AN ANALYSIS MODEL FOR REGIONAL

LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT ALTERNATIVES*

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ABSTRACT

The Department of Energy Low-Level Waste Management Program has developed an interactive computer model and linked database to be used by state and regional policy makers to evaluate various waste management system configurations and technologies. The computer program resides on an IBM 4341 mainframe host, and was developed and is supported by EG&G Idaho, Inc. Both user access and terminal workstations are provided to regional and state representatives as part of the Low-Level Waste Management Program Information Management System. The analysis model was developed to provide decision support information about regional waste management options for low-level radioactive waste (LLRW) processing, packaging, transportation, storage, and disposal. This model concept represents an extension of several independent analysis programs that were developed as stand-alone planning aids by the Program.

Coupled with the computer model is a comprehensive database of default parameters that is utilized by the computer unless the user has developed a custom dataset. This database allows the inexperienced user to use the model as a productive tool immediately, yet provides extreme flexibility if or when advanced applications and questions need to be addressed. The user may review and alter any value within the default datasets in developing a custom file for analysis.

This paper outlines the nature of this new analytical tool, with special emphasis on how a regional planner might utilize the system to help answer appropriate questions concerning a specific regional waste management configuration.

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PROJECT SUMMARY

Two related projects were initiated in 1985 by the EG&G Idaho, Inc. Low-Level Waste Management Program to provide this computer system. The first step constituted a technical project to determine the decision logic upon which the computer model would base decisions and compute output values for a given waste management configuration. Subsequent to this, default datasets were developed that could be accessed by the program during operation. Existing information about each respective element of a "cradle to grave" low-level waste management system was compiled and organized for reference. This gathered information was then entered into a hierarchical database for ease of retrieval, categorized first by system element (e.g., Processing) and then by specific technology within a given system element (e.g., Incineration.) As the model system and datasets developed, this hierarchical database became the preliminary documentation for both end products.

The implementation of this decision logic and default dataset structure was initiated as a third task and utilized existing programs, lookup tables, and subroutines wherever possible. This adaptation began with the expansion of an existing, stand-alone waste volume projection model concept to include physical, chemical, radiological, and other values. This new system was then coupled with a new waste processing model developed to use these waste stream parameters. Storage was included as a processing option, even if institutionally required rather than technically productive. A prototype transportation model was refined and coupled with a packaging and waste classification model to estimate the cost, exposure, and other considerations related to these system elements. Finally, an existing disposal economics model was expanded to include disposal alternatives other than shallow land burial, and to provide output information beyond cost categories and financial requirements. Because of the program structure, the respective model components and subroutines were integrated so that they could be invoked in any order, as long as generation is the first selection.

The computer program development, database organization, and input screen layout is being completed with a threefold objective. The primary objective was the creation of simple, self explanatory screens that would guide the user with minimal memorization and confusion, allowing nearly immediate use of the tool for configuration analysis. Another objective was the ability to alter default datasets to represent hypothetical or emerging scenarios. Finally, the user (and the Program) had to be able to add new technologies as options as they developed. These additional options are expected to include the combination of several processing technologies at one regional facility, or a processing facility co-located at a new disposal facility. Because a user may be interested in utilizing each submodel as an independent tool, the integrated system has been developed with this option.

TYPICAL QUESTIONS FOR ANALYSIS

Example 1

A regional planner is considering hiring a consultant engineer to evaluate the potential benefits of a regional processing or storage facility for a five state compact, but would like to maximize the information to be gained by limiting the scenarios that the consultant should consider. By using the analysis model he could 1) develop a regional waste stream profile for his region, 2) explore conventional processing options for this waste stream, 3) explore disposal technology alternatives for ultimate disposal, 4) consider the overall system costs and incompatibilities for specific technologies, and 5) review the regulatory specifics of each host state. The net effect of his time invested will probably not completely substitute for the consultant, but may greatly reduce the resources required to examine viable waste management options of that region.

