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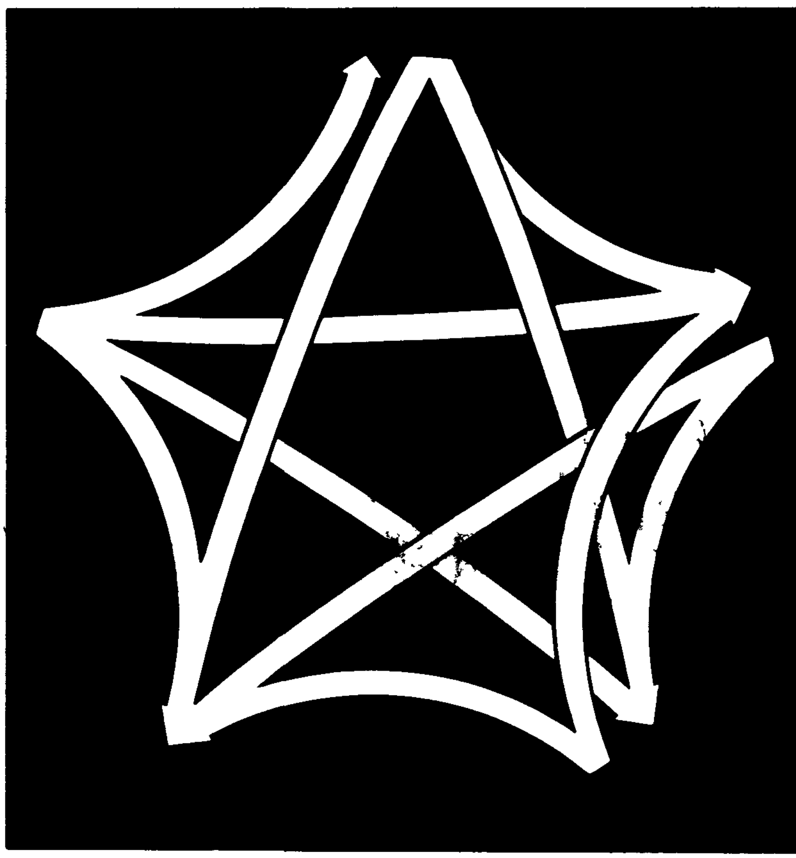
WASTES-II: Waste System Transportation and Economic Simulation - Release 24

User's Guide



December 1988

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
by Battelle Memorial Institute

PNL-5714-1

PACIFIC NORTHWEST LABORATORY
operated by
BATTELLE MEMORIAL INSTITUTE
for the
UNITED STATES DEPARTMENT OF ENERGY
under Contract DE-AC06-76RLO 1830

Printed in the United States of America
Available from
National Technical Information Service
United States Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

NTIS Price Codes
Microfiche A01

Printed Copy

DO NOT MICROFILM
COVER

Pages	Price Codes
001-025	A02
026-050	A03
051-075	A04
076-100	A05
101-125	A06
126-150	A07
151-175	A08
176-200	A09
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DE89 005506

WASTES-II: WASTE SYSTEM TRANSPORTATION AND ECONOMIC SIMULATION - RELEASE 24

USER'S GUIDE

S. J. Ouderkirk[(a)]

December 1988

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

(a) Boeing Computer Services, Richland, Inc.

EXECUTIVE SUMMARY

The WAste System Transportation and Economic Simulation (WASTES) computer code was developed in 1984 to simulate nearly any feasible logistics scenario under consideration for the Civilian Radioactive Waste Management System being developed by the U.S. Department of Energy.

This user's guide updates the latest changes to the WASTES computer model, and is intended to assist analysts who are familiar with current nuclear spent fuel technology in the use of WASTES. It contains descriptions of the computer code, input and output data, simulation control, and sample programs.

Additional detail concerning the WASTES computer model can be found in PNL-5977, WASTES: Waste System Transportation and Economic Simulation - Version II Technical Reference Manual, February 1988.

ABSTRACT

The original development of the WAste System Transportation and Economic Simulation (WASTES) computer model was sponsored by the U.S. Department of Energy (DOE) through the Monitored Retrievable Storage (MRS) Program at Pacific Northwest Laboratory (PNL) and the Transportation Technology Center at Sandia National Laboratory. Enhancements to the WASTES model that resulted in the development of the WASTES-II model were primarily sponsored by two DOE programs at PNL: 1) the MRS Program for use in analyzing the effects of various policy decisions, waste system logistics considerations, and facility operating schedules; and 2) the Nuclear Waste Fund Analysis Program to provide transportation economics for DOE's Total System Life-Cycle Cost (TSLCC) analysis. The model was developed to provide detailed analyses beyond the capabilities of other available models. WASTES uses discrete event simulation techniques to model the generation of commercial spent nuclear fuel, the buildup of spent fuel inventories within the civilian radioactive waste management system, and the movement of spent fuel throughout the system.

WASTES models each reactor pool and an at-reactor, out-of-pool (ex-pool) storage facility for each reactor site. Spent fuel transfers between pools can be simulated under various constraints controlled by user input. In addition to simulating each pool and ex-pool facility, WASTES can accommodate up to ten other storage facilities of four different types: federal interim storage (FIS), monitored retrievable storage (MRS), auxiliary plants, and repositories. Considerable flexibility is allowed for the user to specify system configuration and priorities for fuel receipts.

In addition, the WASTES computer code simulates very detailed (assembly-specific) movements of spent fuel throughout the waste management system. Spent fuel characteristics that are tracked by WASTES for each movement are: discharge year and month, number of assemblies, weight of uranium (MTU), exposure, original enrichment, and heat generation rate (calculated from the preceding characteristics). Data for the WASTES model is based upon the DOE reactor-specific spent fuel data base, which is developed and maintained by the Energy Information Administration (EIA). In addition to the spent fuel

characteristics, this data includes reactor location, type, transportation access, and historical and projected discharge data on the number of fuel assemblies.

The movement of spent fuel by WASTES may be controlled by a combination of source and/or destination-driven transfers that are specified by the user. Source-driven transfers can be triggered by any one of three conditions: 1) when a reactor pool violates its full-core-reserve (FCR) storage margin, 2) when a reactor is decommissioned, or 3) when list-driven transfers are specified by the user. The spent fuel requiring transfer would be shipped to facilities with available capacity. Destination-driven transfers occur, in general, when the annual spent fuel capacity of a facility will not be completely met by source-driven shipments. In this case, additional fuel will be shipped from sources with non-critical storage needs.

WASTES provides considerable flexibility in determining which spent fuel is transferred, and can be used for setting acceptance priorities, disallowing transportation links between facilities, and defining different types of transportation casks and limiting where they may be used. With this flexibility, a creative user can simulate nearly any feasible logistics scenario currently under consideration for the civilian radioactive waste management system being developed by DOE.

Information generated by the WASTES model includes: annual inventories of spent fuel in each facility; annual at-reactor, ex-pool-storage inventories and costs; annual decommissioned reactor inventories; annual summaries of shipments between facilities; characterization of fuel received at each facility; and shipping summaries, including shipping costs, number of casks required, and cask miles.

CHANGES SINCE RELEASE 22

This user's guide documents WASTES-II, Release 24. Many changes have been made to the WASTES computer code since the previous user's guide that documented Release 22 was issued in 1986 (Shay and Buxbaum 1986). The following information identifies all significant additions and deletions to the code's capability and logic.

Changes in logic:

Heat content of batches	Through use of various input cards the selection/rejection of spent fuel can be based upon the heat content as well as the age.
Shipping costs	The default shipping cost functions have been modified to conform with PNL-5977 (Sovers et al. 1988). Optionally the costing functions defined by Weston may be selected. The values of the variables used in Weston's functions may be modified by the user.
Ex-pool costing	The functions used to calculate ex-pool storage costs have been modified to conform with PNL-5977 (Sovers et al. 1988).
Ex-pool filling logic	The logic used to select fuel for ex-pool storage has been changed to default to selecting the most recently discharged fuel (or hottest if sorted by heat) instead of the oldest fuel. In addition, the pools violating their FCR margin are prioritized to minimize the number of storage sites. The selection of youngest fuel minimizes the amount of fuel shuffled between pool and ex-pool storage. The default constraints may be overridden.
Reactor data	The code used to identify the reactors in the spent fuel data base has been changed from PNL to INIS. The discharge data base has been broken into two parts, historical and projected.
SLAM	The SLAM simulation language is no longer needed for WASTES execution.
List-driven shipments	It is now possible to specify the quantity of fuel removed from each reactor pool every year.

Discontinued input cards:

LIMITS	Ignored.
FIN	Ignored.
COSTREPORT	Ignored, all cost reports are generated.
DATASET	Input error will be generated. Use DATAFILE card.
DISCHARGE	Input error will be generated.
QSTATS	Input error will be generated.
RXCASKS	Ignored, replaced by the SHIPLINK card.

New input cards:

DECOMHEAT	Allows constraining heat content of fuel shipped from decommissioning reactors.
FCRHEAT	Allows constraining heat content of fuel shipped from reactor pools to restore FCR margins.
HEATSORT	Allows specifying that reactors and/or facilities primary selection criteria is to be heat content (coldest) rather than age (oldest).
HEATTO	Allows constraining heat content of shipments.
PRINT	Allows the generation of a subset of the main output report.
PROCESS	Allows the specification of the order/operation of fuel transfer processes.
REPORT	Generates reports of fuel discharges and transfers between pool and ex-pool storage.
RIGHTSAGE	Allows constraining the age of fuel shipped due to list-driven transfers.
RIGHTSHEAT	Allows constraining the heat content of fuel shipped due to list-driven transfers.
SHIPLINK	Allows the specification of shipping links between reactors and facilities, and facilities and facilities.
USERCOST	Allows modification of shipping cost variables.

Modified cards:

DATAFILE	Added list-driven data type.
MSHIP	Added basic shipping cost multiplier and security cost multiplier.
REACTORS	Identification must be in INIS code not PNL code.

ACKNOWLEDGMENTS

Many individuals have contributed to the development of the WASTES computer model. The following listing acknowledges the contributions of those involved in this effort.

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CONTENTS

FIGURES

TABLES

1.0 INTRODUCTION

The original development of the WASTES computer model was sponsored by the U.S. Department of Energy (DOE) through the Monitored Retrievable Storage (MRS) Program at Pacific Northwest Laboratory (PNL) and the Transportation Technology Center at Sandia National Laboratory. Enhancements to the WASTES model that resulted in the development of the WASTES-II model were primarily sponsored by two DOE programs at PNL: 1) the MRS Program for use in analyzing the effects of various policy decisions, waste system logistics considerations, and facility operating schedules within the federal waste management system; and 2) the Nuclear Waste Fund Analysis Program for use in DOE's Total System Life-Cycle Cost (TSLCC) analysis. The model provides extensive capabilities for simulating the response of the waste management system under a variety of configurations and operational philosophies. It was developed to provide detailed analyses beyond the capabilities of other available computer models.

The WASTES model uses detailed reactor-specific spent fuel discharge histories and projections as the basis for simulating the operation of various facilities within the waste management system. WASTES provides the user with detailed time-dependent information consisting of system shipping and cask fleet requirements, facility spent fuel inventories and receipt characteristics, and overall transportation costs. This information is useful for analyzing the trade-offs associated with facility deployment, design variations, and/or various operating strategies.

1.1 DOCUMENT DESCRIPTION

Chapter 1.0, Introduction, presents a brief overview of the WASTES computer model and the ways in which the waste sources, processing/storage facilities, and transportation facilities are handled by the model. The transportation algorithms and computer requirements are also discussed.

In Chapter 2.0, Model Description, the following topics are discussed: 1) the ways in which the pools and out-of-pool storage locations at reactor sites are modeled; 2) the way in which the full-core-reserve (FCR) storage margin is maintained; 3) the use of the user-specified centroid regions and the way in which transshipments occur between pools; 4) the management of simulated time and file maintenance routines; and 5) the way in which the facilities in a waste management system are modeled and the purposes of each facility. Operation of the transportation algorithms, the algorithms used for developing transportation cost estimates, the levelized cask purchasing philosophy, and the techniques used for establishing heat generation rates are other topics presented in Chapter 2.0.

Chapter 3.0, Input Data Set Descriptions, reviews the input required to run WASTES. WASTES input statements and the format of the two data files necessary to execute the model are also described.

In Chapter 4.0, Output Description, a summary of the reports generated by WASTES is presented. WASTES generates reports on facility inventories, facility receipts characterized by incoming heat rate and transportation, and transportation system characteristics and costs.

Chapter 5.0, Sample Input Card Files, contains sample input decks. Several waste management scenarios, a description of the input cards required to specify the scenario, and a discussion of the action initiated by the various input cards are presented.

Chapter 6.0, Sample Problems, contains two sample problems and a discussion of the results obtained, as well as listings of input and output data set descriptions.

The references that are cited in this report are listed in Chapter 7.0.

In addition to the main report, six appendixes provide supplemental information on the WASTES code. These are, by title: (A) Input Card Descriptions, (B) WASTES Input Card Default Summary, (C) Sample Problems, (D) Transportation Costs for the USERCOST Option, (E) Spent Fuel Processing Alternatives, and (F) File Usage.

1.2 BASIC LOGISTICS LOGIC

The WASTES model simulates the flow of spent fuel through a user-defined system for nuclear waste transportation, storage, and disposal. Allowable non-reactor facility types for processing or disposing of spent fuel are: auxiliary plants, monitored retrievable storage (MRS), repositories, and federal interim storage (FIS). The number of facilities of each type, their locations and capacities, and priorities for spent fuel acceptance are all specified by the user. The facilities that can be modeled and the interfaces between these facilities are shown in Figure 1.1.

The system is initiated with historical and projected individual reactor discharges of spent fuel as described in the reactor discharge data file or with data supplied by the user. The reactor discharge file contains the dates (year/month) and quantities of spent fuel discharged. Flow of spent fuel in the model is controlled by a user-specified combination of source- and destination-driven transfers.

Source-driven transfers may occur when: 1) a reactor pool violates the FCR storage margin, 2) the reactor is decommissioned, or 3) list-driven shipping rights are input. When a source-driven spent fuel transfer has been identified, WASTES checks each destination facility until a facility is found that can accept material from the source. An ex-pool[(a)] storage capability is assumed to exist for each reactor pool. No limit is placed on ex-pool storage capacity. WASTES will always maintain the specified FCR margins in reactor pools.

Destination-driven transfers occur when the annual receiving capacity of a facility is greater than required by source-driven shipments. An attempt is made in each calendar year to schedule enough shipments of spent fuel from facilities or reactors with the highest priority eligible fuel to fill the annual receipt capacity of each destination facility.

1.3 WASTE GENERATION SOURCE MODELS

Spent fuel generation sources modeled by WASTES include both existing and planned reactors. Data that describes these sources is provided in two files. The first file contains site-descriptive information such as the accessibility to rail transportation, the location of the site, spent fuel pool capacity, the type of reactor, and the reactor's start-up and shutdown dates.

(a) A storage capacity required in excess of maximum pool capacity for intact spent fuel.

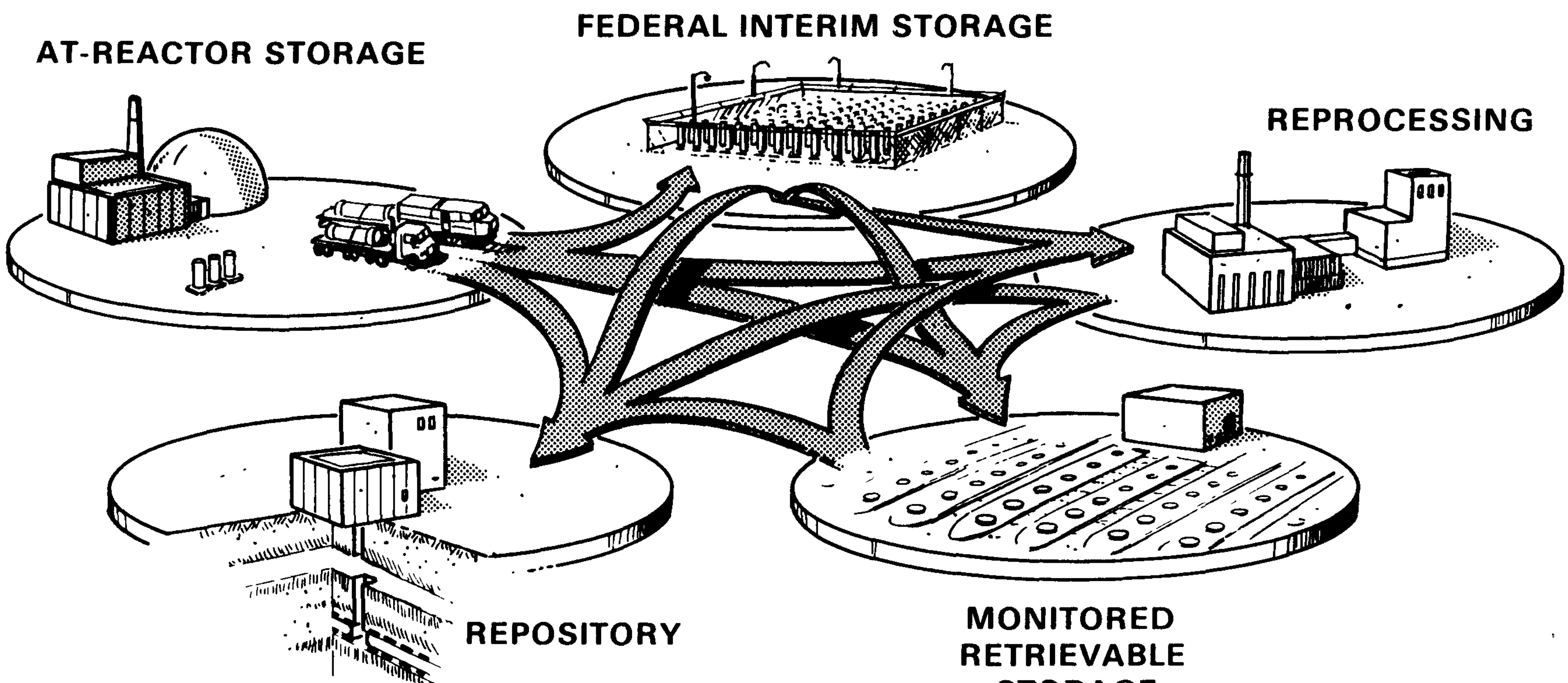


FIGURE 1.1. Interactions Among Facilities in the Spent Fuel Logistics System

The second file describes the historic and projected spent fuel discharges. It contains information on the date of discharge, fuel exposure, batch size in number of assemblies, and weight in metric tons uranium (MTU). This file defines the rate of arrival of waste into the simulation as the program executes. Examples of both types of data files are provided in Appendix C.

1.4 NON-REACTOR WASTE FACILITY MODELS

WASTES accepts input statements that describe each of the major non-reactor facilities to be included in the simulation. Any combination of four types of these facilities (auxiliary, MRS, repositories and FIS) are allowed in the simulation up to a maximum of 10 facilities. Each of the four types of facilities has different operating characteristics. Auxiliary plants are facilities that do not fit into the other three categories. The class of auxiliary plants may be configured to match the characteristics of MRSs or repositories. An MRS facility can simultaneously receive waste for storage and ship waste from storage to other facilities (typically repositories). A repository will normally only receive waste for permanent disposal. Operation of FIS facilities are limited in duration by law; therefore, FIS facilities are given priority in unloading to an MRS facility or repository.

The user specifies an operations schedule for each facility that determines its maximum storage capacity, its annual receiving rate, its maximum annual shipping rate, its annual "sprint"[a] capabilities, and any changes of the age acceptance criteria. The user also enters the minimum amount of time that material must remain at the facility and the minimum time since discharge for acceptance at each facility.

1.5 TRANSPORTATION MODEL

WASTES incorporates logic for handling both truck and rail transportation between reactor and facility sites and allows user specification to

(a) The sprint rate is defined as receipt capacity in excess of the nominal receipt rate that can be used to accept forced transfers from reactor pools (when FCR storage is exceeded) or shipments from decommissioned reactors.

disable either mode in order to perform alternative analysis of the transportation costs. By default, the model will preferentially ship by rail if both sites have rail access.

The model calculates total transportation costs incurred for shipping material by either truck or rail transportation modes. Shipment quantities occur in full cask loads except for the last shipment from each reactor. Up to a total of ten different casks may be specified. At least one truck and one rail cask must be defined. Each cask is defined by: cask name, cask type (truck or rail), empty weight, the number of usable days per year, the turnaround time for loading or unloading (not the sum), the usable cask life in years, the daily rental rate for the cask, the capital cost, the annual operating and maintenance cost, and the number of PWR and BWR assemblies that the cask can accommodate.

1.6 BASIC LOGISTICS SCHEME

Within the WASTES model, spent fuel is selected based on age and/or heat generation rate of the spent fuel. Material will only be shipped if it meets the user-supplied minimum age, maximum heat, or minimum residence time for that facility.

The availability of destination facilities is determined by their unfilled receiving capacity in a given year, whether or not a transportation cask can be used by both the source and destination, and whether or not any spent fuel meets the minimum age/maximum heat acceptance criteria for that facility.

The WASTES model contains two logistics algorithms as user-specifiable options for assigning source/destination pairs: the optimal algorithm and the proximal algorithm. The optimal routing allows a true minimization of shipping distance or shipping cost (user option) to be performed, while proximal routing performs a sub-optimal minimization. Each type of facility may be specified to be filled in a different manner. Descriptions of these algorithms are given in Section 2.4.2.

1.7 COMPUTER REQUIREMENTS

Because of the large amount of memory required, the WASTES model requires a computer that allows virtual memory for most simulations. The actual size of core required varies widely and is dependent upon the synergistic effects of the exact situation being simulated. To date, all work on WASTES has been done on DEC VAX-11/780s and a DEC MicroVAX II (virtual machines) operating under VMS (virtual memory system).

The CPU time requirements for executing WASTES will vary widely with the number of reactors and discharges, the simulation desired (number of facilities, transportation algorithm, etc.), the computer, operating system, and system resources used. Representative run times on a MicroVAX II for a multiple facility optimization range from 20 CPU minutes to 18 CPU hours, depending upon the options selected by the analyst.

2.0 MODEL DESCRIPTION

WASTES is a discrete-event simulation model. A discrete-event simulation model advances simulated time from one event to the next as the system status changes.

A general flow diagram of the execution of WASTES is shown in Figure 2.1. WASTES begins by processing the input data, then the simulation to be run is initiated. An annual sequence of activities then begins that continues until the last year of the simulation. Finally, output reports are prepared.

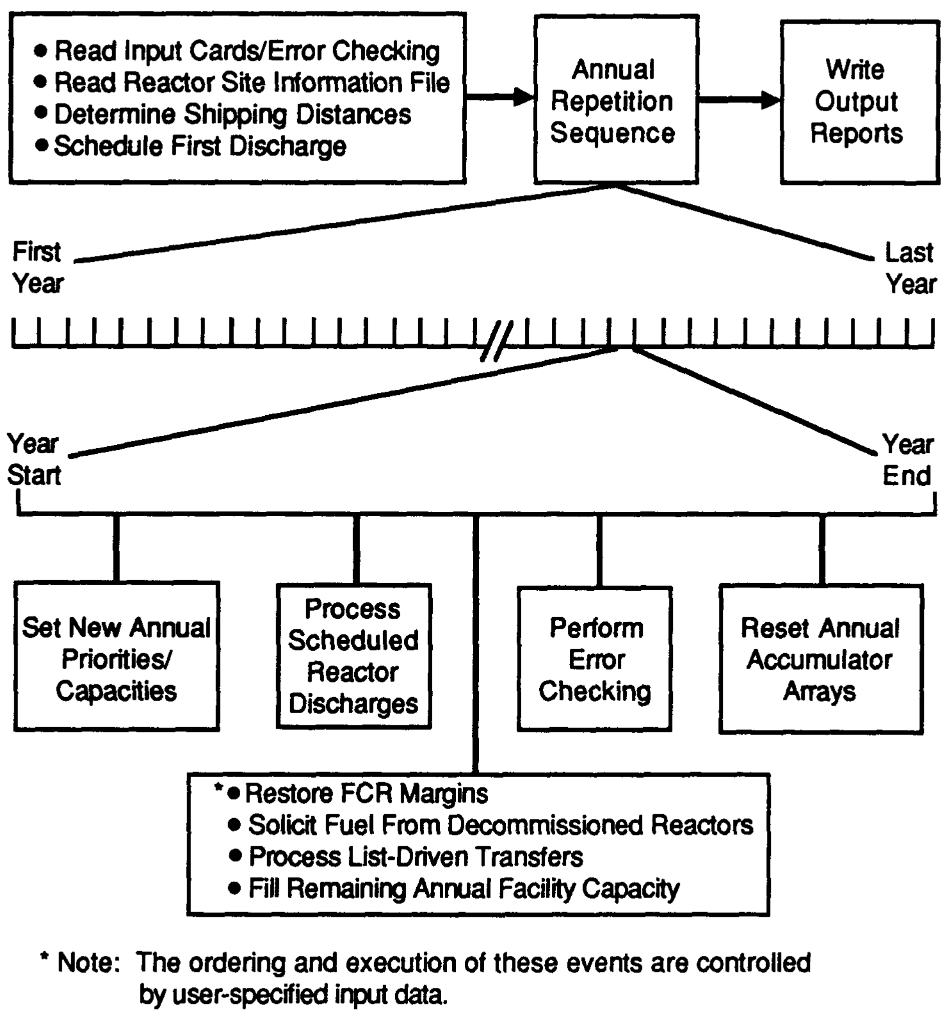


FIGURE 2.1. General Sequence of Events as WASTES Executes

Within each simulation year, five types of processes occur. First, the simulation parameters, such as priorities and capacities, are adjusted if necessary. Second, the discharges of spent fuel scheduled for that year in the data base are placed into the appropriate reactor pools. Third, the processes that move fuel from the facilities and reactor sites are called. Fourth, error-checking routines are called to determine if shipments from reactor pools and ex-pool (at-reactor, out-of-pool) storage sites were in integer cask quantities. Fifth, the accumulator arrays are reset for the following simulation year.

Discharge of spent fuel into reactor pools is modeled as a discrete event. This discharge event is driven by the dates specified in the discharge data file and occurs during the specified month.

Movement of spent fuel from reactors and facilities is handled by four types of logic: 1) restoration of full-core-reserve (FCR) margins in reactor pools, 2) unloading of reactors in the process of decommissioning, 3) shipments from reactors specified in a shipping list, and 4) facilities (excluding FISs) soliciting fuel to fill any remaining annual receipt capacity. Additional information on the way WASTES processes fuel transfers is contained in Appendix E.

The default annual sequence of fuel transfer processes, if no list-driven transfers are specified, is as follows. If, as a result of a discharge, the FCR storage margin of a pool is violated, the reactor ships to a facility or moves to ex-pool storage a sufficient amount of fuel to maintain the FCR margin. WASTES will then attempt to ship fuel from any decommissioned reactors that are past the user-defined date for decommissioning priority. Then the heat content is updated for all fuel batches. Following that step, destination facilities will attempt to solicit enough acceptable fuel to fill any unused annual receipt capacity the facility may have.

The default configuration, if list-driven shipping is specified, is as follows. The heat content of all fuel batches is updated. Then the reactors that are authorized to ship, move fuel to the facilities until the facilities cannot accept any more fuel or all authorized shipping rights are used. List-driven transfers may be used in conjunction with non-list-driven transfers if specified by the user.

Fuel movement in WASTES is not resolved more finely than annually. Although the month of discharge is used to determine the priority of the waste for shipment, the month of shipment reported for fuel transfer in the shipping file is not meaningful.

The following subsections describe the reactor site facilities, the use of the simulation modules, the storage/processing facilities, the possible flows of spent fuel through the system, the possible methods of selecting source/destination pairs, the calculation of transportation costs, the calculation of levelized cask purchasing, and the way in which the spent fuel heat generation rate is calculated.

2.1 REACTOR SITE MODEL (POOLS AND EX-POOL STORAGE)

The reactor pools and ex-pool storage are modeled differently than the other facilities in the simulation because of their large number and their function as the sources of spent fuel coming into the simulation. Each reactor pool is modeled as a separate holding area. Up to 375 reactors may be modeled in each simulation. The data defining the characteristics of each reactor are read into the simulation from a data file that is described in Section 3.4.

The spent fuel data base may specify that up to three reactors share the same pool and ex-pool storage facilities. The share type indicates the number of reactors, and the number of reactors with pool capacities greater than zero indicates the number of pools in the share group. All pool capacity is available from the time the first reactor in the share group opens to the time that the last reactor in the share group closes and the pool(s) are decommissioned.

The FCR storage margin requirement is calculated as the maximum reracked capacity of the pool minus the number of assemblies in a full core multiplied by the user-specified FCR fraction. If a discharge will cause a pool to be filled to a point exceeding its FCR margin storage requirement, previously discharged batches are removed from the pool and transferred elsewhere. The pool's FCR storage margin is maintained by removing (by shipping to a facility, transshipping to another reactor pool, or transferring to ex-pool storage) previously discharged batches until the spent fuel inventory is reduced to or below the available pool capacity. Fuel selected for shipment is on an oldest (or coldest) basis for all movements except to ex-pool storage. The fuel that is just older than the minimum age specified in the AGETO or FCRAGE user input card for ex-pool storage is selected for movement to ex-pool storage; however, if no fuel is found that meets this requirement, the oldest fuel at the reactor pool is removed. Except for the last cask removed from a decommissioned reactor pool, full casks are always shipped to facilities or placed in ex-pool storage.

