APR 28 1995
(70) 4. (36)

ENGINEERING DATA TRANSMITTAL

1. EDT 157501

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) Risk Assessment and Environmental Modelling	4. Related EDT No.: N/A
5. Proj./Prog./Dept./Div.: W-236A Multi-Function Waste Tank Facility	6. Cog. Engr.: Garill A. Coles	7. Purchase Order No.: N/A
8. Originator Remarks: For Review. Send comments (or "no comment") by 04/11/95. Electrical RCR appreciated.		9. Equip./Component No.: N/A
		10. System/Bldg./Facility: N/A
11. Receiver Remarks:		12. Major Assm. Dwg. No.: N/A
		13. Permit/Permit Application No.: N/A
		14. Required Response Date: ~~04/11/95~~ ASAP

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	WHC-SD-W236A-ES-014	All	0	MWTF Path Forward Engineering Analysis Technical Task 3.6, Estimate of Operational Risk in 200 Area West	N/A	~~4~~ 1,2		

16. KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
E, S, Q, D or N/A (see WHC-CM-3-5, Sec.12.7)	1. Approval 2. Release 3. Information 4. Review 5. Post-Review 6. Dist. (Receipt Acknow. Required)	1. Approved 2. Approved w/comment 3. Disapproved w/comment 4. Reviewed no/comment 5. Reviewed w/comment 6. Receipt acknowledged

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.
1	1	Cog.Eng. GA Coles	[signature]	4/25/95	B4-66	RL Fritz	[signature]	4-26-95	B4-08		1
1	1	Cog. Mgr. JM Light	[signature]	4/26/95	B4-08						
		QA									
		Safety									
		Env.									

18.	19.	20.	21. DOE APPROVAL (if required)
G.A. Coles [signature] 4/26/95 Signature of EDT Originator Date	J. M. Light [signature] 4/26/95 Authorized Representative Date for Receiving Organization	J. M. Light [signature] 4/26/95 Cognizant Manager Date	Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments

SUPPORTING DOCUMENT

1. Total Pages ~~139~~ 140

2. Title	3. Number	4. Rev No.
MWTF Path Forward Engineering Analysis - Technical Task 3.6, Estimate of Operational Risk in 200 Area West	WHC-SD-W236A-ES-014	0

5. Key Words

MWTF, TANKS, PATH FORWARD, W236A, ENGINEERING ANALYSIS

6. Author

Name: GA Coles

Signature [signature] for

Organization/Charge Code DPMTF

7. Abstract

8. RELEASE STAMP

OFFICIAL RELEASE
BY W-236A IMT
DATE APR 28 1995
STATION ~~70~~ 36 CLERK 70

A-6400-073 (08/94) WEF124

RELEASE AUTHORIZATION

Document Number:	WHC-SD-W236A-ES-014, Rev. 0
Document Title:	MWTF Path Forward Engineering Analysis - Technical Task 3.6, Estimate of Operational Risk in 200 Area West
Release Date:	April 28, 1995

This document was reviewed following the procedures described in WHC-CM-3-4 and is:

APPROVED FOR PUBLIC RELEASE

WHC Information Release Administration Specialist:

V.L. Birkland (signature)   April 28, 1995

V.L. Birkland

MULTI-FUNCTION WASTE TANK FACILITY PATH FORWARD ENGINEERING ANALYSIS TECHNICAL TASK 3.6, ESTIMATE OF OPERATIONAL RISK IN THE 200 WEST AREA

by

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EXECUTIVE SUMMARY

Introduction

Project W-0236A has been proposed to provide additional waste tank storage in the 200 East and 200 West Areas. This project would construct two new waste tanks in the 200 West Area and four new tanks in the 200 East Area, and a related project (Project W-058) would construct a new cross-site line. These projects are intended to ensure sufficient space and flexibility for continued tank farm operations, including tank waste remediation and management of unforeseen contingencies. The objective of this operational risk assessment is to support determination of the adequacy of the free-volume capacity provided by Projects W-036A and W-058 and to determine related impacts.

The approach taken is an operational risk assessment to identify the possible free-volume requirements based on potential operational decisions and upset events. The scope of the assessment is the 200 West Area only and covers the time period from the present to the year 2005. This assessment addresses the minimum core activities and proposed options contained in WHC-SD-WM-ER-029, *Operational Waste Volume Projection** and an evaluation of other possible activities for the 200 West Area tank farm. Two different time periods (1995 through 1998 and 1999 to 2005) were analyzed because the new cross-site tie line will not be available until 1999. It is assumed, for this study, that there is no limitation on transfer of waste to the 200 East Area.

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*Koreski, G. M., and J. N. Strode, *Operational Waste Volume Projection*, WHC-SD-WM-ER-029, Rev. 20, Westinghouse Hanford Company, Richland, Washington.

Free-volume limitations in the 200 East Area would affect successful operation in the 200 West Area.

Conclusions

For the 1995 through 1998 time frame, the most likely situations (79% of the cases) will result in free-volume requirements in the 200 West Area in excess of 5,000 kgal.* There is a 75% confidence that the free-volume requirements will be less than approximately 8,600 kgal and a 90% confidence that it will be less than 9,200 kgal. The major contributors to the total waste volume in the 1995 through 1998 time period are normal facility-generated waste, salt well pumping of the single-shell tanks (SST), SST leaks, and facility upsets. This includes cases in which the tank farm facility does not have any flexibility to deal with waste generated by unplanned facility activities. In addition, dilution is not performed on the waste contained in tanks 241-SY-101 and 241-SY-103 in these operational scenarios.

For the 1999 to 2005 time period, the most likely situations (65% of the cases) will result in mean free volume requirements between 4,200 and 5,800 kgal. There is a 75% confidence that the generated waste will not exceed 5,500 kgal and a 90% confidence that the free volume will not exceed 5,800 kgal. The major contributors to these totals in the 1999 to 2005 time frame are normal facility-generated waste, salt well pumping of the remaining SSTs, no flexibility for dealing with waste generated by unplanned facility activities, the retrieval of the TX-107 and TX-118 solids, SST leaks, and

*To convert kgal to kL, multiply by 3.785.

facility upsets. Dilution is not performed in the waste contained in tanks 241-SY-101 and 241-SY-103 in these operational scenarios.

Unsuccessful scenarios range from 31% to 17% chance of occurrence for the 1995 through 1998 and 1999 to 2005 time periods, respectively. Success is defined as having enough existing free tank space in the 200 West Area or the ability to transfer the volume to the 200 East Area. Given the degree of uncertainty of particular input parameters in this assessment, this position is not operationally favorable. The situation is even less favorable if free tank space in the 200 East Area is limited and, therefore, unavailable for transfers from the 200 West Area. Some of the potentially major and severe impacts of the unsuccessful scenarios are as follows.

Key major impacts include: (1) no free tank space to handle contingencies such as confirmed tank leaks, (2) no free tank space to handle unscheduled volumes, which may or may not have safety significance, and (3) no room to handle dilution waste from mitigation of tank 241-SY-103 if needed.

Key severe impacts include: (1) inability to accommodate facility waste which primarily jeopardizes the tank characterization effort and decontamination activities at T Plant, (2) inability to accommodate salt well pumping effluent which jeopardizes Tri-Party Agreement commitments and waste retrieval schedules and increases the chance of a leak to the environment, (3) inability to accommodate unplanned and unscheduled volumes which could represent a major or severe impact depending on the safety implications, and (4) inability to support the single-shell tank retrieval schedule which has a significant impact on many other programs.

The probabilities reported in these results should be used with caution. This is particularly true in this study because knowledge about waste volume issues continues to evolve. Probabilities change because risk prediction is based on present information. Also, scenarios will evolve as contingency planning progresses. The main values this risk assessment are the engineering insights, the capability to highlight significant risk issues, and the ability to establish a framework that can be used to assess future changes. The following are key insights:

- Success of 200 West Area tank farm operations is highly correlated to the success of the cross-site transfer line and the ability of the 200 East Area to receive waste from 200 West.

- There is a high likelihood of a leak in a complexed single-shell tank in the next 4 years (sampling pending).

- There is a strong likelihood, in the next 4 years, that some combination of tank leaks, facility upsets, and cross-site line failure will require more free tank space than is currently available in tank 241-SY-102.

- In the next 4 to 10 years, there is a strong likelihood that a combination of a cross-site line failure and the need to accommodate some unscheduled waste volume will require more free tank space than is presently available in tank 241-SY-102.

- The inherent uncertainty in volume projections is in the range of 3 million gallons.* This uncertainty needs to be seriously considered if plans are to operate with a marginal free tank space volume of less than this amount.

- New million-gallon tanks increase the ability to manage contingencies and unplanned events. In the 1999 to 2005 time frame, it significantly reduces risks with major impacts (contingencies and unplanned events) but does not significantly decrease certain risks with severe impacts (significant affects on operational programs).

Assessment Approach

This risk assessment (1) identifies the tank waste free-volume issues, (2) identifies the possible paths that future operations could take, and (3) quantifies the likelihoods and free-volume impacts of such paths. These possible paths are referred to in this assessment as operational scenarios. Development of operational scenarios was done in two parts: identification of the operational volume and waste handling issues and development of possible combinations of handling system configurations and failures. The operational volume and waste handling issues included in this risk assessment are shown in Table 1. The combinations of waste handling issues and failures (operational scenarios) were developed and quantified using an event tree analysis method.

Large numbers of operational scenarios were developed and grouped by similar characteristics (e.g., potential for similar free-volume generation).

*To convert gallons to liters, multiply by 3.785.

In this way, the impact and likelihood of a comprehensive set of operational scenarios were assessed. A sensitivity analysis was performed on the results to gain insight into certain dependencies and the effect of certain input assumptions.

Additionally, the uncertainty associated with each operational scenario free-volume prediction was estimated and a probability distribution was assigned. These distributions were used to assess the character of all identified, potential, combined free volumes associated with an operational scenario and identify the 75% and 90% confidence limits.

Table 1. Operational Volume and Handling Issues Addressed.

200 West Area operation	
Facility waste	Facility-generated waste volumes
Dilution volume	Volumes from dilution of tanks 241-SY-101 and 241-SY-103
Salt well pumping	Salt well pumping volumes
Flexibility	Volumes from unplanned activities
Retrieval	Volumes from retrieval of single-shell tanks
Tank leak and facility upsets	
Single-shell tank leak	Single-shell tank leaks
Double-shell tank leak	Double-shell tank leaks
Facility upset	Facility upsets
Waste volume handling	
SY Farm	SY Farm tank, line, and pump availability
Transport	Transfer by tanker car or truck versus pumping
Cross-site	Operability of cross-site transfer line

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MULTI-FUNCTION WASTE TANK FACILITY PATH FORWARD ENGINEERING ANALYSIS TECHNICAL TASK 3.6, ESTIMATE OF OPERATIONAL RISK IN THE 200 WEST AREA

1.0 INTRODUCTION AND SCOPE

Additional waste tank space is proposed for the 200 East and 200 West Areas. Accordingly, Project W-0236A would construct two new waste tanks in the 200 West Area and four new tanks in the 200 East Area. This project, combined with Project W-058, the new cross-site transfer line construction, will (1) ensure sufficient space and flexibility for continued tank farm operations, (2) allow tank waste remediation operations to go forward, and (3) provide for any unforeseen contingencies. An assessment is needed to determine the urgency and benefits of these new construction projects.

1.1 PURPOSE AND SCOPE

This assessment determines the likely distribution of various free-volume requirements to assess the basis for Projects W-036A and W-058 and to determine their impacts. The approach taken is an operational risk assessment. The outcomes of concern were related to tank waste generated. The study includes safety, environmental, and programmatic concerns. The scope of the assessment is confined to the 200 West Area and extends through 2005. The assessment will include the minimum core activities and proposed options contained in WHC-SD-WM-ER-029, *Operational Waste Volume Projection* (Koreski and Strode 1994); and an evaluation of other possible activities for the 200 West Area tank farm.

1.2 DESCRIPTION OF WASTE HANDLING EQUIPMENT AND FACILITIES

The major waste handling equipment includes double-shell tanks (DST), single-shell tanks (SST), salt well jet pumps, various interconnecting lines and receiver tanks, the cross-site transfer line and pump, and tanker cars and trucks used to transfer waste across the site. Facilities that continuously generate new waste volumes are described later in this section.