Example 2

A second region wishes to examine the feasibility of requiring that all waste generated by that region be solidified or encapsulated as an added precaution against waste subsidence. What fraction of the overall regional waste stream would be affected, and how equitably would the incurred costs be distributed across the utility, industrial, and institutional generating sectors? The model could be effectively utilized to address each of these issues, and might provide some indication of waste streams that might be incompatible with such an effort. Other waste form requirements could be evaluated similarly.

Example 3

A particular technical planner is feeling pressure from a well organized and vocal group opposed to the siting of a regional incinerator in her state. Among other objections, the group contests the volume reduction figures cited by the potential developer, asserting that only a small fraction of the regional waste stream could be processed by incineration. Using the model and the linked database, the state planner could examine the validity (and sensitivity) of this assertion, and would have a general basis and reference source for drawing a conclusion about the stated concerns.

A TYPICAL SESSION

Because the model was developed to be accessible to both the novice and experienced user, the approach will vary depending on the type of question to be explored and the specific information available about the region and technologies to be considered.

Step 1 - Select a Waste Management Sequence

The user selects from the menu of waste system components, creating a sequential order of technologies through which the regional waste stream will traverse. The configuration must begin with generation and will usually end with disposal, but may include any sequence, or combination of technologies available.

Examples:

Generation/Storage/Disposal

Generation/Incineration/Storage

Step 2 - Define the waste generation profile

The user next identifies the waste stream of interest. This could be as simple as accepting the default volume projections and assumptions from the database, or as complex as creating a totally hypothetical waste stream dataset through optional review screens. Such an optional generation profile can be saved for later recall, or could be further altered at a later time. The ratio of utility, industrial, and institutional waste contributions may be altered as desired.

Step 3 - Designate Base Years

The user must next specify the base year for the current analysis. The model will account for the time value of money, financial ramifications, and waste volume carryover due to storage.

Example:

First year of Waste Disposal	= 1986
First year of Disposal Operation	= 1992
Base Year Dollars	= 1986 Dollars
(6 Years of Storage Implied)	

Step 4 - Modify Specific Waste Stream Parameters

The user may optionally review and alter any or all of the 24 waste stream categories which comprise the overall waste stream profile for a given generation region. Figure 1 presents the relationship of these waste streams to the input values of Step 2.

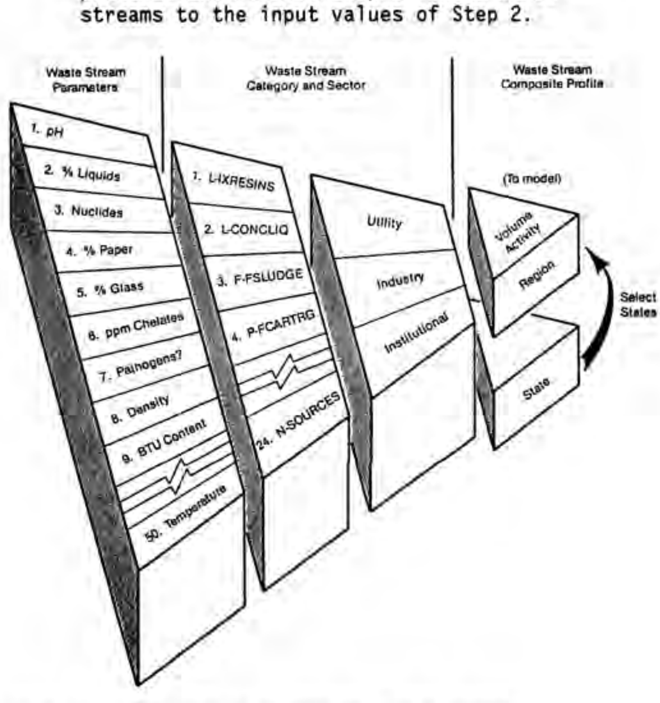

Fig. 1. Building a composite waste stream.

Material contributors (wood, glass, paper, et. al.,), physical parameters (void ratio, compressive strength, etc.,), chemical characteristics (free water content, degradability, pH, etc.,), and nuclide mix may be reviewed and modified as appropriate. Because this flexibility might produce unpredictable output, this option will be made available after the models have been introduced and demonstrated.

