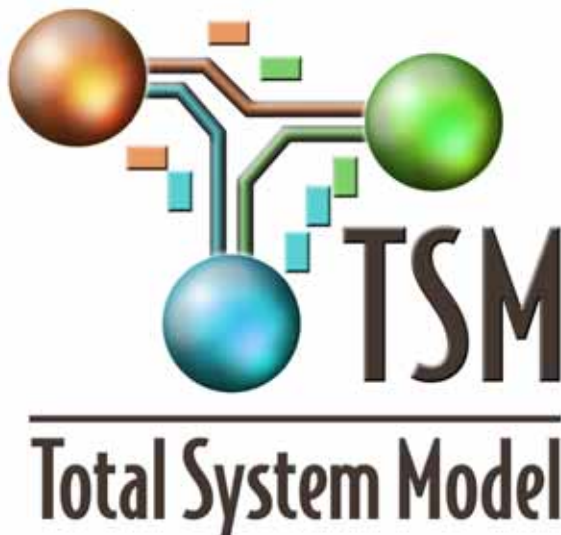




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October 2007

## **User Manual for the Total System Model Version 6.0 Preprocessor**



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## **DISCLAIMER**

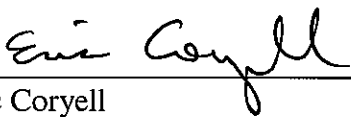
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# User Manual for the Total System Model Version 6.0 Preprocessor

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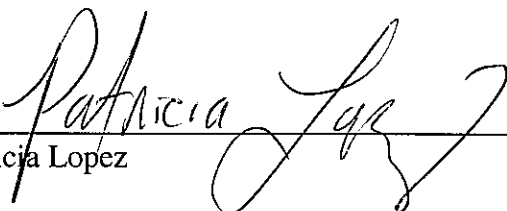
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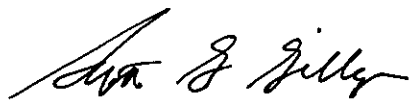
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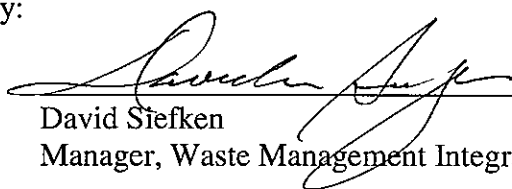
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## CHANGE HISTORY

<b>Revision Number</b>	<b>Interim Change No.</b>	<b>Date</b>	<b>Description</b>
00		10/2007	Original Issue, for use with TSMPP Version 6

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## ACRONYMS AND ABBREVIATIONS

APR	Acceptance Priority Ranking
B-E	Burnup/Enrichment
BSC	Bechtel SAIC Company, LLC
BWR	Boiling Water Reactor
CALVIN	CRWMS Analysis and Logistics Visually Interactive model
CMMP	TSM Configuration Management and Maintenance Plan
CRWMS	Civilian Radioactive Waste Management System
CSNF	Commercial Spent Nuclear Fuel
DOE	U.S. Department of Energy
DOE SNF	DOE Spent Nuclear Fuel
DPC	Dual-Purpose Canister
EIA	Energy Information Agency
EM	U.S. Department of Energy Office of Environmental Management
FCR	Full Core Reserve
GROA	Geologic Repository Operating Area
HLW	High-Level (Radioactive) Waste
INL	Idaho National Laboratory (formerly the Idaho National Engineering and Environmental Laboratory).
IS	Initial State
ISF	Interim Storage Facility
k	Criticality factor
LWT	Legal Weight Truck
MCO	Multi-Canister Overpack
MGR	Monitored Geologic Repository
MOX	Mixed Oxide Fuel
MT	Metric Tons
MTHM	Metric Tons of Heavy Metal
MTU	Metric Tons of Uranium
OCRWM	Office of Civilian Radioactive Waste Management (DOE)
OFF	Oldest Fuel First
OWT	Overweight Truck
PWR	Pressurized Water Reactor

SNF	Spent Nuclear Fuel
SP	Single Purpose
SRS	Savannah River Site
SSA	Site Specific Allocation
TAD	Transportation, Aging, and Disposal
TSM	Total System Model
TSMPP	Total System Model Preprocessor
UCF	Uncanistered Fuel
W	Watt
WO	Work Order
WP	Waste Package
WV	West Valley
WVDP	West Valley Demonstration Project
YFF	Youngest Fuel First

# 1. INTRODUCTION

The Total System Model Preprocessor (TSMPP) is a part of the Total System Model (TSM), which is a PC-based simulator that is a decision aid to achieve overall Office of Civilian Radioactive Waste Management (OCRWM) disposal objectives. The TSMPP combines information about existing conditions, such as waste inventory estimates and site capabilities, with projections of future conditions, such as projected waste discharges and expected cask capabilities, to provide a waste shipment schedule that is input to the TSM. The TSM then uses this shipment schedule to simulate national transportation and operations at the repository.

The TSMPP databases and logic are largely based on the previous systems analysis methods implemented in the CRWMS Analysis and Logistics Visually Interactive (CALVIN) model (BSC 2003a, BSC 2003b). The CALVIN software and databases were reviewed and were deemed an adequate basis on which to build the TSMPP. The TSMPP was developed primarily by removing unneeded portions of CALVIN and adding code (programming) to generate cask load information and shipping dates. Examples of portions that have been removed from CALVIN are those related to repository operations, cost analyses, Interim Storage Facility (ISF) usage, and areas the TSM now simulates (like transportation logistics). However, some of the structures in CALVIN that were used for these functions have been retained to ensure the TSMPP functions properly and for possible future use.

## 1.1 FUNCTIONAL OVERVIEW

The complete TSM, consisting of the TSM and the TSM Preprocessor (TSMPP), is used to simulate the Civilian Radioactive Waste Management System (CRWMS) mission. As shown in Figure 1, the TSM incorporates a number of elements to form a comprehensive systems analysis tool. The TSM is:

- a real-time process simulation model that achieves the established requirements and provides a rapid means to evaluate alternative approaches to achieve program and project goals,
- based on established process optimization tools and methods, usability and accepted system analysis techniques; and
- an end-to-end model with interaction of waste acceptance, transportation, and repository parameters and constraints.

The role of the TSMPP is to simulate the operation of the reactor sites, characterizing the contents of the reactor pools and dry storage pads, and to apply a combination of user options to analyze waste acceptance and cask options. The TSMPP then defines a queue of casks to be accepted at each reactor site with a proposed schedule for acceptance. This schedule provides the Initial State (IS) file that drives the transportation and repository performance simulation.

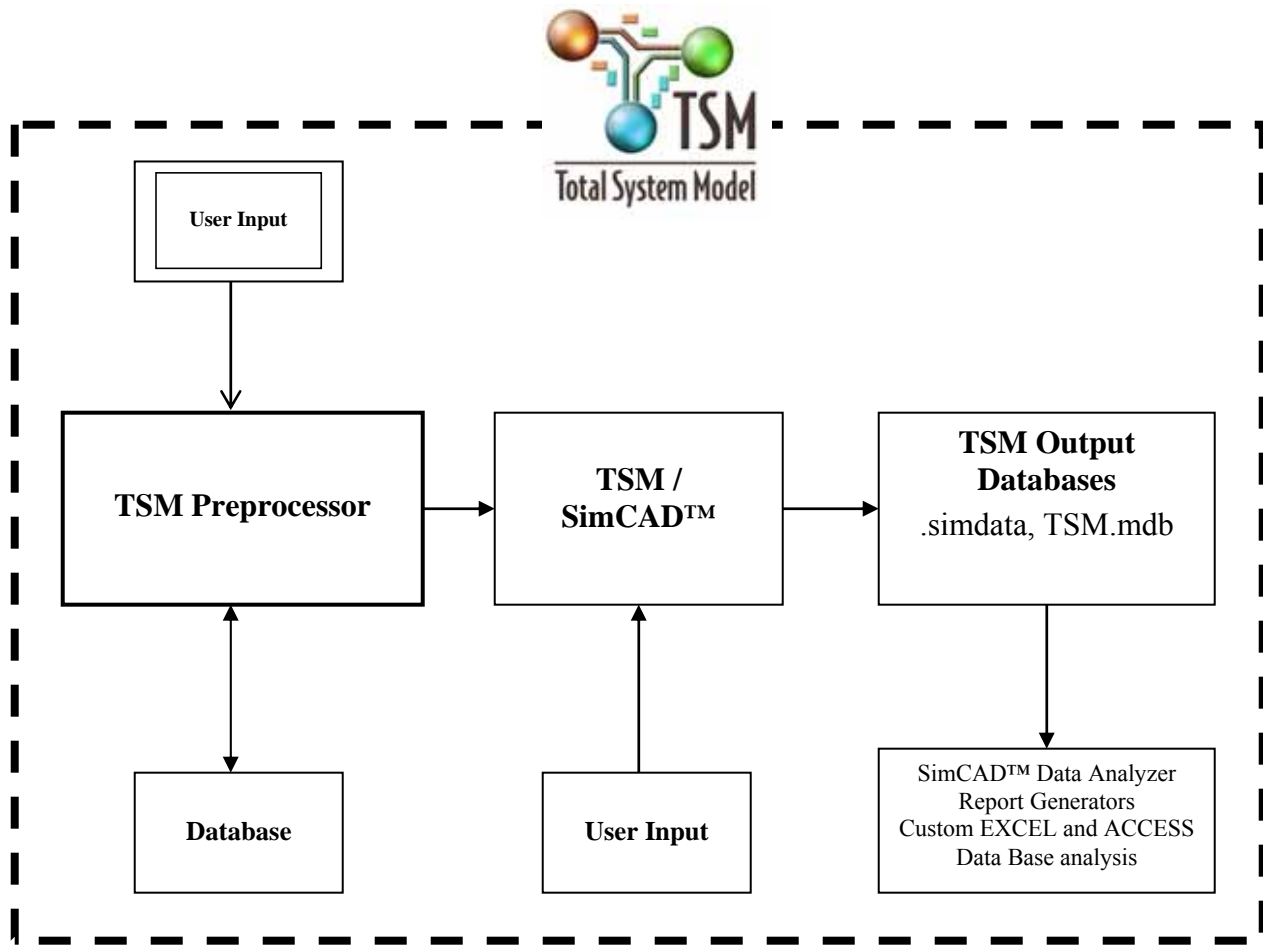


Figure 1. TSM Operating Elements

The TSMPP uses databases, along with user-supplied run-time input, in a logic that combines projections of fuel discharges and aging, utility allocations, site capabilities, and transportation cask parameters to develop the cask loads and associated shipment schedules. The TSMPP models how the inventory of commercial spent nuclear fuel (CSNF) assemblies, U.S. Department of Energy (DOE) spent nuclear fuel (SNF), and high-level radioactive waste (HLW) can be combined into “cask loads” depending on the acceptance scenario. This information is output to a separate file of cask load shipment parameters and target shipping dates, called the IS File, which is the main input to the TSM.

### 1.1.1 TSMPP Capabilities

The TSMPP can handle various cask and canister/cask technologies, such as transportable storage casks (TSC), dual-purpose canisters (DPC), and transportation, aging, and disposal (TAD) canisters. In addition, various types of single-purpose transportation and storage casks are simulated.

Fuel can be accepted in an Oldest Fuel First (OFF) methodology or in a Youngest Fuel First greater than or equal to a specified year x (YFFx) methodology. In addition, a priority acceptance rate can be specified, which can be used to accept fuel from overflowing pools and/or from shutdown facilities.



The TSMPP provides information that describes how and when CSNF assemblies will move from reactor pools to dry storage at reactor sites and schedules acceptance for transport to the Monitored Geologic Repository (MGR). Acceptance rates and shipment schedules are also provided for DOE SNF and HLW.

The TSMPP also utilizes the following parameters in modeling SNF and HLW movement:

- System Operating Rules
  - Annual rates for shipping fuel from reactors/DOE sites to the repository
  - Minimum SNF aging times
- Acceptance Rights (method by which the annual CSNF acceptance rate is allocated among the various storage locations)
  - Based on discharge order of waste (i.e., OFF)
  - Option to grant priority acceptance for pool overflow conditions and decommissioning activities
  - Option to share allocations among reactors owned by a utility
  - Option to specify annual allocations at specific pools
- CSNF Selection
  - Total accepted based on acceptance rights
  - Particular assemblies accepted determined by user-selected criteria (OFF, YFFx, Strict YFF, thermal limits, burnup/enrichment [B-E] limits)
  - Option to "zone load" transportation casks
  - Option to accept casks from the dry storage pad in First In – First Out (FIFO) or Last In – First Out (LIFO) order
  - Option to preferentially accept TAD canisters from the dry storage pad
  - Option to accept DPCs on or after a specific date, or to accept DPCs only from sites shutdown on or before a specific date
- Reactor Management
  - Option to unload shutdown sites and to specify the number of years after shutdown to wait before unloading
  - Option to give priority to shipment of fuel from dry storage versus shipment of fuel from the pool
- Cask Specifications
  - Heat limits
  - Capacity (assemblies or canisters/cask)
  - Cask loading priority sequence
  - Burnup/enrichment curves
  - Cavity length

Each year, commercial reactors discharge CSNF assemblies into CSNF storage pools. If a pool overflows (exceeds available capacity), an appropriate number of assemblies are selected, based on input parameters, and are moved to onsite dry storage. Assemblies remain in dry storage, or in the pool, until accepted by the CRWMS. Once accepted, the assemblies are loaded into

transportation casks and sent to the MGR for final emplacement. For HLW and DOE SNF canisters, annual shipping rates from each facility are specified as input.

### **1.1.2 Data Sources and Parameters**

The source data used by the TSMPP currently includes the following:

- CSNF – current waste site inventories provided by the Energy Information Agency (EIA), coupled with future discharge projections based on current industry trends for commercial fuel
- DOE SNF and HLW - inventories provided by the DOE Office of Environmental Management (EM)

Note that source data versions in use are updated periodically. Scenario-specific parameters can be specified by the user for fuel selection rules, dry storage options, inventory management, and cask capacities. The default for these parameters also are updated frequently using data compiled from the OCRWM's Facts and Figures database for reactor pool capacities, dry storage preferences, and modal site capability upgrades. In addition, Certificates of Compliance, issued by the U.S. Nuclear Regulatory Commission (NRC), are a source of data used to update cask information.

## **1.2 LIMITATIONS OF THE TSMPP**

Known limitations of the TSMPP include:

- The TSMPP has the capability to model the movement of only the following waste forms: CSNF, DOE SNF, and HLW. Other waste forms such as high temperature gas-cooled reactor fuel and Greater Than Class C waste are not included in the current version of the TSMPP.
- Dry storage requirements are calculated on an individual pool basis. The physical transfer of CSNF to another onsite pool cannot currently be modeled by the TSMPP.
- Individual pool allocations for CSNF are calculated automatically. However, the user must specify allocations for DOE SNF and HLW.
- For CSNF, the user can specify the methodology of fuel selection (e.g., OFF, YFFx or Strict YFF). However, for DOE SNF and HLW, fuel selection is based on the user-specified shipping schedule for each waste type.
- When the TSM simulates the transportation of waste to the repository, waste shipment delays may occur. At present these delays are not fed back and replicated in the TSMPP modeling of storage at reactor sites.

### 1.3 ENHANCEMENTS FOR TSM VERSION 6.0

Changes for TSMPP Version 6 are listed in Table 1. Additional details about the changes made can be found in the *Total System Model Version 6.0 Preprocessor Validation Report (BSC 2007a)*.

Table 1. Version 6.0 Enhancements

	Category	Enhancement
IS Generation	DOE Smoothing	Optimize acceptance for codisposal waste packages.
	DOE Shell and Basket	DOE transportation casks categorized as canister with transportation overpack.
	Additional Work Orders	Work orders generated for DOE and rolling stock.
	IS Generation	Disabled the tracking of high criticality ("crit") CSNF assemblies and changed "Offset" value to calendar year in the IS file.
	Consist Size	Consist size for Navy shipments changed from 5 to 6.
Logistics	Dry Storage Acceptance	Accept from storage pads in either FIFO or LIFO order. Accept TAD canisters preferentially.
	DPC Acceptance Options	Option to accept DPCs only after an input date or only from sites that shutdown before an input date.
Report Changes	Additional Reports	Additional reports provided to characterize HLW and DOE SNF storage needs.
	Modified Reports	Arrival Report categorized for cask average or batch specific information.
Input	HLW & DOE SNF Production Rates	Production rates for DOE Owned material defined as scenario specific and can be input or changed on an options screen.
	DOE Canister Metric Tons of Heavy Metal (MTHM)	Values updated, allowed to be scenario specific, and placed on new input screen (DOE Production Rates).
	Error Correction	DOE SNF & HLW Input Correction (SPR TSM-0012 <sup>1</sup> ).

<sup>1</sup> Software Problem Reports (SPR) had been filed which provide additional detail regarding the error.

### 1.4 QUALITY ASSURANCE

The TSM is identified as Level 3 (i.e., not Important To Safety (ITS) and not Important To Waste Isolation (ITWI)) software in the Bechtel SAIC Company, LLC (BSC) Controlled Software Report. This implies that all analyses in which this software is used should be categorized as Non-Q/A.

The TSMPP, as part of the TSM, is maintained in the (software) CMSynergy system. Changes to the TSMPP, unless temporary, are made and documented in accordance to the TSM Configuration Management and Maintenance Plan (CMMP) and procedure AP-ENG-006. The

enhancements for TSM Version 6, described in Table 1, are validated in the *Total System Model Version 6.0 Preprocessor Validation Report* (BSC 2007a).

## 2. INSTALLATION

### 2.1 HARDWARE AND SOFTWARE REQUIREMENTS

In order to run the TSMPP, the runtime environment must include:

- Windows 2000 or Windows XP operating system
- 1 Gigabyte of random access memory (RAM), minimum.
- 100 Megabyte disk space (an estimate for application files and the TSM Access database)
- Microsoft Excel
- Microsoft Access (optional)
  - If the analyst wishes to modify the database directly, Microsoft Access 2000 (or later) must be installed.

### 2.2 INSTALLATION INSTRUCTIONS

The TSMPP (as part of the TSM) is usually delivered with the associated TSM simulation model and other files to support TSM analysis.

- If the TSMPP installation package has been delivered as a CD-ROM, insert the CD-ROM into the drive and open the folder. If the package has been delivered as a zipped file, unzip the package to a temporary folder. The zip file contains installation files and a TSMPP Access database.
- Run setup.exe. After choosing the directory, install the TSMPP. Note that a TSMPP database will be installed in the same folder, and a TSMPP icon will be added to the start menu.

Additionally, if a version of Visual Basic has not been installed on the machine, it will be necessary to install some Microsoft components. Microsoft has provided a download which will perform this function. This download, called *Msvbvm50.exe*, is a self-extracting file that installs the latest versions of the Microsoft Visual Basic run-time files that all applications created with Visual Basic 5.0 need in order to run. This download is available at:

*<http://download.microsoft.com/download/vb50pro/utility/1/win98/en-us/msvbvm50.exe>*

The download installs the files shown in Table 2, which ship with Visual Basic 5.0 Service Pack 2 and Service Pack 3, and are the base dependencies for any component or application created in Visual Basic 5.0.

Table 2. Required Microsoft Visual Basic Components

<b>FILE</b>	<b>VERSION</b>
Msvbvm50.dll	05.00.8244
Oleaut32.dll	2.20.4118
Olepro32.dll	5.0.4118
Stdole2.tlb	2.20.4118
Asycfilt.dll	2.20.4118
Comcat.dll	4.71

### 3. EXECUTION OF TSM PREPROCESSOR

This section provides a general overview for running the TSMPP. The application can be run from the Start Menu. Click on the group TSM then select TSM Preprocessor. An alternative is to use Windows Explorer to find the file “TSMPreprocessor.exe,” then double click with the left mouse button on the file.

#### 3.1 INITIATION

When the TSMPP is started, the first dialog displayed is similar to Figure 2. The title bar, at the top, will display the version of the TSMPP which is being executed. The menu options are:

- Select Database  
Specify a pre-existing database which contains input data for processing,
- Select Scenario  
Specify the scenario in the current database to be used for processing (this option will only be enabled if a database has been chosen),
- Exit  
Terminate the program.

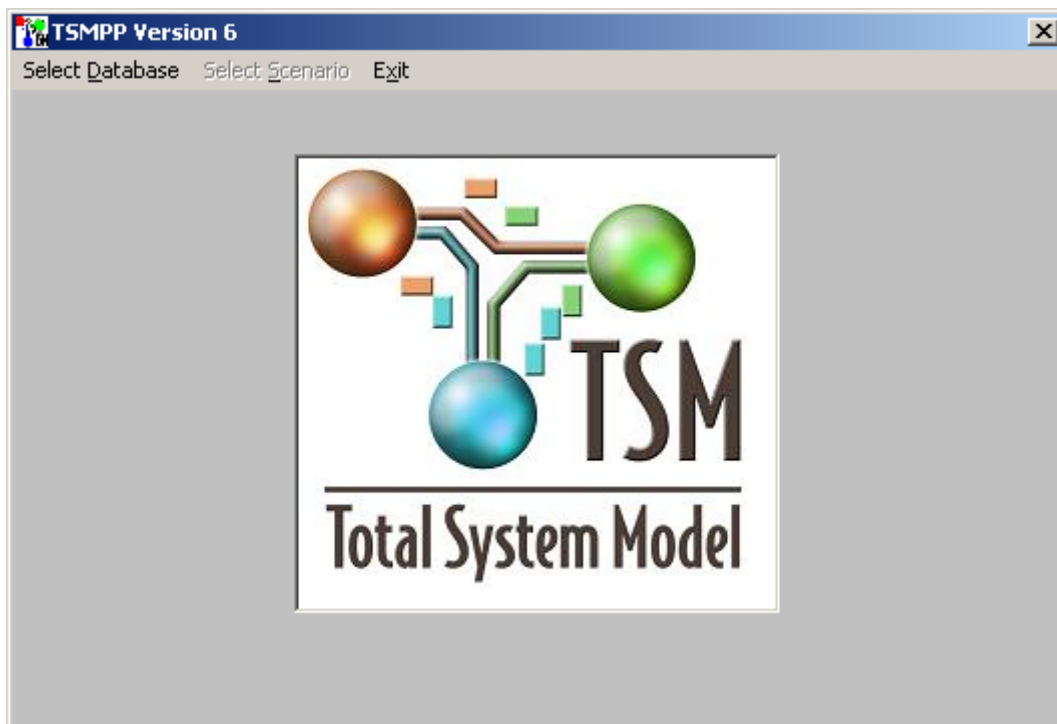


Figure 2. Initial Screen

The TSMPP software uses a Microsoft Access database to save and retrieve input parameters specific to each analysis. Before the TSMPP can be used, it is necessary for the user to select a pre-existing database containing the input data for one or more scenarios which can be processed

and executed, or modified and either saved as a new scenario or the input scenario updated. When the program is initially run, the menu option labeled “Select Scenario” will be disabled (i.e., visible but can not be used) until a database is defined.

A sample TSMPP input database is provided as part of the installation package, as discussed in Section 2. To select one of these files, use the “Select Database” menu option. The standard Windows File Selection dialog should appear asking the user to “Select TSMPP Database File”. Choose a file by clicking on the filename from the list of files or entering a filename in the “File name” field. If the correct database is displayed in the “File name” field, select it by clicking on the “Open” button.

Once a database has been selected, the initial screen will appear as shown in Figure 3. Note that the name of the current database is shown in the text box at the bottom of the window, and the “Select Scenario” menu option is now enabled. After a database has been selected, the most recently used database will be listed whenever the TSMPP is launched. The user may now continue processing by selecting the “Select Scenario” menu option.

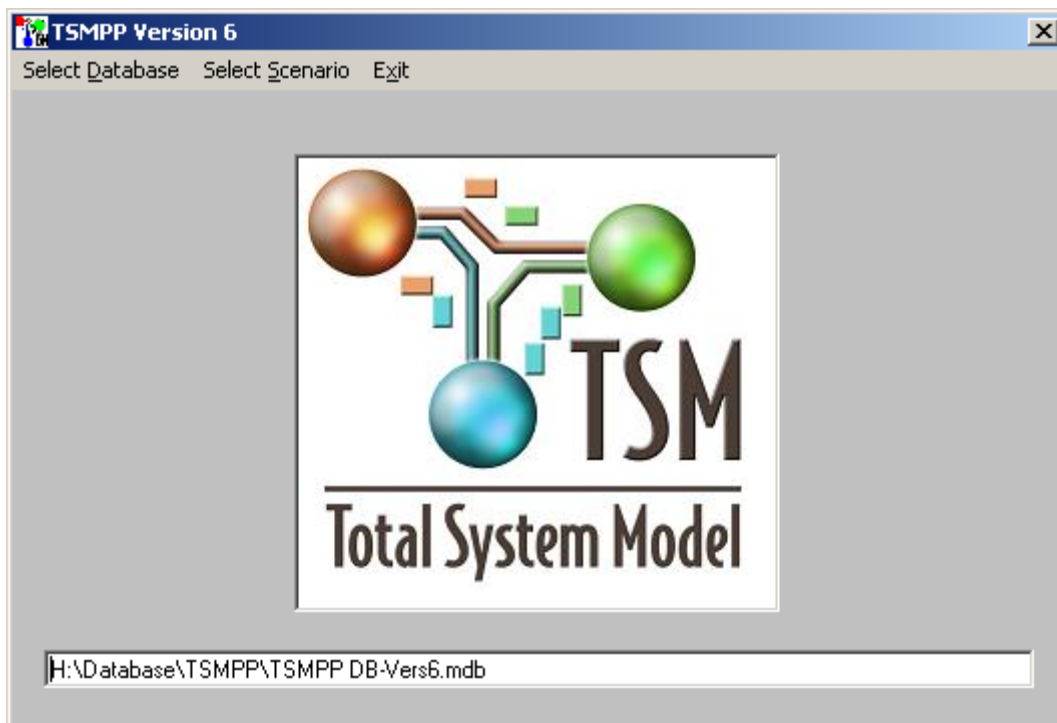


Figure 3. Initial Screen After Database Selection

### 3.2 SELECT SCENARIO

After choosing the “Select Scenario” menu option, the “Scenario Selection” dialog (Figure 4) will be displayed. A scenario is a collection of all the inputs for an analysis, and defines the information needed to perform a logistics calculation. The upper portion of the dialog displays the number and name of the most recently used scenario in the database. The lower portion of the screen displays the long description of the selected scenario. Clicking on the down arrow on



the right side of the scenario title displays a list of available scenarios. Select the scenario to be processed by clicking on it, and then click the “OK” button. Choosing the “Cancel” button returns the application to the “Initial” dialog.

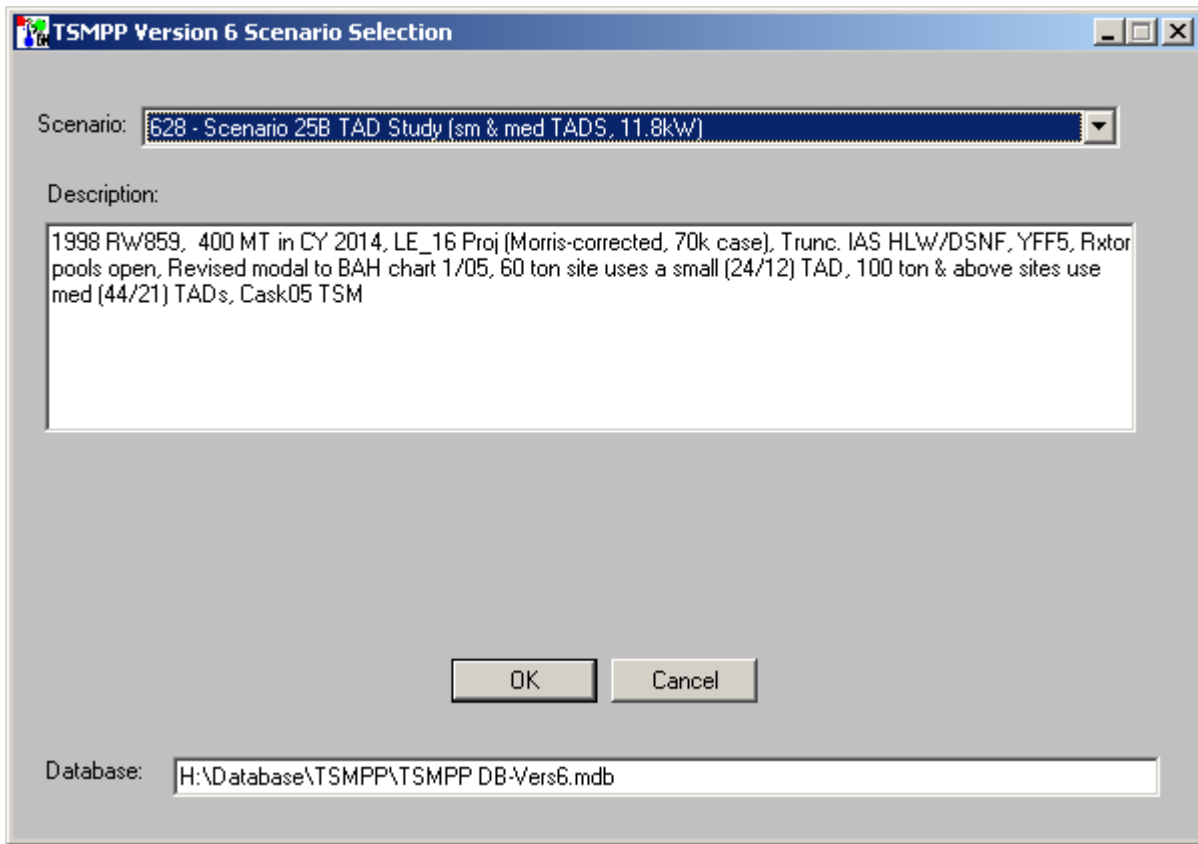


Figure 4. Scenario Selection

### 3.3 TABLE SELECTION

The next dialog, “Table Selection” (Figure 5), allows the user to select a set of data tables to be used in the analysis. The currently selected table for each data table type is shown in its respective pull-down box. The database may have additional tables for each type, which can be accessed by using the down arrow on the right side of each table name. Details on the contents of the data tables are included in Appendix B. One table for each table type must be selected for a scenario. Clicking on the down arrow and selecting a new desired table name from the list of available tables changes the table selected for use in the scenario.

Pressing the “OK” button causes the program to read the selected tables for the desired scenario. Note that certain combinations of the “fuel discharge” table and “pool information” table are not compatible (a table titled “Valid Names” in the TSMPP database controls these combinations – see Appendix B); an error message is generated when the “OK” button is pressed if an unacceptable combination is selected. If the table selection is valid, the main dialog is displayed.

