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CANISTER MODEL
USER'S MANUAL
Version 1.0

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**CANISTER MODEL
USER'S MANUAL
Version 1.0**

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September 1993

**Westinghouse Idaho
Nuclear Company, Inc.**

PREPARED FOR THE
**DEPARTMENT OF ENERGY
IDAHO OPERATIONS OFFICE**
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Contents

Foreword	ii
I. Introduction to Systems Modeling	1
II. Introduction to the Canister Model	2
III. Installation of the Canister Model	3
IV. Using the Canister Model	4
File Menu	5
Run Menu	5
Report Menu	6
Graph Menu	7
Decisions Menu	9
V. Interpreting the Results	10
Appendix 1: Simplified Canister Causal Loop	14
Appendix 2: Canister Program Design	15
Appendix 3: Systems Modeling Contacts	16
Appendix 4: Input and Output Variable Definitions	17
Appendix 5: Input Log Sheet	24
Appendix 6: Output Log Sheet	25

Foreword

The Canister Model described in this User's Manual is both an educational and an exploration tool for the issues surrounding the construction of a canister for the storage of ICPP material in a repository. The Canister Model described herein, as with all computer modeling software, has inherent application limitations based on the assumptions and relations used in the program. Due to these limitations, it is recommended that this model be used only for qualitative evaluations and trending of the variables of concern, and to gain familiarity with the concepts of Systems Modeling. Any conclusions drawn from working with the Canister Model should be validated with the personnel listed below to assure that the analysis is valid and does not push the model beyond the limits of what it is intended to accomplish. Questions regarding the Canister Model should be referred to the personnel listed in Appendix 3 of this User's Manual.

This release represents the most recent version of the Canister Model, with upgrades to the program expected in the future. In order to assure that all users have current versions of the program available to them, it is essential that the Systems Modeling Subsection of WINCO's Applied Technology Division know where copies of this software reside. Therefore, the software for the Canister Model has been designed as a controlled item and should not be copied for other users without the express written consent of one of the personnel responsible for the program. These include:

Terry A. Bingham	(208) 526-9109
Mike A. Caldwell	(208) 526-8967
Todd T. Nichols	(208) 526-9173
Chris A. Dahl	(208) 526-3583

User cooperation in software control of this Canister Model is greatly appreciated.

I. Introduction to Systems Modeling

Systems Modeling uses the latest advances in computer software and hardware to electronically simulate the effects of future uncertainties on various business decisions, strategies, and approaches. It considers both technical and non-technical factors (i.e. regulatory compliance, risk, cost, public perception, and stakeholder interest) and assists management-level decision-making processes by evaluating the relationships between various factors affecting the results of a particular program. Generally, the issues and dynamics of complex business situations can be hypothetically explored without the risk of lost investments on failed experiments.

Computer simulation, the most advanced modeling tool, allows exploration and testing of potential operating strategies against a wide range of possible scenarios. Through the compression of time and space, and the integration of both soft and hard issues, computerized modeling techniques can accommodate high levels of detailed and dynamic complexity and can provide invaluable insights for the comparative evaluation of process options.

Utilization of Systems Modeling in the decision-making process can drastically reduce cost and time expenditures by helping management:

- Identify internal contradictions before a particular strategy is put into place;
- Recognize previously unexplored management options;
- Show that seemingly insignificant factors have a drastic impact on the overall outcome;
- Focus on qualitative trends rather than quantitative measurements; and
- Apply "what if. . ." scenarios to business decision.

II. Introduction to the Canister Model

The canister model is a computer simulation program designed to analyze various scenarios related to the filling and disposing of waste canisters. Intended to aid the decision-making process, this program:

- Allows users to run various waste disposition scenarios;
- Shows the sensitivity of variables to change;
- Calculates the number of canisters required to dispose of ICPP waste and fuel;
- Identifies cost for a given scenario; and
- Shows the dynamics of canister filling and shipping.

The simplified and detailed causal loop diagrams that were used as the basis of the Canister Model are shown in Appendix 1 and 2. These diagrams illustrate the relationships of the various tangible and intangible factors associated with Waste canister development and implementation. Each arrow represents the direction of the effects of change in one factor on numerous other factors involved in the process; an S indicates a *similar* effect (as one factor increases so does the other), and an O indicates an *opposite* effect (as one factor increase, the other decreases). Arrows without an S or O indication are either too close to tell or are unaffected by the change.

