REGIONAL LLRW PROCESSING ALTERNATIVES

APPLYING THE DOE REGINALT SYSTEMS ANALYSIS MODEL[a]

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ABSTRACT

The DOE Low-Level Waste Management Program has developed a computer-based decision support system of models that may be used by nonprogrammers to evaluate a comprehensive approach to commercial low-level radioactive waste (LLRW) management. REGINALT (Regional Waste Management Alternatives Analysis Model) implementation will be described as the model is applied to a hypothetical regional compact for the purpose of examining the technical and economic potential of two waste processing alternatives.

Using waste from a typical regional compact, two specific regional waste processing centers will be compared for feasibility. Example 1 will assume that a regional supercompaction facility is being developed for the region. Example 2 will assume that a regional facility with both supercompaction and incineration is specified. Both examples will include identical disposal facilities, except that capacity may differ due to variation in volume reduction achieved.

The two examples will be compared with regard to volume reduction achieved, estimated occupational exposure for the processing facilities, and life cycle costs per generated unit waste. A base case will also illustrate current disposal practices. The results of the comparisons will be evaluated, and other steps, if necessary, for additional decision support will be identified.

BACKGROUND

The management of low-level radioactive waste has always been a difficult task for state and regional compact decision-makers and is becoming more difficult as disposal costs continue to rise, restrictions are imposed, and public pressure increases. To aid these administrators in the selection of waste processing, storage, and disposal technologies suitable for their specific waste inventories, the Department of Energy Nuclear Energy Low-Level Waste Management Program at EG&G Idaho, Inc. has developed the Regional Waste Management Alternatives Analysis Model (REGINALT). REGINALT is an easy-to-use computer system with default data bases which provides information for the preliminary analysis of technical adequacy and economic viability of waste management alternatives relative to a given waste inventory.

This paper will provide an understanding of REGINALT by describing the model's data sets and internal functions and its use in a hypothetical application from input data development to output data analysis.

THE REGINALT MODEL

REGINALT is an interactive computer model written in the NOMAD2 Data base Management System procedural language and residing on an IBM 4341 mainframe computer at the Idaho National Engineering Laboratory (INEL) in Idaho Falls, Idaho. The system implements many concepts of expert systems, basically a structured "template" driven by the data residing in its data bases. REGINALT consists of a main control module and six major and fully integrated submodels (GENERATION, PROCESSING, STORAGE, DISPOSAL, PACKAGING, and TRANSPORTATION) which duplicate the decision-making processes, operations, and technical and economic attributes associated with each waste management function. Figure 1 shows REGINALT as an integrated system.

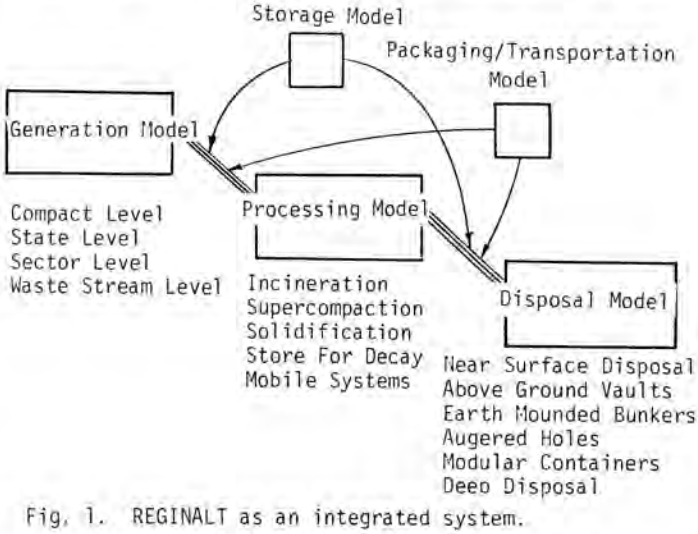

Fig. 1. REGINALT as an integrated system.

Each submodel may be executed in any order to simulate the most complex waste management scenario. During the process of making the best decisions possible, a submodel independently yet systematically considers the radiological, material, physical, and chemical characteristics of each waste stream and all relevant regulatory concerns. REGINALT gets its information from its complete default data bases containing each state's waste streams. Up to twenty-six waste streams may be characterized by over sixty parameters. In addition, REGINALT has detailed

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decision making, technical, economic, and regulatory information for each technology, facility, and container described in detail.

