feasible, and provided that any environmental damage is kept within acceptable limits. Whatever the national philosophies towards waste disposal, however, there is agreement among all the contracting parties to the Oslo Convention that pollution of the sea by the dumping of harmful substances should be prevented. The Oslo Convention provides the international mechanism for regulating dumping at sea in the north east Atlantic region.

Perhaps the most fundamental principle of the Oslo Convention is the decision which the contracting parties took when they decided to prohibit the dumping of certain substances and materials. This "black list" of substances comprises organohalogen and organosilicon compounds (and compounds which may form such substances in the marine environment), substances which have been agreed between the contracting parties as likely to be carcinogenic under the conditions of disposal, mercury and mercury compounds, cadmium and cadmium compounds, persistent plastics and other persistent synthetic materials which may float or remain in suspension in the sea.

From a scientific point of view it would be satisfying to think that the comprehensive list of substances had been drawn up following detailed scientific investigation. However, the negotiation of international treaties rarely allows the time to consider scientific questions on such a methodical basis. What the drafters of the Convention appear to have had in mind when they agreed upon the first black list of substances, is that the substances listed should have shown in the scientific literature then available some evidence of the properties of toxicity, persistence in the marine environment, and bioaccumulation in the food chain.

At least in the view of the Oslo Commission this initial list has stood the test of time. In 1979/80, the Commission reviewed the Annexes to the Convention to consider whether in the light of more recent scientific knowledge it was appropriate to amend the Annexes in any way. After consideration of various proposals for the removal of certain substances from the lists and the inclusion of others, the Commission came to the conclusion that for the time being no changes were justified. The Commission agreed that the composition of the Annexes should be reviewed every five years and the next such review will take in 1984/85. In the meanwhile, the Commission has established a List of Hazardous Substances upon which substances are entered pending full review every five years. At present, this List of Hazardous Substances contains a proposal to include lead in Annex I to the Convention rather than in Annex II, and also a proposal that organosilicon compounds should be removed from Annex I.

Although the concept of prohibiting the dumping of certain substances was clear to the drafters of the Convention, they were also aware of the fact that some of the substances included in the black list were naturally occurring elements and therefore it was not feasible to ban their dumping absolutely, provided one accepted the fact that the dumping of the waste itself was a necessary activity. It was also evident that not all organohalogen and organosilicon compounds were equally toxic, persistent and bioaccumulative. Therefore, the drafters of the Convention realised that it was necessary to make certain exemptions from the black list.

The first exemption applied to all substances listed in Annex I to the Oslo Convention. Article 8(2) of the Convention states that "The provisions of Article 5 (i.e. the prohibition of the dumping of the substances listed in Annex I) shall not apply where these substances occur as trace contaminants in waste to which they have not been added for the purpose of being dumped. However, that dumping shall remain subject to Articles 6 and 7" (i.e. subject to the requirement that the dumping is authorised by a specific permit or approval).

Secondly, in the case of organohalogen and organosilicon compounds and compounds which may form such substances in the marine environment, Annex I specifically excludes "those which are nontoxic, or which are rapidly converted in the sea into substances which are biologically harmless".

The legal concepts of these exemptions are clear. It has been left to the scientists working within the framework of the Commission to attempt to provide a practical interpretation of the legal rule. In the very earliest days of the Oslo Commission, working groups were established to attempt to define the concepts of "trace contaminants", "nontoxic" and "biological harmlessness". From the start they decided that it was not possible to establish simple pass/fail criteria for acceptance or rejection. Rather they decided that all three concepts should be evaluated in the context of a number of specific test procedures. In 1976 the Commission's scientific experts agreed upon the following tests for the evaluation of the Annex I fraction of wastes presented for dumping :

- (i) a lethality test (with constant concentrations) on an easily available fish and crustacean (preferably shrimp) and on Artemia salina ;
- (ii) "recovery tests" using the same animals as of (i) ;
- (iii) a "growth test" on a phytoplankton species ;
- (iv) a test on the reproduction of Artemia salina or any other suitable animal ;
- (v) a "die-away" test to measure degradation ;
- (vi) a sublethal low concentration test to assess bioaccumulation potential performed on at least one species of fish (as used in (i)) and one species of mollusc ; accumulation to continue for 14 days and elimination for at least 7 days.

