



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

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OFFICE OF  
THE ADMINISTRATOR

Ms. Rita M. Lavelle  
Assistant Administrator for Solid  
Waste and Emergency Response  
Mail Code: WH-562A  
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Washington, D.C. 20460

Dear Ms. Lavelle:

In July 1982, your office asked that the Science Advisory Board (SAB) review the scientific and technical adequacy of the "RCRA Risk/Cost Policy Model Project Phase 2 Report." The review, which was assigned to the SAB's Environmental Engineering Committee, has now been completed, and we are pleased to forward to you our report.

We appreciate the opportunity to work with your office on what is an interesting and innovative project. If you have any questions, or should you wish further review as revisions or additions to the model are made, please feel free to call Mr. Harry Torno, Executive Secretary, Environmental Engineering Committee (382-2552), who will make the necessary arrangements.

Sincerely,

Gerard A. Rohlich  
Chairman, Environmental  
Engineering Committee  
Science Advisory Board

Earnest F. Gloyna  
Chairman, Executive Committee  
Science Advisory Board

REPORT  
on the  
RCRA RISK/COST POLICY MODEL  
PHASE 2 REPORT

BY

ENVIRONMENTAL ENGINEERING COMMITTEE  
SCIENCE ADVISORY BOARD  
U. S. ENVIRONMENTAL PROTECTION AGENCY

January 1983

## EPA NOTICE

This report has been written as a part of the activities of the Environmental Engineering Committee of the Science Advisory Board, a public advisory group providing primarily extramural scientific information to the Administrator and other officials of the Environmental Protection Agency. The Board is structured to provide a balanced expert assessment of the scientific matters related to problems facing the Agency. This report has not been reviewed for approval by the Agency, and hence its contents do not represent the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

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## BACKGROUND

On July 30, 1982, the Environmental Engineering Committee (EEC) was asked to review the "RCRA Risk/Cost Policy Model Project Phase 2 Report" (RCRA report), dated June 15, 1982. The report was prepared for the Office of Solid Waste, USEPA, by ICF, Inc., Washington, D.C., SCS Engineers, Reston, VA and Clement Associates, Washington, D.C. The Committee was assisted in its review by three consultants:

Dr. Julius Johnson  
Member, Executive Committee  
Science Advisory Board

Dr. M. Granger Morgan  
Department of Engineering and Public Policy  
Carnegie-Mellon University

Dr. Francis C. McMichael  
Department of Engineering and Public Policy  
Carnegie-Mellon University

The review consisted of a briefing at a meeting of the EEC on July 30-31, 1982 by Mr. Curtis Haymore, Office of Solid Waste, on the objectives of the project and the general nature of the Report. The Report was then individually reviewed by the Committee members and its consultants. The Report was discussed at length at an open meeting of the EEC held on September 28, 1982 in Washington. (Minutes and a verbatim transcript are available for public review in the Agency's Committee Management Office). At that meeting comments were also received from other Agency personnel, the Office of Technology Assessment (U.S. Congress), and the

Environmental Defense Fund. Association. This report presents the results of the Environmental Engineering Committee's review. General comments are noted first; Committee views on specific issues raised by the Office of Solid Waste follow. The report closes with a summary and recommendations.

#### GENERAL COMMENTS

##### 1. MODEL CONCEPT BASICALLY SOUND

With the reservations noted in the remainder of this report, the Committee feels that the RCRA Risk/Cost Policy Model is basically sound in its concept and construction. It should be particularly useful in helping EPA policymakers understand the complex interactions between hazardous wastes, their effects, and the means available for their management. There was, however, a pervasive uneasiness about the intended uses of the model. Most members agreed that the model is potentially useful as a tool to help screen or rank alternatives, as a part of more detailed regulatory impact analyses. At least some EPA staff seem to understand fully what the model can and cannot do. There are other indications, however, in the report (see, for instance, page 1-11 paragraph 2, or Exhibit 1-1, page 1-2, which imply a more direct link between the model and regulatory decisions) and elsewhere, that the model will be the basis for regulatory decisions. The Committee strongly believes that the model is not scientifically or technically

adequate to be the sole basis for regulatory decisions, nor can it be reasonably modified to fulfill that purpose.