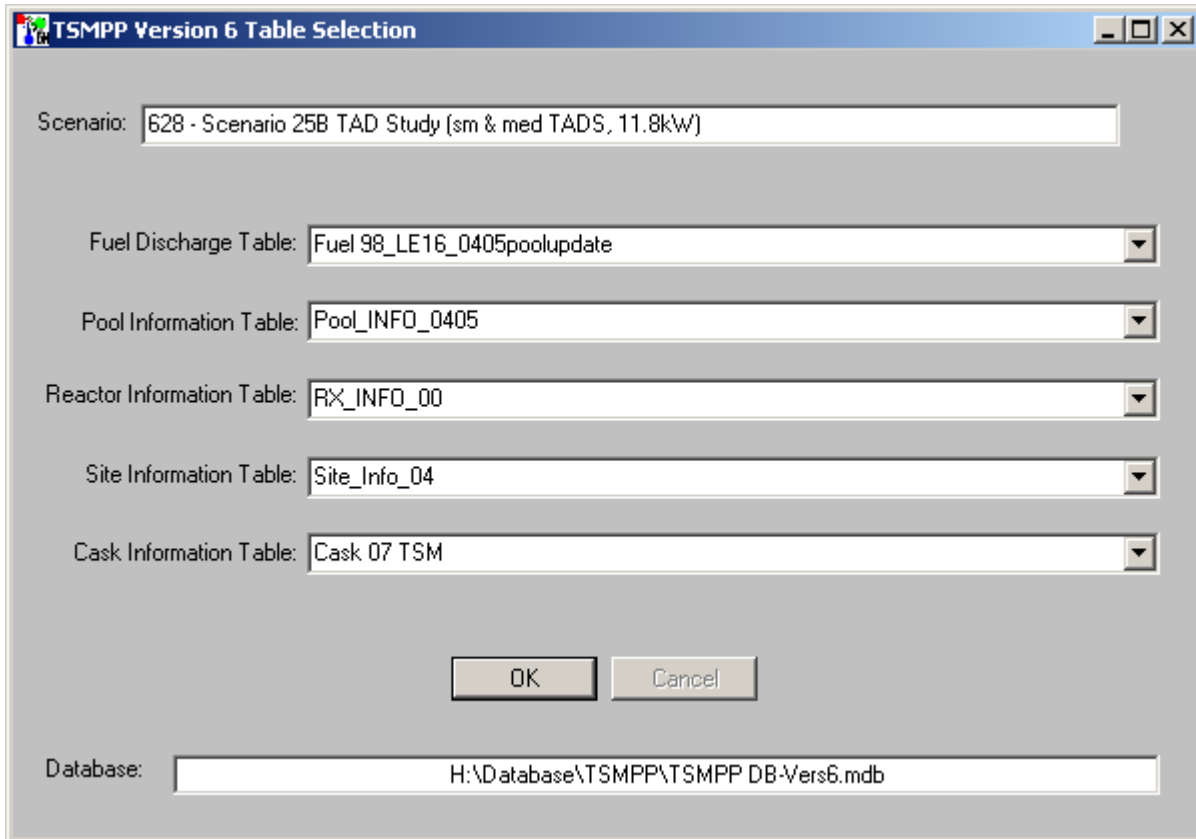


Figure 5. Table Selection

### 3.4 MAIN

The Main Menu is the dialog from which the user input may be changed. This dialog (Figure 6) displays the title of the selected scenario at the top, with menus and submenus available as follows:

- Casks Menu
  - Cask Linkage
  - Loading Options
- Options Menu
  - Utility Options
  - Cask Acceptance
  - CSNF Acceptance
- Rates Menu
  - Commercial
  - High Level Waste
  - DOE SNF

Each of the menu and submenu items will be discussed in more detail in Section 4.

If the “Strict Calendar Year CSNF Acceptance” checkbox has been selected all acceptance rates will be treated as the amount accepted in each calendar year, regardless of the initial starting month. Otherwise, the acceptance rates are treated as annual rates, beginning in the starting month of the initial acceptance year (i.e., each rate lasts for 12 months, beginning in the initial acceptance month). The starting month is selected in the “CSNF Annual Acceptance Rates” dialog discussed in Section 4.3.1.

By selecting the “OK” button, the “Run Model / Save Scenario” dialog will be displayed. If the “Cancel” button is selected, the application returns to the “Initial” dialog.

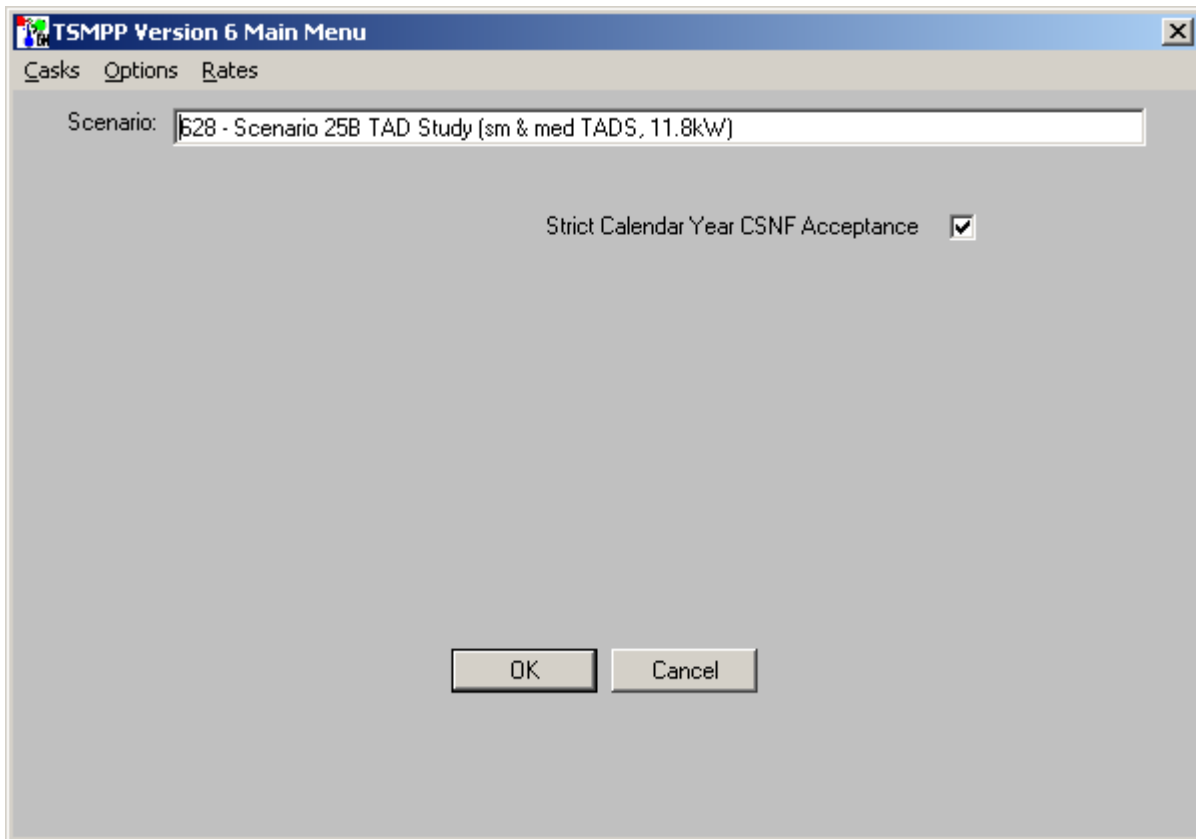


Figure 6. Main Menu

### 3.5 RUN MODEL / SAVE SCENARIO

The “Run Model / Save Scenario” dialog (Figure 7) displays the Scenario title, TSMPP input database, and a description of the selected scenario. The title and description may be modified prior to saving the scenario to a database or running the analysis. The button in the lower left of the screen, the “Run Logistics” button, will cause the TSMPP to calculate the logistics for the selected scenario. The “Cancel” button in the lower right of the screen will return the user to the “Main” dialog, discussed in the previous step.

A scenario is a collection of all the inputs from the previous screens, and defines the information needed to perform a logistics calculation. The “Save Scenario” menu offers the following menu options:

- Save Into Another Database  
Saves the currently defined scenario into a database other than the currently selected database.
- Save as New Scenario  
Saves the currently defined scenario into the current database, but with a new scenario number. Prior to saving the scenario, the user can modify the name and/or description of the scenario. The new scenario with its new scenario number will then be available in the scenario list on the “Scenario Selection” dialog.
- Update Current Scenario  
Updates the selected scenario in the current database with parameters selected in the previous steps. Prior to saving the scenario, the user can modify the name and/or description of the scenario. A new scenario number is not assigned.

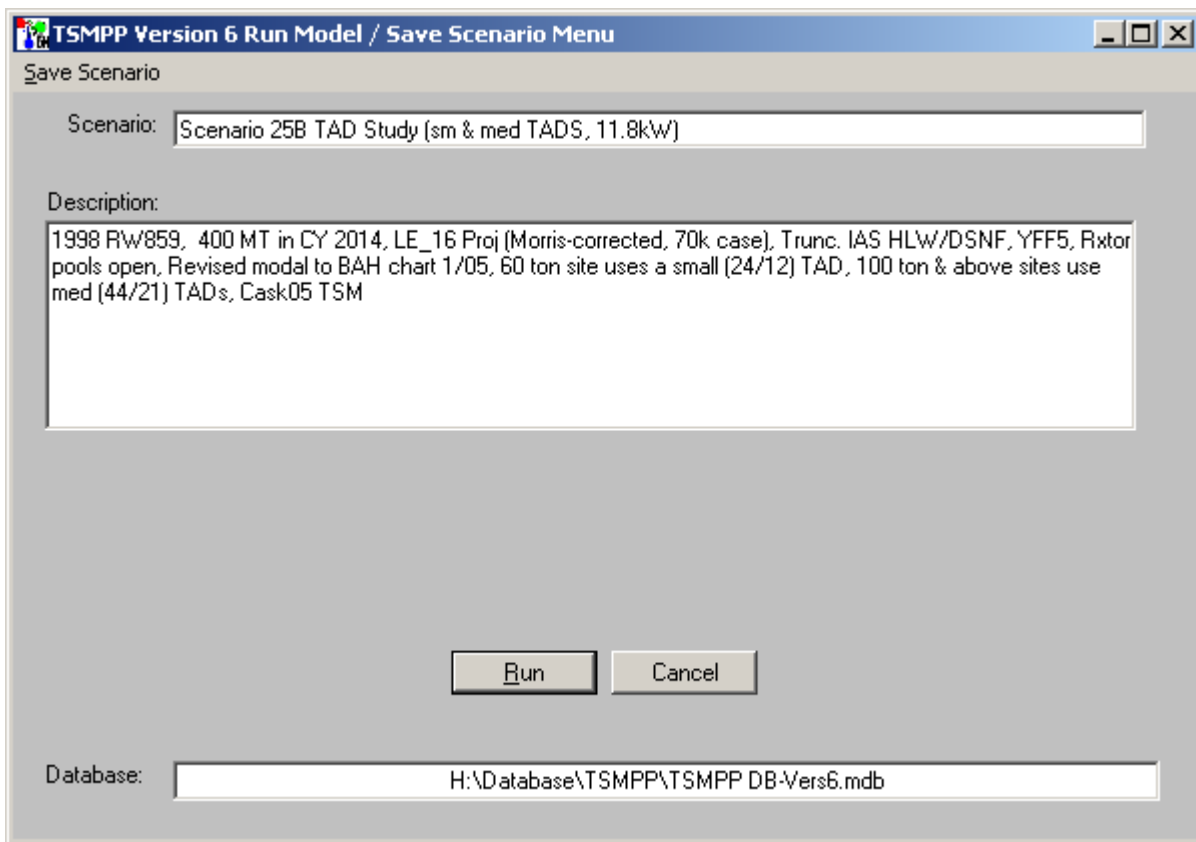


Figure 7. Run Model / Save Scenario

If a scenario is updated or saved to the current TSMPP input database or another database, this modifies the selected TSMPP input database. Since the TSMPP input database is a configuration

item listed in the CMMP, it is incumbent on the user to adequately document all temporary changes and rename the modified TSMPP database.

### 3.6 LOGISTICS

After the logistics models have run to completion, the “Logistics” dialog appears (Figure 8). The lower section of this dialog shows several parameters intended to summarize the scenario results, such as the number of truck and rail casks shipped, the tonnage of CSNF and HLW and the number of canisters of DOE SNF which were shipped.

In the center of the screen are three command buttons which will allow the user to analyze the logistics results or interface with the SimCAD™ (CaS 2006) portion of the TSM. Selecting the “Reports” button takes the user to the Report screen discussed in the next section. Selecting the “Generate Initial State File” button takes the user to the Initial State File Generation dialog discussed in Section 3.8.

To terminate the TSMPP, select the “Exit” button.

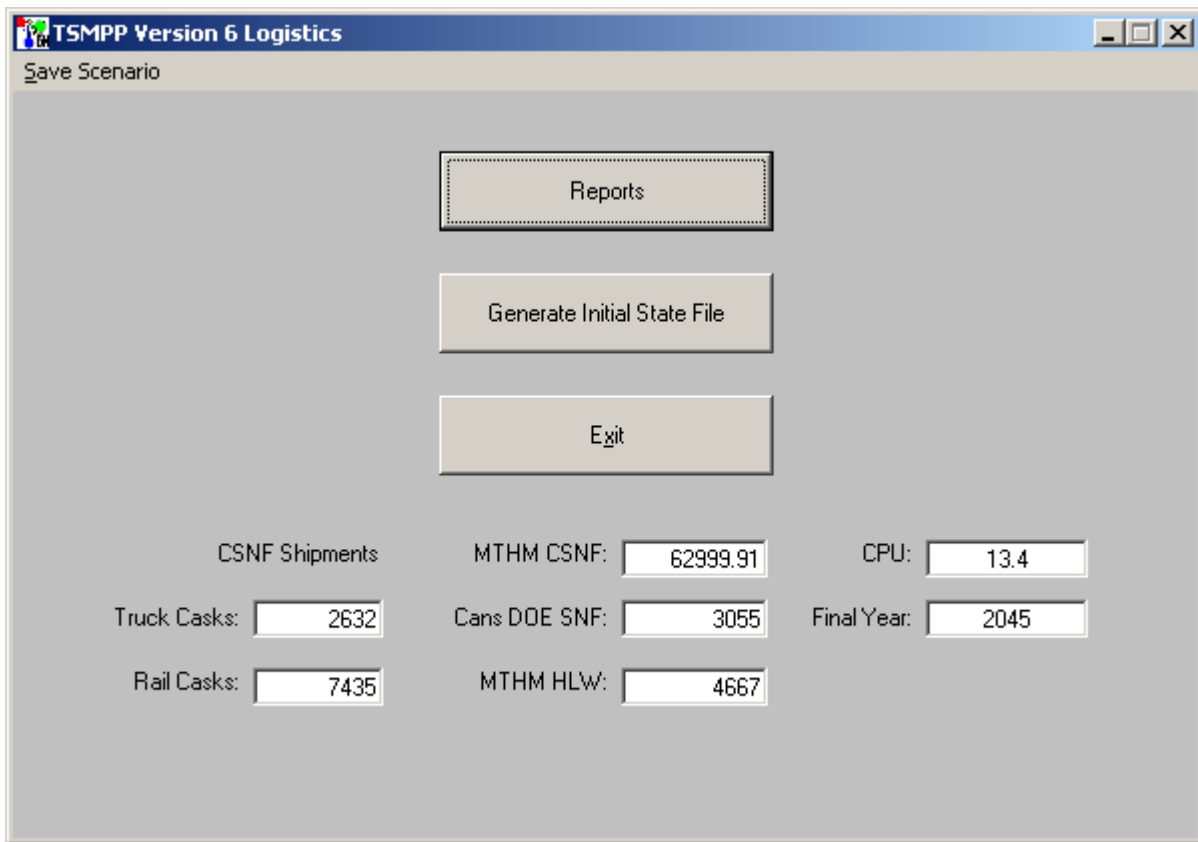


Figure 8. Logistics Results

## 3.7 REPORTS

The Logistics Reports dialog is shown in Figure 9, and shows the type of information available to the analyst. Unless otherwise noted, these reports are generated as sheets in an Excel workbook. Please note that the user should not attempt to save this Excel file from the Excel task bar. Instead, when the user “returns” from the report menu, a prompt will be offered to save the file. If the users saves the file before this prompt is offered, an error may be generated indicating that the Excel object no longer exists.

The available reports are

- **Storage**

- CSNF

- Summary report documents the number of dry storage casks used at each pool and the number which were left on the pad.

- Detailed report documents the year each cask goes into storage, the year taken from storage, the cask name, number of assemblies loaded, the cask capacity, the cask heat and heat limit, the number of MTHM, whether or not the cask is on the pad at the end of the calculation, and whether or not it is transportable. Note that for historical dry storage, the cask heat is set to zero.

- HLW or DOE SNF

- Summary report documents the total number of glass canisters that have been produced at each site less the number that have been accepted.

- **Shipments**

- CSNF

- Summary by site report documents the number of truck and rail shipments from each site.

- Annual Total report documents the number of casks shipped each year, broken down into categories of CSNF Truck, uncanistered (UCF) and DPC Rail casks, HLW Truck and Rail, and DOE SNF Truck and Rail.

- HLW or DOE SNF

- Summary by site report documents the total number of shipments from each pool.

- Annual Total report documents the number of canisters, metric tonnage, and number of casks shipped each year.

- **Site Information**

- A report which gives the EIA number, year of last discharge, year of first shipment, year of first and last dry storage pickup, and year of last shipment (pickup).

- **Scenario Options**

- A report listing all input options.

- **Acceptance**

- Summary report documents the MTHM accepted each year of CSNF and HLW, and canisters of DOE SNF.
- Detail by Pool report documents either the total annual MTHM of acceptance from each pool, the total annual acceptance from just the pool, or the total annual acceptance from dry storage.

- **Allocation**

- Summary report documents the total CSNF, HLW, and DOE SNF allocated each year.
- Annual report documents either the annual CSNF allocation by pool or by utility.

- **Trading Reports**

Note that this report option is available only if IntraUtility Trading is enabled.

- Pool ID by Utility lists the pools that have been identified as being owned by each utility.
- Trading Priority details the priority of each pool within each utility.
- Trading Delta details the amount of allocation traded by each pool within each utility.

- **Detailed Reports**

- Arrival report  
Documents the characteristics of each CSNF cask load which is transported. An option is provided to generate cask-average results, or batch-average results (a “batch” is a group of assemblies with identical characteristics, a cask load is made up of one or more “batches”). Because of the detailed nature of this report, a separate Excel file is generated. The user is prompted to save this file with the default file name “AvailShip.CSV”. This name can be changed, if desired, to avoid overwriting the file in subsequent TSMPP runs.
- Detail by pool  
A report which breaks down the number of CSNF shipments from each reactor in casks, metric tonnage, and assemblies, by cask type. Because of the detailed nature of this report, a separate Excel file is generated. The user is prompted to save this file with the default file name “RX\_DET.CSV”. This name can be changed, if desired, to avoid overwriting the file in subsequent TSMPP runs.
- Detail by site  
A report which breaks down the number of shipments from all reactors in casks, metric tonnage, and assemblies, by cask type. Because of the detailed nature of this report, a separate Excel file is generated. The user is prompted to save this file with the default file name “RX\_ALL.CSV”. This name can be changed, if desired, to avoid overwriting the file in subsequent TSMPP runs.

When all desired reports have been generated, press the “Return” button. At this point the user will be prompted to save the Excel workbook generated by the above reports with a default name

“TSMRpts.xls”. This name can be changed, if desired, to avoid overwriting the file in subsequent TSMPP runs. If “Cancel” is selected, the spreadsheet is closed without saving.



Figure 9. Logistics Reports

### 3.8 INITIAL STATE FILE GENERATION

When the “Generate Initial State File” button on the logistics dialog is pressed, the Initial State Generation dialog is presented, as shown in Figure 10. The options on this screen provide the user the ability to generate only the information of interest.

The three check boxes allow the user to eliminate unwanted information from the generated initial state file. The user may include/eliminate the DOE SNF and the HLW cask loads, generate Batch information, or track high criticality casks (not currently activated). The defaults for these choices are to include HLW/DOE SNF, and not to generate Batch information. These choices are not stored in the database with the other scenario information, and if an alternative is desired, the user must override the default each time the IS file is generated.



If the user does not check the “Include DOE SNF and HLW” box, only CSNF will be included in the IS file. If the user includes the DOE SNF and HLW waste streams, then two additional options are available, “Use DOE Shells and Baskets” and “Smooth”.

The "Use DOE Shells and Baskets" option will allow the DOE SNF, multi-canister overpack (MCO), and HLW waste streams to share a common transportation overpack (“shell”) with individual baskets for each waste type. This option will append the characters “\_OV” to the “Start Process” of each DOE SNF and HLW cask and the characters “\_INS” to the “Cask ID” of those casks. This will divert the DOE SNF and HLW casks to the appropriate department within the SimCAD™ model, and will trigger the insertion of an appropriate cask buy order.

The Smoothing option will adjust the shipping times of the codisposal streams (DOE SNF, HLW and MCO) to ensure they arrive at the Geologic Repository Operating Area (GROA) in the proper codisposal ratios. Smoothing with "DOE SNF Lead" will adjust the timing of the HLW stream while "HLW Lead" will adjust the timing of the DOE SNF and MCO waste streams. Smoothing will attempt to enforce that these streams are shipped in consists of 5 transport casks each. Explanation of the smoothing features and TSM model impacts are explained in greater detail in the smoothing validation report (BSC 2007d).

If the user selects the “Generate Batch Information” box, then an additional file is generated which provides detailed information (fuel batch numbers, enrichment, burnup, etc.) for use in TSM post-processors.

The “Track High Criticality Assemblies” option is not activated. This option is not needed, and is no longer available in the TSM SimCAD™ model.

Note that appended to the bottom of the IS File is a list of transportation cask Work Orders (WO), that are generated using the automated Work Order generator. A description of how cask WOs are used in the TSM is contained in Section A.4.1 and in the TSM User Manual (BSC 2007b).

After the IS File generation is complete, the user is prompted to save the IS File (and the batch information file, if generated).

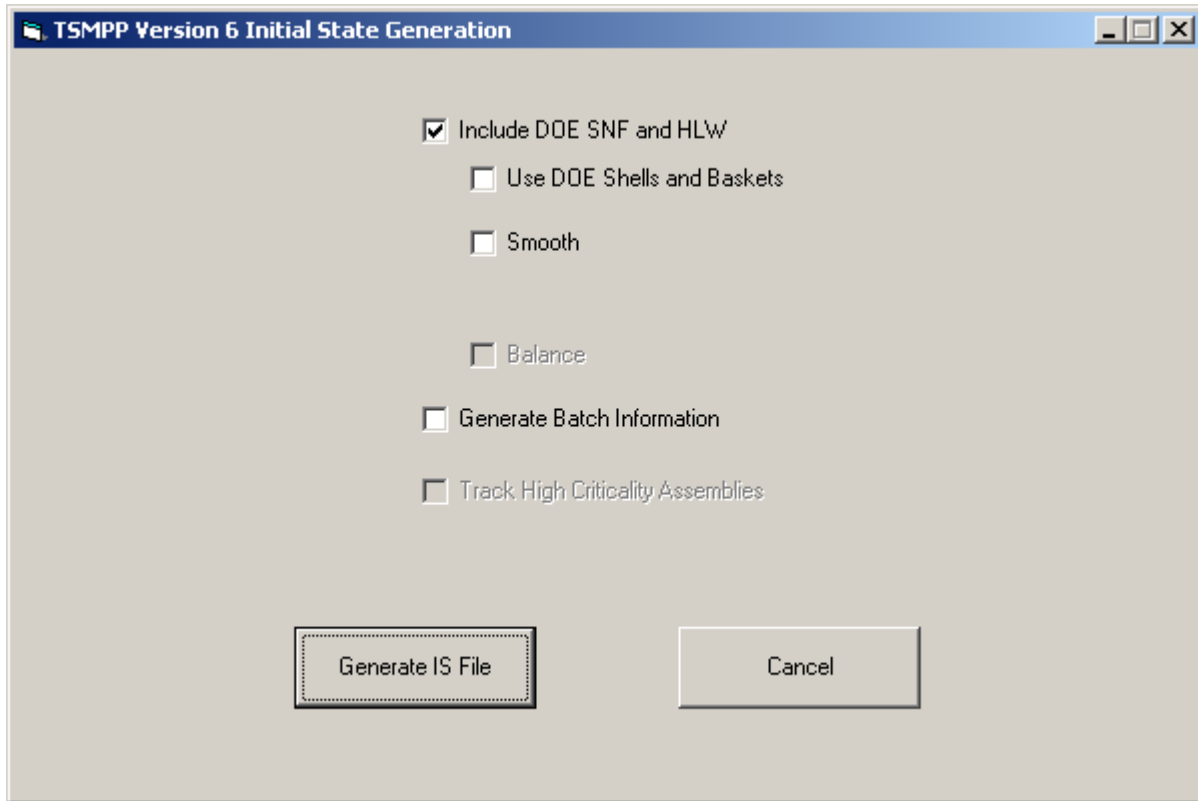


Figure 10. Initial State Generation – default conditions

### 3.9 SUMMARY

Table 3 lists the various dialogs in the TSMPP, along with their primary function, and it indicates the application execution workflow and how the various dialogs relate to each other.

Table 3. Summary of TSMPP Dialogs

Dialog	Function	Parameter
<b>Initial</b>	Selects the desired database to use, and allows access to subsequent dialogs	
<b>Scenario Selection</b>	Selects a scenario from the chosen database	
<b>Table Selection</b>	Selects the desired data input tables from the database	
<b>Main</b>		
Casks	Cask Linkage	Specify cask types and when in use at each facility for dry storage and transportation.

<b>Dialog</b>	<b>Function</b>	<b>Parameter</b>
	Loading Options	Specify cask loading options, such as Uniform or non-Uniform (Zone) Loading.
Options	Utility Options	Option to modify allocation method, priority acceptance criteria and rates, early reactor shutdown, and unload shutdown reactor options.
	Cask Acceptance	Selection of global pool or dry storage acceptance preference, DPC and dry storage acceptance options.
	CSNF Acceptance	Fuel selection (annual acceptance criterion), minimum fuel age for acceptance, option to set MTHM acceptance limit.
Rates	CSNF Annual Acceptance Rates	Annual CSNF acceptance rates and starting month of acceptance.
	HLW Annual Production and HLW Annual Facility Allocations	Annual HLW per facility production rates and allocation rates with starting month of allocation.
	DOE SNF Annual Production and DOE SNF Annual Facility Allocations	Annual DOE SNF per facility production rates and allocation rates with starting month of allocation.
<b>Run Model / Save Scenario</b>	Save scenario options, run scenario	
<b>Logistics</b>	Reports	Generate reports detailing analysis results of acceptance and logistics.
	Generate IS file	Options to include DOE SNF and HLW, generate batch information file, option to track high criticality assemblies.

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## 4. CHANGING SCENARIO OPTIONS

This section provides a detailed explanation of dialogs used for changing scenario options. After the database, scenario, and data tables have been determined, the “Main” dialog (see Figure 6) is displayed. It offers the following menu options for modifying a scenario.

- Casks Menu
  - Cask Linkage
  - Loading Options
- Options Menu
  - Utility Options
  - Cask Acceptance
  - CSNF Acceptance
- Rates Menu
  - Commercial
  - High Level Waste
  - DOE SNF

### 4.1 CASKS MENU

The Casks Menu allows the user to define the cask modals for both transportation and storage, as well as the cask loading options.

#### 4.1.1 Cask Linkage

**Note:** Throughout this section, the cask information represents examples of the types of casks that may be selected for use in the TSMPP. The actual transportation casks used in the TSM are a subset of these and are documented in Table 2 of the “User Manual for the Total System Model” (BSC 2007b).

The “Casks” menu option allows the user to access the “Cask Linkage” dialog (Figure 11), which is used to specify several parameters related to cask loading, cask selection, and cask assignment. The box on the bottom left-hand side of the dialog allows the user to access and modify various pool links and cask sequences. The cask sequences allow various sets of casks, and their priority loading sequence and the range of years to use them, to be defined (together referred to as the modal type). Separate modal types need to be defined for storage casks and transportation casks. The pool links allow these modal types to be assigned to the various storage locations (i.e., pools).

Cask sequences can be modified by selecting “Cask Seq” and then “Transportation” or “Dry Storage”. Pool links can be modified by selecting “Pool Link” and then “Transportation” or “Dry Storage”. Subsequent sections provide background information and brief explanations of the pool links and cask sequences that the user may modify.

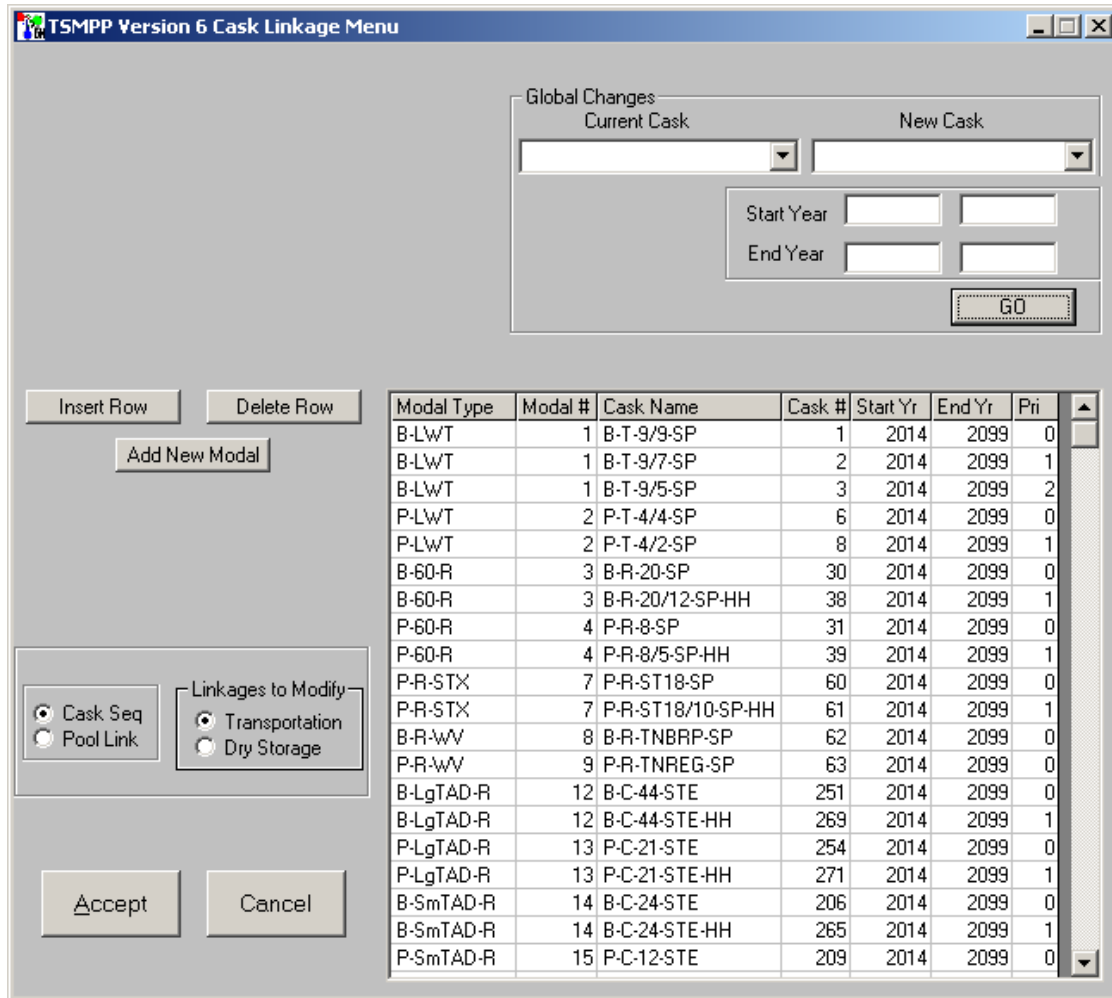


Figure 11. Cask Linkage – Cask Sequences with Transportation Option

In addition, subsequent sections will discuss transportation cask loading options presented in this dialog. These options include uniform or non-uniform zone loading of a cask and the option to specify a multiplier on the cask loading thermal limit.

#### 4.1.1.1 Background Information – Modal Types

As part of the program, each “pool” (or location where fuel is stored) has a unique pool number. Some spent fuel pools may have more than one pool number if the pool stores both Pressurized Water Reactor (PWR) and Boiling Water Reactor (BWR) fuel or if SNF is stored in a spent fuel pool not associated with the unit from which it came.

For each “pool”, the user can assign a modal type and associated modal number to categorize the type of transportation cask that can be used to transport the fuel to the MGR. All “pools” from which bare fuel will be transported must be assigned a transportation cask modal type so that the proper transportation cask can be selected. Examples of transportation modal types that can be utilized are listed in Table 4.