In order to minimize the cost of ex-pool storage, reactors that are in violation of FCR requirements are handled at one time after all discharges for the year have been processed. Fuel is accepted first from reactors without ex-pool storage, lowest-to-highest storage requirement, then from reactors that already have ex-pool storage yards, lowest-to-highest storage requirement. This first minimizes the number of new ex-pool storage sites and then the number of existing ex-pool storage sites receiving fuel.

When batches of spent fuel are removed from a pool, they are transferred to a storage facility, processing facility, or repository if any of the facilities have both unused receiving capacity and storage capacity for that year and if the reactor has fuel that is acceptable to the facility. The facilities are scanned in a sequence that may be user-specified. The default priorities treat auxiliary sites first, followed in order by repositories, MRS facilities, and FIS facilities. If allowed to default, multiple facilities of the same type will attempt to receive waste according to the proximal transportation algorithm.

If the FCR storage margin cannot be maintained by transferring spent fuel to any of the other facilities, the simulation will attempt to transship the discharge to another reactor pool, if transshipment is allowed. If transshipment is not allowed or if the transshipment is refused, the excess fuel is placed in ex-pool storage. Transshipment of spent fuel will only be refused if receipt of the transshipped fuel would violate the FCR margin of each possible receiving reactor. Ex-pool storage is assumed to be unlimited, so fuel can always be removed from pools when required.

Transshipment can be user-specified to occur 1) within a utility, 2) within a state, or 3) within a user-specified transshipment network (specified in the reactor site data file). If the reactor is placed in a transshipment network, it is allowed to transship to all other reactor pools in the same network. Transshipment is made to the pool within the transshipment network having the largest unused capacity.

WASTES also provides for a user-specified centroid region that allows waste sources to be clustered at a given point source (the centroid). In this way, the spent fuel generated within a geographic area can be identified. Up to 21 centroid regions may be specified. The centroid specification does not affect the simulation and is used only in reporting results.

Reactor pools, along with any associated ex-pool storage, are the only facilities that are considered to be decommissioned by WASTES. The shutdown date specified in the reactor site data file is used in conjunction with a user-supplied decommissioning lag time to determine when fuel from the decommissioned reactor is eligible for shipment.

2.2 SIMULATION STRUCTURE OF WASTES

WASTES uses general-purpose, discrete-event simulation routines to maintain a calendar (time clock) for all activities being simulated and to maintain ordered queues of spent fuel at each reactor and facility.

The simulated discharge of fuel by reactors is initiated when the simulated time reaches the discharge time specified on the batch data record. The discharge time is read from the reactor discharge data file. As each batch or sub-batch is discharged, a fuel batch information packet is created and placed in an internal file that represents the reactor pool used by the site. The information contained in each packet is described below.

Fuel Batch Information Packet

1. Time of reactor batch discharge (yr, mo).
2. ID of facility where currently stored.
3. Number of assemblies.
4. Average amount of uranium in each assembly (MTU/assembly).
5. Average discharge exposure (MWd/MTU).
6. Unique number to identify individual batches.
7. Current heat rate (kW/MTU).
8. Time of arrival at facility where the batch is currently stored.
9. ID of reactor from which last stored.
10. Waste type (PWR, BWR).
11. Package type of material.
12. Consolidation flag.
13. Fuel package type.
14. ID of reactor from which originally discharged.
15. Batch history code.
16. Original batch identification number.

Those elements that may change during the simulation are numbered 2, 3, 7, 8 and 15. Note that item number 3 may change if a batch is subdivided. When subdivision occurs, a new sub-batch is created and the size of the original batch is reduced. Subdivision is necessary if only part of a batch can be handled by a facility.

2.3 NON-REACTOR FACILITIES MODELED

There are four types of non-reactor facilities that can be included in a WASTES simulation: auxiliary plants, MRS facilities, repositories, and FIS facilities. Each of these facilities is viewed as a separate holding facility with its own unique characteristics.

The MRS facilities generally perform more functions than the other non-reactor facilities because they receive, store, and ship materials. Repositories are similar except that they generally do not ship material and may have different acceptance criteria. FIS facilities are also similar to MRS facilities but are much more constrained as to application and do not solicit material to satisfy an annual receipt rate.

The common features that must be defined for user-specified, non-reactor facilities include:

- total storage capacity (MTU)
- nominal annual receipt rate (MTU/yr)
- annual removal rate (MTU/yr)
- minimum age imposed on incoming spent fuel (yr)
- minimum facility residence time (yr)
- annual sprint rate (receipt capacity, which is in addition to the nominal loading rate and is used for FCR restoration and decommissioning reactors)
- facility prioritization (facilities or groups of facilities from which a particular facility will preferentially receive spent fuel).

Any of the features listed and defined above may be modified on an annual basis. Facilities are started up by specifying non-zero annual receipt rates and total storage capacities for the first year of operation. A facility shutdown may be achieved by specifying zero annual acceptance and removal rates. Alternatively, a facility may be shut down by achieving its maximum total storage capacity (a repository) or by unloading all of its total storage capacity (reactor storage, FIS facility, MRS facility, auxiliary plant) during the simulation.

The logic employed by the model to simulate the operation of the non-reactor facilities is different from the logic used to simulate individual reactors. Non-reactor facilities are controlled by their respective annual receipt rates. In a given year, part or all of the annual receipt capacity may be filled by source-driven shipments. An attempt is made to fill the unused receipt capacity of each operating non-reactor facility by examining all other facilities, including reactor pools and ex-pool storage, to determine if they contain any spent fuel that qualifies for transfer. These qualifications include minimum age for acceptance at the soliciting facility, the identification of a shipping cask type acceptable to both the source and destination, and a minimum residence time requirement at the originating site. The acceptance rates for the soliciting facilities are filled in the order determined by priorities that may be user-specified. If default priorities are used, auxiliary sites have the highest priority, followed in order by repositories, MRS facilities, and FIS facilities. If allowed to default, multiple facilities of the same type will attempt to fill according to the proximal algorithm.

Repositories represent the end point for disposal of waste in the system. They can accept fuel from any of the other types of facilities, but normally will not ship fuel to any other facility (although user options permit such shipments to be simulated).

MRS facilities can accept fuel from any of the other types of facilities, including repositories if necessary. Material stored in the MRS can be shipped to repositories or auxiliary facilities.

FIS facilities are similar to MRS facilities in that they receive, store, and ship spent fuel. However, FIS facilities are temporary sites provided by the federal government and are limited to receiving fuel only from individual reactor pools having FCR storage margin shortfalls. They do not solicit spent fuel as do the other storage/processing facilities but may ship fuel to all the other facilities. Generally, FIS facilities have the highest priority for off-loading to other facility types.

Auxiliary plants are currently modeled as generic storage facilities. They can accept fuel from individual reactor sites, FIS facilities, and MRS facilities. Auxiliary plants can ship fuel to MRS facilities, FIS facilities, and repositories.

2.4 SPENT FUEL FLOW

In this section, the possible flows of waste through the system and the methods by which source/destination pairs can be selected are discussed.

2.4.1 Overview

Figure 1.1 gives an overall view of the possible flows of spent fuel through the system.

For a spent fuel shipment to occur, a shipping cask link must exist between the source and the destination. The use of a specific cask type may be constrained by either the shipping facilities' limitations or the receiving facilities' limitations. A total of 10 cask types may be described in each simulation. By default, all reactors with rail access are assigned an R1 cask, which is designated to be both a shipping and receiving cask. All reactors are assumed to be able to handle a T1 truck cask.

Shipment quantities are calculated as multiples of the appropriate shipping cask capacity. Thus, slightly more than the minimum required number of assemblies may be shipped to fill the last required cask.

Source-driven transfers will occur when a reactor would violate its FCR storage margin, when a reactor has been given decommissioning priority, or when reactors are given list-driven shipping rights.

For FCR restoration, the model will first attempt to ship such discharges to one of the user-defined facilities. If no facility can accept the shipment, the model will then attempt to transship the discharge to another reactor pool if transshipment is allowed. If transshipment is not allowed, the spent fuel will be placed into ex-pool storage at the reactor site, except in the case of reactors being decommissioned where the fuel will remain in the pool.

If default priorities are used, the model attempts to place the spent fuel in the auxiliary facilities first, then the repositories, then the MRS facilities, and finally in the FIS facilities. If more than one facility of the same type exists, the default priority is to fill the facilities of that type according to the proximal algorithm. Fuel selection occurs on an oldest-first basis subject to various user constraints (e.g., cask links, residence time at previous facility, age of fuel, etc.)

Destination-driven transfers occur when the annual capacity of a facility will not be met by FCR or by source-driven shipments. An attempt is made in each calendar year to schedule enough shipments of spent fuel from facilities with non-critical storage capacity to fill the annual receipt rate of each destination facility.

2.4.2 Source/Destination Pair Assignments

Two shipping algorithms are available for selecting source/destination pairs, optimal and proximal. Each type of facility may be specified to be filled in a different manner. Within each year the optimal routing algorithm allows a true minimization of shipping distance or of shipping costs to be performed, while proximal routing performs a sub-optimal minimization. Descriptions of these algorithms follow.

1. Optimal Algorithm: In general, for multiple facilities, it is necessary to solve a set of simultaneous equations to minimize the transportation costs or total number of miles over which spent fuel is transported. If exactly two facilities of the same type can receive the same fuel shipments, the distance or costs can be minimized by preferentially sending a shipment to the destination that would yield the greatest savings (or least cost) in relation to all other shipments made that year to these destinations. This technique is used by WASTES to optimize the allocation of shipments to minimize transportation cost or distance. Thus with WASTES, optimization can only take place for two facilities. The optimizing algorithm examines all spent fuel to be shipped to the specified facility type within a calendar year and creates a list of shipments ordered on the difference in distances or the difference in costs to the two facilities from the source facility. This list is periodically scanned and fuel transfers are allocated so that the first facility's receipt rate is met with fuel from source/destination pairs so that the total shipping miles or shipping cost is minimized for each year. It should be noted that if insufficient fuel is available (in a given year) to meet the annual receipt rates of both facilities, the facility with the lowest user-specified facility ID number is filled first, possibly yielding non-optimal results.

2. Proximal Algorithm: The proximal algorithm does not result in the globally optimum routing of material. The algorithm determines the distances from the source to the possible destination facilities at the time each fuel transfer is to occur. The closest facility that has the capacity to accept the fuel is chosen and the final source/destination pair is determined immediately. No allowance is made for fuel that will require shipment later in the year. The proximity algorithm does not

reallocate earlier shipment assignments to minimize the impact of this situation.

2.4.3 Transportation Costing

The default transportation costs calculated in the WASTES model are the estimated costs that would be incurred for shipping spent fuel by either truck or rail modes of transport (for non-default costing refer to the USERCOST option in Appendix D). The costs for safeguards and security charges are also estimated. In addition, the estimated cask transport time for each shipment is calculated.

The equations utilized in calculating these costs were derived from curve-fitting techniques using data from research conducted at PNL. The equations are expressed as a function of the distance traveled and the weight for each shipment. Separate equations are used for both truck and rail shipments. The equations include an estimate of the safeguards and security charges that would be incurred for each shipment. The equations used are contained in the WASTES Technical Reference Manual (Sovers et al. 1988).

The number of cask-days utilized for a shipment is a function of the transit speed and the cask turnaround time. Again, data from PNL research were used.

WASTES contains a table look-up routine for reading a user-supplied table of shipping distances from reactor sites to facilities and from facility to facility. Facility locations in the look-up table are specified by their latitude and longitude. For each facility specified in the input stream, WASTES will attempt to find a matching latitude/longitude (in degrees) in the look-up table. If no distance is found, WASTES will use a great-circle algorithm and a multiplier to estimate actual transportation distances. Separate multipliers are used for truck and rail distances. These multipliers were derived by comparing actual miles with the great-circle distance between the sites. WASTES lists the transportation distances used and the source of the distances (look-up table or calculated). If the distance between the source and destination is less than 10 miles, a message is written to the output file and the distance is reset to 10 miles.

Total shipping costs are reported on Table 9 of the WASTES output according to the following four costing scenarios: minimum lease, required lease, maximum purchase, and levelized purchase.

The minimum-lease option assumes that shipping casks can be leased for the exact number of cask-days required. The required-lease option assumes that each cask that is required must be leased for the entire year.

The maximum-purchase option assumes that casks are purchased whenever needed. In times of decreasing facility acceptance of fuel, use of this method will result in under-utilization of the available casks.

The levelized-cask algorithm does not affect the WASTES simulation but is useful in estimating minimum cask purchases. The levelized-cask purchasing algorithm acts as a levelizer by moving cask requirements from years having peak requirements to prior years having lower requirements. The annual cask requirements that were previously calculated are compared to the total number of casks available. If the required number of casks exceeds the number of casks available, additional casks are purchased in that year. If the required number of casks is less than the number of casks available, the excess cask capacity is used to pre-ship fuel to offset new cask purchases in the next year. The algorithm allows up to 10 percent of the combined annual receipt rate of the non-reactor facilities in the next year to be pre-shipped to offset new cask purchases. Both cask purchase options calculate cask retirement and replacement.

2.4.4 Multi-Cask Rail Shipment Modeling

WASTES provides the ability for users to simulate multi-cask rail shipments from MRS facilities to downstream facilities (e.g., repositories). The facility(ies) receiving the multi-cask shipments cannot be specified to be filled according to the optimized shipping algorithm. The rail shipping casks used on the train must be compatible with the MRS facility and the destination facility. This compatibility is accomplished by designating the cask to be used as a shipping cask for the MRS facility and as a receiving cask for the destination facility and by not assigning the cask to any other facilities or reactors. Shipping costs are calculated the same as for single cask shipments. Security and support costs are the same for the entire train as for a single shipping cask. The user may elect to apply a dollar-per-mile surcharge and/ or a speed multiplier to single- and unit-train shipments. The user must also supply a train turnaround time.

2.5 HEAT-RATE CALCULATIONS

Heat-rate characterizations of receipts, shipments, and inventories are generated by WASTES, so it is necessary to keep the current heat rate as part of the information on each fuel batch. Heat rate is calculated for each fuel batch as it is moved to the next facility for storage. If the user requests fuel characterization, heat rates of fuel in facility inventories are recalculated annually. The heat rate is dependent upon the age, exposure and waste type of the fuel batch.

WASTES uses a second-order interpolation/extrapolation of tabular data for the heat rate calculations during the simulation. The data values were generated by runs of the ORIGEN-2 code (Croff 1980) for PWR and BWR reactors for exposures of 10,000, 20,000, 30,000, 40,000, and 50,000 MWd/MTU for decay times up to 50 years after discharge (Libby and Holter 1984). For decay times less than 1 year or for exposures less than 10,000 MWd/MTU, the closest border value is returned. For exposures or decay times outside the range covered by the tabular data, the heat value is extrapolated.

3.0 INPUT DATA SET DESCRIPTIONS

This chapter contains an abbreviated description of the input cards for WASTES and the reactor site and discharge data files. A more detailed description of the input options and their syntax is presented in Appendix A.

3.1 SIMULATION CONTROL INPUT STATEMENTS

To execute WASTES, two simulation control cards must be included in the run stream. An abbreviated description of each of the cards follows.

GEN	The GEN card provides general information to identify the simulation and is used in titling the output.
INITIALIZE	The INITIALIZE card is used to specify start and end dates of the simulation.

3.2 MODEL DESCRIPTION INPUT STATEMENTS

The input processor is designed to allow the user to input directives into the model in any order desired after the INITIALIZE card of the simulation input stream. The input is organized as a set of cards (lines) identified by a unique key word.

Section A.2 of Appendix A provides complete descriptions, syntax, and the defaults for each of the input cards. An abbreviated description of each card follows.

AGEAT	The AGEAT card allows the user to specify the minimum number of years the spent fuel must remain at a facility before it can be moved to another facility.
AGETO	The AGETO card allows the user to specify the minimum age for spent fuel accepted at a facility.
ALTPRI	The ALTPRI card allows the user to alter the spent fuel source facilities for destination-driven transfers.
CAPACITY	The CAPACITY card allows the user to specify annual receiving rate, shipping rate, maximum capacity, and age acceptance criteria.

CASK	The CASK card describes the attributes associated with each type of shipping cask.
CHARACTERIZE	The CHARACTERIZE card allows the user to obtain detailed characterizations of fuel inventories and shipments. Use of this feature will result in significantly increased run times.
DATAFILE	The DATAFILE card provides the location of the data files.
DECOM	The DECOM card allows the user to specify the lag time between reactor shutdown and the beginning of fuel shipping priority for reactors being decommissioned.
DECOMAGE	The DECOMAGE card allows the user to specify how old the spent fuel from reactors being decommissioned must be to be acceptable at a facility. If present, this card overrides the action of the AGETO card.
DECOMHEAT	The DECOMHEAT card allows the user to specify how cold the spent fuel from reactors being decommissioned must be to be acceptable at a facility. If present, this card overrides the action of the HEATTO card.
DISCOUNT	The DISCOUNT card is used to specify the base year and discount rate for cost discounting (optional).
DRYTYPE	The DRYTYPE card allows the user to specify the type of ex-pool storage container and the number of PWR and BWR assemblies it can contain.
EXECUTE	The EXECUTE card allows the user to prohibit the attempted execution of code. This option is useful to allow WASTES to perform error checking on the input card file without beginning execution.
FACSPEC	The FACSPEC card is used to describe the locations, titles and cask usage of the various destination facilities in the system.
FCRAGE	The FCRAGE card is used to specify the minimum age for spent fuel from forced discharges to be acceptable at a facility.

FCRFRAC	The FCRFRAC card specifies the fraction of a full-core reserve to be maintained.
FCRHEAT	The FCRHEAT card is used to specify the maximum heat generation rate for spent fuel from forced discharges to be acceptable at a facility.
FILLORDER	The FILLORDER card allows the user to specify the order in which the types of facilities will be filled.
FUELSTOP	The FUELSTOP card limits the time duration or quantity of spent fuel discharged from reactors. Additional discharges in the DISDAT file are ignored.
HEATSORT	The HEATSORT card is used to specify that spent fuel is sorted and selected by the current heat generation rate (kW/MTU) of a batch instead of age (age selection is default).
HEATTO	The HEATTO card is used to specify the maximum heat generation rate for spent fuel to be accepted at a facility.
MSHIP	The MSHIP card is used to specify multi-cask rail shipments from an MRS facility to downstream facilities.
NOTRXIDS	The NOTRXIDS card is used to eliminate reactors from the analysis.
PREVENT	The PREVENT card is used to eliminate age and heat checking on source-driven transfers.
PRIOR	The PRIOR card is used to prioritize source locations for destination-driven transfers.
PRINT	The PRINT card is used to generate a subset of the .PRT file (FORTRAN unit 6) in order to reduce printing volume.
PROCESS	The PROCESS card prioritizes fuel movement selection alternatives.
REACTORS	The REACTORS card specifies which reactors will be considered in the analysis.
REPORT	The REPORT card specifies the types of transfers to be reported in the shipping file.

RIGHTSAGE	The RIGHTSAGE card specifies the minimum spent fuel age for list-driven transfers.
RIGHTSHEAT	The RIGHTSHEAT card specifies the maximum heat generation rate for list-driven transfers.
RUNTYPE	The RUNTYPE card specifies whether destination selection for transfer is optimal or proximal.
SHIPLINK	The SHIPLINK card defines which casks are used for shipping between the various sites.
SPEED	The SPEED card specifies a transportation speed multiplier to the truck and rail speeds.
TMODE	The TMODE card specifies transport mode for shipments from reactors.
TSHIP	The TSHIP card specifies the type of transshipment allowed and when it is to begin and end.
USERCOST	The USERCOST card specifies the use of a secondary set of costing algorithms that contains some parameters that are user definable.

3.3 REACTOR SITE DATA

The reactor site data file provides the site-specific data for each reactor in the spent fuel data base. It is read in fixed format. The file must be organized in order of ascending reactor identification (ID) number.

The parameters that are read from the file are: reactor ID number (INIS), reactor type (PWR, BWR), number of reactors sharing pool(s), shared reactor ID (lowest numbered reactor in share group), nominal pool capacity (assemblies), maximum pool capacity (assemblies), North American Electric Reliability Council (NERC) region, core size (assemblies), utility ID number, state in which reactor is located, start-up year and month, shutdown year, latitude, longitude, rail or truck access indicator, secondary transshipment network, centroid region, federal region, common reactor number for a dry storage site if a dry storage site is to be shared, reactor ID (PNL), reactor name, and default fuel specification type. For additional information on transshipment, sharing of reactor pools, and centroid regions, see Section 2.1.

Table 3.1 provides the format and descriptors for each of these parameters as used in the reactor site data file. Figure 3.1 shows the NERC regions and the region identifications (ID) as used in WASTES.

3.4 REACTOR DISCHARGE DATA

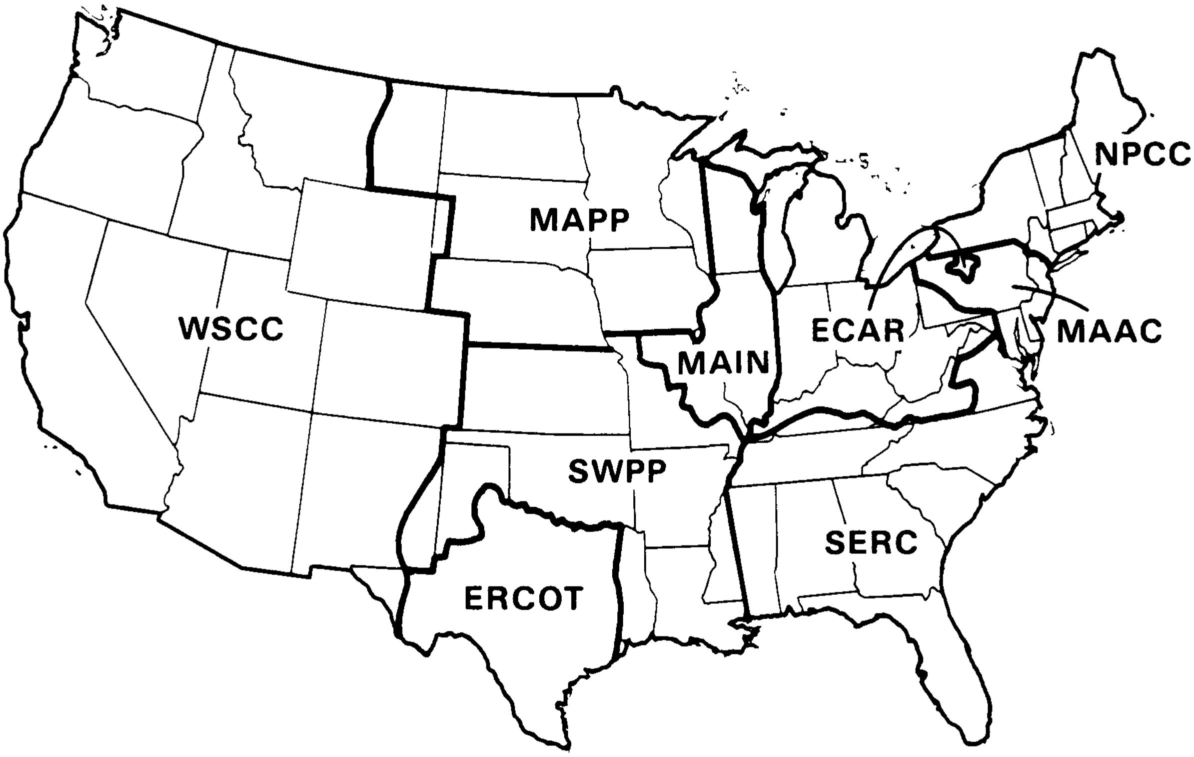
The reactor discharge data file provides the quantity and characteristics of each batch of spent fuel discharged in the simulation. It is read in fixed format. The file must be listed in ascending order of time of discharge (i.e., from first to last).

The parameters that are read from the file are: ID number of discharging reactor (INIS), the year and month of discharge, the number of assemblies discharged, the amount of material discharged (MTU), the historical/expected discharge exposure of the spent fuel in MWd/MTU, the initial enrichment (if known), batch ID number, reactor type (BWR/PWR), discharging/previous reactor, caretaker/multiburn flag, start-up year of the discharging reactor, date of shipment to caretaker site (if applicable), and fuel specification type.

Table 3.2 provides the format of each of the parameters read from the reactor discharge data file.

TABLE 3.1. Reactor Site Data File Description

Field	Format	Description
1	I4	Reactor identification number (INIS)
2	I2	Reactor type [1 = PWR; 2 = BWR]
3	I2	Number of reactors in share group
4	1X, I4	Common reactor identification number (INIS) for a pool site, if pools are shared
5	I5	Nominal pool capacity (assemblies)
6	I5	Maximum pool capacity (reracked) (assemblies) [Fields 5 and 6 are zero if this is not the first reactor of a common pool]
7	I2	North American Electric Reliability Council (NERC) Region
8	I4	Core size (FCR) (assemblies)
9	1X, I2	Utility identification number
10	1X, A2	State in which reactor is located
11	I5	Year of reactor start-up
12	I3	Month of reactor start-up
13	I5	Year of reactor shutdown
14	F7.2	Latitude (degrees, minutes)
15	F7.2	Longitude (degrees, minutes)
16	I2	Rail access indicator [0 = truck, 1 = rail]
17	I5	User-defined transshipment network; reactors with the same number are in the same transshipment network
18	I3	Centroid region user-specified; see Section 2.1 for more information
19	I3	Federal region
20	1X, I4	Common reactor identification number (INIS) for a dry storage site, if a dry storage facility is shared
21	I4	Reactor identification (PNL number)
22	1X, A20	Reactor name
23	A8	Default fuel specification type



1	ECAR	-	EAST CENTRAL AREA RELIABILITY COORDINATION AGREEMENT
2	MAIN	-	MID-AMERICAN INTERPOOL NETWORK
3	MAAC	-	MID-ATLANTIC AREA COUNCIL
4	MAPP	-	MID-CONTINENT AREA POWER POOL
5	NPCC	-	NORTHEAST POWER COORDINATING COUNCIL
6	SERC	-	SOUTHEASTERN ELECTRIC RELIABILITY COUNCIL
7	SWPP	-	SOUTHWEST POWER POOL
8	ERCOT	-	ELECTRIC RELIABILITY COUNCIL OF TEXAS
9	WSCC	-	WESTERN SYSTEMS COORDINATING COUNCIL

FIGURE 3.1. North American Electric Reliability Council Regions with Region IDs as Used in WASTES

TABLE 3.2. Reactor Discharge Data File Description

Field	Format	Description
1	I4	Identification number of originating reactor (INIS)
2	I5	Year of discharge
3	1X, I2	Month of discharge
4	I4	Number of assemblies discharged in batch
5	F7.2	Amount of material in MTU
6	I6	Average exposure of the material, expressed as MWd/MTU
7	F6.3	Initial enrichment, if known
8	1X, A6	Batch ID, utility assigned, if known (not unique)
9	1X, A3	Reactor type, BWR/PWR
10	1X, I4	Discharging reactor, if caretaker; previous reactor, if multiburn (INIS)
11	1X, A1	Caretaker/multiburn flag [C = caretaker, M = multiburn]
12	1X, I4	Start-up year of discharging reactor
13	1X, A6	Date of shipment to caretaker site, if applicable
14	1X, A8	Fuel type (WE17, etc.)

3.5 LIST-DRIVEN SHIPPING DATA

The list-driven shipping data file specifies the amount of fuel to be shipped and year for each reactor. This file is optional. The name and location of this file are specified using the DATAFILE card in the user input deck. It is read in fixed format and is in ascending order by year. Table 3.3 provides the format and description for each of the parameters. WASTES writes a file of this type to FORTRAN unit 93 that may be used in subsequent runs.

TABLE 3.3. Reactor Shipping Rights Authorization Description

Field	Format	Description
1	1X, I4	Year in which authorization starts
2	1X, I4	Reactor identification (INIS)
3	1X, F10.2	Amount of fuel authorized for shipment (MTU)

4.0 OUTPUT DESCRIPTIONS

WASTES generates detailed reports of annual facility inventories; the facility receipts characterized by incoming heat rate, age, and transportation; and the transportation system characteristics and costs.

Prior to producing these reports, WASTES echoes the WASTES input card descriptions. Immediately after each set of input card descriptions, any errors that were detected are flagged with an informational error message. Following this are a variety of statements specifying options in effect for the given run and summary tables of the various inputs. If any errors are detected in the input deck, the run is terminated.

WASTES will print informational messages as the simulation progresses under the banner INTERMEDIATE RESULTS. At a minimum, these results will consist of one printed line per year detailing the number of pools with ex-pool storage. Warning and notification messages from internal WASTES checks will also be printed in this section of the output. The reports described in the following sections of this chapter are generated by WASTES upon completion of the simulation. The reports are generated as tables that are numbered 1 through 11 as described below. These tables are contained in the main output file (FORTRAN unit 6), which usually is given the extension ".PRT".

4.1 INVENTORY AND SHIPPING SUMMARIES

The Table 1 series provides the annual inventory (assemblies and MTU) at reactor pools, ex-pool storage, and at each waste management facility. Table 1 also shows the sum of all of these inventories that provides an annual total of the amount of fuel discharged up to that point. The Table 2 series contains a summary table for each facility that shows the amount of fuel shipped from each facility.

4.2 FACILITY RECEIPT CHARACTERIZATIONS

In the Table 3 series, annual receipts of spent fuel for every facility are characterized by heat generation rate and by mode of transportation.

The amount of spent fuel arriving at each facility is categorized into seven discrete fuel age and seven discrete estimated heat generation rate intervals. The seven age categories are: 0-5, 5-8, 8-10, 10-12, 12-15, 15-20 and >20 years. The heat generation rate intervals begin at less than 0.5 kW/MTU and increase to greater than 2.5 kW/MTU in intervals of 0.5 kW/MTU. Additionally, the minimum, average and maximum values are reported annually for both fuel age and heat generation rate. The average fuel exposure (burnup) in each year is also reported.