In 1980 the Commission decided that it would be appropriate to establish a new Working Group on Test Procedures with the mandate to review the established tests in the light of subsequent developments in the state of scientific knowledge and to advise the Commission accordingly. In fulfilling its task, the Working Group recognised that the state of the art had developed considerably since the adoption of the original test procedures in 1976. In particular, the Working Group felt that it was no longer necessary to specify precise tests which had to be rigidly adhered to. Rather, it was felt that the objective should be to define certain agreed principles and criteria which the individual test procedures should meet. Within the agreed principles, the laboratories of contracting parties would be free to apply the test procedures that they considered most appropriate in the circumstances. The Working Group's recommendations were adopted by the Oslo Commission in June 1982 and now form part of the current Oslo Commission procedures for assessing the acceptability of the dumping of Annex I substances in wastes.

### GENERAL GUIDELINES FOR THE IMPLEMENTATION OF TEST PROCEDURES

First, the Oslo Commission has adopted General Guidelines for the Implementation of Test Procedures under the Prior Consultation Procedure (PCP). This is the procedure which must be followed by a contracting party whenever it proposes to issue a permit for the dumping of substances and materials mentioned in Annex I of the Convention :

- (a) on the assumption that they are "nontoxic", or are "rapidly converted in the sea into substances which are biologically harmless", or appear only as "trace contaminants in waste to which they have not been added for the purpose of being dumped" ; or
- (b) when a contracting party considers that the dumping at sea of these substances and materials is acceptable because there is no appropriate alternative means of disposal.

Before issuing such a permit, the contracting party concerned must consult the other members of the Commission and provide the results of the tests which have been carried out to demonstrate the acceptability of the waste for dumping.

The object of the General Guidelines is to provide guidance on the carrying out of ecotoxicological testing under the PCP, including tests on biodegradation, to investigate whether or not Annex I substances in a waste can be qualified as nontoxic, rapidly degradable or as a trace contaminant.

The General Guidelines recognise that inorganic mercury or inorganic cadmium cannot qualify for the exemptions of nontoxic or rapidly degradable. The Guidelines acknowledge that sufficient scientific knowledge on the toxicological properties of these two substances exists for numerical criteria to be defined to describe their presence as "trace contaminants". Consequently, the Guidelines confirm that no further testing is required with regard to inorganic mercury and inorganic cadmium. (The Commission's decision regarding the numerical values of these two substances are dealt with in later paragraphs.)

The testing of waste under the PCP therefore has to concentrate on the organic fraction of Annex I substances. The General Guidelines require that testing should be performed in such a way that the test results relate to

this fraction. It is acknowledged that this may be simple when only one or two organic Annex I substances are present but that testing becomes progressively more difficult when more complex wastes are tested.

When it is known that toxic components such as  $\text{NH}_4^+$ ,  $\text{NO}_2^-$ ,  $\text{CN}^-$ , heavy metals or specific organic compounds are present in the waste, available knowledge on their toxicity may be used to arrive at a more correct interpretation of the test results. The presence of significant amounts of  $\text{PO}_4^{3-}$ ,  $\text{NO}_3^-$ ,  $\text{K}^+$ ,  $\text{Na}^+$ ,  $\text{Ca}^{2+}$ ,  $\text{Cl}^-$ ,  $\text{Mg}^{2+}$ ,  $\text{SO}_4^{2-}$  and  $\text{CO}_3^{2-}$  should also be taken into account. The General Guidelines stipulate that if it is not possible to discriminate between that part of the given toxicity of a waste which is attributable to the Annex I fraction, and that part which results from other fractions in the waste, then the total toxicity has to be attributed to the Annex I fraction. This is an important safeguard.

Furthermore, although the testing under PCP is focused on a specific Annex I fraction of the waste, the final decision of the national authorities on the granting of a dumping permit must be based on the overall ecotoxicological profile of the waste, including factors such as pH, and the toxicological properties of fractions in the waste other than the Annex I fraction.

