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A SYSTEMS ENGINEERING COST ANALYSIS CAPABILITY FOR USE IN ASSESSING NUCLEAR WASTE MANAGEMENT SYSTEM COST PERFORMANCE

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A SYSTEMS ENGINEERING COST ANALYSIS CAPABILITY FOR USE IN ASSESSING NUCLEAR WASTE MANAGEMENT SYSTEM COST PERFORMANCE

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The System Engineering Cost Analysis (SECA) capability has been developed by the System Integration Branch of the U.S. Department of Energy's Office of Civilian Radioactive Waste Management for use in assessing the cost performance of alternative waste management system configurations. The SECA capability is designed to provide rapid cost estimates of the waste management system for a given operational scenario and to permit aggregate or detailed cost comparisons for alternative waste system configurations. This capability may be used as an integral part of the System Integration Modeling System (SIMS) or, with appropriate input defining a scenario, as a separate cost analysis model.

The SECA capability differs from other existing cost analysis capabilities in that:

- All unit costs supplied by the capability are fully traceable to either an original reference or to an engineering estimate through an electronic database. The cost library used by the cost model is prepared electronically by the database software.
- The cost accounts utilized in the SECA capability are structured such that the costs associated with performing a given function at a given location can be explicitly identified.
- The cost accounts are mapped into the functional description which is generated and maintained as part of SIMS thus allowing cost/performance comparisons for competing system configurations or technologies to be developed on a consistent basis.
- The software tool used by the capability, the System Engineering Cost Analysis Model (SECAM), has been engineered specifically to provide a high degree of reliability and to reduce long-term maintenance costs.

The SECA capability includes the SECA Database, the SECAM Software, and the SECA Algorithm Library. The SECA Algorithm Library contains the relationships which are used to estimate costs in each cost account. In addition, the model utilizes a user supplied control/input file and several scenario specific data files which provide direct interfaces to data which is either required or generated by other SIMS analysis capabilities.

The System Engineering Cost Analysis Model (SECAM) uses a hierarchical cost-accounting structure for estimating and reporting costs at any one of several levels. Figure 1 shows a single path in the structure as an illustration of the accounting structure. The waste management system is divided into its major system components: waste generator on-site storage and cask loading activities, the transportation system, the MRS, and the repository. Each system component is further subdivided into categories reflecting major cost-contributing buildings or activities, such as a spent fuel handling building or site support. These major costing categories are called cost centers. Each cost center is then subdivided into specific activities, such as waste processing, called cost elements. Each cost element represents a single function or set of functions whose costs can be expected to scale similarly as the facility operations or designs are modified to meet a specific scenarios. The cost centers associated with each system component are not necessarily the same across all system components and, in general, each cost center has its own unique set of cost elements.

The form and behavior of the cost algorithms used to estimate costs within an individual cost element often vary with the life-cycle phase of operation (e.g. engineering and construction, operating, caretaker, closure, or decommissioning). In addition, the costs incurred in a particular cost element, during a

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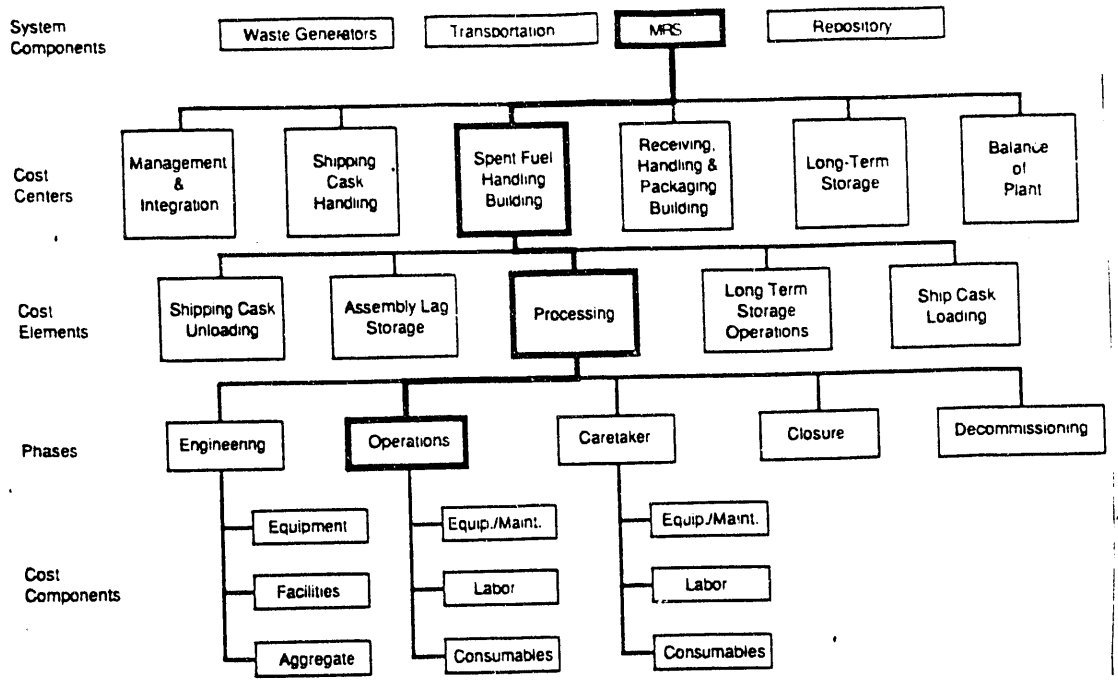

