PLAINTIFF'S EXHIBIT

DOW-680

GUIDELINES FOR ENVIRONMENTAL TESTING

Presented by:

Robert J. Moolenaar, Director
Environmental Sciences Research
The Dow Chemical Company
Midland, Michigan

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Dow's Johnson and Blair estimated in 1972 (1), that one new pesticide emerges for every 10,000 compounds tested, that the time from discovery to market is 8-10 years, and that the cost of development is in excess of 10 million dollars. We know we cannot afford to develop a pesticide only to have it follow down the trail after DDT and other materials on the EPA list of "thou shalt not use" chemicals. While the protocol for getting pesticides and pharmaceuticals on the market is growing in cost and complexity, there is an alarming tendency for any new chemical product to have to meet the same kind of environmental evaluation.

It is our view that the only corporate posture which will still the cries for governmental barriers to the introduction of new products into the market must be based on corporate responsibility for product performance and behavior not only during use, but also after disposal. Many have already adopted this posture, and we hope it will become a uniform industrial policy. To do otherwise is to invite the Congress to clamp down with rigorous product review protocols which will cost all of us more money to do an inferior job, and which will price product development so high some good products will not make it to market.

Another reason for paying attention to environmental parameters is to be found in the market place. Favorable environmental properties and data to back them up have an impact in the market place. We are finding more and more customers asking about the environmental effects of products we supply, and at the same time, we're asking our suppliers for the same type of data. I'm convinced that more, not less, of this sort of thing will be done in the future.

I welcome the opportunity today to present my views on guidelines for environmental testing of chemicals. I hope this won't be a one-way communication. I welcome your thoughts on the subject.

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Perhaps a communication medium could be established to share thoughts and ideas in this area as an on-going activity.

The approach I would like to emphasize today is that of laboratory testing as a means of assessing the environmental impact of a chemical. I believe much can be learned about the behavior of a chemical in the biosphere by obtaining data in the laboratory on its physical, chemical, and biological properties. The question is: what do we really need to know about a chemical, and how do we go about obtaining the information?

I offer the following as guidelines:

I. Basic Considerations

The material under study should be adequately characterized chemically prior to extensive environmental testing. This means the structure of the compound in question should be determined and its purity ascertained. Chemical structure alone often allows one to predict with reasonable accuracy the chemical, physical, and sometimes biological properties of a compound.

Products that find their way into the market place are often formulations or mixtures of a number of distinct compounds. For purposes of evaluating the environmental impact of formulations, tests should be performed on the individual components. The reason for this is that when mixtures enter the environment, the components will separate and behave as individual chemicals. There are exceptions where significant environmental exposure could occur prior to separation of components, or where environmental tests might disclose an unsuspected impurity, but for the most part, environmental tests on mixtures should be considered supplementary data.

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If the chemical under study undergoes chemical change in the environment, it is necessary to obtain some understanding of the nature of the decomposition products and their environmental fate. The detail necessary is highly dependent on the specific chemical involved, but one wants some information on the nature of the decompositon products until conversion to products already in the environmental sink takes place.

II. Predictive Tests Related To Environmental Exposure

Factors related to environmental transport include:

A. Water solubility
B. Vapor pressure
C. Adsorption on soil

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Generally, non-polar molecules tend to exhibit low water solubility and low adsorption on soil. If their vapor pressure is appreciable, transport via the atmosphere will be favored. Water transport is favored by more polar compounds. Ionic materials are often immobilized by adsorption on soil. These properties can be evaluated by relatively simple laboratory tests, and they are excellent indicators of how a molecule will move after it is released to the environment.

The bionconcentration of certain chemicals plays an important role in environmental transport, especially in entry and accumulation in living tissue. The octanol/water partition coefficient is becoming recognized as an indicator of the tendency for a molecule to bioconcentrate. Neely, et al. (2) in our laboratories have shown a good correlation between the partition coefficient and the actual bioconcentration of a number of organic chemicals in rainbow trout. Further experiments indicate the

partition coefficient probably provides an upper limit for the bioconcentration potential of a chemical. Other factors, such as decompositon or the inability to cross certain biological membranes, may result in lower than expected bioconcentration under environmental conditions.