The General Guidelines recognise that when tests are performed a number of difficulties may be encountered arising from the following causes : pH ; the solubility or degree of miscibility with seawater ; the presence or absence of volatile compounds, solids and adsorbing substances ; the biochemical oxygen demand. The General Guidelines address each of these parameters in turn and the effect which they may have on the total toxicity of the waste and provide advice on methods for overcoming the problems encountered.

#### PRINCIPLES FOR THE CONDUCT OF TOXICITY TESTS

The Oslo Commission's Prior Consultation Procedure prescribes a certain number of basic toxicity tests to be performed on the waste. The PCP recognises that in some special cases it may not be necessary to carry out all the tests listed (e.g. the reproduction tests) in order to make a proper assessment. In such cases the reasons for failure to carry out the tests need to be clearly stated.

Furthermore, in some cases the information provided by the specified tests may indicate the need for extra tests to be carried out in order to provide sufficient data for an assessment to be made. Such additional tests may include the recovery test adopted by the Commission in 1976, or early life-stage tests with fish.

The test to be carried out are as follows :

A. Acute tests

1. Marine crustacean LC50, NOEC, 96 h exposure
2. Salt water fish LC50, NOEC, 96 h exposure

B. (Sub)-chronic tests

3. Marine algae EC50, at least 96 h exposure  
Criterion of effect : growth inhibition
4. Marine crustacean LC50, NOEC, 3 weeks exposure

C. Reproduction tests

6. Reproduction with a suitable fish or crustacean,  
preferably, but not necessarily, with salt water species.

The following test organisms are recommended by the Oslo Commission for the acute and subchronic toxicity tests :

Crustaceans : Chaetogammarus marinus or other marine gammarids  
Crangon crangon  
Palaemonetes spp.

Fish : Poecilia reticulata  
Agonus cataphractus  
A flatfish species such as Pleuronectes platessa or  
Platichthys flesus

Algae : Skeletonema costatum  
Phaeodactylum tricornutum  
Dunaliella tertiolecta  
Tetraselmis suecica  
Prorocentrum micans



For the conduct of reproduction tests, the Oslo Commission recommends :

Crustaceans : Chaetogammarus marinus  
Daphnia magna

Fish : Poecilia reticulata  
Jordanella floridae

Following the review by its Working Group on Test Procedures, the Oslo Commission has stipulated that the following test organisms may not be used in any toxicity test under the PCP : any member of the family Gobiidae (Pisces, Perciformes) and Artemia salina (Crustacea, Anostraca).

It will be observed that Chaetogammarus marinus is the only marine species recommended for use for the reproduction tests. This is because the Oslo Commission's Working Group recognised that no other suitable marine test organism (fish or crustacean) is available on which reproduction tests can be performed within a reasonable period of time and for which sufficient experience exists. It was noted, however, that there were promising developments in this field which may result in other suitable marine reproduction tests becoming available in the near future. In the meantime, reproduction tests using the recommended freshwater species must be preceded by corresponding acute toxicity tests.

Furthermore, when the results of the acute toxicity tests indicate that fish are more sensitive than crustaceans to the waste, it is important that an egg-laying fish species is included in the reproduction tests.

Since it is the object of the toxicity tests to relate effects to concentration, it follows that the test solutions must be maintained as consistently as possible over the test period. The Oslo Commission therefore requires that evidence is submitted either from analysis, from chemical properties or from the test system used, to demonstrate that the concentration of the test substances has been satisfactorily maintained (e.g. within 80 % of the initial concentration over the test period). The results of the toxicity tests have to be presented in accordance with a standard format.

Certain guidelines and test protocols are recommended (see Annex I). The Commission requires that if other procedures are followed, a detailed description of the methods used must be provided. If the recommended methods are followed, any deviation from the quoted reference has to be reported.

#### **PRINCIPLES FOR THE DETERMINATION OF THE BIODEGRADABILITY OF THE ORGANIC FRACTION OF CHEMICAL WASTES**

The determination of the biodegradability of complex wastes proposed for dumping at sea is perhaps more difficult than the determination of pure toxicity. The Oslo Commission's Working Group on Test Procedures acknowledged that experience gained in investigating chemical wastes showed that insight into "degradability" could only be obtained by using a number of different determinations, including chromatographic fingerprints, extractable organohalogen (EOH) and toxicity. The latter is especially important because a decrease in toxicity indicates a degradation "relevant" to the protection of the aquatic environment.