FIGURE 1 SYSTEMS ENGINEERING COST ANALYSIS MODEL (SECAM) - EXAMPLE COST ACCOUNTING STRUCTURE

particular phase, may vary differently for equipment, facilities, labor, consumable products, or maintenance activities. These specific cost accounts are referred to as cost components. Where this level of detail is not required or is not available, an aggregate cost component is used. Each combination of system component, cost center, cost element, cost component, and phase of operation (referred to as a cell) may require a unique algorithm for estimating its associated costs.

Since SECAM estimates annual costs for each cell in the cost accounting structure, the SECAM results include year-by-year allocations of costs for each Waste Management system component. Detailed reports and graphs are structured to provide information in increasing levels of detail to aid the analyst or decision maker in identifying the system functions which are most effected by a particular system configurations or operating strategy.

Figure 2 shows the aggregated total annual system construction, operating, and decommissioning costs by major system component for a system containing a single storage-only MRS (2000 start-up) and a single repository (2003

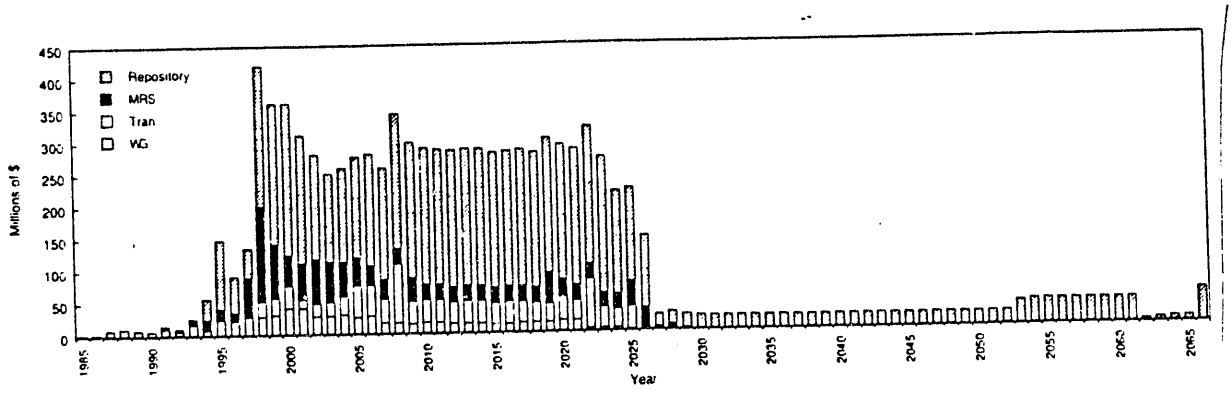

FIGURE 2 TOTAL SYSTEM COST BY YEAR (STORE-ONLY MRS, SINGLE REPOSITORY)

start-up). The graph effectively shows the year-by-year contribution to total system costs by each system component. Multiple-bar graphs of this type are useful in depicting the patterns of aggregated expenditures to be expected over the life of the waste management system.

The cost of each system component may be displayed for each cost center or cost element by each phase of an individual facility's life-cycle. Figure 3 shows a graph of the costs associated with a storage-only MRS for each cost element by operating phase. Graphs of this type and their associated data tables are useful for identifying which cost elements are the major contributors to a system components total cost. Tabular and graphic displays of the output data are available as desired.

It is anticipated that as the designs and configuration of the waste management system mature, the cost structures and algorithms will need to be revised. To facilitate long-term maintenance of the model, a data driven, object-oriented architecture was implemented within SECAM. This architecture allows new objects (system components, cost centers, cost elements, or cost components) to be declared and linked into the model by supplying data for them in the SECA Data library or user input file. No additional code needs to be written, verified, or tested for these major structural modifications to the existing SECA capability.

