S

ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 661453

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [] Cancel/Void []	A.L. Pajunen, Process Engineering, R3-86, 376-7115	[X] Yes [] No	6/22/00
	6. Project Title/No./Work Order No. Spent Nuclear Fuel Project	7. Bldg./Sys./Fac. No. N/A	8. Approval Designator N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.) HNF ~~WHC~~-SD-SNF-RPT-011, Rev. 1 & 1A (8-15-00 MHA)	10. Related ECN No(s). N/A	11. Related PO No. N/A

12a. Modification Work	12b. Work Package No.	12c. Modification Work Complete	12d. Restored to Original Condition (Temp. or Standby ECN only)
[] Yes (fill out Blk. 12b) [X] No (NA Blks. 12b, 12c, 12d)	N/A	N/A Design Authority/Cog. Engineer Signature & Date	N/A Design Authority/Cog. Engineer Signature & Date

13a. Description of Change   13b. Design Baseline Document? [] Yes [X] No

Complete revision to describe cases applicable to FY 2000 scenarios. Added shipping fuel movement from T Plant to CSB. Reduced number of CVD station to 2 and extended start of KE Basin fuel removal, consistent with FY 2000 planning assumptions.

USQ SCREENING: K-00-0912, CVDF-00-1249, CSB-00-1097, ISA-00-1011

14a. Justification (mark one)	14b. Justification Details
Criteria Change [X] Design Improvement [] Environmental [] Facility Deactivation [] As-Found [] Facilitate Const [] Const. Error/Omission [] Design Error/Omission []	Incorporates applicable scenarios defined in FY 2000.

15. Distribution (include name, MSIN, and no. of copies)	RELEASE STAMP
See distribution list	DATE: AUG 17 2000 STA: 4 HANFORD RELEASE ID: 2

A-7900-013-2 (10/97)

A-7900-013-1

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1): 661453

16. Design Verification Required	17. Cost Impact						18. Schedule Impact (days)	
	ENGINEERING			CONSTRUCTION				
[] Yes	Additional	[N/A]	$	Additional	[N/A]	$	Improvement	[N/A]
[X] No	Savings	[N/A]	$	Savings	[N/A]	$	Delay	[N/A]

19. Change Impact Review: Indicate the related documents (other than the engineering documents identified on Side 1) *that will be affected by the change described in Block 13.* Enter the affected document number in Block 20. N/A

SDD/DD	[]	Seismic/Stress Analysis	[]	Tank Calibration Manual	[]
Functional Design Criteria	[]	Stress/Design Report	[]	Health Physics Procedure	[]
Operating Specification	[]	Interface Control Drawing	[]	Spares Multiple Unit Listing	[]
Criticality Specification	[]	Calibration Procedure	[]	Test Procedures/Specification	[]
Conceptual Design Report	[]	Installation Procedure	[]	Component Index	[]
Equipment Spec.	[]	Maintenance Procedure	[]	ASME Coded Item	[]
Const. Spec.	[]	Engineering Procedure	[]	Human Factor Consideration	[]
Procurement Spec.	[]	Operating Instruction	[]	Computer Software	[]
Vendor Information	[]	Operating Procedure	[]	Electric Circuit Schedule	[]
OM Manual	[]	*Operational Safety Requirement*	[]	ICRS Procedure	[]
FSAR/SAR	[]	IEFD Drawing	[]	Process Control Manual/Plan	[]
Safety Equipment List	[]	Cell Arrangement Drawing	[]	Process Flow Chart	[]
Radiation Work Permit	[]	Essential Material Specification	[]	Purchase Requisition	[]
Environmental Impact Statement	[]	Fac. Proc. Samp. Schedule	[]	Tickler File	[]
Environmental Report	[]	Inspection Plan	[]		[]
Environmental Permit	[]	Inventory Adjustment Request	[]		[]

20. Other Affected Documents: (NOTE: Documents listed below will not be revised by this ECN.) Signatures below indicate that the signing organization has been notified of other affected documents listed below.

Document Number/Revision	Document Number/Revision	Document Number Revision
N/A		

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. A. L.Pajunen	[signature]	6/27/2000	PE		
Cog. Mgr. J. R. Frederickson	[signature]	6/28/2000	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other D. M. Johnson	[signature]	7/12/00	Other		
W. C. Miller	[signature]	8/14/00			

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Process Engineering	Date 6/26/00
Project Title/Work Order		EDT No. N/A
Spent Nuclear Fuel Project Design Basis Capacity Study		ECN No. 661453

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
Spent Nuclear Fuel Project					
P. S. Blair	R3-11	X			
T. Choho	R3-86	X			
K. J. Cleveland	X3-85	X			
P. T. Day	R3-11	X			
D. R. Duncan	R3-86	X			
J. R. Frederickson	R3-86	X			
L. H. Goldmann	R3-86	X			
J. R. Gregory	X3-78	X			
D. F. Hicks	S7-12	X			
D. M. Johnson	R3-11	X			
M. L. Lee	R3-73	X			
R. L. McCormack	R3-11	X			
J. D. Mathews	X3-65	X			
W. C. Miller	R3-11	X			
A. L. Pajunen	R3-86	X			
T. J. Ruane	X3-61	X			
O. M. Serrano	S2-44	X			
R. A. Sexton	R3-86	X			
J. A. Swenson	R3-11	X			
J. E. Truax	X3-71	X			
J. H. Wicks	X3-71	X			
R. B. Wilkinson	R3-11	X			
SNF Project	R3-11	X			
SNF Training	S2-45	X			
SNF Procedures	X3-86	X			
U. S. Department of Energy – Richland Operations Office					
P. G. Loscoe	R3-81	X			

HNF-SD-SNF-RPT-011
Revision 2

Spent Nuclear Fuel Project Design Basis Capacity Study

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200

Fluor Hanford
P.O. Box 1000
Richland, Washington

HNF-SD-SNF-RPT-011
Revision 2
ECN 661453

Spent Nuclear Fuel Project Design Basis Capacity Study

K. J. Cleveland
A. L. Pajunen
Fluor Hanford

Date Published
June 2000

Prepared for the U.S. Department of Energy
Assistant Secretary for Environmental Management

Fluor Hanford
Project Hanford Management Contractor for the
U.S. Department of Energy under Contract DE-AC06-96RL13200
P.O. Box 1000
Richland, Washington

Release Approval — Date 8/16/00

Release Stamp: DATE: HANFORD RELEASE STA: 4 ID: 2 AUG 17 2000

Approved for public release; further dissemination unlimited

Total Pages: 49

HNF-SD-SNF-RPT-011, REV 2

RECORD OF REVISION	(1) Document Number HNF-SD-SNF-RPT-011, Rev. 2	Page 1

(2) Title

Spent Nuclear Fuel Project Design Basis Capacity Study

CHANGE CONTROL RECORD

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release	
		(5) Cog. Engr.	(6) Cog. Mgr. Date
0	(7) EDT 616135, September 10, 1996	A.L. Pajunen	J.R. Frederickson
1	ECN 645113, July 1998. Complete revision.	A.L. Pajunen	J.R. Frederickson
1A	ECN 651420, January 1999. Replace cover page and page ii. Add Appendix B.	A.L. Pajunen	J.R. Frederickson
2 RS	ECN 661453, July 2000. Revised all cases evaluated to reflect planning assumptions for TY 2000.	A.L. Pajunen	J.R. Frederickson 7/12/00

A-7320-005 (08/91) WEF168

SPENT NUCLEAR FUEL PROJECT DESIGN BASIS CAPACITY STUDY

Executive Summary

This study of the design basis capacity of process systems was prepared by Fluor Federal Services for the Spent Nuclear Fuel Project. The evaluation uses a summary level model of major process sub-systems to determine the impact of sub-system interactions on the overall time to complete fuel removal operations. The process system model configuration and time cycle estimates developed in the original version of this report have been updated as operating scenario assumptions evolve. The initial document released in Fiscal Year (FY) 1996 varied the number of parallel systems and transport systems over a wide range, estimating a conservative design basis for completing fuel processing in a two year time period. Configurations modeling planned operations were updated in FY 1998 and FY 1999. The FY 1998 Base Case continued to indicate that fuel removal activities at the basins could be completed in slightly over 2 years. Evaluations completed in FY 1999 were based on schedule modifications that delayed the start of KE Basin fuel removal, with respect to the start of KW Basin fuel removal activities, by 12 months. This delay resulted in extending the time to complete all fuel removal activities by 12 months. However, the results indicated that the number of Cold Vacuum Drying (CVD) stations could be reduced from four to three without impacting the projected time to complete fuel removal activities.

This update of the design basis capacity evaluation, performed for FY 2000, evaluates a fuel removal scenario that delays the start of KE Basin activities such that staffing peaks are minimized. The number of CVD stations included in all cases for the FY 2000 evaluation is reduced from three to two, since the scenario schedule results in minimal time periods of simultaneous fuel removal from both basins. The FY 2000 evaluation also considers removal of Shippingport fuel from T Plant storage and transfer to the Canister Storage Building for storage.

All cycle time estimates for completing the preparation of an MCO were updated based on the latest available documentation. These estimates are expected to be updated as operating experience is accumulated. The initial case evaluated in the FY 2000 assumed that all systems are operated on a 7 day/week operating schedule for comparison with the FY 1999 Base Case. A series of alternative cases were evaluated that reduce the resources used to operate plant systems. This was accomplished by reducing the number of operating shifts assumed to be available to operate selected systems. The results indicate that, in general, the systems must effectively be operated 3 shifts/day, 7 days/week to avoid extending the total time required to remove fuel from the basins. However, it was found that CSB and transport system operation could be reduced to a general operating schedule of 2 shifts/day, 5 days/week (increased to 3 shifts/day during handling of T Plant fuel) without significantly impacting total fuel removal times. This operating approach was selected as the FY 2000 Base Case.

While fuel removal activities are projected to require effective 3 shift/day, 7 day/week operation to avoid extending the time to remove fuel from the basins, operating experience may identify that a full operating staff on off-shifts is not required. Experience can be accumulated during the initial operating period, where modeling assumes a ramp up to full capacity, to define staffing adjustments.

MCO welding at the CSB was assumed to begin approximately 2.2 yrs (2 yrs and 2 months) after the start of KW Basin fuel removal activities in all cases investigated. Weld stations are operated on the same shift schedule as the CSB and transportation activities. These assumptions model one of many alternatives available for applying resources to MCO welding. Current models indicate that total MHM utilization (used to move MCO to weld stations and back) is on the order of 25% such that a number of weld station operating schedules can be considered to adjust the completion time for welding independent of other fuel removal activities.

The end time of activities are reported using the start of KW Basin fuel removal as a common initial time all systems. For example, KW fuel removal begins at 0 yr, while T Plant fuel removal begins at 1 yr. A reported end time for T Plant fuel removal of 1.9 yr indicates a total operating period of 0.9 yr. The FY 2000 Base Case evaluation predicts that fuel removal will be completed at the KW Basin in less than 2 yrs after plant startup. T Plant fuel removal is predicted to be completed 1.9 yrs after the start of KW fuel removal and KE Basin fuel removal is predicted to be complete 3.8 yrs after the start of KW fuel removal. The FY 2000 Base Case assumptions at the CSB result in completion of welding 5.4 yrs after the start of KW fuel removal.

A sensitivity study was also performed on T Plant fuel removal drying cycle times. The sensitivity case assumed that the T Plant fuel drying cycle is reduced from 10 working days to 5 working days. All other operating assumptions in the FY 2000 Base Case were held constant. This resulted in reducing the predicted time for T Plant fuel removal from 1.9 yrs to 1.6 yrs after the start of KW fuel removal. No significant impact on completion of other activities was predicted by the reduced T Plant drying cycle times.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SPENT NUCLEAR FUEL PROJECT DESIGN BASIS CAPACITY STUDY

1.0 INTRODUCTION

The missions of the Spent Nuclear Fuel (SNF) Project includes removal of SNF from the 100K Area fuel storage basins and from 200W area storage at T Plant and transfer of the fuel to a safe, dry storage facility in the 200E Area plateau. The Multi-Canister Overpacks (MCOs) are filled with fuel elements retrieved from the 100 K East (KE) and 100 K West (KW) wet storage basins, moved into a vacuum drying process line, transported to staging at the Canister Storage Building (CSB), sampled, sealed, and placed into dry storage in the CSB. The SNF at T Plant (72 blanket fuel assemblies from Shippingport PWR Core 2) are loaded into Shippingport Spent Fuel Containers (SSFC) at T Plant, conditioned, and transported to the CSB to be sealed and placed into dry storage. The SSFC is a modified MCO that will be transported by the MCO cask transportation system and physically handled the same as the MCO at the CSB.

A process simulation model that depicts the architecture of the SNF process systems was developed. The model is a basic high-level model that includes:

- The fuel retrieval system (FRS),
- cask loadout station,
- transportation to the vacuum drying stations,
- cold vacuum drying (CVD)stations,
- transportation to the CSB,
- fuel retrieved from T Plant and transported to CSB,
- the MCO handling machine (MHM),
- validation test station,
- the MCO weld stations,
- and transportation of the empty cask to the basin/T Plant.

The model can be modified as needed to evaluate a variety of SNF operating scenarios.

2.0 SUMMARY

2.1 METHOD

Witness-TM (TRADEMARK) is a discrete simulation software used by manufacturing industries to determine equipment capability, capacity, efficiency, and utilization; and to investigate system queues, bottlenecks, and other parameters. Witness models are flexible and allow different scenarios to be developed and tested quickly and efficiently. Witness extends the analytical capability of an industrial engineer, by enabling him to perform repeated random experiments on a system.

Revision one of this document, released 7/22/98, details six cases that reflected 1998-updated cycle times and operating scenarios. Revision one can be retrieved from archives.

2.2 ASSUMPTIONS

The following assumptions were made in developing the Witness model. The accuracy of these assumptions could affect the validity of the results of this study.

- Analysis results based on the utilization of the Witness software will not affect health or safety of the personnel engaged with the SNF Project.
- Process cycle times of the model were generally based upon triangular distributions. These distributions are characterized with a low, high, and mode cycle time for production of an MCO/SSFC. The low value is the minimum time to process an MCO, the high value is the maximum time to process an MCO/ SSFC, and the mode value is the most likely time required to process an MCO/ SSFC.
- The supply of MCOs and SSFC will satisfy the processing requirements. Either an adequate inventory of MCOs and SSFC will exist or delivery of the MCOs and SSFC will be just in time to satisfy any rate or production requirement.
- 200 MCOs from each basin and 18 SSFC from T Plant will be enough to completely remove all of the SNF.
- All subsystems except the transportation systems are not labor resource limited or restricted. There is an unlimited labor pool available for the required operation and repairs.
- The system runs long enough to achieve a steady-state condition, the probability law governing the behavior of the real system will stabilize.
- Once a loaded MCO/ SSFC is in the system it may not leave the queue.
- Cycle times of the MHM and CSB load-in/load-out crane are independent. Interferences between the two were not modeled.
- The first six MCOs from the K West basin are used for sampling. During actual operations, six MCOs will be randomly selected for sampling. Using the first six will not affect the finish times of the different stations. The SSFC will not be sampled
- Weather delays are not incorporated in the production estimates.
- Detailed modeling of sludge removal at the KE Basin has not been performed and it is assumed that parallel sludge removal activities do not interfere with fuel removal.