The DSTs support the ongoing cleanup missions at the Hanford Site. Three DSTs in the 200 West Area have a design capacity of 1.14 million gal* each; all these tanks are partly or nearly full. The DSTs confine liquid, salt cake, and sludge wastes from the environment. None of the existing DSTs have collapsed or leaked and none are planned to be replaced. The continued acceptability of their performance depends on the degree to which aging degradation affects the concrete and steel components.

*To convert gallons to liters, multiply by 3.785.

Waste segregation and compatibility are requirements of DOE Order 5820.2A, *Radioactive Waste Management* (DOE 1988) and WAC 173-303-395, "Dangerous Waste Regulations." The overriding purpose of segregation and compatibility requirements is to ensure the safety of waste storage and tank farm operations. Tanks 241-101-SY (101-SY) and 241-103-SY (103-SY) are hydrogen-generating Watch List tanks and contain complexed concentrate (CC). It is unlawful to add to these tanks. Tank 241-SY-102 (102-SY) is a dilute receiver tank but contains transuranic (TRU) and dilute noncomplexed waste.

The SSTs were constructed between 1943 and 1964 to store liquid and solid by-product wastes as a by-product of plutonium production. In 1980, all 149 200 East and West Area SSTs were declared out of service and all newly generated waste was pumped to DSTs. The SSTs contain salt cake and salt sludge solid volumes and supernatant and interstitial liquid. Most of the supernatant liquid has been pumped out.

Salt well liquid pumping will occur for SSTs that have 50,000 gal or more of drainable interstitial liquid. The schedule for pumping these tanks is a Tri-Party Agreement (Ecology et al. 1994) milestone. Twenty-five more tanks have >50,000 gal of drainable liquid remaining. Jet pumps suction water out of the tanks at a low rate (i.e., 5 gpm) and deliver it to double-contained receiver tanks (DCRT). Many of the lines from the SSTs to receiver tanks are direct-buried carbon steel lines. These lines are past their design life and have a relatively low reliability.

The DCRTs provide short-term storage of drainable liquids pumped from salt wells. The DCRTs also serve as a valve pit to route waste to another storage or process. There is more than one design, but in general the DCRT capacity is about 20,000 gal. When full, the contents are pumped out of the DCRT to the 102-SY DST dilute receiver tank through double-encased lines. The 102-SY tank contains the cross-site transfer pump for waste transport to the 200 East Area.

The current cross-site transfer line is a relatively old, stainless steel line in a concrete enclosure and is approximately 5.7 miles[1] long. The reliability of this line is questionable and it has not been used since 1986. Hydrostatic tests are planned in the near future. A new cross-site transfer line is scheduled to be in service in 1998. The new design is a 3-in.[2] stainless steel line inside a 6-in. carbon steel line. The new line will be about 6.5 miles long. Plugging in this line, because of crystallization or sedimentation, is a concern because plugging caused four of six cross-site transfer lines to fail in the 1960's.

Facility-generated waste is being transferred by truck or rail car to the 200 East Area 204-AR Waste Unloading Facility. The 5,000-gal stainless steel trailer tank is a commercial, unshielded tank that has been modified to interface with the 204-AR Waste Unloading Facility. The rail tank cars are standard, single-shell, unshielded, commercial interstate railroad cars

[1]To convert miles to kilometers, multiply by 1.6093.

[2]To convert inches to centimeters, multiply by 2.54.

(classified as Department of Transportation Type 111 A 100 wg) that have been modified for current use. Safety analysis reports (SAR) provide accident analyses for the 204-AR Waste Unloading Facility and for railroad liquid waste tank cars. The trailer tank is not discussed in an SAR because it contains only low specific activity waste.

Facilities that generate continuous new waste volume for the DSTs are (1) the S Plant (222-S Laboratory), (2) the T Plant (decontamination and treatment facility), and (3) the Plutonium Finishing Plant (PFP).

The 222-S Laboratory is a dedicated laboratory facility that provides analytical chemistry services in support of the processing plants on the Hanford Site. The 222-S Plant radioactive liquid waste is generated by decontamination operations and disposal of process and environmental samples. The primary program being supported is tank characterization. Dilute, noncomplexed wastes resulting from 222-S Plant operations are transported by tanker truck to the 204-AR vault in the 200 East Area.

The primary mission of the T Plant is decontamination and treatment of radioactively and chemically contaminated waste and equipment. The T Plant 2706-T Low-Level Decontamination Facility has recently been approved for restart and should reach full operating capacity in calendar year 1995. Dilute, noncomplexed wastes collected at T Plant during decontamination, repackaging, condensate collection, or rail car certification are currently being transported via rail car to the 204-AR vault in the 200 East Area.

The PFP in the 200 West Area houses the process and supporting operations for a number of different plutonium processing operations. Current plans for PFP include a stabilization run in 1998 to clean up the currently active process lines. This run would increase the liquid waste output to a high level for approximately 2 years. The current output level is low (36,000 gal a month plus flush water).

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2.0 ASSESSMENT

This risk assessment (1) examines the identified waste volume issues, (2) identifies the possible paths that future operations could take, and (3) quantifies the likelihood and impacts of such paths. These possible paths are referred to in this assessment as operational scenarios.

Development of operational scenarios was done in two parts: development of possible waste generator volumes, and development of possible handling system configurations and failures. These parts together make scenarios that can be represented in the form of event trees. Each line through the event tree is a representative path.

This section consists of three parts. Section 2.1 discusses the identification of operational issues related to tank space volume. Section 2.2 discusses modeling of the possible operational scenarios, including projected waste volumes and handling system operability and corresponding likelihoods. Section 2.3 discusses the resulting scenarios and how they were grouped.

2.1 OPERATIONAL VOLUME AND HANDLING ISSUES

Before the operational scenarios can be developed, the issues concerning tank space need to be examined. This section briefly describes some key issues as well as sources of information important to this effort. These issues fall into three categories: 200 West Area operations, tank leaks and facility upsets, and waste volume handling tank lines and pumps. These issues are shown in Table 2-1.

Facility-generated waste volumes come primarily from S Plant, T Plant, and PFP. These volumes are generated in support of waste sampling, decontamination, flushing, and other activities. As program and operational needs change, these volumes are likely to change. Because free tank space is limited, there is motivation to reduce generated waste volumes. However, as the cleanup mission at the Hanford Site becomes better defined there is a potential that other waste streams will be produced.

Additional waste volume will be created if 101-SY and 103-SY are passively mitigated using a dilution volume. There is some question as to how much water is needed for mitigation and safe transfer. Currently, a 1:1 ratio should be more than adequate and a 1:0.5 would probably be adequate (Hudson 1995). However, ratios ranging up to 3:1 were proposed at one time. Additionally, the costs to actively versus passively mitigate 101-SY and 103-SY may affect the decision to proceed with one option or the other. The current plan is to continue with active mitigation to eliminate the need for dilution water, thus greatly reducing projected waste volumes.

Table 2-1. Operational Volume and Handling Issues.

200 West Area operations	
Facility waste	Facility-generated waste volumes
Dilution volume	Volumes from dilution of tanks 241-SY-101 and 241-SY-103
Salt well pumping	Salt well pumping volumes
Flexibility	Volumes from unplanned activities
Retrieval	Volumes from retrieval of single-shell tanks
Tank leaks and facility upsets	
Single-shell tank leak	Single-shell tank leaks
Double-shell tank leak	Double-shell tank leaks
Facility upset	Facility upsets
Waste volume handling	
SY Farm	SY Farm tank, line, and pump availability
Transport	Transfer by tanker car or truck versus pumping
Cross-site	Operability of cross-site transfer line

One of the greatest sources of liquid waste volume comes from salt well pumping of the SSTs. The projected pumpable liquid volume from these tanks is based on assumptions about the porosity of the tank contents, primarily, salt cake and sludge. Volume projections in the past have been based on 35% salt cake porosity. Drainable liquid amounts reported in WHC-EP-0182-79, *Waste Tank Summary for Month Ending October 31, 1994* (Hanlon 1994), are based on 45% porosity. However, calculations done with recent field measurements and recalculations of old data indicate porosities for salt cake may average about 63% and vary from 30% to 100% (Brown and Mattichak 1995). A change in the porosity for sludge is not as great and could be about 16%. The difference between the actual versus projected porosity has led to underestimation in the waste volume projection.

There is a need for operational flexibility to accommodate future activity that is presently unscheduled, particularly because the mission at the Hanford Site changed only a few years ago and is still evolving. In the past few years, major swings have occurred in such programs as the startup and shutdown of the grout facility. This particular evolution has an important affect on current waste storage volumes. Clearly there is uncertainty about what affect future changes may have on projected waste volumes.

Remediation of TX-107 and TX-118 could be initiated before 2005 (Certa 1995). Additional volume is generated from the dilution needed for removal and transport. The dilution ratio is in the same range as for 101-SY and 103-SY.

Leaks that occur in SSTs require emergency salt well pumping (Wiggins 1994). This volume is pumped to a DCRT and then by batches to a DST. The Hanlon document reports the month and year in which SSTs were discovered to be leaking. It is almost certain that additional tanks will begin leaking during the next few years.

Leaks that occur in DSTs will likely be contained by the outer tank shell; however, waste cannot be stored this way because double containment is required. The DSTs are newer than the SSTs and none have failed yet. If a DST does fail, up to about 1 million gal of high-level liquid waste may be at risk. Life management of the DST and associated lines is important because it is assumed that waste can be safely stored until the waste is retrieved. Failure probabilities are assumed to be low but analysis is ongoing.

Facility upsets have occurred in contaminated areas and have required quantities of liquid to be transferred to a waste tank. The volume of these upsets ranges from a few thousand gallons to tens of thousands of gallons.

The SY Farm could become degraded in a number of ways because of line, tank, or pump failure. For example, 102-SY could be available for storage but unavailable for staging and cross-site transport; or it could be available for cross-site transport but not storage. It could be unavailable for both.

Segregation of waste is also an issue affecting use of the SY Farm. Different waste types are required to be segregated for safety reasons. Three DSTs (101-SY, 102-SY, and 103-SY) are located in the 200 West Area. Tanks 101-SY and 103-SY are on the Watch List; therefore, no waste can be added to those tanks unless the Secretary of Energy deems it necessary. The remaining tank, 102-SY, currently has 380,000 gal of additional capacity. It also contains the cross-site transfer pump. Accordingly, any cross-site transfer must be done via SY-102. However, 102-SY contains TRU waste which should not be mixed with CC. Because 40% of the 200 West Area tanks are of this type, this is an issue. If a tank containing CC develops a leak, there is an issue of where to pump the drainable liquid in the leaking tank.

Currently, waste is being transferred to the 200 East Area from T Plant by rail car and from 222-S to the 200 East Area by tanker truck. This arrangement is intended to be temporary but a necessary safety basis is in place. Free tank space is limited in the 200 West Area, so if the cross-site line is unavailable, transport by tanker could be important.

The current cross-site transfer line has not been used since 1986 and its reliability is questionable. A new cross-site transfer line is scheduled to be in service in 1998. Plugging is a important failure mode (six of eight lines are plugged). Both sedimentation and crystallization have caused plugging.

The most important and current sources of information are ongoing studies supporting the Multi-Function Waste Tank Facility (MWTF) path forward decisions, of which this report is a part. In September 1994, an action plan was initiated that set into motion several technical and trade studies which are critical to understanding the waste volume and handling issues. They are as follows:

- 101-SY and 103-SY dilution ratios
- Evaporator system performance
- SST liquid contents
- Waste segregation analysis
- Life management of existing DSTs
- Estimates of operational risk (this assessment)
- Passive versus active mitigation cost analysis
- Retrieval sequence
- Systems engineering.

Another important source of information is the annual tank space volume projections given in WHC-SD-WM-ER-029 (Koreski and Strode 1994). This document identifies important volume generation factors. However, these projections are point estimates, and in reality, various volume uncertainties exist. Management decisions about how to operate the tank farm change over time and invalidate the assumptions used in the projections. Also, there is uncertainty about the size of certain streams. For example, there is uncertainty about the porosity of the salt cake in the SSTs. This affects the amount of calculated drainable liquid remaining. The Koreski and Strode document does not explicitly calculate contingency needs related to leaks and facility upsets that contribute to the waste volume.