The Table 4 series summarizes annual number of shipments and amounts of spent fuel received at each facility. This information is subdivided into the number of shipments carrying PWR and BWR fuel by transportation type (Truck-PWR, Truck-BWR, Rail-PWR, Rail-BWR). Lifetime totals are also reported.

4.3 TRANSPORTATION SYSTEM CHARACTERIZATIONS

The Table 5 series reports, by facility, the total annual cost of shipping spent fuel to that facility and cask requirements (number of casks and cask busy days) for each transportation mode (truck and rail).

The Table 6 series summarizes the facility-to-facility lifetime average shipping costs on a unit cost basis ($/kg). Tables in the 7 and 8 series, respectively, provide information on the maximum- and levelized-fleet purchase requirements. In the 7 and 8 series, the number of shipments by cask type; the number of miles by cask type; and the number of casks available, purchased, and retired each year are identified. Additionally, estimates of the costs associated with purchasing and maintaining this fleet are provided.

The Table 9 series provides lifetime transportation costs broken down into the categories of shipping, security/surcharge, lease, purchase, and maintenance costs for four shipping scenarios. The shipping scenarios are: minimum lease, required lease, maximum purchase and levelized purchase. The costing methodology represented by these shipping scenarios was discussed previously in Section 2.4.3.

The Table 10 series characterizes shipments in user-specified aggregates (centroids). Table 10.01 provides details on the number of cask shipments by centroid, while Table 10.02 provides information on the average age and exposure of spent fuel as it is shipped from each centroid.

4.4 EX-POOL STORAGE COST REPORTS

The costs associated with ex-pool storage are reported in the Table 11 series. These costs are calculated in accordance with the methods described by Merrill and Fletcher (1983). Table 11.01 is a summary table reporting annual capital, operating and maintenance, and decommissioning costs for all ex-pool storage sites. Table 11.02 gives the number of active ex-pool storage yards and the active number of PWR and BWR ex-pool storage casks.

4.5 OTHER OUTPUT FILES

There are three output files written by WASTES that are particularly noteworthy. The first of these files provides a detailed summary of ex-pool storage requirements; the second provides a computer-usable summary of the information contained in the printed output file; and the third provides a list of fuel movements between facilities. The second file also contains the output generated when the Characterize option is used.

The ex-pool storage summary file is written to FORTRAN unit 80. For every year in which ex-pool storage occurred, the following information is written for each reactor site having ex-pool storage capability: the reactor ID, the amount (MTU) of spent fuel in ex-pool storage, the number of assemblies in ex-pool storage, the available pool capacity for the reactor, and the latitude and longitude of the reactor. The lifetime total number of assemblies and MTU for all reactors is then reported. The costs reported in this file are valid only if each reactor is considered to have an independent storage facility. A second ex-pool storage summary file is written to FORTRAN unit 75 that aggregates costs based on ex-pool site.

The condensed version of the .PRT file (FORTRAN unit 6) is intended for use by post-processors and is written to FORTRAN unit 1. Some preliminary information on the cask capacities, cask and facility names is also included. Preceding each section is a banner line containing the major and minor table IDs, the number of lines following in the section, and the FORTRAN format for use in reading the table.

The third file is the shipment file and is written to FORTRAN unit 99. By default the shipment file contains information on shipments of fuel between facilities. Through use of the REPORTS card in the user input deck, information on core discharges and/or movement of fuel between pool and ex-pool storage can also be recorded. The format for the shipment file is contained in Table 4.1.

TABLE 4.1. Shipment Data File Description

Field	Format	Description
1	I2	Reason for shipment 1 = FCR restoration 2 = Decommissioning reactor 3 = Facility solicitation 4 = List-driven shipments 5 = Optimized shipment (type 1 - 4)
2	I5	Year shipment took place
3	I3	Month shipment took place
4	I5	Number of assemblies shipped
5	F8.4	Number of MTU shipped
6	1X, A2	Shipping cask identification (T# or R#)
7	F7.1	Site shipped from (negative number denotes ex-pool source)
8	F7.1	Site shipped to (negative number denotes ex-pool destination)
9	1X, A3	Fuel type (BWR or PWR)
10	I4	Utility identification number
11	1X, A8	Fuel specification code
12	1X, I4	Identification of reactor that last contained this batch
13	1X, F6.2	Number of days shipment took, including turnaround time at shipping site
14	1X, F5.2	Current heat content of batch
15	1X, I9	Discharge exposure of batch
16	1X, F8.2	Time that batch was originally discharged
17	1X, I8	Unique batch identification
18	1X, I8	Batch history code
19	1X, I8	Batch identification number of original batch (same as #17 if batch has not been split)
20	1X, I4	Original discharging reactor identification (INIS)

5.0 SAMPLE INPUT CARD FILES

This chapter is divided into two sections: 1) general examples that illustrate the use of WASTES input cards to model relatively simple straightforward systems, and 2) input card examples that illustrate uses of WASTES to simulate more complex systems. The latter section is for advanced users and generally requires a greater understanding of the code and its capabilities.

The examples depicted in this chapter approximate commercial waste management system parameters under contemplation at this time. The examples are shown solely to expose new users to the capabilities of the WASTES model and do not represent endorsement by PNL or DOE.

The examples are presented in the form of a problem statement, the input cards required to model the situation, and a discussion of the effects of the input cards.

The required simulation control input cards are the same for all of the following examples and are listed below.

```
GEN,ANALYST NAME,SIMULATION CARDS,11/01/85
INIT,1962,2020
```

The only changes the user would desire to make to the INIT card is the ending year of the simulation (2020 used). The initial year of the simulation _must_ be the year of the first discharge. That year is 1962 for all of the data files used by PNL.

5.1 GENERAL INPUT CARD EXAMPLES

Example 1

Problem Statement: Model a single repository opening in 1998 with a loading rate of 3000 MTU/year. Use current-technology truck and rail casks. Allow reactors being decommissioned to have priority over repository-solicited fuel two years after each individual reactor shuts down. Use the middle-case growth projections of the 1988 utility spent-fuel data base (Walling, Heeb, and Purcell 1988).

```
FACSPEC,3.1,36.50,116.27,REPOSITORY #1,R1,T1
CASK,T1,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R1,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
DATAFILE,DISDAT,DATA:MID86.DIS
DATAFILE,RXINFO,DATA:MID86.RXL
DECOM,2.0
CAPACITY,1998.,3.1,70000.,3000.,0,0
EXECUTE,YES
```

Discussion: The resulting fuel shipping priorities are 1) FCR, 2) reactors being decommissioned, and 3) facility-solicited fuel (default for source-driven transfers - may be overridden by PROCESS card). The oldest fuel will be selected in each case except for movement to ex-pool storage, which will move the youngest fuel in the pool. All fuel is eligible since there are no limitations on the age/heat content of the fuel or the residence time at a previous facility, and shipping cask compatibility exists between each reactor and the repository.

Example 2

Problem Statement: Begin accepting fuel at the repository according to a ramped buildup: 400 MTU in 1998, 900 MTU in 2001, 1800 MTU in 2002 and 3000 MTU in 2003. Allow spent fuel to be transshipped among reactors within utilities. Require that fuel remain in ex-pool storage for 1 year. Set an age acceptance limit of 10 years for all fuel except for fuel from reactors being decommissioned which may ship 5-year-old fuel.

```
FACSPEC,3.1,36.50,116.27,REPOSITORY #1,R1,T1
CASK,T1,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R1,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
DATAFILE,DISDAT,DATA:MID86.DIS
DATAFILE,RXINFO,DATA:MID86.RXL
DECOM,2.0
TSHIP,1,1962                    ; enable transshipment beginning 1962
AGEAT,0,0,0,0,0,1               ; set age for time of residence
AGETO,0,0,10,0,0,0              ; set min age for acceptance
DECOMAGE,0,0,5,0,0,0            ; set different acceptance age for decom rx
CAPACITY,1998.,3.1,70000.,400.,0,0
CAPACITY,2001.,3.1,70000.,900.,0,0       ; establish receipt rate ramp-up
CAPACITY,2002.,3.1,70000.,1800.,0,0
CAPACITY,2003.,3.1,70000.,3000.,0,0
EXECUTE,YES
```

Discussion: Fuel movements will occur according to the same priorities as in the preceding example. The repository will accept fuel at a slower rate. The age limitations will make some fuel unavailable for shipment. Allowing transshipment within utilities will significantly reduce at-reactor ex-pool storage requirements (approximately 1000 MTU).

Example 3

Problem Statement: Add a second repository that accepts spent fuel on the following ramped-up schedule: 1800 MTU in 2002 and 3000 MTU in 2003. Stop acceptance of fuel into the simulation after a total of 120,000 MTU has been accepted. Do not allow utilities to transship among reactors after the first repository opens. Determine reactor/repository shipping-pair assignments so that shipping distance is minimized.

```
FACSPEC,3.1,36.50,116.27,REPOSITORY #1,R1,T1
FACSPEC,3.2,40.10,79.54,REPOSITORY #2,R1,T1  ;   add a second repository
CASK,T1,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R1,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
DATAFILE,DISDAT,DATA:MID86.DIS
DATAFILE,RXINFO,DATA:MID86.RXL
DECOM,2.0
FUELSTOP,120000.               ; stop fuel acceptance after 120,000. MTU
TSHIP,1,1962
TSHIP,0,1998                   ; turn transshipment off
RUNTYPE,REPOS,OD               ; optimize distance in filling repositories
AGEAT,0,0,100,0,0,1
AGETO,0,0,10,0,0,0
DECOMAGE,0,0,5,0,0,0
CAPACITY,1998.,3.1,70000.,400.,0,0
CAPACITY,2001.,3.1,70000.,900.,0,0
CAPACITY,2002.,3.1,70000.,1800.,0,0
CAPACITY,2003.,3.1,70000.,3000.,0,0
CAPACITY,2002.,3.2,70000.,1800.,0,0    ; set acceptance rate for new
CAPACITY,2003.,3.2,70000.,3000.,0,0    ; repository
EXECUTE,YES
```

Discussion: The FUELSTOP card will stop the acceptance of new fuel into the system after 120,000 MTU has been received. By specifying a TSHIP type of 0, transshipment is turned off in 1998. With exactly two facilities of one type open for acceptance of fuel, filling can be accomplished in such a way as to minimize shipping distance (RUNTYPE card).

Example 4

Problem Statement: Same as problem three except force western reactors to ship to western repository.

```
FACSPEC,3.1,36.50,116.27,REPOSITORY #1,R1,T1,R2,T2 ; force west rx to w repos
FACSPEC,3.2,40.10,79.54,REPOSITORY #2,R1,T1
CASK,T1,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R1,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
CASK,T2,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2     ; define
CASK,R2,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14 ; special casks
DATAFILE,DISDAT,DATA:MID86.DIS
DATAFILE,RXINFO,DATA:MID86.RXL
DECOM,2.0
FUELSTOP,120000.
TSHIP,1,1962
TSHIP,0,1998
SHIPLINK,1962,R2,T2,301,302,303,3501,3502,3503,3801,4501,4701,4702; western
SHIPLINK,1962,R2,T2,4703,5301,5302,8001,8901,8902,8903,8904,9001; reactors
SHIPLINK,1962,R2,T2,9901,9902,9903,9904,9905,9906,9907,9908
RUNTYPE,REPOS,OD
AGEAT,0,0,100,0,0,1
AGETO,0,0,10,0,0,0
DECOMAGE,0,0,5,0,0,0
CAPACITY,1998.,3.1,70000.,400.,0,0
CAPACITY,2001.,3.1,70000.,900.,0,0
CAPACITY,2002.,3.1,70000.,1800.,0,0
CAPACITY,2003.,3.1,70000.,3000.,0,0
CAPACITY,2002.,3.2,70000.,1800.,0,0
CAPACITY,2003.,3.2,70000.,3000.,0,0
EXECUTE,YES
```

Discussion: By assigning R2 and T2 casks to western reactors, default reactor cask assignments do not occur. The only casks then available to the western reactors for shipping are the R2 and T2 casks. By assigning the R2 and T2 casks to the western repository, the only shipping cask link available to the western reactors is to the western repository. Note that the R2 and T2 casks are the same as the R1 and T1 casks except for the name. The cask requirements and levelized-cask purchases are based on each cask type (name) individually. In this simulation, the sum of the cask requirements for the two truck and two rail casks may be greater than the requirements for truck and rail casks in the previous run.

Example 5

Problem Statement: Add an MRS facility to the system. Establish cask compatibility links so that all eastern reactors ship to the MRS facility while all western reactors ship to the western repository. Allow the MRS facility to ship to either repository. Force the MRS facility to unload reactor ex-pool storage first. Begin accepting fuel at the MRS facility according to the following ramped buildup: 1998 - accept 1800 MTU, 1999 - accept 1800 MTU and unload 1800 MTU, 2000 - accept 3000 MTU and unload 3000 MTU.

```
FACSPEC,2.1,39.06,84.12,MRS #1,R1<,T1<,R3>       ; load MRS from rx
FACSPEC,3.1,36.50,116.27,REPOSITORY #1,R3,R2,T2 ; load from MRS + W rx
FACSPEC,3.2,40.10,79.54,REPOSITORY #2,R3         ; load only from MRS
CASK,T1,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R1,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
CASK,T2,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R2,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
CASK,R3,R,258000.0,300.0,1.25,15.0,1389.00,2.75E6,1.25E5,28,63 ;big MRS cask
DATAFILE,DISDAT,DATA:MID86.DIS
DATAFILE,RXINFO,DATA:MID86.RXL
DECOM,2.0
PRIOR,1962,2.0,6.0              ; force MRS to take ex-pool storage first
FUELSTOP,120000.
FILLORDER,REPRO,MRS,REPOS,FIS ; set filling order of facilities.
TSHIP,1,1962
TSHIP,0,1998
SHIPLINK,1962,R2,T2,301,302,303,3501,3502,3503,3801,4501,4701,4702; western
SHIPLINK,1962,R2,T2,4703,5301,5302,8001,8901,8902,8903,8904,9001; reactors
SHIPLINK,1962,R2,T2,9901,9902,9903,9904,9905,9906,9907,9908
RUNTYPE,REPOS,P             ; change repository routing to proximal
AGEAT,0,0,100,0,0,1
AGETO,0,0,10,0,0,0
DECOMAGE,0,0,5,0,0,0
CAPACITY,1998.,2.1,30000.,1800.,0,0      ; start up MRS
CAPACITY,1999.,2.1,30000.,1800.,1800.,0
CAPACITY,2000.,2.1,30000.,3000.,3000.,0
CAPACITY,1998.,3.1,70000.,400.,0,0
CAPACITY,2001.,3.1,70000.,900.,0,0
CAPACITY,2002.,3.1,70000.,1800.,0,0
CAPACITY,2003.,3.1,70000.,3000.,0,0
CAPACITY,2002.,3.2,70000.,1800.,0,0
CAPACITY,2003.,3.2,70000.,3000.,0,0
EXECUTE,YES
```

Discussion: This problem introduces the designation of loading and unloading casks. Cask usage at the MRS facility is defined so that the R1 and T1 casks can only be received at the MRS facility and the R3 cask can only be shipped from the MRS facility. The R3 cask used for shipments from the MRS facility is a special large-capacity cask. The PRIOR card forces the MRS facility to first solicit fuel from reactor ex-pool storage rather than simply taking the oldest fuel in the system. The FILLORDER card is necessary to override the default facility filling order for systems that model an integral MRS facility so that the MRS facility is filled before the repositories. This is required to avoid a 1-year lag in the filling of the repositories since they fill from the MRS. In that all shipments that can go to either repository originate from the same point (the MRS facility), the optimized run type is not meaningful and will increase execution time. The repository run type has then been specified as proximal, which will improve execution efficiency.

5.2 INPUT CARD EXAMPLES FOR THE ADVANCED USER

Example 6

Problem Statement: Modify the Example 5 waste management system so that the MRS facility and eastern repository compete for fuel from reactors on an optimized cost basis. Force the western repository to receive shipments only from western reactors and the MRS facility.

```
FACSPEC,2.1,39.06,84.12,MRS #1,R1<,T1<,R3>
FACSPEC,3.1,36.50,116.27,REPOSITORY #1,R3,R2,T2  ; load from w rx and MRS
FACSPEC,2.2,40.10,79.54,REPOSITORY #2,R1<,T1<    ; load only from Reactors
CASK,T1,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R1,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
CASK,T2,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R2,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
CASK,R3,R,258000.0,300.0,1.25,15.0,1389.00,2.75E6,1.25E5,28,63
DATAFILE,DISDAT,DATA:MID86.DIS
DATAFILE,RXINFO,DATA:MID86.RXL
DECOM,2.0
PRIOR,2.0,6.0
FUELSTOP,120000.
FILLORDER,REPRO,MRS,REPOS,FIS
TSHIP,1,1962
TSHIP,0,1998
SHIPLINK,1962,R2,T2,301,302,303,3501,3502,3503,3801,4501,4701,4702; western
SHIPLINK,1962,R2,T2,4703,5301,5302,8001,8901,8902,8903,8904,9001; reactors
SHIPLINK,1962,R2,T2,9901,9902,9903,9904,9905,9906,9907,9908
RUNTYPE,MRS,OC     ; fill MRSs according to optimized cost algorithm
AGEAT,0,0,100,0,0,1
AGETO,0,0,10,0,0,0
DECOMAGE,0,0,5,0,0,0
CAPACITY,1998.,2.1,30000.,1800.,0,0
CAPACITY,1999.,2.1,30000.,1800.,1800.,0
CAPACITY,2000.,2.1,30000.,3000.,3000.,0
CAPACITY,1998.,3.1,70000.,400.,0,0
CAPACITY,2001.,3.1,70000.,900.,0,0
CAPACITY,2002.,3.1,70000.,1800.,0,0
CAPACITY,2003.,3.1,70000.,3000.,0,0
CAPACITY,2002.,2.2,70000.,1800.,0,0
CAPACITY,2003.,2.2,70000.,3000.,0,0
EXECUTE,YES
```

Discussion: WASTES does not allow for two facilities of different types to be optimized. The input cards shown above trick the code by modeling the second repository as an MRS facility. WASTES keys off of the facility ID to determine what type of facility is being specified. The title is used only in generating the output reports. Since the second repository (modeled as MRS 2.2) has only loading casks and no unloading capacity, it cannot ship spent fuel.

Example 7

Problem Description: In 1998, open a repository that accepts 3000 MTU/yr of the oldest fuel available from reactor pools and ex-pool storage.

```
FACSPEC,3.1,36.50,116.27,REPOSITORY #1,R1,T1
CASK,T1,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R1,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
DATAFILE,DISDAT,DATA:MID86.DIS
DATAFILE,RXINFO,DATA:MID86.RXL
CAPACITY,1998.,3.1,70000.,3000.,0,-3000
EXECUTE,YES
```

Discussion: Sprint capacity is defined as capacity in excess of nominal receipt capacity that is reserved for FCR margin discharges and decommissioning reactors. This capacity is added to the annual receipt capacity of the destination facility during the times of the year in which FCR and decommissioning discharges occur. By specifying a negative sprint capacity equal to the annual capacity, the repository has no capacity to accept FCR or decommissioning discharges but has its full capacity of 3000 MTU/yr with which to solicit the oldest fuel in the system.

Example 8

Problem Statement: Begin accepting 10-year-old fuel at the repository according to the following ramped buildup: 400 MTU in 1998, 900 MTU in 2001, 1800 MTU in 2002, and 3000 MTU in 2003. Accept additional fuel as required to prevent any increase in ex-pool storage even if this means the repositories' age acceptance criteria must be violated. Do not give reactors being decommissioned priority (accept only FCR and oldest fuel).

```
FACSPEC,3.1,36.50,116.27,REPOSITORY #1,R1,T1
CASK,T1,T,47500.0,300.0,1.5,15.0,516.00,1.E6,0.75E5,1,2
CASK,R1,R,180000.0,300.0,2.5,15.0,1263.00,2.5E6,1.25E5,7,14
DATAFILE,DISDAT,DATA:MID86.DIS
DATAFILE,RXINFO,DATA:MID86.RXL
DECOM,100.0                    ; do not give decommissioning rx priority
AGETO,0,0,10,0,0,0             ; 10 age acceptance criteria
PREVENT,YES                    ; do not perform age checking on FCR discharge
CAPACITY,1998.,3.1,70000.,400.,0,70000.
CAPACITY,2001.,3.1,70000.,900.,0,70000.
CAPACITY,2002.,3.1,70000.,1800.,0,70000.
CAPACITY,2003.,3.1,70000.,3000.,0,70000.
EXECUTE,YES
```

Discussion: By specifying a lag time of 100 years before giving decommissioning reactors priority, no priority is given to reactors being decommissioned. By specifying a prevent command, age-checking for FCR and for discharges from reactors being decommissioned is disabled. In this case, when a FCR discharge occurs, the oldest fuel at the reactor will be shipped whether or not it meets age acceptance requirements. The specification of a large positive sprint at the repository will give the repository ample capacity to accept all forced discharges. In years in which the nominal receipt capacity is not totally filled with forced discharges, the facility will attempt to fill the annual receipt capacity with the oldest fuel in the system.

6.0 SAMPLE PROBLEMS

The sample problems provided in this chapter illustrate two simulations having different complexities and different philosophies in using the WASTES model. For clarity, both sample problems model a simplified three-reactor system. The system parameters were chosen to illustrate the model performance and do not necessarily constitute realistic values. Sample Problem 1 is a simplistic example that uses default input parameters when possible. Sample Problem 2 is more complex and has user input parameters whenever possible. Input data and output file listings are provided for both problems in Appendix C.

6.1 SAMPLE PROBLEM 1

Sample Problem 1 is a three-reactor/single-repository simulation where default input parameters are used whenever possible. Only six WASTES input cards are read to perform the analysis; however, the resulting scenario is considerably more complex than might be expected. This example illustrates the extensive use of default values available to the user.

Default values request that all reactors in the data file be analyzed and that the lag time between shutdown of the reactor and reactor decommissioning be one year. No sharing of reactor pools is specified (reactor site data file), and transshipment between reactor pools is not allowed (default specification). The default specification for ex-pool storage is a metal dry storage cask having a capacity of 24 PWR or 52 BWR assemblies.

Default values also request that rail transportation be used whenever possible and that truck transportation be used otherwise. The shipping casks are to be leased (also a default specification). The descriptions of the casks are specified to establish the capacities, lifetime, weight, costs to purchase, lease conditions, cask maintenance requirements, and several other cask parameters. Shipping is to proceed in a sequential manner based on the facility ID (default specification).

A minimum spent fuel age of 5 years for repository acceptance is specified. The repository opened in 1981 with an ultimate capacity of 1407 MTU and an annual receipt rate of 323 MTU. In an attempt to fill its annual receipt rate every year, the repository is to be filled first from FCR storage margin requirement discharges and then from solicited non-critical fuel from each reactor (pool and ex-pool).

The analysis also uses default values to specify that execution will be attempted, and that age checking will not be prevented. Discounting of transportation costs is not to be performed.

An examination of the results shows that 5640 MTU of spent fuel was accepted into the simulation, that the repository filled to ultimate capacity in 1992, that 1116 MTU of fuel required ex-pool storage, and that the remainder of the fuel was still stored in reactor pools. Additionally, a considerable amount of information was generated on the heat characteristics of the fuel in storage, the methods used to transport the fuel, and the costs of the transportation.

The input files (reactor site, discharge, and input cards) and resulting output for this sample problem are shown in Appendix C. The format of the input files is discussed in Chapter 3.0.

6.2 SAMPLE PROBLEM 2

Sample Problem 2 is a more complex simulation that models three reactors, a single MRS facility, and two repositories. Explicitly defined inputs are used to a large extent. The reactor site and discharge data files are the same as those used in Sample Problem 1. The scenario modeled in this simulation is described below.

The analysis requests that reactors 1 through 3 be included in the simulation and that the lag time between shutdown of the reactor and reactor decommissioning be 2 years. Reactor pools are not to be shared; however, transshipment of material within a utility is allowed. If ex-pool storage is required at a reactor, a transportable ex-pool storage cask having a capacity of 12 PWR or 32 BWR assemblies is specified.

The analysis also requests that rail transportation be used whenever possible and that truck transportation be used otherwise. Optimization of transportation to the repositories is requested.

The analysis specifies that spent fuel must be 5 years old to be placed in the MRS facility and 10 years old to be placed in the repository. Additionally, the fuel must remain in the MRS facility for 5 years before it can be discharged. All of the storage/processing facilities opened in 1981. Both repositories (essentially) have maximum capacities of 703 MTU and annual receipt rates of 161 MTU. The MRS facility is specified to have a maximum capacity of 500 MTU, an annual receipt rate of 100 MTU, an annual removal rate of 100 MTU, and an annual incremental sprint rate of 50 MTU.

The priorities for filling the repositories are specified, in respective order, to be pools, ex-pool storage and the MRS facility. By default, the MRS facility can only be filled from the pools and ex-pool storage.

The analysis also specified that discounting of transportation-cost cash flows is to be performed in 1981 dollars at a discount rate of 10 percent. Age checking is not prevented. Execution of the simulation is to be attempted.

An examination of the results shows that 5640 MTU of spent fuel was accepted into the simulation and that repository 1 filled to capacity in 1998 while repository 2 filled to capacity in 1999. The MRS facility also filled to capacity in 1998. The amount of fuel in ex-pool storage was reduced to 520 MTU and that in the pools was reduced to 3183 MTU. Again, considerable information on the heat characteristics of the material in storage and the transportation methods used was generated.

The input card file and the resulting output for this sample problem are provided in Appendix C. The reactor site and discharge data files are the same as those used in Sample Problem 1.

7.0 REFERENCES

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APPENDIX A

INPUT CARD DESCRIPTIONS

APPENDIX A

INPUT CARD DESCRIPTIONS

A.1 SIMULATION CONTROL INPUT CARD DESCRIPTIONS

GEN — The GEN card provides general information concerning the simulation being run and is used in titling the output. The card is expected to have the following form:

GEN,ANALYSTS NAME,PROJECT NAME,MONTH/DAY/YEAR

The ANALYSTS NAME and the PROJECT NAME are both alphanumeric and must contain 20 characters or less. The MONTH, DAY, and YEAR are entered as integers separated by slashes.

INITIALIZE — The INITIALIZE card is used to specify start and end dates of the simulation. It is expected to have the following form:

INIT,TTBEG,TTFIN

TTBEG is the beginning year of the simulation. TTFIN is the ending year of the simulation. Note: TTBEG must be the year in which the first discharge occurs (1962). TTFIN must be at least one year greater than the desired ending year of the simulation.

A.2 MODEL INPUT CARD DESCRIPTIONS

Card Type	Description
AGEAT	The AGEAT card allows the user to specify the minimum number of years the spent fuel must remain at a facility before it can be moved to another facility. The card is expected to have the following form:

AGEAT,p1,p2,p3,p4,p5,p6

Where

p1 minimum number of years for auxiliary plants.
p2 minimum number of years for MRS plants.
p3 minimum number of years for repository plants.
p4 minimum number of years for FIS plants.
p5 minimum number of years for pools.
p6 minimum number of years for ex-pool storage.

Default is: AGEAT,0,0,0,0,0,0

Card Type	Description
AGETO	The AGETO card allows the user to specify the minimum age for spent fuel to be accepted at a facility. The card is expected to have the following form:

AGETO,p1,p2,p3,p4,p5,p6

Where

p1 minimum age for auxiliary plants (years).
p2 minimum age for MRS facilities (years).
p3 minimum age for repositories (years).
p4 minimum age for FIS facilities (years).
p5 minimum age for pools (year).
p6 minimum age for ex-pool storage (years).

Default is: AGETO,0,0,0,0,0,0

Note: This card is overridden by the DECOMAGE card for decommissioning reactors, by the FCRAGE card for FCR margin discharges, and by the RIGHTSAGE card for list-driven transfers. Also see the PREVENT card.

Card Type	Description
ALTPRI	The ALTPRI card lists the sources to be simultaneously searched for the oldest/coldest spent fuel in destination-driven transfers. These sources are examined after all sources listed in the PRIOR card have been exhausted of acceptable fuel. The card is expected to have the following form:

ALTPRI,year,facid,p1,p2,...,p10

Where

- year — is the year that these alternate priorities take effect.
- facid — is the facility ID whose search list is to be changed.
- p1 - p10 — are the ID's of the facilities to be searched after the priority facilities have been searched.

Default is: All facility types not specified in the PRIOR card.

Card Type	Description
CAPACITY	The CAPACITY card allows the user to specify when a plant is opening or closing or changing its annual receipt rate, annual removal rate, maximum capacity, or making annual changes in the age acceptance criteria. The card is expected to have the following form:

CAPACITY,time,facid,p1,p2,...,p5

Where

- time — is the year in which the event is to be scheduled.
- facid — is the facility ID for which the event is to be scheduled. This can be generic like 3.0 to apply to all repositories or unique like 2.2 to apply to the second MRS facility only.
- p1 — is the maximum capacity of the facility (MTU).
- p2 — is the facilities annual receipt rate (MTU).
- p3 — is the facilities annual removal rate (MTU).
- p4 — is the facilities annual sprint rate (used to accept forced discharges) (MTU).
- p5 — if p5 is less than 0.0, p5 is the required age for fuel to be acceptable to this facility. If p5 is greater than or equal to 0.0, there is no change in the selection criteria.

There is no default capacity specification.

Card Type	Description
CASK	The CASK card describes the attributes associated with each type of shipping cask. The card is expected to have the following form:

CASK,n,m,w,d,t,l,r,c,o,i,j

where

- n is the cask name, typically R1...Rn for rail casks and T1...Tn for truck casks
- m must be R for rail casks, T for truck casks
- w is the empty weight of the casks (lbs).
- d is the number of days/year that the cask can be used.
- t is the turnaround time on one end for the cask (days).
- l is the number of years the cask can be used (cannot be a fractional year - must be an integer number of years).
- r is the daily rental rate for the cask ($).
- c is the actual purchase price for the cask ($).
- o is the annual operating and maintenance cost for the cask($).
- i is the number of PWR assemblies the cask can carry.
- j is the number of BWR assemblies the cask can carry.

