DATA PROCESSING IN THE INTEGRATED DATA BASE FOR SPENT FUEL AND RADIOACTIVE WASTE*

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ABSTRACT

The Integrated Data Base (IDB) Program at Oak Ridge National Laboratory (ORNL) produces for the U.S. Department of Energy (DOE) the official spent fuel and radioactive waste inventories and projections for the United States through the year 2020. Inventory data are collected and checked for consistency, projection data are calculated based on specified assumptions, and both are converted to a standard format. Spent fuel and waste radionuclides are decayed as a function of time. The resulting information constitutes the core data files called the Past/Present/Future (P/P/F) data base. A data file management system, SAS®, is used to retrieve the data and create several types of output: an annual report, an electronic summary data file designed for IBM-PC®-compatible computers, and special-request reports.

INTRODUCTION

The IDB Program at ORNL produces for the U.S. DOE the official spent fuel and radioactive waste inventories and projections[1] for the United States through the year 2020. These inventories and projections are for both government and commercial wastes and include spent fuel, high-level waste (HLW), transuranic (TRU) waste, low-level waste (LLW), mill tailings, and airborne waste. Wastes are characterized by type, site, date of generation, waste generator, volume, mass, curies as a function of time, watts as a function of time, packaging, and other characteristics. Spent fuel and wastes are also projected for alternative scenarios. Additional program details are available in ref. 2.

DATA COLLECTION IN IDB

The operations of IDB can be divided into three categories: (1) collecting the information, (2) processing the information to produce an internally consistent data base on spent fuel and radioactive waste, and (3) using the data base to produce the desired outputs. The first step is primarily a manual operation (but is being automated), while steps two and three are currently computerized operations.

Inventory and projection information is collected from DOE lead sites and other sources [waste disposal site operators, waste generators, literature sources, the U.S. Environmental Protection Agency (EPA), and the U.S. Nuclear Regulatory Commission (NRC)]. The basic ground-rule assumptions for projections are supplied by DOE. The data collection effort is coordinated by the IDB Steering Committee and DOE lead sites. DOE assigns certain laboratories the responsibility of managing waste programs in particular areas, and these lead sites collect waste inventory information for their own programmatic needs. Duplicate efforts are avoided and consistent sets of numbers and assumptions are used by working with these lead sites.

Coordination through a steering committee is a major activity of IDB because it is the tool used to ensure consistent, reliable data and projections for all waste types and sites. For example, inconsistencies between waste reporting systems at different storage sites were discovered with TRU waste inventories. These inconsistencies were due to different definitions of TRU waste and of waste volume (waste in container, container volume, and volume of storage facility), as well as different reporting methods for radionuclides. In this case, a TRU data workshop was held in 1983 with the participation of IDB, the Transuranic Waste Systems Office (TWSO), and the TRU storage sites. By consensus, common definitions, procedures, and approaches to handle waste information were adopted which are now eliminating earlier data inconsistency problems.

PROCESSING OF DATA

The computerized data handling system,[3,4] shown schematically in Fig. 1, has three components: (1) a set of codes which input data into the data base, (2) the data base, and (3) the system to produce reports, graphs, and tables from the data base.

The key component of the system is the P/P/F data base, which stores all information on each waste type after quality assurance (QA) operations, conversion to a common data format, and accounting for radioactive decay. This central core data base of IDB stores waste information on a batch-by-batch basis — where a batch can be a single package of waste, all the waste produced by a facility for a year, all the waste at a disposal site, or any other definition of a batch of waste. This variable definition of batch allows the system user to inventory or project waste information with different levels of detail, depending on user needs. Future projected quantities of waste are stored like historical inventory except that their date of generation is in the future. The list of data collected and calculated on each batch of waste is shown in Table I. In many cases, additional information is available.