Using numeric values for each variable (e.g. fissile material loading per canister, recycled and new canister material, repository cost per canister, budget pressure, and canning and repository startup dates), the Canister Model calculates the overall programmatic cost; number of canisters; average percent of fuel, waste and inerts per canister; and fuel and waste inventories for canistering ICPP waste for geologic disposal. Trends that surface while using the model are of greater importance than actual numbers.

The Canister Model was created by WINCO's Systems Analysis Section of Applied Technology. Any ideas, comments or questions related to this program should be forwarded to those individuals listed in Appendix 3.

III. Installation of the Canister Model

The Canister Model requires, as a minimum, an IBM compatible computer running Windows version 3.1, and must be installed to your hard disk prior to running the program. To install the Canister Model, copy the **CAN.EXE** file to the desired directory on your hard disk. Additionally, the Canister Model requires the following files to run: GSW.EXE, GRAPH.VBX, GAUGE.VBX, GSWDLL.DLL, and MFC200.DLL. If these files do not exist in your \WINDOWS\SYSTEMS directory, copy them there before attempting to initiate the Canister Model.

After the necessary files are copied to their respective directories, exit to the Windows Program Manager, highlight the group in which you want the Canister Model icon to appear, and open the File menu. Choose the New option and select *Program Item* to create the new icon. Fill in each line with the Description (name for program item,) Command line (CAN.EXE), and working directory (directory where the Program is located) as directed. Be careful to move from line to line using the cursor; DO NOT press enter after each entry, doing so will close the *Program Item Properties* box. Next, select *Change Icon* and choose the icon provided. A sample icon configuration will look something like this.

After all configurations are entered as desired, select OK and return to the *Program Manager*.

IV. Using the Canister Model

Launch the model by double-clicking the *Canister Model* icon after locating it in the proper program group. You are now in the model.

The menus across the top of the window are: File, View, Run, Report, Graph, Decision, and Help; and each menu will be explained in detail later. The Simulation Year for each run is displayed at the bottom right side of the window, and indicates the year that you are in at each point of the simulation. The gauge just above *Simulation Year* fills to show how much of the simulation is complete. Above the gauge is where the input variables are displayed and changed; the default display is *General Decisions*. The left half of the window is where all reports and graphs are displayed; the default setting is the *Summary* report. Reports and graphs are updated each time a simulation is paused, stopped, or reaches the simulation end. A sample Startup screen appears below.

The following section lists each menu item and describes the function of their respective options. Any menu items not covered in this manual are standard Windows functions, and you should refer to your Windows User's Guide as needed.

File Menu

File menu options allow users to save or print information, and to exit the program.

Use

To

Save

Save all data associated with the last run of the model. The data is saved as a generic text document, and the model itself cannot do anything with this data once it is saved. To look at it you must use a word processor, spreadsheet, or text editor.

Print

Print a copy of whatever is currently being displayed on the screen.

Exit

Exit the Canister Model Program.

Run Menu

Run Menu options allow users to set simulation specifications; run, pause, or stop the program; and reset the program to default values.

Use**To****Time Spec**

Set the year the simulation will start and end. The default is set to start in 1993 and end in 2075. You can also set the Delta Time, the time between calculations. For accurate results, the DT should be set to a power of 2, (i.e. 2, 4, 8, 16, 32, or 64). Use 16 for months and 64 for years; the default value is 16.

Run

Start the simulation.

Pause

Pause the simulation, allowing you to change the inputs or look at the outputs. Select *Run* to continue with the simulation.

Stop

Stop the simulation.

Reset

Reset all inputs to there default value.

Time Steps

Configure the simulation to pause at specified intervals; the values are in years. "1 Time," which is the default, will cause the simulation to pause every year. Selecting "Continuously" will cause the simulation to run until it reaches the simulation end date specified in the *Time Spec* option. There will be a check mark displayed next to the selected time step.

Report Menu

Report options allow the user to select the type of report that will appear in the left half of the program screen.