## 2. THE DATA BASE HAS SERIOUS DEFICIENCIES

The report outlines several data base components, which basically can be categorized as "waste related" and "technology related." The waste related data base was derived from 83 waste streams identified from Part A RCRA applications and specified EPA contractors' reports. Of these 83, 20 are classified as "NOS" or "Not otherwise specified," the characterization of which significantly depends upon subjectivity as to the constituent of concern. The other 63 are characterized in more detail, listing several critical constituents. The weaknesses of this waste related data base include:

- a. These 83 streams represent 22.6 million tons/year, which is approximately one-half of the estimate of 41 million tons/year by Putnam, Hayes and Bartlett, Inc, an EPA consultant cited in the report.
- b. The Part A applications from which data were taken may be inaccurate.
- c. Not all of the 83 streams are currently designated by EPA as "hazardous" (some of these are not Subtitle C wastes only because of their "small quantity generator" exemption, and are, in fact, hazardous).
- d. Some of the data base represents wastes not regulated under Subtitle C.

The Office of Solid Waste (OSW) has noted that the data base is dynamic, and questionnaire information and site visits are being used to augment the waste stream data base as outlined in the Phase 2 report.

It is the consensus of the Committee that the waste stream data base, which represents only a fraction of the total hazardous waste generated, is taken from RCRA applications of questionable accuracy, and is compounded by the subjectiveness of critical constituent selection (subject to the receiving media), is inadequate. Subsequent accumulation of data from site visits and questionnaires, plus the possible addition of Superfund information, may broaden this base.

The "technology related" data base received considerable comment, particularly with respect to cost accuracy, release rates, and treatment technology applications. The criticisms of cost estimates include:

- a. the apparent lack of present worth analyses, adjustments for geographical location, and appropriate discount rates adjusted for plant life; and  
the failure to incorporate third party liability costs, which have previously been cited by EPA as major costs in RCRA compliance.

Concerns about release rate data center on what appear to be subjective judgments about phase separation and transformation efficiencies, rather than on reliance on published performance data. Subjective judgment also prevails with respect to treatment technology, rather than providing data on documented plant performance in such areas as process applicability, matching unit processes with waste streams,



and predicting process performance. Biological treatment is completely omitted without rationale or justification, even though some hazardous wastes are biodegradable. (The land treatment disposal technology is, in fact, used in the model only for biodegradable wastes.)

In summary, the data base is neither complete nor representative, and relies far too heavily on subjective judgment.

### 3. THE MODEL HAS NOT BEEN TESTED OR VERIFIED

It is crucial that the model, as it now stands, be tested and verified. In particular, sensitivity testing must be done in such a way that users may explore how the selection of objective functions and input values affect the conclusions that are drawn from the model. Since many potential users will not have the background or training to make these judgments intuitively, it is important that these sensitivity analyses, and the results obtained, be clearly and carefully documented. This testing must certainly precede any practical application of the model.

### 4. HEALTH EFFECTS INADEQUATELY TREATED

The model treats all health effects identically, whether they occur in many scattered incidents or one big accident, whether they occur immediately after exposure or many years later, and whether they involve death, serious disability, or

minor and perhaps reversible effects. The model also fails to acknowledge the wide variety of other factors which may influence one's perception of risk or cost, associated with even a single health end point, such as death. The Committee feels that some differentiation should be attempted, and the results evaluated.

5. INFLUENCE OF EXISTING STATE LAWS AND REGULATIONS NOT RECOGNIZED

Some states have laws or regulations which are more stringent than those of the Federal Government. This is likely to continue to be the case, and some means must be provided to accommodate these differences in the analysis of regulatory alternatives. These means should be explicitly stated, though they need not necessarily be a part of the model itself.

6. REPORT RELIES TOO HEAVILY ON OPINION

The report is replete with the unsubstantiated opinions of unnamed authors, with neither specific literature references nor a detailed explanation of the logic and rationale for the judgments which are made. This is a serious problem, in view of the inherent complexity of the model and the fact that users of the model (and interpreters of its results) may not be aware of these complexities. The results of models which use linear programming optimizations, for instance, can vary with the choice of objective function, even though the

technical details are unchanged.