Step 5 - Specify Shipping Routes and Distances

Should the user be interested in the specific routes and distances to be utilized in the conveyance of the selected waste stream, specific assumptions and facility locations may be specified as the basis for computing transport miles, costs, and times. Default geographical centroids are assumed if the user relies on default information.

Step 6 - Modify Technology Parameters

Finally, the user may review and alter any or all parameters associated with the processing, storage, or disposal technologies selected in Step 1 above. Processing assumptions can be revised to reflect specific equipment or operational information. Similarly, cost items can be adjusted to reflect changing estimates or to evaluate cost sensitivities.

Step 7 - Save Any Custom Datasets

The user may elect to save any custom dataset developed in the above steps as a unique file for later retrieval. In such a manner, a user can develop many distinct scenarios that can be compared or contrasted against other configurations.

Following the completion of the steps, the user allows the program to evaluate the configuration selected, providing a multilevel output summary for evaluation and comparison by the user.

TYPICAL OUTPUT INFORMATION

The output report for a given configuration will consist of the following general categories of information:

1. Summary (echo) of Input Dataset

The user selections for the given analysis will be summarized in a consistent format. The stored datafile names will be included for later reference. The user may suppress portions of this report if the contents are known.

2. Qualitative Summary of Configuration

The model will next provide a descriptive summary of the selections and sequence of the various technologies included for the present analysis. This section would also report any incompatibilities, contradictions, or redundancies that might exist due to a user error or oversight. Also, specific issues which may be implied by a given configuration would be documented in the form of a written warning message. If a given input dataset can not be analyzed for some reason, a summary of the reason(s) would be presented. Other constraints might also be identified in this section if possible, such as legislative exclusions on certain technologies for a given state, or the elimination of a mixed waste stream due to process conversion.

3. Quantitative Summary of Configuration Performance

In conjunction with the text summary described in Category 2, quantitative results are generated for comparison against output datasets from other system analyses. These output values would be relative to other output datasets, and could not be assumed to be absolute values. Where a dimensional value cannot be computed, a relative index would be provided. Quantitative output parameters to be provided are anticipated to be expanded as the default dataset is augmented, but the following values are provided at present:

- Net Present Value, Life Cycle, system unit costs for the defined waste stream. This is anticipated to be a cumulative, adjusted present value cost to handle and dispose of a unit volume of waste from "cradle to grave". The incremental cost for each technology step would be provided as well.

- Implementation schedule for each system element included in defined system. These values will provide a relative estimate of the development period required for the selected technologies.

- Occupational Hazard Risk Index. This value is anticipated to be a relative index of the cumulative hazard that a particular configuration might pose with respect to occupational proximity to the waste. This index will be derived by examining the general quality of worker contact with the waste throughout the defined system, using consistent assumptions regarding hazard.

- Long Term Care Requirement Index. This value is anticipated to be a relative index of the long term maintenance that can be expected throughout the institutional control period. This index will be derived based on best engineering assumptions about the disposal system components employed, and will rely on consistent statistical assumptions regarding the potential for failure.

- Ease of Remedial Action Index. This value is anticipated to be a relative index of the ease with which disposed waste might be exhumed after closure. This index will be based on an engineering estimate of the relative difficulty that could be expected if the waste matrix was required to be physically retrieved as a remedial action effort.

- Overall Volume Reduction Factor. This value is anticipated to represent the overall ratio of the original projected generation volume for the input waste stream divided by the actual disposal facility volume required to permanently dispose of the waste over the relevant time period. It is possible that this factor could be greater than one for some configurations, and would include the added volume of containers, pallets, grouts, or other volume displacing components.

- Non-Radioactive Hazard Reduction Index. This value is anticipated to represent the general ability of the selected treatment and packaging technology to reduce the non-radioactive hazard of a given waste stream. This index will not be an absolute risk index, but will indicate a technology which could be effective in reducing the non-radioactive hazard component of a given waste stream.

Because the model does not consider site specific factors, disposal system performance and environmental release scenarios cannot be addressed by the present model. The potential for eventually coupling this model with an existing site specific performance prediction program is being investigated, and could be considered as a future enhancement, if feasible.