2.3 RESULTS

Results in this report are based on process cycle times determined from input by the sub-project design authorities. The results should not be taken as absolute answers but should be used as guides in decision making. Some key areas examined in this report are: time to empty the basins, time to complete T Plant fuel movement, time to finish final sealing of the MCO/ SSFC, number of operations of cold vacuum drying, and the number of casks used. The results, and a comparison of the differences between cases, are listed in Table 2.3. Descriptions of each case, and various operational details are listed in Sections 4.1 to 4.7.

The concept for the FY 2000 modeling, case 1, was to create a new model that compares with the FY 1998 modeling and has the following conditions:

- Cycle times that reflect the FY 2000 operating estimates,
- start the KE basin fuel removal 1.75 years after the start of the KW basin,
- reduce the number of CVD stations from 3 to 2 because simultaneous fuel removal from both basins has been eliminated,
- change the quantity of MCO's sampled from 12 to 6,
- include the removal of fuel from T Plant and shipping it to the CSB,
- keep all stations operating 3 shifts/day, 7 days/week.

Cases 2 through 5 are an investigation into the effects of reducing the available resources (i.e., operating personnel) used to operate the project facilities. Case 3 will represent the base case for the FY 2000 modeling. Case 6 is used to evaluate the impact on case 3 of reducing the T Plant process time from 10 working days to 5 working days.

Table 2.3. Results and Comparison of Studies.

FY 2000 Cases	Time to finish (yrs)				CVD Operations		Notes
	KW	KE	T Plant	Weld	CVD 1	CVD 2	
K Basin Fuel Removal Sensitivity Cases							
Case 1	1.88	3.62	1.80	3.70	207	193	KW finished 0.27 years earlier than in FY 99 base case and KE finished 0.9 years later. Weld stations finished 0.7 years later.
Case 2	1.89	3.76	1.96	5.44	210	190	KW finished the same time as case 1 and KE finished 0.14 years later. Weld stations finished 1.74 years later.
Case 3 *	1.96	3.84	1.90	5.41	211	189	KW finished 0.08 years later than case 1 and KE finished 0.22 years later. Weld stations finished 1.71 years later.
Case 4	2.78	5.23	1.83	5.45	251	149	KW finished 0.90 years later than case 1 and KE finished 1.61 years later. Weld stations finished 1.80 years later.
Case 5	2.94	4.95	1.89	5.50	240	160	KW finished 1.06 years later than case 1 and KE finished 1.33 years later. Weld stations finished 1.80 years later.
T Plant Fuel Removal Sensitivity Case							
Case 6	2.02	3.92	1.59	5.41	211	189	KW finished 0.06 years later than case 3 and KE finished 0.08 years later. Weld stations finished at the same time as Case 3 and T Plant finished 0.31 years earlier.

* Selected as the FY2000 Base Case

3.0 RECOMMENDATIONS

3.1 CSB OPERATIONS

There are a number of uncertainties in the process cycle times for the CSB, which could cause distortions in results and conclusions. This is compounded by the fact that there are several pieces of equipment that are single items with no identified work-arounds, because of schedule conflicts when some of this equipment is competing for common space. Receiving, inspecting, and rework/testing of empty MCO's are not addressed in the model. Schedule interferences between the cask handling function of the overhead crane and the loading/unloading function of the material handling machine, working in the same common space, are not currently addressed in the model.

3.2 LABOR RESOURCE ALLOCATION

The Witness model assumes that there is an unlimited supply of labor resources available, whenever and wherever needed. This deficiency detracts from the validity of the results, and should be addressed in the model. Accurately allocating labor resources within the model will require the development of process flow charts, precedence network diagrams, time standards and work allowances, and line balancing and manpower models. A process flow chart provides graphic representation of the work performed on a product as it passes through each stage of a process, including quantity, distance moved, type of work done, and equipment used. A precedence network diagram graphically depicts the discrete tasks within each work element, the predecessors, successors, restrictions, and limitations on each task, and logically connects them in parallel or series to show how the work could be structured. Time standards can then be developed for each task by using K Basins studies, industrial engineering handbooks and texts, and Department of Defense work measurements and standards. Work allowances are applied to cover the use of personnel protective equipment, personnel fatigue and mental stress, radiation exposure and environmental conditions, etc. Then the line balancing and manpower modeling optimizes the work process and allocates the labor resources. This information can be incorporated into the Witness model to further improve the accuracy of the simulation and validity of the results.

4.0 DETAILED DISCUSSION

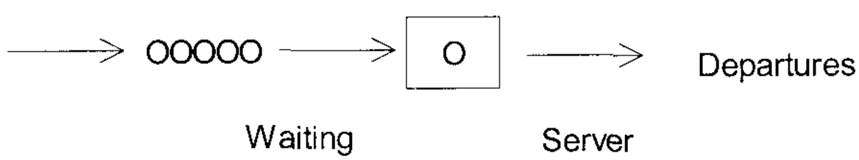
4.1 GENERAL WITNESS MODELING

Witness is a simulation programming language used to build computer models of queuing systems. The SNF project simulation is a closed system with a set amount of serving devices moving through a series of processes. Each of these processes may be seen as a simple queuing model. Each of these simple models consist of a single process containing a piece or group of equipment performing a service on demand. "Customers" come up to this "server" at random times, wait their turn (if necessary) for service, are served on a first-come-first-served basis, then leave. This situation is depicted schematically in Figure 4.1.1 in which the row of circles represents waiting customers, the square represents the server, and the circle within the square represents the customer currently being served.

The line formed by those waiting for service is termed a "queue". The configuration consisting of the server, the customer being served, and those waiting to be served, is termed a "queuing system".

The simple system shown in Figure 4.1.1 is characterized by two independent random variables. The time between consecutive arrivals of customers to the system, often called the "interval time," is a random variable. The time required for the server to perform a service is also a random variable and termed "service time". The distributions followed by these two independent random variables influence system properties and are listed below.

Figure 4.1.1 Illustration of a One-line, one Server Queuing System



1. Number of customers who arrive for service during a given time span.

2. Number of customers who are able to go immediately into service when they arrive.

3. Average time customers spend in the queue.

4. Average length of the queue.

5. Maximum length of the queue.

6. Server's utilization; that is the fraction of the time that the server spends providing service during a given time span. System properties such as these are of special interest when economic considerations or project milestones are involved.

The SNF Project Witness model is composed of a series of simple models that are integrated into a larger system, adding complexity because of the interaction between each model. Additional constraints are added because of the interaction with the queuing system, consequently increasing its complexity.

Discrete simulation occurs when the dependent system variables change at specific points in simulated time. The time variable may be either continuous or discrete in such a model, depending on whether the discrete changes in the dependent variable can occur at any time or only at specified times.

Running a discrete simulation model on a computer is in essence a complex sampling experiment. Thus the procedures for designing and analyzing simulation runs are similar to the techniques used in other scientific experiments. The main difference is that the simulation analyst has greater control over the experimental conditions. An appropriate statistical analysis is necessary to (1) use simulation-generated data efficiently in the estimation of system performance measures and (2) reveal the scope and limitations of the conclusions based on the data.

It is necessary to characterize the random variables of a system by particular probability distributions when formulating a simulation model. When selecting an appropriate distribution for an input process, the analyst must understand some of the basic properties of common distributions and the circumstances in which those distributions arise. Initially, a uniform distribution was used to examine the system response. This distribution is often used as a first approximation when the real quantity varies between two values but little else is known. Following the initial model development, a triangular distribution was selected because of confidence that a minimum, maximum and a most likely value - (mode) could be established.

The schematic of the SNFP operating system shown in Figure 4.1.2, and process cycle times and efficiencies from Table 4.1.3 were used to develop the FY 2000 case 1 model. Startup of KE basin is delayed one year nine months from the startup of KW Basin. The weld stations in the CSB have a two year two month delayed start from the start of KW Basin. The CVD has a staged startup procedure where only one process bay is available when the fuel removal process begins and the other bays come online in one month. Table 4.1.3 lists each process, a description of what's included in the cycle time, the operating efficiency, the cycle time distribution for each process, and the hours work per week.

All cases have a learning curve factored into the model. The learning curve is 6 months for KW and 3 months for KE. Table 4.1.1 and Table 4.1.2 shows a breakdown of the hours worked per day for each month of the learning curve.

Table 4.1.1. Ramp-up Cycle for K West Basin.

Month	1	2	3	4	5	6	7
Hrs work	3	6	9	12	15	19	21
Hrs Rest	21	18	15	12	9	5	3
Hrs delay	0.00	720	1440	2184	2904	3624	4368

Table 4.1.2. Ramp-up Cycle for K East Basin.

Month	22	23	24	25
Hrs work	3	9	15	21
Hrs Rest	21	15	9	3
Hrs delay	2184	2904	3624	4368

The FY 2000 cases are modeled using the SNF operations schematic in Figure 4.1.2, and the process cycle times and efficiencies from Table 4.1.3. The learning curves and sequence of operation startups are the same as the FY 98 base model.

Figure 4.1.2 Spent Nuclear Fuel Operations Schematic

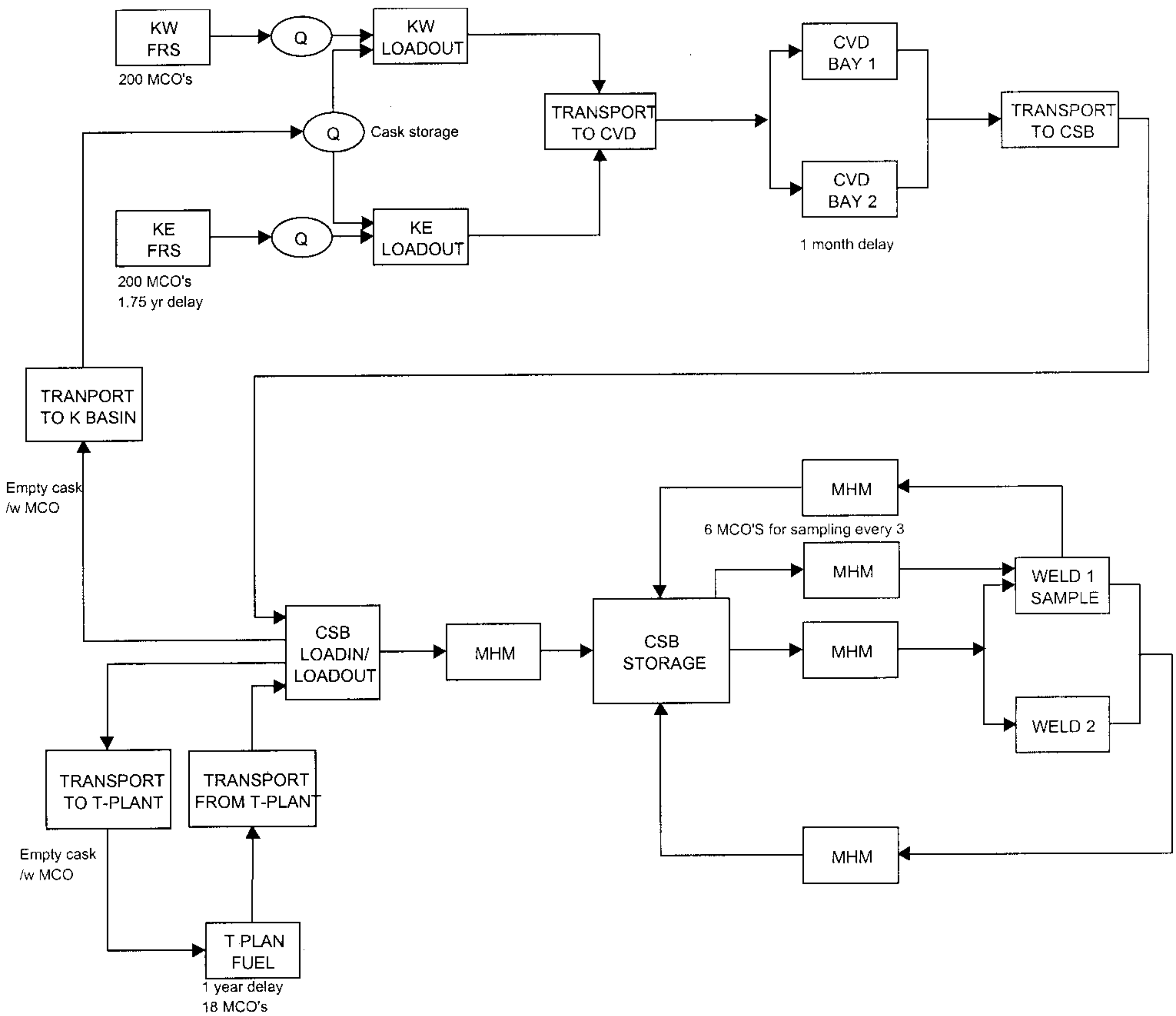


Table 4.1.3. Spent Nuclear Fuel Process Cycle times

Process Name	Cycle Time Description	Operating Efficiency	Dist. Type, hrs min/mode/max	Work Week
Transport new MCO from CSB to basin	Time to transfer new MCO cask from just outside the CSB to just outside the Basin Loadout Area door.	70%	Triangular 0.5 / 1 / 4	7 days/week 3 shifts/day
Fuel Retrieval	Time to produce the equivalent of one MCO of fuel baskets placed in the basin queue.	70%	Triangular 28.88 / 43.32 / 57.76	7 days/week 3 shifts/day
Cask Loadin/Loadout	Time basin loadout area is occupied by a single MCO/Cask. Includes transport entering basin loadout area door, placing cask in loadout pit, loading baskets in MCO, placing shield plug on MCO, returning MCO to transport, removing transport form loadout area, and preparing to receive next empty cask/MCO at basin.	70%	Triangular 12 / 16.9 / 26	7 days/week 3 shifts/day
Transport MCO from Basin to Cold Vacuum Drying	Time to transfer MCO/Cask from just outside basin door to just outside entry point of a Vacuum Drying station within the 100K Area.	70%	Triangular 0.1 / .25 / .5	7 days/week 3 shifts/day
K Basin Cold Vacuum Drying	Time a single Vacuum Drying station is occupied by a MCO. Includes time to bring MCO/Cask from entry point into station, secure MCO/Cask in station, complete pre-processing attachments, complete the actual drying cycle, test for free water removal, remove the dried MCO/Cask from the station to just outside the drying station entry point, and prepare the drying station to receive another MCO/Cask.	70%	Triangular 70 / 78 / 88	7 days/week 3 shifts/day
Transport MCO from 100K to 200E Area	Time to move the MCO/Cask from just outside a Vacuum Drying station located in the 100K Area to a point just outside the Canister Storage Building entry point located in the 200E Area.	70%	Triangular 0.5 / 1 / 4	7 days/week 3 shifts/day
CSB MCO/Cask Loadin/Loadout	Time the CSB cask loadin/loadout area is occupied by a single cask. Includes transport entering the building with a loaded MCO/Cask from just outside the CSB entry point, off loading the cask to the service pit, removal of MCO from the cask by the MHM, insertion of a new MCO in the cask, returning the cask to the transport, ready the transport for hookup, and any preparations of the CSB loadin/loadout area for receipt of the next cask.	95%	Triangular 16.9 / 18.75 / 31.05	7 days/week 3 shifts/day
MCO/MHM Transfer from Cask Loadin/Loadout Area to Interim Storage Tube	Time the MHM is occupied with transfer of a MCO to a storage tube. Includes the MHM transfer of a MCO from the CSB service pit to placement in a storage tube. Does not include waiting period during storage.	90%	Triangular 3.2 / 3.6 / 4.3	7 days/week 3 shifts/day
MCO/MHM Transfer from Storage Tube to Sample/Weld Station	Time the MHM is occupied with transfer of a MCO from the CSB storage tube to placement in a weld station. Includes moving the MHM to a position over the storage tube for removal of a MCO, removal of the MCO from the tube, moving the MHM/MCO to a sample/weld station, placing the MCO in the station, and any other time the MHM is used to support placing that specific MCO in the station until it is free to move another MCO.	90%	Triangular 3 / 3.3 / 4	7 days/week 3 shifts/day
MCO Welding at the CSB Sample/Weld Station	Time a single sample/weld station is occupied by a MCO during welding. Includes time to leak test MCO ports, inspect and clean MCO surface in preparation for weld, weld first pass and inspect, weld final passes and inspect, weld cover cap and inspect, repair any weld failure as is found, and finally leak test the weld and remove equipment.	70%	Triangular 27.1 / 30.2 / 36.4	7 days/week 3 shifts/day
MCO Sampling at the CSB Sample/Weld Station	Time a single sample/weld station is occupied by a MCO during sampling. Includes time to insert MCO, position hood, leak test equipment, configure sample cart, sample, remove equipment, and remove MCO from station.	70%	Triangular 13.2 / 14.7 / 17.2	7 days/week 3 shifts/day
MCO/MHM Transfer to Storage	Time the MHM is occupied with transfer of a MCO from a Weld Station to an interim storage tube. Includes moving the MHM to a weld station, removal of the MCO from the station, moving the MHM/MCO to an interim storage tube, placing the MCO in the tube, and any other time the MHM is used to support placing that specific MCO in interim storage until it is free to move another MCO.	90%	Triangular 3 / 3.3 / 6.3	7 days/week 3 shifts/day