Another source of data is tank farm records, which are important in understanding the probability and size of tank leaks and facility upsets. These records are also needed to determine the reliability of certain lines, pumps, and tanks used in the handling. Interviews with tank farm operators are another important source of information.

2.2 MODELING OF OPERATIONAL SCENARIOS

Possible paths that future tank farm operations could take can be modeled using operational scenarios, which are developed by systematically identifying possible future events. Identification of future possible events is derived by examining tank farm operations and corresponding limited tank space issues. Operational scenarios can be represented with event trees, which are graphical representations of scenarios that depict many series of events that diverge from each other at various branch points.

Operational scenarios in this assessment are represented by three separate but linked event trees. The first event tree depicts possible waste volumes that can be generated depending on what decisions are made about tank farm operations. The second tree provides a continuation of each end point in the first tree. It depicts contingency volumes that must be handled from facility upsets or tank leaks. Each path through these combined trees, which relate to potential volumes, feeds the third and final tree. This tree depicts different possible tank farm configurations and operability. When linked together, these event trees represent the operational scenarios.

Operational scenarios were developed for two different time regimes. The total mission is 10 years but is divided into a 1995 through 1998 case and a 1999 to 2005 case. There are a number of differences between the two time regimes. Salt well pumping would be nearly done by 1999 if it proceeds as scheduled. Also, in 1999 the cross-site line would be in service and the two new tanks would be in service if plans proceed to initiate their construction.

The remainder of this section identifies future possible events. Section 2.2.1 discusses development of different waste volume possibilities from 1995 through 1998. All operational scenarios begin with some waste volume being generated. Section 2.2.2 describes modeling of the waste handling system for 1995 through 1998. The combination of possible generated waste volumes with how those volumes are handled or stored represents complete operational scenarios. Sections 2.2.3 and 2.2.4 are similar to the previous two sections except the modeling is from 1999 to 2005.

For each issue affecting operational scenarios, there are a number of different possible contributing events (see Table 2-2 for a summary). Variability in actual volumes caused by uncertainty about specific parameters is addressed later in this assessment as probability distributions.

Table 2-2. Possible Events for Operational Scenarios.

200 West Area operations				
Issues	Possible future events			
Facility waste	Generation	No generation	--	--
Dilution volume	Dilute	Mix	--	--
Salt well pumping	Pump	Pump tanks left	Pump all tanks	Delay/delay again
Flexibility	Flexibility	None	--	--
Retrieval	Yes	No	--	--
Tank leaks and facility upsets				
SST leak	No SST leak	SST leak (1 to 10)	--	--
DST leak	No DST leak	DST leak	--	--
Facility upset	No upsets	Upsets (1 to 10)	--	--
Waste volume handling				
SY Farm	Available	Transfers only	Storage only	Totally unavail
Cross-site	Available	Unavailable	Emergency only	--
New cross-site	Fully available	Fails in service	Not built	--
Old cross-site	Fully available	Fails in service	Out-of-service	--
Transport	Pump	Truck/rail	No transfer	--

DST = Double-shell tank
SST = Single-shell tank

Future possible events related to these 200 West Area operations are shown in Table 2-2. Although unlikely, there is a theoretical chance that the facility waste stream could be eliminated or drastically reduced. Accordingly, two future possibilities are predicted and identified in Table 2-2: 'Generation' and 'No generation.' Variability in actual facility-generated waste is assessed later in this report.

Waste volume resulting from dilution of 101-SY or 103-SY will depend on the decision to actively or passively mitigate those tanks. Accordingly, two events are postulated as 'Dilute' and 'Mix.'

Salt well pumping generates a large volume of high-level waste and four possibilities are postulated. Possibilities identified as 'Pump' and 'Pump tanks left' represent the chance that salt well pumping proceeds as scheduled and is nearly complete by 1999. One is related to the volume that would be pumped from 1995 through 1998, and the other is related to the remaining volume that would be pumped from 1999 to 2005. Still another possibility is that salt well pumping is delayed entirely into the 1999 to 2005 time frame and is identified as 'Pump all.' A final possibility is that salt well pumping is delayed into the later time period and then delayed again.

Maintaining operational flexibility represents the desire to be able manage future unknown volumes. Extra free tank space is required and this operating mode is represented in the table as 'Flexibility.' The absence of this, 'None,' means that future, undetermined waste generations will not be accounted for.

Retrieval of 107-TX and 118-TX could be delayed if tank space is unavailable. The 'Yes' possibility represents the possibility that these tanks are retrieved in the next 10 years.

Future possible events related to tank leaks and facility upsets are also shown in Table 2-2. There is a chance that one or more SST will leak. The effect of different possible volumes combined with different numbers of leaks is described later in this report. There is also the possibility that there will not be a leak at all. These two possibilities are identified in Table 2-2. Additionally, there is a chance that a DST leaks. However, the chance is low and the chance of having more than one DST leak in either the 1995 through 1998 or 1999 to 2005 year time period is low. Finally, there is a chance of having a facility upset. As with SST leaks, there could be no, or some number of, occurrences.

Future possible events related to the waste handling system are again shown in Table 2-2. The SY Farm could be successful or fail in a number of ways depending on what lines, pumps, or tanks fail. The SF Farm could be available, available for transfers only, available for storage only, or totally unavailable.

Possibilities related to the cross-site line depend on the time frame. In the early time period, through 1998, the line will be available or unavailable or possibly reserved for limited service such as emergencies. It is unavailable if it leaks, plugs, or is not allowed to remain in service. In the late time period, 1999 to 2005, it is possible that the new line is fully available, built but in a failed state after some service, or not built. In the same time period, the old line could be fully available, in service but in a failed state, or taken out of service.

The capacity to transfer facility waste by tanker truck or rail is identified in the table as 'Truck/rail.' If the capacity to transfer by tanker no longer exists, there are two possibilities: no transfer possible and transfer by pumping cross-site.

2.2.1 Operational Scenarios, 1995 Through 1998 - Waste Volume

This section describes development of different waste volume possibilities from 1999 to 2005. All operational scenarios begin with some waste volume being created and end with the handling of that volume. Created volumes include waste volumes generated from tank farm operations and contingency volumes from leaks and upsets. This section describes how waste volumes and their corresponding probabilities and magnitudes are derived, and how uncertainties are determined.

The first portion of this section discusses waste volumes generated from 200 West Area operations and their corresponding probabilities. The second portion discusses contingency waste volumes from leaks and upsets and corresponding probabilities. The third portion quantifies all volumes and probabilities.

<u>Waste Volume Through 1998 - 200 West Area Operations</u>

Future possible events related to 200 West Area operations shown in Table 2-2 can be combined in a number of ways to create different waste volumes. An event tree, shown in Figure 2-1, shows these possibilities. The following assumptions were made in the development of the event tree.

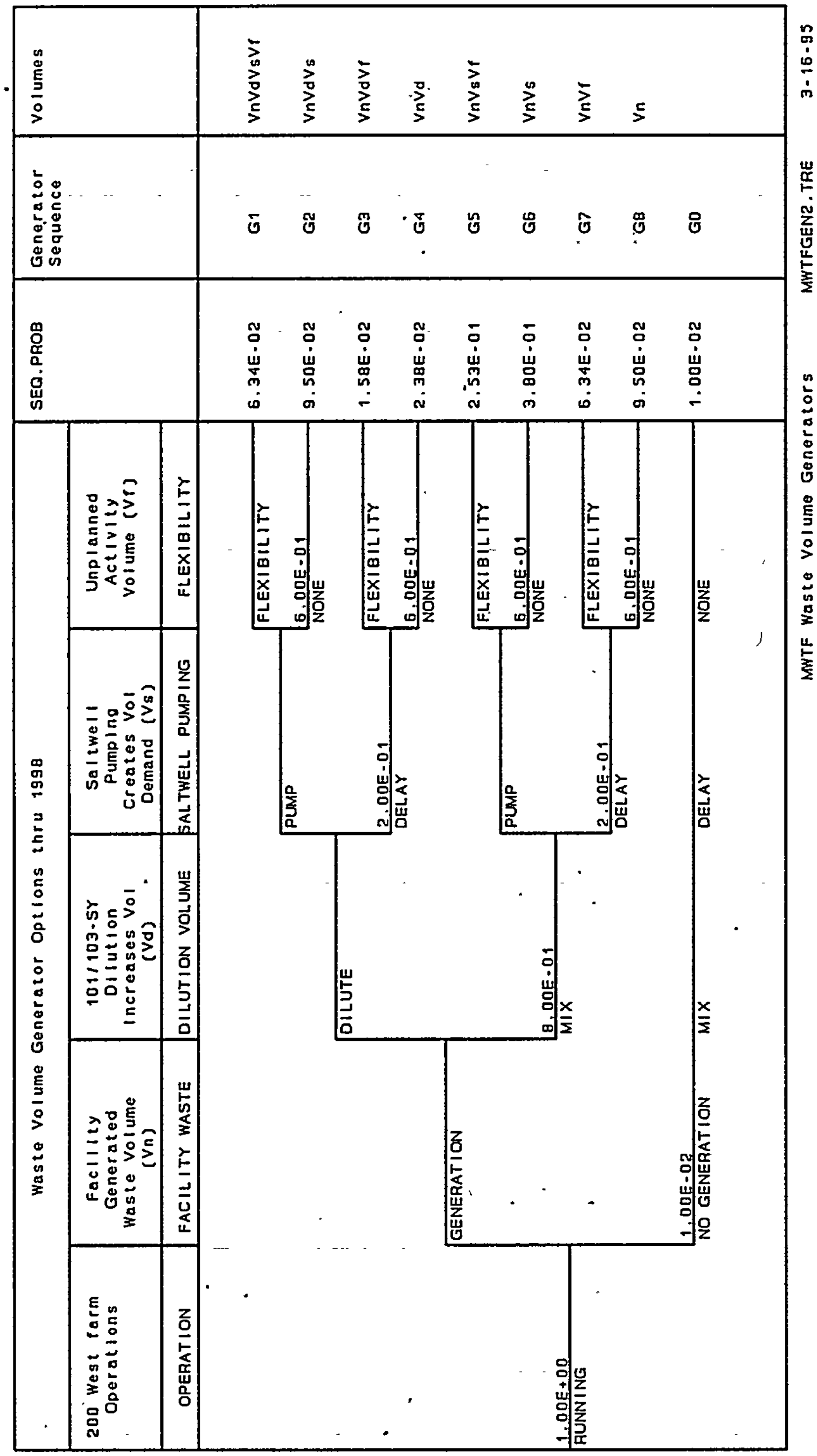
1. The schedule for salt well pumping or possible dilution of 101-SY or 103-SY could not be accelerated but might be delayed.

2. Outright elimination of normal facility waste is improbable, although volume combinations that exclude this waste stream are theoretically possible. Given the extraordinary effort required to eliminate all facility waste, it is unlikely that other waste streams would be allowed.

3. Probabilities selected for operational decisions are based on the following:

Decision	Probability
Decision is virtually guaranteed	0.99
Sure that option will used	0.80
Think option will be used	0.60
Do not think option will used	0.40
Doubt option will be used	0.20
Option is theoretically possible	0.01

Figure 2-1. Waste Volume Generator Options, 1995 Through 1998.



Each future possibility shown in Table 2-2 and each corresponding branch point in the Figure 2-1 event tree are predicted to occur at some probability (see Table 2-3).

Each set of possibilities shown in Table 2-3 and Figure 2-1 must sum to 1, because one or the other possibility must occur. Because it is highly unlikely that there is any alternative to accepting the facility-generated waste, a 0.01 probability was assigned to the 'No generation' possibility. The probability of the 'Generation' possibility is 0.99. The probability of generation and no generation sums to 1.0.

Related to possible dilution volumes, management has recently decided that continued active mitigation probably is the correct path. Opinion over this issue has evolved. Accordingly, the 'Mix' possibility is assigned a probability of 0.80 while the 'Dilute' possibility is assigned 0.20. If the dilution option is initiated, one tank would be done in the 1995 through 1998 time frame and one tank would be done in the 1999 to 2005 time frame.

Delaying salt well pumping would mean that Tri-Party Agreement milestones would have to be renegotiated, which is undesirable. However, in light of budget restraints it is a possibility. Therefore, the possibility that salt well pumping is delayed was assigned a probability of 0.20. The possibility that salt well pumping proceeds as scheduled was assigned a probability of 0.80.