The algorithms used by the model are also treated as data by SECAM and are read from the SECA Algorithm Library. The current algorithm library contains a wide variety of algorithms for use by SECAM. These algorithms can be utilized by any cost component within any cost element and phase of operations by specifying which algorithm applies within the cell. The default assignment of algorithms to cells is contained with the SECA Database. If an appropriate algorithm does not exist in the algorithm library for use by a cell, a new algorithm can be written and added to the library. Some programming knowledge is required to generate a new algorithm and any new algorithm is required to be tested and verified prior to inclusion in the SECA Algorithm Library.

The SECA Database provides a means of providing a consistent, fully traceable set of SIMS

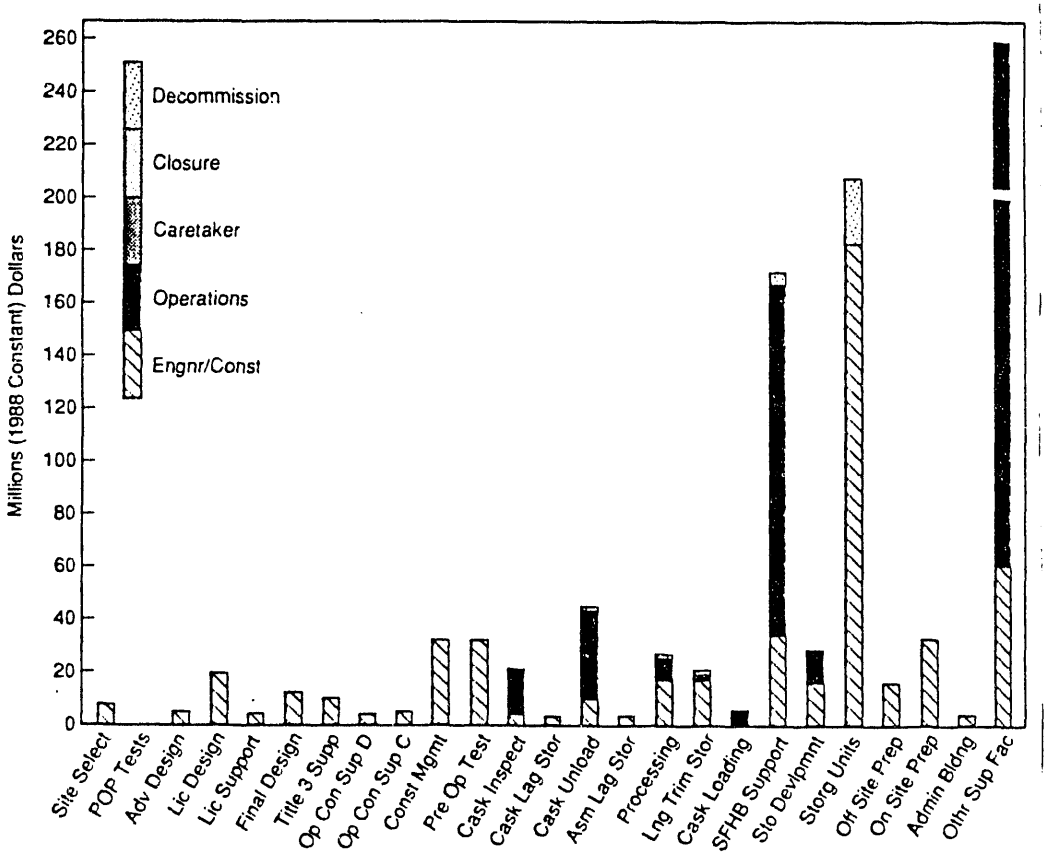

FIGURE 3 MRS COSTS BY COST ELEMENT

reference cost data to the SECAM software. Currently the SECA Database includes cost data which was developed by R. M. Parsons (MRS), Sandia National Laboratories (Repository), the Office of Transportation Systems and Planning (Transportation), and Pacific Northwest Laboratories (At-reactor storage) as part of the MRS System Studies.

SECAM may be used to assess the sensitivity of system costs to changes in design and operating parameters. These parameters include:

- The start-up date and operating period of each facility,
- The annual processing rates of assemblies, packages, or casks at each step in the functional description,
- The technology employed in performing each function (e.g., storage concept employed at reactor sites or at the MRS, and whether or not consolidation of spent fuel is performed), and
- Redefinition or modification of the facility operational assumptions (e.g., rail cask pass through an MRS rather than unloading the rail casks at the MRS for reshipment to a repository, or holding an MRS facility in standby while waiting for opening of a second repository).

Some limited scaling capability is provided in SECAM to estimate the costs of modifications to facilities and equipment used in various handling, processing, storage, or emplacement functions, and to accommodate changes in spent fuel throughput. However, changes involving the addition or deletion of facility functions or major modifications to the technologies employed would require additional design information as input, and may require changing or adding new cost algorithms.

The SECA Database is currently implemented in dBase III Plus on an IBM AT. The SECAM software is currently running on a Micro Vax II.

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