Process Name	Cycle Time Description	Operating Efficiency	Dist. Type, hrs min/mode/max	Work Week
Transport new SSFC from CSB to T Plant	Time to transfer new SSFC/cask from just outside the CSB to just outside the T Plant Loadout Area door.	70%	Triangular 0.5 / 1 / 4	7 days/week 3 shifts/day
T Plant Loading and Drying of Shippingport Fuel	Time to produce the equivalent of one SSFC of dried Shippingport fuel at T Plant.	NA	Constant 10 working days	5 days/week 1 shifts/day
Transport SSFC from T Plant to CSB	Time to transfer SSFC/cask from just outside the T Plant Loadout Area door to just outside the CSB.	70%	Triangular 0.5 / 1 / 4	7 days/week 3 shifts/day
CSB SSFC/Cask Loadin/Loadout	Time the CSB cask loadin/loadout area is occupied by a single cask. Includes transport entering the building with a loaded SSFC/Cask from just outside the CSB entry point, off loading the cask to the service pit, removal of SSFC from the cask by the MHM, insertion of a new SSFC in the cask, returning the cask to the transport, ready the transport for hookup, and any preparations of the CSB loadin/loadout area for receipt of the next cask.	95%	Triangular 16.1 / 17.9 / 19.7	7 days/week 3 shifts/day
SSFC/MHM Transfer from service pit to storage tube	Time the MHM is occupied with transfer of a SSFC containing Shippingport Fuel from T Plant to a storage tube. Includes the MHM transfer of a SSFC from the CSB service pit to placement in a storage tube. Does not include waiting period during storage.	90%	Triangular 3.2 / 3.6 / 4.3	7 days/week 3 shifts/day
SSFC/MHM Transfer to Weld Station	Time the MHM is occupied with transfer of a SSFC from the CSB storage tube to placement in a weld station. Includes moving the MHM to a position over the storage tube for removal of a SSFC, removal of the SSFC from the tube, moving the MHM/SSFC to a weld station, placing the SSFC in the station, and any other time the MHM is used to support placing that specific SSFC in the station until it is free to move another MCO/SSFC.	90%	Triangular 3 / 3.3 / 4	7 days/week 3 shifts/day
SSFC Weld Station in the CSB	Time a single weld station is occupied by a SSFC. Includes time to leak test ports, inspect and clean surface in preparation for weld, weld first pass and inspect, weld final passes and inspect, weld cover cap and inspect, repair any weld failure as is found, and finally leak test the weld and remove equipment.	70%	Triangular 27.1 / 30.2 / 36.4	7 days/week 3 shifts/day
SSFC/MHM Transfer to Storage	Time the MHM is occupied with transfer of a SSFC from a Weld Station to an interim storage tube. Includes moving the MHM to a weld station, removal of the SSFC from the station, moving the MHM/SSFC to an interim storage tube, placing the SSFC in the tube, and any other time the MHM is used to support placing that specific SSFC in interim storage until it is free to move another MCO or SSFC.	90%	Triangular 3 / 3.3 / 6.3	7 days/week 3 shifts/day

4.2 FY 2000 CASE 1

In case 1, KE fuel retrieval starts 1.75 years after the start of KW. All stations operate 7 days/wk, 3 shifts/day, 7 hrs work/shift after ramp up. One bay at the CVD is operational at the start of KW and the other bay is operational 1 month later, the two spare bays can be used to store MCO's. The CVD operates 24 hours/day 7 days/week. T Plant fuel movement (18 MCO's) starts 1 year after the start of KW. An SSFC ships from T Plant every 10 working days. When T Plant is operating, one shipping cask is dedicated to T Plant. Welding at the CSB starts 2 years, 2 months after the start of KW. Six MCO's from KW go through the validation process and are sampled every 3 months for a year.

The system is limited to a single crew to support transportation activities. The crew operates the KE & KW basin cask loadin/loadout pits, the transportation from the loadin/loadout pits to the cold vacuum drying, the transportation from CVD to the CSB, transportation to and from T Plant, and the transportation of the cask and empty MCO back to the basins. Only one of the six systems can operate at a time.

The transporters between the basins and the CVD and between the CVD and the CSB are assigned the highest priority and can preempt other operations. The basin loadin/loadout pits have the next highest priority, followed by the transporter from T Plant, and the transporter between the CSB and the basins has the lowest priority. It is assumed that after an MCO is unloaded at the CSB the cask and empty MCO are stored out of the way until the crew is available to transport them back to the basins.

Figure 4.2.1. shows the percentage of time that each machine was busy processing the fuel, blocked and waiting to release a MCO, or broken down and waiting for repairs. The percentages shown in Figure 4.2.1 are outputs from the Witness report and are defined as follows. The percent busy is the percentage of time that the machine spent running. The percent blocked shows the percentage of time that parts were unable to move out of the machine after it had finished cycling because other stations where the part went next were busy, broken down, or unavailable. The percent broken down is the percentage of its time that a machine was broken down.

Figure 4.2.1 Case 1 Machine Usage

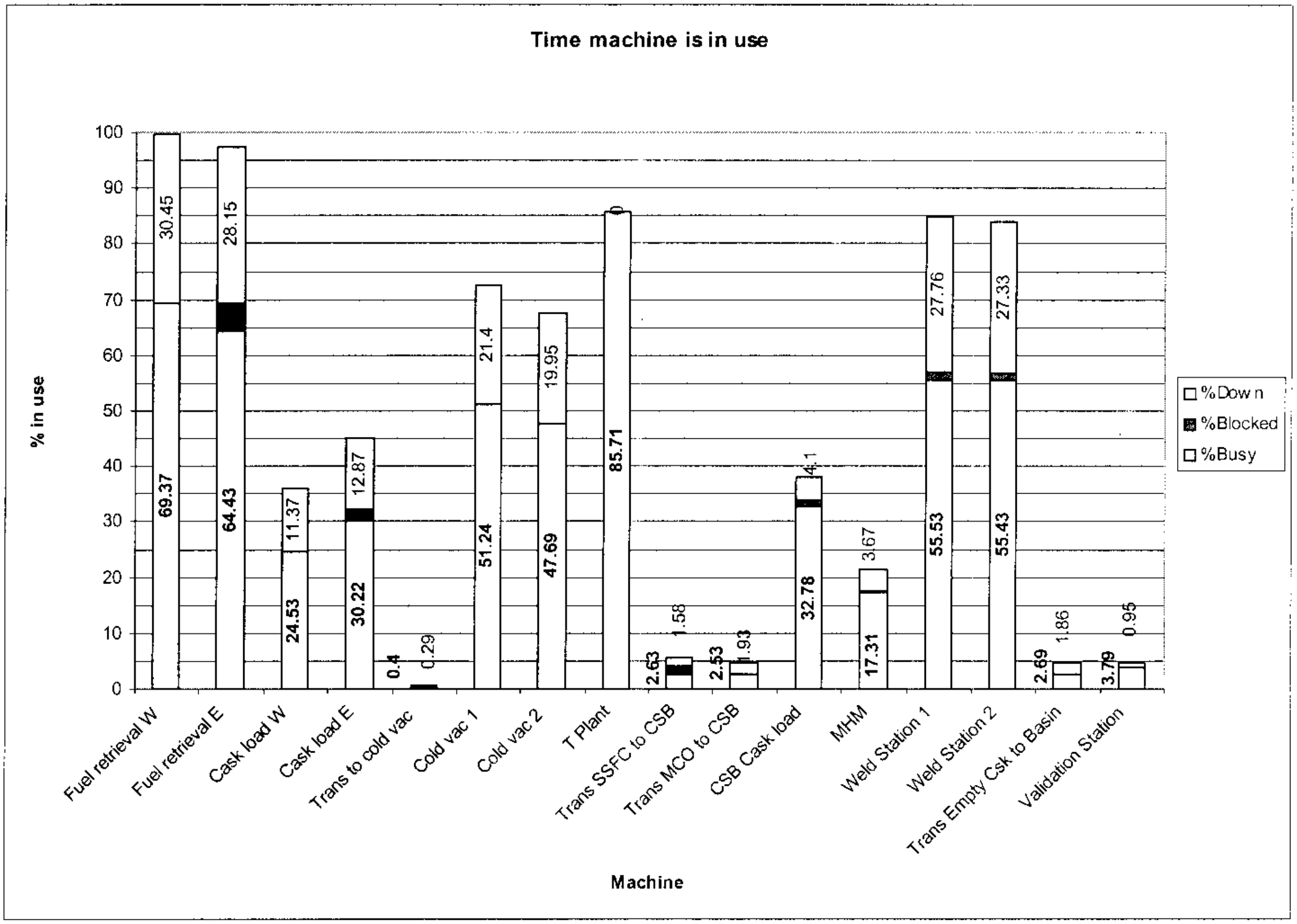


Figure 4.2.2 is the frequency of which a specific number of casks are in use. Witness reports the number of casks in the cask buffer every time a one is pulled from the buffer. The number of casks in use is determined by subtracting the number of casks in the buffer from the total number of casks. Approximately 62% of the time 4 casks are in use.

Figure 4.2.2 Case 1 Cask Usage

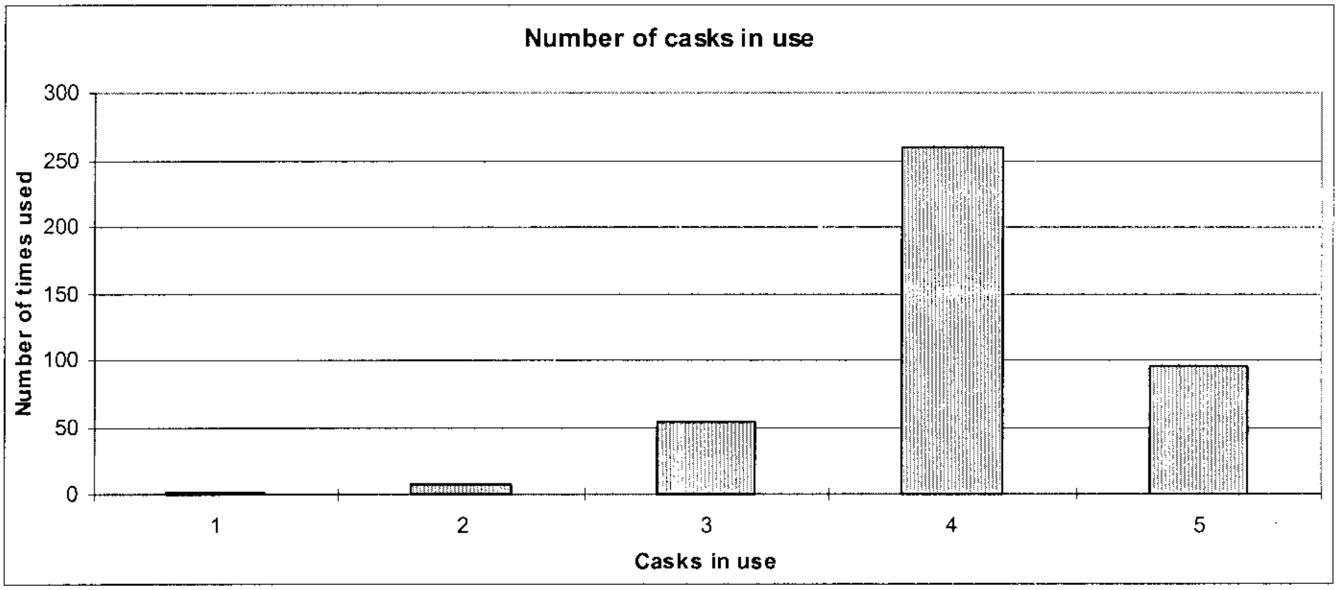


Figure 4.2.3 shows the time to empty each basin, the time to empty T Plant, and the time to complete welding.

Figure 4.2.3 Case 1 Times to Completion

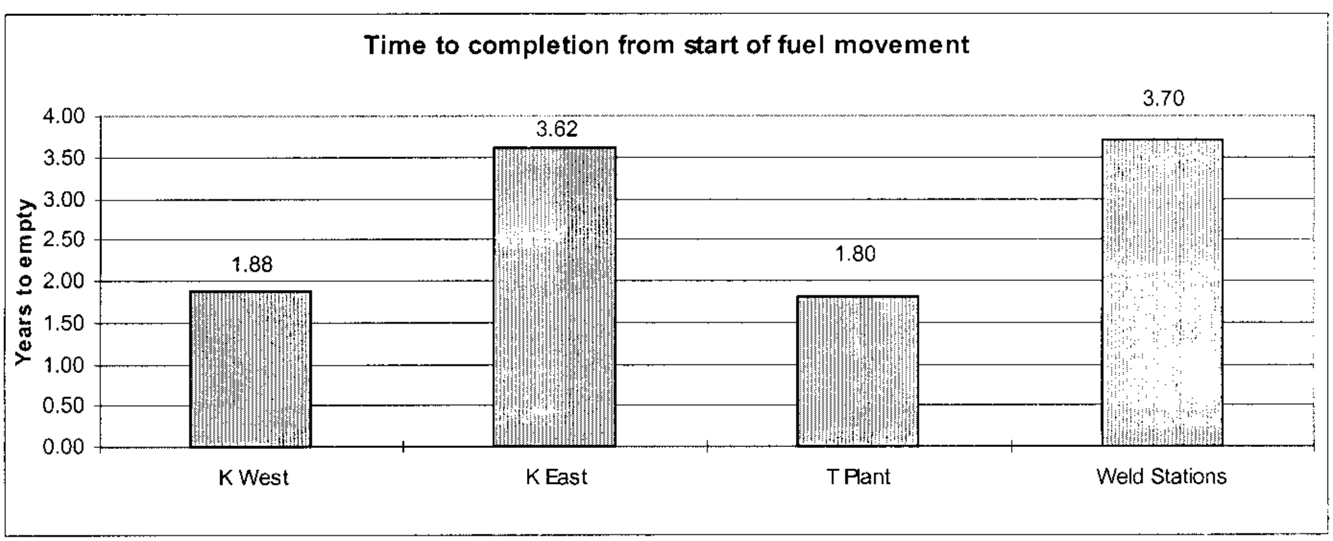


Table 4.2 is a break down of the number of CVD operations per month for each station.