Use	To
Summary	Display a Summary Report of the major outputs from the simulation. As mentioned earlier, the Summary Report is the default option for the left side of the program screen.
Causal Loops	Display a picture of the basic causal loop for the model. This is the same causal loop that is shown in Appendix 1.

Graph Menu

Selecting any of the graphs listed will replace the left side of the Program screen with that particular graph. Graphs are particularly helpful to the decision-making process in that they illustrate program trends, thus supporting the Systems Modeling premise that trends arising through process simulations are more important than concrete figures. Each graph is automatically updated

whenever the simulation is paused.

Use	To
Canister Production Inventories	Show inventories of empty and filled canisters.
Canister Throughput	Show rates for canister fabrication, filling, and shipping.

Overpack and Super Canister Material	Show total material used for fabrication of overpacks and super canisters.
--------------------------------------	--

General Canister Cost 1

Show Transportation, Repository, Regulation, and Interim Storage costs associated with the canisters .

General Canister Cost 2

Show Operating, Fabrication, Inerts, and Cutting costs associated with the canisters .

Inventory of Canisters in Repository

Show the number of canisters shipped to the repository.

Material Used in Fabricating Canisters

Show the total amount of material used in the fabrication of canisters, broken down by material type.

Decisions Menu

The Decisions menu options, displayed on the right side of the Program screen, are used to change simulation inputs. The menu options have been broken down into eight major input categories:

- General Decisions (default)
- Product Decisions
- Cost Decisions
- Regulatory Decisions
- Canister Decisions
- Certification Decisions
- Canning Decisions
- Materials Decisions

Select any of the major categories listed in the menu display to show input options under that category; a check mark will appear beside the chosen option.

Inputs are shown in default values, but these values can be altered within a given range. Appendix 4 lists the inputs and their definitions, default values, and acceptable ranges. Inputs that have a range of 0-1 need to have leading zeros (in front of the decimal) when the number is between 0 and 1.

V. Interpreting the Results

Run the model with all the input variables set at their default settings. First, select *Continuously* from the run menu. Next, select *Run*; this will cause the model to run a simulation beginning in 1993 and ending with the year 2075 (Appendixes 4, 5, and 6 list all inputs and outputs and their default values).

When the simulation stops, the Canister Model will automatically update the summary report. Look at the summary report and each of the graphs.

The values should be the same as those in Appendix 5; note that some of the values change over time and are hard to document with a number. Print the

graph titled *Canister Throughput*—it will be useful in the next example.

Change the input budget pressure from its default of 0.5 to 0.9. If the General Decisions option is not being displayed, select *General Decisions*, change the Budget Pressure value, and run the simulation. Now, compare the results.

Notice that the actual startup date changed from 2010 to 2031. This is a logical adjustment considering that the increase in budget pressure results in less funding for the program, thus delaying the canning start date. Also notice that the maximum yearly cost and total cost are lower. This change is caused by the decrease in operational canning years (24 to 22) and by the elimination of interim storage costs (the need for interim storage goes away because the repository is open before canning operations begin).

Display the Canister Throughput graph using the graph menu and compare it to the Canister Throughput graph that you just printed.

Notice that the shipping rate to the repository went from an initial 3750 canisters per year to 550 canisters per year for an extended period of the program. The maximum shipping rate to the repository is set at a variable of 5000 canisters per year, but the maximum fill rate is set at only 1000 per year. With the repository opening and canning operations commencing at approximately the same time, the limiting factor is not the shipping rate, but the filling rate. This scenario spreads the operative costs more evenly over the program without extending the duration of canning operations.

Select *Reset* from the Run menu to restore the default values. Now, change one or more of the input variables using the decision menu and log any changes in the space provided in Appendix 5 (You may want to make additional copies of these logs to help you keep track of simulation runs). After making the change(s), run the model again to see what effect the change(s) have on the output variables. Note these changes using Appendix 6. After a few practice runs, you will notice that some variables are of little concern, while others have a substantial impact

on the end result. Variables having the most significant impact are termed *Leverage Points* and produce the highest payback on investment. Be careful, however, to examine all output variables; changing an input might have a positive effect on something you are concerned with, while negatively effecting something else.