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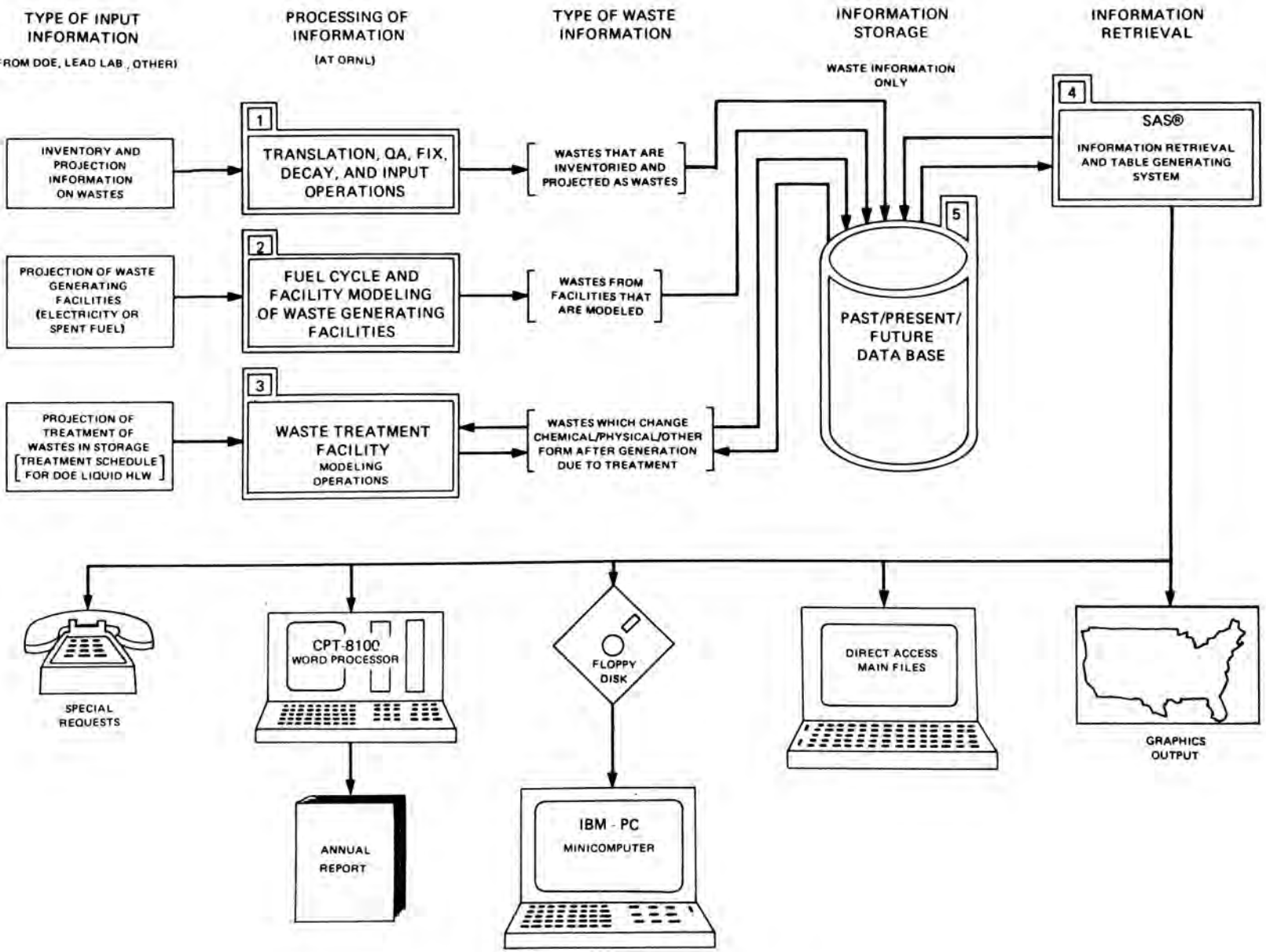

Fig. 1. Information Flow in the Integrated Data Base.