There are two possibilities in regards to new potential waste volumes that are presently not projected. There may or may not be a need for tank space flexibility. Although there is an intention to minimize waste streams, new waste streams might be created as the cleanup mission evolves. In fact it might be unrealistic to account for that possibility. Therefore, the possibility that no flexibility is needed is assigned a probability of 0.60 and the possibility that flexibility is needed is assigned a probability of 0.40.

Table 2-3. 200 West Area Operations Event Probabilities, 1995 Through 1998.

Issues	Possible future events			
	Possibility	Probability	Possibility	Probability
Facility waste	Generation	0.99	No generation	0.01
Dilution volume	Dilute	0.20	Mix	0.80
Salt well pumping	Pump	0.80	Delay	0.20
Flexibility	Flexibility	0.40	None	0.60

Waste Volume, 1995 Through 1998 - Contingency Volumes

Future possible events related to tank leaks and facility upsets shown in Table 2-2 can be combined in several ways to create different waste volumes. An event tree in Figure 2-2 shows these possibilities and the scenarios created. The following assumptions were made in the development of the event tree.

1. Because a DST leak is improbable, any combination of a leak or upset with a DST leak is unlikely. Therefore, these combinations are not further considered. This volume was not included as a contributor to the volumes of any operational scenarios.

2. Once an SST is determined to be leaking, it will be completely pumped in accordance with guidance given in WHC-SD-WM-AP-005, *Single-Shell Tank Leak Emergency Pumping Guide* (Wiggins 1994).

3. The expected SST leak frequency and facility upset frequency will not increase or decrease significantly in the next 4 years.

Each future possibility shown in Table 2-2 and each corresponding branch point in the Figure 2-2 event tree are predicted to occur at some probability (see Table 2-4).

Each set of possibilities shown in Table 2-4 and Figure 2-2 must sum to 1, because one or the other possibility must occur. For example, the probability of having one or more SST leaks is 0.70 and the chance of no SST leak is 0.30. The probability of a DST leak is 9.6E-04. The probability determination for a DST leak and the supporting bases are given in Appendix A. The chance of having at least one facility upset is 0.62 and the chance of having none is 0.38.

The probability of a facility upset, from 1995 through 1998, is based on historical evidence; one major event (56,000 gal) in 4 years at the facilities of interest. The operational data and bases for this determination are given in Appendix A. The Poisson distribution was used to determine the probability of combinations of failures happening in 1995 through 1998. See Table 2-5 for probabilities.

Table 2-4. Tank Leak and Facility Upset Event Probabilities, 1995 Through 1998.

Issues	Possible future events			
	Possibility	Probability	Possibility	Probability
SST leak	No SST leak	0.30	SST leak (1-10)	0.70
DST leak	No DST leak	0.999	DST leak	9.6E-04
Facility upset	No upsets	0.38	Upsets (1 to 10)	0.62

DST = Double-shell tank
SST = Single-shell tank

Figure 2-2. Waste Volume from Leaks/Upsets, 1995 Through 1998.

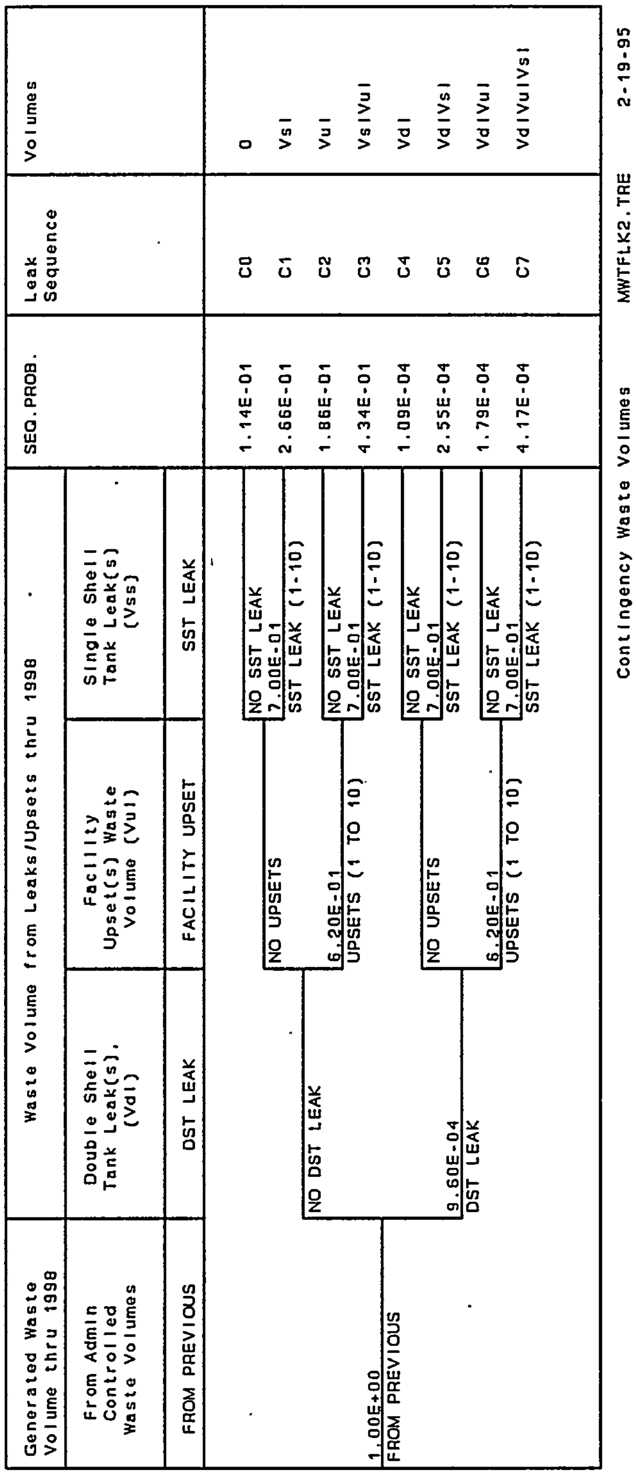


Table 2-5. Probability of a Major Facility Upset, 1995 Through 1998.

Time period	Probability of X number of failures in time period*					
	1	2	3	4	5	6
1995 through 1998	0.368	0.184	0.061	0.015	0.003	0.0005

*Prob = $e^{-lambda} lambda^{X}/X!$, where X = 1,2,3... failures and lambda = failure rate

The probability of an SST leak is also based on historical evidence. Figure 2-3 shows that the average leak rate has changed since 1980 when interim stabilization began. In the last 15 years there have been 5 leaks. This is the basis for the leak rate. The operational data and bases for this determination are given in Appendix A. The Poisson distribution was used to determine the probability of combinations of failures happening from 1995 through 1998. See Table 2-6 for probabilities.

<u>Waste Volume Magnitudes, 1995 Through 1998</u>

The bases for individual volume contributors from 200 West Area operations and from leaks and upsets are given in the appendixes to this report. The bases for volumes from 200 West Area operations (shown as future possible events in Table 2-3) are given in Appendixes B and C. Appendix B provides baseline information and Appendix C develops a probability distribution for each volume. The bases for contingency volumes from leaks and upsets are given in Appendixes A and D. Appendix A provides baseline information and Appendix D develops a probability distribution for each volume.

The event tree in Figure 2-1 shows how the volume contributors (Vn, Vd, Vs, and Vf) can be combined for 1995 through 1998. A few more combinations are theoretically possible but are considered nonsensical. The following combined volumes are associated with each of the end-states from the event tree:

- Generator Sequence, G1 = VnVdVsVf
- Generator Sequence, G2 = VnVdVs
- Generator Sequence, G3 = VnVdVf
- Generator Sequence, G4 = VnVd
- Generator Sequence, G5 = VnVsVf
- Generator Sequence, G6 = VnVs
- Generator Sequence, G7 = VnVf
- Generator Sequence, G8 = Vn
- Generator Sequence, 0 = No volume.

Each of these volumes has some uncertainty associated with it because Westinghouse Hanford Company has incomplete knowledge of certain factors affecting the volume projections.

Figure 2-3. History of Single-Shell Tank Leaks.

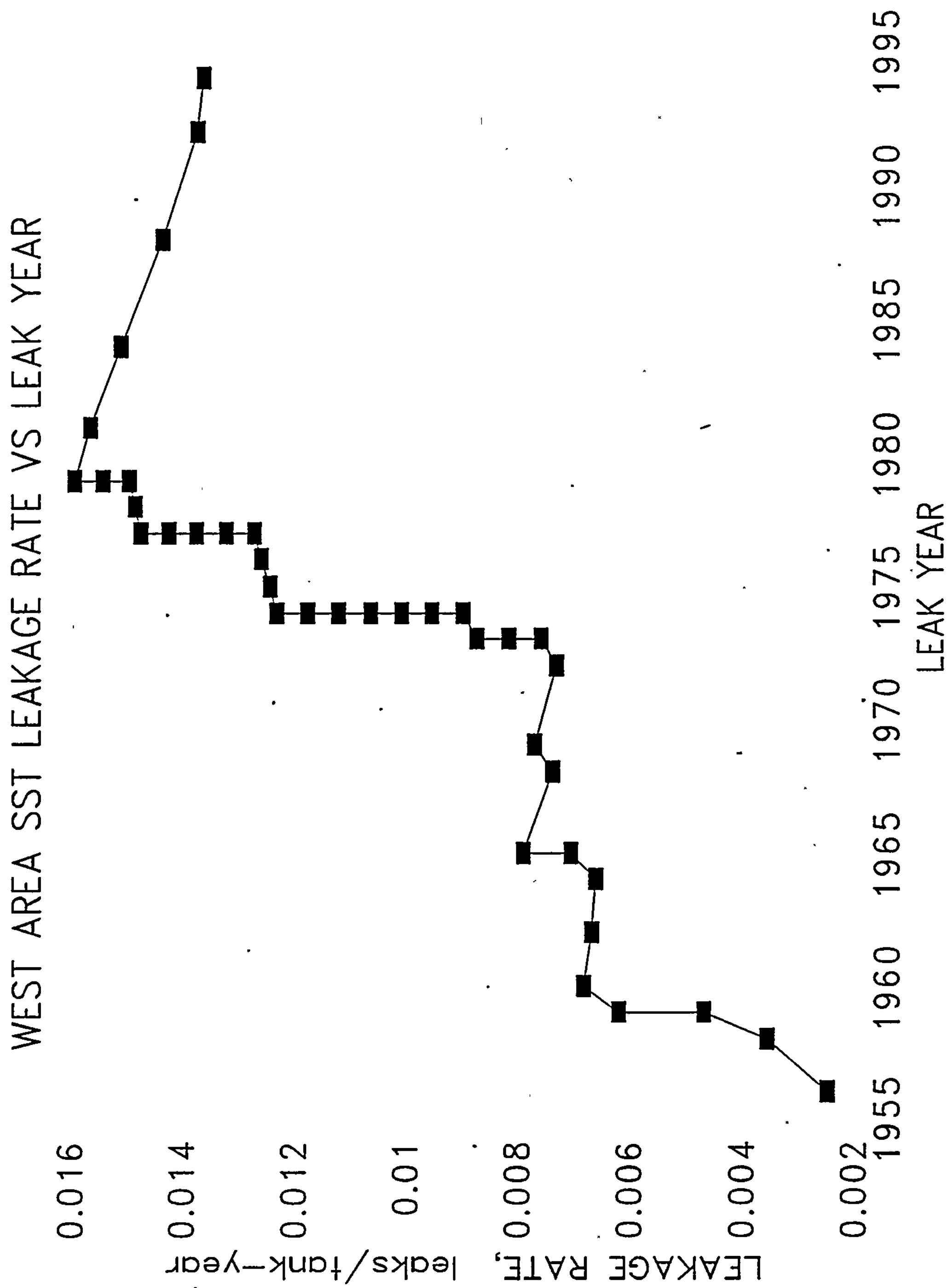


Table 2-6. Probability of a Single-Shell Tank Leak, 1995 Through 1998.

Time period	Probability of X number of failures in time period*					
	1	2	3	4	5	6
1995 through 1998	0.361	0.217	0.087	0.026	0.006	0.001

*Prob = $e^{-lambda} lambda^{X}/X!$, where X = 1,2,3... failures and lambda = failure rate

Waste volume from facilities is variable and could change as programs, projects, and missions change. Waste volumes projected for possible dilution of 101-SY and 103-SY depend on the dilution ratio used which could between 0.5:1 and 1.5:1. Waste volumes from salt well pumping volume depend on the actual salt cake porosities which have proven to be different than projected porosities. Tank space flexibility is needed to handle waste volumes for future unknown activities.