To briefly illustrate how REGINALT uses this information, the model is asked to analyze a waste volume of compactible trash and ion exchange resins from a utility (L-COTRASH and L-IXRESIN, respectively)[a] in state X with a remotely situated incinerator and near-surface disposal. The generation model first generates the waste streams based on default volumes, growth predictions, and characteristics in its data base. The generation model then passes the waste stream data to the processing model for analysis. The processing model then analyzes L-COTRASH characteristics relevant to incineration. This waste stream is accepted for incineration because its properties are considered compatible. Its combustible elements are then converted to ash, its volume is recomputed, and various other radiological, physical, and chemical changes are noted. L-IXRESIN is similarly analyzed but is determined to contain an excess of noncombustibles and is rejected for incineration. Its volume and characteristics remain unchanged. When all technical decisions are completed and waste volumes are determined, REGINALT configures a processing or disposal facility of the appropriate capacity. Development, operational and postoperational costs of each facility, and generator costs per unit volume are computed.

Volume reduction (VR) achieved at each facility is also calculated. At the system level, unit costs, VR factors, estimates of occupational exposure, and volumes handled at each facility are assembled, along with a system cost per unit waste volume generated. At the conclusion of an analysis, REGINALT provides all of this information in printed reports. A decision-maker may then compare the results with other REGINALT analyses or with other documented examples to determine which alternative may best serve all compact generators.

APPLYING REGINALT FOR THE ANALYSIS OF TWO WASTE MANAGEMENT ALTERNATIVES

Using REGINALT to analyze waste management alternatives is a simple task for the regional compact decision-maker. Only a few input parameters are required, in spite of the complex functions and data analysis described in the previous section. In this section, a hypothetical application will be used to describe the steps necessary to implement and analyze results from REGINALT.

A hypothetical regional compact was investigating two waste management scenarios and wanted to gain some preliminary insight on how well each would serve its generators. The alternatives were a regional supercompaction and belowground-vault disposal facility, and a regional supercompaction, incineration, and belowground-vault disposal facility. As a base case, the compact's decision-maker also wanted to generate costs of a belowground-vault facility without processing operations or disposal restrictions.

Describing the Scenarios to REGINALT

To analyze these alternatives using REGINALT, the decision-maker determined: (1) the waste inventory of the compact using several of the default waste streams in the REGINALT data bases; (2) volumes and activities for each waste stream; (3) isotope and curie content of each waste stream; and (4) the material, physical, and chemical characteristics of each waste stream. The hypothetical compact's waste inventory was described to REGINALT as:

UTILITY SECTOR	350,000 Cubic Feet annually from 1.4E+05 Ci	L-IXRESIN[b] L-CONCLIQ L-FSLUDGE L-COTRASH* L-IRRCOMP
INDUSTRIAL SECTOR	15,000 Cubic Feet annually from 1.1E+04 Ci	N-SSTRASH N-LOTRASH N-LOWASTE N-SOURCES N-IXRESIN
INSTITUTIONAL SECTOR	35,000 Cubic Feet annually from 1.5E+02 Ci	I-COTRASH I-HIGHACT I-LQSCNVL I-ABSLIQD I-BIOWAST

* sixty percent of total volume

The isotopes and other characteristics described to REGINALT were typical of the waste streams listed above and are contained in the REGINALT System Guide.(1)

With the generation source appropriately described, the decision-maker then entered the configuration of alternative Example 1 into REGINALT. (Example 2 and the base case were entered in successive analyses). The elements of the configurations were entered as:

Example 1) Generator > Transport > Compaction/ Belowground Vault (BGV)[c]

Example 2) Generator > Transport > Compaction/ Incineration/ Concrete Solidification/ BGV

Base Case: Generator > Transport > BGV

The final parameter given to REGINALT was a typical shipping distance. REGINALT normally computes this value using existing highway networks, but for this

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a. L-COTRASH and L-IXRESIN are symbolic representations of composite waste streams as used in the REGINALT model. Complete descriptions may be found in the REGINALT Introductory System Guide (1).

b. Complete descriptions may be found in the REGINALT Introductory System Guide (1).

c. REGINALT used the following assumptions to analyze the systems:

Compaction: generic supercompaction equipment which is capable of producing 1000 to 2500 tons of net force on a 55-58 gal steel drum.

Incineration: conventional two-stage controlled-air incinerator with a dry off-gas system.