There are essentially two methods for determining biodegradability which have the approval of the Oslo Commission. The first is the so-called die-away test which was originally adopted by the Commission in 1976. In the die-away test, the substance to be investigated (the substrate) is added to a definite amount of a medium (either natural seawater collected from a nonpolluted source or artificial seawater prepared from commercially available sea salt) containing bacteria. During the incubation period, the concentration of the substrate is determined at regular intervals. The decrease in concentration ("the dying-away") is taken as the criterion of degradability. It is assumed that the processes taking place during the tests are the same as those occurring in a "compartment" of water which has received a single discharge without being diluted. The procedure is a very simple one requiring nothing but an erlenmeyer flask. Provided that an analytical method is available for its determination, the substrate can be soluble or insoluble in the medium, a liquid or a solid.

In its initial concentration the substrate should on no account be toxic to the microflora present in the medium. If there is no certainty that the substrate in the concentration added is nontoxic, its toxicity has to be

determined first. The sampling frequency can be adjusted to the degradability of the substrate. Usually a sampling frequency of alternate days will be sufficient.

As an alternative to the die-away test, the Commission has approved in principle the use of a continuous-flow technique, based on a chemostat, as an alternative (see Annex I). In general, the die-away test cannot be used when toxicity is used as a parameter for determining degradation because of the large volumes of degraded waste needed (10 - 25 l). The use of toxicity as an analytical determination implies the choice of a sensitive test organism. This choice can be made on the basis of tests carried out with the waste itself using an alga, a crustacean and a fish as test organisms. The results of these tests also determine the influent concentration of the chemostat, which equals or exceeds the LC50 of the selected test organism. There has been little international experience in the use of such a test but it has the potential of being a useful addition to the range of degradation measurements.

In general, the Commission recognises that degradation studies of complex mixtures of organic compounds cannot lead to a simple conclusion that they are "biodegradable" or "non-biodegradable".

In the context of the Prior Consultation Procedure another difficulty occurs as well. When the degradation test is based on the determination of changes in, for example, toxicity, fingerprints, EOH and organic carbon content, only EOH content is related to the organohalogenes. Even when a decrease in toxicity is accompanied by a decrease in EOH content, it is not certain that the organohalogenes caused the toxic effects. The fingerprints only give information on the transformation of groups of compounds, which cannot be identified without a detailed analytical programme. Therefore biodegradation testing carried out according to the outlines given above mainly detects the presence of those organohalogenes, and/or toxic compounds, which are slowly or non-biodegradable.

### PRINCIPLES ON THE BIOACCUMULATION TESTING OF THE ANNEX I FRACTION OF CHEMICAL WASTES

In 1976 the Oslo Commission adopted a test protocol for assessing bioaccumulation in the context of the Prior Consultation Procedure. The experience at the same time was confined mainly to the testing of pure compounds. With increased experience in the testing of industrial wastes, however, it was found that difficulties in determining the "concentrations" of the significant compounds (or Annex I substances) in both water and organisms made it impossible to comply with these test guidelines. Consequently, in 1980 a new approach was developed.

In the interest of harmonization, it was decided that the test procedures should as far as possible follow the test guidelines published by the OECD (see Annex 1). It was recognised that two lines of testing had to be distinguished :

- the testing of wastes containing no more than a few defined (Annex I) compounds ;
- the testing of other complex wastes.

When wastes containing a few defined Annex I compounds are tested for bioaccumulation properties, it is assumed that methods for a specific analysis of each of these Annex I compounds are available. In such a case, "normal" bioaccumulation tests can be carried out along the lines of the test philosophy elaborated in the report of the OECD Expert Group on Degradation and Accumulation.