Appendix 1

Simplified Canister Causal Loop

Appendix 2 CANISTER PROGRAM DESIGN

Appendix 3

Systems Modeling Contacts

<u>Name</u>	<u>Phone Number</u>
Terry A. Bingham	(208) 526-9109
Mike A. Caldwell	(208) 526-8967
Todd T. Nichols	(208) 526-9173

Appendix 4

Input and Output Variable Definitions

Actual Startup Date (output). The year the canister fabrication facility starts up operations. Units: Year.

Allowed Maximum Empty Canister Inventory (input). The maximum number of empty canisters allowed to be stored in an inventory, waiting for filling. In the present model, this parameter only appreciably effects how many empty cans you will have remaining after the filling process is complete. Its impact on the size of a storage facility required, and hence its cost, is not taken into account. Based upon the other processing rates involved, a default value of 500 cans was considered to be reasonable. Default: 500. Range: 0-100,000. Units: Canisters.

ASTM Certification (input). Flag to indicate if ASTM/ASME certification is required. Default: No. Range: No or Yes; No=Not required, Yes=Required. Unitless.

Average Volume % Fuel (output). The average portion of all canisters occupied by fuel. Units: Volume Percent.

Average Volume % Inerts (output). The average portion of all canisters occupied by inerts. Units: Volume Percent.

Average Volume % Waste (output). The average portion of all canisters occupied by waste. Units: Volume Percent.

Budget Pressure (input). The budget pressure of the U.S. federal govt. Value is a number between 0-1. A value of 0.5 represents the level that was assumed when selecting the projected startup dates for the canning and repository. A value less than 0.5 represents an "easier" monetary policy than assumed for projecting the startup dates, and a value higher than 0.5 means a "tighter" monetary policy than originally assumed. Default: 0.5. Range: 0-1; 0=Loose, 1=Tight. Unitless.

Canister Filling (output). The amount of canisters which can be filled based on the empty cans available, the maximum canning rate and the amount of canisters actually needed by the process. Units: Canisters/Year.

Canister Filling Efficiency (input). The efficiency of getting the canister full of materials. Default: 90. Range: 0-100. Units: Percent.

Canister Material (input). The choice of materials for manufacturing the canisters. Selecting a material type selects the cost, density and fabrication cost. Default: 2. Range: 1-6; 1=Stainless Steel 316L, 2=Stainless Steel 304L, 3=Titanium Grade 12, 4=Hastelloy C12, 5=Hastelloy C4 and 6=Incoloy 825. Unitless.

Canister Production (output). The canister fabrication rate. There are two assumptions: 1) the production pressure and the budget pressure have equal impact, and 2) the maximum fabrication rate can not occur unless the budget pressure is 0 (100% lower than assumed for the projected canning & repository startup dates), the production pressure is 1 (the repository has come on line), and there is enough fuel in inventory to meet it. Units: Canisters/Year.

Canister Sealing (input). Flag to indicate consideration of sealing costs. Default: Yes. Range: No or Yes; No=Ignore sealing costs, Yes=Included sealing costs. Unitless.

Canister Wall Thickness (input). The thickness of the canister wall. The default value for this is .9525 cm based on information in the *FY-93 WINCO Performance Assessment*, 4/27/93. Default: 0.9525. Range: 0-1000. Units: Centimeters.

Canisters in Repository (output). The number of canisters that have been shipped to the repository. Units: Canisters.

Cold Chemical Filler (input). The type of cold chemical used as a filler in the canister. Default: 2; Range: 1-3; 1=Boron, 2=Lead, 3=Zinc. Unitless.

Cutting (output). Cost to cut fuel rods into smaller pieces. Units:Dollars/Canister.

Desired Fuel Loading (input). This tells how much, by volume, of the canister should be filled with fuel (if possible). Default: 20. Range: 0-100. Units: Percent.

Drop Testing (input). Flag to indicate consideration of drop testing costs in canister costs. Default: Yes. Range: No or Yes; No=Ignore drop testing costs, Yes=Include drop testing costs. Unitless.

Empty Canisters (output). The number of empty canisters in inventory waiting to be filled. Units: Canisters.

Ending Calcine Inventory (output). The approximate calcine inventory contained in the six bin sets located at the ICPP. Units: Cubic Meters.