Defaults are: None. At a minimum, an R1 and a T1 cask card must be supplied.

Card Type	Description
CHARACTERIZE	The CHARACTERIZE card requests detailed reports of reactor inventories, reactor shipments, facility inventories, and shipments between facilities. These reports are written to FORTRAN unit 1. The card is expected to have the following form:

CHARACTERIZE,x

Where

- x Should be either YES or NO.

Default is: CHARACTERIZE,NO

NOTE: IF CHARACTERIZATION IS REQUESTED, EXECUTION TIMES WILL INCREASE BY A FACTOR OF BETWEEN 2 AND 10.

Card Type	Description
DATAFILE	The DATAFILE card provides the location of a data file. A card must be provided for each data file. The card is expected to have the following form:

DATAFILE,ft,fn,rn

Where

ft must be one of the following:

DISDAT for the discharge data file.
RXINFO for the reactor site data file.
RIGHTS for the list driven data file.

fn is the actual name of the file.
rn is the fraction of a cask load above which the number of casks authorized by RIGHTS is rounded upwards. Note: this field is only used if "ft" is declared RIGHTS.(Defaults to 0)

Default is: None. DATAFILE cards must be provided.

Card Type	Description
DECOM	The DECOM card allows the user to specify the lag time between reactor shutdown and the beginning of fuel shipping priority for decommissioning reactors. The card is expected to have the following form:

DECOM,t

Where

t is the decommissioning lag time in years.

Default is: DECOM,0.0

Card Type	Description
DECOMAGE	The DECOMAGE card specifies the minimum age of spent fuel from decommissioning reactors for acceptance at a facility. If present, this card will override the action of the AGETO card for decommissioning reactors. The card is expected to have the following form:

DECOMAGE,p1,p2,p3,p4,p5,p6

Where

p1 is the minimum age of spent fuel for auxiliary plants (years).
p2 is the minimum age of spent fuel for the MRS facilities (years).
p3 is the minimum age of spent fuel for the repositories (years).
p4 is the minimum age of spent fuel for the FIS facilities (years).
p5 is the minimum age of spent fuel for the pools. (years)
p6 is the minimum age of spent fuel must be to enter ex-pool storage (years).

Default is: The values used on the AGETO card.

Note: See the PREVENT card.

Card Type	Description
DECOMHEAT	The DECOMHEAT card allows the user to specify maximum heat generation rate for spent fuel from decommissioning reactors to be acceptable at a facility. If present, this card will override the action of the HEATTO card for decommissioning reactors. The card is expected to have the following form:

DECOMHEAT,p1,p2,p3,p4,p5,p6

Where

p1 is the maximum heat generation rate for spent fuel accepted at auxiliary plants (KW/MTU).
p2 is the maximum heat generation rate for spent fuel accepted at MRS facilities (KW/MTU).
p3 is the maximum heat generation rate for spent fuel accepted at repositories (KW/MTU).
p4 is the maximum heat generation rate for spent fuel accepted at FIS facilities (KW/MTU).
p5 is ignored
p6 is ignored

Default is: The values used on the HEATTO card.

Note: The DECOMHEAT card is considered a development feature. If a zero is specified for the p1-6 values they will default to 100. Also see the PREVENT card.

Card Type	Description
DISCOUNT	The DISCOUNT card is used to specify the base year and discount rate. The card is expected to have the following form:

DISCOUNT,yyyy,r

Where

yyyy is the year on which discounting is to be based.
r is the discount rate in percent.

Default is: DISCOUNT,1984,0.0

Card Type	Description
DRYTYPE	The DRYTYPE card allows the user to specify the type of ex-pool storage containers and the number of PWR and BWR assemblies that it can contain. The card is expected to have the following form:

DRYTYPE,n,k,l

Where

n indicates one of the following:
- 1 metal cask.
- 2 transportable metal cask.
- 3 water basin storage.
- 4 drywell storage.
- 5 concrete cask.
- 6 vault storage.

k is the number of PWR assemblies the cask will hold.
l is the number of BWR assemblies the cask will hold.

Default is: DRYTYPE,1,24,52

Card Type	Description
EXECUTE	The EXECUTE card allows the user to prohibit execution. This is useful in allowing the user to run the error processor to check the input and not begin execution. The card is expected to have the following form:

EXECUTE,x

Where

x Should be either YES or NO.

Default is: EXECUTE,YES

Card Type	Description

FACSPEC

The FACSPEC cards are used to describe the location, name, and cask usage of various facilities in the waste management system. Ten facilities may be modeled in an analysis. The card is expected to have the following form:

```
FACSPEC,x.x,lat,long,title,c1,c2,...,cn
```

Where

- x.x is the facility ID (e.g., 2.1)
- lat is the latitude of the facility (deg.min).
- long is the longitude of the facility (deg.min).
- title is the title heading of the facility (17 char).
- c1 ... cn is a list of the cask names that are acceptable to the facility. If a simple cask name is given, the cask may be used for either loading or unloading the facility. If a < symbol immediately follows the cask name, the cask is available for loading the facility only. If a > symbol immediately follows the cask name, the cask is available for unloading the facility only. NOTE: This list of acceptable casks may be modified by the SHIPLINK card.

Default is: There is no default facility.

Card Type	Description

FCRAGE

The FCRAGE card specifies the minimum age of spent fuel to be acceptable at a facility if the FCR margin is violated. If present, the action of the AGETO card will be overridden for FCR margin discharges. The card is expected to have the following form:

```
FCRAGE,p1,p2,p3,p4,p5,p6
```

Where

- p1 is the minimum age for acceptance at auxiliary plants (years).
- p2 is the minimum age for acceptance at the MRS facilities (years).
- p3 is the minimum age for acceptance at the repositories (years).
- p4 is the minimum age for acceptance at the FIS facilities (years).
- p5 is the minimum age for acceptance at the pools (year).
- p6 is the minimum age for acceptance at ex-pool storage (years).

Default is: The values used on the AGETO card. Also see the PREVENT card.

Card Type	Description
FCRFRAC	The FCRFRAC specifies the fraction of the FCR margin to be maintained. The card is expected to have the following form:

FCRFRAC,t,x

Where

- t is the year.
- x is the fraction/multiple of FCR to be maintained.

Default is: FCRFRAC, Beginning Year of Simulation, 1.

Card Type	Description
FCRHEAT	The FCRHEAT specifies the maximum heat generation rate for spent fuel transferred to facilities due to FCR violation. This card overrides the HEATTO card. The card is expected to have the following form:

FCRHEAT,p1,p2,p3,p4,p5,p6

Where

- p1 is the maximum heat generation rate for spent fuel to be accepted at auxiliary facilities (kW/MTU).
- p2 is the maximum heat generation rate for spent fuel to be accepted at the MRS facilities (kW/MTU).
- p3 is the maximum heat generation rate for spent fuel to be accepted at the repositories (kW/MTU).
- p4 is the maximum heat generation rate for spent fuel to be accepted at the FIS facilities (kW/MTU).
- p5 is the maximum heat generation rate for spent fuel to be accepted at the pools (kW/MTU).
- p6 is the maximum heat generation rate for spent fuel to be accepted at ex-pool storage (kW/MTU).

Default is: The values used on the HEATTO card.

Note: The FCRHEAT card is considered a development feature. If a zero is specified for the p1-6 values they will default to 100. Also see the PREVENT card.

Card Type	Description
FILLORDER	The FILLORDER card allows the user to specify the order in which the types of facilities attempt to fill. The card is expected to have the following form:

FILLORDER,cl1,cl2,cl3,cl4

Where

cl1,cl2,cl3,cl4 must be one of the following. Each type designator must be used exactly once.

REPRO
MRS
REPOS
FIS

Default is: FILLORDER,REPRO,REPOS,MRS,FIS

Card Type	Description
FUELSTOP	The FUELSTOP card is used to terminate fuel discharges from reactors. Additional discharges in the DISDAT file are ignored. The card is expected to have the following form:

FUELSTOP,x

Where:

if x is less than 2200, the xth year is the last year in which fuel will be processed.
if x is greater than 2200, x is the quantity of spent fuel (MTU) which will be processed.

Default is: All reactor discharges in the DISDAT file are processed.

Card Type	Description
HEATSORT	The HEATSORT card specifies that spent fuel selection is based upon the current heat generation rate instead of the age. The card is expected to have the following form:

HEATSORT,x

Where

x Should be either YES or NO.

Default is: HEATSORT,NO (oldest fuel is selected)

Note: The HEATSORT card is considered a development feature. Use of this card will more than double execution times.

Card Type	Description
HEATTO	The HEATTO card specifies the maximum heat generation rate for spent fuel to be acceptable at a facility type. The card is expected to have the following form:

HEATTO,p1,p2,p3,p4,p5,p6

Where

- p1 is the maximum heat generation rate for auxiliary plants (kW/MTU).
- p2 is the maximum heat generation rate for MRS facilities (kW/MTU).
- p3 is the maximum heat generation rate for repositories (kW/MTU).
- p4 is the maximum heat generation rate for FIS facilities (kW/MTU).
- p5 is the maximum heat generation rate for pools (kW/MTU).
- p6 is the maximum heat generation rate for ex-pool storage (kW/MTU).

Default is: HEATTO,100,100,100,100,100,100

Note: The HEATTO card is considered a development feature. If a zero is specified for the p1-6 values they will default to 100.

Note: This card is overridden by the DECOMAGE card for decommissioning reactors, by the FCRAGE card for FCR margin discharges, and by the RIGHTSAGE card for list-driven transfers. Also see the PREVENT card.

Card Type	Description
MSHIP	The MSHIP card specifies multi-cask rail shipments from an MRS facility to downstream facilities. The card is expected to have the following form:

MSHIP,n,m,d,s,t,bc,sc

Where:

- n is the name of rail cask to be used for multi-cask shipments. The cask must be assigned to both the MRS and the destination facility.
- m is the number of rail shipping casks in the shipment.
- d is the shipping charge adjustment factor ($/one-way mile).
- s is the speed multiplier.
- t is the train turnaround time (total for both ends) (days).
- bc is the basic shipping charge multiplier.
- sc is the security and support shipping cost multiplier.

Default is: No multi-cask rail shipments.

Card Type	Description
NOTRXIDS	The NOTRXIDS card is used to eliminate reactors from the analysis. The card is expected to have the following form:

NOTRXIDS,p1,p2,p3,...,pn

Where

- p1-pn is the first reactor ID in a range pair or simply a reactor ID. If p1 is the ID of a single reactor, it must be positive. If p1 is the first reactor ID in a range pair, it must be positive, if p1 is the last ID in a range pair, it must be negative. e.g., NOTRXIDS,1,3,5,-20,100 would ask for reactors 1,3,5 through 20, and 100 to be excluded from the analysis.

Default is: No reactor exclusions

Card Type	Description
PREVENT	The PREVENT card is used to eliminate age and heat checking for source-driven transfers (FCR discharges and decommissioning). If PREVENT, all other age and heat specifications (AGETO FCRAGE, DECOMAGE, HEATTO, DECOMHEAT, FCRHEAT, etc. cards) will be overridden. The card is expected to have the following form:

PREVENT,x

Where

x should be either YES or NO.

Default is: PREVENT,NO

Card Type	Description
PRINT	The PRINT card specifies that an abbreviated copy of the information in FORTRAN unit 6 (.PRT) be created. It will have the following format:

PRINT, name, f1,...,f12

Where

name — is the name and location of the subset file being generated.

f1 - f12 — are the options selected from the following list:

- IDA — Input deck analysis which describes the conditions under which the simulation was run.
- IR — Intermediate results which gives information on the number of active ex-pool storage sites, changes in some run time options (eg. a shift from optimal to proximal shipping), and the occurrence of any unusual events during the simulation.
- T# — Information tables. The number indicates the table series number from the .PRT file (FORTRAN unit 6). All tables within the series will be printed. A range of table series is selected by placing a dash in front of the second table number (e.g., T1,-T6 would print all tables between one and six inclusive). The valid range of values is one to eleven.

Defaults: No subset is generated.

Note: The contents of the .PRT file is discussed in Chapter 4.0.

Card Type	Description
PRIOR	The PRIOR card specifies the source locations in order of preference for destination-driven transfers. The card is expected to have the following form:

PRIOR,time,facid,p1,p2,...,p5

Where

- time — is the year in which the event is to be scheduled.
- facid — is the facility ID for which the event is to be scheduled. This can be a generic ID like 3.0 to apply to all repositories or a unique ID like 2.2 to apply to the second MRS facility only. If a zero is used as an ID for one of the fields P1-S, the ALTPRI will be used to select a facility.
- p1 — is the ID of the first facility to be considered.
- p2 — is the ID of the second facility to be considered.
- p3-p5 etc.

Default priorities are FIS and those specified under the ALTPRI card.

Card Type	Description
PROCESS	The PROCESS card prioritizes spent fuel transfer selection alternatives. It will have the following format:

PROCESS,p1,p2,p3,p4,p5

Where

p1- p5 can contain the following in any order, no more than once each:

- RHT - Process rights allocation list
- FCR - Restore FCR margins
- UDH - Update heat content for all batches
- DEC - Process decommissioned reactors with priority
- FAC - Solicit oldest available fuel to fill remaining facility capacities

Normal default is: PROCESS,FCR,DEC,UDH,FAC
Default if RIGHTS DATAFILE is specified: PROCESS,UDH,RHT

Card Type	Description
REACTORS	The REACTORS card specifies which reactors will be considered in the simulation. The card is expected to have the following form:

REACTORS,p1,p2,p3,...,pn

Where

p1-pn is a reactor index (INIS) from the reactor information file. If p(x) is the ID of a single reactor, it must be positive. If p(x) is the first reactor ID in a range pair, it must be positive, if p(x) is the last ID in a range pair, it must be negative. e.g., REACTORS,101,103,1005,-2020,5100 would ask for reactors 101,103,1005 through 2020, and 5100 to be used in the analysis.

Default is: REACTORS,1,-10000

Card Type	Description
REPORT	The REPORT card specifies the type of transfers to be reported in the shipping file. The card is expected to have the following form:

REPORT,keyword

Where

keyword

- DISCHARGE causes all discharges to the reactor pool and normal inter-facility shipments to be reported in the shipping file.
- DRYSHIP causes all transfers between pool and ex-pool storage and normal inter-facility shipments to be reported in the shipping file.
- ALLSHIP causes discharges, ex-pool transfers and normal inter facility shipments to be reported.

Default: No additional reports generated, only normal intra-facility shipments will be reported.

Card Type	Description
RIGHTSAGE	The RIGHTSAGE card specifies the minimum age for spent fuel to be accepted for list driven transfers. If present, this card will override the action of the AGETO card. The card is expected to have the following form:

RIGHTSAGE,p1,p2,p3,p4,p5,p6

Where

- p1 is the minimum spent fuel age for auxiliary plants (years).
- p2 is the minimum spent fuel age for MRS facilities (years).
- p3 is the minimum spent fuel age for repositories (years).
- p4 is the minimum spent fuel age for FIS facilities (years).
- p5 is the minimum spent fuel age for pools (years).
- p6 is the minimum spent fuel age for ex-pool storage (years).

Default is: The values used on the AGETO card.

Card Type	Description
RIGHTSHEAT	The RIGHTSHEAT card specifies the maximum heat generation rate for list driven transfers. If present, this card will override the action of the HEATTO card. The card is expected to have the following form:

RIGHTSHEAT,p1,p2,p3,p4,p5,p6

Where

p1 is the maximum heat generation rate for auxiliary plants (kW/MTU).
p2 is the maximum heat generation rate for MRS facilities (kW/MTU).
p3 is the maximum heat generation rate for repositories (kW/MTU).
p4 is the maximum heat generation rate for FIS facilities (kW/MTU).
p5 is the maximum heat generation rate for pools. (kW/MTU)
p6 is the maximum heat generation rate for ex-pool storage (kW/MTU).

Default is: The values used on the HEATTO card.
Note: The RIGHTSHEAT card is considered a development feature. If a zero is specified for the p1-6 values they will default to 100.

Card Type	Description
RUNTYPE	The RUNTYPE card specifies whether the facilities will be filled optimally or proximally. In an optimized run, the two facilities are filled in such a manner that the first facility of the pair is filled as much as possible with the available material and the second facility will take the remainder of the material, if any, so that the transportation miles or transportation costs (user option) are minimized in a given year. In a proximal run, the facilities will simply take the material in such a manner that the material is accepted by the nearest facility. There may be one RUNTYPE card for each major facility ID. The card is expected to have the following form:

RUNTYPE,factype,opt

Where

factype is the facility type and must be one of the following:

- REPRO for auxiliary facilities
- MRS for monitored retrievable storage
- REPOS for repository facilities
- FIS for Federal Interim Storage

opt is the processing type and must be one of the following:

- OC for optimized cost processing
- O or Od for optimized distance processing
- P for proximity processing

Default is: Proximity processing for all facility types.

Card Type	Description

SHIPLINK

The SHIPLINK card allows the user to modify the truck and rail shipping links during the simulation. The shipping links are established at the beginning of the year specified on the card. The SHIPLINK card is expected to have the following format:

SHIPLINK,yr,c1,..,cn,s1,...,sn

Where

- yr — is the year in which the specified shipping links are to be established.
- c1-cn — are the ID's of the casks used to establish the shipping links (e.g., T1, R4, etc.). Up to ten casks may be specified. Cask ID's may be preceded by an ">" to indicate that facilities specified may only receive this cask or by an "<" to indicate that the facilities may only ship that cask. If this field is left blank it will result in no cask links to the sites specified. The ordering of the casks listed here determine their priority (e.g., the c1 has the highest priority and cn has the lowest priority).
- s1-sn — are the ID's of the sites to which the preceding casks are assigned. Reactor ID's consist of four digit integers (INIS numbers) and facility ID's are the same as specified in the FACSPEC card (e.g., 1.1, 3.2, etc). A range of ID's is specified by placing a dash preceding the second number in the sequence (e.g., 1,-10000 or 1.1,-5.1).

Defaults: Reactors are assigned the casks R1 and T1 at the start of the simulation. Facilities are assigned the casks specified in the FACSPEC cards. The SHIPLINK card overrides these defaults.

Note: This card must follow the cask definition cards if it is to be included.

Card Type	Description
SPEED	The SPEED card specifies transportation speed multipliers. Calculated speeds are multiplied by the factors on the speed card. The card is expected to have the following form:

SPEED,tfac,rfac

Where:

tfac — is the truck speed multiplication factor. This factor must be a real number greater than 0 and less than or equal to 10.

rfac — is the rail speed multiplication factor. This factor must be a real number greater than 0 and less than or equal to 10.

Default is: SPEED,1.0,1.0

Card Type	Description
TMODE	The TMODE card specifies the shipping mode for reactors. The card is expected to have the following form:

TMODE,x

Where

x must be one of the following:

- TRUCK - truck shipments from reactors.
- TRAIN or RAIL - train shipments from reactors.
- TAT - either train or truck shipments from reactors based on the reactor site data file. In actuality, TAT may be any alphabetic string as the model only looks for truck, train, or rail.

Defaults is: TAT

Card Type	Description
TSHIP	The TSHIP card is used to tell the model what type of transshipment is to be allowed and when it is to begin/end. The card is expected to have the following form:

TSHIP,N,Y

Where

N is one of the following:
- 0 disables transshipping.
- 1 indicates transshipping within utility.
- 2 indicates transshipping within a state.
- 3 indicates user specified type of transshipping.

Y is the year in which the change is scheduled.

Default is: TSHIP,0,Beginning Year of Simulation

Note: Transshipping may be enabled no more than once and disabled no more than once.

Card Type	Description
USERCOST	The USERCOST card specifies the use of a secondary set of transportation costing algorithms. Additional information on this option is contained in Appendix D. The format of the card is expected to have the following format:

USERCOST{,var1=dd.d, var2=dd.dd, ...}

Where

var(n) is the name of a cost variable that is to be changed.
dd.dd is the new value of the variable.

Note: See Appendix D for further information on the costing algorithms, variable names, default values, assumptions, and methodology.

Defaults: If the USERCOST card is omitted it will default to using the costing algorithms specified in PNL document 5977. Otherwise the defaults are as noted above.

APPENDIX B

WASTES INPUT CARD DEFAULT SUMMARY

APPENDIX B

WASTES INPUT CARD DEFAULT SUMMARY

AGEAT,0,0,0,0,0,0
AGETO,0,0,0,0,0,0
ALTPRI - see Section 2.3 for shipping priorities.
CAPACITY - there is no capacity default.
CASK - there is no default, a truck and a rail cask must always be described.
CHARACTERIZE,NO
DATAFILE - there is no default, a pair of data file cards or a dataset card must be provided.
DATASET - there is no default, a pair of data file cards or a dataset card must be provided.
DECOM,0.
DECOMAGE - default is the values provided on the AGETO card. If no AGETO card is present, all values will be 0.
DECOMHEAT - default is the values provided on the HEATTO card. If no HEATTO card is present, all values will be 100.
DISCOUNT,1984.,0.
DRYTYPE,1,24,52
EXECUTE,YES
FACSPEC - There are no default facilities.
FCRAGE - default is the values provided on the AGETO card. If no AGETO card is present, all values will be 0.
FCRHEAT - default is the values provided on the HEATTO card. If no HEATTO card is present, all values will be 100.
FCRFRAC,1.0
FILLORDER,REPRO,REPOS,MRS,FIS
FUELSTOP - all fuel is accepted up to the end date of the simulation.
HEATAT,0,0,0,0,0,0
HEATTO,100,100,100,100,100,100
MSHIP - no multi-cask rail shipping.
NOTRXIDS - no reactor exclusions.
PREVENT,NO
PRIOR - see Section 2.3 for shipping priorities.
PROCESS - If no RIGHTS - PROCESS,FCR,DEC,DEC,UDH,FAC
- If RIGHTS - PROCESS,HDH,RHT
REACTORS - all reactors are included.
REPORTS - no additional reports generated.
RIGHTSAGE,0,0,0,0,0,0
RIGHTSHEAT,100,100,100,100,100,100
RUNTYPE - proximity processing for all facility types.
RXCASKS - all reactors are assigned an R1,T1 cask. There are no default cask assignments for facilities.
TMODE - both truck and rail transportation are used to reactors with preference given to rail.
TSHIP - transshipment will not occur.

APPENDIX C

SAMPLE PROBLEMS

APPENDIX C

SAMPLE PROBLEMS

C.1 DATA FILES

Reactor Information files

```
TR85.RXL TR85.RXL 1-14-88 VERIFICATION REFERENCE  REV 1.1
0101 1 1        1407 1407 6 157 01 AL 1977 12 2017  31.13  85.06 1   01 12  4 0101   1 FARLEY 1          WE17J
0102 1 1        1407 1407 6 157 01 AL 1981  7 2021  31.13  85.06 1   01 12  4 0101   2 FARLEY 2          WE17J
0601 2 1        2320 2320 5 580 06 MA 1972 12 2013  41.57  70.35 0   06  7  1       12 PILGRIM 1         GE 8L
```

Reactor Discharge File

```
TR85.DIS TR85.DIS 1-14-88 VERIFICATION DISCHARGES REV 1
9999 1962 12  20  3.881  5997 2.190 1000   BWR         1972        GE 8    0601
 601 1973 12  20  3.881  5997 2.190 1000   BWR         1972        GE 8    0601
 601 1976 01 132 25.421 11308 2.190 2000   BWR         1972        GE 8    0601
 601 1977 08 428 82.597 16480 2.190 3000   BWR         1972        GE 8    0601
 101 1979 03  45 20.676 17443 2.115 01A01  PWR         1977        WE17    0101
 101 1979 03   1  0.459 17898 2.608 02A01  PWR         1977        WE17    0101
 601 1980 01   4  0.739 17135 2.620 8000   BWR         1972        GE 8    0601
 601 1980 01  52  9.565 19907 2.620 5000   BWR         1972        GE 8    0601
 601 1980 01  16  2.944 19772 2.620 10000  BWR         1972        GE 8    0601
 601 1980 01  20  3.689 23326 2.620 4000   BWR         1972        GE 8    0601
 101 1980 11   2  0.920 22412 2.115 01A02  PWR         1977        WE17    0101
 101 1980 11  51 23.446 27434 2.608 02A02  PWR         1977        WE17    0101
 601 1981 09 172 31.634 19126 2.190 13000  BWR         1972        GE 8    0601
 601 1981 09  36  6.636 23128 2.620 7000   BWR         1972        GE 8    0601
 601 1981 09  20  3.678 23598 2.620 6000   BWR         1972        GE 8    0601
 601 1981 09   4  0.736 22564 2.620 9000   BWR         1972        GE 8    0601
 101 1981 09   1  0.460 18237 2.115 01A05  PWR         1977        WE17    0101
 101 1981 09  26 11.966 29443 3.102 03A01  PWR         1977        WE17    0101
 101 1981 09   1  0.461 27693 3.102 03A01  PWR         1977        WE17    0101
 102 1982 10  52 23.795 16946 2.122 01A01  PWR         1981        WE17    0102
 101 1983 01  12  5.493  7655 2.995 06A01  PWR         1977        WE17    0101
 101 1983 01   1  0.460 23311 2.115 01A04  PWR         1977        WE17    0101
 101 1983 01   1  0.458 18607 2.801 05A02  PWR         1977        WE17    0101
 101 1983 01   1  0.459 16047 2.801 05A02  PWR         1977        WE17    0101
 101 1983 01  31 14.228 28275 3.113 04A01  PWR         1977        WE17    0101
 101 1983 01   1  0.458 26228 3.113 04A01  PWR         1977        WE17    0101
 101 1983 01  19  8.745 36123 3.102 03A02  PWR         1977        WE17    0101
 102 1983 09   1  0.458 23339 2.122 01A02  PWR         1981        WE17    0102
 102 1983 09  52 23.883 27470 2.601 02A01  PWR         1981        WE17    0102
 102 1983 09  11  5.031 25655 3.100 03A01  PWR         1981        WE17    0102
 601 1983 12  48  8.838 21871 2.190 11000  BWR         1972        GE 8    0601
 601 1983 12  44  8.088 22159 2.190 12000  BWR         1972        GE 8    0601
 601 1983 12 132 24.296 21076 2.190 15000  BWR         1972        GE 8    0601
 101 1984 02   1  0.457 10176 2.995 06A03  PWR         1977        WE17    0101
 101 1984 02   1  0.457 10187 2.995 06A04  PWR         1977        WE17    0101
 101 1984 02   4  1.837 19260 2.115 01A03  PWR         1977        WE17    0101
 101 1984 02   5  2.303 31108 3.102 03A03  PWR         1977        WE17    0101
 101 1984 02  49 22.453 28058 2.801 05A02  PWR         1977        WE17    0101
 101 1984 02   1  0.456 27413 2.801 05A02  PWR         1977        WE17    0101
 101 1984 02  16  7.347 29928 3.113 04A02  PWR         1977        WE17    0101
 101 1984 02   1  0.424 39556 3.108 04B01  PWR         1977        WE17    0101
 102 1985 01  30 13.766 27023 3.096 04A01  PWR         1981        WE17    0102
 102 1985 01   1  0.460 24132 3.096 04A03  PWR         1981        WE17    0102
 102 1985 01  41 18.796 33435 3.100 03A02  PWR         1981        WE17    0102
 101 1985 04   2  0.920 31383 3.113 04A03  PWR         1977        WE17    0101
 101 1985 04  17  7.785 23711 2.995 06A03  PWR         1977        WE17    0101
 101 1985 04   1  0.458 22134 2.995 06A01  PWR         1977        WE17    0101
```