The Oslo Commission Working Group recognised, however, that this philosophy was developed for the testing of pure substances. When more complex wastes are being tested where the composition is not fully known, those bioaccumulation tests which rely on the determination of the concentration of the substances in the tissue of the test organisms cannot be used. The only possibility remaining for testing such a waste is to use a static test in which the concentration of EOH in the aqueous phase is determined by analysis.

Because of the analytical limitations, the results of the static test provide only a broad indication of bioaccumulative potential of the waste. For a more precise evaluation additional information will be needed in most cases. Also, appropriate controls should be included in the experiments so

that loss from solution of the substances under investigation by processes other than accumulation can be distinguished. The tests are carried out either with mussels or with fish.

When it comes to interpreting the results of the static bioaccumulation test on complex wastes, it is generally necessary to make a comparison with what might have been expected on the basis of existing information on the waste and the chemical process it originated from. The results can roughly be divided into three categories :

- Where there is no detectable uptake of the Annex I fraction, no evidence of significant bioaccumulation is obtained.
- Where there is considerable uptake of the Annex I fraction (over 70 %), a very strong indication for bioaccumulation is made and should be considered as such unless the opposite can be unambiguously proven.
- When only a small percentage of the Annex I fraction of the waste is accumulated by the test organism it is very difficult to decide whether this is due to a minority of compounds, each with a high bioaccumulation potential, or to many compounds with a low bioaccumulation potential. In such cases further studies are needed to discriminate between these two possibilities.

#### **THE PRIOR CONSULTATION PROCEDURE FOR DUMPING**

The test procedures described above are those which have been approved by the Oslo Commission to be applied within the context of the Prior Consultation Procedure for Dumping to demonstrate the characteristics of "trace contaminants", "non-toxicity" and "biological harmlessness".

Following detailed discussion in the Oslo Commission's Standing Advisory Committee for Scientific Advice (SACSA), the Commission adopted at its meeting in June 1983 a revised Prior Consultation Procedure. There were a number of modifications to the Procedure as adopted at the Commission's first meeting. The two most important changes concern the additional information required to be submitted by a contracting party in respect of the alternative disposal options which have been considered and rejected in favour of dumping, and the numerical values of inorganic mercury and inorganic cadmium below which the Prior Consultation Procedure need not be followed.

Concerning the latter, the Commission accepted SACSA's recommendation that, on the basis of present scientific data, concentrations of  $1 \mu\text{g.l}^{-1}$  for dissolved inorganic Hg, and  $4.5 \mu\text{g.l}^{-1}$  for dissolved inorganic Cd in seawater are levels below which adverse effects of these elements will not occur. Taking into consideration that some safety margin is necessary to compensate for other possible toxic factors in the waste, and that a minimum initial dilution of at least 1:1000 takes place within 5 minutes after discharge, the following levels for inorganic Hg and inorganic Cd have been agreed by the Commission as trace contaminants for the purpose of the PCP :

0.3 mg (dissolved) Hg per litre of waste

0.1 mg (dissolved) Cd per litre of waste

In other words, wastes containing less than these levels of inorganic mercury and cadmium need not be subjected to the PCP before a permit is issued.

In addition, however, the Commission has also decided that when a contracting party issues a permit for the disposal of a waste containing between  $1 \mu\text{g.l}^{-1}$  and  $0.3 \text{ mg.l}^{-1}$  of dissolved inorganic mercury, or between  $4.5 \mu\text{g.l}^{-1}$  and  $1.0 \text{ mg.l}^{-1}$  of dissolved inorganic cadmium, it shall provide the Secretariat with all the details which are required under a normal Prior Consultation Procedure case, i.e. information about alternative disposal options, the origin of the waste, amount of waste, the form in which it is presented for dumping, its chemical composition and physicochemical characteristics. These details are then circulated immediately by the Secretariat to all contracting parties in the same way as for a specific permit, i.e. a waste containing significant quantities of Annex II substances. The Commission has agreed that the information should be reviewed annually by SACSA.

The Commission has also agreed that in view of the provisional character of these definitions, it is necessary for all wastes containing dissolved inorganic Hg and Cd in concentrations exceeding  $0.3 \text{ mg.l}^{-1}$  and  $0.1 \text{ mg.l}^{-1}$  respectively, and which are not exempted (i.e. sewage sludges, dredged spoils, solid mineral wastes and wastes originating from the production of titanium dioxide), to be subject to the Prior Consultation Procedure.