7. COMMENTS ON SPECIFIC ISSUES RAISED BY THE OFFICE OF  
SOLID WASTE

When the Committee was briefed on July 30, 1982, Mr. Curtis Haymore, Office of Solid Waste, provided a list of issues on which he specifically wanted SAB comment. These issues and the Committee's responses follow.

1. "Are general models a potentially useful way to help analyze policy options in the regulation of hazardous waste? Specifically, can enough generalities be made to construct a meaningful model or are the differences among specific sites too great and variable to make broad comparisons? Is the level of understanding advanced enough to justify attempts to develop models, or are the uncertainties so great so as to preclude attempts at more comprehensive analyses at this time?"

General models have merit and may be useful in the early analysis of policy options, and as a screening tool when order-of-magnitude differences are appropriate. Large differences between waste mixtures, site environments, available facilities, levels of hazards, and state regulations preclude more specific uses of the model. In spite of its deficiencies, the model is a first step, and further testing and development of the model should proceed.

2. "The model defines waste-environment-technology combinations as the units of analysis when assigning risk and cost scores. Is this a useful construct for evaluating the threats of hazardous waste to human health and the environment?"

The waste-environment-technology construct effectively organizes the wide variety of considerations involved in the evaluation of waste management alternatives to minimize risk on a cost-effective basis. Judgments about the usefulness of the construct for assessment purposes must await testing and evaluation; however, a review of the model's components suggests a variety of oversimplifications and flaws due to poor data or inadequate parameterization. These, combined with the considerable subjectivity and judgment needed to initiate model calculations, lead the Committee to strong reservations about the ability of the model, as presently constructed, to make logically defensible evaluations. A thorough testing and evaluation of the model could increase the level of confidence.

3. "The model uses order-of-magnitude differences between relative risk levels. Is this level of precision sufficient for the priority-setting purpose we intend for the model's results? Is it important and necessary, or impractical, to calibrate the model to attempt to predict absolute risk levels rather than to estimate relative risk?"

The order-of-magnitude differences between relative risk levels are sufficiently precise for general screening or ranking purposes. Human health risks are calculated using two major components, the severity of physiological response to a given exposure and the statistical probability of that exposure taking place. Both are complex functions and poorly understood. It would, therefore, be neither practical nor

necessary to refine the model (it would certainly be more than a calibration exercise) to predict absolute rather than relative risk. Even an attempt to achieve an order of magnitude precision by methods available today is probably optimistic.

4. "To derive a single scale for scoring health effects, we matched scores for graded and dichotomous responses by assuming that a dose of the  $MED_{10}$  (in humans) corresponds roughly to a probability that one percent of the exposed population will suffer a substantial adverse effect. The scales also generally assume no threshold level of effects. Are these approximations appropriate to the level of data used and the expected use?"

There is no evidence that the matching of graded and dichotomous health responses, by assuming that an  $MED_{10}$  dose in humans corresponds to a probability of one percent of the exposed population suffering a substantial adverse health effect, is valid. This approach neglects the severity of the injury, and, for example, equates reversible and irreversible health effects. It is an adequate assumption for a preliminary screening tool, but the assumptions negate the use of the model for any quantitative evaluation of human health impacts. Even for preliminary screening, some measure of the severity of the responses should be included. The no-threshold level of effects is a reasonable assumption for this model.

5. "The scoring procedure for graded responses makes no distinction between compounds that produce different types of responses (e.g., dermatitis vs. reproductive dysfunction). Is the proposed approach of eventually testing alternative weighting schemes an appropriate method of comparing effects or is there a generally accepted way of balancing different health effects?"

There is no generally accepted way to balance different health effects. The wide variation in health effects, mechanisms of toxicity, and toxicity variations related to chemical state are such that the proposed approach is not appropriate. A weighting scheme should be developed, as noted above. As a first step, contact should be made with the NAS/NRC Board on Toxicology and Environmental Health Hazards (Executive Director, Dr. Robert Tardiff, 202-334-2616).

6. "In improving the model and the base, on which areas would it be best to concentrate resources (e.g., sensitivity testing, release rates, inherent hazard scoring for more compounds, waste stream characterization, delineation of environmental categories, environmental transport mechanisms, incorporating the strength of evidence of alternative toxicity studies, incorporate ecological effects)?"