Table 4. Examples of Transportation Cask Modal Types

Modal #	Modal Type	Fuel Type <sup>1</sup>	Modal Description
<b>Modal Types for Commercial SNF "Pools"</b>			
1	B-LWT	B	Commercial BWR Truck Site
2	P-LWT	P	Commercial PWR Truck Site
3	B-60-R	B	Commercial BWR Site w/ 60 Ton Lifting Capacity
4	P-60-R	P	Commercial PWR Site w/ 60 Ton Lifting Capacity
5	B-100-R	B	Commercial BWR Site w/ 100 Ton Lifting Capacity
6	P-100-R	P	Commercial PWR Site w/ 100 Ton Lifting Capacity
7	P-R-STX	P	South Texas PWR SNF <sup>2</sup>
8	B-R-WV	B	West Valley BWR SNF <sup>2</sup>
9	P-R-WV	P	West Valley PWR SNF <sup>2</sup>
10	P-125-R	P	Commercial PWR Site w/ 125 Ton Lifting Capacity
11	B-125-R	B	Commercial BWR Site w/ 125 Ton Lifting Capacity
12	B-LgTAD-R	B	Commercial BWR Site w/ Large TAD
13	P-LgTAD-R	P	Commercial PWR Site w/ Large TAD
14	B-SmTAD-R	B	Commercial BWR Site w/ Small TAD (70 Ton Lifting Capacity)
15	P-SmTAD-R	P	Commercial PWR Site w/ Small TAD (70 Ton Lifting Capacity)
<b>Modal Types for DOE SNF "Pools"</b>			
21	DOE SNF	X	DOE SNF in standard canisters
22	DOE SNF-MCO	X	Hanford DOE SNF in Multi-Canister Overpacks (MCO)
23	NAVY-L	X	Naval SNF - Long
24	NAVY-S	X	Naval SNF - Short
<b>Modal Types for HLW "Pools"</b>			
20	HLW	H	INL, SRS, Hanford, and West Valley HLW

Notes:

<sup>1</sup> Fuel types are as follows: B - Commercial BWR SNF, P - Commercial PWR SNF, X - DOE SNF, and H - HLW.

<sup>2</sup> The pools for certain sites have special transportation modal types because a specific cask(s) has been identified for use at these sites.

Similarly, for each “pool,” the user can assign a modal type and associated modal number to categorize the type of storage cask in which bare fuel from the “pool” may be stored on site. All “pools” at which bare fuel will be stored must be assigned a modal type so that a proper storage cask can be selected. Example storage modal types that can be utilized are listed in Table 5. Examples of transportation and storage modal type assignments for each “pool” for modeling are listed in Table 6.

Table 5. Examples of Commercial Site Storage Cask Modal Types

Modal #	Modal Type	Fuel Type <sup>1</sup>	Modal Description
5	B-125	B	Commercial BWR Site w/ Lifting Capacity = 125 tons
6	P-125	P	Commercial PWR Site w/ Lifting Capacity = 125 tons
7	P-Surry	P	Surry (various casks in dry storage) <sup>2</sup>
8	P-ANO	P	Arkansas Nuclear (VSC24 & HI STORM 100) <sup>2</sup>
9	P-McGuire	P	McGuire (TN-32 & NAC UMS) <sup>2</sup>
10	B-Big Rock	B	Big Rock Point (TS-125 DPC) <sup>2</sup>
11	B-Hum. Bay	B	Humboldt Bay (HI STAR HB DPC) <sup>2</sup>
12	P-Pr. Island	P	TN-40 Transportable Storage Cask <sup>2</sup>
13	P-S. Texas	P	South Texas DPC <sup>3</sup>
14	P-Ynk. Rowe	P	Yankee Rowe (NAC STC) <sup>2</sup>
15	P-N. Anna	P	North Anna (TN-32 & MP-187) <sup>2</sup>
16	P-Palis	P	Palisades (VSC24 & MP-187) <sup>2</sup>
17	P-Pt. Beach	P	Point Beach (VSC24, TN-32 & MP-187) <sup>2</sup>
18	B-Susque	B	Susquehanna (NUHOMS 52 and MP-197) <sup>2</sup>
19	P-C.Cliffs	P	Calvert Cliff (MP-187 w/ both 24 and 32 PWR capacity) <sup>2</sup>
20	B-MP61	B	MP-197 DPC
21	P-MP24	P	MP-187 DPC
22	P-MP32	P	MP-187 DPC
23	P-STC26	P	NAC STC DPC
25	P-UMS24	P	NAC UMS DPC
26	B-TN68	B	TN-68 Transportable Storage Cask
27	P-HI24	P	HI STAR 100 DPC

Notes:

<sup>1</sup> Fuel types are as follows: B – Commercial BWR SNF, P – Commercial PWR SNF.

<sup>2</sup> The pools for certain sites have special storage modal types because a specific cask(s) has been identified for use at these sites.

<sup>3</sup> The pool for South Texas has a special storage modal type because the fuel is long PWR fuel.



Table 6. Example "Pool" Modal Types Assigned

Pool <sup>2,3</sup> #	EIA Pool ID	Pool Name	Fuel Type <sup>4</sup>	Transportation Modal Type <sup>1</sup>	Dry Storage Modal Type <sup>1</sup>
2	401	ARKANSAS NUCLEAR 1	P	P-100-R	P-ANO
5	1601	BEAVER VALLEY 1	P	P-100-R	P-125
9	1201	BIG ROCK POINT 1	B	B-125-R	B-Big Rock
10	1001	BRAIDWOOD 1	P	P-100-R	P-125
11	4803	BROWNS FERRY 1	B	B-100-R	B-125
15	701	BRUNSWICK 1	B	B-60-R	B-MP61
16	1003	BYRON 1	P	P-100-R	P-125
17	5101	CALLAWAY 1	P	P-125-R	P-125
18	501	CALVERT CLIFF 1	P	P-100-R	P-C.Cliffs
19	1501	CATAWBA 1	P	P-100-R	P-UMS24
21	2301	CLINTON 1	B	B-LWT	B-125
22	4901	COMANCHE PEAK 1	P	P-125-R	P-125
23	5801	COOK 1	P	P-LWT	P-125
24	3001	COOPER STATION	B	B-60-R	B-125
25	1701	CRYSTAL RIVER 3	P	P-LWT	P-MP32
26	5001	DAVIS-BESSE 1	P	P-125-R	P-MP24
27	3501	DIABLO CANYON 1	P	P-125-R	P-125
30	1006	DRESDEN 2	B	B-60-R	B-125
32	2401	DUANE ARNOLD	B	B-100-R	B-MP61
33	1402	ENRICO FERMI 2	B	B-100-R	B-125
34	101	FARLEY 1	P	P-125-R	P-125
36	3901	FITZPATRICK	B	B-125-R	B-125
37	3401	FORT CALHOUN	P	P-60-R	P-MP32
38	4401	GINNA	P	P-LWT	P-125
39	2901	GRAND GULF 1	B	B-125-R	B-125
40	5701	HADDAM NECK	P	P-125-R	P-STC26
41	7017	HANFORD WA BWR	B	B-LWT	B-125
43	703	HARRIS 1	P	P-60-R	P-125
44	793	HARRIS - BWR	B	B-60-R	B-125
46	2001	HATCH 1	B	B-125-R	B-125
47	4201	HOPE CREEK	B	B-125-R	B-125
48	3503	HUMBOLDT BAY	B	B-125-R	B-Hum. Bay
49	1101	INDIAN POINT 1	P	P-100-R	P-125
53	7002	INL-PWR	P	P-LWT	P-125
54	5501	KEWAUNEE	P	P-100-R	P-125

<b>Pool <sup>2,3</sup>#</b>	<b>EIA Pool ID</b>	<b>Pool Name</b>	<b>Fuel Type<sup>4</sup></b>	<b>Transportation Modal Type<sup>1</sup></b>	<b>Dry Storage Modal Type<sup>1</sup></b>
55	1301	LACROSSE	B	B-LWT	B-125
56	1008	LASALLE 1	B	B-100-R	B-125
57	3701	LIMERICK 1	B	B-100-R	B-125
58	2801	MAINE YANKEE	P	P-125-R	P-UMS24
59	1504	MCGUIRE 1	P	P-100-R	P-McGuire
61	3201	MILLSTONE 1	B	B-60-R	B-125
62	3202	MILLSTONE 2	P	P-125-R	P-MP32
64	3301	MONTICELLO	B	B-60-R	B-125
66	6602	HadNck at MORRIS	P	P-60-R	P-125
67	3101	NINE MILE POINT 1	B	B-100-R	B-125
69	5201	NORTH ANNA 1	P	P-125-R	P-N. Anna
70	1506	OCONEE 1	P	P-100-R	P-MP24
72	1903	OYSTER CREEK 1	B	B-100-R	B-MP61
73	1204	PALISADES	P	P-100-R	P-Palis
74	301	PALO VERDE 1	P	P-125-R	P-UMS24
77	3704	PEACH BOTTOM 2	B	B-125-R	B-TN68
79	901	PERRY 1	B	B-125-R	B-125
80	601	PILGRIM 1	B	B-LWT	B-125
81	5401	POINT BEACH 1	P	P-100-R	P-Pt. Beach
82	3302	PRAIRIE ISLAND 1	P	P-100-R	P-Pr. Island
83	1010	QUAD CITIES 1	B	B-60-R	B-125
84	4501	RANCHO SECO 1	P	P-125-R	P-MP24
85	705	ROBINSON 2	P	P-100-R	P-MP24
86	2101	RIVER BEND 1	B	B-125-R	B-125
87	4202	SALEM 1	P	P-100-R	P-125
90	4701	SAN ONOFRE 1	P	P-125-R	P-MP24
93	5901	SEABROOK 1	P	P-125-R	P-125
94	4808	SEQUOYAH 1	P	P-125-R	P-125
96	2201	SOUTH TEXAS 1	P	P-R-STX	P-S. Texas
98	1801	ST LUCIE 1	P	P-100-R	P-125
100	4601	SUMMER 1	P	P-100-R	P-125
101	5203	SURRY 1	P	P-125-R	P-Surry
102	3601	SUSQUEHANNA 1	B	B-100-R	B-Susque
103	3801	TROJAN	P	P-125-R	P-HI24
104	1803	TURKEY POINT 3	P	P-LWT	P-125
106	2003	VOGTLE 1	P	P-100-R	P-125

Pool <sup>2,3</sup> #	EIA Pool ID	Pool Name	Fuel Type <sup>4</sup>	Transportation Modal Type <sup>1</sup>	Dry Storage Modal Type <sup>1</sup>
107	6001	VERMONT YANKEE 1	B	B-100-R	B-125
108	5302	COLUMBIA	B	B-125-R	B-125
109	2701	WATERFORD 3	P	P-125-R	P-125
110	4810	WATTS BAR 1	P	P-100-R	P-125
111	6401	WVDP-BWR	B	B-R-WV	B-125
112	6402	WVDP-PWR	P	P-R-WV	P-125
113	2501	WOLF CREEK 1	P	P-125-R	P-125
114	5601	YANKEE-ROWE 1	P	P-125-R	P-Ynk. Rowe
115	1012	ZION 1	P	P-100-R	P-125
116	1901	THREE MILE ISLAND 1	P	P-100-R	P-125
123	7007	HANFORD-HLW	H	HLW	N/A
124	7012	INL-HLW	H	HLW	N/A
125	7001	SRS-HLW	H	HLW	N/A
126	6401	WVDP-HLW	H	HLW	N/A
135	7007	HANFORD-DOE SNF-15 ft	X	DOE SNF	N/A
136	7007	HANFORD-DOE SNF-MCO	X	DOE SNF-MCO	N/A
137	7012	INL-NAVY-10 ft	X	NAVY-S	N/A
138	7012	INL-NAVY-15 ft	X	NAVY-L	N/A
139	7012	INL-DOE SNF-10 ft	X	DOE SNF	N/A
140	7012	INL-DOE SNF-15 ft	X	DOE SNF	N/A
141	7001	SRS-DOE SNF-10 ft	X	DOE SNF	N/A

Notes:

<sup>1</sup> The modal type does not have to be the same for both transportation and dry storage.

<sup>2</sup> When two or more reactors share a single pool, such as Byron 1 and Byron 2, only one pool number is assigned.

<sup>3</sup> When two pools are joined by a transfer canal, only one pool number is assigned, as they are typically treated as one pool (e.g., Calvert Cliffs 1 and Calvert Cliffs 2).

<sup>4</sup> Fuel types are as follows: B – Commercial BWR SNF, P – Commercial PWR SNF, X - DOE SNF, and H - HLW.

#### 4.1.1.2 Background Information – Cask Types

Table 7 provides examples of some of the cask types currently defined. After all of the modal types/modal numbers are defined, the various transportation and storage casks can be assigned to each modal type/modal number in order of priority. Further explanation is provided following the table.

Table 7. Examples of Cask Types

Cask No.	Cask Name <sup>1</sup>	Base Cask	Type	Capacity	Dry Overpack	Transp. Overpack	Additional Information
<b>TRANSPORTATION CASKS</b>							
CSNF Truck Casks							
1	B-T-9/9-SP	1	B	9	0	0	BWR LWT
2	B-T-9/7-SP	1	B	7	0	0	BWR LWT High Heat
3	B-T-9/5-SP	1	B	5	0	0	BWR LWT High Heat
6	P-T-4/4-SP	6	P	4	0	0	PWR LWT
8	P-T-4/2-SP	6	P	2	0	0	PWR LWT High Heat
Single Purpose CSNF Rail Transportation Casks							
26	B-R-68-SP	26	B	68	0	0	BWR Large Rail
27	P-R-32-SP	26	P	32	0	0	PWR Large Rail
28	B-R-42-SP	28	B	42	0	0	BWR Medium Rail
29	P-R-18-SP	29	P	18	0	0	PWR Medium Rail
30	B-R-20-SP	30	B	20	0	0	BWR Small Rail
31	P-R-8-SP	31	P	8	0	0	PWR Small Rail
32	B-R-68/44-SP-HH	26	B	44	0	0	BWR Large Rail High Heat
33	P-R-32/24-SP-HH	26	P	24	0	0	PWR Large Rail High Heat
34	B-R-68/32-SP-HH	26	B	32	0	0	BWR Large Rail High Heat
35	P-R-32/16-SP-HH	26	P	16	0	0	PWR Large Rail High Heat
36	B-R-42/24-SP-HH	28	B	24	0	0	BWR Medium Rail High Heat
37	P-R-18/10-SP-HH	29	P	10	0	0	PWR Medium Rail High Heat
38	B-R-20/12-SP-HH	30	B	12	0	0	BWR Small Rail High Heat
39	P-R-8/5-SP-HH	31	P	5	0	0	PWR Small Rail High Heat
60	P-R-ST18-SP	60	P	18	0	0	South Texas
61	P-R-ST18/10-SP-HH	60	P	10	0	0	South Texas High Heat
62	B-R-TNBRP-SP	62	B	85	0	0	West Valley (TN-BRP)
63	P-R-TNREG-SP	63	P	40	0	0	West Valley (TN-REG)
66	B-R-TN68-SP	66	B	68	0	0	TN-68, Pool Pickup
Single Purpose HLW and DOE SNF Rail Transportation Casks							
44	H-R-5-SP-L&S	44	H	5	0	0	HLW
50	D-R-4-SP-MCO	50	X	4	0	0	DOE SNF (MCO)
51	D-R-9-SP	50	X	9	0	0	DOE SNF
52	D-R-1-SP-NAVY S	52	X	1	0	0	Naval Short
53	D-R-1-SP-NAVY L	52	X	1	0	0	Naval Long

Cask No.	Cask Name <sup>1</sup>	Base Cask	Type	Capacity	Dry Overpack	Transp. Overpack	Additional Information
<b>STORAGE CASKS</b>							
Single Purpose CSNF Storage Casks							
93	B-S-68-SP	93	B	68	0	0	Generic BWR Storage Cask
98	P-S-32-SP	98	P	32	0	0	Generic PWR Storage Cask
101	P-S-40-SP	101	P	40	0	0	TN40
<b>DUAL-PURPOSE CANISTERS AND OVERPACKS</b>							
Dual Purpose CSNF Rail Systems							
200	B-C-HI68-ST	200	B	68	201	202	HI STAR 100
201	B-S-HI68-OV	201	B	68	0	0	HI STAR 100
202	B-R-HI68-OV	26	B	68	0	0	HI STAR 100
203	P-C-HI32-ST	203	P	32	204	205	HI STAR 100
204	P-S-HI32-OV	204	P	32	0	0	HI STAR 100
205	P-R-HI32-OV	26	P	32	0	0	HI STAR 100
212	P-C-YR36-ST	212	P	36	213	214	Yankee Rowe DPC (NAC STC)
213	P-S-YR36-OV	213	P	36	0	0	Yankee Rowe DPC (NAC STC)
214	P-R-YR36-OV	223	P	36	0	0	Yankee Rowe DPC (NAC STC)
215	B-C-BRP64-ST	215	B	64	216	217	Big Rock Point DPC (TS-125)
216	B-S-BRP64-OV	216	B	64	0	0	Big Rock Point DPC (TS-125)
217	B-R-BRP64-OV	217	B	64	0	0	Big Rock Point DPC (TS-125)
218	P-C-HI24-ST	218	P	24	219	220	HI STAR 100
219	P-S-HI24-OV	219	P	24	0	0	HI STAR 100
220	P-R-HI24-OV	26	P	24	0	0	HI STAR 100
221	P-C-STC26-ST	221	P	26	222	223	NAC STC
222	P-S-STC26-OV	222	P	26	0	0	NAC STC
223	P-R-STC26-OV	223	P	26	0	0	NAC STC
224	P-C-MP24-ST	224	P	24	225	226	MP-187 (24 assembly)
225	P-S-MP24-OV	225	P	24	0	0	MP-187 (24 assembly)
226	P-R-MP24-OV	226	P	24	0	0	MP-187 (24 assembly)
227	P-C-ST18-ST	227	P	18	228	229	South Texas DPC
228	P-S-ST18-OV	228	P	18	0	0	South Texas DPC
229	P-R-ST18-OV	60	P	18	0	0	South Texas DPC
230	B-C-TN68-ST	230	B	68	231	232	TN-68 (Dry Storage)
231	B-S-TN68-OV	231	B	68	0	0	TN-68 (Dry Storage)

Cask No.	Cask Name <sup>1</sup>	Base Cask	Type	Capacity	Dry Overpack	Transp. Overpack	Additional Information
232	B-R-TN68-OV	66	B	68	0	0	TN-68 (Dry Storage)
233	P-C-TN32-ST	233	P	32	234	235	TN-32 (Dry Storage)
234	P-S-TN32-OV	234	P	32	0	0	TN-32 (Dry Storage)
235	P-R-TN32-OV	235	P	32	0	0	TN-32 (Dry Storage)
236	B-C-UMS56-ST	236	B	56	237	238	NAC UMS
237	B-S-UMS56-OV	237	B	56	0	0	NAC UMS
238	B-R-UMS56-OV	238	B	56	0	0	NAC UMS
239	P-C-UMS24-ST	239	P	24	240	241	NAC UMS
240	P-S-UMS24-OV	240	P	24	0	0	NAC UMS
241	P-R-UMS24-OV	238	P	24	0	0	NAC UMS
242	B-C-HB80-ST	242	B	80	243	244	HI STAR HB
243	B-S-HB80-OV	243	B	80	0	0	HI STAR HB
244	B-R-HB80-OV	244	B	80	0	0	HI STAR HB
245	B-C-MP61-ST	245	B	61	246	247	MP-197
246	B-S-MP61-OV	246	B	61	0	0	MP-197
247	B-R-MP61-OV	247	B	61	0	0	MP-197
248	P-C-MP32-ST	248	P	32	249	250	MP-187 (32 assembly)
249	P-S-MP32-OV	249	P	32	0	0	MP-187 (32 assembly)
250	P-R-MP32-OV	226	P	32	0	0	MP-187 (32 assembly)
<b>MULTI-PURPOSE CANISTERS AND OVERPACKS</b>							
TAD Canister CSNF Rail Systems							
206	B-C-24-STE	206	B	24	207	208	BWR Small TAD
207	B-S-24-OV	207	B	24	0	0	BWR Small TAD
208	B-R-24-OV	208	B	24	0	0	BWR Small TAD
209	P-C-12-STE	209	P	12	210	211	PWR Small TAD
210	P-S-12-OV	210	P	12	0	0	PWR Small TAD
211	P-R-12-OV	208	P	12	0	0	PWR Small TAD
251	B-C-44-STE	251	B	44	252	253	BWR Large (44 assembly) TAD
252	B-S-44-OV	252	B	44	0	0	BWR Large (44 assembly) TAD
253	B-R-44-OV	253	B	44	0	0	BWR Large (44 assembly) TAD
254	P-C-21-STE	254	P	21	255	256	PWR Large (21 assembly) TAD
255	P-S-21-OV	255	P	21	0	0	PWR Large (21 assembly) TAD
256	P-R-21-OV	253	P	21	0	0	PWR Large (21 assembly) TAD
257	B-C-68-STE	251	B	68	258	259	BWR Large (68 assembly) TAD

Cask No.	Cask Name <sup>1</sup>	Base Cask	Type	Capacity	Dry Overpack	Transp. Overpack	Additional Information
258	B-S-68-OV	252	B	68	0	0	BWR Large (68 assembly) TAD
259	B-R-68-OV	253	B	68	0	0	BWR Large (68 assembly) TAD
260	P-C-32-STE	254	P	32	261	262	PWR Large (32 assembly) TAD
261	P-S-32-OV	255	P	32	0	0	PWR Large (32 assembly) TAD
262	P-R-32-OV	253	P	32	0	0	PWR Large (32 assembly) TAD

<sup>1</sup> While any name can be specified for a cask, a descriptive name is helpful when analyzing the output. The casks shown here typically have a designator of the following format:

Fuel Type – Cask Use – Capacity – Cask Type – Other Information

Where:

Fuel Type = B - BWR, P - PWR, H - HLW, X – DOE SNF

Cask Use = T - truck, R - rail, S - storage, C - canister (in dual purpose systems)

Capacity = assemblies or canisters. Some casks also contain a code indicating the name of the cask, if available (e.g., TN68, MP32, UMS56).

Cask Type = OV - overpack, SP - single purpose, ST - storage and transportation, STE – storage, transportation and emplacement

Other Information = L - Long , S - Short, HH – High Heat.

Priority assignments of casks can be made over a set number of years and in a set order of priority (0 to 3), with “0” being the highest priority. For example, for “pools” that have been designated “B-LWT” modal type for transportation, the transportation cask priority ranking might look similar to the ranking provided in Table 8 below (assumes fuel pickup starting in 2010).

Table 8. “B-LWT” Transportation Cask Priority

Modal Type	Modal #	Cask Name	Cask #	Start Year	End Year	Priority
B-LWT	1	B-T-9/9-SP	1	2010	2099	0
B-LWT	1	B-T-9/7-SP	2	2010	2099	1
B-LWT	1	B-T-9/5-SP	3	2010	2099	2
B-LWT	1	B-T-2-SP	11	2010	2099	3

For the example in Table 8, the application will try to load CSNF in the truck casks in order of the priority ranking (i.e., in order from “0” to “3”). If the priority “0” cask cannot be used (because the CSNF assemblies selected cannot be loaded in the cask due to heat, criticality, or physical size limitations), then the next highest priority cask (which may have a higher heat limit, less restrictive criticality limits, or greater length) will be tried, and so forth until all the casks in the list have been tried. If none of the casks can be used, the pickup for the specified site will be skipped for that year. As an example, a scenario with the CSNF acceptance criterion of Strict YFF5 attempts to load the hottest fuel that may be transported from a site (i.e., fuel with the highest thermal output), and if a high heat cask is not included in the modal type that site will be skipped over and over while its allocation accumulates. In the last year of pickup, if no cask can be used, an error message is generated (see Table 14).

#### 4.1.1.3 Selection of “Pool Link” and “Transportation”

The selection of “Pool Link” and “Transportation” allows the user to modify the transportation cask modal types for CSNF, DOE SNF, and HLW sites. The modal type for each site is already included as part of the user’s currently selected scenario.

When this combination is selected, a spreadsheet appears containing the pool number and name, the modal type and number, and the fuel type (see Figure 12).

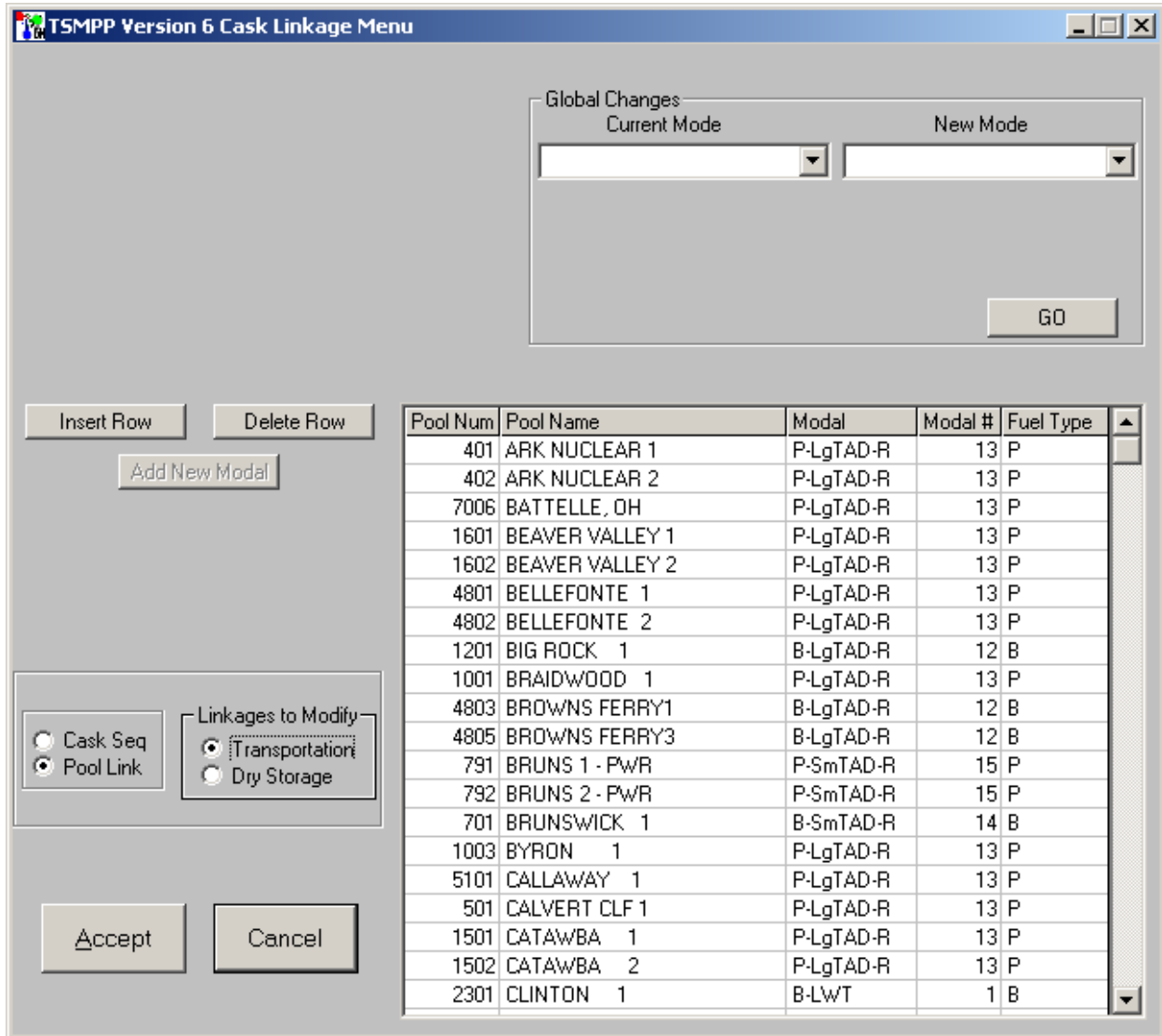


Figure 12. Pool Linkage and Transportation Screen

The user is allowed to change the modal type via the “Modal” column or via the “Modal #” column. Selecting any data in these columns causes a box to appear in the upper left-hand portion of the “Cask Linkage” dialog. This box contains the available transportation cask modal



types and associated modal numbers. To change an existing entry for the transportation cask modal type for a specific site, the steps are:

1. Find the preferred site in the spreadsheet and select the current modal type or modal number for that site.
2. Select the preferred modal type from the box in the upper left-hand corner of the “Cask Linkage” dialog.
3. Change the modal type for the selected site by double clicking on the preferred modal type.

After double clicking on the preferred modal type, the data in the “Modal” column and in the “Modal #” column changes to reflect the new modal type and associated modal number.

For new entries, the user may add and delete lines within the spreadsheet as necessary via the “Insert Row” and “Delete Row” buttons to the left of the spreadsheet. This can be used to add new pools to the system or to remove pools that are no longer being used. Clicking on the pool number or pool name columns in the spreadsheet will cause a box to appear in the upper left-hand portion of the “Cask Linkage” dialog that contains a list of pools and their associated pool numbers. Data can be changed in the pool name and pool number columns of the spreadsheet in the same manner as the modal type data (i.e., by selecting the data in the pool name or pool number in the spreadsheet and double clicking on the preferred pool from the box in the upper left-hand corner).

#### **4.1.1.4 Selection of “Pool Link” and “Dry Storage”**

The selection of “Pool Link” and “Dry Storage” allows the user to modify the storage cask modal type for CSNF, DOE SNF, and HLW sites as shown in Figure 13. The modal type for each site is already included as part of the user’s currently selected scenario. If the user wishes to modify the dry storage cask, the “Pool Link” / “Dry Storage” combination should be selected. Use the steps discussed in the previous section for changing existing entries or adding new entries.

#### **4.1.1.5 Selection of “Cask Seq” and “Transportation” Priorities**

This selection of “Cask Seq” and “Transportation” (see Figure 11) allows the user to specify the transportation cask priority sequence for each modal type specified. The transportation cask priority sequence for each modal type is already included as part of the user’s currently selected scenario. If the user wishes to modify the transportation cask priority sequence, the “Cask Seq” / “Transportation” combination should be selected. A spreadsheet will then appear containing:

- Modal type
- Modal number
- Cask name
- Cask number
- Start year
- End year

- Cask priority (order to attempt to load casks).