In order for organohalogen and organosilicon compounds to be defined as a "trace contaminant", wastes containing these substances must satisfy the following criteria :

- (a) When a waste can be tested in its complete form, the concentration in seawater within five minutes after discharge shall not exceed the 96 h LC50 for the most sensitive test organism in the PCP test procedure
- (b) When it is necessary to test an extracted organic fraction of the waste for the purpose of the PCP test procedure, the concentration in seawater within 5 minutes after discharge shall not exceed the NOEC for the most sensitive test organism in the test procedure.
- (c) The outcome of the biodegradability and bioaccumulation test procedures shall be satisfactory.

All wastes intended to be dumped at sea (other than those exempted) must be examined and those which contain Annex I substances other than inorganic Hg and inorganic Cd compounds must be subjected to the PCP test procedures before a licence is granted.

#### **THE LONDON DUMPING CONVENTION**

As previously mentioned, the Oslo Convention is a regional Convention covering only the northeast Atlantic and Arctic oceans and ratified by the maritime States of Europe. Immediately following the negotiation of the Oslo Convention, and arising in part from the United Nations Conference on the Human Environment (Stockholm, 1972), negotiations commenced on a global convention covering dumping at sea. The Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (the London Dumping Convention) was opened for signature in December 1972 and entered into force in 1975. The LDC has been ratified by all the contracting parties to the Oslo Convention with the exception of Belgium.

As might be expected, the London Dumping Convention follows a broadly similar pattern to the Oslo Convention. It provides the general framework requiring the issue of permits before wastes may be dumped at sea. It also follows the Oslo Convention in that it lists those substances which are prohibited from dumping and identifies those substances which require a

special permit. As with the Oslo Convention, the LDC acknowledges that permits for the dumping of wastes containing Annex I substances may be issued under certain conditions. The prohibition does not apply to :

- (a) Annex I substances which are rapidly rendered harmless by physical, chemical or biological processes in the sea ; or
- (b) wastes or other materials, such as sewage sludges and dredged spoils, which contain the prohibited substances as trace contaminants.

In the context of exemption (a), Annex I substances may be regarded as meeting the exemption provisions of the Convention if tests of the waste proposed for dumping, including tests on the persistence of the material, show that the substances can be dumped so as not to cause acute or chronic toxic effects or bioaccumulation in sensitive marine organisms typical of the marine ecosystem at the disposal site. A persistent substance may not be regarded as harmless except when present as a trace contaminant.

In the context of exemption (b), the contracting parties to the LDC have agreed that organohalogen compounds, mercury and cadmium and their compounds, and crude oil shall not be regarded as "trace contaminants" under the following three conditions :

- (a) if they are present in otherwise acceptable wastes or other materials to which they have been added for the purpose of being dumped ;
- (b) if they occur in such amounts that the dumping of the wastes or other materials could cause undesirable effects, especially the possibility of chronic or acute toxic effects on marine organisms or human health whether or not arising from their bioaccumulation in marine organisms and especially in food species ; and
- (c) if they are present in such amounts that it is practical to reduce their concentrations further by technical means.

As with the Oslo Commission, the procedures and tests agreed by the LDC are considered to apply equally to the interpretation of "harmlessness" and "trace contaminants". The objective of the test procedures is to provide evidence of the potential for acute or chronic toxic effects, the persistence of the material (where appropriate), inhibition of life processes, and bioaccumulation under the proposed disposal conditions.



Such test procedures may include, as appropriate, chemical characterization of the material, bioassays of the material, application of emission standards or environmental quality criteria in use by the contracting party, scientific literature or the results of field surveys of the proposed disposal site or a similar marine environment.