A projection of waste volumes (G1 through G8) was performed by combining probability distributions using a Monte Carlo simulation. The simulation bases, assumptions, and results are given in Appendix C. The resulting waste volumes are given as probability distributions. Results show millions of gallons of difference between the mean value and the 90 percentile value. This demonstrates significant uncertainty of actual versus projected values.

The event tree in Figure 2-2 shows how the contingency volume contributors (Vsl, Vdl, and Vul) can be combined for 1995 through 1998. A few more combinations (Leak Sequences C5, C6, C7) are theoretically possible but are related to combining with the chance of a DST leak, which is improbable:

- Leak Sequence C0 No leak or upset
- Leak Sequence C1 Vsl
- Leak Sequence C2 Vul
- Leak Sequence C3 VslVul
- Leak Sequence C4 Vdl.

In addition to the chance that certain contingencies will occur and need to be managed, there is also uncertainty in the volume of the contingency. For facility upsets, records show a number of upsets that fall into the 0 to 100 kgal range, Hanford Site wide. Small upsets (a few thousand gallons) are more frequent but larger spills (tens of thousands of gallons) do occur. One significant upset has occurred in a 200 West Area facility in the last 4 years. The probability distribution for one upset or some combinations of upsets was combined into a single probability distribution using a Monte Carlo simulation. This simulation and the supporting basis are given in Appendix D.

There is also some uncertainty related to what the volume of an SST leak could be. A leak could occur in any tank and they all contain different amounts of drainable volume. Accordingly, a volume distribution was created based on the volume of drainable liquid left in the subject tanks. The probability distribution for one upset or some combinations of upsets was combined into a single probability distribution using a Monte Carlo simulation. This simulation and the supporting basis are given in Appendix D, which includes the resulting mean and 90 percentile values.

Total possible waste volumes are the operationally generated volumes plus any contingency volumes. The bases for these volumes are the mean values generated from simulations described in Appendixes C and D, respectively. The contingency volumes are small (0 to 500 kgal) compared to the operationally generated volumes (2,000 to 10,000 kgal). Table 2-7 shows the combined mean volumes. The contingency volume designators across the top of the table (C0, C1, C2, and C3) correspond to those from Figure 2-2 and represent the different contingency volumes. The operationally generated volume designators are in the farthest left column of the table (G1 through G0) and correspond to volumes represented in Figure 2-1.

Total possible waste volumes have corresponding probabilities of occurrence. These probabilities of occurrence were generated by combining different events depicted in the event tree shown of operational and contingency volumes in Figures 2-1 and 2-2. The probability of the operationally generated volumes is combined with the probability of contingency volumes in Table 2-8.

Table 2-8 shows that there is a large number of total possible volumes, too many to handle individually. These volumes were collected into bins (volume bins). If a calculated volume fell into a certain range, it was assigned to the bin corresponding to its range. Its probability of occurrence was added to the probability of all other volumes collected into that bin. This process is shown in Table 2-9 for selected volume bins.

Table 2-7. Combined Generated and Contingency Mean Volume Totals, 1995 Through 1998.

Generated waste volumes (kgal)		Contingency leak and upset volume (kgal)			
		C0	C1	C2	C3
		0	Vsl	Vul	VslVul
G1	VnVdVsVf	8,804	9,078	8,883	9,157
G2	VnVdVs	7,804	8,078	7,883	8,157
G3	VnVdVf	4,352	4,626	4,431	4,705
G4	VnVd	3,356	3,630	3,435	3,709
G5	VnVsVf	8,569	8,843	8,648	8,922
G6	VnVs	7,074	7,348	7,153	7,427
G7	VnVf	3,622	3,896	3,701	3,975
G8	Vn	2,622	2,896	2,701	2,975
G0	0	0	274	79	353

Table 2-8. Combined Generated and Contingency Probability of Occurrence for Mean Volumes, 1995 Through 1998.

Generated waste volumes (prob)		Contingency leak and upset volume (prob)				
		None	C0	C1	C2	C3
		--	0	Vsl	Vul	VslVul
None	--	--	0.114	0.266	0.186	0.434
G1	VnVdVsVf	0.063	0.0072	0.0168	0.0117	0.0273
G2	VnVdVs	0.095	0.0108	0.0253	0.0177	0.0412
G3	VnVdVf	0.016	0.0018	0.0043	0.0030	0.0069
G4	VnVd	0.024	0.0027	0.0064	0.0045	0.0104
G5	VnVsVf	0.253	0.0288	0.0673	0.0471	0.1098
G6	VnVs	0.380	0.0433	0.1011	0.0707	0.1649
G7	VnVf	0.063	0.0072	0.0168	0.0117	0.0273
G8	Vn	0.095	0.0108	0.0253	0.0177	0.0412
G0	0	0.010	0.0011	0.0027	0.0019	0.0043

The following are the volume bin definitions:

Vol Bin 5 are those volumes <2,600 kgal but >400 kgal.
Vol Bin 4 are those volumes <3,000 kgal but >2,600 kgal.
Vol Bin 3 are those volumes <4,600 kgal but >3,000 kgal.
Vol Bin 2 are those volumes <5,000 kgal but >4,600 kgal.
Vol Bin 1 are those volumes >5,000 kgal.

The range of the volume bins is not arbitrary but corresponds to the following key waste handling capacities.

400 kgal — is approximately the volume that could be stored in head space of 102-SY.

2,600 kgal — is approximately the mean normally generated facility waste which is presently managed by truck and rail in the 1995 through 1998 time frame.

3,000 kgal — is a combination of the volume that could be stored in the head space of 102-SY and the normally generated waste volume which could be transported by truck or rail in the 1995 through 1998 time frame.

4,600 kgal — is a combination of the normally generated waste volume which could be transported by truck or rail and 2,000 kgal of additional storage made available in the 1995 through 1998 time frame.

Table 2-9. Binning of Total Volumes, 1995 Through 1998.

Combination	kgal	Prob	Combination	kgal	Prob
Vol Bin 1			Vol Bin 3		
G1/C3	9,167	0.0273	G3/C2	4,455	0.0030
G1/C2	8,883	0.0117	G3/C0	4,352	0.0018
G1/C1	9,081	0.0168	G4/C3	3,710	0.0104
G1/C0	8,804	0.0072	G4/C2	3,435	0.0045
G5/C3	8,923	0.1098	G4/C1	3,632	0.0064
G5/C2	8,648	0.0471	G4/C0	3,356	0.0027
G5/C1	8,843	0.0673	G7/C3	3,972	0.0273
G5/C0	8,569	0.0288	G7/C2	3,701	0.0117
G2/C3	8,158	0.0412	G7/C1	3,896	0.0168
G2/C2	7,883	0.0177	G7/C0	3,622	0.0072
G2/C1	8,078	0.0253	Total prob		0.0918
G2/C0	7,804	0.0108	Vol Bin 4		
G6/C3	7,428	0.1649	G8/C3	2,976	0.0412
G6/C2	7,153	0.0707	G8/C2	2,701	0.0177
G6/C1	7,348	0.1011	G8/C1	2,898	0.0253
G6/C0	7,074	0.0433	G8/C0	2,622	0.0108
Total prob		0.7910	Total prob		0.0950
Vol Bin 2			Vol Bin 5		
G3/C3	4,708	0.0069	G0/C3	353	0.0043
G3/C1	4,626	0.0043	G0/C2	79	0.0019
Total prob		0.0011	G0/C1	274	0.0027
			Total prob		0.0089

5,000 kgal is a combination of the volume that could be stored in the head space of 102-SY, the normally generated waste volume which could be transported by truck or rail, and 2,000 kgal of additional storage made available in the 1995 through 1998 time frame.

2.2.2 Operational Scenarios, 1995 Through 1998 - Handling System

This section addresses how well the tanks, lines, and pumps handle different waste volumes for 1995 through 1998. This section also discusses the likelihood of various configurations based on successes and failures in the waste handling system. All operational scenarios begin with some waste volume being created and end with the handling of that volume. This section assesses each possible volume against each possible configuration. Combinations of all these sets represent the full set of operational scenarios. These are then grouped by similar characteristics and evaluated.

Future possible events related to 200 West Area waste handling, shown in Table 2-2, can be combined in several ways to create different waste handling configurations and situations. An event tree in Figure 2-4 shows these possibilities and the scenarios created. Attached to the right side of the event tree is a matrix of the waste handling configurations matched against the waste volume bins. The column marked 'SEQ PROB' is for the handling portion of the scenario only. It must be combined with the probability of a volume bin to complete the operational scenario. The following assumptions were made in the development of the event tree.

1. If the cross-site line is given emergency-use status only, normal facility waste will be transferred by tanker truck or rail car.

2. The unavailability of the cross-site line is based on pessimistic projections about passing leak tests, its age, and its single-pipe-wall design. This probability is assumed to be more restrictive than random failure of the pipe taken over some time frame, given it passes leak tests.

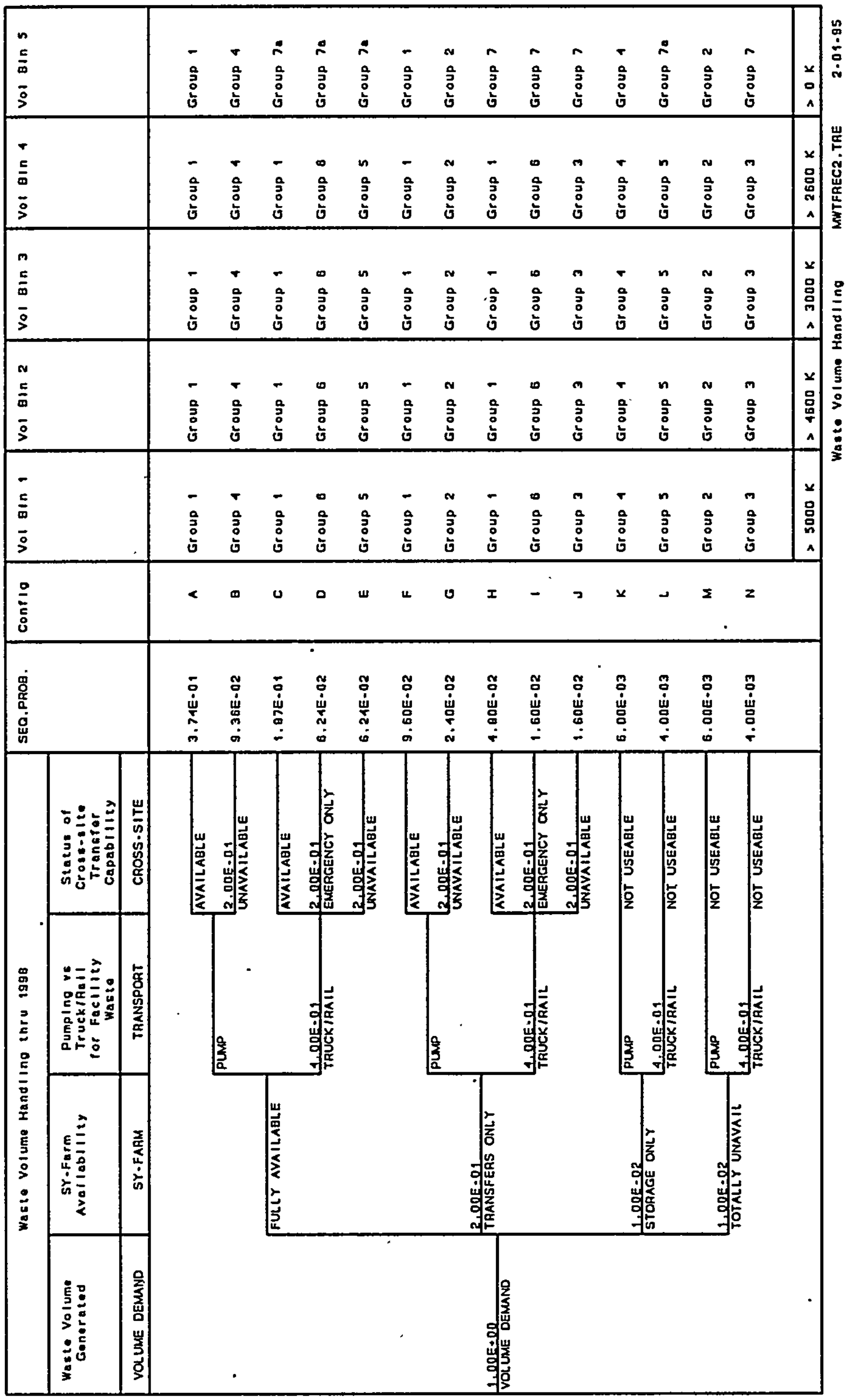
3. The CC waste cannot be transferred via 102-SY or stored there. Currently, there is no procedure for handling CC waste from a leaking SST. Tank 102-SY is classified as containing relatively large amounts of PFP TRU solids (Hanlon 1994). Restrictions disallow mixing CC with TRU waste.