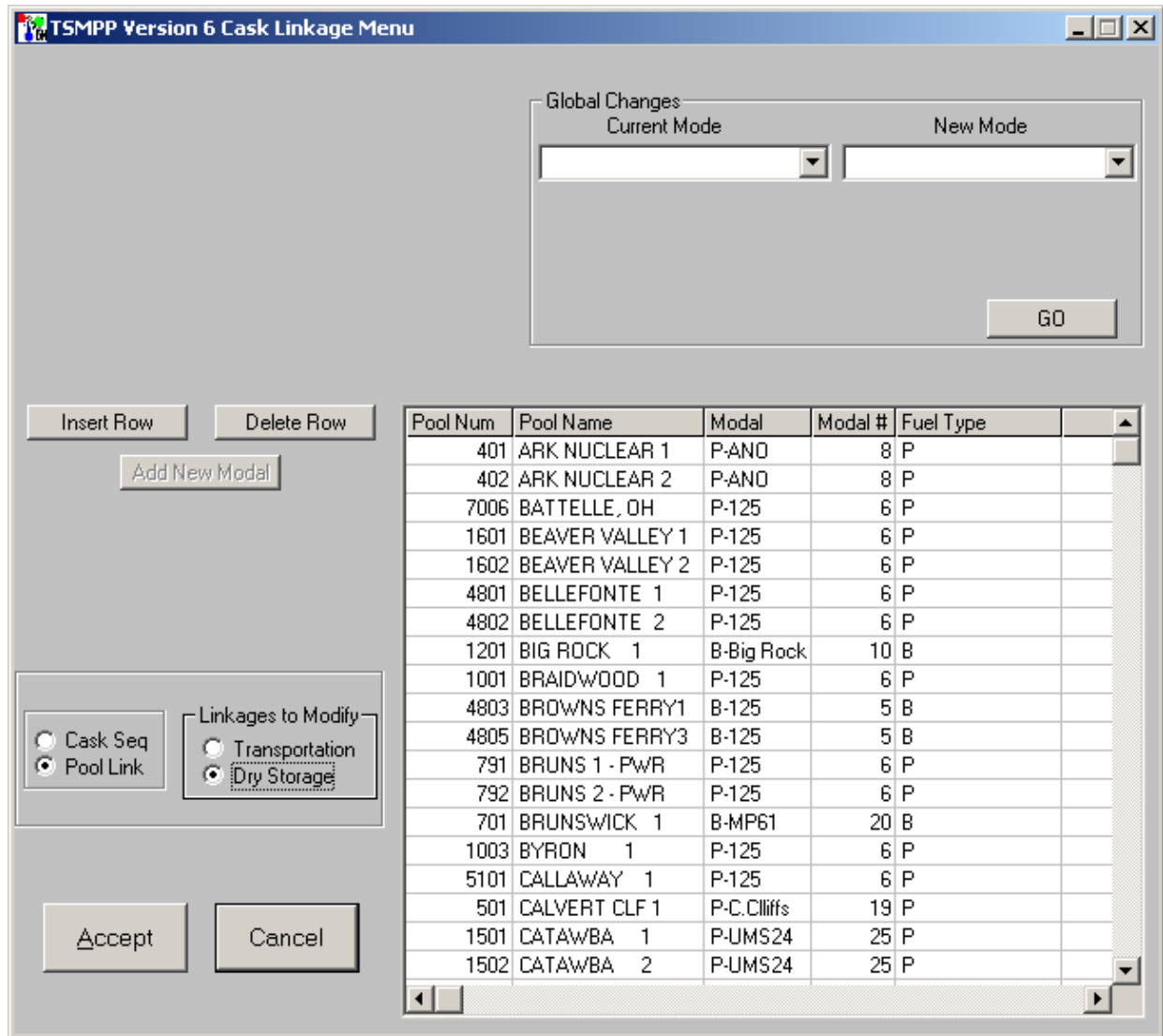


Figure 13. Pool Linkage and Dry Storage Option

#### 4.1.1.6 Modal Type and Number

The modal type can be changed via the “Modal Type” column or via the “Modal #” column. Selecting any data in these columns causes a box to appear in the upper left-hand portion of the “Cask Linkage” dialog. This box contains the available transportation cask modal types and associated modal numbers. To edit the transportation cask modal type, the user should do the following:

1. Find the line to be edited in the spreadsheet and select the current modal type or modal number.
2. Select the preferred modal type from the box in the upper left-hand corner of the “Cask Linkage” dialog.

3. Change the modal type for the selected line by double clicking on the preferred modal type.

After double clicking on the preferred modal type, the data in the “Modal Type” column and in the “Modal #” column changes to reflect the new modal type and associated modal number.

#### **4.1.1.7 Cask Type and Number**

The cask type can be changed via the “Cask Name” column or via the “Cask #” column. Selecting any data in these columns causes a box to appear in the upper left-hand portion of the “Cask Linkage” dialog. This box contains the available casks and associated cask numbers. To edit the cask type, the user should do the following:

1. Find the line to be edited in the spreadsheet and select the current cask name or cask number.
2. Select the preferred cask type from the box in the upper left-hand corner of the “Cask Linkage” dialog.
3. Change the cask type for the selected line by double clicking on the preferred cask type.

After double clicking on the preferred cask type, the data in the “Cask Name” column and in the “Cask #” column changes to reflect the new cask type and associated cask number.

#### **4.1.1.8 Starting and Ending Years**

Data for the start year, the end year, and the cask loading sequence priority is entered manually by clicking on the desired “Start Yr,” “End Yr,” and “Pri” column respectively and typing in the data. This data must be entered for each cask type. The priority ranking of the casks for each modal type over a specified start year and end year must be as follows:

- first choice – priority “0,”
- second choice – priority “1,”
- third choice – priority “2,”
- fourth choice – priority “3,” and
- so on, up to the maximum priority ranking allowed (currently 24).

#### **4.1.1.9 Changing Cask Modals**

The user may add and delete lines within the spreadsheet as necessary via the “Insert Row” and “Delete Row” buttons. In addition, new modal types can be added via the “Add New Modal” button. These buttons are located to the left of the spreadsheet. Clicking on the “Add New Modal” button causes a box indicating the new modal number to appear. The user may use the number suggested by the application by clicking on the “OK” button in this box, or the user may type in another unassigned number and click on the “OK” button. The user is then prompted via a similar box to enter a new modal name. After entering the new modal name, click on the “OK”

button. The user may then use this modal type when modeling. Note that if a modal type is defined but not used, it will not be saved.

#### 4.1.1.10 Selection of “Cask Seq” and “Dry Storage”

The cask priority sequence for each modal type is already included as part of the user’s currently selected scenario. The selection of “Cask Seq” and “Dry Storage” (Figure 14) allows the user to specify the dry storage cask priority sequence for each storage cask type. The “Cask Seq” / “Dry Storage” combination allows the user to modify the dry storage cask priority sequence similarly to the method for modifying the cask sequence and transportation options discussed in section 4.1.1.5.

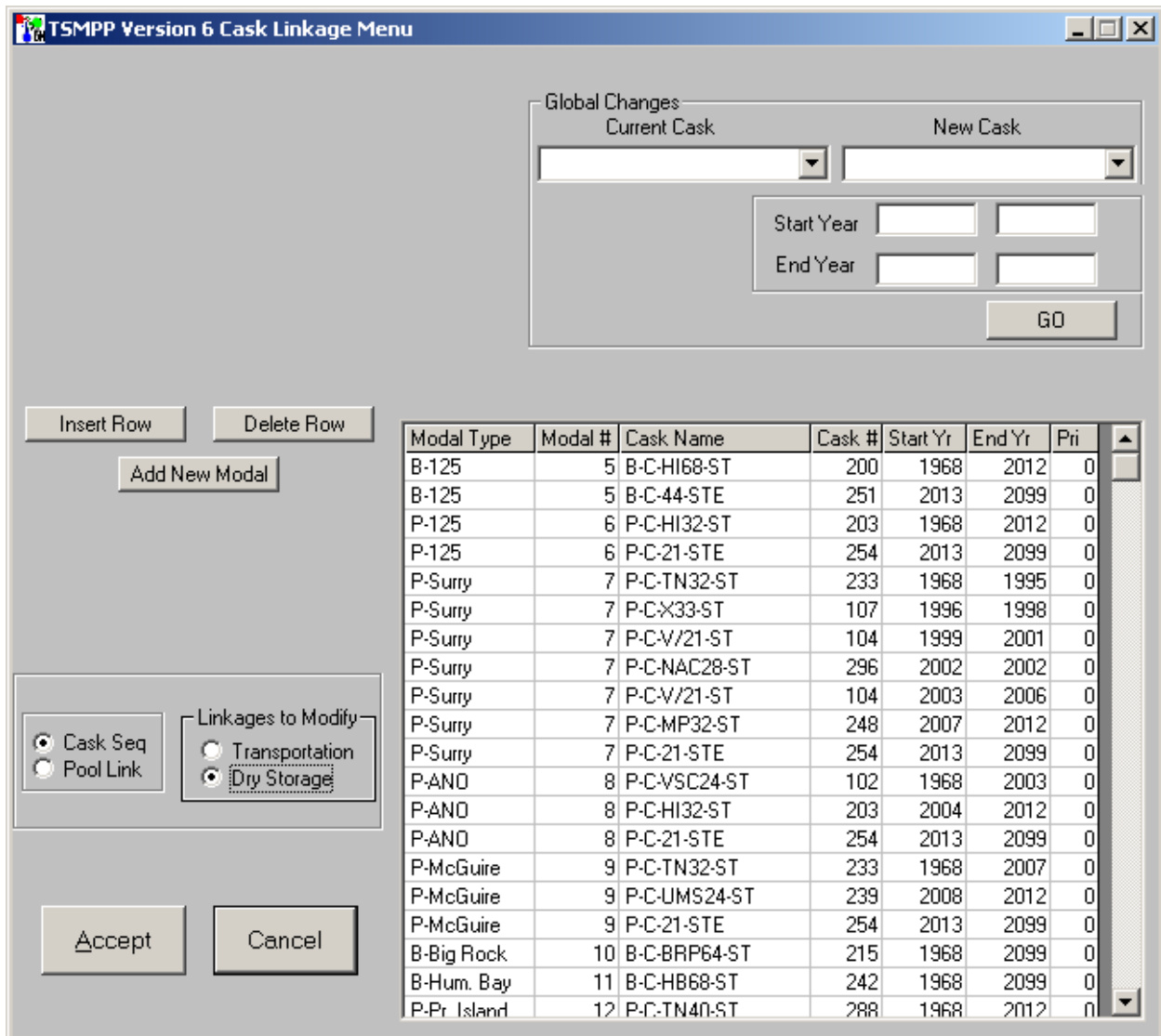


Figure 14. Cask Sequence and Dry Storage Option

#### **4.1.1.11 Modal Global Changes**

An additional feature included as part of the “Cask Linkage” dialog consists of a “Global Changes” box. Depending upon whether pools are being assigned a specific modal type and modal number (i.e., the “Pool Link” option shown in the box in the bottom left-hand corner is selected) or if priority rankings are being established for the various modal types (i.e., the “Cask Seq” option shown in the box in the bottom left-hand corner is selected), the “Global Changes” box allows the user to perform different functions.

If the “Pool Link” option shown in the box in the bottom left-hand corner is selected (see Figure 13), the “Global Changes” box allows the user to globally change one modal type to another modal type. The “Current Mode” and the “New Mode” are selected by scrolling through the list provided via the arrow symbol.

If the “Cask Seq” option shown in the box in the bottom left-hand corner is selected (see Figure 14), the “Global Changes” box allows the user to globally change one cask type to another cask type or to globally change a specified “Start Year” or “End Year” to another start year or end year. The “Current Cask” and the “New Cask” are selected by scrolling through the list provided via the arrow symbol. To change the “Start Year” or “End Year,” the current value must be manually entered in the first box and the new value must be entered in the second box. To change the “Start Year” and/or “End Year” values for all casks, the “Current Cask” box must be left blank; to change the “Start Year” and/or “End Year” values for a specific cask type, that cask type must be selected in the “Current Cask” box.

#### **4.1.2 Loading Options**

The Cask Loading dialog is shown in Figure 15. These options determine how each transportation cask is loaded, and are used to determine the configuration of the waste stream which is input to the GROA.

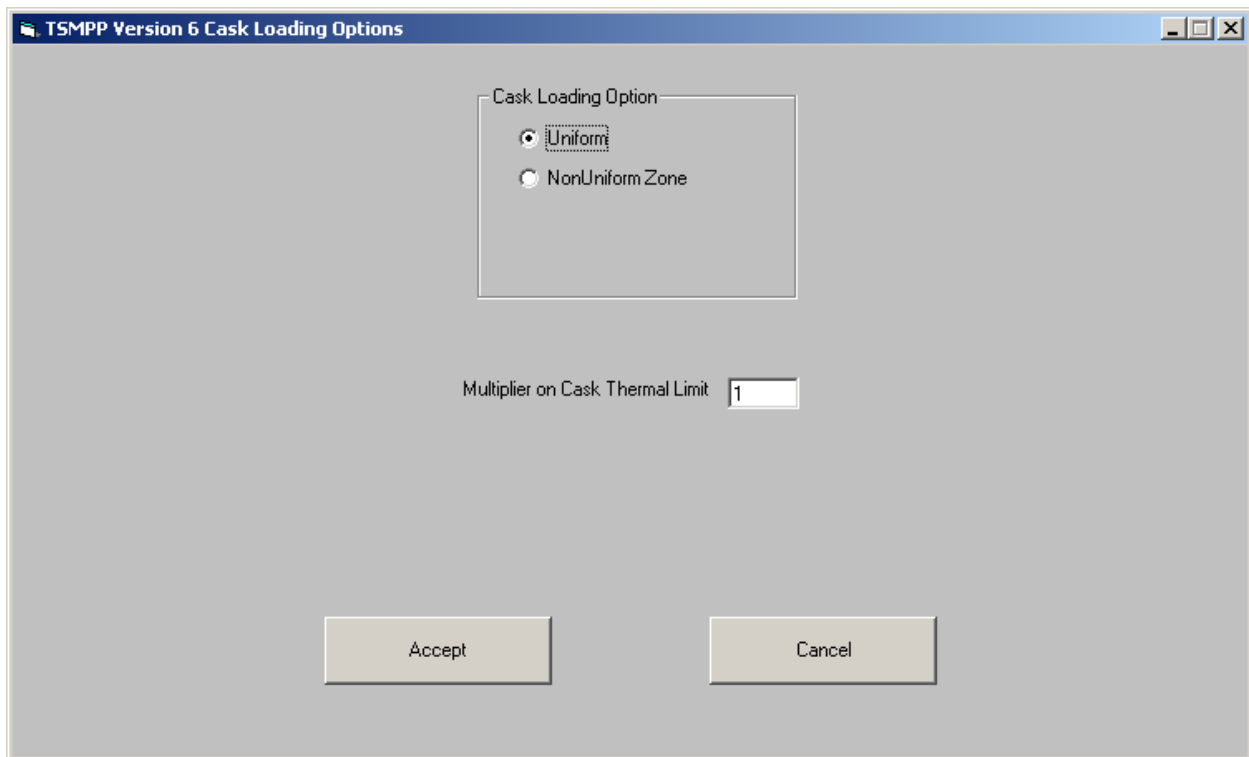


Figure 15. Cask Loading Options

#### 4.1.2.1 Cask Loading Option

The “Cask Loading Option” box includes radio buttons that allow the user to define whether the transportation cask will be loaded using a uniform heat limit or a non-uniform, region-specific heat limit. Non-uniform cask loading places cooler assemblies in the outer regions of a cask and hotter assemblies in the interior regions. Additional detail on non-uniform zone loading of transportation casks can be found in Appendix A, Section A.2.3.2.1.

The “Uniform” cask loading option uses the fuel acceptance algorithm also discussed in Section A.2.3.2.1 and accepts the fuel if the assembly heat is below the cask’s assembly heat limit as defined by the cask loading limit (for additional information on cask limits see Section B.1.3.1). This approach yields the most conservative cask heat load and is the current practice for licensed transportation casks.

The “NonUniform Zone” loading algorithm with credit for radiation self-shielding defines two regions in the cask. When this option is selected, two additional input boxes appear which allow the user to define the fraction of the cask to be used for the “cold” region (<1.0), and a loading multiplier. The coldest fuel available is loaded into the outer region and the deficit heat (i.e., the resulting gain accumulated by staying below the cask’s assembly heat limit) is tracked. Then the hottest fuel available is examined to determine if it is suitable for the inner, shielded cask region. If this fuel batch is too hot, then the next coolest batch is examined until a cask load is defined. If the hottest fuel is less than the cask’s assembly heat limit, that is, if there is no benefit to zone loading, then non-uniform loading is abandoned, and uniform cask loading is used.

#### 4.1.2.2 Multiplier on Cask Thermal Limit

Transportation cask operational loading, through procedures or administrative orders, often yield cask loads at some fraction, less than 1.0, of their regulatory load limit. The basic reasons for this are the characteristics (i.e., burnup and age) of the fuel available for loading and, at some utilities, the practice of providing a margin (deliberately loading to a fraction of the load limit) to assure compliance with regulations. The practice of providing a margin may be used to minimize financial and schedule risks associated with having to reload the cask if post-loading measurements indicate it exceeds administrative or regulatory limits.

In order to provide a user with the capability of including a cask loading “performance measure”, this input allows the user to define a single global factor that may be used to reduce each cask thermal limit.

## 4.2 OPTIONS MENU

The “Options” menu provides access to dialogs for specifying parameters related to fuel selection through the following options:

- Utility Options
- Cask Acceptance
- CSNF Acceptance

### 4.2.1 Utility Options

The “Utility Options” menu option displays the “Utility Options” dialog (Figure 16), for specifying pool selection and unloading criteria. The features provided in this dialog are in separate subsections below.

#### 4.2.1.1 Allocation Method

This option allows the user to specify the methodology used to define the means by which fuel pickup allocations are determined for CSNF pools. If “Oldest Fuel First (OFF)” is chosen, fuel pickup is allocated based on Acceptance Priority Ranking (APR) allocations (i.e., discharge order where the site with the oldest fuel gets its fuel picked up). If “Site Specific Allocation” (SSA) is chosen, the user may specify annual fuel allocations by reactor pool.

If the OFF method is selected, two additional check boxes appear that allow the user to specify additional allocation as described below.

- **Overflow Method:** The OFF methodology still applies for the primary receipt rates; however, a “Set Pri Rates” button appears that allows the user to specify a secondary receipt rate, which will only be used at pools that are overflowing (require dry storage).
- **Shutdown Method:** The OFF methodology still applies for the primary receipt rates. However, a “Years of Shutdown” field appears that allows the user to specify the preferred number of years for a site to be emptied after reactor shutdown (if there is

insufficient allocation, it will take longer). The “Set Pri Rates” button also appears, which allows the user to specify a secondary receipt rate for shutdown sites. If there is unused priority allocation, shutdown priority allocation will be granted to sites before they shut down, up to the number of years specified in “Years of Shutdown.” For example, with a “Years of Shutdown” value of 5 years, the application will finish emptying sites 5 years after they shut down. In addition (assuming there is sufficient priority allocation), the application will start emptying the pools at shutdown sites 5 years before they shut down.

**Note:** The method for entering the secondary receipt rates is identical to the method for entering the primary CSNF receipt rates in the “CSNF Acceptance” dialog.

The user may select both the overflow methodology and the shutdown methodology. However, the user must assign a priority of “1” to one methodology while assigning a priority of “2” to the other methodology via the “Priority” lines that appear. It should be noted that the secondary receipt rate specified for the overflow methodology and/or the shutdown methodology is in addition to the primary receipt rates set via the “CSNF Annual Acceptance” dialog of the “Waste Acceptance” menu. A more detailed discussion of “overflow” and “shutdown” priorities is included in Appendix A, Section A.2.3.1.

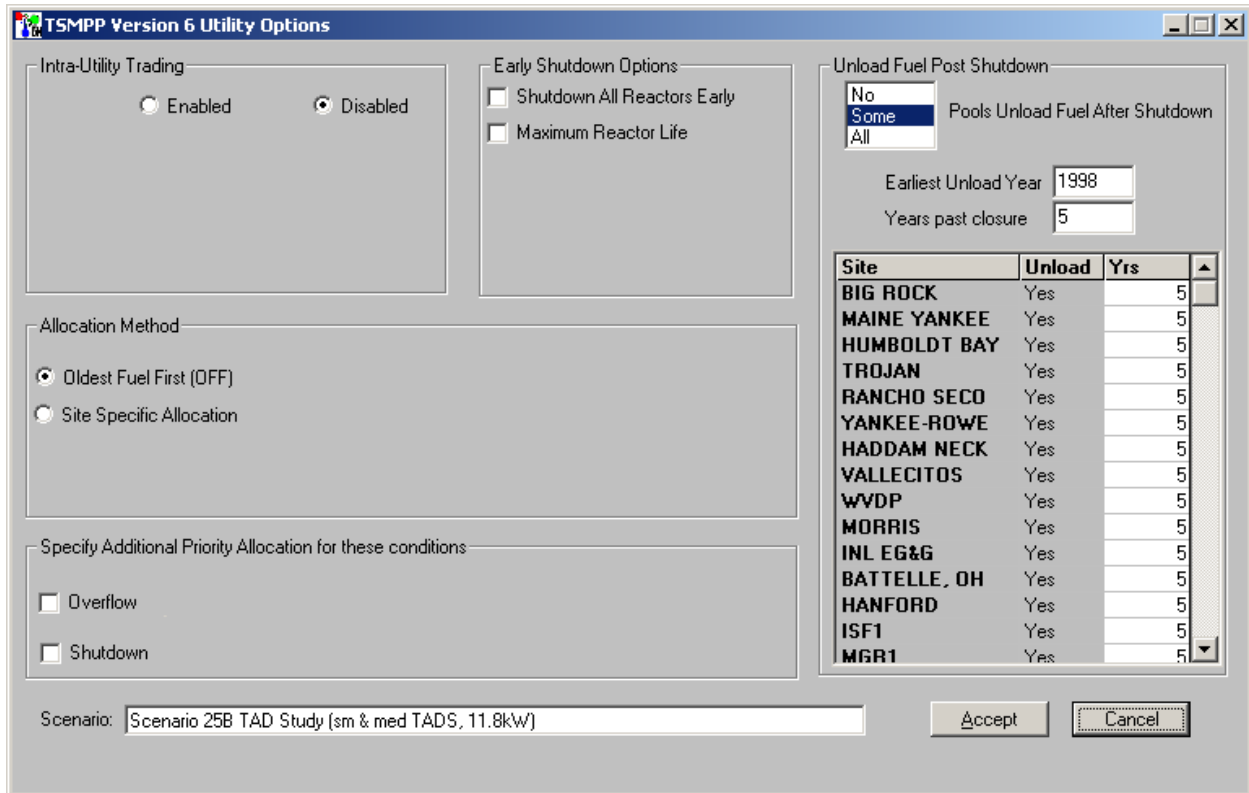


Figure 16. Utility Options

If the Site Specific Allocation method is selected, two additional buttons and a check box appear that allow the user to specify an input method of allocating fuel and the option of subtracting these allocations from APR allocations if the scenario later switches to the OFF method. The



two Site Specific Allocation input options are “Display/Change Allocation” or “Read External Excel File”. A picture of a truncated example input worksheet is shown in Figure 17.

	2014	2015	2016	2017	2018
6401					
ARK NUCLEAR 1					
ARK NUCLEAR 2					
BATTELLE, OH					
BEAVER VALLEY 1					
BEAVER VALLEY 2					
BELLEFONTE 1					
BELLEFONTE 2					
BIG ROCK 1					
BRAIDWOOD 1					
BROWNS FERRY1					
BROWNS FERRY3					
BRUNS 1 - PWR					
BRUNS 2 - PWR					
BRUNSWICK 1					
BYRON 1					
CALLAWAY 1					
CALVERT CLF 1					
<b>Reactor pools (presently 131 CSNF entries) are listed in order of increasing pool number, initially assigned by alphabetical order with the exception of newer pools, added later, and thus are not in alphabetical order.</b>					
WOLF CREEK 1					
YANKEE-ROWE 1					
ZION 1					
3 MILE ISL 1					
BRUNSWICK 2					
DRES 1 IN 2					
DRES 1 IN 3					
TURKEY PT 4					
SAN ONOFRE 3					
SAN ON 1 IN 3					
Cooper at MORRIS					
Montic at MORRIS					
SOnfo1 at MORRIS					

Figure 17. Example Site-Specific Allocation Excel Input Worksheet

Selecting the “Display/Change Allocation” button opens a Microsoft Excel worksheet that lists CSNF reactor pools from the TSMPP input database pool information table in the first column (see Figure 17). The allocation years are listed in the top row. In each additional column, annual allocation, in MTHM, for each site may be entered. If the selected scenario previously used the Site Specific Allocation option, the worksheet is populated with the existing MTHM allocations

and can be modified easily. Allocation years are aligned with those specified in the “CSNF Annual Acceptance Rate” dialog spreadsheet (see Section 4.3.1). For this reason it may be helpful for the user to update the “CSNF Annual Acceptance Rate” dialog prior to specifying SSA data. Upon closing the worksheet, the user receives a prompt, “Accept changed data into TSMPP?” which temporarily saves the entered SSA data until changes in the dialog are accepted.

Selecting the “Read External Excel File” button opens a standard Window File Selection dialog. This standard dialog asks the user for the “Excel file to open?” A file is chosen by clicking on the filename from the list of files or by entering the filename in the “File name” field. A sample of this file may be generated by first selecting the “Display/Change Allocation” button, and then saving the worksheet to a file. The user may then modify this file, with Excel, outside the TSMPP. This option enables the user to use the same SSA file in several scenarios without having to re-enter data, as well as the ability to change data easily. Upon closing the worksheet, the user receives a prompt, “Accept changed data into TSMPP?” which temporarily saves the entered SSA data until changes in the dialog are accepted.

After the last year of SSA input, the CSNF allocation method switches back to the default APR method. The option to subtract SSA allocations from the APR is typically selected, in order to ensure that cumulative allocations for all sites are consistent with the APR once APR allocations are resumed. However, this option may lead to some years where sites selected for SSA receive zero allocation upon switching back to APR allocations.

#### **4.2.1.2 Intra-Utility Trading**

This option allows the user to model trading of allocation between reactor pools that are owned by a single utility. The allocation will first be defined according to the traditional OFF policy, then utilities which own more than one spent fuel pool are allowed to accumulate allocations for each pool owned by the utility, and then re-apportion the allocation for that year to other pools based upon a pre-defined priority. If trading is enabled, additional controls will become visible allowing the user to define the priority of each of four categories of reactor pools as shown in Figure 18. These four categories are:

1. Pools with operating reactors, no dry storage capability, and minimal pool storage remaining, (see note below to define “minimal” pool storage)
2. Pools with operating reactors, with dry storage capability, and minimal pool storage remaining
3. Pools with shutdown reactors
4. Pools with operating reactors, and prioritized by the amount of pool storage remaining

In addition to defining the priority of each category, the user may specify the threshold of available pool storage below which the application will consider the pool as having “minimal pool storage”. The measure used to define remaining pool storage is the number of Full Core Reserves (FCR), which remains available for additional fuel storage in the reactor pool. To the right of the first category is a field to enter the number of FCR’s remaining in the pool that sets the minimal pool storage.

Note that Intra-Utility Trading may not be used in the same analysis with Site Specific Allocation.

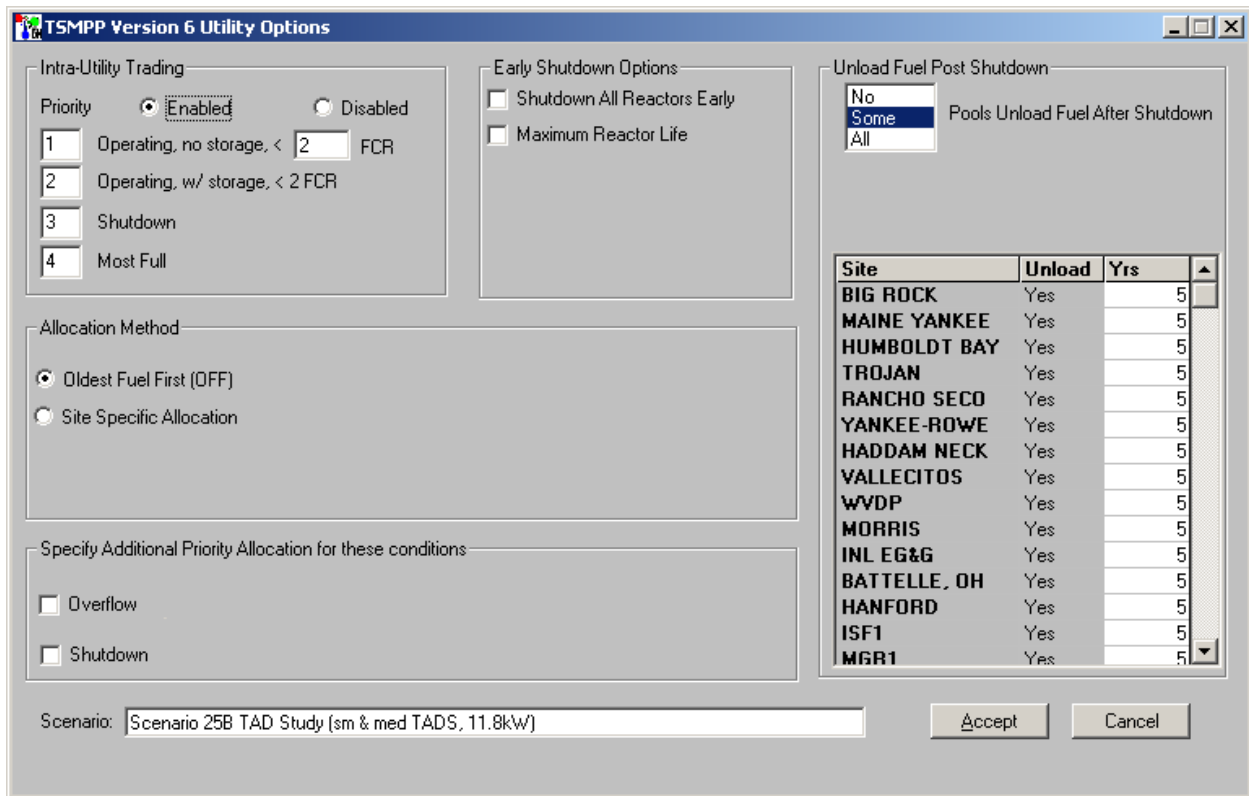


Figure 18. Utility Options with Trading enabled

#### 4.2.1.3 Early Shutdown Options

This option consists of using Early Reactor Shutdown Years or Maximum Reactor Life, and allows the user to globally adjust the expected shutdown dates for reactor sites by entering the number of years to reduce each reactor’s lifetime or by entering the maximum reactor life. If the “Shutdown All Reactors Early” option is selected, two fields will appear allowing the user to specify the number of years to reduce all reactors operating lifetime, and a Minimum Year” to specify the earliest date the reactors may be shutdown. If “Maximum Reactor Life” is chosen, only the number of years to reduce the reactor lifetime can be specified.

#### 4.2.1.4 Unload Fuel Post Shutdown

The “Unload Fuel Post Shutdown” allows the user to specify if the fuel pool(s) at a site are to be unloaded into dry storage after all reactors on the site are shut down. The user may specify either “No”, “Some”, or “All” Pools Unload Fuel After Shutdown.

If “No pools unload fuel after shutdown” is chosen, no further input is necessary.

If “Some pools unload fuel after shutdown” is selected, a list of sites appears that contains columns, listing:

- the site name
- an indication whether the site pool is to be unloaded post shutdown
- the number of years after the last fuel discharge at the site before the fuel in the pool is to be placed into dry storage

When the display is initially loaded, those sites which have been specified to unload fuel will be listed first, followed by those which do not unload. To change a specific site to load/unload after shutdown, double-click on the yes/no entry in the “Unload” column. The user may change the number of years to wait after shutdown for specific sites in the “Yrs” column. It should be noted that unload shutdown will only occur at a given site if a storage cask is specified in the year of unload. It is also worth noting that if a single purpose storage cask is specified, the cask will be left stranded on the pad, with no transportation mode possible.

If “All pools unload fuel after shutdown” is selected, the dialog displays “Earliest Unload Year” and “Years past closure” fields. The first parameter is used to set the earliest year in which pool unload is allowed for any site. The second parameter is used to specify the minimum number of years between the desired unload date and the final pickup date for unload to occur. For example, if the delay before pool unload is set at 5 years and the “Years past closure” parameter is set at 4 years (a total of 9 years after last fuel discharge), the pool will be unloaded only if the final pickup date is greater than 9 years after last fuel discharge.

#### **4.2.2 Cask Acceptance**

Selecting the Cask Acceptance button on the Options menu brings up the Cask Acceptance Options dialog, as shown in Figure 19. This dialog allows the user to define those cask acceptance choices which impact the logistics calculations. The options on this screen are divided into three groups: options that control acceptance from dry storage, options that control acceptance of DPCs, and global fuel acceptance preferences.