For the initial evaluation of an industrial waste containing Annex I substances, the LDC has agreed that the test procedures should include the following :

- (a) acute toxicity tests on plankton, crustaceans or mollusc, and fish
- (b) chronic toxicity tests capable of evaluating long-term sublethal effects, such as bioassays covering an entire life cycle ;
- (c) tests to determine the potential for bioaccumulation of substances listed in Annex I and, if appropriate, the potential of elimination. The test organisms should be those most likely to bioaccumulate Annex I substances ; and
- (d) tests for determining the persistence of Annex I substances. The potential for degradability of Annex I substances should be determined using bacteria and water typical of the proposed dumping site. The tests should reflect the conditions at the dumping site.

Some of the tests may be augmented by new scientific developments, e.g. predictions from structure/activity relationships and environmental models.

As might be expected for a global convention, the LDC therefore specifies only the broad framework of test procedures which should be carried out to evaluate the effects of Annex I substances in wastes proposed for dumping. It does not provide the detailed guidance to contracting parties which have been elaborated under the Oslo Convention. Indeed, the LDC acknowledges that contracting parties may develop and use test procedures either individually or through a regional convention in order to implement the interpretation of "trace contaminants" and "harmlessness" in regard to the London Dumping Convention.

Furthermore, it has been agreed that if a contracting party to the London Dumping Convention is also a party to a regional convention, and has followed a consultation procedure under a regional convention, that procedure may be substituted for the procedures agreed within the LDC. In such cases the Secretariat of the regional convention is required to inform

the International Maritime Organization (which has the secretariat responsibilities for the LDC) of the result of the consultation which has taken place.

#### **THE BONN AGREEMENT**

Perhaps the most obvious evidence of marine pollution is the oil spill. When such an incident occurs, the authorities concerned are faced with the problem of determining the most appropriate response. In the past there has been a difference of opinion among the European nations as to whether the most appropriate response was to attempt to combat the spill by mechanical recovery means or whether the application of dispersants was the most effective method of removing the oil from the sea and from beaches.

The earliest international agreement for taking practical measures to combat oil spills was the Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil, commonly called the Bonn Agreement, which was signed in 1969. Its signatories are those states which border the North sea, namely Belgium, Denmark, France, the Federal Republic of Germany, the Netherlands, Norway, Sweden, and the United Kingdom.

There has been considerable discussion in the technical group of the Bonn Agreement in order to define the problem presented by an oil spill incident with greater clarity and thereby to assess more realistically the most cost-effective response technique. In such an assessment, all states now acknowledge that dispersant application has a role to play. It is recognised, however, that some oils, because of high initial viscosity in the fresh state, do not respond to dispersant treatment. Even those fresh oils which do respond eventually cease to be amenable to dispersant treatment because of water-in-oil emulsion formation.

Given the efficacy of dispersant application in certain situations, however, the contracting parties to the Bonn Agreement have agreed that, in the case of emergency, dispersants approved individually by states should be mutually accepted subject to the following provisos :

- (1) that in general there should be no objection to the acceptance in joint operations of products authorised by another contracting party on the understanding that the decision to make use of dispersants in a nation's coastal waters must be left to the national authorities concerned ;
- (2) that mutual acceptance of dispersants in this way does not imply automatic acceptance of approval tests and procedures but must be viewed as a provision applying to emergency situations only.

The contracting parties have recognised, however, the value of developing a regime for the testing of dispersants with the aim, in the longer term, of either adopting a single test regime or modifying existing national tests to facilitate mutual acceptance. Such a common assessment scheme would be advantageous both to the national authorities concerned with dispersant testing and to the manufacturers of dispersants. The Bonn Agreement technical working group has therefore been charged with proposing to the contracting parties a basic test regime for general guidance in dispersant evaluation taking into account the effectiveness, toxicity and degradability aspects. In the development of such a regime, the working group will have regard to the following principles which have been agreed by the contracting parties :

- (1) that, given the general satisfaction with current methods of efficiency testing, the main emphasis should be on efficiency evaluation ;
- (2) that toxicity levels should be regulated as far as possible by reference to a dispersant specification ;
- (3) that in general the introduction of non-degradable substances into the environment should be avoided ;
- (4) that more information on the toxicity of dispersants alone and of oil alone should be made available ;
- (5) that approvals tests could not be designed to simulate the marine environment and that any attempt to do so would be futile and could only serve to complicate test regimes unnecessarily ;
- (6) that a ranking of products was required so that the least toxic and most efficient can be used. It has been agreed that whether dispersants should be used in a given situation is best handled by reference to seasonal and geographical limits established by means other than the approvals test itself.