Ending Fuel Inventory (output). This is a combined total of all the fuel rods excluding Ft St Vrain and Peach Bottom. This also includes the assumed 20 years of ATR fuel rod production (112 rods/year). The tank depletion order of the 33 fuel types was determined by fissile loading and quantity of pieces. Units: Fuel Rods.

Fabrication (output). Cost of the materials used to fabricate the canisters. Units: Dollars/Canister.

Filled Canisters (output). The number of filled canisters sitting in interim storage waiting to be shipped to the repository. Units: Canisters.

Fissile Loading Limit (input). Limit to the amount of fissile material allowed in a canister. Default: 700. Range: 0-100,000. Units: Grams of Uranium/Canister.

Fixed Cost for Canister Fabrication (input). Cost of running a facility to produce canisters. Does not include labor costs. "Plant Design and Economics for Chemical Engineers," Peters and Timmerhaus, 3rd Edition, McGraw-Hill, 1980, pg. 207 gives the following two rules of thumb for cost estimation: 1) utilities are 10-20% of total product cost, and 2) maintenance/repairs are 2-10% of fixed-capital investment. Preliminary simulations of the model gave yearly total costs to be around \$100M, and assuming that capital investment in the canning and filling facilities will be on the same order of magnitude, we use \$100M/year as the base product/capital cost. We assume that the utilities will be less than the rule of thumb because we generate our own steam, 5% say. And we assume another 5% for maintenance & repair. Consequently, we get 10% of \$100M, or \$10M/year, as the default value. Default: 10,000,000. Range: 0-100,000,000. Units: Dollars/Year.

Growth in Environments Regulations (input). The constant growth in U.S. federal/state regulations. Its value range is 0-1. A value of 0.5 represents the level of growth that was assumed when selecting the projected startup dates for the canning and repository. A value less than 0.5 represents a growth level less than assumed for projecting the startup dates, and a value higher than 0.5 means higher growth than originally assumed. Default: .5. Range: 0-1; .5 Average. Units: Unitless.

Hastelloy C22 (output). Amount of Hastelloy C22 used in the fabrication of canisters. Units: Kilograms.

Hastelloy C4 (output). Amount of Hastelloy C4 used in the fabrication of canisters. Units: Kilograms.

Incoloy 825 (output). Amount of Incoloy 825 used in the fabrication of canisters. Units: Kilograms.

Inerts (output). Cost of inert filler material used in filling the canisters. Units: Dollars/Year.

Interim Storage (output). Cost associated with storing filled canisters prior to shipping to the repository. The only costs taken into account were the those for monitoring. Units: Dollars/Canister/Year.

Interim Storage Cost (input). The cost of monitoring one filled canister in storage. Based on information provided by the Manager of the ICPP Fuel Basin

Area (4/93), the average monitoring cost for fuel rods stored in dry storage was calculated to be about \$750 per rod per year (annual fully-burdened labor cost divided by number of rods). Holding to the assumption that the cost for monitoring canisters would be similar to that of rods, we have set this parameter's default value to 750. Default: 750. Range: 0-10,000. Units: Dollars/Canister/Year.

Internal Canister Size (input). The internal volume of the canister. Default: 0.81568. Range: 0-100. Units: Cubic Meters.

Labor Costs for Canister Fabrication (input). Cost for labor for a facility that produces canisters. Assuming 35 employees at \$100,000/year to get the default value of \$3.5M/Year. Default: 3,520,000. Range: 0-100,000,000. Units: Dollars/Year.

Length of Canister (input). The internal length of the canister. The default value of this is set to 2.978 meters based on information used in the *FY-93 WINCO Performance Assessment*, 4/27/93. Default: 2.978. Range: 0-100. Units: Meters.

Max Canister Fabrication Rate (input). The maximum annual production rate of the canister fabrication facility. WINCO Quality Assurance Personnel involved in the canister fabrication process estimate that spin forming canisters can be performed at a maximum rate of about 2000 cans/yr. Consequently, under the assumption that the spin forming process is representative of fabrication technology, the default value is set at 2000. Default: 2000. Range: 0-100,000. Units: Canisters/Year.

Max Canister Filling Rate (input). The maximum rate at which canisters are able to be filled. The value of the maximum is set at 1000 canisters/year based on information provided by WINCO's Applied Technology Department for the *Preliminary Analysis of Cost Report* (SAND 83-0867), 4/30/93. Default: 1000. Range: 0-100,000. Units: Canisters/Year.