101	1985	04	38	17.522	25415	3.002	07A01	PWR	1977	WE17	0101
101	1985	04	20	9.160	27965	2.995	06A02	PWR	1977	WE17	0101
102	1986	04	44	20.209	40152	3.400	05A01	PWR	1981		
102	1986	04	19	8.719	40221	3.100	04A02	PWR	1981		
601	1986	09	30	5.518	28204	2.190	14000	BWR	1972		
601	1986	09	52	9.200	41348	2.820	17000	BWR	1972		
601	1986	09	96	17.009	38041	2.650	16000	BWR	1972		
101	1986	10	30	13.815	30019	3.442	08B01	PWR	1977		
101	1986	10	1	.424	60000	3.108	04B02	PWR	1977		
101	1986	10	1	.460	60000	3.102	03A04	PWR	1977		
101	1986	10	1	.461	35038	3.002	07A02	PWR	1977		
101	1986	10	26	12.007	25548	2.999	08A01	PWR	1977		
102	1987	09	40	18.490	44214	3.450	06A01	PWR	1981		
102	1987	09	12	5.512	53640	3.400	05A02	PWR	1981		
102	1987	09	1	.459	59060	3.100	04A03	PWR	1981		
101	1988	03	13	5.987	49590	3.900	09B01	PWR	1977		
101	1988	03	13	6.004	39165	3.000	08A02	PWR	1977		
101	1988	03	34	15.670	45376	3.600	09A01	PWR	1977		
601	1988	04	14	2.481	37131	2.650	18000	BWR	1972		
601	1988	04	51	9.040	37547	2.650	20000	BWR	1972		
601	1988	04	97	17.192	38379	2.820	21000	BWR	1972		
601	1988	04	7	1.240	40820	2.820	19000	BWR	1972		
102	1989	03	44	20.302	45013	3.600	07A01	PWR	1981		
102	1989	03	17	7.858	44696	3.450	06A02	PWR	1981		
101	1989	09	11	5.070	51322	3.600	09A02	PWR	1977		
101	1989	09	6	2.763	55340	3.900	09B02	PWR	1977		
101	1989	09	41	18.917	45818	3.600	10A01	PWR	1977		
601	1990	06	132	23.367	31481	2.820	23000	BWR	1972		
601	1990	06	3	.531	31481	2.820	24000	BWR	1972		
601	1990	06	27	4.821	26761	2.820	25000	BWR	1972		
102	1990	09	44	20.302	39136	3.600	08A01	PWR	1981		
102	1990	09	14	6.460	40838	3.600	07A02	PWR	1981		
101	1991	03	53	24.454	38049	3.600	11A01	PWR	1977		
101	1991	03	16	7.382	41022	3.600	10A02	PWR	1977		
102	1992	03	14	6.460	39776	3.600	08A02	PWR	1981		
102	1992	03	49	22.609	37174	3.600	09A01	PWR	1981		
601	1992	08	171	30.103	31766	2.990	26000	BWR	1972		
101	1992	09	14	6.460	39322	3.600	11A02	PWR	1977		
101	1992	09	47	21.686	37925	3.600	12A01	PWR	1977		
102	1993	09	44	20.302	37158	3.600	10A01	PWR	1981		
102	1993	09	13	5.998	38727	3.600	09A02	PWR	1981		
101	1994	03	46	21.224	38681	3.600	13A01	PWR	1977		
101	1994	03	14	6.460	41328	3.600	12A02	PWR	1977		
601	1994	11	165	29.181	37515	3.400	27000	BWR	1972		
102	1995	03	14	6.460	39554	3.600	10A02	PWR	1981		
102	1995	03	49	22.609	37086	3.600	11A01	PWR	1981		
101	1995	09	47	21.686	37711	3.600	14A01	PWR	1977		
101	1995	09	14	6.460	39378	3.600	13A02	PWR	1977		
102	1996	09	39	17.995	39823	3.600	12A01	PWR	1981		
102	1996	09	12	5.537	41584	3.600	11A02	PWR	1981		
601	1997	01	154	27.148	38668	3.400	28000	BWR	1972		
101	1997	03	45	20.763	39352	3.600	15A01	PWR	1977		
101	1997	03	13	5.998	42006	3.600	14A02	PWR	1977		
102	1998	03	13	5.998	42291	3.600	12A02	PWR	1981		
102	1998	03	45	20.763	39620	3.600	13A01	PWR	1981		
101	1998	09	43	19.840	40288	3.600	16A01	PWR	1977		
101	1998	09	13	5.998	42068	3.600	15A02	PWR	1977		
601	1999	04	152	26.796	39705	3.400	29000	BWR	1972		
102	1999	09	12	5.537	42876	3.600	13A02	PWR	1981		
102	1999	09	42	19.379	41061	3.600	14A01	PWR	1981		

C.2 SAMPLE PROBLEM 1

```
            WW      WW    AAAAAA      SSSSSSSS  TTTTTTTTTT  EEEEEEEEEE    SSSSSSSS                222222
            WW      WW    AAAAAA      SSSSSSSS  TTTTTTTTTT  EEEEEEEEEE    SSSSSSSS                222222
            WW      WW  AA      AA  SS              TT      EE          SS                      22      22
            WW      WW  AA      AA  SS              TT      EE          SS                      22      22
            WW      WW  AA      AA  SS              TT      EE          SS                              22
            WW      WW  AA      AA  SS              TT      EE          SS                              22
            WW  WW  WW  AAAAAAAAAA    SSSSSS        TT      EEEEEEEE      SSSSSS                  222222
            WW  WW  WW  AAAAAAAAAA    SSSSSS        TT      EEEEEEEE      SSSSSS                  222222
            WW  WW  WW  AA      AA          SS      TT      EE                  SS              22
            WW  WW  WW  AA      AA          SS      TT      EE                  SS              22
            WWWW  WWWW  AA      AA          SS      TT      EE                  SS              22
            WWWW  WWWW  AA      AA          SS      TT      EE                  SS              22
            WW      WW  AA      AA  SSSSSSSS        TT      EEEEEEEEEE  SSSSSSSS                2222222222
            WW      WW  AA      AA  SSSSSSSS        TT      EEEEEEEEEE  SSSSSSSS                2222222222

WW      WW  EEEEEEEEEE  RRRRRRRR      SSSSSSSS  IIIIIIIIII    OOOOOO    NN      NN                222222      333333    EEEEEEEEEE
WW      WW  EEEEEEEEEE  RRRRRRRR      SSSSSSSS  IIIIIIIIII    OOOOOO    NN      NN                222222      333333    EEEEEEEEEE
WW      WW  EE          RR      RR  SS              II      OO      OO  NNNN    NN              22      22  33      33  EE
WW      WW  EE          RR      RR  SS              II      OO      OO  NNNN    NN              22      22  33      33  EE
WW      WW  EE          RR      RR  SS              II      OO      OO  NNNN    NN                      22          33  EE
WW      WW  EE          RR      RR  SS              II      OO      OO  NNNN    NN                      22          33  EE
  WW  WW    EEEEEEEE    RRRRRRRR      SSSSSS        II      OO      OO  NN  NN  NN                222222        3333    EEEEEEEE
  WW  WW    EEEEEEEE    RRRRRRRR      SSSSSS        II      OO      OO  NN  NN  NN                222222        3333    EEEEEEEE
  WW  WW    EE          RR  RR              SS      II      OO      OO  NN    NNNN              22                  33  EE
  WW  WW    EE          RR  RR              SS      II      OO      OO  NN    NNNN              22                  33  EE
    WW      EE          RR    RR            SS      II      OO      OO  NN    NNNN              22          33      33  EE
    WW      EE          RR    RR            SS      II      OO      OO  NN    NNNN              22          33      33  EE
    WW      EEEEEEEEEE  RR      RR  SSSSSSSS    IIIIIIIIII    OOOOOO    NN      NN              2222222222    333333    EEEEEEEEEE
    WW      EEEEEEEEEE  RR      RR  SSSSSSSS    IIIIIIIIII    OOOOOO    NN      NN              2222222222    333333    EEEEEEEEEE

DDDDDD      EEEEEEEEEE  WW      WW  EEEEEEEEEE  LL            OOOOOO    PPPPPPPP    MM      MM  EEEEEEEEEE  NN      NN  TTTTTTTTTT
DDDDDD      EEEEEEEEEE  WW      WW  EEEEEEEEEE  LL            OOOOOO    PPPPPPPP    MM      MM  EEEEEEEEEE  NN      NN  TTTTTTTTTT
DD    DD    EE          WW      WW  EE          LL          OO      OO  PP      PP  MMMM  MMMM  EE          NNNN    NN      TT
DD    DD    EE          WW      WW  EE          LL          OO      OO  PP      PP  MMMM  MMMM  EE          NNNN    NN      TT
DD      DD  EE          WW      WW  EE          LL          OO      OO  PP      PP  MM  MM  MM  EE          NNNN    NN      TT
DD      DD  EE          WW      WW  EE          LL          OO      OO  PP      PP  MM  MM  MM  EE          NNNN    NN      TT
DD      DD  EEEEEEEE      WW  WW    EEEEEEEE    LL          OO      OO  PPPPPPPP    MM  MM  MM  EEEEEEEE    NN  NN  NN      TT
DD      DD  EEEEEEEE      WW  WW    EEEEEEEE    LL          OO      OO  PPPPPPPP    MM  MM  MM  EEEEEEEE    NN  NN  NN      TT
DD      DD  EE            WW  WW    EE          LL          OO      OO  PP          MM      MM  EE          NN    NNNN      TT
DD      DD  EE            WW  WW    EE          LL          OO      OO  PP          MM      MM  EE          NN    NNNN      TT
DD    DD    EE              WW      EE          LL          OO      OO  PP          MM      MM  EE          NN    NNNN      TT
DD    DD    EE              WW      EE          LL          OO      OO  PP          MM      MM  EE          NN    NNNN      TT
DDDDDD      EEEEEEEEEE      WW      EEEEEEEEEE  LLLLLLLLLL    OOOOOO    PP          MM      MM  EEEEEEEEEE  NN      NN      TT
DDDDDD      EEEEEEEEEE      WW      EEEEEEEEEE  LLLLLLLLLL    OOOOOO    PP          MM      MM  EEEEEEEEEE  NN      NN      TT
```

CREATION

DATE

1/19/1988

WASTES 2
VERSION 23E
DEVELOPMENT
CREATION
DATE
1/19/1988

IMPLEMENTATION FOR VAX/VMS 4.1

BATTELLE
PACIFIC NORTHWEST LABORATORIES
RICHLAND, WASHINGTON 99352

DEVELOPED FOR THE U. S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC06-76RLO 1830

FUNDING PROVIDED BY: 1) MONITORED RETREIEVABLE STORAGE PROGRAM
2) DOE - TRANSPORTATION TECHNOLOGY CENTER (SANDIA)

TECHNICAL PROGRAMMING SUPPORT PROVIDED BY BOEING COMPUTER SERVICES RICHLAND, INC.

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PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

INPUT CARDS READ FOR THIS RUN ARE:

CARD NUMBER	CARD CONTENTS
1	GEN,ANALYST NAME,SAMPLE #1,1/18/88
2	INIT,1982,2000
3	FACSPEC,3.1,46.30,119.30,REPOS #1,R1,T1
4	DATAFILE,DISDAT,TR85.DIS
5	DATAFILE,RXINFO,TR85.RXL
6	CASK,T1,T,47500.00,300.,1.5,15.0,800.00,1.4E6,0.75E5,2,5
7	CASK,R1,R,160000.00,300.,2.5,15.0,1800.00,5.3E6,1.25E5,7,18
8	CAPACITY,1981.,3.1,1407.,323.,0.,0.,-5
9	

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

INPUT ERROR SUMMARY.

A TOTAL OF 8 CARDS WERE READ.
A TOTAL OF 0 CARDS WERE SKIPPED.
A TOTAL OF 0 ERRORS WERE DETECTED.

SYNOPSIS OF INPUT.

BASIC FACILITY DATA FOR THIS RUN: (1=>REPRO,2=>MRS,3=>REPOS,4=>FIS,5=>NPOOL,6=>NDRY)

FACILITY	LATITUDE	LONGITUDE	FACILITY TITLE
3.1	46.30	119.30	REPOS #1

FACILITY TYPE 3 WILL BE PROCESSED ON A SEQUENTIAL BASIS.

DISCOUNTING BASED ON 1984 DOLLARS AT 0.00%.

THIS RUN USES TRAIN ACCESS TO REACTORS IF AVAILABLE, ELSE, TRUCK ACCESS IS USED.

FUEL DISCHARGES WILL NOT BE ACCEPTED AFTER YEAR 2000.00

FUEL DISCHARGES WILL NOT BE ACCEPTED AFTER A TOTAL OF 10000000. MTU
LAG TIME FOR DECOMMISSIONING SHUT DOWN REACTOR POOLS IS: 1.
TRANSSHIPMENT TYPE 0 WILL BE USED.
DRY STORAGE TYPE 1 WILL BE USED.

INPUT DATA FILES ARE:

REACTOR INFORMATION FILE IS: TR85.RXL

FIRST RECORD IS: TR85.RXL TR85.RXL 1-14-88 VREIFICATION REFERENCE REV 1.1
DISCHARGE DATA FILE IS: TR85.DIS

FIRST RECORD IS: TR85.DIS TR85.DIS 1-14-88 VERIFICATION DISCHARGES REV 1

FACILITIES WILL INITIALLY ATTEMPT TO FILL IN THE FOLLOWING ORDER

REPRO REPOS MRS FIS

THIS ORDER MAY LATER BE MODIFIED BY THE ACTION OF PRIOR AND ALTPRI EVENTS.

CASK USE AT FACILITIES

FACID	SHIPPING CASKS		RECEIVING CASKS	
3.1	R1	T1	R1	T1

CASK ASSIGNMENT FOR REACTOR IDS PROCESSED:

ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1
101	2	1	102	2	1	601	1	0															

CASK ATTRIBUTES:

CASK TYPE	EMPTY WEIGHT (LBS)	ACTIVE DAYS PER YEAR	TURN AROUND TIME(DAYS)	CASK LIFE YEARS	DAILY LEASE RATE($)	PURCHASE PRICE ($-MILLIONS)	O & M COSTS ($-MILLIONS)
T1	47500.00	300.00	1.50	15.	800.00	1.400000	0.075000
R1	160000.00	300.00	2.50	15.	1800.00	5.300000	0.125000

WASTE TYPE - CASK TYPE SCENARIO.

WASTE TYPE	UNITS / CASK TYPE T1	R1
1	2	7
2	5	18

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

AGE CONSTRAINTS

	REPRO	MRS	REPOS	FIS	POOLS	DRY STORE
MINIMUM AGE AT .... TO ACCEPT AT NEXT FACILITY	0.	0.	0.	0.	0.	0.
MINIMUM AGE FOR ACCEPTANCE TO	0.	0.	0.	0.	0.	0.
MINIMUM AGE FOR DECOM TO SHIP	0.	0.	0.	0.	0.	0.
MINIMUM AGE FOR RIGHTS TO SHIP	0.	0.	0.	0.	0.	0.
MINIMUM AGE FOR FCR TO SHIP	0.	0.	0.	0.	0.	0.

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

HEAT CONSTRAINTS

	REPRO	MRS	REPOS	FIS	POOLS	DRY STORE
MINIMUM HEAT AT .... TO ACCEPT AT NEXT FACILITY	0.000	0.000	0.000	0.000	0.000	0.000
MAXIMUM HEAT FOR ACCEPTANCE TO	100.000	100.000	100.000	100.000	100.000	100.000
MAXIMUM HEAT FOR DECOM TO SHIP	100.000	100.000	100.000	100.000	100.000	100.000
MAXIMUM HEAT FOR RIGHTS TO SHIP	100.000	100.000	100.000	100.000	100.000	100.000
MAXIMUM HEAT FOR FCR TO SHIP	100.000	100.000	100.000	100.000	100.000	100.000

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

PRIOR ARRAY CONTENTS BY FACILITY:

```
1
4.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

ALTPRI ARRAY CONTENTS BY FACILITY:

```
 3. 1  5.1  6.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

SCHEDULED INPUT EVENTS

NUMBER OF CAPACITY CARDS READ: 1

CAPACITY TIME	IEVENT	EVENTS TO BE SCHEDULED ARE: FACILITY ID	MAXIMUM CAPACITY	ANNUAL LOADING CAPACITY	ANNUAL UNLOADING CAPACITY	ANNUAL SPRINT CAPACITY	AGE CONSTRAINT OR HEAT
1981.	3	3.10	1407.00	323.00	0.00	0.00	-5.00

SHIPPING DISTANCES DETERMINED AS FOLLOWS:

REACTOR SHIPPING DISTANCES TO REPOS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCE

INTERMEDIATE RESULTS

```
For year   1962.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1963.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1964.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1965.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1966.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1967.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1968.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1969.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1970.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1971.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1972.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1973.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1974.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1975.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1976.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1977.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1978.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1979.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1980.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1981.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1982.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1983.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1984.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1985.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1986.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1987.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1988.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1989.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1990.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1991.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1992.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1993.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1994.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1995.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1996.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1997.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1998.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
For year   1999.00 Number of pools w/ dry storage is   0 Number increasing =   0 Number of decreasing is   0
```

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

DRY STORAGE INVENTORIES MONITORED DURING EXECUTION.
INTEGER DRY STORAGE CASKING CONFIRMED.

SHIPMENTS FROM REACTORS MONITORED DURING EXECUTION.
INTEGER CASK SHIPPING CONFIRMED.

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

Total material accepted into system:
Number of Assemblies = 3939. MT's material = 1180.8

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 1.0 Inventory of Spent Fuel by Year

YEAR	REACTOR POOL		DRY STORAGE		REPOS #1		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	876.	200.0	0.	0.0	155.	29.9	1031.	229.9
1982	503.	141.8	0.	0.0	580.	111.9	1083.	253.7
1983	857.	242.7	0.	0.0	580.	111.9	1437.	354.6
1984	886.	255.9	0.	0.0	629.	134.4	1515.	390.3
1985	885.	281.5	0.	0.0	780.	177.6	1665.	459.2
1986	927.	314.2	0.	0.0	1038.	232.8	1965.	547.0
1987	924.	313.0	0.	0.0	1094.	258.5	2018.	571.5
1988	802.	271.4	0.	0.0	1445.	357.7	2247.	629.1
1989	844.	291.0	0.	0.0	1522.	393.0	2366.	684.0
1990	917.	279.0	0.	0.0	1669.	460.5	2586.	739.5
1991	680.	220.8	0.	0.0	1975.	550.5	2655.	771.3
1992	919.	282.3	0.	0.0	2031.	576.3	2950.	858.6
1993	755.	253.5	0.	0.0	2252.	631.4	3007.	884.9
1994	854.	252.3	0.	0.0	2378.	689.5	3232.	941.8
1995	757.	254.4	0.	0.0	2599.	744.6	3356.	999.0
1996	745.	248.9	0.	0.0	2662.	773.7	3407.	1022.6
1997	661.	214.7	0.	0.0	2958.	861.8	3619.	1076.5
1998	719.	241.5	0.	0.0	3014.	887.6	3733.	1129.1
1999	697.	234.9	0.	0.0	3242.	945.8	3939.	1180.8

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 1.1 Inventory of Spent Fuel at Decommissioned Reactors

	FUEL REMAINING AT DECOMMISSIONED REACTORS (MTU)																	FUEL SHIPPED FROM DECOMMISSIONED REACTORS (MTU)			
	AGE < 1			1 < AGE < 5			5 < AGE < 10			10 < AGE			TOTAL	TOTAL		# SITES	TOTAL				SITES
YEAR	POOL	DRY	# RX	POOL	DRY	# RX	POOL	DRY	# RX	POOL	DRY	# RX	POOL	DRY	TOTAL	W FUEL	#SITES	POOLS	DRY	TOTAL	SHIPPING
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.	0.	0.	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.	0.	0.	0

NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.

PRIORITY GIVEN TO DECOMMISSIONED REACTORS AFTER 0. YEARS

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 2.01 Spent Fuel Shipped from REACTOR POOL

YEAR	REACTOR POOL		DRY STORAGE		REPOS #1		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	0.	0.0	0.	0.0	155.	29.9	155.	29.9
1982	0.	0.0	0.	0.0	425.	82.0	425.	82.0
1983	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1984	0.	0.0	0.	0.0	49.	22.5	49.	22.5
1985	0.	0.0	0.	0.0	151.	43.2	151.	43.2
1986	0.	0.0	0.	0.0	258.	55.2	258.	55.2
1987	0.	0.0	0.	0.0	56.	25.6	56.	25.6
1988	0.	0.0	0.	0.0	351.	99.2	351.	99.2
1989	0.	0.0	0.	0.0	77.	35.3	77.	35.3
1990	0.	0.0	0.	0.0	147.	67.5	147.	67.5
1991	0.	0.0	0.	0.0	306.	90.0	306.	90.0
1992	0.	0.0	0.	0.0	56.	25.8	56.	25.8
1993	0.	0.0	0.	0.0	221.	55.1	221.	55.1
1994	0.	0.0	0.	0.0	126.	58.1	126.	58.1
1995	0.	0.0	0.	0.0	221.	55.1	221.	55.1
1996	0.	0.0	0.	0.0	63.	29.1	63.	29.1
1997	0.	0.0	0.	0.0	296.	88.1	296.	88.1
1998	0.	0.0	0.	0.0	56.	25.8	56.	25.8
1999	0.	0.0	0.	0.0	228.	58.2	228.	58.2

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 2.02 Spent Fuel Shipped from DRY STORAGE

YEAR	REACTOR POOL		DRY STORAGE		REPOS #1		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1982	0.	0.0	0.	0.0	0.	0.0	0.	0.0

NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 2.03 Spent Fuel Shipped from REPOS #1 (FACILITY # 3.1) TO ...

YEAR	REACTOR POOL		DRY STORAGE		REPOS #1		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1982	0.	0.0	0.	0.0	0.	0.0	0.	0.0

NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 3.01 CHARACTERISTICS OF SPENT FUEL RECEIVED AT OTHER REACTOR POOL

	RECEIPTS, BY AGE (MTU)										RECEIPTS, BY HEAT (MTU)										
	>= 0	5	8	10	12	15	20				>= 0.0	0.5	1.0	1.2	1.5	2.0	2.5				AVG
YEAR	< 5	8	10	12	15	20		MIN	AVG	MAX	< 0.5	1.0	1.2	1.5	2.0	2.5		MIN	AVG	MAX	EXP
TOTAL	0	0	0	0	0	0	0				0	0	0	0	0	0	0				

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 3.02 CHARACTERISTICS OF SPENT FUEL RECEIVED AT DRY STORAGE

YEAR	RECEIPTS, BY AGE (MTU) :>= 0 :< 5	5 8	8 10	10 12	12 15	15 20	20	MIN	AVG	MAX	RECEIPTS, BY HEAT (MTU) :>= 0.0 :< 0.5	0.5 1.0	1.0 1.2	1.2 1.5	1.5 2.0	2.0 2.5	2.5	MIN	AVG	MAX	AVG EXP
TOTAL	0	0	0	0	0	0	0				0	0	0	0	0	0	0				

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 3.03 CHARACTERISTICS OF SPENT FUEL RECEIVED AT REPOS #1

YEAR	RECEIPTS, BY AGE (MTU) :>= 0 :< 5	5 8	8 10	10 12	12 15	15 20	20	MIN	AVG	MAX	RECEIPTS, BY HEAT (MTU) :>= 0.0 :< 0.5	0.5 1.0	1.0 1.2	1.2 1.5	1.5 2.0	2.0 2.5	2.5	MIN	AVG	MAX	AVG EXP
1981	1	26	4	0	0	0	0	4.4	6.2	8.1	29	1	0	0	0	0	0	0.33	0.45	0.84	11.
1982	0	82	0	0	0	0	0	5.4	5.4	5.4	0	82	0	0	0	0	0	0.70	0.70	0.70	16.
1983	0	0	0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.
1984	1	21	0	0	0	0	0	4.2	5.7	5.8	0	21	0	1	0	0	0	0.75	0.79	1.66	18.
1985	3	40	0	0	0	0	0	4.3	5.4	6.0	0	17	1	23	2	0	0	0.69	1.15	1.71	25.
1986	3	52	0	0	0	0	0	3.1	5.3	5.3	0	35	10	10	0	0	0	0.64	0.97	1.68	21.
1987	2	24	0	0	0	0	0	4.3	5.2	5.3	0	24	0	0	1	0	0	0.78	0.83	1.58	18.
1988	3	96	0	0	0	0	0	2.3	5.4	6.0	4	26	22	37	10	0	0	0.42	1.15	2.78	25.
1989	1	34	0	0	0	0	0	4.8	5.9	5.9	0	1	0	32	1	0	0	0.82	1.25	1.85	29.
1990	1	67	0	0	0	0	0	4.3	5.9	6.0	0	0	38	28	0	0	0	0.97	1.24	2.29	28.
1991	3	87	0	0	0	0	0	3.8	5.4	5.8	0	0	0	31	46	10	4	1.21	1.79	3.65	36.
1992	2	24	0	0	0	0	0	3.8	5.2	5.3	0	0	0	0	0	18	8	2.33	2.56	3.47	47.
1993	0	55	0	0	0	0	0	4.3	5.8	5.8	0	0	0	0	35	16	4	1.68	1.96	3.39	41.
1994	6	53	0	0	0	0	0	3.8	5.4	5.8	0	0	0	0	0	48	10	2.19	2.41	3.16	46.
1995	2	53	0	0	0	0	0	3.4	5.4	5.6	0	0	5	24	18	7	2	1.16	1.70	2.79	35.
1996	0	29	0	0	0	0	0	5.8	5.8	5.8	0	0	0	0	29	0	0	1.78	1.83	1.96	39.
1997	3	85	0	0	0	0	0	3.2	5.5	5.8	0	0	0	30	55	2	1	1.45	1.73	2.81	36.
1998	1	24	0	0	0	0	0	3.8	5.3	5.3	0	0	0	0	24	0	1	1.86	1.93	2.77	38.
1999	3	56	0	0	0	0	0	3.0	5.4	5.8	0	0	0	0	56	2	0	1.82	1.88	3.07	38.
TOTAL	35	907	4	0	0	0	0				33	207	76	216	277	103	30				

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 4.01 Transportation Characterization Summary for Spent Fuel Shipped to REACTOR POOL

YEAR	TRUCK SHIP. PWR /	BWR	%(PWR)	RAIL SHIP. PWR /	BWR	%(PWR)	NUMBER OF SHIP. TRUCK /	RAIL	TOTAL	%(TRK)	MT'S RECEIVED PWR /	BWR	%(PWR)	TOTAL	MT'S SHIPPED FROM FACILITY			
1981	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0./	30.	0.0	29.88
1982	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0./	82.	0.0	82.02
1983	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0./	0.	0.0	0.00
1984	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	23./	0.	100.0	22.51
1985	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	26./	17.	59.6	43.24
1986	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	13./	42.	23.3	55.19
1987	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	26./	0.	100.0	25.63
1988	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	58./	41.	58.3	99.25
1989	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	35./	0.	100.0	35.28
1990	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	67./	0.	100.0	67.49
1991	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	58./	32.	64.4	90.01
1992	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	26./	0.	100.0	25.84
1993	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	26./	29.	46.9	55.06
1994	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	58./	0.	100.0	58.14
1995	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	26./	29.	46.9	55.09
1996	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	29./	0.	100.0	29.07
1997	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	58./	30.	66.0	88.07
1998	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	26./	0.	100.0	25.84
1999	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	29./	29.	49.9	58.25

TOTALS FOR REACTOR POOL

	TRUCK SHIPMENTS PWR /	BWR	% PWR	RAIL SHIPMENTS PWR /	BWR	% PWR	TOTAL NUMBER OF SHIPMENTS TRUCK /	RAIL	TOTAL	% TRUCK
TOTAL	0. /	0.	0.0	0. /	0.	0.0	0. /	0.	0.	0.0

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 4.02 Transportation Characterization Summary for Spent Fuel Shipped to DRY STORAGE

YEAR	TRUCK SHIP. PWR / BWR	%(PWR)	RAIL SHIP. PWR / BWR	%(PWR)	NUMBER OF SHIP. TRUCK / RAIL	TOTAL	%(TRK)	MT'S RECEIVED PWR / BWR	%(PWR)	TOTAL	MT'S SHIPPED FROM FACILITY

TOTALS FOR DRY STORAGE

	TRUCK SHIPMENTS PWR	BWR	% PWR	RAIL SHIPMENTS PWR	BWR	% PWR	TOTAL NUMBER OF SHIPMENTS TRUCK	RAIL	TOTAL	% TRUCK
TOTAL	0. /	0.	0.0	0. /	0.	0.0	0. /	0.	0.	0.0

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 4.03 Transportation Characterization Summary for Spent Fuel Shipped to REPOS #1 (FACILITY # 3.1)

YEAR	TRUCK SHIP. PWR /	BWR	%(PWR)	RAIL SHIP. PWR /	BWR	%(PWR)	NUMBER OF SHIP. TRUCK /	RAIL	TOTAL	%(TRK)	MT'S RECEIVED PWR /	BWR	%(PWR)	TOTAL	SQUARES SHIPPED TO FACILITY FULL SQUARES	HALF SQUARES
1981	0./	31.	0.0	0./	0.	0.0	31./	0.	31.	100.0	0./	30.	0.0	29.9	0.00	0.00
1982	0./	85.	0.0	0./	0.	0.0	85./	0.	85.	100.0	0./	82.	0.0	82.0	0.00	0.00
1983	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0.00	0.00
1984	0./	0.	0.0	7./	0.	100.0	0./	7.	7.	0.0	23./	0.	100.0	22.5	0.00	0.00
1985	0./	19.	0.0	8./	0.	100.0	19./	8.	27.	70.4	26./	17.	59.6	43.2	0.00	0.00
1986	0./	46.	0.0	4./	0.	100.0	46./	4.	50.	92.0	13./	42.	23.3	55.2	0.00	0.00
1987	0./	0.	0.0	8./	0.	100.0	0./	8.	8.	0.0	26./	0.	100.0	25.8	0.00	0.00
1988	0./	45.	0.0	18./	0.	100.0	45./	18.	63.	71.4	58./	41.	58.3	99.2	0.00	0.00
1989	0./	0.	0.0	11./	0.	100.0	0./	11.	11.	0.0	35./	0.	100.0	35.3	0.00	0.00
1990	0./	0.	0.0	21./	0.	100.0	0./	21.	21.	0.0	67./	0.	100.0	67.5	0.00	0.00
1991	0./	36.	0.0	18./	0.	100.0	36./	18.	54.	66.7	58./	32.	64.4	90.0	0.00	0.00
1992	0./	0.	0.0	8./	0.	100.0	0./	8.	8.	0.0	26./	0.	100.0	25.8	0.00	0.00
1993	0./	33.	0.0	8./	0.	100.0	33./	8.	41.	80.5	26./	29.	46.9	55.1	0.00	0.00
1994	0./	0.	0.0	18./	0.	100.0	0./	18.	18.	0.0	58./	0.	100.0	58.1	0.00	0.00
1995	0./	33.	0.0	8./	0.	100.0	33./	8.	41.	80.5	26./	29.	46.9	55.1	0.00	0.00
1996	0./	0.	0.0	9./	0.	100.0	0./	9.	9.	0.0	29./	0.	100.0	29.1	0.00	0.00
1997	0./	34.	0.0	18./	0.	100.0	34./	18.	52.	65.4	58./	30.	66.0	88.1	0.00	0.00
1998	0./	0.	0.0	8./	0.	100.0	0./	8.	8.	0.0	26./	0.	100.0	25.8	0.00	0.00
1999	0./	33.	0.0	9./	0.	100.0	33./	9.	42.	78.6	29./	29.	49.9	58.2	0.00	0.00

TOTALS FOR REPOS #1

	TRUCK SHIPMENTS PWR	BWR	% PWR	RAIL SHIPMENTS PWR	BWR	% PWR	TOTAL NUMBER OF SHIPMENTS TRUCK	RAIL	TOTAL	% TRUCK
TOTAL	0. /	395.	0.0	181. /	0.	100.0	395. /	181.	576.	68.6

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 5.01 Shipping Fleet Requirements for Spent Fuel Shipped to REACTOR POOL

YEAR	SHIPPING COSTS($)*10**6 TRUCK / RAIL	%(TRUCK)	BUSY DAYS*10**3 TRUCK / RAIL	%(TRUCK)	NO. OF CASKS REQ. TRUCK / RAIL	%(TRUCK)

TOTAL TRUCK BUSY DAYS = 0.00
TOTAL RAIL BUSY DAYS = 0.00

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 5.02 Shipping Fleet Requirements for Spent Fuel Shipped to DRY STORAGE

YEAR	SHIPPING COSTS($)*10**6 TRUCK / RAIL	%(TRUCK)	BUSY DAYS*10**3 TRUCK / RAIL	%(TRUCK)	NO. OF CASKS REQ. TRUCK / RAIL	%(TRUCK)

TOTAL TRUCK BUSY DAYS = 0.00
TOTAL RAIL BUSY DAYS = 0.00

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 5.03 Shipping Fleet Requirements for Spent Fuel Shipped to REPOS #1 (FACILITY # 3.1)

YEAR	SHIPPING COSTS($)*10**6 TRUCK	RAIL	%(TRUCK)	BUSY DAYS*10**3 TRUCK	RAIL	%(TRUCK)	NO. OF CASKS REQ. TRUCK	RAIL	%(TRUCK)
1981	0.5450	0.0000	100.0	0.297	0.000	100.0	1	0	100.0
1982	1.4946	0.0000	100.0	0.814	0.000	100.0	3	0	100.0
1983	0.0000	0.0000	0.0	0.000	0.000	0.0	0	0	0.0
1984	0.0000	0.4687	0.0	0.000	0.222	0.0	0	1	0.0
1985	0.3336	0.5359	38.4	0.182	0.254	41.7	1	1	50.0
1986	0.8081	0.2678	75.1	0.441	0.127	77.6	2	1	66.7
1987	0.0000	0.5358	0.0	0.000	0.254	0.0	0	1	0.0
1988	0.7905	1.2046	39.6	0.431	0.572	43.0	2	2	50.0
1989	0.0000	0.7356	0.0	0.000	0.349	0.0	0	2	0.0
1990	0.0000	1.4068	0.0	0.000	0.667	0.0	0	3	0.0
1991	0.6321	1.2053	34.4	0.345	0.572	37.6	2	2	50.0
1992	0.0000	0.5355	0.0	0.000	0.254	0.0	0	1	0.0
1993	0.5793	0.5360	51.9	0.316	0.254	55.4	2	1	66.7
1994	0.0000	1.2053	0.0	0.000	0.572	0.0	0	2	0.0
1995	0.5793	0.5357	52.0	0.316	0.254	55.4	2	1	66.7
1996	0.0000	0.6031	0.0	0.000	0.286	0.0	0	1	0.0
1997	0.5969	1.2059	33.1	0.326	0.572	36.3	2	2	50.0
1998	0.0000	0.5358	0.0	0.000	0.254	0.0	0	1	0.0
1999	0.5794	0.6029	49.0	0.316	0.286	52.5	2	1	66.7

SUB-T 6.9387 / 12.1207 36.4 MT'S OF PWR = 583.072 , MT'S OF BWR = 362.778 , 61.65 %(PWR)
TOTAL 19.0594 , TOTAL MT'S = 945.850 , AVG. COST = 20.15 ($/KG)

TOTAL TRUCK BUSY DAYS = 3783.44
TOTAL RAIL BUSY DAYS = 5750.74

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 5.04 SUMMARY TABLE.

