

REPORT

on the

Review of EP-III

(A Procedure for Determining the Leaching Potential
of Organic Constituents from Solid and Hazardous Wastes)

by

The Environmental Engineering Committee
Science Advisory Board
U. S. Environmental Protection Agency

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INTRODUCTION

On February 2, 1984, the Science Advisory Board was asked by Ms. Eileen Claussen, Director, Characterization and Assessment Division, Office of Solid Wastes (see Appendix A), to review a report, entitled "Mobility of Leachates-Development of a Laboratory Extraction Method to Simulate Co-Disposal of Solid Wastes in Municipal Waste Landfills". This report, prepared by Oak Ridge National Laboratory under the supervision of EPA's Environmental Monitoring Systems Laboratory, Las Vegas, Nevada, outlines a procedure (commonly known as EP-III) for determining the leaching potential of organic constituents from solid and hazardous wastes. The EP-III procedure is an extension to an existing procedure (EP Toxicity Test), which is limited to eight metals (As, Ba, Cd, Cr, Pb, Hg, Se, Ag), four pesticides and two herbicides for which National Primary Drinking Water Standards have been established. The intended characteristics of EP-III were to include:

- A. The capability of simulating leaching in a landfill containing municipal and industrial wastes in proportions of 95% and 5%, by weight, respectively.
- B. Compatibility with toxicity tests.
- C. The procedure should be relatively inexpensive in terms of time, equipment and personnel.
- D. If possible, it also should be effective in extracting metals so that only one extraction procedure need be specified.

The report was referred to the Environmental Engineering Committee, which established a Subcommittee consisting of Dr. J. William Haun, Chairman, Dr. Charles O'Melia and Mr. Richard Conway. They were assisted in their review by two consultants, Dr. Mary M. McKown and Mr. Cary L. Perket, and in one meeting by Dr. Raymond Loehr, Chairman of the EEC.

The Subcommittee has held two meetings. The first, on March 19, 1984, was for the purpose of getting detailed information on the proposed EP-III procedure, and for the drafting of issues for Subcommittee consideration (in addition to the series of technical questions posed by Ms. Claussen in her February 2 memorandum). The second, held on May 4, 1984, was for the purpose of getting Subcommittee members' and consultants' responses to the issues defined, and for the purpose of receiving public comment on the proposed procedure.

FINDINGS AND RECOMMENDATIONS

A. Basic Data Base

For a model, EPA selected a co-disposal scenario as the one to simulate in defining toxicity of solid wastes. They then developed a two-stage (municipal waste followed by industrial waste) lysimeter approach to represent an actual landfill and thereby develop leachate contaminant concentrations. These concentrations served as target levels for the various extraction procedures.

The Environmental Engineering Committee finds that this approach "reasonably" represents an actual landfill and EPA is commended for its efforts in developing a data base for its EP-III, as this reportedly was not done for EP-I. The contractor, Oak Ridge National Laboratory, made an adequate simulation in terms of physical apparatus, operating procedures, and results as compared to actual municipal landfill leachate data.

The Office of Solid Wastes should answer the following questions:

1. Would the municipal leachate in a more mature landfill (aerobic conditions and elevated pH) be more or less aggressive to organics?
2. Should degradation of certain industrial wastes when landfilled and before leached be considered?

B. Comparison of Candidate Extraction Procedures to the Lysimeter Targets

There are very few statistically significant differences among the various test procedures, particularly when organic substances are considered. For example, in Table 53 (page B-53) of the contractor's report, it appears that there are no statistical differences among the top 30 of the 34 test procedures for simulating "AMC20" target concentrations. The reasons for this are not clear. This makes selection of the "best" extraction procedure questionable, and also seriously weakens a scientific evaluation of the adequacy of the EP-III approach. Consider the following information taken from Table 53.

Rank	Media	Type	L/S Ratio	Difference (%)			CV (%)
				Avg.	Min.	Max.	
1	sodium acetate	batch	20	58.7	4.8	94.1	46.7
12	sodium acetate	column	10	76.6	37.7	98.8	27.2

The tests have been ranked in terms of their average differences between extraction and lysimeter results for a suite of organic substances. The direction (+ or -) of the difference should also be important. We suspect that the test ranked first (above) had results of extraction that were always less than those from the lysimeters, giving rise to the lowest average difference (58.7%), but also a coefficient of variation of 46.7%. The twelfth-ranked test may have had results which were distributed around the mean of the lysimeter results (+ and -), yielding a greater average difference (76.6%) but a lower coefficient of variation (27.2%). We conclude, therefore, that the data from the candidate leach tests as compared to the lysimeter targets should be subject to additional statistical analysis. Also, the results of current tests using eleven additional industrial waste leachates should be added to the data base. Included in the analysis should be the following:

1. Ranking of tests by comparing mean concentrations rather than average differences for the extraction and lysimeter tests.