### THE MARPOL CONVENTION

This review of ecotoxicological testing in the framework of international conventions would not be complete without a reference to the work being carried out under the International Convention for the Prevention of Pollution from Ships, 1973/78 (MARPOL). In order to assess the potential pollution risks of chemicals carried by ships, GESAMP (The Joint Group of Experts on the Scientific Aspects of Marine Pollution) has been given the task of examining the available data and evaluating the hazard potential of chemicals shipped in bulk. This hazard evaluation is based on tests carried out to assess toxicity to aquatic life, and the potential for biodegradation and bioaccumulation. Four pollution categories are defined by IMO in order to classify noxious liquid substances in accordance with the MARPOL Convention. The four pollution categories govern the requirements concerning tank washings and residues discharged from chemical tankers at sea. Detailed test procedures are not prescribed but certain parameters have of course to be followed by the testing agencies in order to ensure compatible assessments.

### CONCLUSIONS

It is pertinent to ask whether marine ecotoxicological testing is necessary at all at the international level. Subsequent papers to be presented to this symposium deal with national testing procedures. Would not such national procedures be sufficient to protect the marine environment ? Can toxicity testing at the international level be justified ?

The answer to such a question must be in the affirmative. The recent UN Conference on the Law of the Sea confirmed that the sea is "the common heritage of mankind". It was therefore in the common interest that the Law of the Sea should be certain, and that it should regulate justly the various interests involved and that it should ensure the preservation of that heritage for the benefit of all.

In considering that guiding principle in relation to marine pollution, it is important to remember that although pollutants may enter the sea at one particular point, whether from shipping, as the result of an oil spill, from dumping activities or indeed from land-based sources, the waters affected by those inputs are constantly on the move. More particularly, fish

contaminated by inputs of polluting substances may be caught and eaten far from the original source of input. It is perhaps a truism that the sea and its living resources know no frontiers.

Bearing this in mind it is clearly necessary to reach agreement at international level on what inputs shall be permitted and what prohibited. Having established the broad principles in the treaty texts themselves it falls to the internationally agreed consultation procedures, and their related test procedures, to give effect to the legal principles.

Although in the case of dumping the decision to issue a permit rests finally with the state concerned, by means of the Prior Consultation Procedure the burden of evaluation and assessing the impact of a problematical dumping operation is shared among all the contracting parties. Similarly, the decision whether or not to use dispersants in combating an oil spill rests with the contracting party most affected, but the desirability of a common test regime has been endorsed by the contracting parties to the Bonn Agreement. In both cases there is a necessity to have a common basis for assessment. It is in this development of internationally agreed principles for ecotoxicological testing, be it for assessing the toxicity of dispersants or acceptability of wastes for dumping, that the international conventions have their role to play in addition to the valuable work which is done in national laboratories.

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**ANNEX 1 :****Guidelines and test protocols in the scientific literature endorsed by the Oslo Commission for application of the Prior Consultation Procedure for Dumping :**

Anonymous. 1980.

Degradability, ecotoxicity and bioaccumulation. The determination of the possible effects of chemicals and wastes on the aquatic environment. Government Publishing Office, The Hague, The Netherlands.

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Assessing the toxicity of industrial wastes, with particular reference to variations in sensitivity of test animals. Fisheries Research Technical Report. MAFF Directorate of Fisheries Research, Lowestoft (61) 10 p.

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Decision of the Council concerning the mutual acceptance of data in the assessment of chemicals. C (81) 30 (final) Annex II. OECD Principles of Good Laboratory Practice.

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**The following internal documents also form part of the Oslo Commission's test procedures**

Anonymous. 1984.

Guideline for the testing of chemicals and waste water with a marine algal growth inhibition test. Eighth Annual Report of the Oslo Commission, Annex 7, p. 144-172.

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Bioconcentration testing with the common mussel, Mytilus edulis Oslo  
Commission reference : TP/4/6.