4. The unreliability of truck or rail transport is not a significant consideration because the potential unavailability of truck or rail transport is high (0.60).

5. Probabilities selected for operational decisions are based on the following:

Decision	Probability
Decision is virtually guaranteed	0.99
Sure that option will used	0.80
Think option will be used	0.60
Do not think option will used	0.40
Doubt option will be used	0.20
Option is theoretically possible	0.01

Figure 2-4. Waste Volume Handling, 1995 Through 1998.



Future possibilities related to waste handling, shown in Table 2-2, and each corresponding branch point in the Figure 2-4 event tree are predicted to occur at some probability (see Table 2-10).

Each set of probabilities shown in Table 2-10 and Figure 2-4 sum to 1. Four future possible events are related to the SY Farm. The possibility that the SY Farm is available is 0.78. The possibility that it is available for transfers across site only is 0.20 while the possibility that it is available for storage only is 0.01. The chance that the SY Farm is available for neither storage or transfers across site is 0.01. These probabilities depend on projected equipment reliability. Further discussion and bases for these values are given in Appendix E.

Three possible events are related to the cross-site transfer line. The possibility that the cross-site line is available and in service is 0.70. The chance that it is available for emergencies only is 0.10. The possibility that it is unavailable for transfers across site is 0.20. As with the SY Farm, these probabilities depend on projected equipment reliability. Further discussion and bases for these values are given in Appendix E.

Three possible events are related to transport of facility-generated waste. It is possible that the capability to transport facility waste by tanker car or truck is preserved, which is identified in Table 2-10 as 'Truck/rail.' If that capacity is not preserved, there is a 60% possibility that facility waste is either transferred via pumping across site or cannot be transferred at all depending on the status of the cross-site line.

2.2.3 Operational Scenarios, 1999 to 2005 - Waste Volume

This section describes development of different waste volume possibilities for 1999 to 2005. All operational scenarios begin with some waste volume being created and end with the handling of that volume. Created volumes include waste volumes generated from tank farm operations and contingency volumes from leaks and upsets. This section describes how waste volumes and their corresponding probabilities and magnitudes are derived. It also describes how uncertainties are determined.

The first portion of this section discusses waste volumes generated from 200 West Area operations and their corresponding probabilities. The second portion discusses contingency waste volumes from leaks and upsets and corresponding probabilities. The third portion quantifies all volumes and probabilities.

Waste Volume, 1999 to 2005 - 200 West Area Operations

Future possible events related to 200 West Area operations shown in Table 2-2 can be combined in a number of ways to create different waste volumes. An event tree, shown in Figure 2-5, shows these possibilities. The following assumptions were made in the development of the event tree.

Table 2-10. 200 West Area Waste Handling System Event Probabilities.

Issues	Possible future events			
	Possibility	Probability	Possibility	Probability
SY Farm	Available	0.78	Transfers only	0.20
	Totally unavail	0.01	Storage only	0.01
Cross-site	Available	0.70	Emergency Only	0.10
	Unavailable	0.20	--	--
Transport	Pump/no transfer	0.60	--	--
	Truck/rail	0.40	--	--

1. Outright elimination of normal facility waste is improbable, although volume combinations that exclude facility waste (Vn) are theoretically possible. Given the extraordinary effort required to eliminate all facility waste, it is unlikely that other waste streams would be allowed.

2. Initiation of the retrieval operations for SSTs was not an option if salt well pumping is being delayed in either the early (1995 through 1998) or late (1999 to 2005) time period.

3. Probabilities selected for operational decisions are based on the following:

Decision	Probability
Decision is virtually guaranteed	0.99
Sure that option will used	0.80
Think option will be used	0.60
Do not think option will used	0.40
Doubt option will be used	0.20
Option is theoretically possible	0.01

Each future possibility shown in Table 2-2 and each corresponding branch point in the Figure 2-5 event tree are predicted to occur at some probability (see Table 2-11).

Each set of possibilities shown in Table 2-11 and Figure 2-5 sum to 1. Because it is highly unlikely that there is any alternative to accepting the facility-generated waste, a 0.01 probability was assigned to the 'No generation' possibility while the 'Generation' possibility was assigned 0.99.

Currently, Westinghouse Hanford Company management is confident that active mitigation is the correct path; however, opinion over this issue has evolved. Accordingly, the 'Mix' possibility is assigned a probability of 0.80 while the 'Dilute' possibility is assigned 0.20. If the dilution option is initiated, one tank would be done in the 1995 through 1998 time frame and one

Figure 2-5. Waste Volume Generator Options, 1999 to 2005.

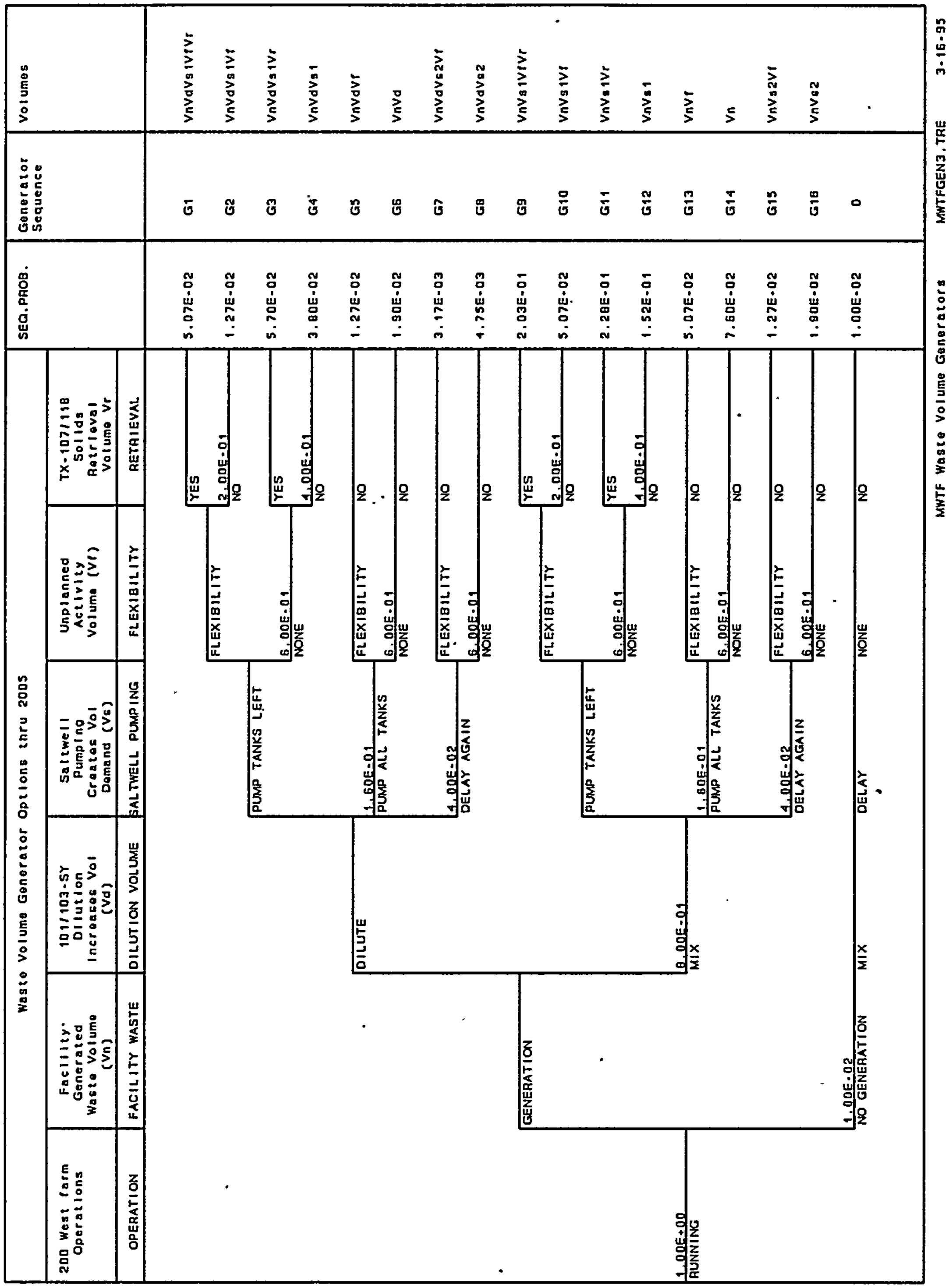


Table 2-11. 200 West Area Operations Event Probabilities, 1999 to 2005.

Issues	Possible future events					
	Possible event	Prob	Possible event	Prob	Possible event	Prob
Facility waste	Generation	0.99	No generation	0.01	--	--
Dilution volume	Dilute	0.20	Mix	0.80	--	--
Salt well pumping	Pump tanks left	0.80	Pump all tanks	0.16	Delay Again	0.04
Flexibility	Flexibility	0.40	None	0.60	--	--
Retrieval	Yes	0.8/0.6	No	0.2/0.6	--	--

tank would be done in the 1999 to 2005 time frame, according to current projections. Also, certain resolutions of the 102-SY CC waste problem may involve diluting the 103-SY in the 1995 through 1998 time period.

Three possibilities are related to salt well pumping. Delaying salt well pumping would mean that Tri-Party Agreement milestones would have to be renegotiated, which is undesirable. The chance that pumping would be delayed originally is 20%. The chance it would be delayed again was assumed to be 20% of 20% or 0.04. The chance that pumping was originally delayed but would be initiated and completed in the 1999 to 2005 time frame was assumed to be 80% of 20% or 0.16. The chance that salt well pumping would not be delayed and the remaining tanks pump in the late time period as scheduled was assumed to 80%.

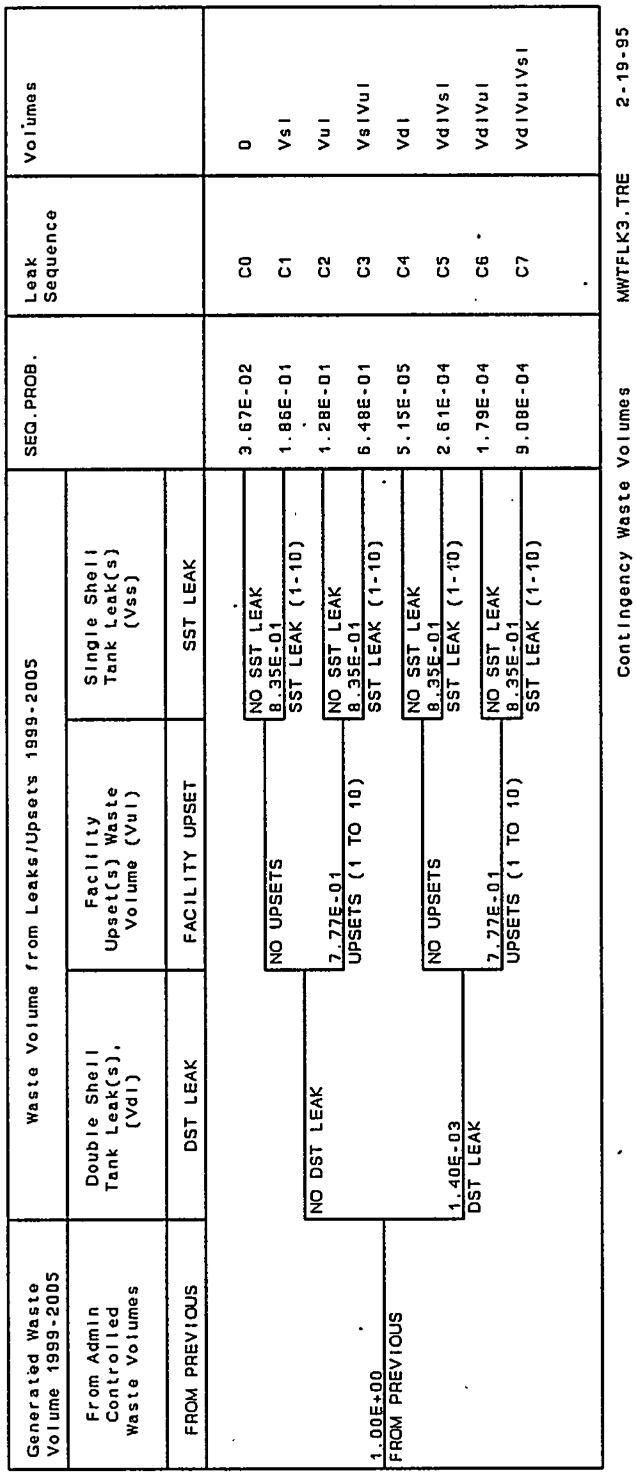
Although there is an intention to minimize waste streams, new waste streams might be created as the cleanup mission evolves. In fact, it might be unrealistic to account for that possibility. Therefore, the 'None' possibility is assigned a probability of 0.60 and the 'Flexibility' possibility is assigned a probability of 0.40.