Table 4.2 Case 1 CVD Operations

Month	CVD 1	CVD 2	Total
1	1	0	1
2	3	0	3
3	3	0	3
4	6	0	6
5	4	4	8
6	4	4	8
7	5	5	10
8	6	5	11
9	5	6	11
10	5	5	10
11	5	5	10
12	5	5	10
13	5	5	10
14	5	5	10
15	5	5	10
16	5	5	10
17	6	5	11
18	5	5	10
19	5	5	10
20	5	5	10
21	5	6	11
22	5	5	10
23	4	3	7
24	0	0	0
25	5	4	9
26	5	5	10
27	5	6	11
28	5	5	10
29	5	4	9
30	5	5	10
31	5	5	10
32	5	6	11
33	6	5	11
34	4	5	9
35	5	5	10
36	5	5	10
37	5	5	10
38	6	5	11
39	5	5	10
40	5	6	11
41	6	5	11
42	5	5	10
43	5	5	10
44	3	4	7
Totals	**207**	**193**	**400**

4.3 FY 2000 CASE 2

Case 2 has the same operating parameters as case 1 except:

- The equipment at the CSB and the transporters normally operate 5 days/wk, 2 shifts/day, 7 hrs work/shift, except while T Plant is operating. During support of T Plant activities, the CSB and transporters operate 5 days/wk, 3 shifts/day, 7 hrs work/shift.

Figure 4.3.1. Is the percentage of time that each machine was busy processing the fuel, blocked and waiting to release a MCO, or broken down and waiting for repairs.

Figure 4.3.1 Case 2 Machine Usage

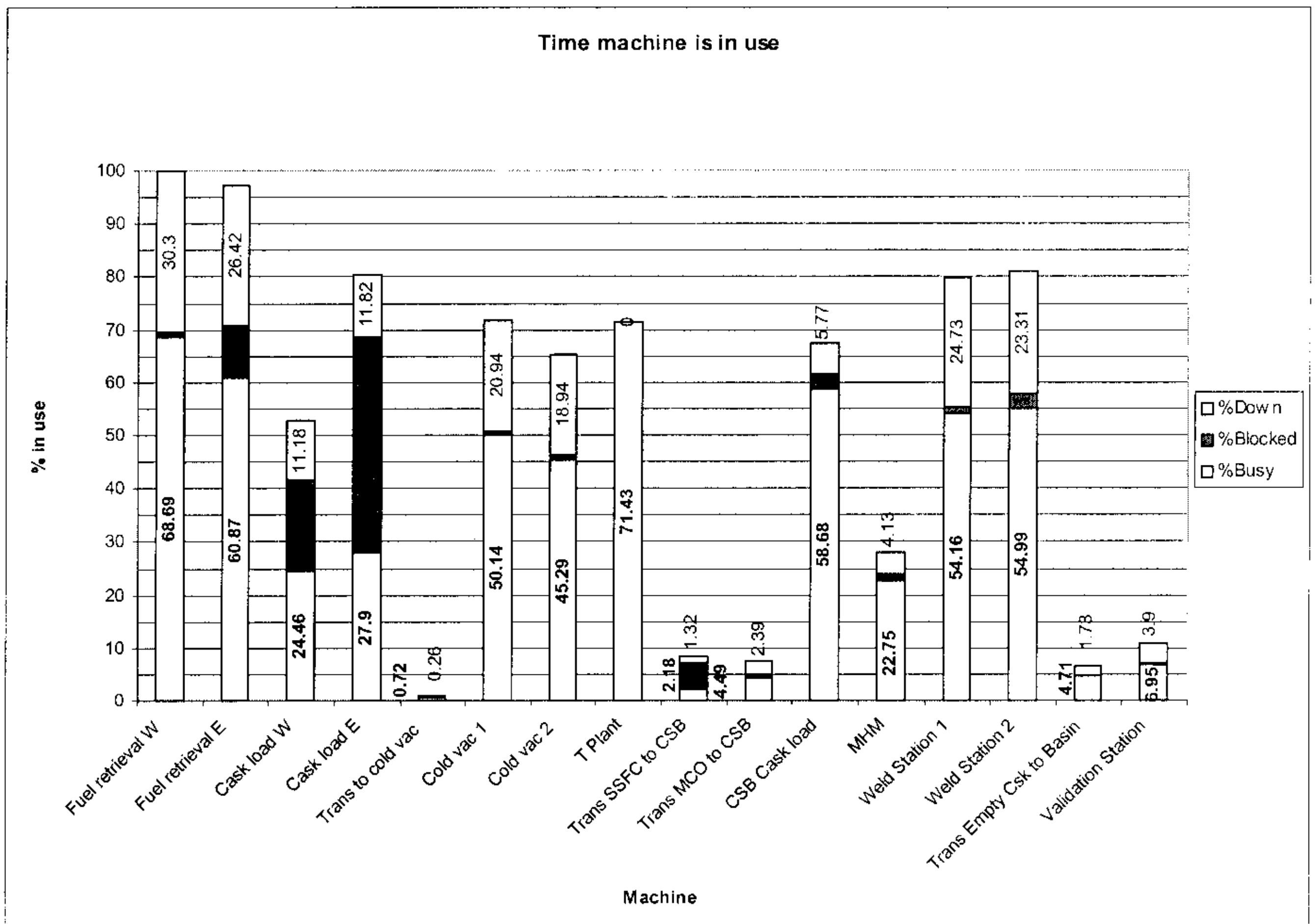


Figure 4.3.2 is the frequency of which a specific number of casks are in use. Witness reports the number of casks in the cask buffer every time a one is pulled from the buffer. The number of casks in use is determined by subtracting the number of casks in the buffer from the total number of casks. Approximately 75% of the time all 5 casks are in use, this is due to the significant blockage in the basin loadout stations.

Figure 4.3.2 Case 2 Cask Usage

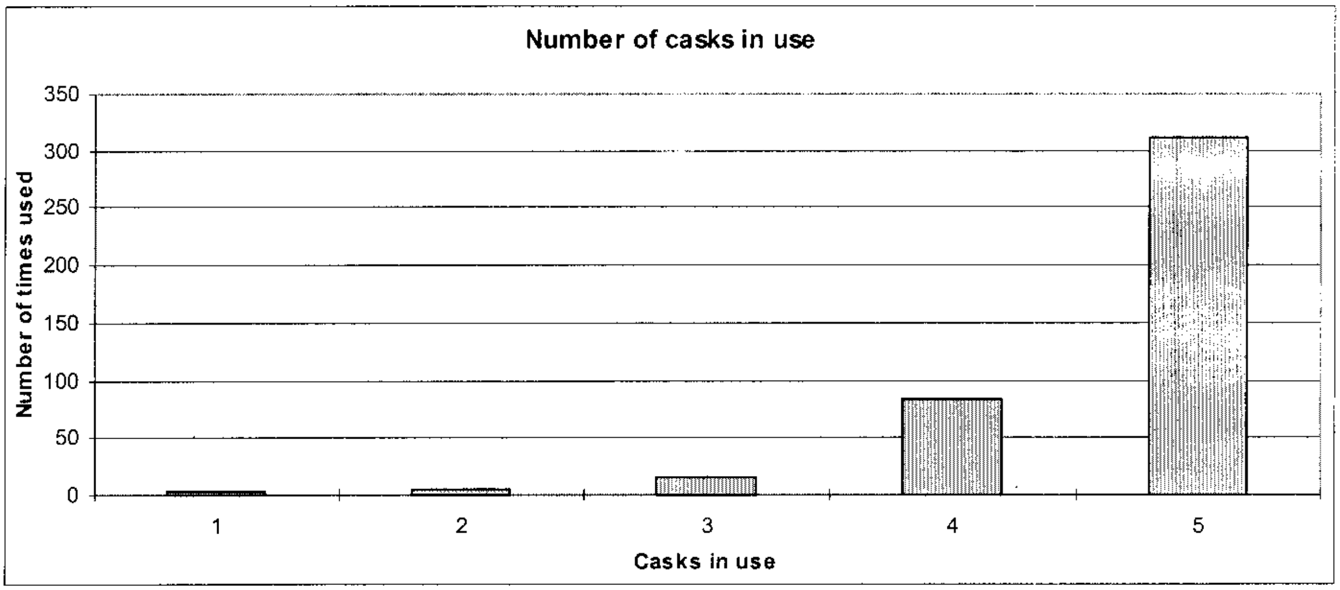


Figure 4.3.3 shows the time to empty each basin, the time to empty T Plant, and the time to complete welding.

Figure 4.3.3 Case 2 Times to Completion

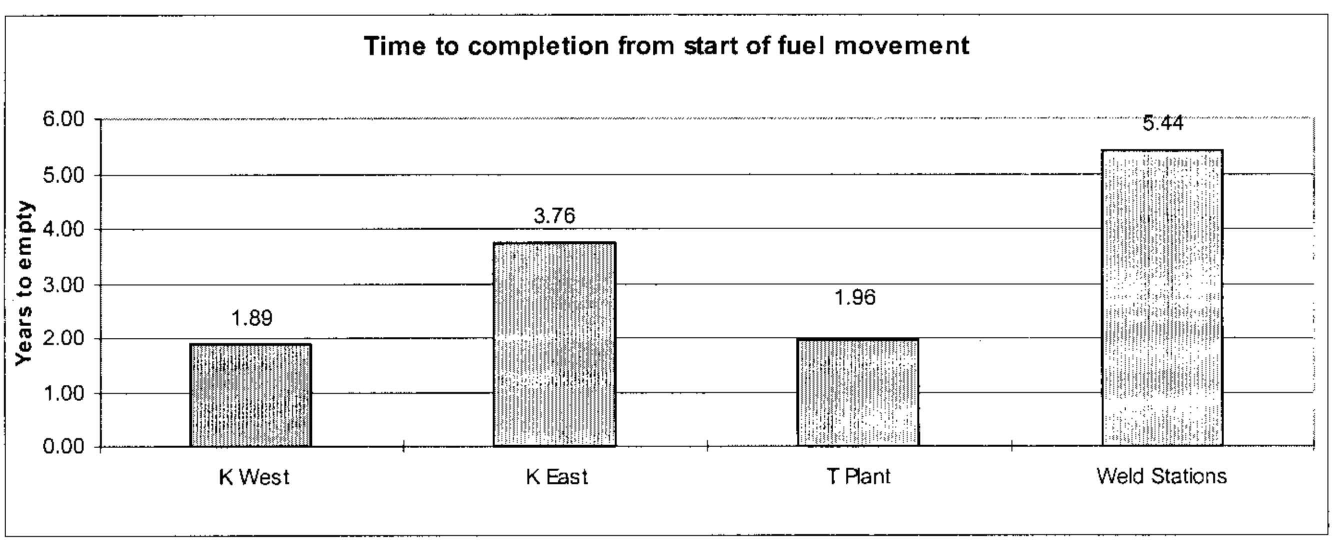


Table 4.3 is a break down of the number of CVD operations per month for each station.

Table 4.3 Case 2 CVD Operations per Month.

Month	CVD 1	CVD 2	Total
1	1	0	1
2	2	0	2
3	5	1	6
4	4	3	7
5	5	4	9
6	4	5	9
7	4	5	9
8	6	5	11
9	6	4	10
10	4	5	9
11	5	4	9
12	4	5	9
13	6	6	12
14	6	5	11
15	5	4	9
16	5	6	11
17	6	5	11
18	5	5	10
19	5	5	10
20	6	5	11
21	5	5	10
22	4	5	9
23	5	0	5
24	0	3	3
25	3	5	8
26	5	6	11
27	5	5	10
28	5	5	10
29	5	4	9
30	4	5	9
31	5	4	9
32	5	5	10
33	5	5	10
34	6	3	9
35	4	5	9
36	4	5	9
37	6	4	10
38	5	4	9
39	5	5	10
40	5	5	10
41	5	4	9
42	5	5	10
43	5	5	10
44	4	4	8
45	4	2	6
46	2	0	2
Totals	**210**	**190**	**400**

4.4 FY 2000 CASE 3 – BASE CASE

Case 3 has the same operating parameters as case 2 except the two spare bays at CVD are not used for MCO storage.

Figure 4.4.1 Is the percentage of time that each machine was busy processing the fuel, blocked and waiting to release a MCO, or broken down and waiting for repairs.

Figure 4.4.1 Case 3 Machine Usage

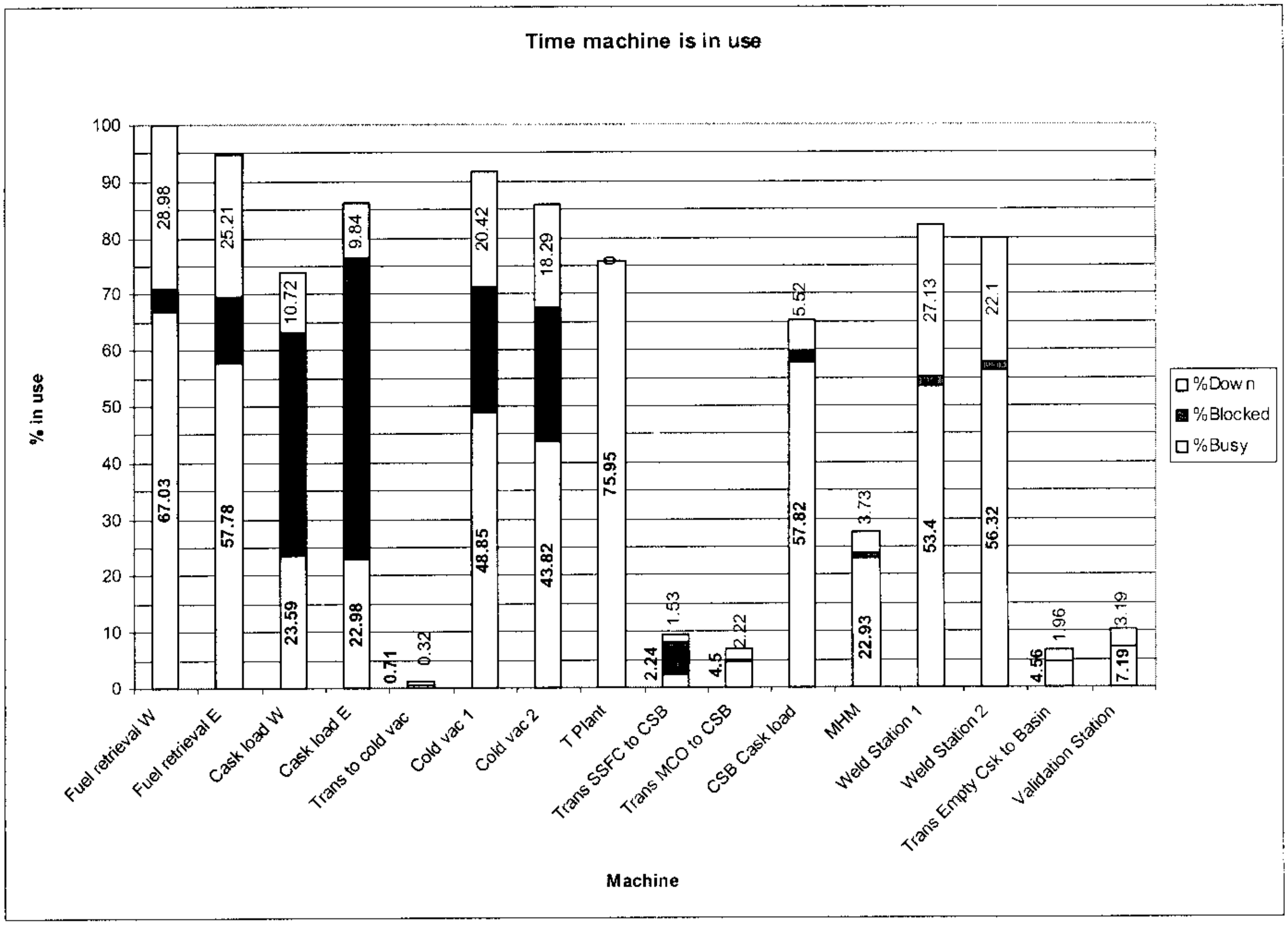


Figure 4.4.2 is the frequency of which a specific number of casks are in use. Witness reports the number of casks in the cask buffer every time a one is pulled from the buffer. The number of casks in use is determined by subtracting the number of casks in the buffer from the total number of casks. Approximately 66% of the time all 5 casks are in use, this is due to the significant blockage in the system stations.