Table I. Minimum information inputted into the Past/Present/Future data base on each batch of spent fuel or waste in inventory or projected for the future

Information required	Description
Package definition	The definition of a package of waste or spent fuel must be decided. Typically, for a disposal site, a package of waste would be all the waste of a particular type received in a single year. For a generator site, it would be all the waste of a particular type generated in 1 year.
Primary category	Type of waste (examples: HLW, transuranic contact waste, LLW, etc.).
Secondary waste characterization	Depending on waste category, the waste is subdivided into subcategories. For example, HLW is subdivided into glass, alkaline liquid, acid liquid, calcine, sludge, etc.
Facility type	Type of facility producing wastes (e.g., BWR, PWR, fuel fabrication plant, etc.).
Owner of waste	Type of owner (i.e., government, utility, other).
Time of waste generation	Self-explanatory.
Location of waste	State and site where waste is presently located.
Time waste ceased to exist	This applies to only certain wastes. For example, a liquid HLW may be converted into HLW glass in the future. The time given is the time this conversion will occur. In such a case, there is a second entry in the data base for the glass.
Waste volume	Volume of waste as packaged (in special cases, volume of waste excludes package, i.e., HLW glass).
Curies as function of time	Radioactivity of package of waste from time generated through the year 2020.
Power generation rate as function of time	Thermal power generated by radioactive decay of package of waste from time generated through the year 2020.

Inventory and projection data are received in a variety of formats: on paper, on tape, and by electronic transfer. A commercially available file management system called SAS®[5] is used to convert the data to a common format and to do preliminary QA. SAS® has the capability to read data files generated by COBOL, FORTRAN, and other programming languages and easily converts the data to a common format.

Input to the system is accomplished by means of three sets of computer codes. The first set of codes inputs waste inventory data and performs decay calculations on the radionuclides. For example, waste information is received on a LLW disposal site. The location, waste type, time of burial, and radionuclide composition are provided as input data. The computer code then determines the curies and watts of the waste as a function of time for each year through 2020 before entering the information to the data base. Radionuclide decay calculations are done using a modified version of ORIGEN2.[6] If the radionuclide composition of the waste is unknown, a default composition is provided. For many waste types, the actual radioactivity at a storage or disposal site is a very small fraction of the total radioactivity sent to the site over many years; therefore, radioactive decay must be fully accounted for if realistic inventory numbers are to be obtained.

The second set of codes takes the Pacific Northwest Laboratory spent fuel projection for the United States and converts it to numbers and types of reactors and fuel cycle facilities, determines the wastes produced by such facilities, performs radioactive decay calculations, and inputs calculated waste quantities into the data base. This fuel projection, which is the official DOE spent fuel projection, is based on the official nuclear electric growth projection of the Energy Information Administration (EIA) within DOE. For example, in the 1983 IDB annual report, future waste projections assumed light-water reactor (LWR) reprocessing. The spent fuel discharge schedule for each set of reactors for all times was determined; then a schedule for reprocessing the fuel was fixed. This schedule included three plants with different startup dates and flowsheets. The spent fuel batches were decayed from time of reactor discharge to time of fuel reprocessing. Reprocessing of the spent fuel was simulated, and each of the waste products was decayed to all times of interest (through the year 2020). The resulting data were inputted to the data base. By such a procedure the volumes, curies, and watts of each batch of waste sent to a repository or other disposal site was tracked as a function of time.

The third set of codes when provided a treatment schedule for waste in the inventory, simulate treatment operations on existing waste and creates new wastes with new characteristics.

A data file management system (SAS®)[5] outputs the information from the P/P/F data base into various report and graphical forms. The output produced by SAS® can vary from summary information about the entire United States to volume, watts, and curies of

Table II. Menu of IDB electronic summary data file

Program question for user	Partial list of answers (options)
1. What type of output is desired?	Tables, graphs
2. What waste type is of interest?	TRU, LLW, HLW, SF
3. What is source of the waste?	DOE, commercial fuel cycle, I/I, all
4. What sites?	Hanford, ICPP, SRP
5. What waste forms?	Liquid, glass, calcine, etc.
6. What years of interest?	All, specific years
7. Is output to printer or screen?	Printer, screen, other

waste of a particular type at a particular time and at a particular disposal site. SAS® is also used to produce an electronic summary data file which may be accessed by personal computers.