Environmental persistence is usually dominated by the reaction of a chemical with the most prevalent and reactive entities in the biosphere. These are water, air, sunlight, and microorganisms. Relevant laboratory tests include:

A. Hydrolysis rate between pH 6 and 9.
B. Oxidation rate in air.
C. Microbiological degradation rate.
D. Photodegradation rate.

The appropriate test or tests to be performed are determined by where the molecule is likely to spend most of its time in the environment as shown by the transport related tests. Once the dominant route for removal of the chemical from the biosphere and its approximate rate have been determined, testing related to persistence can usually be discontinued.

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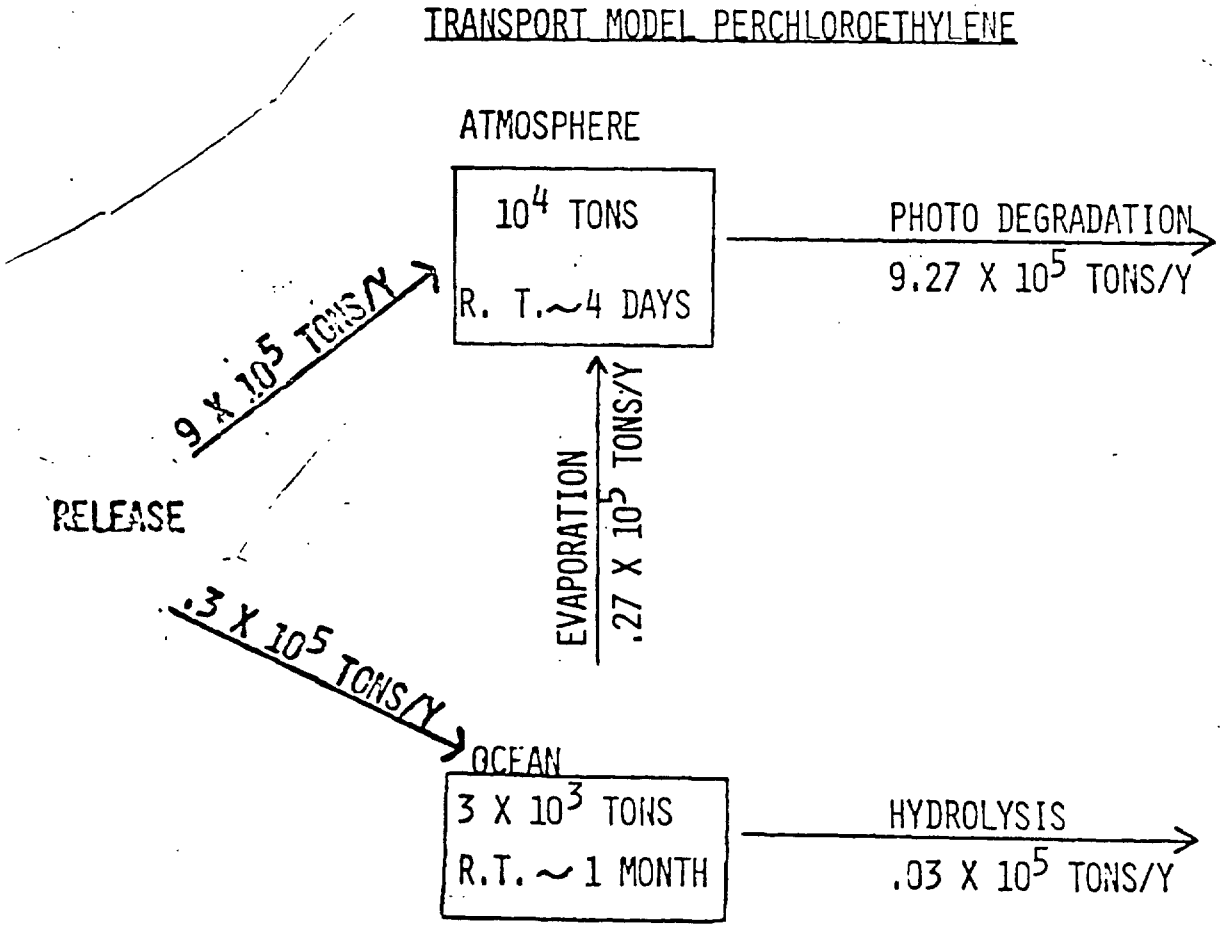
From these basic laboratory measurements, it is possible to get a pretty good understanding of how a chemical will move in the environment, how long it will persist, and whether it will tend to bioconcentrate. We have found it useful to consider data of this type in light of similar information on certain benchmark chemicals, i.e. those chemicals for which we have both laboratory data and information on environmental behavior.