Figure 4.4.2 Case 3 Cask Usage

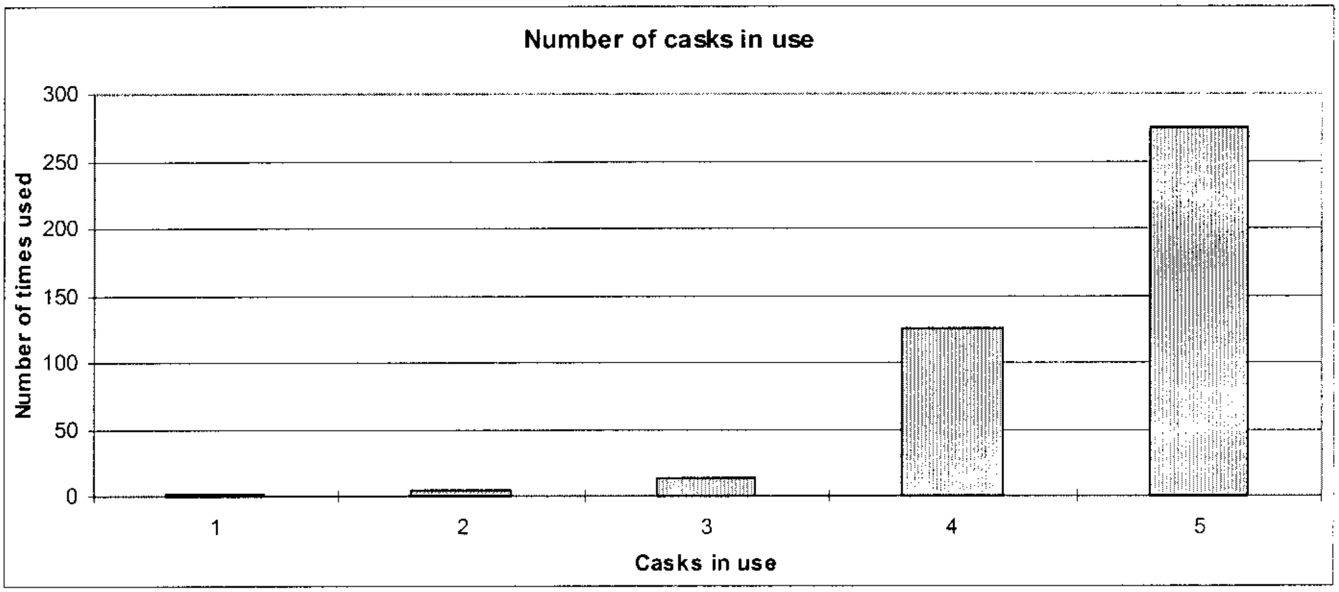


Figure 4.4.3 shows the time to empty each basin, the time to empty T Plant, and the time to complete welding.

Figure 4.4.3 Case 3 Times to Completion

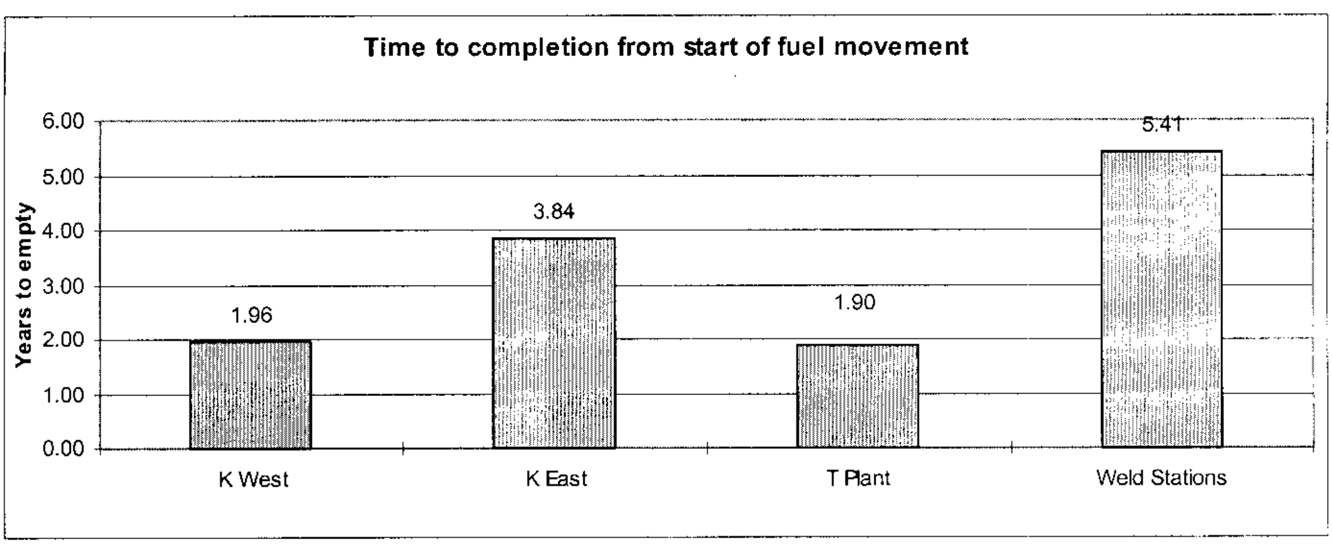


Table 4.4 is a break down of the number of CVD operations per month for each station.

Table 4.4. Case 3 CVD Operations per Month

Month	CVD 1	CVD 2	Total
1	1	0	1
2	3	0	3
3	4	1	5
4	4	3	7
5	5	4	9
6	4	4	8
7	4	4	8
8	5	5	10
9	5	5	10
10	4	4	8
11	5	5	10
12	4	5	9
13	5	4	9
14	5	5	10
15	5	4	9
16	5	5	10
17	6	6	12
18	5	4	9
19	5	6	11
20	5	5	10
21	6	4	10
22	4	5	9
23	6	5	11
24	4	4	8
25	4	5	9
26	5	4	9
27	4	4	8
28	5	5	10
29	4	4	8
30	4	5	9
31	5	4	9
32	5	4	9
33	4	4	8
34	4	5	9
35	5	4	9
36	5	4	9
37	6	5	11
38	4	4	8
39	4	4	8
40	5	5	10
41	5	4	9
42	4	4	8
43	5	5	10
44	4	3	7
45	4	4	8
46	5	2	7
47	2	0	2
Totals	**211**	**189**	**400**

4.5 FY 2000 CASE 4

Case 4 has the same operating parameters as case 3 except:

- During the first year KW fuel retrieval operates 5 days/wk, 2 shifts/day, 7 hrs work/shift,
- after the first year KW fuel retrieval operates 5 days/wk, 3 shifts/day, 7 hrs work/shift,
- cask loading at both basins operates 5 days/wk, 3 shifts/day, 7 hrs work/shift while T Plant is operating and 5 days/wk, 2 shifts/day, 7 hr work/shift the rest of the time,
- KE fuel retrieval starts after KW is finished.

Figure 4.5.1 is the percentage of time that each machine was busy processing the fuel, blocked and waiting to release a MCO, or broken down and waiting for repairs.

Figure 4.5.1 Case 4 Machine Usage

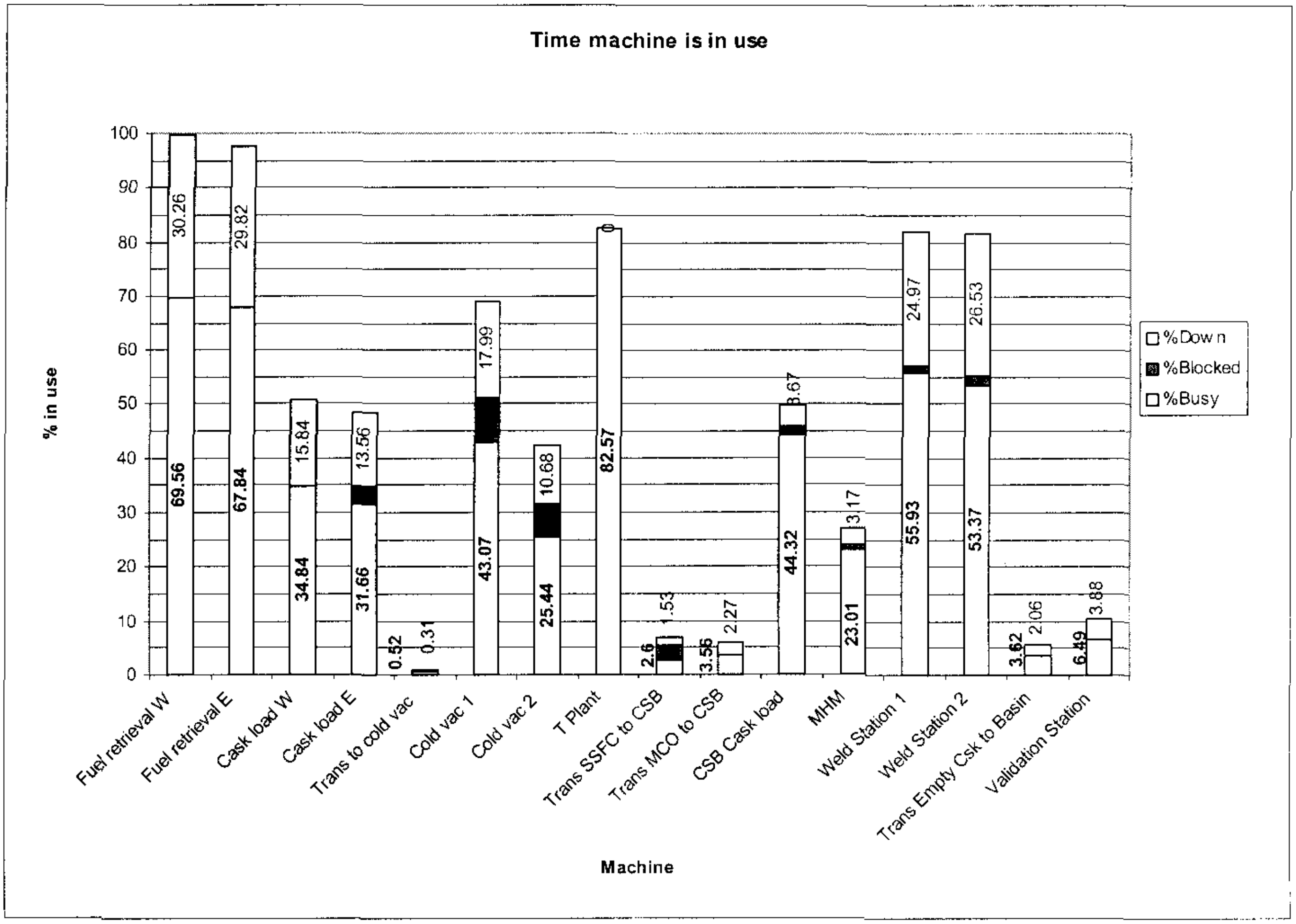


Figure 4.5.2 is the frequency of which a specific number of casks are in use. Witness reports the number of casks in the cask buffer every time a one is pulled from the buffer. The number of casks in use is determined by subtracting the number of casks in the buffer from the total number of casks. Approximately 51% of the time 4 casks are in use.

Figure 4.5.2 Case 4 Cask Usage

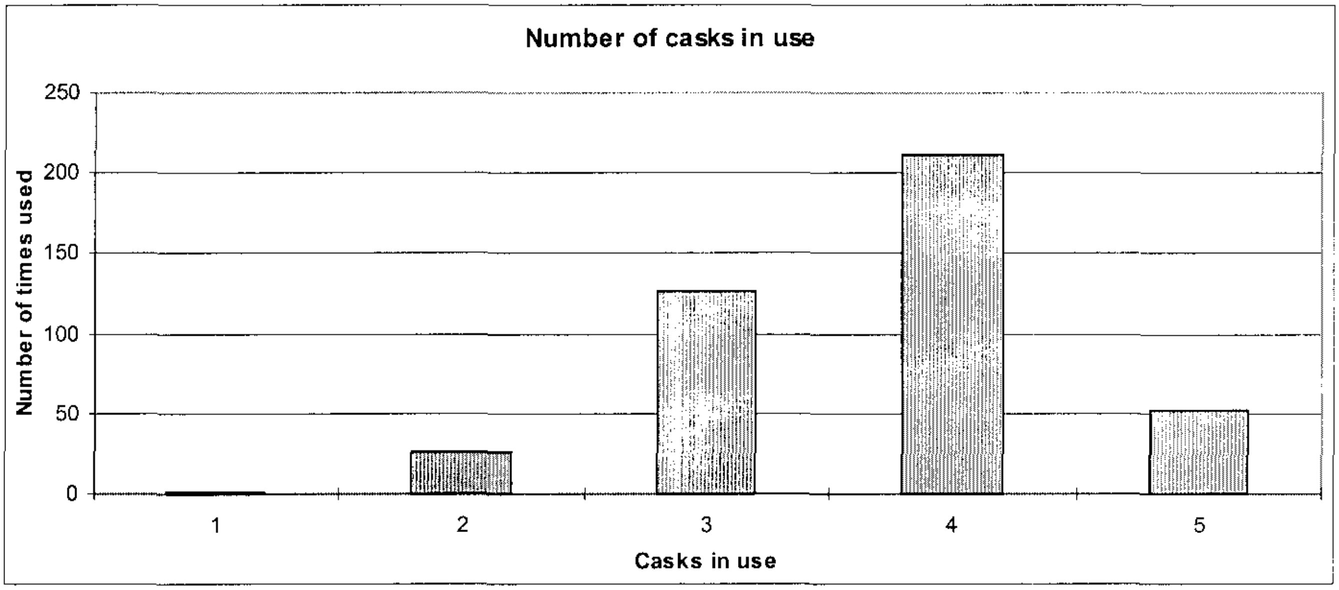


Figure 4.5.3 shows the time to empty each basin, the time to empty T Plant, and the time to complete welding.