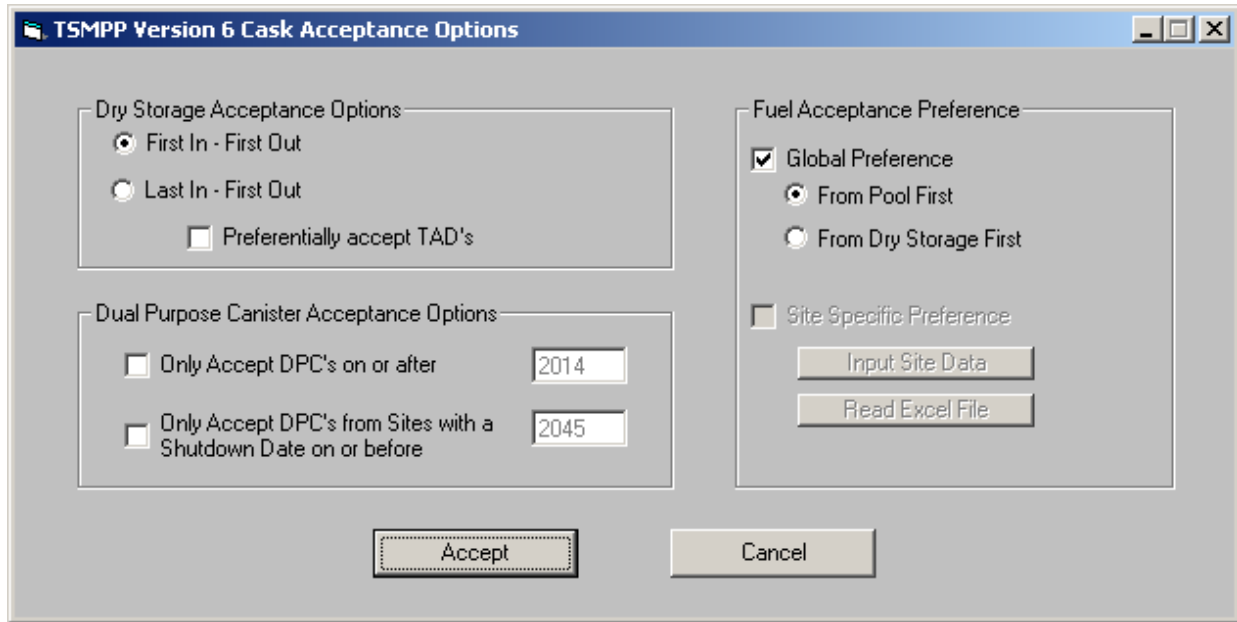


Figure 19. Cask Acceptance Options

The options in the upper left frame control the acceptance from dry storage. When a cask is selected from those on the dry storage pad, the selection may either be the cask that has been on the pad the longest (a FIFO queue), or the cask that has been on the pad the shortest period of time (a LIFO queue). In either case, the option to select TAD canisters before any other type of cask (e.g., DPCs) is available.

The options in the lower left frame limit the acceptance of DPCs from the dry storage pad. The user can select to only accept DPCs after a specific date (defaulted to be the start of acceptance), or to accept DPCs only from sites that have been shut down on or before a specific date (defaulted to be the end of acceptance).

The options in the right hand frame allow the user to select a global preference for fuel acceptance first from the pool, or first from the dry storage pad.

#### 4.2.3 CSNF Acceptance

The “CSNF Acceptance” menu option displays the “Fuel Acceptance” dialog (Figure 20), which allows the user to specify a time-variant condition for fuel acceptance at all reactor pools. Once a reactor pool receives an annual allocation, the determination of which fuel assemblies will be selected for transport, or “accepted” becomes significant. There are three methodologies utilized to determine the order of fuel pickup at the reactor pool. These are the OFF methodology, the YFFx methodology, and the Strict YFFx methodology.

- OFF method: Fuel from a pool is picked up in order from the oldest fuel to the youngest fuel (i.e., the oldest fuel in the pool is picked up first), down to the “Minimum Fuel Age.”
- YFFx method: If the YFFx methodology is selected, the user must specify a minimum age (i.e., age x) for the youngest fuel preferentially selected for pick up. Fuel age x or

older that meets the cask design limits (e.g., cask's assembly heat limit) of the highest priority (priority "0") cask is initially picked up. If necessary, lower priority casks (typically with higher assembly heat limits) will be tried.

- **Strict YFFx Method:** If this variation of the YFFx method is chosen all fuel at a pool is forced to be picked up in strict order of age, from the specified age to the oldest fuel.

**Note:** If the Strict YFFx method is chosen, a cask with an assembly heat limit high enough to accept CSNF of age x must be specified for each pool, or else no CSNF will be picked up from the pool. See Section 4.1.1 for information on selecting casks.

Additional detail on the fuel selection methodologies can be found in Appendix A, Section A.2.3.2.

The user can specify a single CSNF acceptance criterion or vary the acceptance criterion as a function of time. This dialog contains six command buttons, two buttons to accept or cancel the information that has been entered, and four buttons to add or delete a year of acceptance. Other data may be entered as follows:

- **Criterion** – The acceptance methodology for a specific year is specified in the "Criterion" column. The user only needs to click on the box needing data, and then typing the first character of "YFF" or "OFF". If "YFF" is selected the "Min.Age" and "Strict YFF" columns must also have data entered. Note that the criterion for the last year selected is used for the remaining years of the scenario.
- **Min. Age** – The Minimum Fuel Age box allows the user to enter the minimum fuel age (in years) for pickup. Typically, the "Minimum Fuel Age" is set at 5 years.
- **Strict YFF** – If YFF is selected, the option of specifying "Strict YFF" is available.

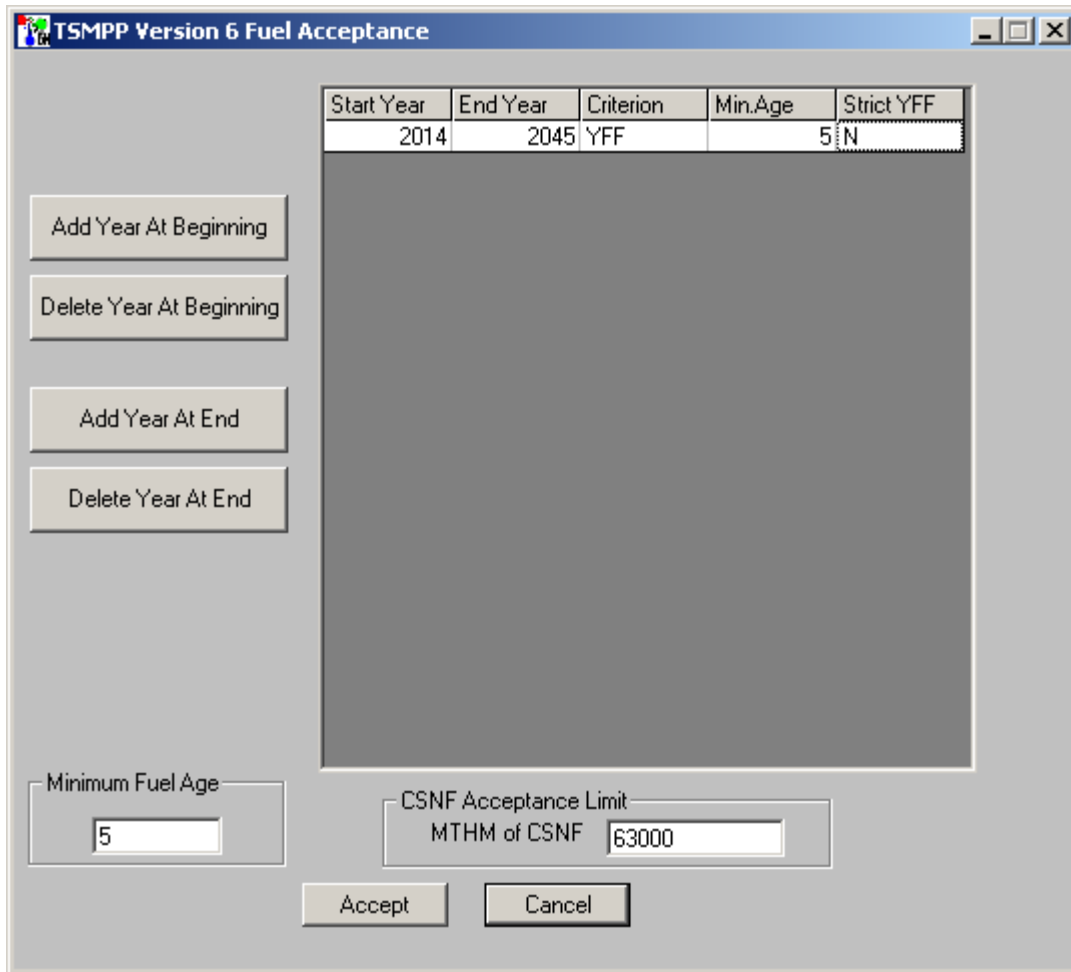


Figure 20. Fuel Acceptance

#### 4.2.3.1 CSNF Acceptance Limit

The CSNF Acceptance Limit box at the bottom of the “Fuel Acceptance” dialog provides a means to run a scenario to a specified total amount of MTHM of CSNF accepted. The total sum of MTHM in a scenario is dependent on the fuel discharge table chosen in the “Table Selection” dialog. If an acceptance limit is specified a common value is 63,000 MTHM of CSNF.

### 4.3 RATES MENU

The “Rates” menu provides access to dialogs for specifying parameters related to waste acceptance through the following options:

- Rates Menu
  - Commercial
  - High Level Waste
  - DOE SNF

### 4.3.1 Commercial SNF Acceptance Rate

The “Commercial” menu option displays the “CSNF Annual Acceptance Rates” dialog (Figure 21). At the top of the dialog, the beginning month, the beginning year, and the end year for CSNF acceptance are displayed. The user can modify the beginning month. The beginning year and end year are coupled to the data entered in the spreadsheet associated with this dialog.

The spreadsheet is used to enter the total acceptance rate in the “Acceptance Rate” column. All rates are in MTHM. Years may be added or deleted using the “Add Year to Beginning”, “Delete Year from Beginning”, “Add Year to End”, and “Delete Year from End” buttons. In addition, the name of the table that contains the CSNF input data is displayed at the top of the dialog for information only (it cannot be changed in this dialog).

\* Enter Desired Quantities in MTHM

Year	Acceptance Rate	Priority Acceptance Rate
2014	400	0
2015	600	0
2016	1200	0
2017	2000	0
2018	3000	0
2019	3000	0
2020	3000	0
2021	3000	0
2022	3000	0
2023	3000	0
2024	3000	0
2025	3000	0
2026	3000	0
2027	3000	0
2028	3000	0
2029	3000	0
2030	3000	0
2031	3000	0
2032	3000	0
2033	3000	0
2034	3000	0
2035	3000	0
2036	3000	0
2037	3000	0
2038	3000	0

Scenario 25B TAD Study (sm & med TADS, 11.8kW)

Figure 21. CSNF Annual Acceptance Rates



### 4.3.2 High Level Waste

The “High Level Waste” menu option displays two sub-options, “Production” and “Allocation”.

The Production sub-option displays the screen “HLW Production Rates”, as shown in Figure 22. This screen shows the site name, the waste type, the reactor number, the year of discharge, the number of canisters discharged, the heat of each canister in watts, and the mass of each canister.

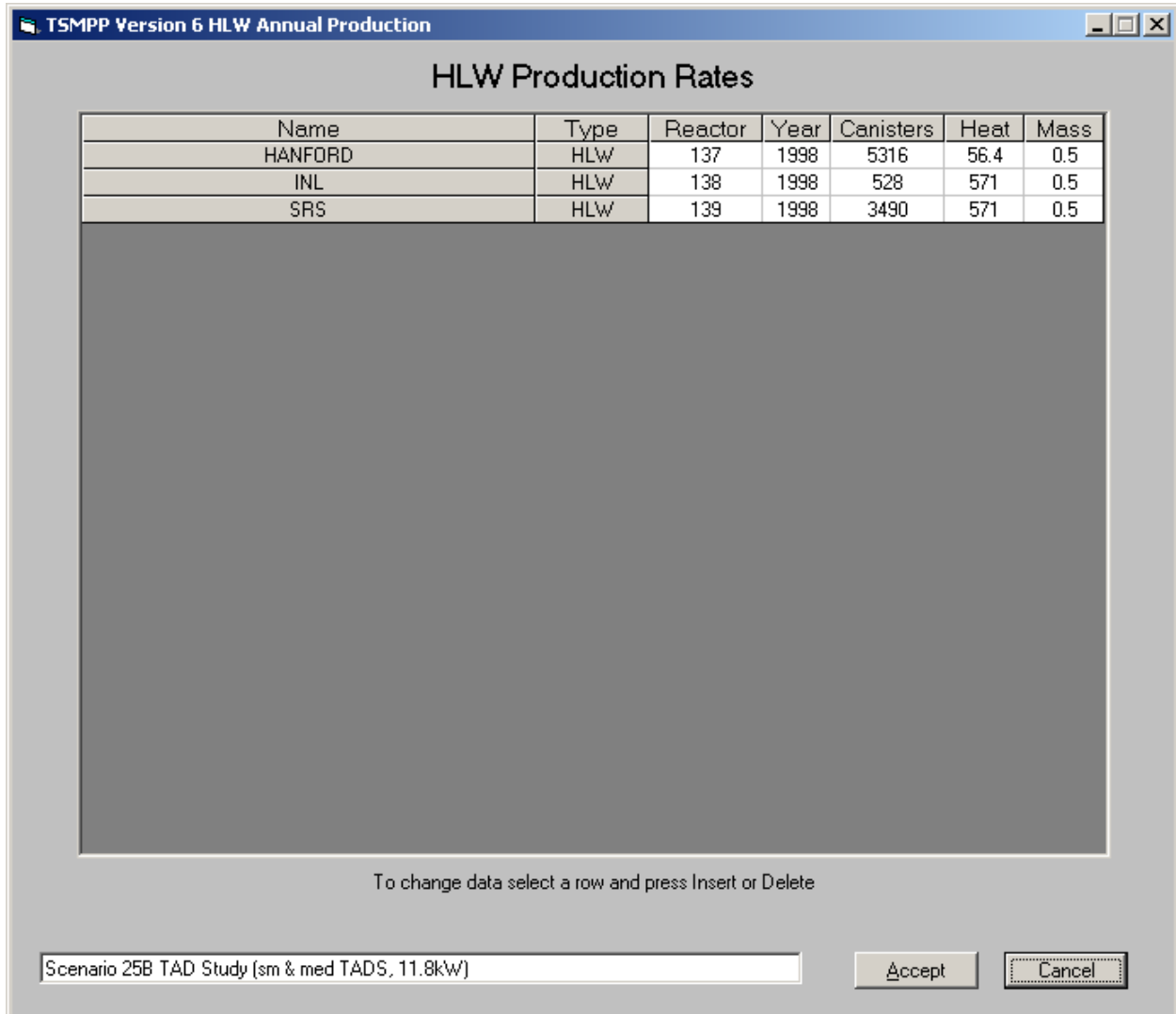


Figure 22. High Level Waste Production Rate Screen

An entry may be deleted by selecting the appropriate row, and pressing the delete key. An entry may be added by selecting a row and pressing the insert key. The user should then enter a recognized HLW “reactor” number, as defined in Table 9. When the reactor number is recognized as a valid HLW reactor, the site name, waste type, and default canister mass will be automatically filled in. If this does not occur, the reactor is not a recognized HLW reactor. The user should then enter the appropriate year of discharge, the number of canisters discharged, and the heat of each discharged canister. The unit mass may also be changed, if desired.

Table 9. HLW Reactor Numbers

Reactor <sup>1</sup>	Site Name
137	HANFORD-HLW
138	INL-HLW
139	SRS-HLW
140	WVDP-HLW
141	SRS-PU-HLW (not currently used)

<sup>1</sup> The “reactors” identified in this table are not true reactors, but are really production sources for each waste type

The Allocation sub-menu will display the HLW annual facility allocation rate screen, as shown in Figure 23. At the top of the screen, the beginning month, the beginning year, and the end year for HLW acceptance are displayed. The user can modify the beginning month. The beginning year and end year are coupled to the data entered in the spreadsheet associated with this dialog.

The spreadsheet is used to enter the acceptance rate for each HLW facility in the appropriate columns. All rates are in MTHM. Years may be added or deleted using the “Add Year to Beginning”, “Delete Year from Beginning”, “Add Year to End”, and “Delete Year from End” buttons. Note that, at present, only the Hanford, INL, West Valley, and SRS facilities may receive an allocation for HLW.

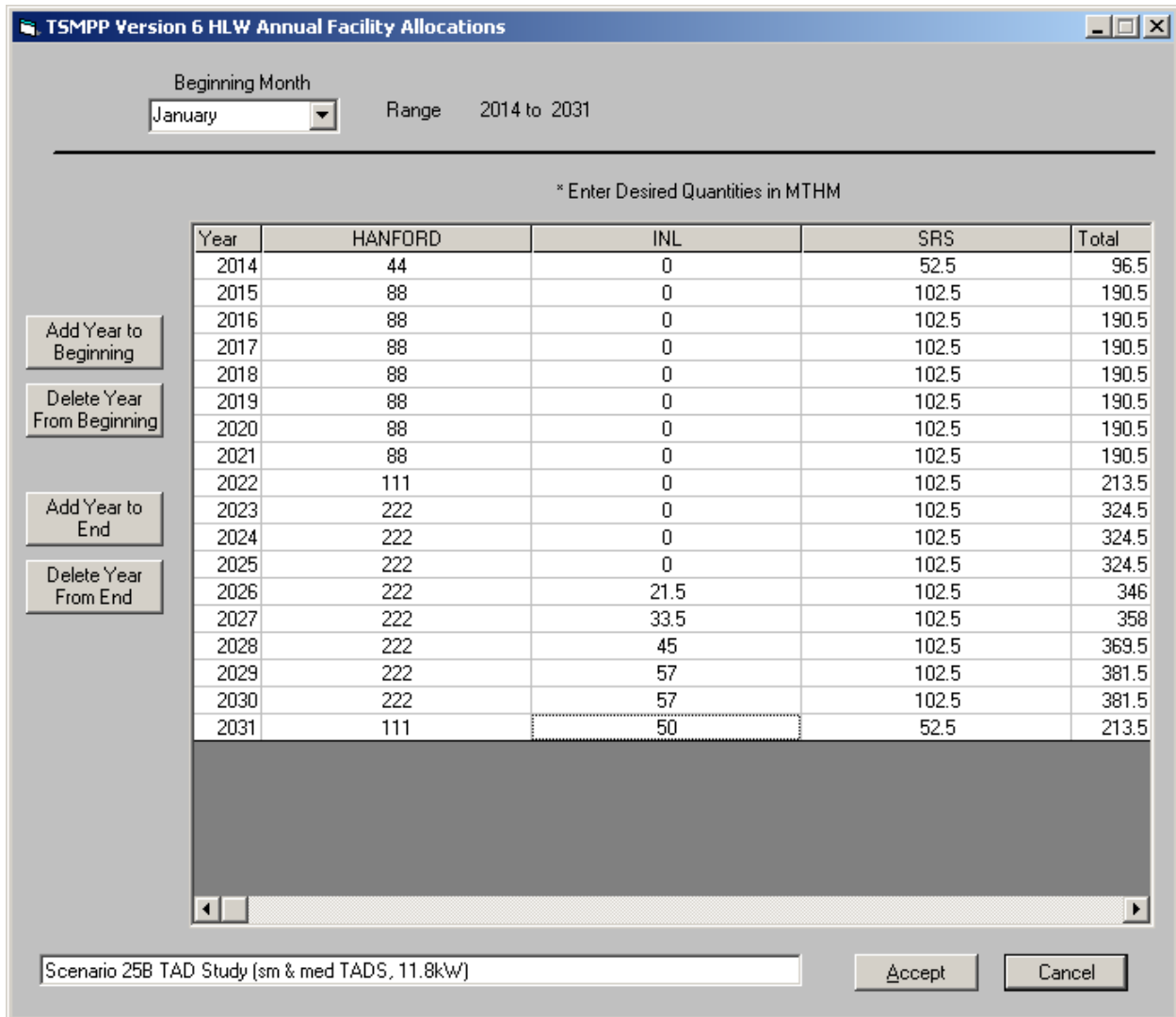


Figure 23. HLW Annual Facility Allocations

### 4.3.3 DOE SNF

The “DOE SNF” menu option displays the “Production” and “Allocation” sub-options. The Production sub-option displays the screen “DOE SNF Annual Production”, as shown in Figure 24. This screen shows the site name, the waste type, the reactor number, the year of discharge, the number of canisters discharged, the average heat of the canisters (watts/canister), and the average mass of the canisters (MTHM/canister).

An entry may be deleted by selecting the appropriate row, and pressing the delete key. An entry may be added by selecting a row and pressing the insert key. The user should then enter a recognized DOE SNF “reactor” number, as defined in Table 10. When the reactor number is recognized as a valid DOE SNF reactor, the site name, waste type, and default canister mass will be automatically filled in. If this does not occur, the reactor is not a recognized DOE SNF

reactor. The user should then enter the appropriate year of discharge, the number of canisters discharged, the average heat (watts/ canister), and if desired, update the mass.

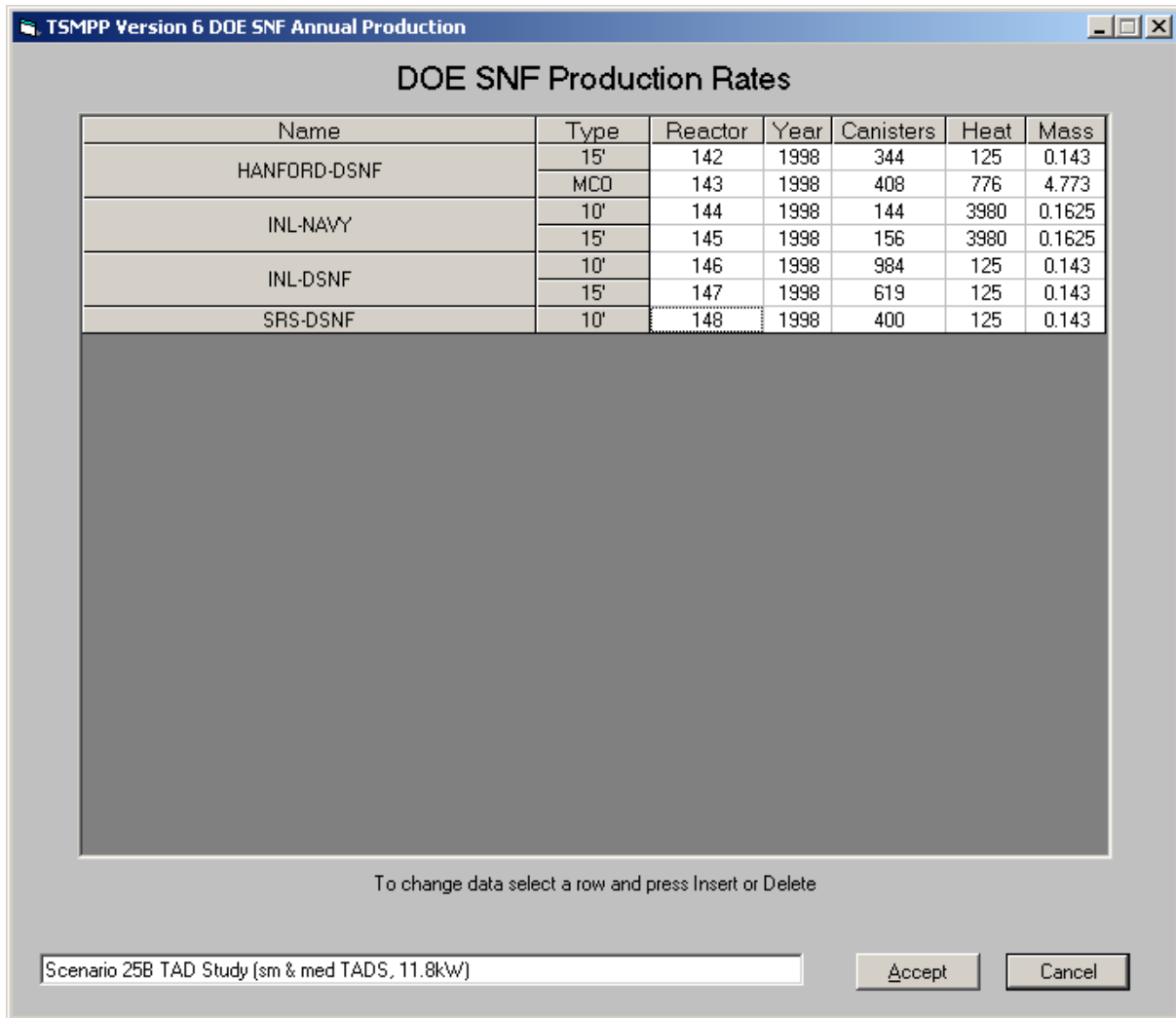


Figure 24. DOE SNF Production Rate Screen

Table 10. DOE SNF Reactor Numbers

Reactor <sup>1</sup>	Site Name
142	HANFORD-DOE SNF-15'
143	HANFORD-DOE SNF-MCO
144	INL-NAVY-10'
145	INL-NAVY-15'
146	INL-DOE SNF-10'
147	INL-DOE SNF-15'
148	SRS-DOE SNF-10'
149	SRS-DOE SNF-15'

<sup>1</sup> The "reactors" identified in this table are not true reactors, but are really production sources for each waste type.

The Allocation sub-menu displays the Facility Allocation screen shown in Figure 25. At the top of the screen, the beginning month, the beginning year, and the end year for DOE SNF acceptance are displayed. The user can modify the beginning month. The beginning year and end year are coupled to the data entered in the spreadsheet associated with this dialog.

The spreadsheet is used to enter the allocation rate for each DOE SNF facility in the appropriate columns. Note that, as commented on this dialog, all rates are in canisters. Years may be added or deleted using the “Add Year to Beginning”, “Delete Year from Beginning”, “Add Year to End”, and “Delete Year from End” buttons.

Note that, at present, only the Hanford, INL, and SRS facilities may receive an allocation for DOE SNF.

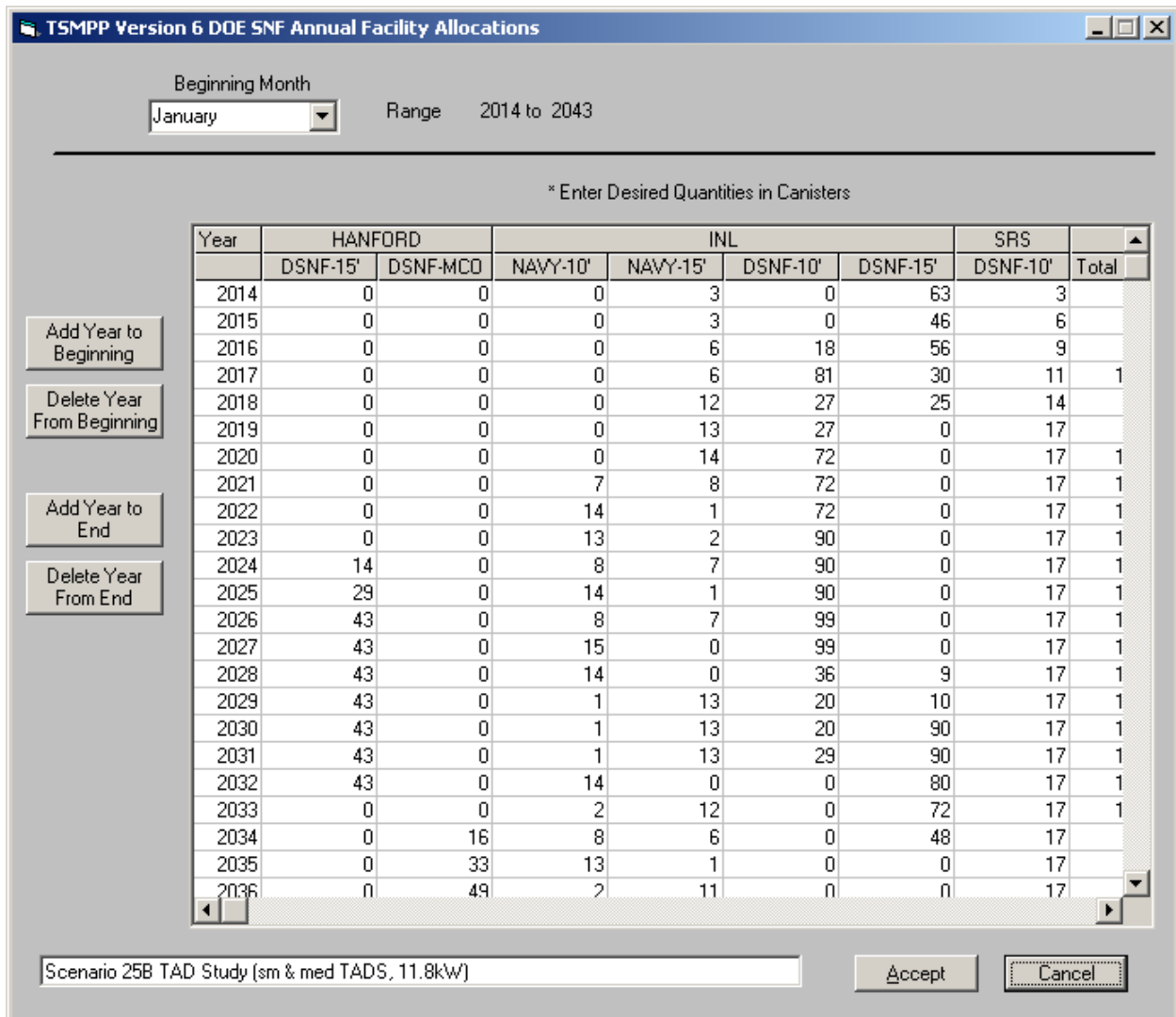


Figure 25. DOE SNF Annual Facility Allocations

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## 5. TSMPP OUTPUT

As previously discussed, the IS file is the main output from the TSMPP. The IS is the “engine” that drives the TSM simulation. The IS file inputs the cask loads into the TSM and this event is the initiator for subsequent actions on the cask load object. Definitions for the custom variables in the IS file are listed in Table 11. The information in this table includes:

*Variable name:* TSM variable name.

*Units:* Measurement units.

*Where used:* The Department and Process where the variable is used or defined.

*Description:* The general function or purpose of the variable in the TSM.

The TSMPP capability of setting custom variables with each cask load object is a key design component of the TSM. Object variables travel with the object throughout the TSM and these variables are local to each object and can be queried by the TSM processes. Since processes can query the objects the process can use any of the variable information to select the appropriate process action, appropriate route, or make calculations. The assembly heat variables (Heat01-Heat10) are used to support the algorithm to fill the waste package (WP) at the GROA and are discussed in the “Design Description for the TSM GROA Department” (BSC 2007c). When custom variables in the object context are defined in the TSM, the IS file structure defined by the TSM automatically expands to add a column for the new custom variable. Therefore any changes in the TSM object variables must be carefully coordinated with the TSMPP programming.

The TSMPP attempts to create periodic shipments throughout the year by spreading calls for a given cask as far apart as possible. This spreading is designed to help reduce the total number of casks required to deliver the loads in a timely manner. In addition, spreading the acceptance prevents too many casks from arriving at the GROA at once and overloading the receipt capability of the site.

After the IS file is generated, standard EXCEL sorting routines can be used to organize the IS file by the waste site, waste type, or any column. For example, if the user desires to change all of the shipping times for a particular site, the user can sort by the site name to see all of the shipments for that site, and then make the changes. After manipulating the IS file, it is recommended that the IS file be re-sorted by the start time before importing it into SimCAD™ for a simulation. While not a requirement, resorting shipments in order by time will allow users to correlate actions and events to time when running the simulation.

In addition to the Object Custom Variables listed in Table 11, two additional variables not used by the SimCAD™ simulation are generated. These are the named “xShipment\_ID” and “Year”. The “xShipment\_ID” variable is used by post-calculation processors in conjunction with the generated BatchInfo file. The variable “Year” is the scheduled year of shipment, and is used to sort and analyze the shipments. These variables are included in Table 11 for completeness.