Max Ship Rate to Repository (input). The maximum annual shipping rate to the repository. NWTs at Sandia used an annual shipping rate of 6000 in their simulations ("NWTs Transportation Interface Technology Development Priority Report," SAND82-1804). Consequently, we set the default high also, at 5000 canisters/yr. Default: 5000. Range: 0-100,000. Units: Canisters/Year.

Max Watts/Canister (input). The allowable heat loading limit in a canister. Default: 1500. Range: 0-1,000,000. Units: Watts/Canister.

Maximum Number of Empty Canisters in Interim Storage (output). The largest quantity of filled canisters stored, at any one time, waiting to be shipped to the repository. Units: Canisters.

Maximum Yearly Cost (output). Amount in dollars from the year that had the highest yearly cost. Units: Dollars/Year.

Number of Canisters Required (output). The number of canisters needed based solely on the number of rods capable of fitting into a canister. Units: Canisters/Year.

Operating (output). The cumulative costs for the canister fabrication and filling facilities divided by the total number of canisters produced. Units: Dollars/Canister.

Overall Certification (input). Flag to indicate consideration of certification and post filling treatment costs. 1 indicates that certification and post filling treatments can be considered, 0 indicates that they will not be considered regardless of whether the other flags are set. This is the override flag. Default: Yes. Range: No or Yes; No=Ignore certification costs, Yes=Include certification costs. Unitless.

Overpack Material (output). The accumulation of overpack material used. Units: Cubic Meters.

Overpack Material Cost (input). The cost of the overpack materials. The default value of the overpack material is lead, at the cost of \$9280.45/Cubic Meter. Default: 9280.45. Range: 0-1,000,000. Units: Dollars/Cubic Meter.

Overpack Thickness (input). The overpack material thickness. This is the thickness at the side of the canister-super canister barrier. The default value is set to 1.6 cm and is derived from information used in the *FY-93 WINCO Performance Assessment*, 4/27/93. Default: 1.6. Range: 0-1000. Units: Centimeters.

Percentage of Canister Rework (input). Percentage of base fabrication cost that needs to be included for rework. Default: 3. Range: 0-100. Units: Percent.

Post-Filling Decon. (input). Flag to indicate consideration of post filling decontamination costs. Default: Yes. Range: No or Yes; No=Ignore post-filling decon. costs, Yes=Include post-filling decon. costs. Unitless.

Projected Startup Date of Canning (input). The year the canister fabrication facility is projected to start up. Default: 2010. Range: 1993-2100. Units: Year.

Recycle Canister Material (input). The option to select recycled or new material for canister production. Default: No. Range: No or Yes; No=New Material, Yes=Recycled Material. Unitless.

Regulation (output). An incremental cost due to regulation burden. Units: Dollars/Canister.

Repository Cost (input). Cost to dispose of a canister in the repository. Default: 200,000. Range: 0-100,000,000. Units: Dollars/Canister.

Repository Startup Date (input). The date the repository is expected to be open for receiving shipments of filled canisters. Default: 2030. Range: 1993-2200. Units: Year.

Required Canisters for Excess Calcine (output). The number of canisters required to can all of the excess calcine. This number has no effect on the rest of the model as far as costs, time, materials, etc. This will take the minimum cubic meters of calcine based on heat loading and volume. $(\text{Cubic Meters})/(\text{Cubic Meters/Canister})=\text{Canisters}$. Units: Canisters.

Seismic Testing (input). Flag to indicate consideration of seismic testing costs in canister design. Default: No. Range: No or Yes; No=Ignore seismic testing costs, Yes=Include seismic testing costs. Unitless.

Shipping Canisters to Repository (output). The amount of canisters being shipped to the repository. Units: Canisters/Year.

Simulation End Date (input). The date the simulation ends. Default: 2075. Range: 1990-2200 and after the simulation start date. Units: Year.

Simulation Start Date (input). The date the simulation starts. Default: 1993. Range: 1990-2200. Units: Year.

Stainless Steel 304L (output). Amount of Stainless Steel 304L used in the fabrication of canisters. Units: Kilograms.

Stainless Steel 316L (output). Amount of Stainless Steel 316L used in the fabrication of canisters. Units: Kilograms.