Figure 4.5.3 Case 4 Time to Completion

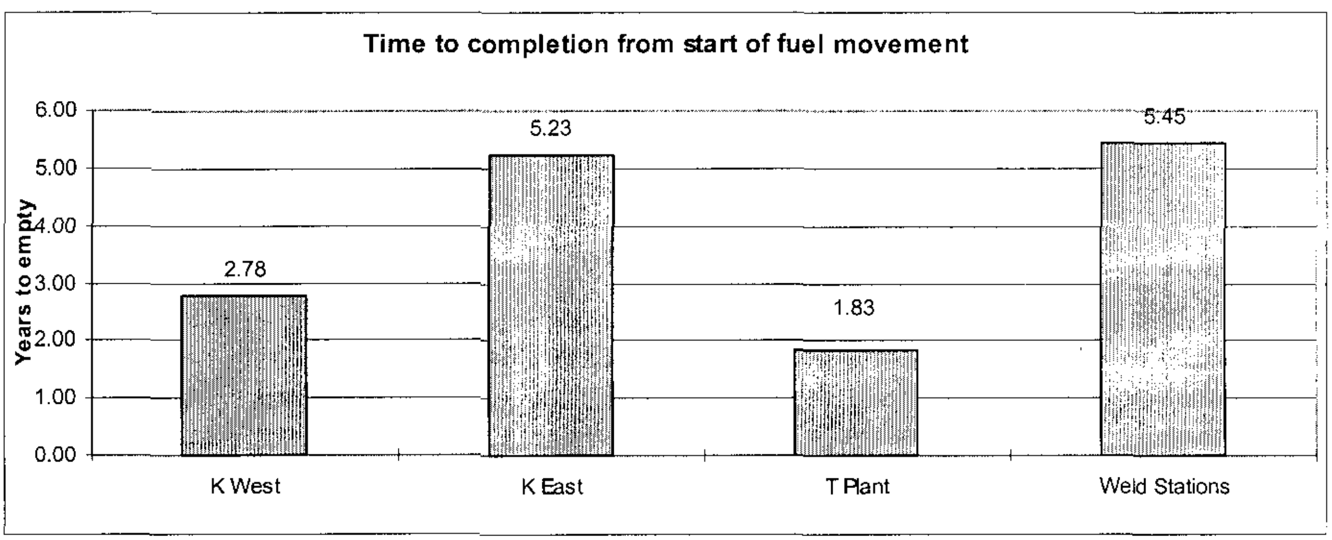


Table 4.5 is a break down of the number of CVD operations per month for each station.

Table 4.5. Case 4 CVD Operations per Month.

Month	CVD 1	CVD 2	Total	Month	CVD 1	CVD 2	Total
1	0	0	0	33	4	4	8
2	1	0	1	34	3	1	4
3	3	0	3	35	2	0	2
4	3	0	3	36	3	0	3
5	3	0	3	37	3	1	4
6	4	0	4	38	5	2	7
7	4	1	5	39	4	4	8
8	4	0	4	40	4	3	7
9	3	2	5	41	4	4	8
10	5	0	5	42	4	3	7
11	4	1	5	43	4	4	8
12	5	0	5	44	3	3	6
13	4	3	7	45	5	3	8
14	4	3	7	46	4	4	8
15	5	3	8	47	4	2	6
16	4	3	7	48	5	3	8
17	4	2	6	49	4	3	7
18	5	3	8	50	4	3	7
19	4	3	7	51	4	3	7
20	5	3	8	52	4	4	8
21	4	3	7	53	5	3	8
22	4	3	7	54	4	4	8
23	4	3	7	55	5	2	7
24	5	4	9	56	3	4	7
25	4	3	7	57	5	2	7
26	5	2	7	58	4	3	7
27	4	3	7	59	5	3	8
28	4	3	7	60	4	3	7
29	5	3	8	61	4	4	8
30	4	3	7	62	5	2	7
31	4	3	7	63	4	3	7
32	5	2	7	Totals	251	149	400

4.6 FY 2000 CASE 5

Case 5 has the same operating parameters as case 4 except all stations, with the exception of CVD, operate 5 days/wk, 2 shifts/day, 7 hrs work/shift

Figure 4.6.1 is the percentage of time that each machine was busy processing the fuel, blocked and waiting to release a MCO, or broken down and waiting for repairs.

Figure 4.6.1 Case 5 Machine Usage

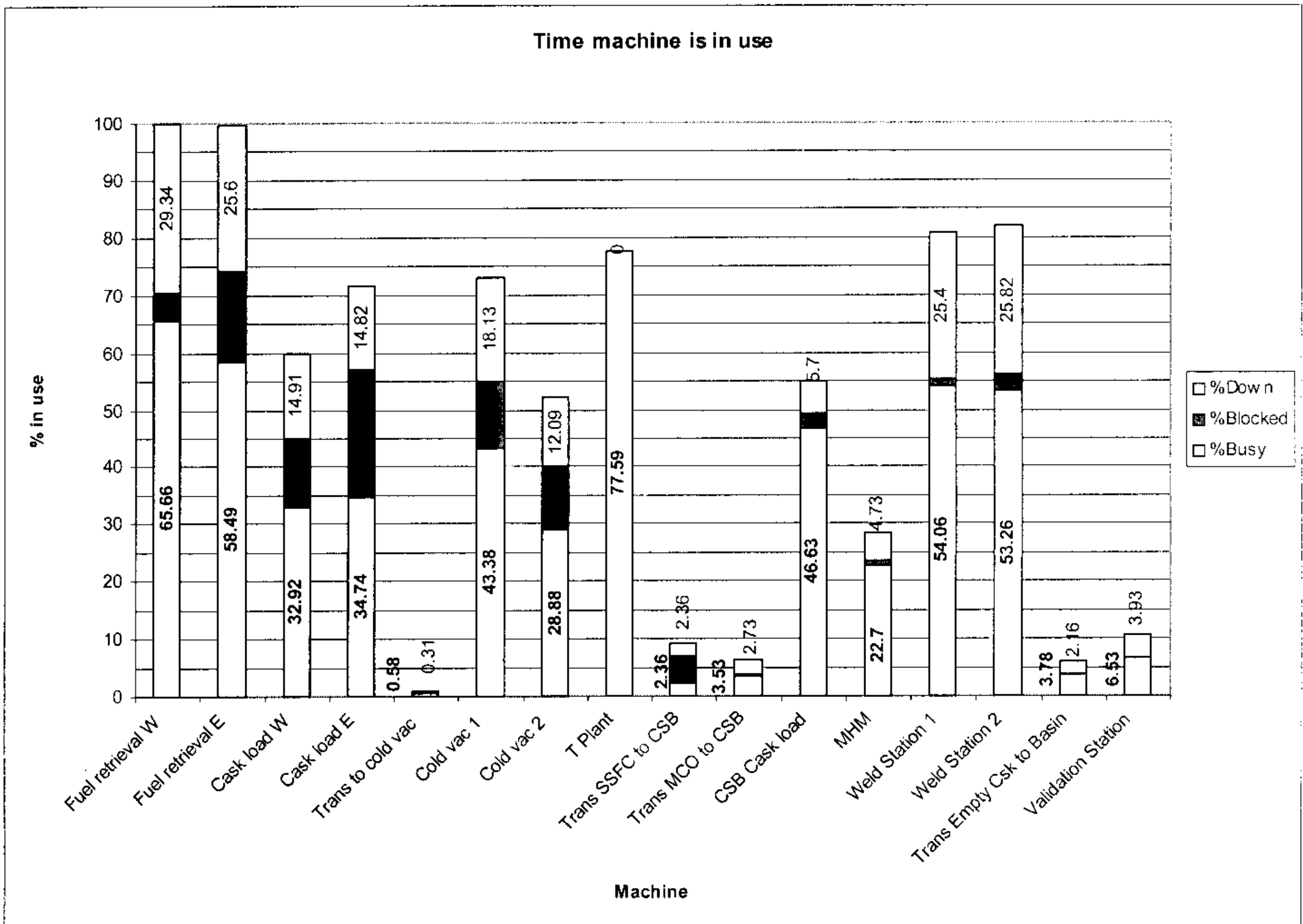


Figure 4.6.2 is the frequency of which a specific number of casks are in use. Witness reports the number of casks in the cask buffer every time a one is pulled from the buffer. The number of casks in use is determined by subtracting the number of casks in the buffer from the total number of casks.

Figure 4.6.2 Case 5 Cask Usage

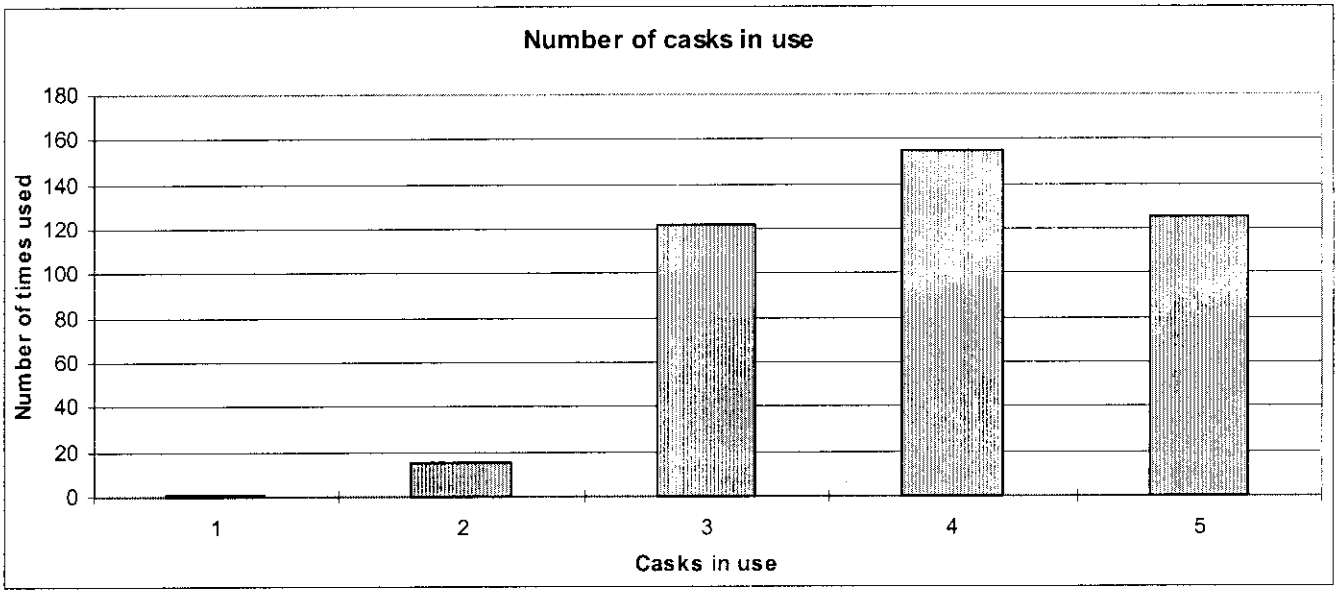


Figure 4.6.3 shows the time to empty each basin, the time to empty T Plant, and the time to complete welding.

Figure 4.6.3 Case 5 Time to Completion

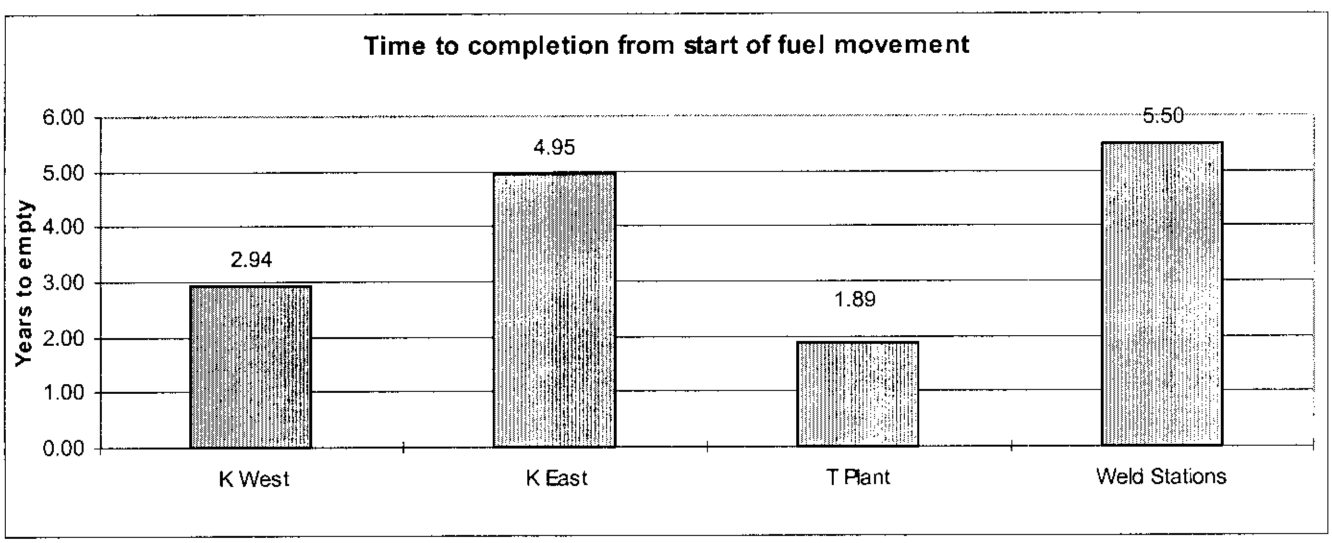


Table 4.6 is a break down of the number of CVD operations per month for each station.

Table 4.6. Case 5 CVD Operations per Month

Month	CVD 1	CVD 2	Total
1	0	0	0
2	1	0	1
3	3	0	3
4	2	0	2
5	4	0	4
6	4	0	4
7	4	1	5
8	4	1	5
9	4	1	5
10	4	1	5
11	4	0	4
12	5	1	6
13	4	2	6
14	3	4	7
15	5	3	8
16	4	3	7
17	4	3	7
18	5	2	7
19	3	3	6
20	4	3	7
21	5	3	8
22	4	4	8
23	5	2	7
24	4	4	8
25	3	3	6
26	5	4	9
27	4	5	9
28	5	4	9
29	3	4	7
30	4	4	8
31	5	4	9
32	4	5	9
33	4	4	8
34	5	4	9
35	4	5	9
36	4	4	8
37	4	4	8
38	4	3	7
39	5	2	7
40	4	3	7
41	5	3	8
42	4	3	7
43	5	2	7
44	3	4	7
45	5	3	8
46	4	2	6
47	5	3	8
48	4	2	6
49	3	4	7
50	5	3	8
51	4	3	7
52	4	3	7
53	5	2	7
54	4	2	6
55	4	4	8
56	5	3	8
57	4	3	7
58	4	3	7
59	4	3	7
60	3	2	5
Totals	**240**	**160**	**400**

4.7 FY 2000 CASE 6

Case 6 has the same operating parameters as case 3 except T Plant has an operating cycle of 5 working days instead of 10 days.

Figure 4.7.1 Is the percentage of time that each machine was busy processing the fuel, blocked and waiting to release a MCO, or broken down and waiting for repairs.