2. Re-examination of the five averaging procedures used to simulate leaching over time.
3. Examination of the results for individual organic compounds to consider possible "chemical" patterns in the data.

These analyses should be directed by statisticians who may be expected to suggest additional useful approaches.

C. Proposed Changes Between EP and EP-III

These proposed changes can be considered apart from the selection of EP-III as a simulator of an actual co-disposal situation. Criteria such as expected effects on precision and operability can be applied.

1. Solids Separation - The paint filter test proposed for free liquids measurement is suggested by EPA. This test seems subject to operational variation, especially in how the waste is added to the filter, which will adversely affect precision. The procedure also will consume much more time than would centrifugation as allowed in the EP test. This is a major departure from the EP test, and it is not clear that the change has been justified. OSW should thoroughly justify its decision not to use centrifugation. This justification should include a comprehensive (10 labs using at least 10 wastes) interlaboratory evaluation.
2. pH - The pH of the final extraction mixture should be recorded. Otherwise, adding the acid all at the beginning seems satisfactory.
3. CO₂-Saturated Water Extractant - If CO₂-saturated water is used, it should be closely standardized, perhaps by adding to dilute sodium hydroxide and back titrating. Its selection over distilled water or a more acid (or alkaline) extractant needs to be on the basis of a significantly closer simulation of a co-disposal scenario, or, failing that, on operational grounds such as having a leachate more amenable to assay. Actual bioassays (e.g. daphnia TL_m or Ames test) should be run on the extracts from the candidate procedures.
4. Liquid-to-Solid Ratio - The base data and operational factors favor the 20:1 ratio recommended by EPA.
5. Temperature - A narrower range of 20-25°C is recommended to increase precision.
6. Extraction Time - The reduction from 24 hours to 18 hours to facilitate operation is reasonable as it should not affect results if agitation is high.

7. Agitation - One device and set of operating conditions should be specified, with proof of equivalency required for any alternatives.

Prevention of volatiles loss should be a major factor; the presently considered approach with a variable headspace is not adequate.

8. Final Filtration - Need to avoid vacuum to prevent volatiles loss. No data were presented to support acceptability of only Nucleopore filters. The ambiguous word "non-filterable" should be replaced.
9. Loss of Volatiles - OSW should provide data quantifying the loss of volatiles. Such losses are sure to occur in EP-III (due to headspace, vacuum filtration, sample manipulation), and the degree of loss should be determined for at least the classes of volatiles expected (halogens, hydrocarbons, sulfur or nitrogen compounds).
10. Requirement for the Method of Standard Additions in All Analyses - OSW should further examine the basis for this recommendation. It appears to be unsubstantiated, and involves significantly higher costs with minimum technical benefit.
11. Interlaboratory Variability - There was a broad consensus that interlaboratory evaluation is essential. Ruggedness testing is currently planned at ORNL, but concurrent interlaboratory evaluation of parts of the procedure (such as the paint filter free liquids test, CO₂ extraction using variable medium preparation methods, etc.), should also be done.

It is recommended that EPA consider the above changes before the EP-III procedure undergoes its ruggedness test and certainly before its multi-laboratory extraction.

SUMMARY

On the whole, the lysimeter data base against which the new extraction procedure for determining the toxicity characteristic of organic wastes will be evaluated is of high quality; the two questions the SAB poses relate to the extent of biodegradation in the simulated landfills.

Conversely, the statistical procedures used to evaluate the performance of the candidate extraction procedures against the lysimeter targets are deemed inadequate and should be improved.

Each change between the current Extraction Procedure (EP) toxicity test and EP-III has been reviewed by the SAB; many of these are supported, but more consideration for some is recommended especially to those regarding solids separation, extraction, agitation and the type of extractant. The changes could also be reviewed again when the additional data are available and the statistical analyses have been extended.

The Environmental Engineering Committee would like to review, at least for informational purposes, the results of the Office of Solid Wastes' additional studies on EP-III.