Concrete: Portland cement hydration reaction process.

hypothetical case, a weighted shipping distance of 130 miles per shipment was provided. Upon completion of the generation and transportation functions, REGINALT requested final selection of parameters controlling the financial calculations. The following information based on current trends was given to REGINALT:

SITE DEVELOPER	PRIVATE
DEVELOPMENT START	1987
STARTUP	1992
OPERATING PERIOD (YRS)	30
LOAN PERIOD (YRS)	30
DEBT FINANCED (%)	70
INTEREST (%)	8
RETURN ON EQUITY (%)	15
INCOME TAX (%)	36

Identical parameters were selected for each analysis. A startup year of 1993 was first computed by REGINALT. However, a shorter development period was desired and the startup date was adjusted to 1992. With all necessary information entered, REGINALT concluded the analysis and printed the results. The second example scenario and the base case were then executed identically except for the waste processing methods used.

ANALYZING REGINALT OUTPUT

REGINALT output data from the two example and base case analyses consisted of many levels of technical, economic, and operational data which could be analyzed for each technology and system configuration. For example, REGINALT provided detailed status of all waste streams at generation and after each processing step. Included were volumes, activities, isotopic and material inventories, compressive strength, dose rate, waste class, container type, chemical content, etc. Additionally, complete economic breakdowns for each facility and shipment, unit costs, and an occupational exposure index (OEI) were included.

When considering whether the compact should develop either Example 1 or Example 2 facilities, numerous technical factors along with economic indicators could be considered. To keep this paper brief, the decision-maker selected information relating to volume reduction, unit costs of facility operations, and occupational exposure as the primary bases for making a decision. Transportation was not a factor because it would occur identically in the three cases. However, it was included in the figures to point out an area needing cost reduction.

Volume Reduction

As previously stated, the waste volume generated annually by this hypothetical compact was four hundred thousand (400,000) cubic feet. In all three cases, approximately 95% of this waste was suitable for burial with five 5% remaining at the generation sites. Figure 2 illustrates the volume reduction (based on generated waste volume) achieved in each of the three cases.

Example 1, the compaction process, achieved an overall volume reduction factor of 1.4 for all waste generated and buried. Example 2, the compaction/incineration processes achieved a factor of 1.8 overall (6.0 for L-COTRASH alone). The base case actually showed an increase in volume buried over volume generated due to the containment necessary for burial. Against this base case, Example 1 represented a reduced burial site capacity of approximately five million cubic feet over a thirty-year lifetime, while Example 2 represented a seven million cubic feet reduction.

Economic Considerations

Figure 3 compares the unit costs of operating each example facility and base case.

The compaction facility's cost per unit volume generated was roughly 15% less than that of the compaction/incineration facility. Both were considerably higher than the practices of disposing of waste in a belowground-vault disposal without processing and acceptance restrictions. The latter's unit cost was lower than the disposal unit costs of the example scenarios because REGINALT's economic analysis indicated that the cost per unit volume of waste handled decreased as the volume increased.

Figure 4 illustrates the unit costs actually incurred by generators using the processing facilities. The costs vary because of different waste streams requiring different processes. This figure points out that the variation in unit costs to generators utilizing the facility are quite different from those spread over all waste generated. For those generators using incineration, actual unit costs are only 10% greater than those for compaction. For those generators requiring only concrete solidification, the unit cost is 20% less.

Occupational Exposure

The last factor considered by the decision-maker was the occupational exposure associated with each facility. REGINALT estimated that the compaction process had an OEI of 2, meaning that workers receive from .25 to 1.0 R/y (significant but an acceptable amount of exposure), while incineration had an OEI of 1 or less than .25 R/y (no significant exposure to personnel). This index is very conservative and primarily serves as a flag to signal the need of further investigation.

Transportation

Although REGINALT indicated that transportation costs did not vary for the three cases, the costs shown were significant as indicated by Fig. 3. REGINALT used drums and high-integrity containers (HICs) to transport the waste to the example facility. Large combustible or steel boxes, which ship efficiently, may be alternatives for incinerated waste streams. These and other containers are currently being loaded into REGINALT's data bases for investigation of their effect on the volume of waste per shipment.