The probabilities for retrieval of 107-TX and 118-TX depend on other events. If there is a choice to retain tank space flexibility for future potentialities, the 'No' possibility is assigned a probability of 0.20. In contrast, if tank space flexibility is not committed to, the 'No' possibility is assigned a probability of 0.40 because free tank space is apparently limited.

<u>Waste Volume, 1999 to 2005 - Contingency Volumes</u>

Future possible events related to tank leaks and facility upsets shown in Table 2-2 can be combined in several ways to create different waste volumes. An event tree in Figure 2-6 shows these possibilities and the scenarios created. The following assumptions were made in the development of the event tree.

Figure 2-6. Waste Volume from Leaks/Upsets, 1999 to 2005.



1. Because a DST leak is improbable, any combination of a leak or upset with a DST leak is unlikely. Therefore, these combinations are not further considered. This volume was not included as a contributor to the volumes of any operational scenarios.

2. Once an SST is determined to be leaking, it will be completely pumped in accordance with guidance given in WHC-SD-WM-AP-005, *Single-Shell Tank Leak Emergency Pumping Guide* (Wiggins 1994).

3. The expected SST leak frequency and facility upset frequency will not increase or decrease significantly in 1999 to 2005.

Each future possibility shown in Table 2-2 and each corresponding branch point in the Figure 2-6 event tree are predicted to occur at some probability (see Table 2-12).

Each set of possibilities shown in Table 2-12 and Figure 2-6 must sum to 1 because one or the other possibility must occur. For example, the probability of having one or more SST leaks is 0.83 and the chance of no SST leaks is 0.17. The chance of having at least one facility upset is 0.77 and the chance of having none is 0.23. The probability of a DST leak is 9.6E-04. The probability determination for a DST leak and the supporting bases are given in Appendix A.

The probability of a facility upset from 1999 to 2005 is based on historical evidence--one major event (56,000 gal) in 4 years at the facilities of interest. The operational data and bases for this determination are given in Appendix A. The Poisson distribution was used to determine the probability of combinations of failures happening in 1999 to 2005. These probabilities are somewhat different for the same values from 1995 through 1998 because the second time period is 6 years rather than 4 (see Table 2-13 for probabilities).

The probability of an SST leak is also based on historical evidence. Figure 2-3 shows that the average leak rate has changed since 1980 when interim stabilization began. In the last 15 years there have been 5 leaks. This is the basis for the leak rate. The Poisson distribution was used to determine the probability of combinations of failures happening in 1999 to 2005. These probabilities are somewhat different from the same values for 1995 through 1998 because the second time period is 6 years rather than 4 (see Table 2-14 for probabilities).

<u>Waste Volume Magnitudes, 1999 to 2005</u>

The bases for individual volume contributors from 200 West Area operations and from leaks and upsets are given in the appendixes to this report. The bases for volumes from 200 West Area operations (shown as future possible events in Table 2-6) are given in Appendixes B and C. Appendix B provides baseline information and Appendix C develops a probability distribution for each volume. The bases for contingency volumes from leaks and upsets are given in Appendixes A and D. Appendix A provides baseline information and Appendix D develops a probability distribution for each volume.

Table 2-12. Tank Leak and Facility Upset Event Probabilities, 1999 to 2005.

Issues	Possible future events			
	Possibility	Probability	Possibility	Probability
SST leak	No SST leak	0.17	SST leak (1-10)	0.83
DST leak	No DST leak	0.9986	DST leak	1.46E-03
Facility upset	No upsets	0.23	Upsets (1-10)	0.77

DST = Double-shell tank
SST = Single-shell tank

Table 2-13. Probability of a Major Facility Upset, 1999 to 2005.

Time period, year	Probability of X number of failures in time period*					
	1	2	3	4	5	6
1999 to 2005	0.298	0.268	0.161	0.0723	0.026	0.008

*Prob = $e^{-lambda} lambda^{X}/X!$, where X = 1,2,3... failures and lambda = failure rate

Table 2-14. Probability of a Single-Shell Tank Leak, 1999 to 2005.

Time period, year	Probability of X number of failures in time period*					
	1	2	3	4	5	6
1999 to 2005	0.298	0.268	0.161	0.072	0.008	0.002

*Prob = $e^{-lambda} lambda^{X}/X!$, where X = 1,2,3... failures and lambda = failure rate

The event tree in Figure 2-5 shows how the volume contributors (Vn, Vd, Vs1, Vs2, and Vf) can be combined for 1999 to 2005. More combinations are theoretically possible but are considered not meaningful. Two kinds of salt well pumping volumes are possible. If pumping is initiated in 1995 through 1998, a few tanks remain to be pumped according to the current schedule. This is defined as volume Vs1. If pumping is not initiated at all, the whole salt well pumping campaign volume (Vs2) remains. The following combined volumes are associated with each of the end states from the Figure 2-5 event tree:

- Generator Sequence, G1 = VnVdVs1VfVr
- Generator Sequence, G2 = VnVdVs1Vf
- Generator Sequence, G3 = VnVdVs1Vr
- Generator Sequence, G4 = VnVdVs1
- Generator Sequence, G5 = VnVdVf
- Generator Sequence, G6 = VnVd

- Generator Sequence, G7 = VnVdVs2Vf
- Generator Sequence, G8 = VnVdVs2
- Generator Sequence, G9 = VnVs1VfVr
- Generator Sequence, G10 = VnVs1Vf
- Generator Sequence, G11 = VnVs1Vr
- Generator Sequence, G12 = VnVs1
- Generator Sequence, G13 = VnVf
- Generator Sequence, G14 = Vn
- Generator Sequence, G15 = VnVs2Vf
- Generator Sequence, G16 = VnVs2.

Each of these volumes has some uncertainty associated with it because Westinghouse Hanford Company has incomplete knowledge of certain factors affecting the volume projections. Waste volume from facilities is variable and could change as programs, projects, and missions change. Waste volumes projected for possible dilution of 101-SY and 103-SY depend on the dilution ratio used, which could be between 0.5:1 and 1.5:1. Waste volumes from salt well pumping volume depend on the actual salt cake porosities, which have proven to be different than projected porosities. Tank space flexibility is needed to handle waste volumes for future unknown activities. Waste volume from remediation of TX-107 and TX-118 depends on dilution ratios and when the tanks are actually remediated.

A projection of waste volumes (G1 through G8 from above) was simulated by combining probability distributions. The simulation bases, assumptions, and results are given in Appendix C. The resulting waste volumes are given as probability distributions. Results show millions of gallons of difference between the mean value and the 90 percentile value. This demonstrates significant uncertainty of actual versus projected values.

The event tree in Figure 2-6 shows how the contingency volume contributors (Vsl, Vdl, and Vul) can be combined for 1995 through 1998. A few more combinations (Leak Sequences C5, C6, C7) are theoretically possible but are related to combining with the chance of a DST leak, which is improbable:

- Leak Sequence C0 No leak or upset
- Leak Sequence C1 Vsl
- Leak Sequence C2 Vul
- Leak Sequence C3 VslVul
- Leak Sequence C4 Vdl.

In addition to the chance that certain contingencies will occur and need to be managed, there is also uncertainty in the volume of the contingency. For facility upsets, records show a number of upsets that fall into the 0 to 100 kgal range, Hanford Site wide. Small upsets (a few thousand gallons) are more frequent but larger spills (tens of thousands of gallons) do occur. One significant upset has occurred in a 200 West Area facility in the last 4 years. The probability distribution for one upset or some combinations of upsets was combined into a single probability distribution using a Monte Carlo simulation. This simulation and the supporting basis are given in Appendix D.

There is also some uncertainty related to what the volume of an SST leak could be. A leak could occur in any tank and they all contain different amounts of drainable volume. Accordingly, a volume distribution was created based on the volume of drainable liquid left in the subject tanks. The probability distribution for one upset or some combinations of upsets was combined into a single probability distribution using a Monte Carlo simulation. This simulation and the supporting basis are given in Appendix D, which includes resulting mean and 90 percentile values.

Total possible waste volumes are the operationally generated volumes plus any contingency volumes. The bases for these volumes are the mean values generated from simulations described in Appendixes C and D, respectively. The contingency volumes are small (0 to 500 kgal) compared to the operationally generated volumes (2,000 to 10,000 kgal). Table 2-15 shows the combined mean volumes. The contingency volume designators across the top of the table (C0, C1, C2, and C3) correspond to those from Figure 2-6 and represent the different contingency volumes. The operationally generated volume designators are in the farthest left column of the table (G1 through G9) and correspond to volumes represented in Figure 2-5.

Total possible waste volumes have corresponding probabilities of occurrence. These probabilities of occurrence were generated by combining different events depicted in the event tree shown of operational and contingency volumes in Figures 2-5 and 2-6. The probability of the operationally generated volumes is combined with the probability of contingency volumes in Table 2-16.

Table 2-16 shows that there is a large number of total possible volumes, too many to handle individually. These volumes were collected into bins (volume bins). If a calculated volume fell into a certain range, it was assigned to the bin corresponding to its range. Its probability of occurrence was added to the probability of all other volumes collected into that bin. This process is shown in Table 2-17 for selected volume bins.

The range of the volume bins is not arbitrary but corresponds to key waste handling capacities which changed somewhat from the 1995 through 1998 time frame to the 1999 to 2005 time frame. There are no volumes <3,725 kgal, and therefore, there are no bins <3,725 kgal. The following is a description of the volume bins and corresponding rationale.

Vol Bin 4 are those volumes <4,200 kgal but >3,800 kgal.
Vol Bin 3 are those volumes <5,800 kgal but >4,200 kgal.
Vol Bin 2 are those volumes <6,200 kgal but >5,800 kgal.
Vol Bin 1 are those volumes <6,200 kgal.

400 kgal — is approximately the volume that could be stored in the head space of 102-SY.

3,800 kgal — is approximately the mean normally generated facility waste which is presently managed by truck and rail in the 1999 to 2005 time frame.

4,200 kgal — is a combination of the volume that could be stored in the head space of 102-SY and the normally generated waste volume which could be transported by truck or rail in the 1999 to 2005 time frame.

Table 2-15. Combined Generated and Contingency Mean Volume Totals, 1999 to 2005.

Generated waste volumes (kgal)		Contingency leak and upset volume (kgal)			
		C0	C1	C2	C3
		0	Vsl	Vul	VslVul
G1	VnVdVslVfVr	6,079	6,450	6,173	6,515
G2	VnVdVslVf	5,833	6,175	5,927	6,269
G3	VnVdVslVr	5,079	5,421	5,173	5,515
G4	VnVdVsl	4,833	5,175	4,927	5,269
G5	VnVdVf	5,197	5,539	5,291	5,633
G6	VnVd	4,197	4,539	4,291	4,633
G7	VnVdVs2Vf	10,781	11,123	10,875	11,217
G8	VnVdVs2	9,782	10,123	9,876	10,217
G9	VnVslVfVr	5,606	5,948	5,700	6,042
G10	VnVslVf	5,360	5,702	5,454	5,796
G11	VnVslVr	4,606	4,948	4,700	5,042
G12	VnVsl	4,361	4,703	4,455	4,797
G13	VnVf	4,725	5,067	4,819	5,161
G14	Vn	3,725	4,067	3,819	4,161
G15	VnVs2Vf	10,309	10,651	10,403	10,745
G16	VnVs2	9,309	9,651	9,403	9,745
G0	0	0	342	94	436

5,800 kgal is a combination of the normally generated waste volume which could be transported by truck or rail in the 1999 to 2005 time frame, and 2,000 kgal that could be available if two 1-million gal MWTF tanks are built.