Improvement of the model cannot reasonably begin without a thorough assessment of the ability of the model, as it now stands, to process real data and to produce results that are reasonable by some standard. Initially, that standard can only be intuitive--does the model output lead to conclusions about relative risks and costs that are reasonable to an experienced expert? Sensitivity testing, as described above,

is the first step to be taken. If it can be shown that small errors (or uncertainties) in input would produce results that would cause decisions about alternatives to be reversed, the model would be useless, and would require extensive revision.

7. "The technologies addressed in the report include not only hazardous waste technologies that OSW has the primary responsibility to regulate, but also underground injection and ocean disposal, which are regulated by other EPA offices. Is it appropriate to consider "non-OSW" technologies in the model?"

Assuming that the model is to be used for broad strategic analyses, not only in OSW but elsewhere in EPA, it is appropriate that "non-OSW" technologies be included. The appropriate strategic analyses that may be considered by an improved model that has been adequately tested and verified include:

- a. intermedia transfer of pollutants (evaluation of types, amounts);
- b. better approaches to end-of-pipe technologies for treatment and disposal of wastes designated as hazardous, as well as those that may have an adverse effect on the environment;
- c. appropriate uses/directions for research and development (R&D) to meet obvious data needs; and
- d. regulatory approaches that may be less successful due to an inadequate data base on the fate/transformation/ effect of a waste or by-product.

## SUMMARY AND RECOMMENDATIONS

The Committee believes that the basic model construct is sound and that the order-of-magnitude differences between relative risk levels are sufficient. The model as it now exists (and is likely to exist in the future) is not technically adequate to be the sole basis for regulatory decisions, but rather should be used as a tool to screen or rank alternatives as part of a more detailed analysis. The data base has serious deficiencies and represents only about one-half of the hazardous wastes now being generated. Some waste stream data is taken from Part A RCRA applications, and hence may be inaccurate. Cost data are not geographically adjusted and do not include third-party liability costs. Subjective judgment, rather than documented performance, seems to dominate the technology data base. The model has not been tested and verified, nor has its sensitivity to the selection of objective function and to input parameter variation been evaluated. This is, perhaps, the most pressing problem to be addressed and must be done before the model can be applied to actual regulatory analyses. The model treats all health effects as equally severe, whether they result in reversible injury or in death. The Committee feels that some method of differentiating the severity of injury should be included. There is no recognition in the model of the influence of state laws and regulations (which may be much more stringent than Federal laws)



on risk/cost analyses. Finally, the Phase 2 report relies far too heavily upon the unsubstantiated opinions of unidentified authors. These judgments and opinions should be replaced, where possible, by references and data on demonstrated plant performance, and by clearly stated logic and rationale.

#### RECOMMENDATIONS

The Committee recommends that:

1. The Office of Solid Waste continue to develop the model.
2. Testing and validation, including adequate sensitivity analyses, be given first priority.
3. The data base should be carefully reviewed for both accuracy and completeness. In particular, the waste stream data base should be enlarged, and existing data carefully checked for accuracy. The technology data base should be updated as well and should include biological treatment, or clear logic for its exclusion.
4. The report should be rewritten in a more clear, specific manner. This is particularly true if later versions of the report will be used as a "users manual" for the Model. Arbitrary or unsubstantiated statements should be eliminated and replaced with statements based on

documented fact or clearly stated logic. All Model assumptions should be clearly stated, preferably in one place. Authors of sections or chapters should be identified.

5. The report should include a concise, technically specific and substantive Executive Summary, which should include a clear, unambiguous statement of project objectives and intended Model uses.
6. The Report should include clear, specific statements about the implications of such factors as the choice of objective functions, and the influence of those choices on modeling results.
7. The Model should be modified to provide some means for differentiating levels of health risk.
8. There should be closer coordination between OSW and the U.S. Congress' Office of Technology Assessment (OTA). OTA has completed a draft review of the RCRA Risk/Cost Policy Model. This draft should be provided to the Agency, and areas of disagreement should be resolved.

The Committee would, finally, like to express their appreciation to all parties participating in the review, and particularly to Mr. Curtis Haymore for his patience and cooperation.