Table 11. Object Custom Variables Used in the IS

IS Variable Name	Units	Where Used	Description
Process Connection	None	Routers at cask areas	The router destination in the cask area
Object	None	Routers at cask areas	The transportation modal in the cask area
Status	None	Not used by the TSM	Required by SimCAD™
Count	None	Not used by the TSM	Required by SimCAD™
Start Time	Time Step	Routers at cask areas	The time at which the cask load is scheduled for acceptance
Elapsed	None	Not used by the TSM	Required by SimCAD™
Create Batch	None	Not used by the TSM	Required by SimCAD™
ObjectID	None	Not used by the TSM	Required by SimCAD™
ParentID	None	Not used by the TSM	Required by SimCAD™
Linked	None	Not used by the TSM	Required by SimCAD™
Del	None	Not used by the TSM	Required by SimCAD™
Buffer_Type	None	Routers at buffer areas	The buffer type for a waste cask load
Cask_ID	None	Routers at cask areas, process extensions for casks triggers	The cask required for a waste cask load
Cask_Source	None	Cost Postprocessor	Source either pool or dry storage, used to differentiate casks loads from dry storage
CritHeat	None	N/A	Not used.
Crit	None	GROA Blending buffer routers	Number of high criticality assemblies
Heat01	Number	Thermal recipe	Number of assemblies in Heat Bin 1
Heat02	Number	Thermal recipe	Number of assemblies in Heat Bin 2
Heat03	Number	Thermal recipe	Number of assemblies in Heat Bin 3
Heat04	Number	Thermal recipe	Number of assemblies in Heat Bin 4
Heat05	Number	Thermal recipe	Number of assemblies in Heat Bin 5
Heat06	Number	Thermal recipe	Number of assemblies in Heat Bin 6
Heat07	Number	Thermal recipe	Number of assemblies in Heat Bin 7
Heat08	Number	Thermal recipe	Number of assemblies in Heat Bin 8
Heat09	Number	Thermal recipe	Number of assemblies in Heat Bin 9
Heat10	Number	Thermal recipe	Number of assemblies in Heat Bin 10
MTU	Tons	Various to track weight processed or received	Metric Tons of Heavy Metal in a waste cask load
Site_ID	None	RDLoad, Rload, and TLoad join processes	Identifies process destination following joining of cask and cask load



<b>IS Variable Name</b>	<b>Units</b>	<b>Where Used</b>	<b>Description</b>
TotalHeat	Watts	N/A	Total thermal output of the object/cask, provided solely as additional information
Waste_Type	None	GROA Blending	Determines type of WP
xShipment_ID	None	TSM post-processing	Shipment identifier
Year	None	N/A	Shipment Year

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## 6. RUN TIME ERROR MESSAGES

This section provides the principal run time error messages associated with the program. These error messages are divided into three categories: errors associated with loading the TSMPP database, errors associated with data entries in the TSMPP database, and errors associated with user inputs when executing the TSMPP. Tables 12 and 13 describe these error messages.

Table 12. TSMPP Database Entry Error Messages

Message	Description
"Fuel File and Pool File are not Compatible"	In the "Select Data Tables" screen, a fuel file – pool file combination has been selected that is not allowed.
"Different Fuel types specified for <i>modal type</i> (Transportation)"	The wrong fuel type is defined in the database for the specified modal type.
"Different Fuel types specified for <i>modal type</i> (Dry Storage)"	The wrong fuel type is defined in the database for the specified modal type.
"More Pools defined for Tran than are in POOL table"	Transportation pool links have been specified in the database for more pools than the number of pools defined in the "Pool" table.
"Transportation cask for <i>poolnum</i> is wrong fuel type"	The wrong transportation cask type has been specified in the database for the pool.
"More Pools defined for Dry than are in POOL table"	Dry storage pool links have been specified in the database for more pools than the number of pools defined in the "Pool" table.
"Cask# xxxx cannot have a zero capacity"	A zero capacity for the cask has been specified in the database.
"Could not find entry for xxxx in Table yyyy"	Parameter xxxx was not listed in Table yyyy of the Access database.
"Can only specify overpacks for canisters (Mode=M)"	An overpack has been specified in the database for a cask that is not a canister.

Table 13. TSMPP Execution Error Messages

Message	Description
"Check cask linkages, no storage cask defined for year = xxxx, poolid= yyyy"	Indicates either that no priority "0" storage cask was defined in the indicated year or no casks were defined at the pool identified. The modal type used at the specified pool should be checked during the specified year for gaps.
"Check cask linkages, no transportation cask defined for year = xxxx, poolid= yyyy"	Indicates either that no priority "0" transportation storage cask was defined in the indicated year or no casks were defined at the pool identified. The modal type used at the specified pool should be checked during the specified year for gaps
"Only xxxx cask changes are allowed per mod. Selection-# yyy has too many"	Currently only 25 cask changes are allowed per modal type. If more are required, a modification must be made to the TSMPP.

Message	Description
"no acceptable storage cask at <i>poolname</i> in year <i>yyyy</i> "	The TSMPP could not find an acceptable cask for the SNF being loaded for storage or disposal in the last year activity occurs at the selected pool (i.e., the fuel parameters exceed the cask design).
"No Priority Acceptance Rate Specified-Continue?"	If priority acceptance is specified, a priority acceptance rate must also be specified, or the rate will be assumed to be zero.
"END Year < START Year for Tran Modal= <i>modalnum</i> priority= <i>yyyy</i> "	The "Start Year" specified for each transportation cask in the "Cask Linkages" form must be less than or equal to the "End Year."
"1 cask must have higher priority when usage ranges overlap [ <i>TranName</i> , Tran casks= <i>yyyy</i> and <i>zzzz</i> ]"	Each cask specified to be used at the same time for a modal type must have a different usage priority.
"END Year < START Year for Dry Modal= <i>modalnum</i> priority= <i>yyyy</i> "	The "Start Year" specified for each storage cask in the "Cask Linkages" data base must be less than or equal to the "End Year."
"when changing to a new cask, you must specify current cask"	When making a global cask type change, you must specify the cask to change from (the current cask input field must not be blank).
"new cask doesn't match fuel type of old cask"	The fuel type for each cask specified for a reactor pool must be the same.
"this specification does not have <i>fueltype</i> Fuel"	An incorrect cask type has been specified for a modal type (e.g., a PWR cask for a BWR modal type).
"Different Fuel types specified for <i>Dryname</i> "	When making global cask changes, the new cask specifications must be of the same fuel type as the old cask.
"Pool Fuel type and modal fuel type do not match "	A transportation cask modal type has been specified that does not match the fuel type in the designated pool.

## **7. MISCELLANEOUS POINTERS**

This section provides various pointers related to the use of the TSMPP program. They are as follows:

1. For each scenario that is executed, the user should create a directory to store the detailed report output files, since the output files are overwritten each time a model is run (unless the default names are changed by the user).
2. Input data should be saved prior to running the model. It is possible to return to the “Save Scenario” screen after the logistics analysis is complete, but it is possible to encounter input parameters which may be changed during the analysis.
3. To run multiple TSMPP scenarios, the user must completely exit the program between runs (i.e., rerun the program from the TSMPP icon). However, multiple IS files can be generated from one TSMPP run.

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## 8. REFERENCES

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**APPENDIX A**  
**TOTAL SYSTEM MODEL PREPROCESSOR**  
**STRUCTURE AND MODELS**

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## **A. TOTAL SYSTEM MODEL PREPROCESSOR STRUCTURE AND MODELS**

This appendix describes the structure of the Total System Model Preprocessor (TSMPP) that is used to determine the cask loads for shipment and the planned time for shipment for the CSNF, DOE SNF, and HLW considered for emplacement within the MGR. The TSMPP output is an EXCEL spreadsheet that lists the cask loads, shipping date (start date), and various parameters about the loaded waste that are used in the TSM Module. The EXCEL sheet is used to generate an Initial State (IS) file that is input to the TSM Module.

Some database information, functions and capabilities are not used in the current version of the TSMPP but may be needed for future scenario development (for example, Repository Parameters). Also, the TSMPP includes analyses that are not used in the EXCEL output for the IS (for example, the Waste Package spacing estimate). These analyses may be used as an alternate estimate in the future versions of the TSM results and the data records and fields to support these analyses are retained in the TSMPP.

The TSMPP and TSMPP database tables are Configuration Items listed in the CMMP. Therefore, requirements in procedure AP-ENG-006 must be met when updating or modifying these items. If the TSMPP and TSMPP input database are being used to perform studies or assessments that lead to temporary changes, it is incumbent on the user to ensure that changes to these CIs have been adequately documented. Renaming or renumbering these items is suggested so that they are not mistaken for the current version TSMPP and TSMPP input database CIs.

**Note:** Much of the logic and the database inputs for the TSMPP is based on previously developed logic and data for CRWMS Analysis and Logistics Visually Interactive Model (CALVIN) (BSC 2003b). Accordingly, some of the data records and fields include “CALVIN” in the name. The TSMPP also retains many of the naming conventions and numbering used in CALVIN such as reactor numbers (Rx\_ID).

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## **A.1 LOGIC FLOW**

The TSMPP tracks the history of CSNF, DOE SNF, and HLW throughout the CRWMS and performs the following major activities:

- Selects the assemblies and MTHM for pickup from each facility
- Determines the shipping destination (the MGR only for the TSMPP)
- Determines if/when CSNF needs to be placed into dry storage for each facility and which fuel is selected
- Selects the appropriate container for storage, transportation, and emplacement of selected fuel

Figure A-1 shows the major activities performed by the TSMPP.

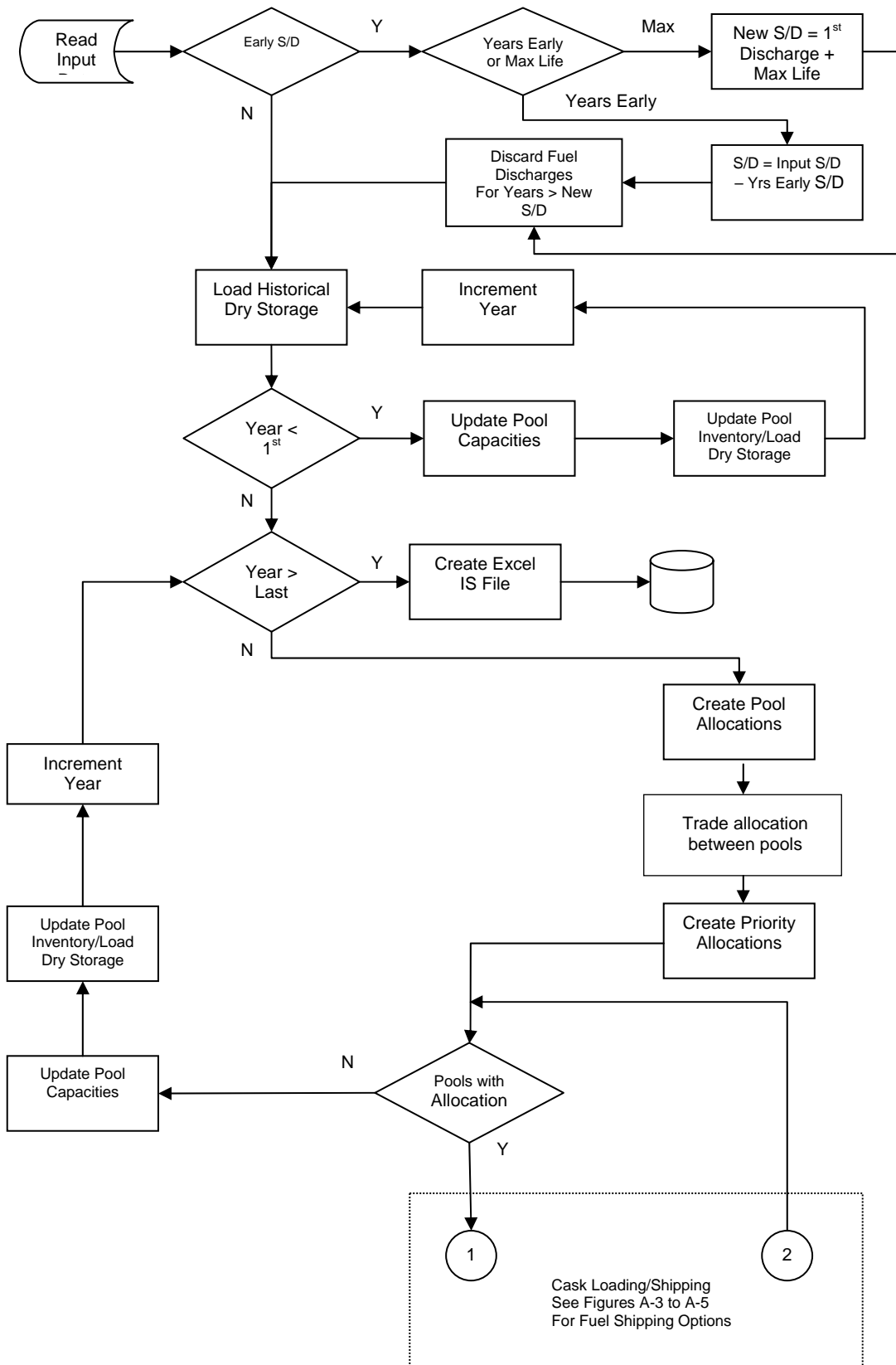


Figure A-1. Flowchart of TSMPP Processing

## **A.2 TSMPP SEQUENTIAL OPERATION**

### **A.2.1 READING INPUT DATA**

The TSMPP begins by reading the scenario specific input data. This input data consists of data that can be entered or altered by the user via the TSMPP input screens. Refer to Section 4 of the main body for further information on making changes via the input screens. The TSMPP also reads additional input data from the tables specified on the “Table Input” screen, which contain large amounts of data grouped in a convenient fashion.

Once all changes are made and the TSMPP has been instructed to run the scenario, the remaining input data is read in (primarily the discharge data for CSNF, and batch data for DOE SNF and HLW).

#### **A.2.1.1 REACTOR SHUTDOWN DATES**

As shown in Figure A-1, the TSMPP performs an initial check to determine if the user has selected the early reactor shutdown option. Early reactor shutdowns may be modeled within the TSMPP by specifying the number of years to reduce reactor lifetimes by or by entering a maximum reactor life. If the scenario includes early reactor shutdowns, the commercial discharge data is updated as follows based on the user specified options:

Minimum Shutdown Date: A new shutdown date is calculated for all reactors that operate past the Minimum Shutdown date input by the user.

- Using Early Reactor Shutdown: The years of shutdown are subtracted from the current shutdown date to obtain a new shutdown date.
- Using Maximum Reactor Life: The new lifetime is added to the year of first discharge to obtain the new year of the last discharge, i.e., new shutdown date.

Note that if the new shutdown date is less than the “Minimum Shutdown Date,” the minimum date will be used instead.

For each reactor, the fuel records discharged after or on the new shutdown date are deleted, with the exception of the records for fuel discharged in the last year of each reactor’s operation. These fuel records have their date changed to the new shutdown date.

After all reactors have been modified, the remaining fuel records are resorted by discharge date and then by the EIA pool number.

#### **A.2.1.2 HISTORICAL DRY STORAGE**

CSNF assemblies that have been flagged as being in dry storage in the fuel database are loaded into dry storage, even if there is still sufficient pool storage space in the storage pool for them. Unlike other cask processing, no cask rounding is done (i.e., if the last cask loaded at a pool is only partially full, no extra assemblies are taken from the pool to fill the cask). Note that a

partially full cask is usually an indication that the cask specified in the TSMPP is different than the cask actually used by the utility.

## **A.2.2 PRE-FIRST ACCEPTANCE YEAR ACTIVITIES**

From the first discharge year until the year prior to the year of first waste acceptance (of CSNF, DOE SNF, HLW, or a combination), the only processing that occurs is:

- Updating of pool inventories (see Section A.2.2.2)
- Updating of pool inventories (with newly discharged fuel)
- Loading of dry storage (if needed).

### **A.2.2.1 Updating Pool Capacities**

Pool capacities are updated by the TSMPP due to various events. In the year of the last discharge into a given pool, the FCR is added back to the pool capacity. In the year that a site is to be unloaded into dry storage (if the unload shutdown option is specified), the pool capacity for each pool on the site is set to zero.

### **A.2.2.2 Updating Pool Inventory/Loading Dry Storage**

This routine updates the reactor pool inventory for each reactor pool and evaluates dry storage requirements. See Figure A-2.

First, historic and/or projected fuel discharges for the current year are added to the inventory of each pool. Next, in the year that a site is unloaded into dry storage, any fuel contained in non-transportable storage casks is emptied from dry storage back into the originating pool (to be reloaded into a transportable storage cask in the next step). Finally, if appropriate, the pool inventory is updated to reflect the assemblies accepted for transport and removed from the pool.

Next, the dry storage requirements are determined. If the updated inventory of the pool exceeds the storage capacity of the pool, assemblies are removed from the pool and placed into dry storage as follows:

1. The oldest assemblies in the pool are selected and tested against the cask limits of the highest priority ("0") storage cask. If these assemblies exceed the cask limits, then the next oldest assemblies are tested, and so on.
2. If all the assemblies in the pool fail, the storage cask with the next highest priority is selected, and the TSMPP repeats the tests, starting with the oldest assemblies in the pool. Note that if the last priority cask has been tried and the pool is still full, the cask limits will be turned off and the cask will be loaded.

Storage casks will continue to be loaded until the pool inventory is less than the pool capacity. Since all storage casks are loaded to capacity as long as there is fuel available, more assemblies than are needed to handle the overflow could be taken from the pool to fill the last cask.



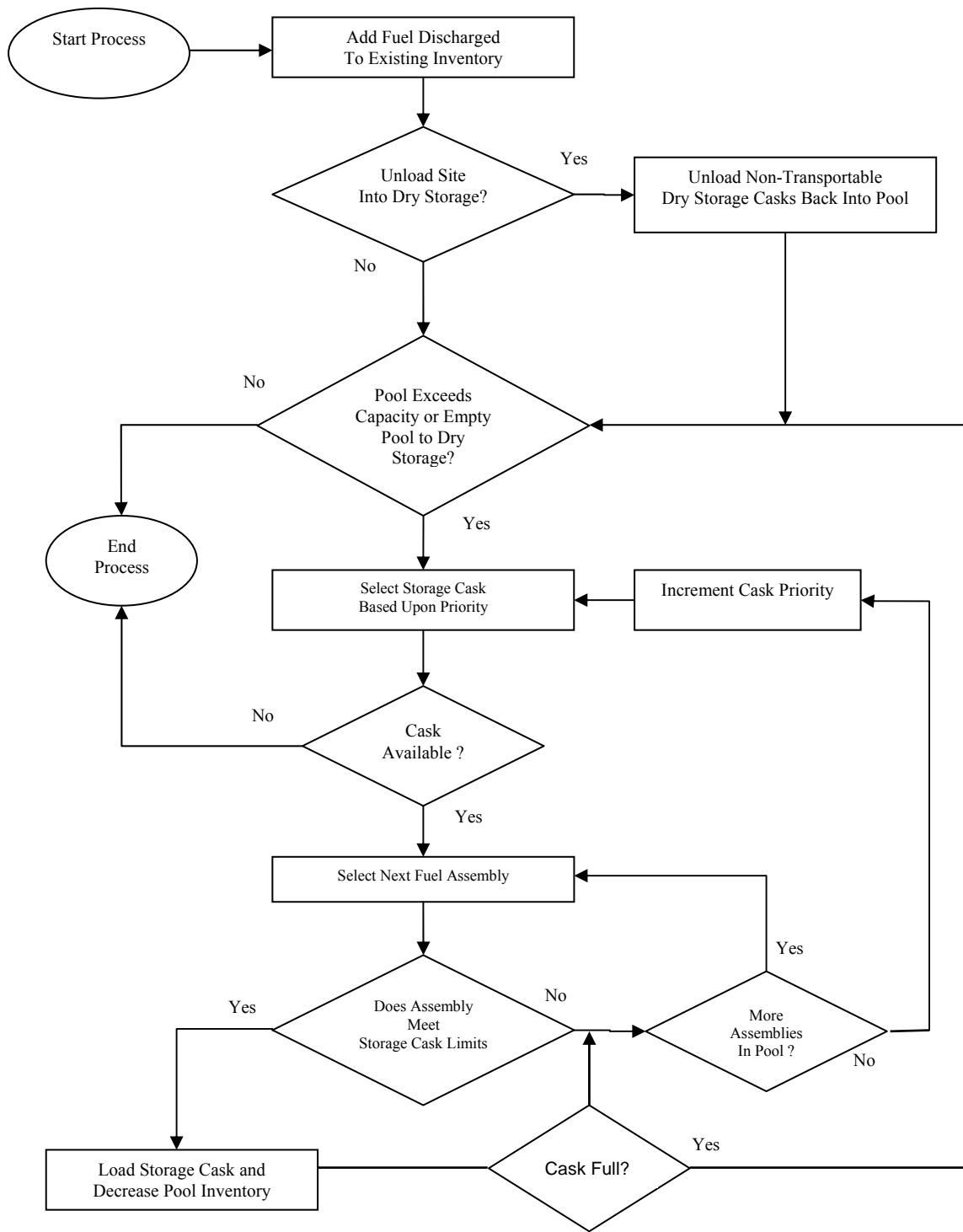


Figure A-2. Flowchart for Updating Pool Inventory/Dry Storage

### **A.2.3 FIRST ACCEPTANCE AND SUBSEQUENT ACTIVITIES**

From the first acceptance year through the last acceptance year, the TSMPP checks whether or not the acceptance rate for the current year is greater than zero (for CSNF, DOE SNF, or HLW). If so, the TSMPP performs the following sequential actions:

1. Creates the pool allocations
2. Determines the destination of the fuel pickups
3. Loads the fuel into casks
4. Updates the pool capacities
5. Updates the pool inventories
6. Determines if dry storage is required and if so, loads fuel into dry storage
7. If creating an IS file, determines target shipping times

#### **A.2.3.1 Creating Pool Allocations**

HLW and DOE SNF pool allocations are currently user specified. Similarly, when using the SSA method of CSNF allocations, the user assigns each CSNF reactor pool a specific annual allocation in MTHM. This data is entered using an Excel worksheet described in detail in Section 4.2.1.1. If SSA data is not provided for the total amount of CSNF to be accepted, the allocation method will switch to the default APR method to determine the remaining pool allocations. In addition, an option is provided to subtract or not subtract previously accepted SSA allocations from APR discharge data prior to this switch.

In years in which the APR acceptance rate is greater than zero, individual pool allocations are calculated for CSNF storage locations. In accordance with the APR, the discharge order is used to determine individual pool allocations for a given receipt rate as follows:

1. The TSMPP runs chronologically through the CSNF discharge data, summing up the MTHM in each batch record with an age greater than the minimum fuel age, until it reaches the acceptance rate specified for the year. (If the total MTHM of the last batch reached exceeds the acceptance rate, only part of the batch is included.)
2. As each batch record is processed, it is marked as having been allocated, to prevent it from being counted again in future allocations.
3. The MTHM of each batch record is summed for each storage location to obtain the pool allocation for the year.
4. The TSMPP then marks the last batch processed so that it can start with this batch when determining the next year's pool allocations.

#### **A.2.3.1.1 Overflow Priority**

If priority acceptance for pool overflow is specified, the TSMPP performs the following procedures:

1. An estimate of the pools with dry storage requirements and the amount of dry storage required for each pool is calculated by temporarily adding the current year's discharges to all the pools, and then subtracting the result from the pool capacity.
2. Each pool's requirement is rounded-up to full cask loads based on the highest priority cask type specified for transportation in the current year.
3. Sites without dry storage capability are separated from those with dry storage capability.
4. Fuel allocations are then prioritized as follows in order to take care of as many sites as possible:
  - a. Sites without dry storage capability (from the site with the smallest quantity of fuel that must go into dry storage to the site with the largest quantity of fuel that must go into dry storage)
  - b. Sites with dry storage capability (from the site with the smallest quantity of fuel that must go into dry storage to the site with the largest quantity fuel that must go into dry storage)

Processing of priority allocation stops if the priority allocation is filled before all sites are handled.

#### **A.2.3.1.2 Shutdown Priority**

If priority acceptance for shutdown sites is specified, the TSMPP performs the following procedures:

1. Shutdown sites are placed in order from the earliest shutdown date to the most recently shutdown date.
2. The amount of fuel at each shutdown site is divided by the number of years specified by the user for emptying sites, to determine the amount to accept from each site for that year.
3. The calculated amount to be accepted is checked against the remaining priority acceptance rate and, if necessary, reduced accordingly. If the priority acceptance rate is greater than 50 MTHM but the calculated amount to be accepted is less than 50 MTHM, the TSMPP carries this amount over to the next year. The exception is in the last year, when all remaining fuel up to the total acceptance rate is shipped.
4. The priority allocation for a site is apportioned among all the pools on the site, based on the fraction of the site's current total inventory contained in each pool.

5. The TSMPP then tests to see if there is sufficient fuel at or older than the minimum fuel age in the pool to meet the desired priority allocation. If not, that pool's priority allocation is adjusted downward accordingly.
6. The process is repeated for the remaining shutdown sites until the priority allocation for the year is filled.

Note that if there is still an unused portion of the priority allocation rate after creating priority allocations for all the shutdown sites, the TSMPP grants the remaining priority allocation rate to pools that have not shut down, up to the number of years specified for emptying sites.

#### **A.2.3.1.3 Shutdown and Overflow Priority**

If both "overflow" priority and "shutdown" priority are selected, sites are prioritized as follows:

If "overflow" is set as the higher priority (over shutdown):

1. Sites without dry storage capability (from the site with the smallest quantity of fuel that must go into dry storage to the site with the largest quantity of fuel that must go into dry storage)
2. Shutdown sites (in order of shutdown, starting with the sites shut down the longest)
3. Sites with dry storage capability (from the site with the smallest quantity of fuel that must go into dry storage to the site with the largest quantity fuel that must go into dry storage).

If "shutdown" is set as the higher priority (over overflow), sites are prioritized as follows:

1. Shutdown sites (in order of shutdown, starting with the sites shut down the longest)
2. Sites without dry storage capability (from the site with the smallest quantity of fuel that must go into dry storage to the site with the largest quantity of fuel that must go into dry storage)
3. Sites with dry storage capability (from the site with the smallest quantity of fuel that must go into dry storage to the site with the largest quantity fuel that must go into dry storage).

#### **A.2.3.1.4 Intra-Utility Trading**

If the IntraUtility Trading option is enabled, each year the logistics are modeled, the following process is followed:

1. The "standard" APR allocation is assigned to each reactor pool using the OFF methodology.
2. If a utility owns more than one pool, as defined in the 'UTILITY\_INFO' table of the database, then the allocation for each pool owned by the utility is totaled and the allocation for each pool is then set to zero.

3. Each year the pools owned by the utility are ranked based upon the priorities defined by the user. Note that the pool ranking changes each year based upon the space available in each pool owned by the utility.
4. The pool with the most priority is then given allocation from the utilities total until either no further fuel is within the limits of acceptance or the utility has no further allocation for that year.

### **A.2.3.2 Selecting and Loading Fuel for Transport**

This routine attempts to select fuel from each pool that has an allocation greater than zero. Two basic methods of fuel selection may currently be employed by the TSMPP: Oldest Fuel First (OFF) and Youngest Fuel First, greater than a certain age (YFFx), where x indicates the age of fuel to begin accepting first. For example, with YFF10, the TSMPP starts the selection process with 10-year-old fuel and proceeds to older fuel if insufficient acceptable 10-year-old fuel is available. Once all acceptable fuel older than or equal to 10 years old has been accepted (including fuel in dry storage), then fuel less than 10 years old will be selected. Note that if the “defer dry storage” option is set, fuel will not be removed from dry storage until the minimum fuel age is reached and all the specified casks have failed.

A variation on the YFFx method is also available, titled “Strict YFFx.” If this option is chosen, the TSMPP forces all fuel to be picked up in strict order of age, from youngest (age x) to oldest (that is, all fuel of age x must be picked up before any older fuel can be picked up). The differences between this method and YFFx are detailed below.

Before beginning to select fuel, the TSMPP tests each pool with an allocation greater than 0 to see if there is a priority “0” transportation cask defined for the current year. If not, a warning message is generated, and the pool’s allocation is deferred to next year. The TSMPP then creates an additional pool allocation(s) to compensate for the deferred allocation.

The TSMPP uses the following logic when attempting to select fuel and load casks to meet a pool’s allocation:

- OFF Cask/Fuel Selection Method (see Figure A-3)
  1. Casks are selected based on priority (from highest [“0”] to lowest). Assemblies are then selected based on the OFF method and are tested against the cask limits.
  2. Assemblies that pass the cask limit tests are loaded. Assemblies that fail the cask limit test are rejected.
    - If sufficient acceptable assemblies cannot be located in the pool to fill the allocation, assemblies are taken from dry storage.
    - If the current cask still cannot be filled, the next priority cask (usually a smaller, more robust design) is chosen, and the assembly selection/testing is repeated.

- Once sufficient assemblies have been loaded to fill the allocation, the next pool is selected. Note that if sufficient acceptable assemblies cannot be loaded, the pool's remaining allocation will be deferred to the next year.
- YFFx Cask/Fuel Selection Method (see Figure A-4)
  1. Casks are selected based on priority (from highest ["0"] to lowest). Assemblies are then selected based on the YFFx method (youngest fuel x years old or older selected first) and are tested against the cask limits.
  2. Assemblies that pass the cask limit tests are loaded. Assemblies that fail the cask limit test are rejected.
    - If sufficient acceptable assemblies cannot be located in the pool to fill the allocation, assemblies are taken from dry storage.
    - If sufficient acceptable assemblies cannot be located in dry storage, fuel younger than age x will be selected from the pool starting at the minimum fuel age and working up to age x. Note that if x = the minimum fuel age, this step is skipped.
    - If the current cask still cannot be filled, the desired fuel age is reset to age x, the next priority cask (usually a smaller, more robust design) is chosen, and the assembly selection/testing is repeated.
    - Once sufficient assemblies have been loaded to fill the allocation, the next pool is selected. Note that if sufficient acceptable assemblies cannot be loaded, the pool's remaining allocation will be deferred to the next year.
- Strict YFFx Cask/Fuel Selection Method (see Figure A-5)
  1. Assemblies are selected based on the YFFx method.
  2. For each assembly, casks are tested against the fuel beginning with the highest priority cask.
    - Assemblies that pass the cask limit test are loaded.
    - If an assembly fails the cask limit test, the next highest priority cask (usually a smaller, more robust design) is chosen, and the assembly testing is repeated. This process repeats until a cask is selected that can accept the assembly. If one cannot be located, then any remaining allocation will be deferred to the next year.
  3. Once all the fuel of a certain age that passes the cask limit tests is loaded, the next oldest age fuel is selected.
    - If sufficient acceptable assemblies cannot be located in the pool to fill the allocation, assemblies are taken from dry storage.

- If sufficient acceptable assemblies cannot be located in dry storage, fuel younger than age  $x$  will be selected from the pool starting at age  $x$  and working down to the minimum fuel age. Note that if  $x =$  the minimum fuel age, this step is skipped.

4. Once a cask has been filled, the cask priority is reset to the highest priority (0).

Once a cask is filled, it will be “shipped” to its destination, which in this case means that the cask load and associated parameters are written to the IS EXCEL sheet.

The following sequential operations are then performed:

1. If the remaining allocation is greater than or equal to one-half of a cask load, the TSMPP attempts to load another cask. If the remaining allocation is insufficient to fill the cask, the extra allocation needed is subtracted from the pool’s next allocation.
2. Loading of fuel continues until the remaining allocation is less than one-half of a full cask or until there is no more acceptable fuel in the pool or in dry storage.
3. The remaining allocation (if any) is carried over to the next year.
4. The TSMPP then proceeds to the next pool.