Figure 4.7.1 Case 6 Machine Usage

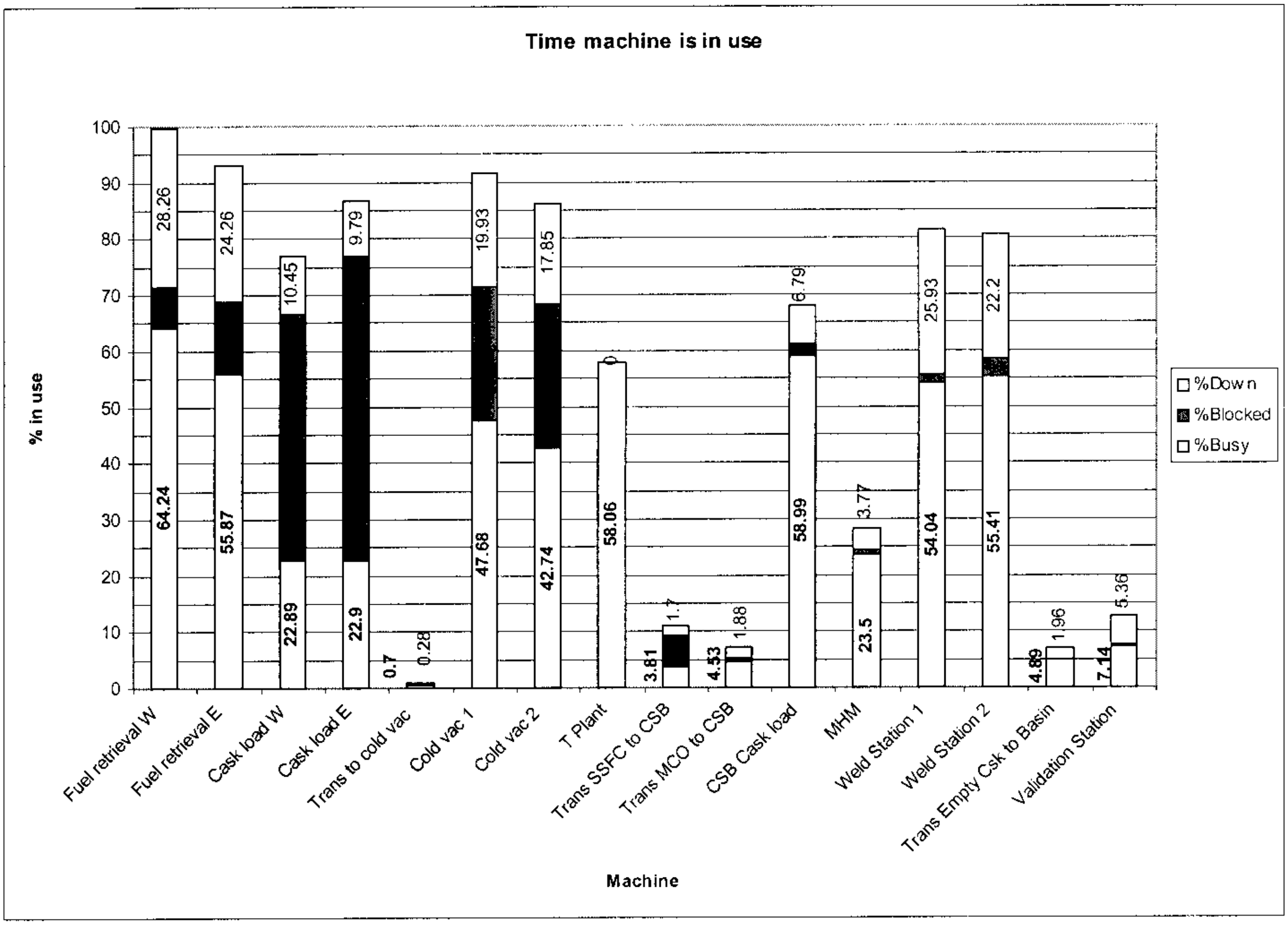


Figure 4.7.2 is the frequency of which a specific number of casks are in use. Witness reports the number of casks in the cask buffer every time a one is pulled from the buffer. The number of casks in use is determined by subtracting the number of casks in the buffer from the total number of casks. Approximately 62% of the time all 5 casks are in use due to the extensive blockage in the system.

Figure 4.7.2 Case 6 Cask Usage

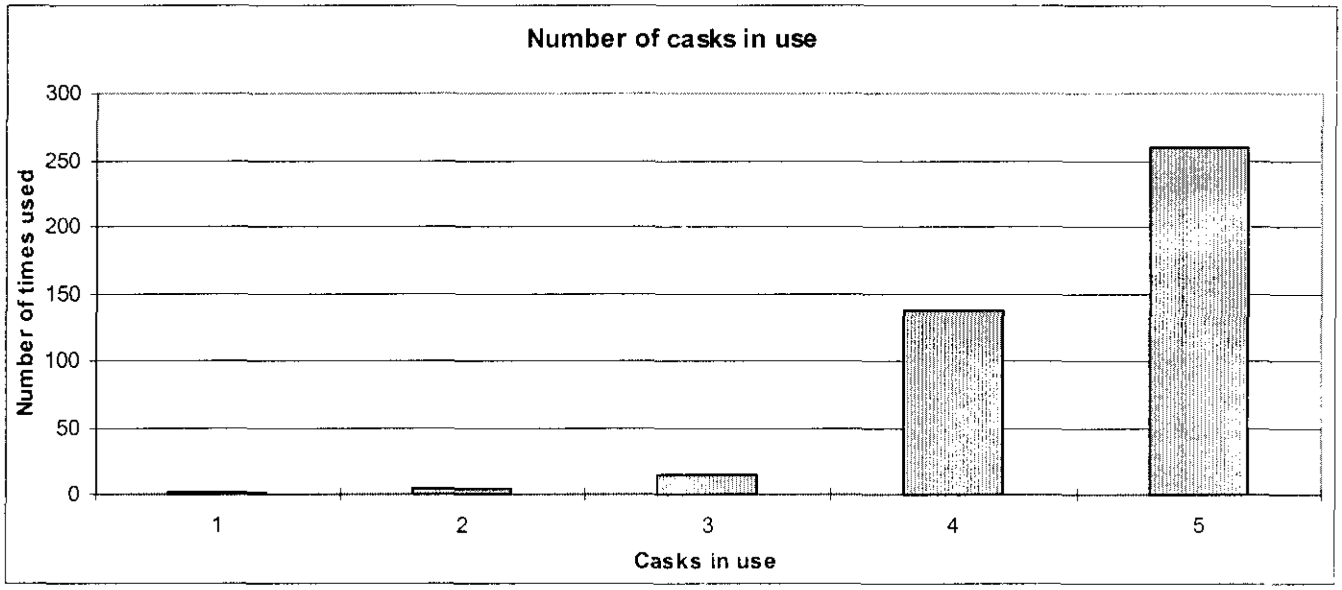


Figure 4.7.3 shows the time to empty each basin, the time to empty T Plant, and the time to complete welding.

Figure 4.7.3 Case 6 Time to Completion

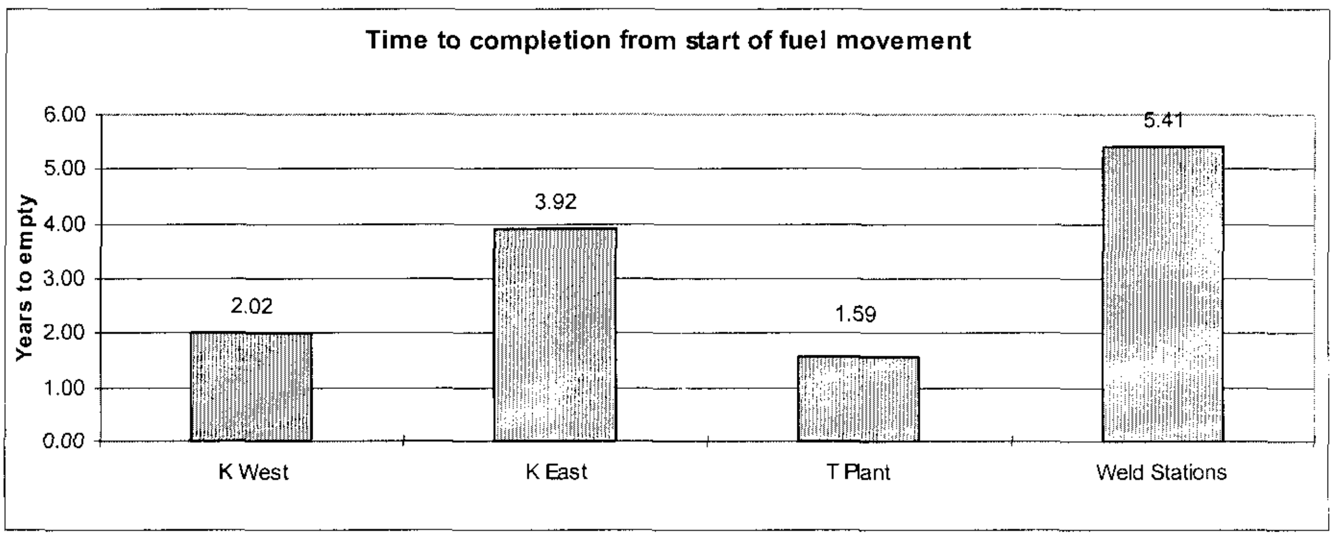


Table 4.7 is a break down of the number of CVD operations per month for each station.

Table 4.7. Case 6 CVD Operations per Month

Month	CVD 1	CVD 2	Total
1	1	0	1
2	2	0	2
3	5	1	6
4	4	3	7
5	4	3	7
6	5	5	10
7	4	4	8
8	5	5	10
9	4	4	8
10	4	4	8
11	5	4	9
12	4	5	9
13	5	5	10
14	5	6	11
15	5	4	9
16	6	4	10
17	5	6	11
18	5	4	9
19	5	4	9
20	5	5	10
21	4	4	8
22	5	4	9
23	5	5	10
24	5	4	9
25	4	5	9
26	5	4	9
27	4	4	8
28	4	5	9
29	5	4	9
30	4	4	8
31	6	5	11
32	5	4	9
33	5	4	9
34	3	5	8
35	5	4	9
36	4	4	8
37	5	5	10
38	4	4	8
39	4	4	8
40	5	5	10
41	4	4	8
42	4	4	8
43	5	5	10
44	4	4	8
45	4	4	8
46	4	4	8
47	5	1	6
48	2	0	2
Totals	**211**	**189**	**400**

5.0 SNF PROCESS CYCLE TIMES

The following discussion describes the basis for cycle time estimates used to model the production of an MCO by each process element. These cycle times represent the peak throughput of each process element, or the actual work time needed to produce an MCO. Potential system down time from equipment failure or operating environment inefficiencies is included as a separate model input parameter. Transport delays due to weather conditions are not considered when determining process cycle times.

5.1 FUEL RETRIEVAL

Fuel retrieval cycle time estimates are based on peak capacity testing per the Final Report - SNF Retrieval System Fuel Handling Development Testing (PNNL-11666, 9/97). Capacity estimates for a single fuel retrieval line are estimated at 7-8 canisters/day average and 12 canisters/day peak. Based on fuel retrieval testing times, 94 minutes was required to load one fuel basket and one scrap basket from the process table, with an additional 20 minutes for miscellaneous related activities. With 3.8 canisters per basket and four baskets per MCO (the scrap basket is included in the time estimate), 28.88 hours is required for producing a MCO. With a 1.5 inefficiency factor for a mode time, and twice the load time for a maximum, this results in a triangular distribution with minimum time of 28.88 hours, mode time of 43.32 hours, and maximum time of 57.76 hours.

5.2 BASIN CASK LOADIN/LOADOUT AND TRANSPORTATION

A preliminary exposure evaluation of the basin cask loadin/loadout activities was used as a basis for estimating the cycle time for basin cask loadin/loadout activities (Transnuclear, nd). The exposure evaluation estimated a total cycle time of 10.9 hours to prepare the cask for MCO loading (cask loadin), load the MCO, and loadout the cask. Additional conservatism was added to this cycle time estimate by increasing the MCO basket loading from 1 to 4 hours, increasing the MCO shield plug decontamination time from 0.5 to 1.5 hours, and increasing the final cask survey and decontamination time from 0.1 to 2.1 hours. The conservatism increases the loadin/loadout cycle time to 16.9 hours, which was used as the mode time of a triangular distribution for the cask cycle time.

A minimum cycle time was estimated at two shifts of operating time, or 12 hours. A maximum cycle time was estimated by tripling the time required for installing the shield plug and decon/survey activities, resulting in increasing the cask loadin/loadout time to 26 hours. These assumptions result in a triangular distribution estimate for the basin cask loadin/loadout with a minimum time of 12 hours, mode time of 16.9 hours, and maximum time of 26 hours.

Transportation time estimates are based on allocations based on the approximate distance traveled. The transfer from just outside the door at a basin to the cold vacuum drying location is approximately 1,000 feet. Based on discussion with the transportation design authority, a triangular distribution with minimum time of 0.1 hour, mode time of 0.25 hour, and maximum time of 0.5 hour was used to model the transfer from the basin to just outside a cold vacuum drying station.

The transport distance from the Cold Vacuum Drying Facility to the Canister Storage Building is approximately 7 miles. Based on discussion with the transportation design authority, a triangular distribution with minimum time of 0.5 hour, mode time of 1 hour, and maximum time of 4 hours was used to model the transportation time required to move a MCO from just outside the cold vacuum drying station to just outside the Canister Storage Building. This triangular time distribution was also used to model the time required to return a cask loaded with an empty MCO back to the basin.

5.3 COLD VACUUM DRYING

The cycle time for a cold vacuum drying station is derived from the SNF Project Cold Vacuum Drying Facility Operations Manual (SNF-2356, Rev. 3) and yields 70 hours to produce a MCO. The CVD process times start with backing the cask trailer into the process bay, and ends with driving the tractor away from the facility with a dried MCO/Cask. The cycle times are expected to vary based on the condition of the fuel and therefore how much drying is required. The minimum time for drying is 70 hours, assuming the fuel is dried on the first cycle. The mode time estimates that one additional drying cycle is required. The maximum time is estimated as a result of a longer drying period. The two additional cycles of drying, and draining and drying of the cask annulus (stated as a parallel action, conservatively assumed as additional time) is estimated to take up to an additional 18 hours. These estimates result in a triangular cycle time distribution with a minimum time of 70 hours, mode time of 78 hours, and a maximum time of 88 hours.

5.4 CANISTER STORAGE BUILDING LOADIN/LOADOUT AND MCO HANDLING MACHINE

Time cycle estimates for the cask loadin/loadout and MCO Handling Machine (MHM) transfer activities within the Canister Storage Building were derived from the CSB Operational Sequence Block Flow Diagram (H-2-123400 Rev. 0). The sequence is broken down into distinct actions, with a time estimate assigned to each action. The blocks are further assigned to specific movements within the CSB; such as cask loadin/loadout, MHM transfer, MCO welding, weld examination, etc.

Based on the task time estimates, the CSB cask loadin/loadout area is occupied for 18.75 hours to unload an MCO and insert an empty MCO. The tasks are shown on the flow diagram (numbered 2-1 to 2-24, combined with 11-1 to 11-24). A minimum time for completing cask loadin/loadout was estimated assuming a 10% reduction in the nominal or mode time due to parallel activities. A maximum time was estimated assuming that additional tasks are required to respond to a detection of pressure in the shipping cask (Blocks 5-1 to 5-10). These additional tasks take 12.3 hours. These assumptions result in a triangular distribution estimate for CSB cask loadin/loadout with a minimum time of 16.9 hours, mode time of 18.75 hours, and maximum time of 31.05 hours.