Super Canister Material (output). The accumulation of super canister material used. Units: Cubic Meters.

Super Canister Material Cost (input). The cost of the super canister materials. Default: 50,000. Range: 0-1,000,000. Units: Dollars/Cubic Meter.

Super Canister Wall Thickness (input). The wall thickness of the super canister. The default value for this is .9525 cm based on information used in the *FY-93 WINCO Performance Assessment*, 4/27/93. Default: 0.9525. Range: 0-1000. Units: Centimeters.

Titanium Grade 12 (output). Amount of Titanium Grade 12 used in the fabrication of canisters. Units: Kilograms.

Total Cost (output). Total Cost for canisters put into repository. (Doesn't include any facility costs except in case of metal recycle). Units: Dollars.

Total Inerts Used (output). Total amount of inerts which are used over the canning cycle. Units: Kilograms.

Transportation (output). If the cask is legal truck load (assumed at 20 tons and 7 meters) then ship by truck else ship by train. Truck shipping charges are estimated at 20 cents per ton-mile. This was taken from an estimate of \$1000 per truckload shipped to ORNL. Also assume shipping cask rental cost of \$20,000 per trip. For shipping by rail, the shipping charges were dropped to 10 cent per ton-mile and cask rental costs were doubled. Distance was assumed to be 1000 miles. Units: Dollars/canister.

Years of Canning (output). The amount of years canning was taking place. Units: Years.

Appendix 5 Input Log Sheet

Input Variable	Default	1	2	3	4	5
Allowed Maximum Empty Canister Inventory	500					
ASTM Certification	No					
Budget Pressure	0.5					
Canister Filling Efficiency	90					
Canister Material	2					
Canister Sealing	Yes					
Canister Wall Thickness	0.9525					
Cold Chemical Filler	2					
Desired Fuel Loading	20					
Drop Testing	Yes					
Fissile Loading Limit	700					
Fixed Cost for Canister Fabrication	10,000,000					
Growth in Environments Regulations	0.5					
Interim Storage Cost	750					
Internal Canister Size	0.81568					
Labor Costs for Canister Fabrication	3,520,000					
Length of Canister	2.978					
Max Canister Fabrication Rate	2,000					
Max Canister Filling Rate	1,000					
Max Ship Rate to Repository	5,000					
Max Watts/Canister	1,500					
Overall Certification	Yes					
Overpack Material Cost	9,280.45					
Overpack Thickness	1.6					
Percentage of Canister Rework	3					
Post-Filling Decon.	Yes					
Projected Startup Date of Canning	2010					
Recycle Canister Material	No					
Repository Cost	200,000					
Repository Startup Date	2030					
Seismic Testing	No					
Simulation End Date	2075					
Simulation Start Date	1993					
Super Canister Material Cost	50,000					
Super Canister Wall Thickness	0.9525					

Appendix 6 Output Log Sheet

Output Variable	Default	1	2	3	4	5
Actual Startup Date	2010					
Average Volume % Fuel	1					
Average Volume % Inerts	41					
Average Volume % Waste	56					
Canister Filling	~800 Max					
Canister Production	~800 Max					
Canisters in Repository	~12,000					
Cutting	~18,000 Max					
Empty Canisters	~500					
Ending Calcine Inventory	0					
Ending Fuel Inventory	0					
Fabrication	~6,000					
Filled Canisters	~8,500 Max					
Hastelloy C22	0					
Hastelloy C4	0					
Incoloy 825	0					
Inerts	~7,000 Max					
Interim Storage	Almost 0					
Maximum Number of Empty Canisters in Interim Storage	8,865					
Maximum Yearly Cost	3.698E+08					
Number of Canisters Required	12105					
Operating	~32,000 Max					
Overpack Material	~1,250					
Regulation	~3750 Max					
Required Canisters for Excess Calcine	0					
Shipping Canisters to Repository	0					
Stainless Steel 304L	~6,000,000					
Stainless Steel 316L	0					
Super Canister Material	~800					
Titanium Grade 12	0					
Total Cost	3.65E+09					
Total Inerts Used	57,551,625					
Transportation	~60,000 Max					
Years of Canning	24					

DATE

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4/28/94

END