CONCLUSIONS

After analyzing plots comparing cost and volume reduction and worker exposure data, the decision-maker decided that both Example 1 and Example 2 appeared to be feasible waste management alternatives for the hypothetical compact. To make the preliminary selection, however, the factors of greatest importance to the compact had to be considered. If economics were the primary concern, Example 1 might have been a more

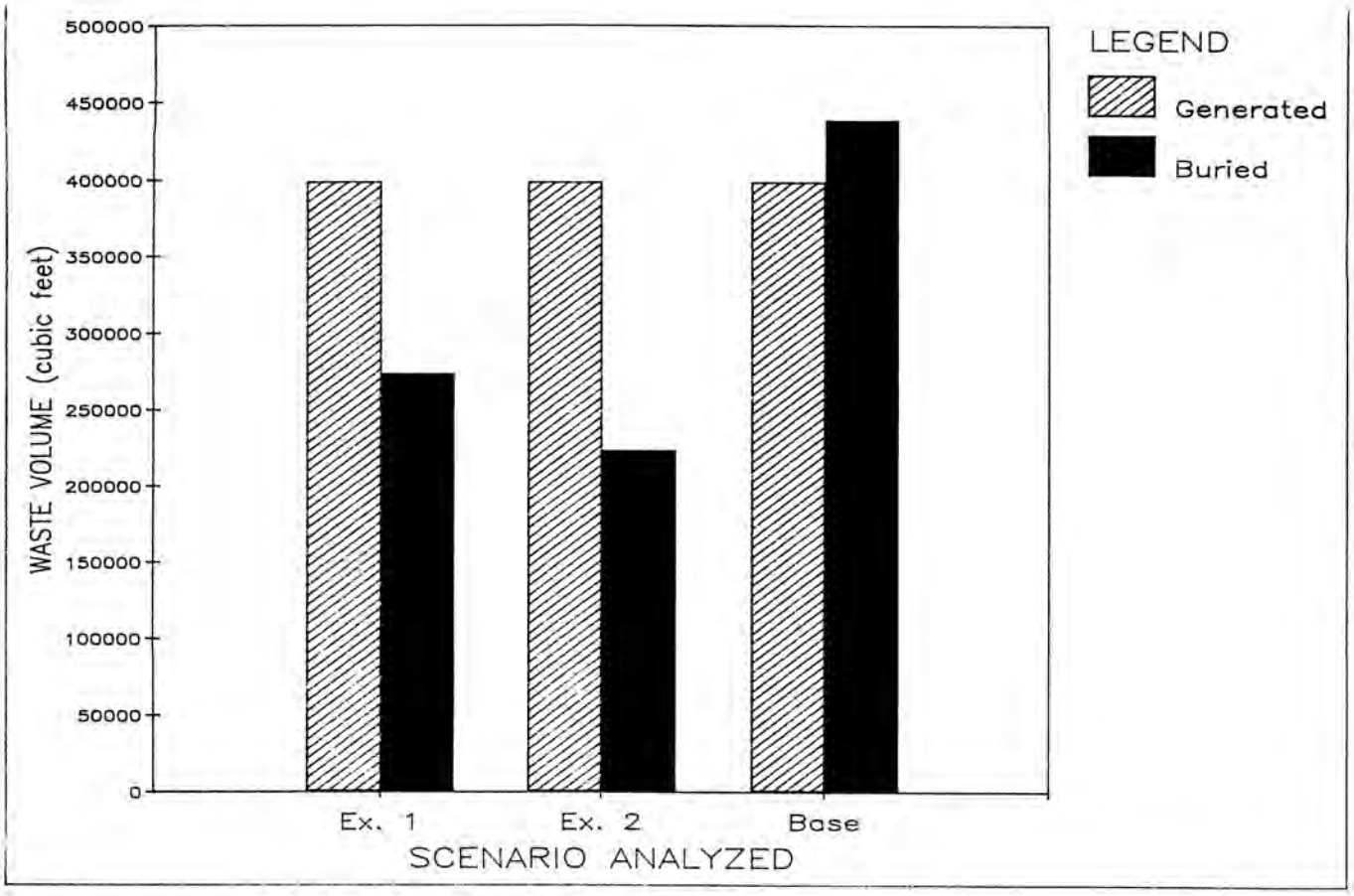

Fig. 2. Hypothetical regional compact volume reduction achieved.