YEAR	SHIPPING COSTS($)*10**6 TRUCK	RAIL	%(TRUCK)	BUSY DAYS*10**3 TRUCK	RAIL	%(TRUCK)	NO. OF CASKS REQ. TRUCK	RAIL	%(TRUCK)	CORR. LEASE COST ($-MILLIONS)	
1981	0.5450	0.0000	100.0	0.297	0.000	100.0	1	0	100.0	0.240000	0.000000
1982	1.4946	0.0000	100.0	0.814	0.000	100.0	3	0	100.0	0.720000	0.000000
1983	0.0000	0.0000	0.0	0.000	0.000	0.0	0	0	0.0	0.000000	0.000000
1984	0.0000	0.4687	0.0	0.000	0.222	0.0	0	1	0.0	0.000000	0.540000
1985	0.3336	0.5359	38.4	0.182	0.254	41.7	1	1	50.0	0.240000	0.540000
1986	0.8081	0.2678	75.1	0.441	0.127	77.6	2	1	66.7	0.480000	0.540000
1987	0.0000	0.5358	0.0	0.000	0.254	0.0	0	1	0.0	0.000000	0.540000
1988	0.7905	1.2046	39.6	0.431	0.572	43.0	2	2	50.0	0.480000	1.080000
1989	0.0000	0.7356	0.0	0.000	0.349	0.0	0	2	0.0	0.000000	1.080000
1990	0.0000	1.4068	0.0	0.000	0.667	0.0	0	3	0.0	0.000000	1.620000
1991	0.6321	1.2053	34.4	0.345	0.572	37.6	2	2	50.0	0.480000	1.080000
1992	0.0000	0.5355	0.0	0.000	0.254	0.0	0	1	0.0	0.000000	0.540000
1993	0.5793	0.5360	51.9	0.316	0.254	55.4	2	1	66.7	0.480000	0.540000
1994	0.0000	1.2053	0.0	0.000	0.572	0.0	0	2	0.0	0.000000	1.080000
1995	0.5793	0.5357	52.0	0.316	0.254	55.4	2	1	66.7	0.480000	0.540000
1996	0.0000	0.6031	0.0	0.000	0.286	0.0	0	1	0.0	0.000000	0.540000
1997	0.5969	1.2059	33.1	0.326	0.572	36.3	2	2	50.0	0.480000	1.080000
1998	0.0000	0.5358	0.0	0.000	0.254	0.0	0	1	0.0	0.000000	0.540000
1999	0.5794	0.6029	49.0	0.316	0.286	52.5	2	1	66.7	0.480000	0.540000

SUB-T 6.9387/ 12.1207 36.4, MT'S OF PWR = 583.072 , MT'S OF BWR = 362.778 , 61.65 %(PWR) 4.560000/ 12.420000
TOTAL 19.0594 , TOTAL MT'S = 945.850 , AVG. COST = 20.15 ($/KG) , TOTAL LEASE COST = 16.980000
AVG. LEASE COST = 17.96 ($/KG)

MT'S BY TRUCK = 362.778, INCLUDING RESHIPMENT
MT'S BY RAIL = 583.072, INCLUDING RESHIPMENT
AVG. ANNUAL MT'S / (TRUCK CASK-YEAR) = 19.094
AVG. ANNUAL MT'S / (RAIL CASK-YEAR) = 25.351

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 6.00 Facility to Facility Shipping Cost ($/KG)

	POOL	DRY	3.1
POOL	0.00	0.00	20.15
DRY	0.00	0.00	0.00
3.1	0.00	0.00	0.00

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 7.00 Maximum Fleet Purchase Requirements and Cost

YEAR	CASK NAME	# OF SHIPMENTS	CASK-MILES	# CASKS PURCHASED	# CASKS RETIRED	# CASKS AVAILABLE	PURCHASE COST ($-MILLIONS)	MAINT. COST ($-MILLIONS)	TOTAL COST ($-MILLIONS)
1981	T1	31	85684.	1	0	1	1.400000	0.075000	1.475000
	R1	0	0.	0	0	0	0.000000	0.000000	0.000000
1982	T1	85	234940.	2	0	3	2.800000	0.225000	3.025000
	R1	0	0.	0	0	0	0.000000	0.000000	0.000000
1983	T1	0	0.	0	0	3	0.000000	0.225000	0.225000
	R1	0	0.	0	0	0	0.000000	0.000000	0.000000
1984	T1	0	0.	0	0	3	0.000000	0.225000	0.225000
	R1	6	19670.	1	0	1	5.300000	0.125000	5.425000
1985	T1	19	52516.	0	0	3	0.000000	0.225000	0.225000
	R1	8	22480.	0	0	1	0.000000	0.125000	0.125000
1986	T1	46	127144.	0	0	3	0.000000	0.225000	0.225000
	R1	4	11240.	0	0	1	0.000000	0.125000	0.125000
1987	T1	0	0.	0	0	3	0.000000	0.225000	0.225000
	R1	7	22480.	0	0	1	0.000000	0.125000	0.125000
1988	T1	45	124380.	0	0	3	0.000000	0.225000	0.225000
	R1	18	50580.	1	0	2	5.300000	0.250000	5.550000
1989	T1	0	0.	0	0	3	0.000000	0.225000	0.225000
	R1	11	30910.	0	0	2	0.000000	0.250000	0.250000
1990	T1	0	0.	0	0	3	0.000000	0.225000	0.225000
	R1	21	59010.	1	0	3	5.300000	0.375000	5.675000
1991	T1	36	99504.	0	0	3	0.000000	0.225000	0.225000
	R1	18	50580.	0	0	3	0.000000	0.375000	0.375000
1992	T1	0	0.	0	0	3	0.000000	0.225000	0.225000
	R1	8	22480.	0	0	3	0.000000	0.375000	0.375000
1993	T1	33	91212.	0	0	3	0.000000	0.225000	0.225000
	R1	8	22480.	0	0	3	0.000000	0.375000	0.375000
1994	T1	0	0.	0	0	3	0.000000	0.225000	0.225000
	R1	18	50580.	0	0	3	0.000000	0.375000	0.375000
1995	T1	33	91212.	0	0	3	0.000000	0.225000	0.225000
	R1	8	22480.	0	0	3	0.000000	0.375000	0.375000
1996	T1	0	0.	0	1	2	0.000000	0.150000	0.150000
	R1	9	25290.	0	0	3	0.000000	0.375000	0.375000
1997	T1	34	93976.	2	2	2	2.800000	0.150000	2.950000
	R1	18	50580.	0	0	3	0.000000	0.375000	0.375000
1998	T1	0	0.	0	0	2	0.000000	0.150000	0.150000
	R1	8	22480.	0	0	3	0.000000	0.375000	0.375000
1999	T1	33	91212.	0	0	2	0.000000	0.150000	0.150000
	R1	9	25290.	0	1	2	0.000000	0.250000	0.250000
CASK SUB-TOTAL	T1	396	1091780.	5	3		7.000000	3.825000	10.825000
	R1	181	500610.	3	1		15.900000	4.625000	20.525000
GRAND TOTAL		576	1600390.	8	4		22.900000	8.450000	31.350000

AVG. T1 UTILIZATION FOR MAXIMUM PURCHASE = 74.19 DAYS/YR
AVG. R1 UTILIZATION FOR MAXIMUM PURCHASE = 155.43 DAYS/YR

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 8.00 Levelized Fleet Purchase Requirements and Cost

YEAR	CASK NAME	# OF SHIPMENTS	CASK-MILES	# CASKS PURCHASED	# CASKS RETIRED	# CASKS AVAILABLE	PURCHASE COST ($-MILLIONS)	MAINT. COST ($-MILLIONS)	TOTAL COST ($-MILLIONS)
1981	T1	N/A	N/A	1	0	1	1.400000	0.075000	1.475000
	R1	N/A	N/A	0	0	0	0.000000	0.000000	0.000000
1982	T1	N/A	N/A	2	0	3	2.800000	0.225000	3.025000
	R1	N/A	N/A	0	0	0	0.000000	0.000000	0.000000
1983	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	0	0.000000	0.000000	0.000000
1984	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	1	0	1	5.300000	0.125000	5.425000
1985	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	1	0.000000	0.125000	0.125000
1986	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	1	0.000000	0.125000	0.125000
1987	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	1	0.000000	0.125000	0.125000
1988	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	1	0	2	5.300000	0.250000	5.550000
1989	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	2	0.000000	0.250000	0.250000
1990	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	1	0	3	5.300000	0.375000	5.675000
1991	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	3	0.000000	0.375000	0.375000
1992	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	3	0.000000	0.375000	0.375000
1993	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	3	0.000000	0.375000	0.375000
1994	T1	N/A	N/A	0	0	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	3	0.000000	0.375000	0.375000
1995	T1	N/A	N/A	0	1	3	0.000000	0.225000	0.225000
	R1	N/A	N/A	0	0	3	0.000000	0.375000	0.375000
1996	T1	N/A	N/A	0	2	2	0.000000	0.150000	0.150000
	R1	N/A	N/A	0	0	3	0.000000	0.375000	0.375000
1997	T1	N/A	N/A	0	0	0	0.000000	0.000000	0.000000
	R1	N/A	N/A	0	0	3	0.000000	0.375000	0.375000
1998	T1	N/A	N/A	0	0	0	0.000000	0.000000	0.000000
	R1	N/A	N/A	0	1	3	0.000000	0.375000	0.375000
1999	T1	N/A	N/A	0	0	0	0.000000	0.000000	0.000000
	R1	N/A	N/A	0	0	2	0.000000	0.250000	0.250000
CASK SUB-TOTAL	T1	N/A	N/A	3	3		4.200000	3.375000	7.575000
	R1	N/A	N/A	3	1		15.900000	4.625000	20.525000
GRAND TOTAL		N/A	N/A	6	4		20.100000	8.000000	28.100000

AVG. T1 UTILIZATION FOR MAXIMUM PURCHASE = 84.08 DAYS/YR
AVG. R1 UTILIZATION FOR MAXIMUM PURCHASE = 155.43 DAYS/YR

PROJECT TITLE: SAMPLE #1 DATE OF RUN: 1/19/88 (13:02:45)

TABLE 9.00 Transportation Cost summary by Category.

	OPTION							
	MINIMUM LEASE		REQUIRED LEASE		MAXIMUM PURCHASE		LEVELIZED PURCHASE	
	COST ($-MILLIONS)	/ $/KG	COST ($-MILLIONS)	/ $/KG	COST ($-MILLIONS)	/ $/KG	COST ($-MILLIONS)	/ $/KG
Shipping Cost								
T1	4.920615	/ 13.56	4.920615	/ 13.56	4.920615	/ 13.56	4.920615	/ 13.56
R1	10.772296	/ 18.48	10.772296	/ 18.48	10.772296	/ 18.48	10.772296	/ 18.48
Security/ Surcharge								
T1	2.018072	/ 5.56	2.018072	/ 5.56	2.018072	/ 5.56	2.018072	/ 5.56
R1	1.348378	/ 2.31	1.348378	/ 2.31	1.348378	/ 2.31	1.348378	/ 2.31
Lease Cost								
T1	3.026749	/ 8.34	4.560000	/ 12.57	0.000000	/ 0.00	0.000000	/ 0.00
R1	10.351338	/ 17.76	12.420000	/ 21.30	0.000000	/ 0.00	0.000000	/ 0.00
Purchase Cost								
T1	0.000000	/ 0.00	0.000000	/ 0.00	7.000000	/ 19.30	4.200000	/ 11.58
R1	0.000000	/ 0.00	0.000000	/ 0.00	15.900000	/ 27.27	15.900000	/ 27.27
Maintenance Cost								
T1	0.000000	/ 0.00	0.000000	/ 0.00	3.825000	/ 10.54	3.375000	/ 9.30
R1	0.000000	/ 0.00	0.000000	/ 0.00	4.625000	/ 7.93	4.625000	/ 7.93
Sub-Total								
T1	9.965435	/ 27.47	11.498686	/ 31.70	17.763686	/ 48.97	14.513686	/ 40.01
R1	22.472012	/ 38.54	24.540674	/ 42.09	32.645674	/ 55.99	32.645674	/ 55.99
Total	32.437448	/ 34.29	36.039360	/ 38.10	50.409360	/ 53.30	47.159360	/ 49.86

TABLE 10.01 Characteristics of Cask Shipments by Centroid for each Facility.

CENTROID NUMBER	TRANS. MODE	REPOS #1 CASK-MILES	/	RECEIPTS
1	TRUCK	0.	/	0.
	RAIL	0.	/	0.
2	TRUCK	0.	/	0.
	RAIL	0.	/	0.
3	TRUCK	0.	/	0.
	RAIL	0.	/	0.
4	TRUCK	0.	/	0.
	RAIL	0.	/	0.
5	TRUCK	0.	/	0.
	RAIL	0.	/	0.
6	TRUCK	0.	/	0.
	RAIL	0.	/	0.
7	TRUCK	1091780.	/	395.
	RAIL	0.	/	0.
8	TRUCK	0.	/	0.
	RAIL	0.	/	0.
9	TRUCK	0.	/	0.
	RAIL	0.	/	0.
10	TRUCK	0.	/	0.
	RAIL	0.	/	0.
11	TRUCK	0.	/	0.
	RAIL	0.	/	0.
12	TRUCK	0.	/	0.
	RAIL	508610.	/	181.
13	TRUCK	0.	/	0.
	RAIL	0.	/	0.
14	TRUCK	0.	/	0.
	RAIL	0.	/	0.
15	TRUCK	0.	/	0.
	RAIL	0.	/	0.
16	TRUCK	0.	/	0.
	RAIL	0.	/	0.
17	TRUCK	0.	/	0.
	RAIL	0.	/	0.
18	TRUCK	0.	/	0.
	RAIL	0.	/	0.
19	TRUCK	0.	/	0.
	RAIL	0.	/	0.
20	TRUCK	0.	/	0.
	RAIL	0.	/	0.
21	TRUCK	0.	/	0.
	RAIL	0.	/	0.
TOTAL	TRUCK	1091780.		
TOTAL	RAIL	508610.		
TOTAL		1600390.		

TABLE 10.02 Characteristics of Fuel Shipped by Centroid (Years / MWD/KG).

CENTROID NUMBER	TRANS. MODE	REPOS #1 AGE / EXP
1	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
2	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
3	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
4	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
5	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
6	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
7	TRUCK	5.5 / 24.91
	RAIL	0.0 / 0.00
8	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
9	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
10	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
11	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
12	TRUCK	0.0 / 0.00
	RAIL	5.5 / 34.13
13	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
14	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
15	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
16	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
17	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
18	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
19	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
20	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00
21	TRUCK	0.0 / 0.00
	RAIL	0.0 / 0.00

TABLE 11.01 CASH FLOWS FOR DRY STORAGE: CUMULATIVE TOTAL
ASSUMING NO CANNING OR CONSOLIDATION

YEAR	CAPITAL INVESTED IN... YARDS	CAPITAL INVESTED IN... CASKS	TOTAL	OPERATION/MAINTENANCE RELATED TO... YARDS	OPERATION/MAINTENANCE RELATED TO... CASKS	TOTAL	DECOMMISSIONING COST FOR... YARDS	DECOMMISSIONING COST FOR... CASKS	EQUIPMENT SALVAGE	TOTAL	ANNUAL TOTAL	DISCOUNTED ANNUAL
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE 11.02 CASH FLOWS FOR DRY STORAGE: CUMULATIVE TOTAL

ACTIVE NUMBER OF...

YEAR	YARDS PWR	YARDS BWR	YARDS MIXED	YARDS TOT	CASKS PWR	CASKS BWR	CASKS TOT	ASSEMBLIES PWR	ASSEMBLIES BWR	ASSEMBLIES TOT

C.3 SAMPLE PROBLEM 2

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WW      WW    AAAAAA      SSSSSSSS  TTTTTTTTTT  EEEEEEEEEE    SSSSSSSS                222222
WW      WW    AAAAAA      SSSSSSSS  TTTTTTTTTT  EEEEEEEEEE    SSSSSSSS                222222
WW      WW  AA      AA  SS              TT      EE          SS                      22      22
WW      WW  AA      AA  SS              TT      EE          SS                      22      22
WW      WW  AA      AA  SS              TT      EE          SS                              22
WW      WW  AA      AA  SS              TT      EE          SS                              22
WW  WW  WW  AAAAAAAAAA    SSSSSS        TT      EEEEEEEE      SSSSSS                  222222
WW  WW  WW  AAAAAAAAAA    SSSSSS        TT      EEEEEEEE      SSSSSS                  222222
WW  WW  WW  AA      AA          SS      TT      EE                  SS              22
WW  WW  WW  AA      AA          SS      TT      EE                  SS              22
WWWW  WWWW  AA      AA          SS      TT      EE                  SS              22
WWWW  WWWW  AA      AA          SS      TT      EE                  SS              22
WW      WW  AA      AA  SSSSSSSS        TT      EEEEEEEEEE  SSSSSSSS                2222222222
WW      WW  AA      AA  SSSSSSSS        TT      EEEEEEEEEE  SSSSSSSS                2222222222

VV      VV  EEEEEEEEEE  RRRRRRRR      SSSSSSSS  IIIIIIIIII    OOOOOO    NN      NN                222222      333333    EEEEEEEEEE
VV      VV  EEEEEEEEEE  RRRRRRRR      SSSSSSSS  IIIIIIIIII    OOOOOO    NN      NN                222222      333333    EEEEEEEEEE
VV      VV  EE          RR      RR  SS              II      OO      OO  NNNN    NN              22      22  33      33  EE
VV      VV  EE          RR      RR  SS              II      OO      OO  NNNN    NN              22      22  33      33  EE
VV      VV  EE          RR      RR  SS              II      OO      OO  NNNN    NN                      22          33  EE
VV      VV  EE          RR      RR  SS              II      OO      OO  NNNN    NN                      22          33  EE
  VV  VV    EEEEEEEE    RRRRRRRR      SSSSSS        II      OO      OO  NN  NN  NN                222222        3333    EEEEEEEE
  VV  VV    EEEEEEEE    RRRRRRRR      SSSSSS        II      OO      OO  NN  NN  NN                222222        3333    EEEEEEEE
  VV  VV    EE          RR  RR              SS      II      OO      OO  NN    NNNN              22                  33  EE
  VV  VV    EE          RR  RR              SS      II      OO      OO  NN    NNNN              22                  33  EE
    VV      EE          RR    RR            SS      II      OO      OO  NN    NNNN              22          33      33  EE
    VV      EE          RR    RR            SS      II      OO      OO  NN    NNNN              22          33      33  EE
    VV      EEEEEEEEEE  RR      RR  SSSSSSSS    IIIIIIIIII    OOOOOO    NN      NN              2222222222    333333    EEEEEEEEEE
    VV      EEEEEEEEEE  RR      RR  SSSSSSSS    IIIIIIIIII    OOOOOO    NN      NN              2222222222    333333    EEEEEEEEEE

DDDDDD      EEEEEEEEEE  VV      VV  EEEEEEEEEE  LL              OOOOOO    PPPPPPPP    MM      MM  EEEEEEEEEE  NN      NN  TTTTTTTTTT
DDDDDD      EEEEEEEEEE  VV      VV  EEEEEEEEEE  LL              OOOOOO    PPPPPPPP    MM      MM  EEEEEEEEEE  NN      NN  TTTTTTTTTT
DD    DD    EE          VV      VV  EE          LL          OO      OO  PP      PP  MMMM  MMMM  EE          NNNN    NN      TT
DD    DD    EE          VV      VV  EE          LL          OO      OO  PP      PP  MMMM  MMMM  EE          NNNN    NN      TT
DD      DD  EE          VV      VV  EE          LL          OO      OO  PP      PP  MM  MM  MM  EE          NNNN    NN      TT
DD      DD  EE          VV      VV  EE          LL          OO      OO  PP      PP  MM  MM  MM  EE          NNNN    NN      TT
DD      DD  EEEEEEEE      VV  VV    EEEEEEEE    LL          OO      OO  PPPPPPPP    MM  MM  MM  EEEEEEEE    NN  NN  NN      TT
DD      DD  EEEEEEEE      VV  VV    EEEEEEEE    LL          OO      OO  PPPPPPPP    MM  MM  MM  EEEEEEEE    NN  NN  NN      TT
DD      DD  EE            VV  VV    EE          LL          OO      OO  PP          MM      MM  EE          NN    NNNN      TT
DD      DD  EE            VV  VV    EE          LL          OO      OO  PP          MM      MM  EE          NN    NNNN      TT
DD    DD    EE              VV      EE          LL          OO      OO  PP          MM      MM  EE          NN    NNNN      TT
DD    DD    EE              VV      EE          LL          OO      OO  PP          MM      MM  EE          NN    NNNN      TT
DDDDDD      EEEEEEEEEE      VV      EEEEEEEEEE  LLLLLLLLLL    OOOOOO    PP          MM      MM  EEEEEEEEEE  NN      NN      TT
DDDDDD      EEEEEEEEEE      VV      EEEEEEEEEE  LLLLLLLLLL    OOOOOO    PP          MM      MM  EEEEEEEEEE  NN      NN      TT
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  CCCCCC   RRRRRRRR  EEEEEEEEEE   AAAAAA   TTTTTTTTTT IIIIIIIIII   000000  NN      NN
  CCCCCC   RRRRRRRR  EEEEEEEEEE   AAAAAA   TTTTTTTTTT IIIIIIIIII   000000  NN      NN
CC      CC RR      RR EE        AA      AA     TT         II     00      00 NNNN    NN
CC      CC RR      RR EE        AA      AA     TT         II     00      00 NNNN    NN
CC         RR      RR EE        AA      AA     TT         II     00      00 NNNN    NN
CC         RR      RR EE        AA      AA     TT         II     00      00 NNNN    NN
CC         RRRRRRRR  EEEEEEEE   AAAAAAAAAA     TT         II     00      00 NN  NN  NN
CC         RRRRRRRR  EEEEEEEE   AAAAAAAAAA     TT         II     00      00 NN  NN  NN
CC         RR  RR     EE        AA      AA     TT         II     00      00 NN    NNNN
CC         RR  RR     EE        AA      AA     TT         II     00      00 NN    NNNN
CC      CC RR    RR   EE        AA      AA     TT         II     00      00 NN    NNNN
CC      CC RR    RR   EE        AA      AA     TT         II     00      00 NN    NNNN
  CCCCCC   RR      RR EEEEEEEEEE AA      AA    TT     IIIIIIIIII   000000  NN      NN
  CCCCCC   RR      RR EEEEEEEEEE AA      AA    TT     IIIIIIIIII   000000  NN      NN

DDDDDD      AAAAAA   TTTTTTTTTT EEEEEEEEEE
DDDDDD      AAAAAA   TTTTTTTTTT EEEEEEEEEE
DD    DD  AA      AA     TT     EE
DD    DD  AA      AA     TT     EE
DD      DD AA      AA    TT     EE
DD      DD AA      AA    TT     EE
DD      DD AAAAAAAAAA    TT     EEEEEEEE
DD      DD AAAAAAAAAA    TT     EEEEEEEE
DD      DD AA      AA    TT     EE
DD      DD AA      AA    TT     EE
DD    DD  AA      AA     TT     EE
DD    DD  AA      AA     TT     EE
DDDDDD    AA      AA     TT     EEEEEEEEEE
DDDDDD    AA      AA     TT     EEEEEEEEEE

    11          //     11      999999       //     11      999999    888888    888888
    11          //     11      999999       //     11      999999    888888    888888
  1111         //    1111    99      99    //    1111    99      99 88      88 88      88
  1111         //    1111    99      99    //    1111    99      99 88      88 88      88
    11        //       11    99      99   //       11    99      99 88      88 88      88
    11        //       11    99      99   //       11    99      99 88      88 88      88
    11       //        11      99999999  //        11      99999999  888888    888888
    11       //        11      99999999  //        11      99999999  888888    888888
    11      //         11            99 //         11            99 88      88 88      88
    11      //         11            99 //         11            99 88      88 88      88
    11     //          11          99  //          11          99   88      88 88      88
    11     //          11          99  //          11          99   88      88 88      88
111111    //       111111      9999   //       111111      9999      888888    888888
111111    //       111111      9999   //       111111      9999      888888    888888
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WASTES 2
VERSION 23E
DEVELOPMENT
CREATION
DATE
1/19/1988

IMPLEMENTATION FOR VAX/VMS 4.1

BATTELLE
PACIFIC NORTHWEST LABORATORIES
RICHLAND, WASHINGTON 99352

DEVELOPED FOR THE U. S. DEPARTMENT OF ENERGY UNDER CONTRACT DE-AC06-76RLO 1830

FUNDING PROVIDED BY: 1) MONITORED RETREIEVABLE STORAGE PROGRAM
2) DOE - TRANSPORTATION TECHNOLOGY CENTER (SANDIA)

TECHNICAL PROGRAMMING SUPPORT PROVIDED BY BOEING COMPUTER SERVICES RICHLAND, INC.

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PROJECT TITLE: SAMPLE #2                                              DATE OF RUN:  1/19/88  (12:05:56)

INPUT CARDS READ FOR THIS RUN ARE:

   CARD     CARD CONTENTS
  NUMBER

     1      GEN,ANALYST NAME,SAMPLE #2,1/18/88
     2      INIT,1962,2000
     3      FACSPEC,2.1,39.06,84.12,MRS #1,R1,T1
     4      FACSPEC,3.1,46.30,119.30,REPOS #1,R1,T1
     5      FACSPEC,3.2,34.00,82.00,REPOS #2,R1,T1
     6      DISCOUNT,1981,10.
     7      TMODE,TANDT
     8      DATAFILE,DISDAT,TR85.DIS
     9      DATAFILE,RXINFO,TR85.RXL
    10      REACTORS,1,-9999
    11      CASK,T1,T,47500.00,300.,1.5,15.0,800.00,1.4E5,0.75E5,2,5
    12      CASK,R1,R,160000.00,300.,2.5,15.0,1800.00,5.3E5,1.25E5,7,18
    13      DECOM,2.0
    14      TSHIP,1,1994
    15      RUNTYPE,REPOS,0
    16      AGEAT,0,1,100,0,0,0
    17      AGETO,0,5,10,0,0,0
    18      CAPACITY,1995.,2.1,500.,50.,50.,50.,-5
    19      CAPACITY,1998.,3.1,7.03E2,1.00E2,0.,0.,-10
    20      CAPACITY,1998.,3.2,7.03E2,1.00E2,0.,0.,-10
    21      DRYTYPE,2,24,52
    22      PREVENT,NO
    23      PRIOR,1981.,3.0,5.0,6.0,2.0
    24      EXECUTE,YES
    25

PROJECT TITLE: SAMPLE #2                                              DATE OF RUN:  1/19/88  (12:05:56)

                                   INPUT ERROR SUMMARY.