A number of codes (written in FORTRAN IV) within this system may be of use in other types of waste modeling. These codes are being documented and will be made available to the public. One subroutine based on the ORIGEN2 code will decay any waste for any time, given the initial isotopic composition of the wastes; this modification of ORIGEN2 will operate on an IBM-PC®-compatible computer. Another computer code, when given the electrical growth scenario as input, projects the size, number, and fissile/fertile throughputs for each future fuel cycle facility and reactor. A third computer code can simulate the operation of any reactor or fuel cycle facility as a series of interconnected black boxes. It has the unique capability to account for radioactive decay within a particular process or facility. Other tools developed for the IDB also exist which may be applicable elsewhere.

DATA OUTPUT

There are three major products of the IDB: (1) an annual inventory report, (2) an electronic summary file, and (3) direct access to the main data base. The first two are available to the public at nominal costs. The last requires a prior agreement with DOE because of the time and effort required by the IDB staff.

The annual report produced by IDB is entitled "Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics," DOE/NE-0017-2 (September 1983).[1] The report maintains the same title and the DOE/NE-0017 designation each year.

The electronic summary file contains the same information as that presented in the annual report, but in an electronic format. This information is downloaded from the core data base — the P/P/F data base; it is not as detailed as the P/P/F. The information is sent in the form of two 5.25-in. floppy disks. One disk contains a menu-driven program to retrieve the spent fuel and radioactive waste inventory and projection information, while the second contains the inventory and projection data. An IBM-PC®-compatible personal computer with the following specifications is needed to use the files: memory, 128K; operating system, MS-DOS®; and two double-sided, double-density (320KB) floppy disk drives.

As a user-friendly, menu-driven system, the electronic summary file system asks the user a series of questions. Based on the answers to those questions, the appropriate data are automatically retrieved from the data disk. Table II lists the questions asked by the system and some of the possible answers by the user if an inquiry is made about HLW. When the personal computer with these two disks is turned on, the computer asks each question sequentially. Since the allowable answers for each question are shown on the screen, the user simply types the number (or numbers) of the answers to the questions. For most questions, the following information about waste batch is supplied: location of waste, volume, volume of all wastes of that type at a given site to the date specified, radioactivity, cumulative radioactivity, thermal power, and cumulative thermal power.

Additional information on the IDB or spent fuel and radioactive waste inventories and projections may be obtained from:

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(FTS) 624-6823

REFERENCES

1. U.S. Department of Energy, "Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics," DOE/NE-0017-2 (September 1983).

2. K. J. NOTZ, C. W. FORSBERG, and E. F. MASTAL, "Spent Fuel and Radioactive Wastes: An Integrated Data Base of Inventories, Projections, and Characteristics," Waste Management '84, Tucson, Arizona (March 11-15, 1984).

3. C. W. FORSBERG, C. W. ALEXANDER, G. W. MORRISON, and O. W. HERMAN, "Integrated Data Base Program: An Overview of Data Handling and Projection Modeling," ORNL/NFW-83-08, Oak Ridge National Laboratory (Aug. 1983).

4. C. W. FORSBERG, "Data Handling in the IDB Program: I — Data Files for the Annual Inventory Report," ORNL/NFW-83/30, Oak Ridge National Laboratory (Feb. 1984).

5. SAS Institute, Inc., *SAS User's Guide: Basics*, P.O. Box 8000, Cary, North Carolina 27511.

6. A. G. CROFF, "A User's Manual for the ORIGEN2 Computer Code," ORNL/TM-7175, Oak Ridge National Laboratory (July 1980).