Note that at least one cask will be shipped from a pool that has an allocation, no matter how small, assuming that there is sufficient acceptable fuel to fill the highest priority cask. If there is insufficient acceptable fuel to fill the primary cask, then a cask will only be shipped if the allocation is greater than or equal to the capacity of the second highest priority cask. Only the last cask shipped from a pool is permitted to be partially filled.

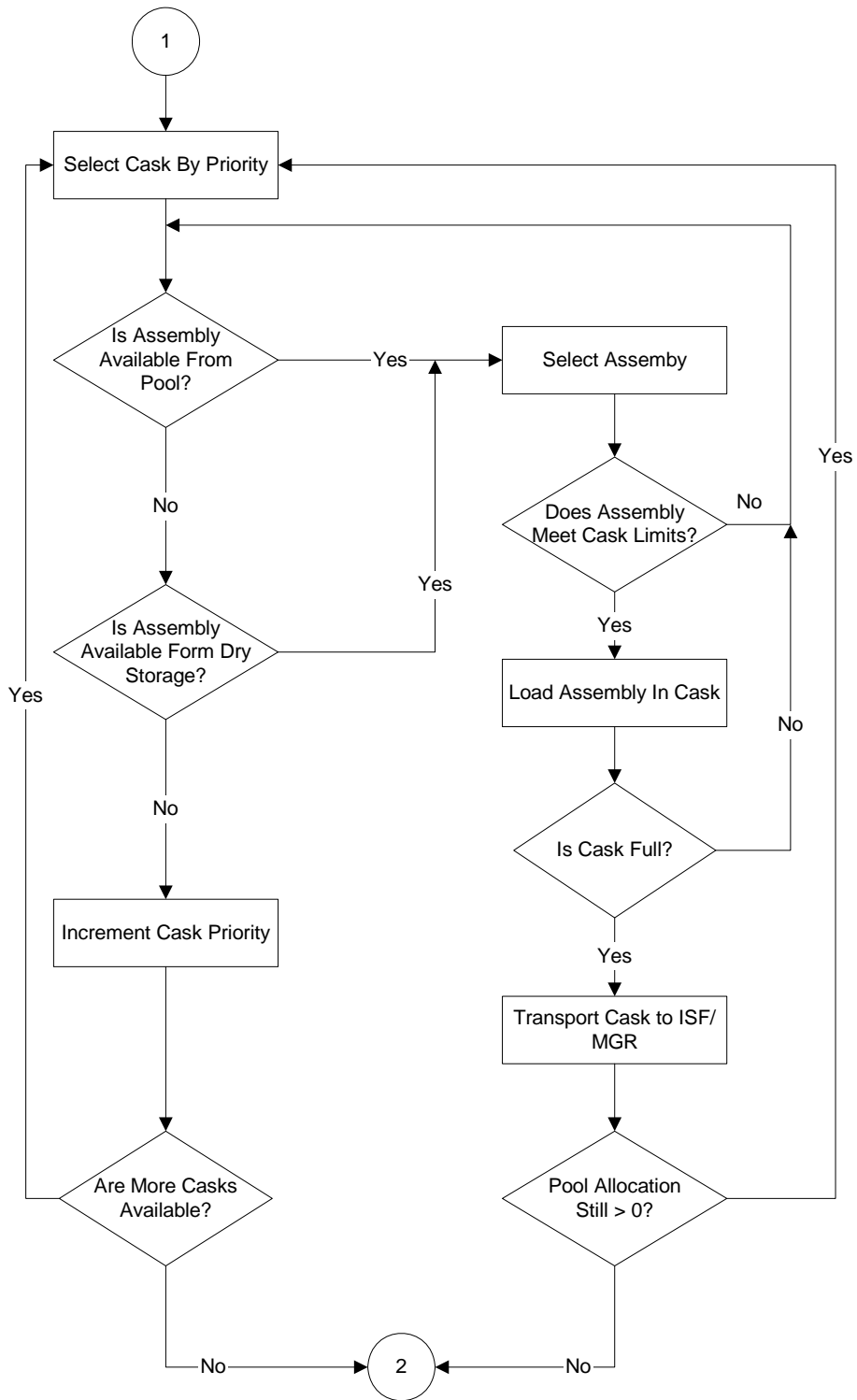


Figure A-3. Oldest Fuel First Selection Option



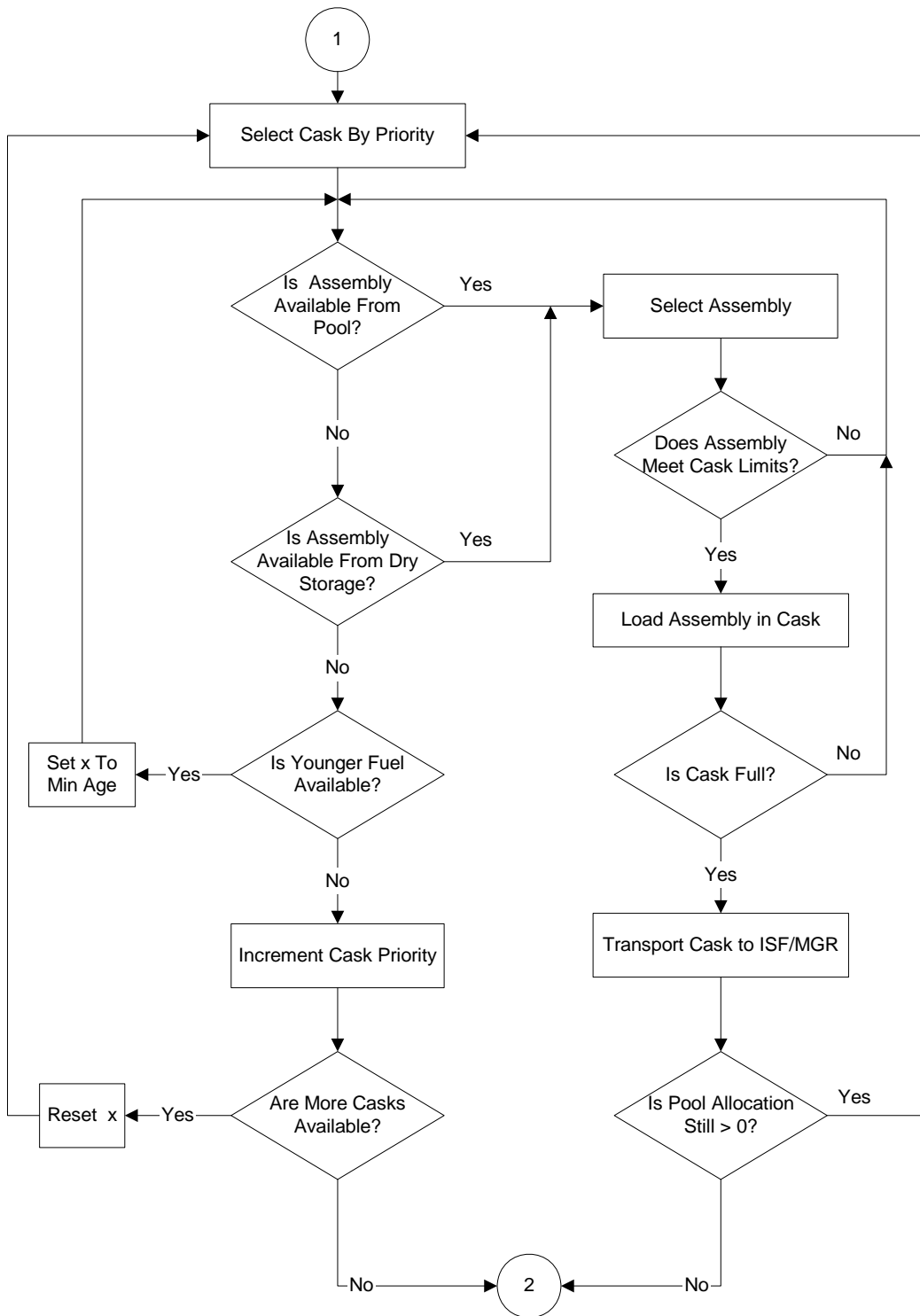


Figure A-4. Youngest Fuel First Selection Option

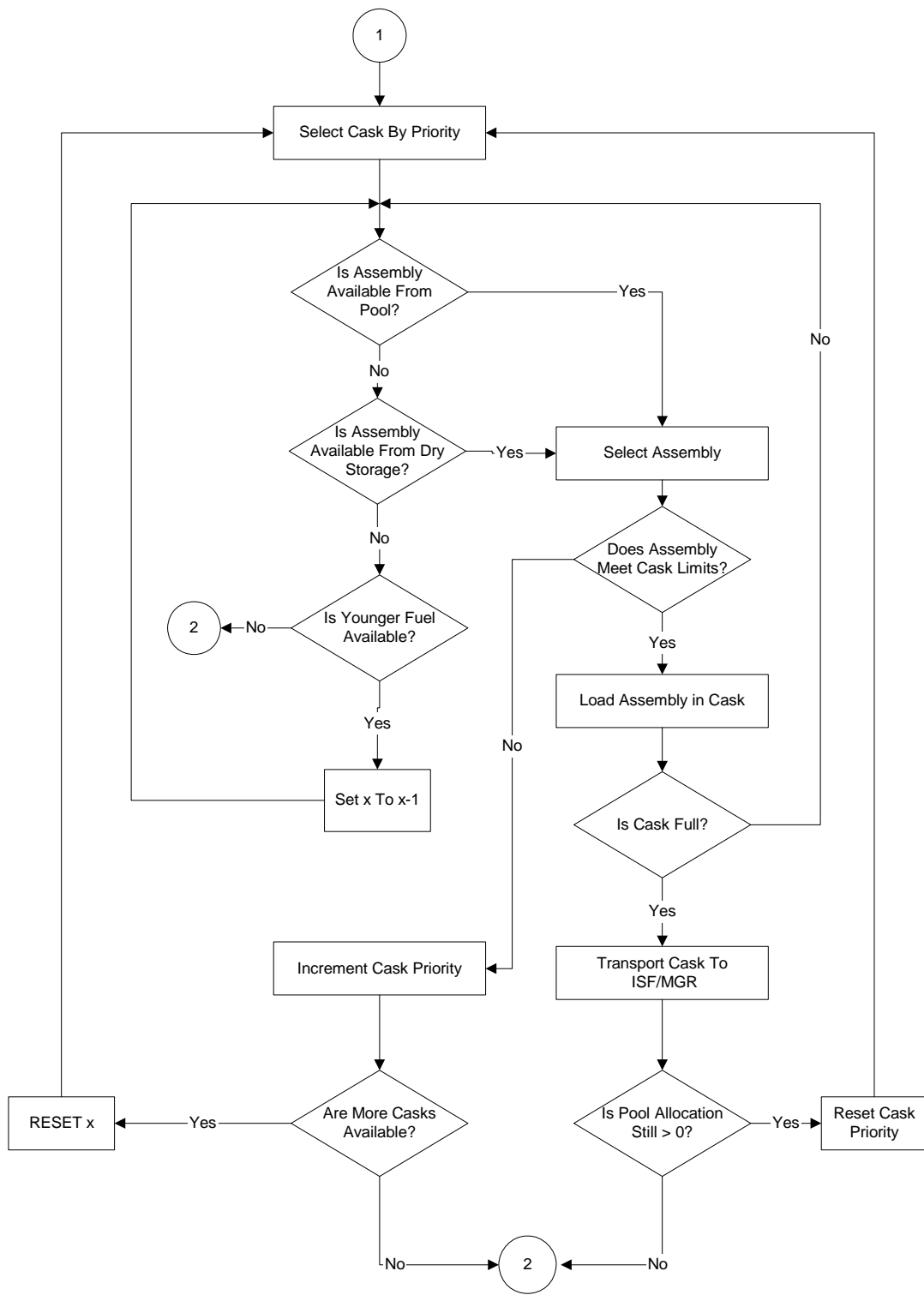


Figure A-5. Strict Youngest Fuel First Selection Option

### **A.2.3.2.1 Cask Loading**

As outlined in the previous section, after assemblies from a pool are selected, they are evaluated to determine if they meet cask loading limits. Given that the assemblies meet fuel type, fuel length, and criticality limits, there are three thermal output (heat) limit options available against which to evaluate the assemblies. These options are uniform loading, uniform loading with a multiplier, and non-uniform (zone) loading of a transportation cask.

#### Uniform Loading

The most commonly used option is uniform thermal loading of transportation casks with no multiplier (i.e., set to 1). Each transportation cask has an assembly thermal limit set in the Cask Information table by the parameter “Assem\_heat”. An assembly heat limit of zero implies the cask has no thermal limit and can be loaded with assemblies of any thermal output. This option uses a simple comparison to determine if the thermal output of each assembly is equal to or below the thermal limit of the cask, and therefore can be loaded. This check is also described in Section B.1.3.1.

#### Uniform Loading with a Multiplier

If uniform thermal loading is used with the multiplier set to a number other than 1 (e.g., setting the dialog box labeled “Multiplier on Cask Thermal Limit” to 0.95), the selected assemblies are checked to see if their thermal output is less than or equal to the thermal limit of the transportation cask times the multiplier. As an example, if selected BWR assemblies are calculated to have a thermal output of 200 watts per assembly, and the cask thermal limit is 207 watts per assembly, assuming a multiplier of 0.95, the assemblies at 200 watts would be rejected because their thermal output is greater than  $207 \times 0.95 = 196.7$  W/assembly, the adjusted cask thermal limit.

#### Non-Uniform (Zone) Loading

Non-uniform (zone) loading is a special feature in the TSMPP that models and takes credit for radiation self-shielding. It characterizes a transportation cask as having two regions, an interior hot (high thermal output) region and an exterior cold (low thermal output) region. In most cases, the radiological loading limit for a cask is set by the regulatory dose limit of 10 mrem per hour at the vertical planes 2 meters from the edge of the cask carrier that supports the cask during transport. The most important physical factor in non-uniform loading is that the fuel assemblies loaded into the exterior, or outer locations, of the cask to a large extent shield the radiation from the assemblies loaded in the interior. As a result, most of the radiation dose measured at 2 meters is from the assemblies loaded next to the cask’s outer wall – the outer assemblies. In a typical situation in which about half of the assemblies are in outer locations and the other half in the inner locations, and the cask is loaded uniformly, 75 to 95% of the external dose comes from the outer assemblies, due to the additional shielding they supply for the inner assemblies. An example 24 assembly PWR transportation cask non-uniform loading scheme is shown in Figure A-6.

As a simplified example, consider a cask uniformly loaded at the regulatory limit of 10 mrem/hr at 2 meters from the outer edge of the cask, and assume that 75% of the external dose, or 7.5

mrem/hr, comes from the outer assemblies. This leaves 2.5 mrem/hr (10 – 7.5) as coming from the inner assemblies. If the radiation from the outer assemblies were reduced by 10%, the external dose from the outer assemblies would be about 6.75 mrem/hr. This 0.75 mrem/hr reduction could be exploited, within the regulatory limits, by increasing the inner assembly radiation by an additional 0.75 mrem/hr external dose. The dose from the inner fuel would then go from 2.5 mrem/hr to 3.25 mrem/hr, a 30% increase in the radiation from the inner assemblies relative to uniform loading. Note that this 30% increase is 3 times the 10% reduction in the radiation from the outer assemblies. Also note that this multiplier (M) depends on the Outer Dose Fraction for the uniformly loaded cask (ODF) and yields the following relationship:

$$M = ODF / (1 - ODF).$$

In the previous example, the multiplier of 3 for an outer dose fraction of 0.75 is consistent with the above equation. However, it should be noted, this example is quite simplified and that presently there is little actual cask design data available for non-uniform loading.

Another aspect of non-uniform loading to consider is CSNF selection. A relatively simple systematic method uses the basic concept of (conceptually) splitting the inventory of pool-stored assemblies at the start of pickups into two categories – a cool part and the remainder, a hot part. These two parts do not have to be physically separate, since utilities track the physical location of each assembly and its characteristics. Because of their higher heat, future discharges would normally be added to the hot part as they occur. The CSNF selection method consists of loading the coolest assemblies from the cool part into the outer region, and loading the coolest assemblies from the hot part into the inner region. The key challenge is to choose the point that defines the size of the cool part of the pool inventory at the time of the initial pickup. Basically, the split should occur at the point that the initial selections from the hot portion, when loaded into the inner region, result in the initial casks being loaded just at or below their (non-uniform) loading limit. Note when using non-uniform loading, the fuel selection methods described in Section A.2.3.2 are not in use.

The application of non-uniform zone loading in the TSMPP requires that two additional parameters be entered, the fraction of the cask to be used for the “cold” region (assign a value <1.0), and a loading multiplier. By default the cold region is defined as 50% of the assembly positions. A typical multiplier is 2.0 and this may be entered in the “Loading Multiplier” labeled input box. When the coldest fuel available is loaded into the outer region, the deficit heat ( $Q_{def}$ , see equation below) is tracked.

$$Q_{def}(W) = \sum [Cask\ thermal\ limit\ (W/assembly) - assembly\ thermal\ output\ (W)]$$

Then the hottest fuel available is examined to determine if it satisfies the thermal limit associated with non-uniform loading:

$$\begin{array}{l} \text{Non-uniform} \\ \text{Thermal Limit} \\ \text{(W/assembly)} \end{array} = [(\text{uniform})\ cask\ thermal\ limit\ (W/assembly) + (\text{Multiplier} * Q_{def})]$$

If this fuel batch is too hot, then the next coolest batch is examined until a cask load is defined. If the hottest fuel is less than the cask's thermal limit there is no benefit to zone loading, then non-uniform loading is abandoned, and uniform cask loading is used.

Non-uniform loading provides the following potential benefits over uniform loading:

- It allows casks more radiological capability, i.e., allows the transport of assemblies with higher burnups, yet at the same age, as those loaded using the uniform loading option.
- The same cask design may be used for a longer duration, i.e., the duration of cask usability is superior to uniform loading, and it can deliver more of the CSNF waste stream.
- It ultimately may reduce the total number of cask shipments, total radiation exposure, and costs associated with CSNF transportation because lower capacity, higher heat transportation casks may not be necessary or at less their use will be greatly reduced.

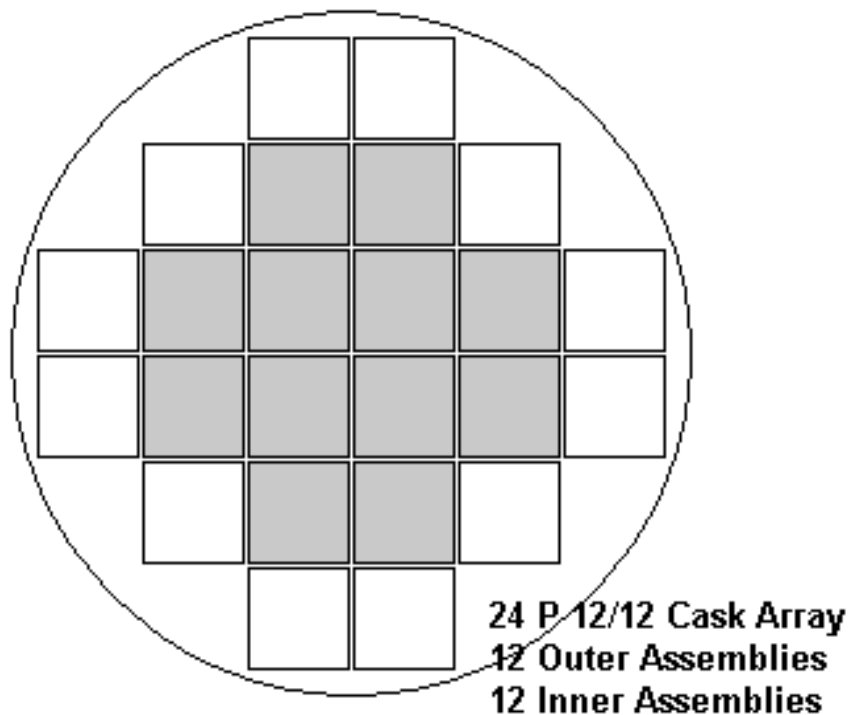


Figure A-6. Example PWR Transportation Cask with Non-Uniform Loading

Note: Non-shaded regions are for coolest assemblies while shaded regions are for the hottest assemblies.

### **A.2.3.3 Updating Pool Capacities and Inventories/Loading Dry Storage**

For utility pools, the TSMPP updates the pool capacities, updates the pool inventories with the current year's discharges, and then loads dry storage (if needed) as described in Sections A.2.2.1 and A.2.2.2.

## A.3 GENERAL ROUTINES

### A.3.1 HEAT CALCULATION

In calculating the heat output for an assembly, the TSMPP utilizes data from five tables (“Heat\_BWR,” “Heat\_BWRSS,” “Heat\_PWR,” “Heat\_PWRSS,” and “HTTIMES”) within the TSMPP database to interpolate or extrapolate (if necessary) from a set of pre-calculated heat points. The “Heat” data tables list heat output data (in watts) for BWR zirconium clad fuel, BWR stainless steel clad fuel, PWR zirconium clad fuel, and PWR stainless steel clad fuel as a function of burnup, enrichment, and age (time after discharge) of the fuel. Twelve burnup values and 11 enrichment values are listed per fuel type. Heat values for 180 decay times are listed for each burnup – enrichment combination. The “HTTIMES” table contains the age values associated with the decay times. Note that for stainless steel fuel, only a limited amount of data is entered in the tables. The heat data points are taken from references CRWMS M&O 1999a and CRWMS M&O 1999b.

The actual burnup and enrichment for batches of spent fuel assemblies are obtained from the CSNF fuel data table (e.g., “Fuel 98”) of the input database; the age after discharge is calculated by subtracting the discharge year in the table from the year in which activity is occurring. This data is used in conjunction with the data provided in the tables to calculate actual heat output for specific batches of spent fuel assemblies by “power-log” interpolation or extrapolation.

### A.3.2 Strict Calendar Year Acceptance

The following formula is used to adjust CSNF acceptance rates for strict calendar year acceptance:

For the first year of acceptance:

$$A(I) = C(I) \times 12 / (13 - M_A)$$

For subsequent years:

$$A(I) = C(I) \times 12 / (13 - M_A) - A(I - 1) \times (M_A - 1) / (13 - M_A)$$

Where:

A(I) = Effective acceptance rate in calendar year I used in calculations

C(I) = TSMPP acceptance rate input on “Acceptance Rates” screen in year I

M<sub>A</sub> = Initial acceptance month number

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## A.4 INITIAL STATE FILE GENERATION

### A.4.1 CASK BUY ORDERS

The Total System Model allows two modes of operation with respect to purchasing transportation casks and over packs. One mode is to allow an “open” buy order for each cask. This means if a facility is scheduled to ship waste and no transportation casks are immediately available, then the TSM will “buy” a new cask immediately to fulfill the shipment request. This has the effect of ensuring that shipments are not delayed due to cask availability. However, with no other delays, it is very possible to ship enough casks that the surface facilities at the repository receive shipments faster than they can process them, causing the waste streams to back up at the waste sites and delaying completion of acceptance.

The other TSM mode of operation for transportation cask acquisition is to provide a schedule for the casks to be purchased at a specific date. The TSM logic for this process is called a work order (WO), and if the mode of operation for a specific cask is “closed” (as set in the SimCAD™ portion of the TSM) then no casks of that type will be purchased until a WO has been processed. The “Work Orders” code in the TSMPP is designed to be used with the TSM in this mode. For this mode, the TSMPP generates WOs for cask purchasing based upon the estimated demand for the specific cask types. The idea is to purchase sufficient casks to ensure that the repository remains busy; but not so many as to overwhelm its processing capacity – a sort of “just-in-time” approach.

As the TSMPP generates the various waste streams for input to the TSM, this information is automatically captured into temporary tables (in the code this is in module WorkOrders, Function CreateWOTables()). The model then characterizes where the demand and the rate of change in demand are and calculates a tailored response to the creation of cask and over pack WOs (in the code this is in module WorkOrders, Function GenerateWorkOrders()). In summary, the TSMPP automatically uses waste-specific acceptance rate information to develop a detailed strategy for the required cask and over pack purchases.

The purchasing of casks and overpacks is divided into “DOE” and “non-DOE” work orders. DOE cask purchases include 5 units for cask types 50 through 52 and 15 units for cask type 44. “Non-DOE” cask purchases are made to correspond to anticipated shipping demand thresholds. As the demand for shipments increase, additional cask purchases are considered. The purchase schedule is shown in Table A-1.

Table A-1. Commercial Cask Purchase Thresholds

<b>Annual Shipments</b>	<b>Required Cask Fleet</b>
1 – 15	3
16-30	6
31-45	9
46-60	12
61-89	15

Annual Shipments	Required Cask Fleet
90-120	21
> 120	24

When a shipping threshold is exceeded in a particular year, the TSMPP will then determine if the increased level of shipping will be sustained for some period of time beyond that year. The purchase is considered “worth it” if more than half of the remaining years for the anticipated cask use have a shipping volume greater than the midpoint between the current shipping threshold and the new threshold at which the purchase was recommended for consideration.

Though not exact, the work order algorithm was designed for good agreement with previous manual calculations. It provides good consistency across model scenarios and does not purchase casks or overpacks that do not participate in the selected scenario.

#### **A.4.2 Creating the Target Shipping Date**

Once the number of cask loads being shipped annually is defined, the TSMPP counts the number of casks from each pool during that year. The number of annual shipments for each pool is then determined by grouping the casks in accordance with a specified number of casks per shipment (currently 3 for CSNF rail shipments, 5 for HLW and DOE SNF rail shipments, 6 for Naval SNF shipments, and 1 for truck shipments). Casks that fall outside these shipment groups are collected into smaller shipments (i.e. less than 3 CSNF, 5 HLW / DOE SNF, or 6 Naval SNF rail casks). The schedule for acceptance is then developed by spreading the number of annual shipments from each pool evenly over the time available for shipping in each year.

#### **A.4.3 Smoothing**

The DOE waste types are emplaced in the MGR in codisposal WPs. The types of waste types that use codisposal WPs are HLW, DOE SNF and MCOs, and the combinations for codisposal are:

- 1 Short DOE SNF / 5 Short HLW
- 1 Long DOE SNF / 5 Long HLW
- 1 Short DOE SNF / 5 Long HLW
- 2 MCO / 2 Long HLW

The timing of DOE waste streams can adversely impact the production efficiency of the GROA if DOE SNF cask loads are not delivered and maintained in the proper ratios to make codisposal WPs. The smoothing algorithm will maintain the constituent waste stream ratios to make these codisposal WP types.

This issue has been addressed within the TSMPP via a “smoothing algorithm” designed to adjust the shipment timing of the codisposal waste streams. Two shipping strategies have been developed. The first strategy has the DOE SNF waste streams shipping on schedule with the shipping times of the HLW waste streams adjusted to ensure proper codisposal inventory ratios. This strategy is called “SNF Lead”. The second strategy has the HLW waste streams ship on schedule with the shipping times of the DOE SNF waste streams adjusted to ensure proper

codisposal inventory ratios. This strategy is called “HLW Lead”. It should be noted that since one DOE SNF transportation cask contains 9 canisters, and one HLW transportation cask contains 5 HLW waste canisters, one cask of DOE SNF will need 9 transportation casks of HLW for codisposal. This implies that “SNF Lead” is the preferred method of smoothing.

The DOE SNF Lead strategy minimizes changes to the shipping schedule of DOE SNF, with the exception of the enforcement that the creation of consists of 5 shipping casks that originate from the same site. As an example, if a DOE SNF shipment is scheduled for the 2<sup>nd</sup> quarter, smoothing will search for the next 4 DOE SNF shipments from the same facility and reschedule those for the 2<sup>nd</sup> quarter as well, regardless of their original arrival schedule.

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**APPENDIX B**  
**TSMPP INPUT DATABASE**

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## B. TSMPP INPUT DATABASE

### B.1 INPUT DATA

Input data for the Total System Model Preprocessor (TSMPP) includes CSNF, DOE SNF, and HLW discharge data, facility parameters, cask characteristics, utility dry storage information, and other data supplied by the user via the TSMPP input screens. Discussions of the waste generation data, facility parameters, cask characteristics, utility dry storage information, and burnup-enrichment curves required as part of a TSMPP run are provided in this section. Parameters supplied by the user via input screens are discussed in Section 4 of the main body. Table B-1 shows the user specified input data tables required as part of a TSMPP run.

Table B-1. TSMPP Input Data Tables

Table Type	Table Description
1	Fuel Discharge
2	Pool Information
3	Reactor Information
4	Site Information
5	Cask Information

A list of data tables available in the TSMPP database, along with each table's table type, is contained in the Microsoft Access database table "Table\_Types." Each time a new data table is created by the user (using Microsoft Access 2000), the "Table\_Types" table must be revised to include the name and type of the new table. Otherwise, the user will not be able to select the table for use in a scenario via the "Select Data Tables" screen.

#### B.1.1 WASTE GENERATION DATA

Commercial SNF, DOE SNF, and HLW represent the major waste categories that can be currently modeled by the TSMPP.

Sources for the waste generation data used by the TSMPP include the following:

- Commercial fuel - RW-859 historical data collected by the EIA, coupled with future discharge projections based on industry trends
- DOE SNF and HLW - inventories provided by the U.S. DOE Office of Environmental Management

An example of the particular data and assumptions used to produce source terms for the TSMPP are given in the *2003 TSLCC Waste Stream Assumptions Report* (BSC 2003c). A description of the general process used to produce these TSMPP input tables is included in the following subsections.

### **B.1.1.1 Commercial SNF**

The discharge data for commercial SNF consists of two parts: historical data and projection data. The historical data includes actual discharge information reported by the utilities to the EIA on form RW-859. This data undergoes a validation process to ensure accuracy and completeness when it is obtained from the utilities. In addition to the historical discharge data, each utility includes a 5-cycle projection of anticipated discharges for each reactor. This projection is extended for each reactor until the end of each reactor's life to create the CSNF discharge data for use with the TSMPP. Mixed oxide (MOX) fuel is incorporated into the projection by assuming that the discharge for PWRs or BWRs could be replaced with an equivalent number of MOX assemblies during the desired discharge period.

The CSNF discharge data is included as one of the tables within the TSMPP input database (for example, one of the current tables is titled "Fuel\_02B\_06LE104\_Projection"). This table contains a listing of the historical and projected CSNF discharge data by batch. Each batch consists of a group of assemblies with the same characteristics. For each batch, the information described in Table B-2 is included. The records in the table are sorted first by the discharge date of the batch (i.e., the date in field "Discharge\_Date") and then by the EIA pool number (i.e., the number in field "Pool\_ID"). This sorted order is used in the calculation of pool allocation rights.

The "Dry\_Year" field (the year that fuel went into dry storage) is a flag to indicate fuel assemblies reported by utilities to already be in dry storage. Due to modeling limitations and the inconsistencies in how utilities report storage data, currently only one year can be specified for all fuel. A date was chosen between 1989 (first known year of dry storage) and the date of the most recent fuel discharge data (currently 2002). For historical dry storage to be correctly modeled, this date must be set early enough to prevent the TSMPP from calculating additional dry storage due to pool overflow.

It should be noted that the discharging reactor and the storage location obtained from the RW-859 data are assigned a TSMPP reactor number (i.e., the number in field "CALVIN\_Rx\_ID") and a TSMPP pool number (i.e., the number in field "CALVIN\_ID") prior to being placed into the table.



Table B-2. Commercial Spent Nuclear Fuel Input Table Format

Field Name	Description
Batch_ID	Numbered order based on the batch discharge date and the EIA pool number
CALVIN_Rx_ID	TSMPP reactor number for the discharging reactor
MTU	Total MTHM in batch
NUM_ASSM	Number of assemblies in batch
Burnup	Power generated (in Megawatt-Days/MTHM)
Enrich	Enrichment (percent of U-235 by weight)
Discharge_Date	Date (day, month, and year) fuel was discharged
Pool_ID	EIA number for storage location (before acceptance by CRWMS)
Mod	Currently used to indicate stainless steel clad fuel (S)
CALVIN_ID	TSMPP pool number (i.e., the storage location)
Dry_Year	Year fuel went into dry storage (for historical dry storage only)

### B.1.1.2 HLW

HLW “discharge” data, the actual schedule for conversion of the waste into glass canisters, is estimated from data provided by the U.S. DOE Office of Environmental Management (EM). HLW annual discharge data is specific to each scenario, and stored in the database table “HLW\_Production”. The user may display and edit this information from the “Rates / HLW / Production” menu item. The information described in Table B-3 is included.