 A TOTAL OF    24 CARDS WERE READ.
A TOTAL OF     0 CARDS WERE SKIPPED.
A TOTAL OF     0 ERRORS WERE DETECTED.


PROJECT TITLE: SAMPLE #2                                              DATE OF RUN:  1/19/88  (12:05:56)


                                   SYNOPSIS OF INPUT.


BASIC FACILITY DATA FOR THIS RUN:  (1=>REPRO,2=>MRS,3=>REPOS,4=>FIS,5=>NPOOL,6=>NDRY)


      FACILITY  LATITUDE  LONGITUDE FACILITY TITLE
      2.1        39.06     84.12    MRS #1
      3.1        46.30    119.30    REPOS #1
      3.2        34.00     82.00    REPOS #2

FACILITY TYPE 2 WILL BE PROCESSED ON A SEQUENTIAL BASIS.

FACILITY TYPE 3 WILL BE PROCESSED ON A 0 BASIS.

DISCOUNTING BASED ON  1981 DOLLARS AT 0.10%.
```

THIS RUN USES TRAIN ACCESS TO REACTORS IF AVAILABLE, ELSE, TRUCK ACCESS IS USED.

FUEL DISCHARGES WILL NOT BE ACCEPTED AFTER YEAR 2000.00

FUEL DISCHARGES WILL NOT BE ACCEPTED AFTER A TOTAL OF 10000000. MTU
LAG TIME FOR DECOMMISSIONING SHUT DOWN REACTOR POOLS IS: 2.
TRANSSHIPMENT TYPE 1 WILL BE USED.
DRY STORAGE TYPE 2 WILL BE USED.

INPUT DATA FILES ARE:

REACTOR INFORMATION FILE IS: TR85.RXL

FIRST RECORD IS: TR85.RXL TR85.RXL 1-14-88 VREIFICATION REFERENCE REV 1.1
DISCHARGE DATA FILE IS: TR85.DIS

FIRST RECORD IS: TR85.DIS TR85.DIS 1-14-88 VERIFICATION DISCHARGES REV 1

FACILITIES WILL INITIALLY ATTEMPT TO FILL IN THE FOLLOWING ORDER

REPRO REPOS MRS FIS

THIS ORDER MAY LATER BE MODIFIED BY THE ACTION OF PRIOR AND ALTPRI EVENTS.

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

CASK USE AT FACILITIES

FACID	SHIPPING CASKS		RECEIVING CASKS	
2.1	R1	T1	R1	T1
3.1	R1	T1	R1	T1
3.2	R1	T1	R1	T1

CASK ASSIGNMENT FOR REACTOR IDS PROCESSED:

ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1	ID	T1	R1
101	2	1	102	2	1	601	1	0															

CASK ATTRIBUTES:

CASK TYPE	EMPTY WEIGHT (LBS)	ACTIVE DAYS PER YEAR	TURN AROUND TIME(DAYS)	CASK LIFE YEARS	DAILY LEASE RATE($)	PURCHASE PRICE ($-MILLIONS)	O & M COSTS ($-MILLIONS)
T1	47500.00	300.00	1.50	15.	800.00	1.400000	0.075000
R1	160000.00	300.00	2.50	15.	1800.00	5.300000	0.125000

WASTE TYPE - CASK TYPE SCENARIO.

WASTE TYPE	UNITS / CASK TYPE T1	R1
1	2	7
2	5	18

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

AGE CONSTRAINTS

	REPRO	MRS	REPOS	FIS	POOLS	DRY STORE
MINIMUM AGE AT .... TO ACCEPT AT NEXT FACILITY	0.	1.	100.	0.	0.	0.
MINIMUM AGE FOR ACCEPTANCE TO	0.	5.	10.	0.	0.	0.
MINIMUM AGE FOR DECOM TO SHIP	0.	5.	10.	0.	0.	0.
MINIMUM AGE FOR RIGHTS TO SHIP	0.	5.	10.	0.	0.	0.
MINIMUM AGE FOR FCR TO SHIP	0.	5.	10.	0.	0.	0.

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

HEAT CONSTRAINTS

	REPRO	MRS	REPOS	FIS	POOLS	DRY STORE
MINIMUM HEAT AT .... TO ACCEPT AT NEXT FACILITY	0.000	0.000	0.000	0.000	0.000	0.000
MAXIMUM HEAT FOR ACCEPTANCE TO	100.000	100.000	100.000	100.000	100.000	100.000
MAXIMUM HEAT FOR DECOM TO SHIP	100.000	100.000	100.000	100.000	100.000	100.000
MAXIMUM HEAT FOR RIGHTS TO SHIP	100.000	100.000	100.000	100.000	100.000	100.000
MAXIMUM HEAT FOR FCR TO SHIP	100.000	100.000	100.000	100.000	100.000	100.000

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

PRIOR ARRAY CONTENTS BY FACILITY:

```
 1    2    3
 4.0  4.0  4.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

ALTPRI ARRAY CONTENTS BY FACILITY:

```
 2. 1  5.1  6.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 3. 1  5.1  6.1  2.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 3. 2  5.1  6.1  2.1  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

SCHEDULED INPUT EVENTS

NUMBER OF CAPACITY CARDS READ: 3

CAPACITY TIME	IEVENT	EVENTS TO BE SCHEDULED ARE: FACILITY ID	MAXIMUM CAPACITY	ANNUAL LOADING CAPACITY	ANNUAL UNLOADING CAPACITY	ANNUAL SPRINT CAPACITY	AGE CONSTRAINT OR HEAT
1995.	3	2.10	500.00	50.00	50.00	50.00	-5.00
1998.	3	3.10	703.00	100.00	0.00	0.00	-10.00
1998.	3	3.20	703.00	100.00	0.00	0.00	-10.00

NUMBER OF PRIOR CARDS READ: 1

PRIOR TIME	IEVENT	EVENTS TO BE SCHEDULED ARE: FACILITY ID	SEARCH PRIORITY				
1981.	4	3.00	5.00	6.00	2.00	0.00	0.00

NUMBER OF TSHIP CARDS READ: 1

TSHIP TIME	IEVENT	EVENTS TO BE SCHEDULED ARE: TRANSSHIPMENT ALLOWED
1994.	10	YES

SHIPPING DISTANCES DETERMINED AS FOLLOWS:

REACTOR SHIPPING DISTANCES TO MRS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
REACTOR SHIPPING DISTANCES TO REPOS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
REACTOR SHIPPING DISTANCES TO REPOS #2 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
RAIL SHIPPING DISTANCES FROM MRS #1 TO REPOS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
TRUCK SHIPPING DISTANCES FROM MRS #1 TO REPOS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
RAIL SHIPPING DISTANCES FROM MRS #1 TO REPOS #2 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
TRUCK SHIPPING DISTANCES FROM MRS #1 TO REPOS #2 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
RAIL SHIPPING DISTANCES FROM REPOS #1 TO MRS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
TRUCK SHIPPING DISTANCES FROM REPOS #1 TO MRS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
RAIL SHIPPING DISTANCES FROM REPOS #1 TO REPOS #2 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
TRUCK SHIPPING DISTANCES FROM REPOS #1 TO REPOS #2 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
RAIL SHIPPING DISTANCES FROM REPOS #2 TO MRS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
TRUCK SHIPPING DISTANCES FROM REPOS #2 TO MRS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
RAIL SHIPPING DISTANCES FROM REPOS #2 TO REPOS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.
TRUCK SHIPPING DISTANCES FROM REPOS #2 TO REPOS #1 WILL BE CALCULATED GREAT CIRCLE DISTANCES.

INTERMEDIATE RESULTS

For year 1962.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1963.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1964.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1965.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1966.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1967.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1968.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1969.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1970.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1971.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1972.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1973.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1974.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1975.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1976.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1977.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1978.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1979.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1980.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1981.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0

For year 1982.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1983.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1984.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1985.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1986.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1987.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1988.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1989.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1990.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1991.00 Number of pools w/ dry storage is 0 Number increasing = 0 Number of decreasing is 0
For year 1992.00 Number of pools w/ dry storage is 1 Number increasing = 1 Number of decreasing is 0
For year 1993.00 Number of pools w/ dry storage is 1 Number increasing = 0 Number of decreasing is 0
For year 1994.00 Number of pools w/ dry storage is 1 Number increasing = 1 Number of decreasing is 0
For year 1995.00 Number of pools w/ dry storage is 1 Number increasing = 0 Number of decreasing is 0
*** FACILITIES TYPE 3 IS CHANGING FROM PROXIMITY PROCESSING TO OPTIMIZED PROCESSING. USING FACILITIES 2 AND 3
For year 1996.00 Number of pools w/ dry storage is 1 Number increasing = 0 Number of decreasing is 0
For year 1997.00 Number of pools w/ dry storage is 1 Number increasing = 0 Number of decreasing is 0
For year 1998.00 Number of pools w/ dry storage is 1 Number increasing = 0 Number of decreasing is 0
For year 1999.00 Number of pools w/ dry storage is 1 Number increasing = 0 Number of decreasing is 1

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

DRY STORAGE INVENTORIES MONITORED DURING EXECUTION.
INTEGER DRY STORAGE CASKING CONFIRMED.

SHIPMENTS FROM REACTORS MONITORED DURING EXECUTION.
INTEGER CASK SHIPPING CONFIRMED.

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

Total material accepted into system:
Number of Assemblies = 3939. MT's material = 1180.8

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 1.0 Inventory of Spent Fuel by Year

YEAR	REACTOR POOL		DRY STORAGE		MRS #1		REPOS #1		REPOS #2		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	1031.	229.9	0.	0.0	0.	0.0	0.	0.0	0.	0.0	1031.	229.9
1982	1083.	253.7	0.	0.0	0.	0.0	0.	0.0	0.	0.0	1083.	253.7
1983	1437.	354.6	0.	0.0	0.	0.0	0.	0.0	0.	0.0	1437.	354.6
1984	1515.	390.3	0.	0.0	0.	0.0	0.	0.0	0.	0.0	1515.	390.3
1985	1665.	459.2	0.	0.0	0.	0.0	0.	0.0	0.	0.0	1665.	459.2
1986	1965.	547.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	1965.	547.0
1987	2018.	571.5	0.	0.0	0.	0.0	0.	0.0	0.	0.0	2018.	571.5
1988	2247.	629.1	0.	0.0	0.	0.0	0.	0.0	0.	0.0	2247.	629.1
1989	2366.	684.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	2366.	684.0
1990	2586.	739.5	0.	0.0	0.	0.0	0.	0.0	0.	0.0	2586.	739.5
1991	2655.	771.3	0.	0.0	0.	0.0	0.	0.0	0.	0.0	2655.	771.3
1992	2846.	840.3	104.	18.3	0.	0.0	0.	0.0	0.	0.0	2950.	858.6
1993	2903.	866.6	104.	18.3	0.	0.0	0.	0.0	0.	0.0	3007.	884.9
1994	2972.	895.9	260.	45.9	0.	0.0	0.	0.0	0.	0.0	3232.	941.8
1995	2836.	903.0	260.	45.9	260.	50.1	0.	0.0	0.	0.0	3356.	999.0
1996	1954.	676.9	260.	45.9	375.	100.2	454.	99.9	364.	99.7	3407.	1022.6
1997	1384.	480.1	260.	45.9	558.	150.4	802.	200.4	615.	199.6	3619.	1076.5
1998	1106.	401.5	260.	45.9	421.	152.1	1169.	298.7	777.	230.9	3733.	1129.1
1999	1139.	402.6	208.	36.7	509.	153.8	1306.	356.7	777.	230.9	3939.	1180.8

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 1.1 Inventory of Spent Fuel at Decommissioned Reactors

	FUEL REMAINING AT DECOMMISSIONED REACTORS (MTU)																	FUEL SHIPPED FROM DECOMMISSIONED REACTORS (MTU)			
	AGE < 2			2 < AGE < 5			5 < AGE < 10			10 < AGE			TOTAL	TOTAL		# SITES	TOTAL				SITES
YEAR	POOL	DRY	# RX	POOL	DRY	# RX	POOL	DRY	# RX	POOL	DRY	# RX	POOL	DRY	TOTAL	W FUEL	#SITES	POOLS	DRY	TOTAL	SHIPPING
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.	0.	0.	0
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.	0.	0.	0

NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.

PRIORITY GIVEN TO DECOMMISSIONED REACTORS AFTER 2. YEARS

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 2.01 Spent Fuel Shipped from REACTOR POOL

YEAR	REACTOR POOL		DRY STORAGE		MRS #1		REPOS #1		REPOS #2		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1982	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.												
1992	0.	0.0	104.	18.3	0.	0.0	0.	0.0	0.	0.0	104.	18.3
1993	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1994	0.	0.0	156.	27.6	0.	0.0	0.	0.0	0.	0.0	156.	27.6
1995	0.	0.0	0.	0.0	260.	50.1	0.	0.0	0.	0.0	260.	50.1
1996	0.	0.0	0.	0.0	115.	50.0	454.	99.9	364.	99.7	933.	249.7
1997	0.	0.0	0.	0.0	183.	50.3	348.	100.5	251.	99.9	782.	250.7
1998	0.	0.0	0.	0.0	115.	50.2	277.	80.9	0.	0.0	392.	131.1
1999	0.	0.0	0.	0.0	201.	49.6	21.	9.7	0.	0.0	222.	59.2

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 2.02 Spent Fuel Shipped from DRY STORAGE

YEAR	REACTOR POOL		DRY STORAGE		MRS #1		REPOS #1		REPOS #2		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1982	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.												
1999	49.	8.6	0.	0.0	3.	0.5	0.	0.0	0.	0.0	52.	9.2

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 2.03 Spent Fuel Shipped from MRS #1 (FACILITY # 2.1) TO ...

YEAR	REACTOR POOL		DRY STORAGE		MRS #1		REPOS #1		REPOS #2		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1982	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.												
1998	0.	0.0	0.	0.0	0.	0.0	90.	17.4	162.	31.2	252.	48.6
1999	0.	0.0	0.	0.0	0.	0.0	116.	48.4	0.	0.0	116.	48.4

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 2.04 Spent Fuel Shipped from REPOS #1 (FACILITY # 3.1) TO ...

YEAR	REACTOR POOL		DRY STORAGE		MRS #1		REPOS #1		REPOS #2		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1982	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.												

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 2.05 Spent Fuel Shipped from REPOS #2 (FACILITY # 3.2) TO ...

YEAR	REACTOR POOL		DRY STORAGE		MRS #1		REPOS #1		REPOS #2		TOTAL	
	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT	ASSEMB	MT
1981	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
1982	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0	0.	0.0
NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.												

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 3.01 CHARACTERISTICS OF SPENT FUEL RECEIVED AT OTHER REACTOR POOL

	RECEIPTS, BY AGE (MTU)										RECEIPTS, BY HEAT (MTU)										
	:>= 0	5	8	10	12	15	20				:>= 0.0	0.5	1.0	1.2	1.5	2.0	2.5				: AVG
	: < 5	8	10	12	15	20		MIN	AVG	MAX	: < 0.5	1.0	1.2	1.5	2.0	2.5		MIN	AVG	MAX	: EXP
YEAR :	---	---	---	---	---	---	---	---	---	---	: ---	---	---	---	---	---	---	---	---	---	: ---
TOTAL	0	0	0	0	0	0	0				0	0	0	0	0	0	0				

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 3.02 CHARACTERISTICS OF SPENT FUEL RECEIVED AT DRY STORAGE

YEAR	Age (MTU) >= 0 < 5	5 – 8	8 – 10	10 – 12	12 – 15	15 – 20	>= 20	MIN	AVG	MAX	Heat (MTU) >= 0.0 < 0.5	0.5 – 1.0	1.0 – 1.2	1.2 – 1.5	1.5 – 2.0	2.0 – 2.5	>= 2.5	MIN	AVG	MAX	AVG EXP
1992	18	0	0	0	0	0	0	0.4	0.4	0.4	0	0	0	0	0	0	18	6.65	6.65	6.65	32.
1993	0	0	0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.
1994	28	0	0	0	0	0	0	0.2	0.2	0.2	0	0	0	0	0	0	28	7.58	7.58	7.58	38.
1995	0	0	0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.
1996	0	0	0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.
NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.																					
TOTAL	46	0	0	0	0	0	0				0	0	0	0	0	0	46				

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 3.03 CHARACTERISTICS OF SPENT FUEL RECEIVED AT MRS #1

YEAR	Age (MTU) >= 0 < 5	5 – 8	8 – 10	10 – 12	12 – 15	15 – 20	>= 20	MIN	AVG	MAX	Heat (MTU) >= 0.0 < 0.5	0.5 – 1.0	1.0 – 1.2	1.2 – 1.5	1.5 – 2.0	2.0 – 2.5	>= 2.5	MIN	AVG	MAX	AVG EXP
1995	0	0	0	0	0	21	29	18.4	19.5	22.1	50	0	0	0	0	0	0	0.24	0.33	0.42	13.
1996	0	0	0	0	50	0	0	12.9	13.8	14.3	12	29	9	0	0	0	0	0.28	0.75	1.09	26.
1997	0	0	3	47	0	0	0	9.8	11.2	11.3	0	26	0	21	2	1	0	0.78	1.13	2.43	34.
1998	0	0	50	0	0	0	0	8.3	9.5	9.8	0	0	2	0	41	7	0	1.13	1.74	2.29	46.
1999	0	1	50	0	0	0	0	7.4	9.4	9.6	0	5	22	18	5	0	0	0.88	1.22	1.51	35.
TOTAL	0	1	103	47	50	21	29				62	59	33	39	48	8	0				

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 3.04 CHARACTERISTICS OF SPENT FUEL RECEIVED AT REPOS #1

YEAR	Age (MTU) >= 0 < 5	5 – 8	8 – 10	10 – 12	12 – 15	15 – 20	>= 20	MIN	AVG	MAX	Heat (MTU) >= 0.0 < 0.5	0.5 – 1.0	1.0 – 1.2	1.2 – 1.5	1.5 – 2.0	2.0 – 2.5	>= 2.5	MIN	AVG	MAX	AVG EXP
1996	0	0	0	0	0	100	0	16.2	18.7	19.4	84	16	0	0	0	0	0	0.41	0.44	0.75	17.
1997	0	0	0	1	99	0	0	11.3	13.9	14.3	0	99	0	1	0	0	0	0.54	0.74	1.43	26.
1998	0	0	2	79	0	0	17	9.3	13.1	26.1	17	0	0	35	39	6	0	0.23	1.30	2.36	37.
1999	0	0	3	7	0	47	2	8.8	15.9	22.4	13	27	9	3	7	0	0	0.26	0.85	1.68	29.
TOTAL	0	0	5	87	99	147	19				114	142	9	39	46	6	0				

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:06:56)

TABLE 3.05 CHARACTERISTICS OF SPENT FUEL RECEIVED AT REPOS #2

YEAR	Age (MTU) >= 0 < 5	5 – 8	8 – 10	10 – 12	12 – 15	15 – 20	>= 20	MIN	AVG	MAX	Heat (MTU) >= 0.0 < 0.5	0.5 – 1.0	1.0 – 1.2	1.2 – 1.5	1.5 – 2.0	2.0 – 2.5	>= 2.5	MIN	AVG	MAX	AVG EXP
1996	0	0	0	0	20	80	0	13.1	15.3	17.0	19	80	0	0	0	0	0	0.28	0.61	0.83	22.
1997	0	0	0	40	60	0	0	10.3	12.4	13.0	0	47	19	34	0	0	0	0.65	1.02	1.60	32.
1998	0	0	0	0	0	0	31	21.4	22.0	23.0	31	0	0	0	0	0	0	0.27	0.35	0.40	15.
1999	0	0	0	0	0	0	0	0.0	0.0	0.0	0	0	0	0	0	0	0	0.00	0.00	0.00	0.
TOTAL	0	0	0	40	80	80	31				50	127	19	34	0	0	0				

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 4.01 Transportation Characterization Summary for Spent Fuel Shipped to REACTOR POOL

YEAR	TRUCK SHIP. PWR	/ BWR	%(PWR)	RAIL SHIP. PWR	/ BWR	%(PWR)	NUMBER OF SHIP. TRUCK	/ RAIL	TOTAL	%(TRK)	MT'S RECEIVED PWR	/ BWR	%(PWR)	TOTAL	MT'S SHIPPED FROM FACILITY			
1995	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0./	50.	0.0	50.14
1996	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	125./	124.	50.2	249.66
1997	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	180./	71.	71.8	250.69
1998	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	100./	31.	76.3	131.13
1999	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	32./	27.	54.5	59.25

TOTALS FOR REACTOR POOL

	TRUCK SHIPMENTS PWR	BWR	% PWR	RAIL SHIPMENTS PWR	BWR	% PWR	TOTAL NUMBER OF SHIPMENTS TRUCK	RAIL	TOTAL	% TRUCK
TOTAL	0. /	0.	0.0	0. /	0.	0.0	0. /	0.	0.	0.0

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 4.02 Transportation Characterization Summary for Spent Fuel Shipped to DRY STORAGE

YEAR	TRUCK SHIP. PWR	/ BWR	%(PWR)	RAIL SHIP. PWR	/ BWR	%(PWR)	NUMBER OF SHIP. TRUCK	/ RAIL	TOTAL	%(TRK)	MT'S RECEIVED PWR	/ BWR	%(PWR)	TOTAL	MT'S SHIPPED FROM FACILITY			
1992	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	18.	0.0	18.3	0./	0.	0.0	0.00
1993	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0./	0.	0.0	0.00
1994	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	28.	0.0	27.6	0./	0.	0.0	0.00
1995	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0./	0.	0.0	0.00
1996	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0./	0.	0.0	0.00
NO MORE CONSECUTIVE 0 VALUES WILL BE PRINTED.																		
1999	0./	0.	0.0	0./	0.	0.0	0./	0.	0.	0.0	0./	0.	0.0	0.0	0./	1.	0.0	0.53

TOTALS FOR DRY STORAGE

	TRUCK SHIPMENTS PWR	BWR	% PWR	RAIL SHIPMENTS PWR	BWR	% PWR	TOTAL NUMBER OF SHIPMENTS TRUCK	RAIL	TOTAL	% TRUCK
TOTAL	0. /	0.	0.0	0. /	0.	0.0	0. /	0.	0.	0.0

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 4.03 Transportation Characterization Summary for Spent Fuel Shipped to MRS #1 (FACILITY # 2.1)

YEAR	TRUCK SHIP. PWR	/ BWR	%(PWR)	RAIL SHIP. PWR	/ BWR	%(PWR)	NUMBER OF SHIP. TRUCK	/ RAIL	TOTAL	%(TRK)	MT'S RECEIVED PWR	/ BWR	%(PWR)	TOTAL	MT'S SHIPPED FROM FACILITY			
1995	0./	52.	0.0	0./	0.	0.0	52./	0.	52.	100.0	0./	50.	0.0	50.1	0./	0.	0.0	0.00
1996	0./	2.	0.0	15./	0.	100.0	2./	15.	17.	11.8	48./	2.	96.3	50.0	0./	0.	0.0	0.00
1997	0./	24.	0.0	9./	0.	100.0	24./	9.	33.	72.7	29./	21.	57.7	50.3	0./	0.	0.0	0.00
1998	0./	2.	0.0	15./	0.	100.0	2./	15.	17.	11.8	48./	2.	96.5	50.2	0./	49.	0.0	48.60
1999	0./	31.	0.0	7./	0.	100.0	31./	7.	38.	81.6	23./	27.	45.1	50.1	45./	3.	93.0	48.36

TOTALS FOR MRS #1

	TRUCK SHIPMENTS PWR	BWR	% PWR	RAIL SHIPMENTS PWR	BWR	% PWR	TOTAL NUMBER OF SHIPMENTS TRUCK	RAIL	TOTAL	% TRUCK
TOTAL	0. /	111.	0.0	46. /	0.	100.0	111. /	46.	157.	70.7

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 4.04 Transportation Characterization Summary for Spent Fuel Shipped to REPOS #1 (FACILITY # 3.1)

YEAR	TRUCK SHIP. PWR	/ BWR	%(PWR)	RAIL SHIP. PWR	/ BWR	%(PWR)	NUMBER OF SHIP. TRUCK	/ RAIL	TOTAL	%(TRK)	MT'S RECEIVED PWR	/ BWR	%(PWR)	TOTAL	SQUARES SHIPPED TO FACILITY FULL SQUARES	HALF SQUARES
1996	0./	81.	0.0	7./	0.	100.0	81./	7.	88.	92.0	23./	77.	22.5	99.9	0.00	0.00
1997	0./	44.	0.0	19./	0.	100.0	44./	19.	63.	69.8	61./	40.	60.7	100.5	0.00	0.00
1998	0./	33.	0.0	16./	5.	76.2	33./	21.	54.	61.1	52./	47.	52.6	98.3	0.00	0.00
1999	0./	0.	0.0	17./	1.	94.4	0./	18.	18.	0.0	55./	3.	94.2	58.1	0.00	0.00

TOTALS FOR REPOS #1

	TRUCK SHIPMENTS PWR	BWR	% PWR	RAIL SHIPMENTS PWR	BWR	% PWR	TOTAL NUMBER OF SHIPMENTS TRUCK	RAIL	TOTAL	% TRUCK
TOTAL	0. /	158.	0.0	59. /	6.	90.8	158. /	65.	223.	70.9

TABLE 4.05 Transportation Characterization Summary for Spent Fuel Shipped to REPOS #2 (FACILITY # 3.2)

YEAR	TRUCK SHIP. PWR / BWR	%(PWR)	RAIL SHIP. PWR / BWR	%(PWR)	NUMBER OF SHIP. TRUCK / RAIL	TOTAL	%(TRK)	MT'S RECEIVED PWR / BWR	%(PWR)	TOTAL	SQUARES SHIPPED TO FACILITY FULL SQUARES	HALF SQUARES
1996	0./ 49.	0.0	17./ 0.	100.0	49./ 17.	66.	74.2	55./ 45.	54.8	99.7	0.00	0.00
1997	0./ 11.	0.0	28./ 0.	100.0	11./ 28.	39.	28.2	90./ 10.	90.1	99.9	0.00	0.00
1998	0./ 0.	0.0	0./ 9.	0.0	0./ 9.	9.	0.0	0./ 31.	0.0	31.2	0.00	0.00
1999	0./ 0.	0.0	0./ 0.	0.0	0./ 0.	0.	0.0	0./ 0.	0.0	0.0	0.00	0.00

TOTALS FOR REPOS #2

	TRUCK SHIPMENTS PWR / BWR	% PWR	RAIL SHIPMENTS PWR / BWR	% PWR	TOTAL NUMBER OF SHIPMENTS TRUCK / RAIL	TOTAL	% TRUCK
TOTAL	0. / 60.	0.0	45. / 9.	83.3	60. / 54.	114.	52.6

TABLE 5.01 Shipping Fleet Requirements for Spent Fuel Shipped to REACTOR POOL

YEAR	SHIPPING COSTS($)*10**6 TRUCK / RAIL	%(TRUCK)	BUSY DAYS*10**3 TRUCK / RAIL	%(TRUCK)	NO. OF CASKS REQ. TRUCK / RAIL	%(TRUCK)

TOTAL TRUCK BUSY DAYS = 0.00
TOTAL RAIL BUSY DAYS = 0.00

TABLE 5.02 Shipping Fleet Requirements for Spent Fuel Shipped to DRY STORAGE

YEAR	SHIPPING COSTS($)*10**6 TRUCK / RAIL	%(TRUCK)	BUSY DAYS*10**3 TRUCK / RAIL	%(TRUCK)	NO. OF CASKS REQ. TRUCK / RAIL	%(TRUCK)

TOTAL TRUCK BUSY DAYS = 0.00
TOTAL RAIL BUSY DAYS = 0.00

TABLE 5.03 Shipping Fleet Requirements for Spent Fuel Shipped to MRS #1 (FACILITY # 2.1)

YEAR	SHIPPING COSTS($)*10**6 TRUCK / RAIL	%(TRUCK)	BUSY DAYS*10**3 TRUCK / RAIL	%(TRUCK)	NO. OF CASKS REQ. TRUCK / RAIL	%(TRUCK)
1995	0.3660 / 0.0000	100.0	0.261 / 0.000	100.0	1 / 0	100.0
1996	0.0118 / 0.4293	2.7	0.010 / 0.291	3.3	1 / 1	50.0
1997	0.1411 / 0.2577	35.4	0.121 / 0.175	40.9	1 / 1	50.0
1998	0.0118 / 0.4297	2.7	0.010 / 0.291	3.3	1 / 1	50.0
1999	0.1822 / 0.2006	47.6	0.156 / 0.136	53.4	1 / 1	50.0

SUB-T 0.6528 / 1.3173 33.1 MT'S OF PWR = 148.257 , MT'S OF BWR = 102.489 , 59.13 %(PWR)
TOTAL 1.9701 , TOTAL MT'S = 250.746 , AVG. COST = 7.86 ($/KG)

TOTAL TRUCK BUSY DAYS = 558.08
TOTAL RAIL BUSY DAYS = 892.94

TABLE 5.04 Shipping Fleet Requirements for Spent Fuel Shipped to REPOS #1 (FACILITY # 3.1)

YEAR	SHIPPING COSTS($)*10**6 TRUCK / RAIL	%(TRUCK)	BUSY DAYS*10**3 TRUCK / RAIL	%(TRUCK)	NO. OF CASKS REQ. TRUCK / RAIL	%(TRUCK)
1996	1.4238 / 0.4687	75.2	0.776 / 0.222	77.7	3 / 1	75.0
1997	0.7604 / 1.2715	37.4	0.421 / 0.604	41.1	2 / 3	40.0
1998	0.5793 / 1.3766	29.6	0.316 / 0.659	32.4	2 / 3	40.0
1999	0.0000 / 1.1114	0.0	0.000 / 0.548	0.0	0 / 2	0.0

SUB-T 2.7636 / 4.2282 39.5 MT'S OF PWR = 189.818 , MT'S OF BWR = 166.920 , 53.21 %(PWR)
TOTAL 6.9918 , TOTAL MT'S = 356.738 , AVG. COST = 19.60 ($/KG)

TOTAL TRUCK BUSY DAYS = 1513.37
TOTAL RAIL BUSY DAYS = 2033.43

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 5.05 Shipping Fleet Requirements for Spent Fuel Shipped to REPOS #2 (FACILITY # 3.2)

SHIPPING COSTS($)*10**6 YEAR	TRUCK / RAIL		%(TRUCK)	BUSY DAYS*10**3 TRUCK / RAIL		%(TRUCK)	NO. OF CASKS REQ. TRUCK / RAIL		%(TRUCK)
1996	0.3155 /	0.3518	47.3	0.258 /	0.260	49.8	1 /	1	50.0
1997	0.0708 /	0.5796	10.9	0.058 /	0.429	11.9	1 /	2	33.3
1998	0.0000 /	0.2110	0.0	0.000 /	0.154	0.0	0 /	1	0.0
1999	0.0000 /	0.0000	0.0	0.000 /	0.000	0.0	0 /	0	0.0

SUB-T 0.3863 / 1.1423 25.3 MT'S OF PWR = 144.633 , MT'S OF BWR = 86.245 , 62.64 %(PWR)
TOTAL 1.5286 , TOTAL MT'S = 230.878 , AVG. COST = 6.62 ($/KG)

TOTAL TRUCK BUSY DAYS = 315.95
TOTAL RAIL BUSY DAYS = 842.52

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 5.06 SUMMARY TABLE.

SHIPPING COSTS($)*10**6 YEAR	TRUCK / RAIL		%(TRUCK)	BUSY DAYS*10**3 TRUCK / RAIL		%(TRUCK)	NO. OF CASKS REQ. TRUCK / RAIL		%(TRUCK)	CORR. LEASE COST ($-MILLIONS)	
1995	0.3066 /	0.0000	100.0	0.261 /	0.000	100.0	1 /	0	100.0	0.240000 /	0.000000
1996	1.7511 /	1.2498	58.4	1.044 /	0.774	57.4	4 /	3	57.1	0.960000 /	1.620000
1997	0.9723 /	2.1067	31.6	0.600 /	1.207	33.2	3 /	5	37.5	0.720000 /	2.700000
1998	0.5911 /	2.0173	22.7	0.326 /	1.104	22.8	2 /	4	33.3	0.480000 /	2.160000
1999	0.1822 /	1.3120	12.2	0.156 /	0.684	18.6	1 /	3	25.0	0.240000 /	1.620000

SUB-T 3.8026/ 6.6878 36.2, MT'S OF PWR = 482.706 , MT'S OF BWR = 355.655 , 57.58 %(PWR) 2.640000/ 8.100000
TOTAL 10.4904 , TOTAL MT'S = 838.362 , AVG. COST = 12.51 ($/KG) , TOTAL LEASE COST = 10.740000
AVG. LEASE COST = 12.81 ($/KG)

MT'S BY TRUCK = 303.669, INCLUDING RESHIPMENT
MT'S BY RAIL = 534.693, INCLUDING RESHIPMENT
AVG. ANNUAL MT'S / (TRUCK CASK-YEAR) = 27.606
AVG. ANNUAL MT'S / (RAIL CASK-YEAR) = 35.646

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 6.00 Facility to Facility Shipping Cost ($/KG)

	POOL	DRY	2.1	3.1	3.2
POOL	0.00	0.00	7.86	19.85	6.66
DRY	0.00	0.00	6.64	0.00	0.00
2.1	0.00	0.00	0.00	18.49	6.75
3.1	0.00	0.00	0.00	0.00	0.00
3.2	0.00	0.00	0.00	0.00	0.00

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 7.00 Maximum Fleet Purchase Requirements and Cost

YEAR	CASK NAME	# OF SHIPMENTS	CASK-MILES	# CASKS PURCHASED	# CASKS RETIRED	# CASKS AVAILABLE	PURCHASE COST ($-MILLIONS)	MAINT. COST ($-MILLIONS)	TOTAL COST ($-MILLIONS)
1995	T1	52	44304.	1	0	1	1.400000	0.075000	1.475000
	R1	0	0.	0	0	0	0.000000	0.000000	0.000000
1996	T1	132	272236.	3	0	4	4.200000	0.300000	4.500000
	R1	39	36572.	3	0	3	15.900000	0.375000	16.275000
1997	T1	79	152536.	0	0	4	0.000000	0.300000	0.300000
	R1	56	69779.	2	0	5	10.600000	0.625000	11.225000
1998	T1	35	92916.	0	0	4	0.000000	0.300000	0.300000
	R1	45	72669.	0	0	5	0.000000	0.625000	0.625000
1999	T1	31	26412.	0	0	4	0.000000	0.300000	0.300000
	R1	25	50426.	0	0	5	0.000000	0.625000	0.625000
CASK SUB-TOTAL	T1	329	588404.	4	0		5.600000	1.275000	6.875000
	R1	165	229446.	5	0		26.500000	2.250000	28.750000
GRAND TOTAL		494	817850.	9	0		32.100000	3.525000	35.625000

AVG. T1 UTILIZATION FOR MAXIMUM PURCHASE = 140.44 DAYS/YR
AVG. R1 UTILIZATION FOR MAXIMUM PURCHASE = 209.38 DAYS/YR

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 8.00 Levelized Fleet Purchase Requirements and Cost

YEAR	CASK NAME	# OF SHIPMENTS	CASK-MILES	# CASKS PURCHASED	# CASKS RETIRED	# CASKS AVAILABLE	PURCHASE COST ($-MILLIONS)	MAINT. COST ($-MILLIONS)	TOTAL COST ($-MILLIONS)
1995	T1	N/A	N/A	1	0	1	1.400000	0.075000	1.475000
	R1	N/A	N/A	0	0	0	0.000000	0.000000	0.000000
1996	T1	N/A	N/A	3	0	4	4.200000	0.300000	4.500000
	R1	N/A	N/A	3	0	3	15.900000	0.375000	16.275000
1997	T1	N/A	N/A	0	0	4	0.000000	0.300000	0.300000
	R1	N/A	N/A	2	0	5	10.600000	0.625000	11.225000
1998	T1	N/A	N/A	0	0	4	0.000000	0.300000	0.300000
	R1	N/A	N/A	0	0	5	0.000000	0.625000	0.625000
1999	T1	N/A	N/A	0	0	4	0.000000	0.300000	0.300000
	R1	N/A	N/A	0	0	5	0.000000	0.625000	0.625000
CASK SUB-TOTAL	T1	N/A	N/A	4	0		5.600000	1.275000	6.875000
	R1	N/A	N/A	5	0		26.500000	2.250000	28.750000
GRAND TOTAL		N/A	N/A	9	0		32.100000	3.525000	35.625000

AVG. T1 UTILIZATION FOR MAXIMUM PURCHASE = 140.44 DAYS/YR
AVG. R1 UTILIZATION FOR MAXIMUM PURCHASE = 209.38 DAYS/YR

TABLE 9.00 Transportation Cost summary by Category.

	OPTION			
	MINIMUM LEASE COST / $/KG ($-MILLIONS)	REQUIRED LEASE COST / $/KG ($-MILLIONS)	MAXIMUM PURCHASE COST / $/KG ($-MILLIONS)	LEVELIZED PURCHASE COST / $/KG ($-MILLIONS)
Shipping Cost				
T1	2.651648 / 8.73	2.651648 / 8.73	2.651648 / 8.73	2.651648 / 8.73
R1	5.860058 / 10.96	5.860058 / 10.96	5.860058 / 10.96	5.860058 / 10.96
Security/ Surcharge				
T1	1.150999 / 3.79	1.150999 / 3.79	1.150999 / 3.79	1.150999 / 3.79
R1	0.827711 / 1.55	0.827711 / 1.55	0.827711 / 1.55	0.827711 / 1.55
Lease Cost				
T1	1.909921 / 6.29	2.640000 / 8.69	0.000000 / 0.00	0.000000 / 0.00
R1	6.784000 / 12.69	8.100000 / 15.15	0.000000 / 0.00	0.000000 / 0.00
Purchase Cost				
T1	0.000000 / 0.00	0.000000 / 0.00	5.600000 / 18.44	5.600000 / 18.44
R1	0.000000 / 0.00	0.000000 / 0.00	26.500000 / 49.56	26.500000 / 49.56
Maintenance Cost				
T1	0.000000 / 0.00	0.000000 / 0.00	1.275000 / 4.20	1.275000 / 4.20
R1	0.000000 / 0.00	0.000000 / 0.00	2.250000 / 4.21	2.250000 / 4.21
Sub-Total				
T1	5.712569 / 18.81	6.442648 / 21.22	10.677647 / 35.16	10.677647 / 35.16
R1	13.471776 / 25.20	14.787776 / 27.66	35.437772 / 66.28	35.437772 / 66.28
Total	19.184344 / 22.88	21.230418 / 25.32	46.115420 / 55.01	46.115420 / 55.01

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 10.01 Characteristics of Cask Shipments by Centroid for each Facility.

CENTROID NUMBER	TRANS. MODE	MRS #1 CASK-MILES	/ RECEIPTS	REPOS #1 CASK-MILES	/ RECEIPTS	REPOS #2 CASK-MILES	/ RECEIPTS
1	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
2	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
3	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
4	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
5	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
6	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
7	TRUCK	94572.	111.	436712.	158.	57120.	60.
	RAIL	0.	0.	0.	0.	0.	0.
8	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
9	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
10	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
11	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
12	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	33534.	46.	126450.	45.	15795.	45.
13	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
14	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
15	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
16	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
17	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
18	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
19	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
20	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
21	TRUCK	0.	0.	0.	0.	0.	0.
	RAIL	0.	0.	0.	0.	0.	0.
TOTAL	TRUCK	94572.		436712.		57120.	
TOTAL	RAIL	33534.		126450.		15795.	
TOTAL		128106.		563162.		72915.	

PROJECT TITLE: SAMPLE #2 DATE OF RUN: 1/19/88 (12:05:56)

TABLE 10.02 Characteristics of Fuel Shipped by Centroid (Years / MWD/KG).

CENTROID NUMBER	TRANS. MODE	MRS #1 AGE / EXP	REPOS #1 AGE / EXP	REPOS #2 AGE / EXP
1	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
2	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
3	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
4	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
5	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
6	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
7	TRUCK	14.8 / 23.54	16.0 / 22.76	14.6 / 22.89
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
8	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
9	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
10	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
11	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
12	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	11.2 / 35.45	13.2 / 33.69	13.5 / 28.97
13	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
14	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
15	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
16	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
17	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
18	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
19	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
20	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
21	TRUCK	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00
	RAIL	0.0 / 0.00	0.0 / 0.00	0.0 / 0.00

TABLE 11.01 CASH FLOWS FOR DRY STORAGE: CUMULATIVE TOTAL
ASSUMING NO CANNING OR CONSOLIDATION

YEAR	CAPITAL INVESTED IN... YARDS	CASKS	TOTAL	OPERATION/MAINTENANCE RELATED TO... YARDS	CASKS	TOTAL	DECOMMISSIONING COST FOR... YARDS	CASKS	EQUIPMENT SALVAGE	TOTAL	ANNUAL TOTAL	DISCOUNTED ANNUAL
1988	0.70	0.00	0.70	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.70	4.31
1989	0.17	0.00	0.17	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.18	0.98
1990	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.04
1991	1.93	1.40	3.33	0.04	0.00	0.04	0.00	0.00	0.00	0.00	3.37	15.48
1992	0.00	0.00	0.00	0.10	0.02	0.11	0.00	0.00	0.00	0.00	0.11	0.47
1993	0.00	2.11	2.11	0.12	0.00	0.12	0.00	0.00	0.00	0.00	2.22	8.44
1994	0.00	0.00	0.00	0.15	0.02	0.17	0.00	0.00	0.00	0.00	0.17	0.59
1995	0.00	0.00	0.00	0.15	0.00	0.15	0.00	0.00	0.00	0.00	0.15	0.46
1996	0.00	0.00	0.00	0.15	0.00	0.15	0.00	0.00	0.00	0.00	0.15	0.42
1997	0.00	0.00	0.00	0.15	0.00	0.15	0.00	0.00	0.00	0.00	0.15	0.38
1998	0.00	0.00	0.00	0.15	0.00	0.15	0.00	0.00	0.00	0.00	0.15	0.35
1999	0.00	0.00	0.00	0.15	0.01	0.15	0.00	0.00	0.00	0.00	0.15	0.33
TOTAL	2.79	3.51	6.30	1.16	0.05	1.21	0.00	0.00	0.00	0.00	7.51	32.25

TABLE 11.02 CASH FLOWS FOR DRY STORAGE: CUMULATIVE TOTAL

ACTIVE NUMBER OF...

YEAR	YARDS PWR	BWR	MIXED	TOT	CASKS PWR	BWR	TOT	ASSEMBLIES PWR	BWR	TOT
1988	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0
1990	0	0	0	0	0	0	0	0	0	0
1991	0	0	0	0	0	0	0	0	0	0
1992	0	1	0	1	0	2	2	0	104	104
1993	0	1	0	1	0	2	2	0	104	104
1994	0	1	0	1	0	5	5	0	260	260
1995	0	1	0	1	0	5	5	0	260	260
1996	0	1	0	1	0	5	5	0	260	260
1997	0	1	0	1	0	5	5	0	260	260
1998	0	1	0	1	0	5	5	0	260	260
1999	0	1	0	1	0	4	4	0	208	208

APPENDIX D

TRANSPORTATION COSTS FOR THE USERCOST OPTION

APPENDIX D

TRANSPORTATION COSTS FOR THE USERCOST OPTION

The USERCOST option was added to the WASTES code in order to support the Total System Life-Cycle Cost (TSLCC) analysis. The algorithms and default values were provided by Weston. It is recommended that Weston be contacted for complete information if this option is to be used. A brief discussion of this feature is included below. Refer to the USERCOST card description in Appendix A for further information.

Assumptions:

- In order for the proper costs to be reported for truck shipments, all facilities that receive truck shipments must have the same latitude and longitude as one of the facilities in the truck distance look-up table (TRUKDIST.TAB) and TRUKDIST.TAB must exist in the logical directory DATA.

- WASTES uses distances (Dist) from the distance look-up tables (TRUKDIST.TAB and RAILDIST.TAB) if they exist and the latitude and longitudes specified in the FACSPEC card of the input deck match the latitude and longitude of a facility in the distance look-up tables. Otherwise the distances are calculated as a function of the great circle distance.

- All rail shipments are in unit train quantities. For shipments from reactors, the number of casks in a unit train shipment (NCIS) equals the number of casks shipped from that reactor to a specific destination during the year (e.g., if reactor 101 shipped 3 casks to facility 1 and 2 casks to facility 2, two unit trains consisting of 3 and 2 casks would be costed). The number of casks in unit trains from reactors does not currently factor into cask acquisition numbers (e.g., a unit train of 7 casks will be allowed even though only 5 have been purchased). For shipments from facilities, the number of casks in a unit train is determined by the MSHIP card for that cask. If no MSHIP card exists single cask shipments are assumed.

- All truck shipments are costed as single cask shipments. No economy of scale exists for multiple cask shipments.

Notes on costing algorithms:

Dist = one-way distance in miles (see above).

NCIS = number of casks in a shipment (see above).

Shipping costs are reported on a $/cask shipped basis.

The following algorithms are used to calculate shipping costs when the USERCOST option is selected. In order to change any of the default values (shown in brackets below the equation), a USERCOST card with the variable and new value is added to the input deck (e.g., USERCOST,RGFS(1)=38.0,RGFS(2)=2.1333). Refer to the input card description in Appendix A for further information.

Rail Costing Algorithms:

Carrier Charges:

```
Base Rate = RBCst(1) * RBCst(2) * (Dist ** RBCst(3)) ($/CWt)
          = [ 9/40 * 0.1616 * (Dist ** 0.5860) ]

Adder Rate = (RBCst(4) * Dist * n) / NCIS
           = [ 48.00 * Dist * n) / NCIS

          n = 1 if source is a reactor
            = 2 if source is a facility

Ship$ = Base Rate * ((Empty Weight + Full Weight) / 100) + Adder Rate
```

Time Calculations:

```
General Freight Speed (GFS) = maximum of RGFS(3) and
                              RGFS(1) * (Dist ** RGFS(2))
                            = [ 40.0, 2.8596 * ( Dist ** 0.5410)]

Travel Speed Full (TS(1)) = RMult(1) * GFS   if source is a reactor
                          = [1.5 * GFS]
                  or      = RMult(3) * GFS if source is a facility
                          = [1.5 * GFS]

Travel Speed Empty (TS(2))= RMult(2) * GFS if source is a reactor
                          = [1.0 * GFS]
                  or      = Rmult(3) * GFS if source is a facility
                          = [1.5 * GFS]

Load Time (BDT(1))   = (RTaT(1) * (NCIS + (NCIS**2))/2)/NCIS if source is
                        a reactor
                     = [ (3.0 * (NCIS + (NCIS**2))/2)/NCIS ]
                or   = (RTaT(3) / NCIS) if source is a facility
                     = [ (4.5 / NCIS) ]

Unload Time (BDT(2)) = RTaT(2) if source is a reactor
                     = [2.0]
                or   = RTaT(3) / NCIS is source is a facility
                     = [ 4.5 / NCIS ]
```

Travel Time Loaded (TODAYS) = Dist / TS(1)

Travel Time Empty (FROMDAYS) = Dist / TS(2)

Average Cask Busy Days (BDays) = BDT(1) + BDT(2) + TODAYS + FROMDAYS

Support and Security Charges:

Escort Travel Cost (CostDet(3)) = (RAECst(2) * (TODAYS + FROMDAYS) * RAECst(3)) / NCIS
= [(250.00 * (TODAYS + FROMDAYS) * 2) / NCIS]

Escort Ticket Cost (CostDet(4) = (RAECst(1) * Dist * RAECst(3) * 2) / NCIS
= [(.19 * Dist * 2 * 2)/NCIS]

Inspection Cost (CostDet(5) = RTaT(1) * RICst(1) * RICst(2) if reactor source
= [3.0 * 470.00 * 1]
or = 0.0 if facility source

Escort Detention Time (EDT) = RTaT(1) if reactor source
= (3.0)
or = RTaT(3) if facility source
= (4.5)

Escort Detention Cost (CostDet(6) = (RAECst(2) * EDT * RAECst(3)) / NCIS
= [(250.00 * EDT * 2) / NCIS]

Support and security cost (SandS$) = CostDet(3) + CostDet(4) + CostDet(5) + CostDet(6)

Cask Rent Charges:

Rent = Daily Rent * BDays

Total Shipping Cost: ($/cask)

Total Cost = Ship$ + SandS$ + Rent

Truck Costing Algorithms:

Carrier Charges:

```
Base Rate Full (BR(1))      = (TBCst(1,1) * Dist) + TBCst(1,2) ($/CWt)
                            = [ (0.004764 * Dist) + 1.1614 ]

Base Rate Empty (BR(2))     = (TBCst(2,1) * Dist) + TBCst(2,2) ($/CWt)
                            = [ (0.004020 * Dist) + 0.3954 ]

Base Shipping Cost (Ship$) =  (BR(1) * Full Weight / 100) +
                              (BR(2) * Empty Weight / 100)
```

Time Calculations:

```
Travel Time (TT)       = 2 * Dist / TrkSpd
                       = [ 2 * Dist / 900.0 ]

Load Time (LT)         = TTaT(1) if source is a reactor
                       = [1.75]
                 or    = TTaT(2) if source is a facility
                       = [1.25]

Unload Time (ULT)      = TTaT(1) if destination is a reactor
                       = [1.75]
                 or    = TTaT(2) if destination is a facility
                       = [1.25]

Cask Busy Days (BDays) = TT + LT + ULT
```

Support and Security Charges:

```
Second Driver (CostDet(1)) = Maximum of TADcst(2) and TADcst(1)*Dist* 2
                           = [120.00, 0.25 * Dist * 2]

Escort Charge (CostDet(2)) = TrukSecCst(Dest, Source) * 2
                           = [ look up table  * 2 ]

Security Equip (CostDet(3)) = Maximum of TSECst(2) and TSECst(1) * Dist
                            = [ 200.0, .92 * Dist ]

Call Check (CostDet(4))   = TCCcst * Dist
                          = [ 0.30 * Dist]

Inspection (CostDet(5))   = TIcst
                          = [822.50]

Detention (CostDet(6))    = TDetCst
                          = [870.00]
```

Constant Surv. (CostDet(7)) = TCScst * Dist
= [0.25 * Dist]

Support and Security Cost (SandS$) = CostDet(1) + CostDet(2) + CostDet(3) + CostDet(4) + CostDet(5) + CostDet(6) + CostDet(7)

Cask Rent Charges:

Rent = Daily Rent * BDays

Total Shipping Cost:

Total Cost = Ship$ + SandS$ + Rent

APPENDIX E

SPENT FUEL PROCESSING ALTERNATIVES

APPENDIX E

SPENT FUEL PROCESSING ALTERNATIVES

Spent fuel processing alternatives are the broad operational philosophies used by the WASTES code to model the various waste disposal options currently under consideration.

E.1 RESTORATION OF FCR MARGINS

The restoration of full-core-reserve (FCR) margins in reactor pools (the FCR option in the PROCESS card) is required to maintain realistic reactor pool inventories. Violation occurs when the available pool capacity falls below zero due to a core discharge. Available pool capacity is the amount of capacity available for storage of spent fuel. The remaining capacity is reserved for dumping of the core in an emergency and for temporary storage processes such as the unloading of ex-pool storage casks prior to loading into shipping casks. The equation used to determine the active pool capacity is as follows:

available pool capacity =
maximum pool capacity - (core size * FCR fraction) - current inventory

The values for the maximum pool capacity and FCR margin are contained in the RXINFO portion of the spent fuel database. The FCR fraction is specified by the FCRFRAC card in the user input deck (defaults to 1.0).

There are three destination options available for the restoration of the FCR margin. In order of default priority they are: transfer of fuel to non-reactor facilities, transfer of fuel to other reactor pools (transshipping), and transfer of fuel to an ex-pool storage site. Selection of these options may be controlled to a limited extent by use of the age and heat cards in the user input deck (e.g., FCRAGE, AGEAT, FCRHEAT, etc.). The restoration process is attempted after all discharges have been processed for the year.

In order to minimize the number of sites incurring ex-pool storage costs, the pools that have exceeded their active pool capacity are ranked by the amount of fuel in violation of the FCR and weather or not the pool has an ex-pool storage site open (e.g., order of processing: low amount/no ex-pool, high amount/no ex-pool, low amount/ex-pool, high amount/ex-pool).

Fuel is removed in integer cask (shipping or ex-pool storage as appropriate) quantities until active pool capacity is positive.

Shipments to Non-reactor Facilities

The first destinations examined are the non-reactor facilities. The order in which they are examined is determined by the FILLORDER card. The type of filling is specified by the RUNTYPE card (i.e., optimal or proximal). The oldest spent fuel in the pool will be selected for shipping to restore the FCR margin. The cask selected is the common cask with the highest priority for the destination. The capacities of non-reactor facilities may be modified for FCR restoration by specifying a "sprint" capacity on the CAPACITY card of the user input deck.

Shipments to Other Reactor Pools (Transshipping)

If the non-reactor facilities were unable to accept all of the fuel due to insufficient capacity, no cask links, or no fuel that passed the acceptance criteria, restoration to other reactor pools (transshipping) is attempted. Transshipping is enabled through the TSHIP card. It is possible to specify transshipping within a state, within a utility, or within a group specified in the RXINFO file. The oldest spent fuel in the pool will be selected for shipping to restore the FCR margin. The destination reactor is that reactor in the transshipping group with the greatest active capacity with which a shipping link exists. A destination reactor will not accept more fuel than its current available pool capacity.

Restoration to Ex-pool Storage

If insufficient fuel has been removed to restore the FCR margin, fuel will be moved into ex-pool storage. In order to minimize shifting of material between pool and ex-pool storage, the youngest/hottest acceptable fuel in the pool is moved to ex-pool storage. This is controlled by the appropriate age and heat cards in the user input deck. If it is desired to model ex-pool storage on an oldest fuel first basis an age of 100 years should be specified in the sixth field of the FCRAGE or AGETO card. In order to not over constrain the problem it is assumed that ex-pool storage has an unlimited capacity and will accept the youngest fuel in the pool in order to restore FCR margins even if it violates acceptance criteria specified in the age and heat cards of the user input deck.

Note: FCR restoration is the only situation allowing transshipping or movement of fuel into ex-pool storage.

Note: Decommissioned reactors do not maintain an FCR margin.

E.2 UNLOADING OF DECOMMISSIONED REACTORS

The unloading of decommissioned reactors is given priority "n" years after the shutdown date specified in the RXINFO file, where "n" is the number of years specified by the DECOM card in the user input deck. The decommissioned reactors are processed in order of shutdown date first and reactor identification number second. Fuel is removed on an oldest-fuel-first basis first from ex-pool storage then reactor pool to non-reactor facilities. The non-reactor facilities are examined in the order specified on the FILLORDER card. The type of filling is that specified on the RUNTYPE card. The common cask that has the highest priority for the destination will be selected. If, once a decommissioned reactor begins to unload it is unable to transfer all of its spent fuel within a year, a message is printed in the intermediate results of the .PRT file (FORTRAN unit 6) stating which reactor was unable to unload all of its fuel and the quantity of fuel remaining to be shipped.

E.3 PROCESSING LIST-DRIVEN TRANSFERS

List-driven transfers use a file that contains the year, reactor identification number (INIS), and amount of fuel authorized to be shipped that year (MTU) to determine the sources to ship from. If a source specified in the list is unable to ship all of the fuel specified in the list within one cask, a message is printed to the output and that source is given first priority for shipping the remainder of the authorized amount in the following year. A file containing information on shipments from reactors is written to FORTRAN unit 93.

E.4 PROCESSING DESTINATION-DRIVEN TRANSFERS

Destination-driven transfers are used to fill the remaining capacity of non-reactor facilities. The order in which they fill is specified by the FILLORDER card except that facility type 4 (FIS's) do not solicit spent fuel. The type of filling (i.e., optimal or proximal) is specified by the RUNTYPE card. The sources of spent fuel can be constrained by the PRIOR and ALTPRI cards of the user input deck. Spent fuel is selected from the sources on an oldest fuel first basis. The facilities will solicit fuel until their annual or total capacity is met or exceeded by no more than one shipment, or until no acceptable fuel remains in the system.

Note: The destination-driven transfer alternative is the only one that removes spent fuel from non-reactor facilities.

E.5 ACCEPTANCE OF SPENT FUEL

A key concept in the use of the WASTES model is the constraining of the acceptance of spent fuel within the system. These constraints exist in three areas. First, for destination-driven transfers only, the valid sources can be constrained through the use of the PRIOR and ALTPRI cards. Second, the source and destination must have a valid cask link at the time of shipment. Third, the spent fuel characteristics must meet the limits specified by the age and heat generation rate constraints.

Cask Constraints

In order for fuel to move between two sites to ship fuel, both sites must be able to handle an identical cask at the time of shipment. If more than one cask type is available, the cask with the highest priority (first in the SHIPLINK or FACSPEC list) to the destination is selected. If optimal shipping is indicated, the cask must be acceptable to both destination sites.

Age and Heat Generation Rate Constraints

Age and heat generation rate constraints are specified by the following user input cards: AGEAT, AGETO, FCRAGE, DECOMAGE, RIGHTSAGE, HEATTO, FCRHEAT, DECOMHEAT, and RIGHTSHEAT. Refer to Appendix A for further information on these options.

APPENDIX F

FILE USAGE

APPENDIX F

FILE USAGE

Logical Unit Number	Assignment
1	Post-Processor Data File
2	Scratch File for Input Processing
3	Scratch File
5	Input File
6	Output File
7	Scratch File
9	Centroid Data File
10	Discharge Data File
11	Reactor Data File
12	Scratch File for Input Processing
13	Scratch File for Input Processing
14	Scratch File for Input Processing
15-59	Scratch File
70	Bi-Annual Reactor Shipments (assemblies)
75	Ex-pool Storage Inventory by Ex-pool Site
80	Ex-pool Storage Inventory by Reactor Site
81-90	Facilities 1 thru 10 Heat/Age Inventory
92	Fuelspec
93	Reactor Shipments File
95	Annual Reactor Shipments (assemblies)
96	Bi-Annual Reactor Shipments (MTU)
97	Scratch File
98	File for MRS Cost Model
99	Shipment Log File for Post-Processors
100	Aggregate Shipping Data
101	Unit Costs for Rail Shipments
102	Unit Costs for Truck Shipments

NOTE: FORTRAN units not listed above are unused.

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