5.5 TRANSFER MCO/MHM FROM LOADIN/LOADOUT TO STORAGE TUBE

Based on the task time estimates in the Operating Sequence Flow Diagram, 3.6 hours is estimated to complete activities using the MHM to transfer a MCO from the cask loadin/loadout pit to a storage tube (H-2-123400, Rev. 0). This includes 95 minutes to transfer the MCO to the MHM in the cask loadin/loadout area (Blocks 2-19 to 2-24), and 120 minutes to position the MCO at the storage tube and return the MHM to a parked position (H-2-123410, Rev. 0, Blocks 12-4 to 12-10). A minimum time for completing the transfer with the MHM was assumed to be 3.2 hours, based on a 10% reduction due to efficiency in operations. A maximum time for completing the transfer was assumed to be 4.3 hours, based on assuming the MHM transfer to the storage tube would take an additional 15 minutes, and positioning the MCO at the storage tube would take an additional 25 minutes. These assumptions result in a triangular distribution estimate for the MHM transfer of a MCO to a storage tube with a minimum time of 3.2 hours, mode time of 3.6 hours, and maximum time of 4.3 hours.

5.6 TRANSFER MCO/MHM FROM STORAGE TUBE TO SAMPLE/WELD STATION

Based on the task time estimates in the Operating Sequence Flow Diagram, 3.3 hours is estimated to complete activities using the MHM to transfer a MCO from the storage tube to a sample/weld station (H-2-123400, Rev. 0, Blocks 13-5 to 13-17). A minimum time for completing the transfer with the MHM was assumed to be 3 hours, based on a 10% reduction due to efficiency in operations. A maximum time for completing the transfer was assumed to be 4 hours, based on assuming the MHM transfer to the sample/weld station would take an additional 15 minutes, and positioning the MCO at the sample/weld station would take an additional 25 minutes. These assumptions result in a triangular distribution estimate for the MHM transfer of a MCO with a minimum time of 3 hours, mode time of 3.3 hours, and maximum time of 4 hours.

5.6.1 MCO Welding

The time a sample/weld station is occupied during welding, based on the CSB Operational Sequence Block Flow Diagram (H-2-123410, Rev. 0), is estimated to be 27.1 hours for a MCO with no weld failure. This is based on the time the station is occupied during placement of the MCO in the station (95 min from Blocks 13-11 to 13-16), the welding operation (1435 min from Blocks 3-6 to 3-40), and removal of the MCO from the station (95 min from Blocks 4-1 to 4-6). It is estimated that if minor weld failure repair is required, then an additional 3.1 hours is needed (H-2- 123400, Rev. 0, Blocks 10-1 to 10-7). If major weld failure repair is required, the weld repair time is assumed to double to 6.2 hours. The welding tasks start with removal of the pit cover for access to the MCO at the weld station, and ends with replacing the pit cover at the weld station upon completion of welding. With three welds to inspect for each MCO, the mode time assumes one of the welds will require minor repair. The maximum weld time assumes that one weld requires minor repair, and a second weld requires major repair. These assumptions result in a triangular distribution estimate for the welding operation of a MCO with a minimum time of 27.1 hours, mode time of 30.2 hours, and maximum time of 36.4 hours.

5.6.2 MCO Sampling During Monitoring

MCO monitoring at the CSB is intended to confirm nominal process operations consistent with analytical predictions (models, testing, sampling). Six MCOs will undergo process validation, which means that, upon entry in the CSB, the MCOs will be immediately staged in a storage tube. Every quarter, the MCOs will be removed from the storage tube and moved to the sample/weld station for gas sampling and monitoring. This will happen approximately four times over the course of one year for each validation MCO. Upon completion of the monitoring period and resulting favorable results, the MCO will then be moved to the sample/weld station for welded closure and back to the storage tube for final interim storage.

Based on the task time estimates in the Operating Sequence Flow Diagram (H-2-123400, Rev. 0), the sample/weld station is occupied for approximately 14.7 hours to complete validation activities. This includes 95 minutes to position the MCO at the sample/weld station (Blocks 13-11 to 13-16), 690 minutes to perform the sampling activities (Blocks 14-1 to 14-29), and 95 minutes to remove the MCO from the station (Blocks 4-1 to 4-6).

A minimum time to complete the validation process MHM transfer was assumed to be 13.2 hours, based on a 10% reduction in the sampling due to efficiency in operations. A maximum time for completing the transfer was assumed to be 17.2 hours, based on assuming that positioning the MCO at the weld station would take an additional 30 minutes and sampling would take an additional 2 hours. These assumptions result in a triangular distribution estimate for the sample station activities with a minimum time of 13.2 hours, mode time of 14.7 hours, and maximum time of 17.2 hours.

5.7 TRANSFER MCO/MHM FROM SAMPLE/WELD STATION TO STORAGE TUBE

The CSB Operational Sequence Block Flow Diagram shows that the MHM is occupied for 3.3 hours to move the MCO from the sample/weld station to a storage tube for interim storage (H-2-123410, Rev. 0, Blocks 4-1 to 4-13). This time includes the MHM removing the welded MCO from the weld station, moving to the interim storage area, removing the tube plug cover, transferring the MCO to the storage tube, and installing the tube plug cover. Assuming a 10% operating efficiency improvement for the transfer time provides a minimum transfer time of 3 hours. Assuming an impact absorber is added to the storage tube during the transfer adds 3 hours to the total time the MHM is occupied for a maximum time estimate. These assumptions result in a triangular cycle time distribution time of 3 hours minimum, 3.3 hours mode time, and 6.3 hours maximum.

6.0 SSFC/SNF PROCESS CYCLE TIME

The following discussion describes the basis for the cycle time estimates used to model the production of a SSFC by its process elements. Cycle times for transporting a SSFC and processing it at the CSB are based on MCO cycle times for similar activities. Weather delays are not incorporated in the production estimates.

6.1 T PLANT LOADING AND DRYING OF SHIPPING PORT FUEL

The total baseline case time estimate for loading a SSFC with Shippingport Fuel at T Plant, drying the fuel, and preparing the cask for transfer to the CSB is approximately 10 working days for the baseline case, based on operating one shift/day, 5 days/week. The cycle time estimate is developed to accomplish this overall cycle assuming 6 hours of effective work per operating shift. This effect is modeled by assigning a 60 hour cycle time to this activity, even though the actual residence time of the SSFC at T Plant will be much longer.

6.2 SHIPPING SSFC FROM T PLANT

The transport distance from T Plant to the Canister Storage Building is shorter than the Cold Vacuum Drying Facility to the Canister Storage Building. To be conservative the same cycle time estimate as transporting from Cold Vacuum Drying will be used. A triangular distribution with minimum time of 0.5 hour, mode time of 1 hour, and maximum time of 4 hours was used to model the transportation time required to move a SSFC from just outside of T Plant to just outside the Canister Storage Building. This triangular time distribution was also used to model the time required to return a cask loaded with an empty SSFC back to T Plant.

6.3 SSFC LOADIN/LOADOUT AT THE CANISTER STORAGE BUILDING

Time cycle estimates for the cask loadin/loadout and MHM transfer activities within the Canister Storage Building specific to handling SSFC from T Plant were derived from the CSB Operational Sequence Block Flow Diagram (H-2-123400 Rev. 0). The sequence is broken down into distinct actions, with a time estimate assigned to each action. The blocks are further assigned to specific movements within the CSB; such as cask loadin/loadout, MHM transfer, SSFC welding, weld examination, etc.

Based on the task time estimates, the CSB cask loadin/loadout area is occupied for 17.9 hours to unload an SSFC and insert an empty SSFC. The tasks are shown on the flow diagram (numbered 2-1 to 2-24, skipping steps 2-9 and 2-10, combined with 11-1 to 11-24). A minimum time for completing cask loadin/loadout was estimated assuming a 10% reduction in the nominal or mode time due to parallel activities. A maximum time was estimated assuming a 10% increase in loading activities. These assumptions result in a triangular distribution estimate for CSB cask loadin/loadout with a minimum time of 16.1 hours, mode time of 17.9 hours, and maximum time of 19.7 hours.

6.4 TRANSFER SSFC MHM FROM LOADIN/LOADOUT TO STORAGE TUBE

Transfer times for a SSFC from the loadin/loadout area to a storage tube are identical to that for K Basin MCOs. Based on the task time estimates in the Operating Sequence Flow Diagram, 3.6 hours are estimated to complete activities using the MHM to transfer a MCO from the cask loadin/loadout pit to a storage tube (H-2-123400, Rev. 0). This includes 95 minutes to transfer the MCO to the MHM in the cask loadin/loadout area (Blocks 2-19 to 2-24), and 120 minutes to position the MCO at the storage tube and return the MHM to a parked position (H-2-123410, Rev. 0, Blocks 12-4 to 12-10). A minimum time to for completing the transfer with the MHM was assumed to be 3.2 hours, based on a 10% reduction due to efficiency in operations. A maximum time for completing the transfer was assumed to be 4.3 hours, based on assuming the MHM transfer to the storage tube would take an additional 15 minutes, and positioning the MCO at the storage tube would take an additional 25 minutes. These assumptions result in a triangular distribution estimate for the MHM transfer of a MCO to a storage tube with a minimum time of 3.2 hours, mode time of 3.6 hours, and maximum time of 4.3 hours.

6.5 TRANSFER SSFC MHM FROM STORAGE TUBE TO WELD STATION

Transfer of the SSFC from a storage tube to the weld station is identical to that for an MCO from the K Basins. Based on the task time estimates in the Operating Sequence Flow Diagram, 3.3 hours are estimated to complete activities using the MHM to transfer a MCO from the storage tube to a sample/weld station (H-2-123400, Rev. 0, Blocks 13-5 to 13-10 and Blocks 2-25 to 2-31). A minimum time to for completing the transfer with the MHM was assumed to be 3 hours, based on a 10% reduction due to efficiency in operations. A maximum time for completing the transfer was assumed to be 4 hours, based on assuming the MHM transfer to the sample/weld station would take an additional 15 minutes, and positioning the MCO at the sample/weld station would take an additional 25 minutes. These assumptions result in a triangular distribution estimate for the MHM transfer of a MCO with a minimum time of 3 hours, mode time of 3.3 hours, and maximum time of 4 hours.

6.6 SSFC WELDING

The time for welding a SSFC expected to be less than for a MCO since the SSFC does not require the pre-welding or leak testing, however for this analysis it is assumed to be identical to that required for an MCO from the K Basins. The time for a sample/weld station is occupied during welding, based on the CSB Operational Sequence Block Flow Diagram (H-2-123410, Rev. 0), is estimated to be 27.1 hours for a MCO with no weld failure. This is based on the time the station is occupied during placement of the MCO in the station (95 min from Blocks 13-11 to 13-16), the welding operation (1435 min from Blocks 3-6 to 3-40), and removal of the MCO from the station (95 min from Blocks 4-1 to 4-6). It is estimated that if minor weld failure repair is required, then an additional 3.1 hours is needed (H-2- 123400, Rev. 0, Blocks 10-1 to 10-7). If major weld failure repair is required, the weld repair time is assumed to double to 6.2 hours. The welding tasks start with removal of the pit cover for access to the MCO at the weld station, and ends with replacing the pit cover at the weld station upon completion of welding. With three welds to inspect for each MCO, the mode time assumes one of the weld will require minor repair. The maximum weld time assumes that one weld requires minor repair, and a second weld requires major repair. These assumptions result in a triangular distribution estimate for the welding operation of a MCO with a minimum time of 27.1 hours, mode time of 30.2 hours, and maximum time of 36.4 hours.

6.7 TRANSFER SSFC MHM FROM WELD STATION TO STORAGE TUBE

The transfer time for a SSFC from the weld station to a storage tube is identical to that required for a K Basin MCO. The CSB Operational Sequence Block Flow Diagram shows that the MHM is occupied for 3.3 hours to move the MCO from the sample/weld station to a storage tube for interim storage (H-2-123410, Rev. 0, Blocks 4-1 to 4-13). This time includes the MHM removing the welded MCO from the weld station, moving to the interim storage area, removing the tube plug cover, transferring the MCO to the storage tube, and installing the tube plug cover. Assuming a 10% operating efficiency improvement for the transfer time provides a minimum transfer time of 3 hours. Assuming an impact absorber is added to the storage tube during the transfer adds 3 hours to the total time the MHM is occupied for a maximum time estimate. These assumptions result in a triangular cycle time distribution time of 3 hours minimum, 3.3 hours mode time, and 6.3 hours maximum.

7.0 REFERENCES

Cleveland, K. J., 1996, *Spent Nuclear Fuel Project Design Basis Capacity Study*, WHC-SD-SNF-RPT-011, (Rev 1), Westinghouse Hanford Company, Richland, Washington.

LATA/BNFL/Foster Wheeler, nd *Fuel Retrieval Sub-Project Conceptual Design Report,* L/B-SD-SNF-RPT-009, Rev 0, Los Alamos Technical Associates/British Nuclear Fuels Limited/Foster Wheeler, Richland, Washington.

Pajunen, A. L., 1996, *Development of Design Basis Capacity for Spent Nuclear Fuel Project Systems*, WHC-SD-SNF-TI-016, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

PNNL, 1997, *Final Report – SNF Retrieval Systems Fuel Handling Development Testing,* Pacific Northwest Laboratories, Richland, Washington.

Transnuclear, nd, "Preliminary Design Analysis Report for the TN-WHC Cask and Transportation System - Project 3035," E-14573, Transnuclear, Inc., Hawthorn, New York.

Irwin, J. J., and Miska C. R., *SNF Project Cold Vacuum Drying Facility Operations Manual,* SNF-2356, Rev 3, Fluor Hanford, Inc., Richland, WA

H-2-1234000, Rev 0, CSB *Operations Sequence Block Flow Diagram*

APPENDIX A

VALIDATION REQUIREMENTS

CONSISTING OF 2 PAGES
INCLUDING COVERSHEET

APPENDIX A

VALIDATION REQUIREMENTS

Witness is a commercially available off-the-shelf software for which validation requirements are covered under WHC-CM-4-2 *Quality Assurance Manual* and WHC-CM-3-10 *Software Practices*. The software is not modified and will not be incorporated into the development of other software. The use of this software does not invoke or address any health or safety issues.

Validation of this software addresses only the SNF process model and is not intended as overall software validation. Other groups using this software will need to validate their particular applications.

Software requirements

This software is intended to be used as a simulation program to model the SNF project and subprojects. The simulation program must be capable of performing "what if" scenarios when analyzing method or process alternatives, performing time and motion studies, determining queuing sizes and frequencies, determining problem elimination or learning curves, evaluating flow restrictions and plant and work station layout, incorporating machine breakdown cycles and repair times, and including workstation staffing.

User documentation

Modeling for this application was based on the flow diagram shown in figures 4.1.2 and the operating efficiencies and cycle times listed in table 4.1.3. Each machine or queue was input into the model along with the proper logic ties to create a representation of the SNF project.

Test case specification

There was no formal test case specification prepared for this study. In various meetings with the software administrator and responsible engineers it was decided that the responsible engineers would review input to the model and determine if the desired results were obtained.

Test procedure specification

As new items or features were added to the base model the output was checked to see if the expected results were obtained. The responsible engineer checked the output against the SNF operating baseline. If the output didn't represent the proposed SNF processes the logic was examined and revised to achieve expected system operations

Software configuration control plan

The computer program is controlled in accordance with WHC-CM-3-10 Software Practices. Maple Lee, the computer programmer, who keeps a separate data file of the input and the output for each case, retains the electronic data files.