Table B-3. High-Level Waste Production Table Format

Field Name	Description
SCN_Num	Numbered order based on the year of creation and the TSMPP pool number
Year	Year of creation (currently 1998)
Reactor	TSMPP reactor number for the facility
Cans	Number of canisters discharged from “Reactor” in “Year”
MassPerCan	MTHM per canister
Heat	Estimated thermal load for a canister in a batch, Watts per canister

The HLW pool allocation rights are also specific to each scenario and may be displayed and edited by the user in the “Rates / HLW / Allocation” menu item. This information is stored in the database table “HLW\_Allocation”, and is shown in Table B-4.

Table B-4. High-Level Waste Allocation Table Format

Field Name	Description
SCN_NUM	Scenario number associated with this dataset
Year	Year of allocation
Poolid	Pool to be given the allocation
Allocation	MTHM allocated to “Poolid” in “Year”

### B.1.1.3 DOE SNF

The format of the DOE SNF “discharge” data is identical to the format for HLW discharge data. Each batch consists of all the DOE SNF of a specific type (e.g., 15 ft canisters) currently scheduled for shipment from a given location. The discharge year for each batch was arbitrarily set to 1998. The information described in Table B-5 is included.

Table B-5. DOE Spent Nuclear Fuel Production Table Format

Field Name	Description
SCN_Num	Scenario number associated with this dataset
Year	Year of creation (currently 1998)
Reactor	TSMPP reactor number for the facility
Cans	Number of canisters discharged from “Reactor” in “Year”
MassPerCan	MTHM per canister
Heat	Estimated thermal load for a canister in a batch, Watts per canister

The DOE SNF pool allocation rights are also specific to each scenario and may be displayed and edited by the user in the “Rates / DOE SNF / Allocation” menu item. This information is stored in the database table “DOE SNF\_Allocation”, and is shown in Table B-6.

Table B-6. DOE Spent Nuclear Fuel Allocation Table Format

Field Name	Description
SCN_NUM	Scenario number associated with this dataset
Year	Year of allocation
Poolid	Pool to be given the allocation
Allocation	MTHM allocated to “Poolid” in “Year”

## B.1.2 FACILITY DESCRIPTIONS

In the following sections the data needed to describe each facility is described.

### B.1.2.1 Pool Information

Pool information is included as one of the tables within the input database (for example, the most current table is called “Pool\_INFO\_07LCC”). This table contains information on each CSNF, DOE SNF, and HLW storage location. For each storage location, the information described in Table B-7 is defined.

The EIA pool number (“EIA\_NUM”) is only used to determine non-reactor storage locations (for CSNF, HLW, or DOE SNF) and for informational purposes on various screens and reports. A pool with an EIA number > 6200 is assumed to be a non-reactor storage location. The shutdown date for these storage locations is automatically set to an arbitrary large number (9999) by the TSMPP to prevent the pool from being unloaded following shutdown. In addition, the pool capacity for these storage locations (e.g., Hanford, INL, Savannah River, Morris, and West

Valley) should be set to a large enough value in the input data (i.e., field “CAPACITY”) to prevent dry storage from occurring.

Table B-7. Pool Information Table Format

Field Name	Description
CALVIN_Pool	TSMPP pool number - consecutive number initially assigned based on the alphabetical order of the pool names. (Note: Newer pools added later will not be in sequence.) This number is used internally in linking the SNF discharge data with its storage location.
EIA_NUM	Four-digit number assigned by EIA to each pool based on the owning utility.
E_W	Indicator for whether pool is in eastern (E) or western (W) part of the U.S. [Not Used]
POOL_NAME	Name of the pool. Included for informational purposes and is not used in any calculations or processes.
CAPACITY	Smaller of the licensed number of assemblies or the maximum established capacity.
FCR	See explanation in subsequent paragraph.
SITE_ID	Consecutive number assigned to each site. This number is used to link various pools together for shipping purposes and to determine when a site is shut down.
UTIL_ID	Consecutive number for each utility. The TSMPP uses the utility identifier from the site information table.
TYPE	Numerical code for the type of fuel that can be stored in a pool (0=BWR, 1=PWR, 2=HLW, 3=DOE SNF).
Main_Pool	See explanation in paragraph below.
ABBREV	Combine with transportation modal type (T, R, or D) to create the IS field ‘OBJECT’. In TSM this object name field is used to track each cask shipment.
SITE_ABBR	Used to generate the IS field ‘Site ID’. In TSM this field defines the starting point for each cask shipment.
WASTE_TYPE	Used to generate the IS field ‘Waste_Type’. In TSM this field defines how the cask is routed through the GROA processes.

An FCR is space set aside in a storage pool equal to a complete discharge of an entire core load of assemblies from a reactor. While not required by the Nuclear Regulatory Commission, a FCR is typically maintained at all pools with operating reactors. Pools with multiple reactors discharging into them typically only retain a single FCR, equal to the core size of the largest reactor. In the TSMPP, this reserve is subtracted from the pool capacity until the last reactor discharging into that pool shuts down, at which point the FCR is added back to the pool capacity.

The “Main\_Pool” field is used to map artificially created pools back to an actual pool. Within the TSMPP, the creation of artificial pools is necessary for pools where more than one type of fuel is stored (e.g., Harris 1). Pools for which the main pool number is different from the TSMPP pool number (i.e., the number in field “CALVIN\_Pool”) are ignored in determining whether or not a site is shutdown. These pools look to the main pool they are linked to when determining when to perform various activities (e.g., if/when the main pool unloads into dry storage, so will any artificial pools mapped to it).

### B.1.2.2 Reactor Information

Reactor information is included as one of the tables within the input database (for example the most current table is called “RX\_INFO\_00”). For each reactor, the information described in Table B-8 is defined.

Table B-8. Reactor Information Table Format

Field Name	Description
CALVIN_RX	TSMPP reactor number – consecutive number initially assigned based on the alphabetical order of the pool names. (Note: Newer reactors added later will not be in sequence.)
EIA_NUM	EIA number. This data is not used in TSMPP calculations or processes and is provided for informational purposes only.
RX_NAME	Reactor name. This data is not used in TSMPP calculations or processes and is provided for informational purposes only.
SNF_Length	SNF length – typical post radiation length (in inches) of fuel discharged by reactor. This data is used in determining if fuel will fit inside a cask.
SNF_Width	SNF width – typical post radiation width (in inches) of fuel discharged by reactor. This data is provided for informational purposes only.
DESIGN_TYPE	Reactor design - This data is provided for informational purposes only.
TYPE	Reactor type - denotes the type of fuel discharged (BWR, PWR, HLW, DOE). This data is provided for informational purposes only.
RX_TYPE	Reactor type - numerical code for the type of fuel discharged. (0 = BWR, 1 = PWR, 2 = HLW, and 3 = DOE SNF)
SHUT_DATE	Shutdown date - shutdown date for each reactor. This data is not currently used. The TSMPP determines reactor shutdown dates by utilizing dates provided in the fuel discharge data.
PREF_POOL	Preferred pool - provides the TSMPP pool number to which the reactor discharges, except for historically trans-shipped fuel.

### B.1.2.3 Site Information

Site information is included as one of the tables within the input database (for example, the most current version is called “Site\_Info\_04”). For each site, the information described in Table B-9 is defined. This information is not used in the IS file produced by the TSMPP.

Table B-9. Site Information Table Format

Field Name	Description
SITE_ID	Site identifier – consecutive number assigned to each site based on the order when sorted by EIA number.
UTIL_ID	Utility identifier – Consecutive numbers assigned for each utility (DOE sites assigned no. 25). Order is based on EIA site number (i.e., the utility owning the first site listed when arranged from lowest to highest EIA number is assigned no. 1). Sites owned by the same utility have the same UTIL_ID. Number also listed in the UTILITY_INFO table.
EIA_NUM	EIA number for the site.
SITE_NAME	Name of the site.
LAT	Site latitude – not currently used.
LONG	Site longitude – not currently used.
BARGE	Barge miles – number of miles a rail cask would need to be shipped by barge from a reactor to the nearest rail line.
HH	Heavy-Haul miles - number of miles a rail cask would need to be heavy-hauled from a reactor to the nearest rail line.
Region	Transportation region where the site is located – previously used in calculation of required transportation fleet (1-5 = commercial transportation region; 6-10 = defense transportation region). Note that up to five commercial transportation regions and five defense transportation regions can be specified. Not currently used.
Operating_Hours	Number of hours a week a site is available to load transportation casks. [Not used]
State	State - two-letter code indicating the state in which the site is located. This data is provided for information only.
Trans_Flag	Transportation flag that indicates what transportation costs to include for all shipments from a given site.  (0=include all costs, 1=eliminate cask fleet cost, 2=eliminate cask fleet and transportation cost)

### B.1.3 CASK INFORMATION

The majority of the cask limits and cask parameters described in this section for casks used in the TSMPP are contained in the “cask information” table within the TSMPP input database (the most current version is called “Cask 07 TSM”). For each cask, the information described in Table B-10 can be specified. A more detailed description is provided in subsequent sections for all fields that are used.

Table B-10. Cask Information Table Format

Field Name	Type	Description
Cask_Num	Parameter	Cask number – numerical code for cask.
Cask_Name	Information	Name of the cask.
Base_Cask	Parameter	If different from Cask_Num, it's the number of the cask to map this cask to. Any transportation activity associated with this cask is added/reported to the base cask instead of this cask, for purposes of estimating cask fleet.
Base_Cask_Name	Information	Name of Base Cask type (see Base_Cask parameter).
Mode	Parameter	Text code indicating purpose of cask (T= Truck, R= Rail, S= Storage, M= Canistered, C= Cask suitable for one-time transport or a transportable storage cask with no canister, A= All purpose canister [storage/transportation/emplacement]).
Type	Parameter	Fuel type that can be loaded into cask (B= BWR, P= PWR, H= HLW, X= DOE SNF).
StartProcess	Parameter	Name used to generate the IS field 'Process Connection' which defines the cask purchase process used to initiate shipments.
Dry Ovpk	Parameter	Cask number for dry storage overpack to use with this canister type.
Tran Ovpk	Parameter	Cask number for transportation overpack to use with this canister type.
Disp Ovpk	Parameter	Cask number for WP overpack to use with this canister type.
Capacity	Limit	Cask Capacity (number of assemblies or canisters cask can hold).
Codisposable	Parameter	Indicates whether both DOE SNF and HLW can be placed in this WP type simultaneously.
B-E Curve	Limit	Number code of the burnup/enrichment curve to use in checking assemblies. If > 1000, number of criticality ("k") curve to use.
Cask_heat	Limit	Maximum heat output for all assemblies in the cask (not used).
Assem_heat	Limit	Maximum heat output per assembly (in watts).
Max_enrich	Limit	Maximum enrichment for assemblies (not used).
Max_AVGBurn	Limit	Maximum burnup for assemblies (not used).
Cavity_Lg	Limit	Maximum length of assemblies (in inches).
Array_Sz	Information	Maximum width of assemblies (not used).
Loaded_Weight	Parameter	Shipping weight of cask when loaded (in pounds).
Empty_Weight	Parameter	Shipping weight of cask when empty (in pounds).
RX_Outer	Parameter	Cask loading time (in minutes) at reactor for outer cask (i.e., overpack, single purpose (SP) cask).
RX_Inner	Parameter	Cask loading time (in minutes) at reactor for inner cask (i.e., canister).
ISF_Outer	Parameter	Cask loading time (in minutes) at ISF for outer cask (i.e., overpack, SP cask).
ISF_Inner	Parameter	Cask loading time (in minutes) at ISF for inner cask (i.e., canister).
ISF_Cell	Parameter	Cask processing time (in minutes) inside a transfer cell (used in calculation of required transfer cells).
MGR_Outer	Parameter	Cask loading/unloading time (in minutes) at MGR for outer cask (i.e., overpack, SP cask).
MGR_Inner	Parameter	Cask loading/unloading time (in minutes) at MGR for inner cask (i.e., canister).

Field Name	Type	Description
MGR_Cell	Parameter	Cask processing time (in minutes) inside a transfer cell. Used in calculation of required transfer cells.
Cask_Life	Parameter	Number of years before cask requires refurbishment or decommissioning.
Utilization	Parameter	Utilization - number of days per year a cask can be used.
Cost	Parameter	Cask purchase cost (in millions of dollars).
Maint_Cost	Parameter	Annual cost of maintaining a transportation cask (in millions of dollars). Not currently used.
Repl_Cost	Parameter	Cost to refurbish a transportation cask (in millions of dollars). Occurs periodically based on cask life.
Reusable	Parameter	Indicates whether a cask can be used more than once (i.e., a transportation cask) or just once (i.e., a storage cask). (Not used)
K_Inf	Limit	Assembly criticality limit.
OWT_FLAG	Parameter	Overweight truck flag - all casks over legal weight have a surcharge added to the shipping cost (Yes/No Option).
MOX	Parameter	Indicates whether cask is capable of handling MOX fuel (Yes/No Option). Not currently used.
Min Drift Length	Limit	Minimum drift length (in meters) required to emplace that WP type based upon the desired thermal loading.

### B.1.3.1 Cask Limits

Several limits can be specified to restrict the fuel that can be shipped, stored, or emplaced in a particular cask. Some of the limits are based on assembly characteristics that change with time (e.g., thermal output), while other limits are fixed (e.g., length of an assembly). In the TSMPP, setting a given limit to zero disables the check of that limit. Non-zero limits are individually checked for each batch until it fails a test or until the batch passes every test and is loaded into a cask.

#### B.1.3.1.1 Thermal Limits

The thermal limit (“Assem\_heat”) field is used to specify the maximum heat output per assembly (in watts) a cask can handle when “Uniform” cask loading is implemented. If the last calculated value for an assembly (based on its age, enrichment, and burnup) is greater than the cask’s thermal limit, the heat output is recalculated to check if it has been reduced sufficiently (i.e., cooled) since the previous calculation to be acceptable. If the last calculated value for an assembly is acceptable or the assembly limit for the cask was set to zero, then the heat calculation is omitted. More details on the calculation of the heat output can be found in Section A.3.1. Note that for dual-purpose and multi-purpose canister systems, the thermal limits apply to the canister overpack (storage, transportation and/or disposal), rather than to the canister itself.

#### B.1.3.1.2 Burnup/Enrichment Limit

The burnup/enrichment limit is specified as a set of data points indicating the minimum burnup an assembly must have for a given enrichment in order to be placed into a given cask. Linear

interpolation is used to check values that fall between points on a burnup/enrichment curve. Any enrichment beyond the maximum enrichment entered is assumed to fail, while any enrichment below the minimum enrichment entered is assumed to pass. The number of the curve to use for a given cask (must be less than or equal to 1000) is entered in the “B-E Curve” field, with the actual curve data being read from the “B-E Curve” table in the TSMPP input database (see Section B.1.4). Due to the uncertainty in burnup measurements, the reported burnup of an assembly is reduced by 5 percent before checking against the specified curve. Note that if a curve number greater than 1000 is entered in the “B-E Curve” field, the criticality limit “k” for the cask is calculated instead (see Criticality Limit item below).

#### **B.1.3.1.3 Cavity Length Limit**

The length limit (“Cavity\_Lg”) field is used to specify either the maximum acceptable length of an assembly (for any fuel except DOE SNF) or as the exact length that can be handled (for DOE SNF only). The length of an assembly is obtained from the reactor that discharged it (i.e., field “SNF\_Length” in the reactor information table).

#### **B.1.3.1.4 Capacity**

The capacity (“Capacity”) field is used to indicate the maximum number of units (assemblies or canisters) that can be placed into a cask. All transportation casks are completely loaded except the last cask from a pool, which is loaded as full as possible with the remaining fuel available. Similarly, all casks utilized for onsite dry storage are loaded to capacity as long as there is fuel available.

#### **B.1.3.1.5 Criticality Limit**

The “k” limit is a measure of criticality based on the burnup, enrichment, and age of the fuel. This limit is specified in field “K\_Inf”. Currently, it is only calculated for WPs and disposable canisters loaded anywhere in the system. The criticality limit is calculated for a cask if a value greater than 1000 is entered in the “B-E Curve” field.

The formula used to calculate k is as follows:

$$k = C_0 + C_1B + C_2A + C_3E + C_4B^2 + C_5E^2 + C_6A^2 + C_7EB + C_8BA + C_9AE + C_{10}EAB + C_{11}B^3 + C_{12}E^3$$

Where:

“E” is initial enrichment in weight percent,

“B” is assembly burnup in Gigawatt-days/MTHM, and

“A” is age of the fuel (in years).



This formula was derived by combining a formula for “ $k_{\infty}$ ” from reference CRWMS M&O 1997 with a formula for “ $k_{eff}$ ” from reference DOE 1999. Note that “ $k_{\infty}$ ” and “ $k_{eff}$ ” are two different methods of measuring criticality; the above equation allows either method to be used, depending on the values of the coefficients. Table B-11 shows the coefficients currently defined for four criticality curve types. These coefficients are contained in the “K-Coeff” database table. Coefficients “ $C_{13}$ ” and “ $C_{14}$ ” in the table are defined as the maximum age and minimum burnup, respectively, for the criticality calculation; assembly ages greater than the maximum are reset to the maximum, and assembly burnups less than the minimum are reset to the minimum.

Table B-11. Criticality Equation Coefficients

Criticality Coefficient	Curve Number/Type			
	1001	1002	1003	1004
	$k_{\infty}$ - BWR	$k_{\infty}$ - PWR	$k_{eff}$ - BWR	$k_{eff}$ - PWR
$C_0$	0.92601	1.06	0.850736	0.640653
$C_1$	-0.0126	-0.01	-0.00775	-0.01029
$C_2$	0	-0.002	0	0
$C_3$	0.19901	0.114	0.087294	0.300169
$C_4$	9.5E-05	7.08E-05	0	-2.5E-05
$C_5$	-0.0067	-0.007	0	-0.04909
$C_6$	0	7.57E-05	0	0
$C_7$	-0.00124	-0.00027	0	0
$C_8$	0	-0.00011	0	0
$C_9$	0	0.000232	0	0
$C_{10}$	0	9.37E-06	0	0
$C_{11}$	0	0	0	9.92E-07
$C_{12}$	0	0	0	0.003645
$C_{13}$	0	40	0	0
$C_{14}$	5	0	0	0

### B.1.3.1.6 Minimum Drift Length Limit

Not used in the TSMPP.

### B.1.3.2 Cask Parameters

#### B.1.3.2.1 Cask Name and Cask Number

Cask names and cask numbers exist for each cask within the cask table of the TSMPP input database. The cask name is indicated in field “Cask\_Name,” while the cask number is indicated in field “Cask\_Num.” Cask names and numbers for new casks are specified by the user.

#### **B.1.3.2.2 Base Cask and Base Cask Name Fields**

The base cask (“Base\_Cask”) field is used to combine requirements from several transportation casks before cask fleet purchases are calculated. Data is typically combined for different (i.e., BWR and PWR) configurations of the same cask. Data may also be combined for derated versions of the same cask. The “Base\_Cask\_Name” field contains a generic name for each base cask type (e.g., Large Rail). An “N/A” entry means that the cask is not a base cask. These base cask names are used as column headings for the “Cask Fleet” logistics report.

**Note:** The cask fleet calculation is currently not used in the TSMPP but its factors retained for possible future use.

#### **B.1.3.2.3 Mode**

The cask mode (“Mode”) field is used to indicate where and how the cask is being used. The modes utilized in the TSMPP are as follows:

- T - Truck transportation cask
- R - Rail transportation cask
- S - Storage cask
- M - Canister
- C - Cask, specifically transportable-storage casks (with no canister) and storage casks assumed to be suitable for a one-time transport license
- A - All-purpose canister, i.e., suitable for storage, transportation, and emplacement

A discussion on canistered fuel casks versus uncanistered fuel casks is provided in a subsequent paragraph.

#### **B.1.3.2.4 Fuel Type Field**

The fuel type (“Type”) field indicates what type of fuel can be placed into a cask. If a cask can handle more than one fuel type, the cask should be specified as many times as necessary in the cask list, once for each fuel type. The casks can then be linked together (for cask purchase requirements) by using the base cask field. The base cask field is discussed above. Fuel types utilized in the TSMPP are as follows:

- P - PWR fuel
- B - BWR fuel
- H - HLW fuel
- X - DOE SNF

#### **B.1.3.2.5 Start Process Field**

The start process (“StartProcess”) field contains the cask identifiers listed in the ‘Process Connection’ field of the IS. Start process field entries define the cask purchase processes (i.e., are used to generate casks) and are used to initiate shipments of that cask type in TSM.

#### **B.1.3.2.6 Canistered Fuel Casks versus Uncanistered Fuel Casks**

An uncanistered fuel (UCF) cask is one in which bare assemblies are individually loaded into it and are removed in the same manner. A canistered cask is one in which fuel assemblies are first loaded into an inner container (i.e., a canister), which is sealed, and the sealed canister is loaded into an overpack. A canister may be utilized for up to three modes (i.e., for storage, transportation, and/or emplacement). Separate fields are provided in the input table so that overpacks may be specified for storage, transportation, and emplacement. These fields are labeled “Dry Ovpk,” “Tran Ovpk,” and “Disp Ovpk,” respectively. An overpack must be defined for at least one mode in order for the canister to be used. As long as an overpack is specified for the next mode, the fuel will remain in the canister. If a given mode is left blank, it is assumed that the canister cannot be used for that mode; therefore, the fuel is unloaded from the canister and the canister is discarded. Note, the same overpack can be specified for more than one mode. If the same overpack is specified for more than one mode, and if the modes are in consecutive order, the canister and overpack will move intact between modes with no additional handling time.

#### **B.1.3.2.7 Co-Disposable Field**

A co-disposable (“Codisposable”) field is provided to indicate which waste forms, if any, may be combined with other waste forms for disposal in the same WP type. Currently, only DOE SNF and HLW can be combined in the same WP. A “Yes” in this field denotes that the cask may be utilized to co-dispose of waste. Note that such a cask will only be utilized if the user has specified that co-disposal will occur. The TSMPP results for Co-disposal are for interest only. The filling of co-disposal WP is modeled in the TSM GROA Module.

#### **B.1.3.2.8 Processing Times**

The processing time for a cask consists of the time it takes to place assemblies into (or to remove assemblies from) a cask and to move the cask into and out of the facility. This time is currently not used in the TSMPP but is retained for possible future use.

#### **B.1.3.2.9 Cost Fields**

Not used in the TSMPP.

#### **B.1.3.2.10 Reusable Field**

Not used in the TSMPP.

#### **B.1.3.2.11 Overweight Truck Field**

The overweight truck (“OWT\_FLAG”) field indicates whether or not a truck transportation cask exceeds legal weight limits and requires special permits for shipping.

#### **B.1.3.2.12 Mixed Oxide (MOX) Field**

The mixed oxide fuel (“MOX”) field is provided to indicate if the cask may contain MOX fuel. However, recent fuel files do not distinguish MOX fuel from standard commercial SNF, therefore regular commercial SNF casks are assumed to be able to carry MOX fuel.

#### **B.1.3.2.13 Cask Weight Fields**

The loaded weight (“Loaded\_Weight”) and the empty weight (“Empty\_Weight”) fields are used to denote the loaded weight and the empty weight, respectively, of a transportation cask. These weights were used in previous versions of the TSM in cost calculations for shipping CSNF, DOE SNF, and HLW in the TSM. Weights are listed in pounds. **Note:** The cask weight fields are not used in the current version of the TSMPP.

#### **B.1.3.2.14 Utilization Field**

The utilization (“Utilization”) field indicates how many days per year a given transportation cask may be used. This data is required in calculating transportation cask fleet requirements. **Note:** The utilization field is not used in the TSMPP.

#### **B.1.3.2.15 Minimum Drift Length Field**

The minimum drift length (“Min Drift Length”) field is used for WPs only, and indicates the minimum length of MGR emplacement drift that will be occupied by the cask. **Note:** The minimum drift length field is not used in the TSMPP.

### **B.1.4 FUEL B-E CURVES**

The parameters contained in the Burnup–Enrichment (B-E) Curves table are shown in Table B-12. B-E curves are used to test fuel assemblies to be loaded in transportation or storage casks. The B-E curve number (if any) for each cask is specified in the cask information file (see Section B.1.3). For each B-E curve number, there is a set of data points showing burnup limits for various enrichments.

Table B-12. Burnup – Enrichment Curve Table Format

<b>Field Name</b>	<b>Type</b>	<b>Description</b>
B-E Curve Number	Parameter	Burnup-Enrichment Curve Identifier
Burnup	Limit	Burnup limit (Megawatt-days/MTHM)
Enrichment	Parameter	Enrichment (%)

## B.2 Auxiliary Database Tables

The Microsoft Access database distributed with the TSMPP program includes the necessary data to run the TSMPP model. The information in this database may be viewed via Microsoft Access 2000. This database actually consists of several tables contained within a single database file. Table B-13 provides details concerning these tables. Note that some table names (those shown in bold type in Table B-13) may be somewhat different than the name listed here (e.g., Pool\_INFO\_04\_05 may be updated and called Pool\_INFO\_05, etc.). Note that a TSMPP database is required for running the TSMPP. New scenarios created by the user and updates to existing scenarios will be stored in the user's TSMPP database.

Table B-13. Tables Within TSMPP Database

Table Name	Description of Contents
Allocation	Shows the site specific pool allocations selected in the Utility Options screen (see Figure 18). The table shows the pool id and allocation to that pool for each year that a site specific allocation is assigned.
B-E Curve	Contains burnup/enrichment curve data points for several burnup/enrichment curves. Burnup/enrichment curves may be assigned to certain casks within the TSMPP in order to determine the minimum burnup an assembly must have at a given enrichment in order to be placed into a particular cask.
<b>Cask 07 TSM</b>	Contains cask information for casks utilized in TSMPP runs. Data for casks may include the following: cask mode, fuel type, cask overpack links, capacity, burnup/enrichment curve assignment, cask heat, assembly heat, maximum enrichment, maximum average burnup, cavity length, array size, loaded weight, empty weight, loading times, cost data, etc.
CaskSeq Store	Stores the storage cask/WP "cask sequences" for each modal type. The "cask sequences" are input by the user via the "Cask Linkages" screen. Data is included for each scenario. The stored data includes the following: the scenario number, the link key (modal number), the link name (modal type), the first year of cask usage, the last year of cask usage, the cask identification number, and the assigned priority.
CaskSeq Tran	Stores the transportation "cask sequences" for each modal type. The "cask sequences" are input by the user via the "Cask Linkages" screen. Data is included for each scenario. The stored data includes the following: the scenario number, the link key (modal number), the link name (modal type), the first year of cask usage, the last year of cask usage, the cask identification number, and the assigned priority.
ReceiptData	Stores user-specified CSNF parameters and acceptance rates. Parameters are entered via the "Options / CSNF Acceptance" screen. Acceptance rates are entered via the "Rates / Commercial" screen. Data is included for each scenario.
DOE SNF_Allocation	Contains user-specified DOE SNF pickup allocations for each pool. These allocations are entered via the DOE SNF "Acceptance Rates" screen accessed by clicking on the "DOE" button on the "Fuel Selection/Waste Acceptance Options Menu." Data is included for each scenario.
DOE SNF_Production	Provides the DOE SNF production rates for DOE sites. For each discharge, the following information is provided: the "discharging" reactor, the year of creation, the number of canisters discharged, the total MTHM per canister, and the estimated thermal output (watts) per canister.

Table Name	Description of Contents
<b>Fuel 02B_06LE104_Projection</b>	Contains CSNF fuel data by batch number. Additional data for each batch number includes the following: the discharging reactor, the MTHM per batch, the burnup, the enrichment, the year of discharge, the storage location, and the year the SNF went into dry storage (historical dry storage only).
Fuel Parameters	Contains user-specified input data from the "Fuel Selection Options" screen for each scenario.
Heat_BWR Heat_BWR_SS Heat_PWR Heat_PWR_SS Heat_MOX	Contain heat data for use in calculating spent fuel assembly heat output. The four tables contain data for BWR zirconium clad fuel, BWR stainless steel clad fuel, PWR zirconium clad fuel, and PWR stainless steel clad fuel. 12 burnup and 11 enrichment values are listed for each fuel type (stainless steel fuel data is limited). Heat values for 180 decay times are listed for each burnup-enrichment combination.
HLW_Production	Provides the HLW production for each HLW site. For each discharge, the following information is provided: the "discharging" reactor, the year of creation, the number of canisters discharged, the total MTHM per canister, and the estimated thermal output (watts) per canister.
HLW_Allocation	Contains user-specified HLW pickup allocations for each pool. These allocations are entered via the HLW "Acceptance Rates" screen accessed by clicking on the "High Level Waste" button on the "Fuel Selection/Waste Acceptance Options Menu." Data is included for each scenario.
HTTIMES	Contains data used in conjunction with data from tables "Heat_BWR," "Heat_BWRSS," Heat_PWR," and "Heat_PWRSS." Table "HTTIMES" contains the time after discharge associated with each of the heat flow rate data points from the "Heat" tables. Data from tables "HTTIMES," "Heat_BWR," "Heat_BWRSS," Heat_PWR," and "Heat_PWRSS" are utilized in calculating rates of heat flow per assembly.
K-Coeff	Contains coefficients for calculating the criticality limit "k" for each assembly.
<b>Pool_INFO_0405</b>	Contains storage location data such as the TSMPP pool number, the EIA pool number, the pool name, the pool capacity, the pool full-core reserve, the site identifier, the utility identifier, the fuel type that can be stored, and the main pool number.
PoolCask Store	Stores the dry storage/emplacment modal types (i.e., "pool links") that are input by the user via the "Cask Linkages" screen for each pool. Data is included for each scenario.
PoolCask Trans	Stores the transportation modal types (i.e., "pool links") that are input by the user via the "Cask Linkages" screen for each pool. Data is included for each scenario.
<b>RX_INFO_00</b>	Contains information about facilities where fuel is stored. The data includes the TSMPP reactor number, the EIA number, the reactor name, the length of the fuel discharged by the reactor, the type of reactor, the shutdown date, the preferred pool number, and the share identifier.
SCN_INFO	Contains user-specified scenario information from the "Save Scenario" screen, along with modeling data not needed for the TSMPP. Data is included for each scenario.
Scn_info2	Lists the data tables (e.g., "Fuel 98_LE16_Projection," "Pool_INFO_0405," etc.) from the TSMPP database that are used for each scenario. These tables do not contain data that is input by the user during run time.

Table Name	Description of Contents
<b>Site_Info_04</b>	Contains site information such as the site identifier, the utility identifier, the EIA number, the site name, the site latitude, the site longitude, the distance traveled via barge to the rail (for locations without onsite rail), the distance traveled via heavy haul to the rail (for locations without onsite rail), and the region. Not used in the TSMPP IS File generation.
Site_Shut_Info	Contains the user-specified "Unload Fuel Post Shutdown" information. This data is entered from the "Utility Options" screen. Data is included for each scenario.
Table_Types	Contains a list of input data table names and corresponding table types that can be selected via the "Select Data Tables" screen. Note that input data tables that are not included in this table cannot be selected for use in TSMPP runs.
Utility Parameters	Contains user-specified input data from the "Utility Options" screen. Data is included for each scenario.
<b>UTILITY_INFO</b>	Lists the facilities where fuel is stored and the utility (or government entity) associated with the facility. Facilities are listed by EIA number, and a utility identifier is assigned to each facility.
Valid_Names	Contains valid (i.e., consistent) sets of input files for fuel discharge and pool data. Note that every fuel discharge file must have a corresponding valid pool data file.

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