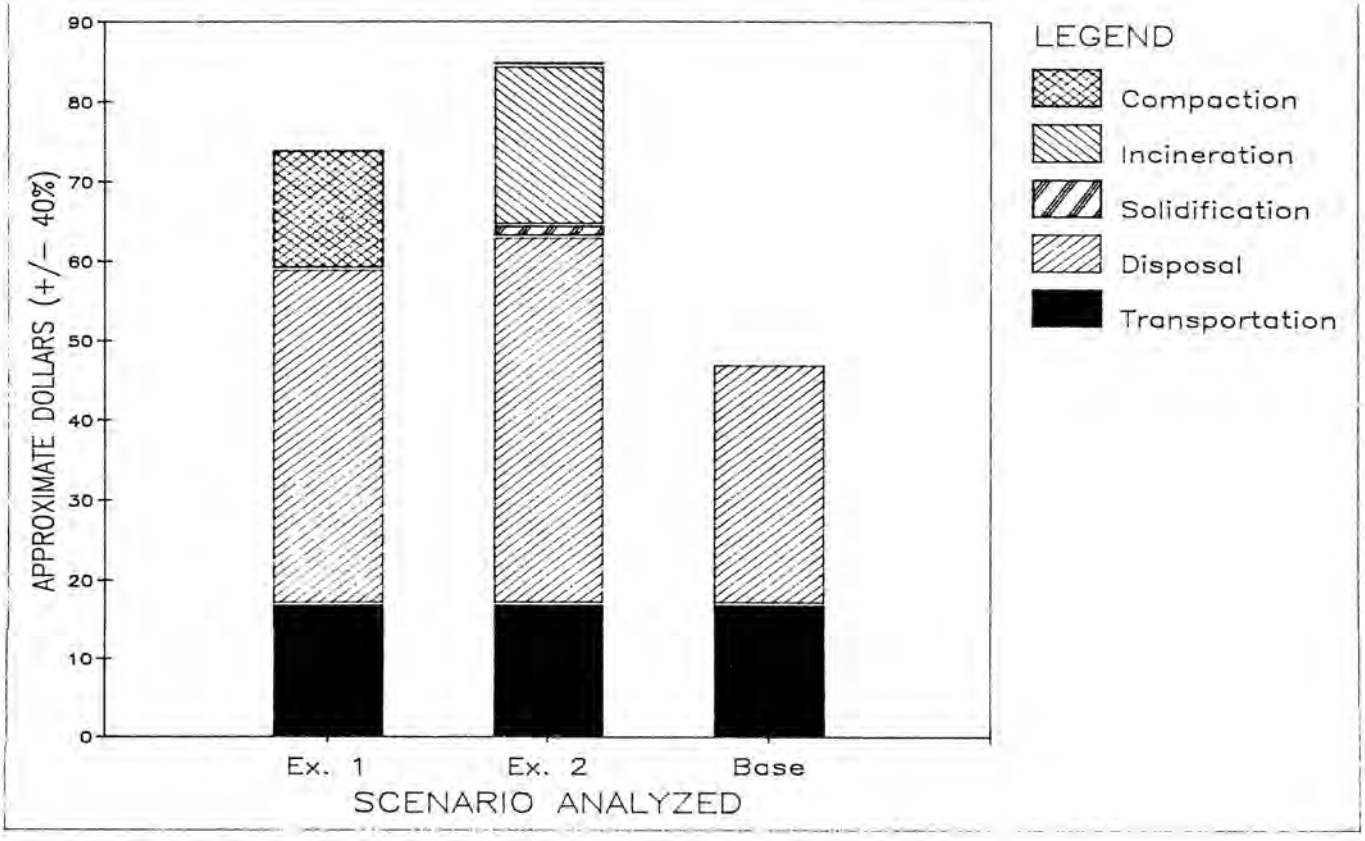

Fig. 3. Hypothetical regional compact cost per unit waste volume generated and buried.