III. Estimate Environmental Levels

Based on results of the laboratory experiments described above, and a knowledge of where and how much of a chemical

is likely to enter the environment, a rough mathematical model can often be developed to predict steady state levels of the chemical in various segments of the environment. This type of modeling has been done extensively in localized areas. However, to my knowledge, in only a few cases has it been applied to individual chemicals in all important segments of the biosphere. This is a technique that should be developed and used more extensively.

An example might serve to illustrate my point. Recently, the National Academy of Sciences published a book entitled, "Assessing Potential Ocean Pollutants." In it a description was made of a tentative environmental transport model for perchloroethylene. The model is summarized below:



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The basic data from which the model was derived is the following:

Environmental Release -	
Atmosphere	9×10^5 ton/yr
Ocean	3×10^4 ton/yr
Ambient Concentrations (Northern Hemisphere)	
Atmosphere	15 ng/m^3
Ocean	0.5 ng/l
Vapor Pressure 20°C	15 mm Hg
Water Solubility	150 mg/l
Hydrolysis Rate (half life)	6 months
Photodegradation Rate (half life at sea level)	2-4 days

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The model seems to be self-consistent. An important conclusion that can be drawn from a model of this type is that perchloroethylene is decomposing at the same rate at which it is being introduced into the environment, and the ambient level of about 15 ng/m^3 will increase or decrease in proportion to changes in release rate. Thus, perchloroethylene is not accumulating in the environment, and its mode of exit from the biosphere is understood.

IV. Testing Of Effects

Once the transport phenomena have been described and an estimate of steady state concentrations have been made, the effects produced by a chemical at these levels should be evaluated. For the most part, these are toxicity effects of one kind or antoher. Clearly, for water soluble chemicals, tests for affects on aquatic species should be considered. If the chemical is volatile and water insoluble, terrestrial indicator species should be chosen as representative organisms. In general, acute testing should be done first on a limited number of organisms. Depending on the nature of the effects noted and the expected exposure levels, long-term tests may be required.

Other effects may need to be evaluated for certain chemicals. These include odor and taste thresholds, aesthetic effects, etc. The recent concern over the effects of fluorochlorocarbons on statospheric ozone indicates the diversity of effects that have been considered.

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One final point might be of interest. The expertise involved in environmental assessment requires skills not normally present in the research organization of chemical companies. Like any other research endeavor, the most effective job of environmental testing can be done if a critical mass of people with like interests can be brought together. At Dow, we have found it advantageous to set up a small research group whose charter is to assist in planning for and obtaining data of this type. This group, called Environmental Sciences Research, consists of specialists with backgrounds in aquatic biology, microbiology, radiotracer synthesis and use, biochemistry, organic and physical chemistry. The group draws heavily on the central analytical and computations

research laboratories for specialized assistance. Our current work load is dominated by measurements related to environmental persistence, bioconcentration, and the toxicity of chemicals to fish.

In summary, I believe the manufacture and use of synthetic chemicals plays an important role in our society. To keep this business healthy, free from stifling governmental intervention, and also to fulfill our role as responsible corporate citizens, it is important for us to conduct suitable studies to determine how chemicals, if released, may affect the biosphere. These studies include laboratory measurements designed to evaluate persistence, movement, tendency for bioconcentration, and biological properties of chemicals which may be released to the environment.

REFERENCES

1. J. E. Johnson and E. H. Blair, Chemtech., p. 666 (November, (1972).

2. W. B. Neely, D. R. Branson, and G. E. Blau, Environmental Science and Technology 8, 1113 (1974).

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