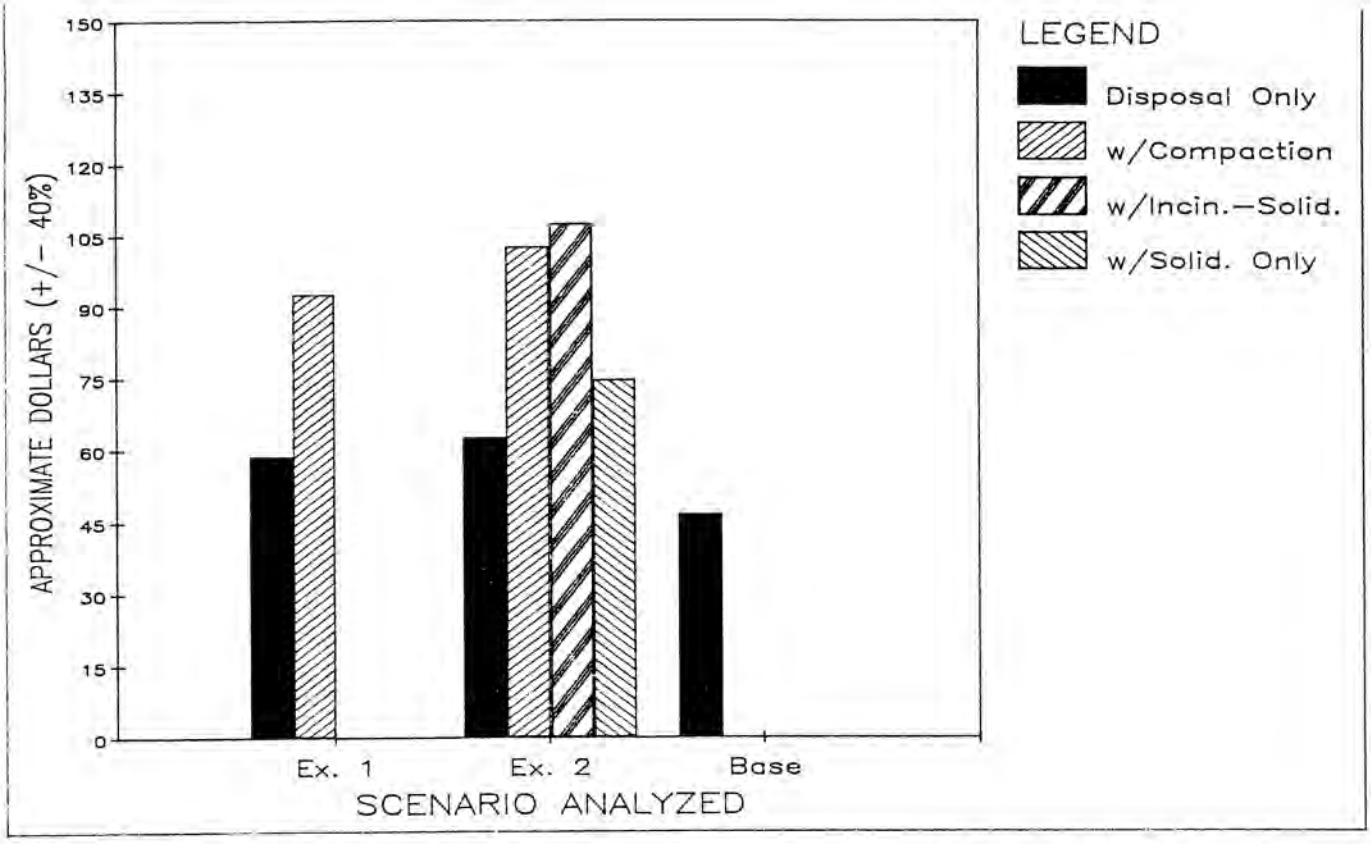

Fig. 4. Hypothetical regional compact cost per unit waste volume handled at a facility.

attractive choice; or, if volume reduction and worker exposure were essential, Example 2 might have been the decision-maker's selection. Regardless of which factors were considered most important, it was necessary to back up the selection with a thorough investigation of REGINALT's technical and regulatory output information for each alternative. The decision-maker was able to answer concerns relating to stack emissions, mobile isotopes, waste bound in concrete versus compacted "hockey pucks", structural soundness and stability of disposed waste, incineration regulations, possible BRC waste streams, etc., and finally make a tentative selection of one alternative.

Because REGINALT was designed to compare waste management alternatives for the determination of feasibility, the final step in the selection process was to contract a full scale, detailed site-specific economic evaluation of the favored alternative. Upon completion of this step, the decision-maker was able to determine which alternative would best serve the hypothetical compact's generators and the environment.

SUMMARY

REGINALT has been developed to assist in the early stages of waste management alternative selection. The model's "friendly" nature, functional capabilities, vast set of default information, and flexible template structure and expert systems concepts make it ideal for use by state and regional compacts and by any decision-maker wanting to save time and monetary resources while matching the most technically compatible and economically viable waste management scenario to a given inventory of waste. REGINALT is still young and currently in the technical review phase of its development. Future plans call for enhancement of the model's technical and economic capabilities and data bases, linkage to existing sophisticated technical models, and even greater user configuration modeling and data accessibility.

REFERENCE

1. REGINALT Introductory System Guide (DRAFT), Low-Level Waste Management Program, EG&G Idaho, Inc., August 1986.