6,200 kgal is a combination of the volume that could be stored in the head space of 102-SY, the normally generated waste volume which could be transported by truck or rail in the 1999 to 2005 time frame, and 2,000 kgal that could be available if two 1-million gal MWTF tanks are built.

Table 2-16. Combined Generated and Contingency Probability of Occurrence for Mean Volumes, 1999 to 2005.

Generated waste volumes (prob)		Contingency leak and upset volume (prob)				
		None	C0	C1	C2	C3
			0	Vsl	Vul	VslVul
None			0.037	0.186	0.128	0.648
G1	VnVdVslVfVr	0.051	0.0019	0.0095	0.0065	0.0330
G2	VnVdVslVf	0.013	0.0005	0.0024	0.0017	0.0084
G3	VnVdVslVr	0.057	0.0021	0.0106	0.0073	0.0369
G4	VnVdVsl	0.038	0.0014	0.0071	0.0049	0.0246
G5	VnVdVf	0.017	0.0006	0.0032	0.0022	0.0110
G6	VnVd	0.019	0.0007	0.0035	0.0024	0.0123
G7	VnVdVs2Vf	0.003	0.0001	0.0006	0.0004	0.0019
G8	VnVdVs2	0.005	0.0002	0.0009	0.0006	0.0032
G9	VnVslVfVr	0.203	0.0075	0.0378	0.0260	0.1315
G10	VnVslVf	0.051	0.0019	0.0095	0.0065	0.0330
G11	VnVslVr	0.228	0.0084	0.0424	0.0292	0.1477
G12	VnVsl	0.152	0.0056	0.0283	0.0195	0.0985
G13	VnVf	0.051	0.0019	0.0095	0.0065	0.0330
G14	Vn	0.076	0.0028	0.0141	0.0097	0.0492
G15	VnVs2Vf	0.013	0.0005	0.0024	0.0017	0.0084
G16	VnVs2	0.019	0.0007	0.0035	0.0024	0.0123
G0	0	0.010	0.0004	0.0019	0.0013	0.006

Table 2-17. Binning of Total Volumes, 1999 to 2005.

Combination	kgal	Prob	Combination	kgal	Prob
Vol Bin 1					
G7/C3	11,217	0.0019	G3/C0	5,079	0.0021
G7/C2	10,875	0.0004	G4/C3	5,269	0.0246
G7/C1	11,123	0.0006	G4/C2	4,927	0.0049
G7/C0	10,781	0.0001	G4/C1	5,175	0.0071
G8/C3	10,218	0.0032	G4/C0	4,833	0.0014
G8/C2	9,876	0.0006	G5/C3	5,633	0.0110
G8/C1	10,124	0.0009	G5/C2	5,291	0.0022
G8/C0	9,782	0.0002	G5/C1	5,539	0.0032
G15/C3	10,745	0.0084	G5/C0	5,197	0.0006
G15/C2	10,403	0.0017	G6/C3	4,633	0.0123
G15/C1	10,651	0.0024	G6/C2	4,291	0.0024
G15/C0	10,309	0.0005	G6/C1	4,539	0.0035
G16/C3	9,745	0.0123	G10/C3	5,796	0.0330
G16/C2	9,403	0.0024	G10/C2	5,454	0.0065
G16/C1	9,651	0.0035	G10/C1	5,702	0.0095
G16/C0	9,309	0.0007	G10/C0	5,360	0.0019
G1/C3	6,515	0.0330	G11/C3	5,042	0.1477
G1/C1	6,392	0.0095	G11/C2	4,700	0.0292
G2/C3	6,269	0.0084	G11/C1	4,948	0.0424
Total Prob		0.0907	G11/C0	4,606	0.0084
Vol Bin 2			G12/C3	4,797	0.0985
G1/C2	6,173	0.0065	G12/C2	4,455	0.0195
G1/C0	6,079	0.0019	G12/C1	4,703	0.0283
G2/C2	5,927	0.0017	G12/C0	4,361	0.0056
G2/C1	6,175	0.0024	G13/C3	5,161	0.0330
G2/C0	5,833	0.0005	G13/C2	4,819	0.0065
G9/C3	6,042	0.1315	G13/C1	5,067	0.0095
G9/C1	5,948	0.0378	G13/C0	4,725	0.0019
Total Prob		0.1823	Total Prob		0.6450
Vol Bin 3			Vol Bin 4		
G9/C2	5,700	0.0260	G6/C0	4,197	0.0007
G9/C0	5,606	0.0075	G14/C3	4,162	0.0492
G3/C3	5,515	0.0369	G14/C2	3,819	0.0097
G3/C2	5,173	0.0073	G14/C1	4,067	0.0141
G3/C1	5,421	0.0106	G14/C0	3,725	0.0028
			Total Prob		0.0765

2.2.4 Operational Scenarios, 1999 to 2005 - Handling System

This section addresses how well the tanks, lines, and pumps handle different waste volumes in 1999 to 2005. This section also discusses the likelihood of various configurations based on successes and failures in the waste handling system. All operational scenarios begin with some waste volume being created and end with the handling of that volume. Accordingly, this section addresses each possible volume against each possible configuration. Combinations of all these sets represent the full set of operational scenarios. These are then grouped by similar characteristics and evaluated.

Future possible events related to 200 West Area waste handling, shown in Table 2-2, can be combined in several ways to create different waste handling configurations and situations. The event tree in Figure 2-7 shows these possibilities and the scenarios created. Attached to the right side of the event tree is a matrix of the waste handling configurations matched against the waste volume bins. The column marked 'SEQ PROB' is for the handling portion of the scenario only. It must be combined with the probability of a volume bin to complete the operational scenario. The following assumptions were made in the development of this event tree.

1. If the old cross-site line is still in service and it is given emergency-use status only, normal facility waste will be transferred by tanker truck or rail car.

2. If the old line is still in service, it must have passed test and maintenance requirements. However, its availability is still based on pessimistic projections about its age and its single-pipe-wall design.

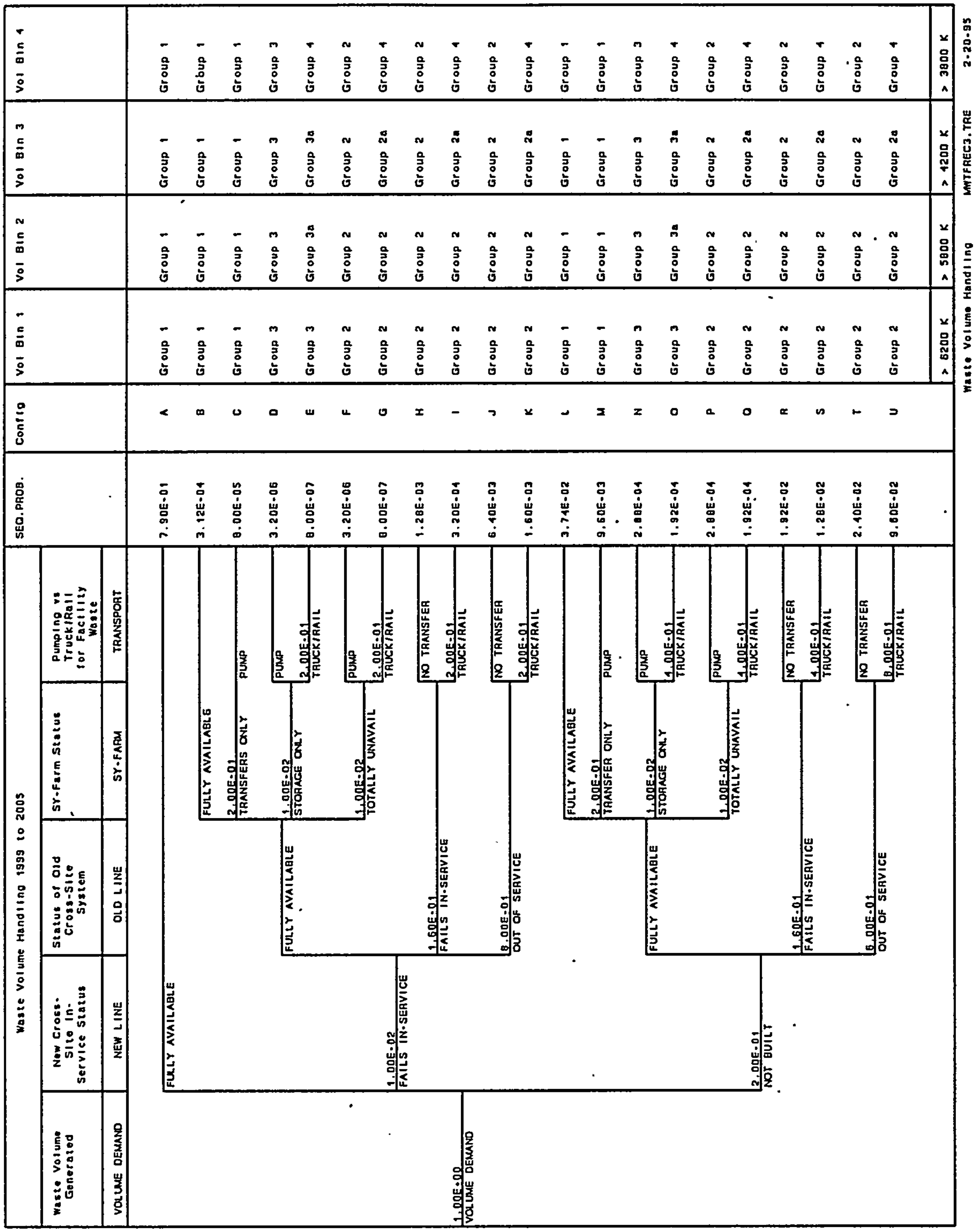
3. The CC waste cannot be transferred via 102-SY or stored there. Currently, there is no procedure for handling CC waste from a leaking SST. Tank 102-SY is classified as containing relatively large amounts of PFP TRU solids (Hanlon 1994). Restrictions disallow the mixing of CC with TRU waste.

4. The unreliability of truck or rail transport is not a significant consideration because the potential unavailability of truck or rail transport is high (0.60).

5. Probabilities selected for operational decisions are based on the following:

Decision	Probability
Decision is virtually guaranteed	0.99
Sure that option will used	0.80
Think option will be used	0.60
Do not think option will used	0.40
Doubt option will be used	0.20
Option is theoretically possible	0.01

Figure 2-7. Waste Volume Handling, 1999 to 2005.



Future possibilities related to waste handling, shown in Table 2-2, and each corresponding branch point in the Figure 2-7 event tree are predicted to occur at some probability (see Table 2-18).

Each set of probabilities shown in Table 2-18 and Figure 2-7 sums to 1. There are four future possible events related to the SY Farm. The possibility that the SY Farm is available is 0.78. The possibility that it is available for transfers across site only is 0.20 while the possibility that it is available for storage only is 0.01. The chance that the SY Farm is available for neither storage or transfers across site is 0.01.

There are six possibilities related to the cross-site line: three related to the new line and three to the old line. The most likely possibility is that a new line is built and that it is fully available and operational. This was assigned a probability of 0.78. There is some chance, 0.01 probability, that the line is built, put into service, but fails in service. Because building of the line is only a program projection into the future, there is a 20% probability that it will not built by 1999.

The most likely possibility for the old line is that it is taken out of service by 1999, particularly if the new line is built. This was assigned a probability of 0.80. If the new line is not built, the probability was assumed to be 0.60. The possibility that it fails in service is 0.16. The possibility that it is fully available is either 0.24 or 0.04 depending on the likelihood that it was kept in service. The probabilities for the new and old lines depend on projected equipment reliability. Further discussion and bases for these values are given in Appendix E.

Table 2-18. 200 West Area Waste Handling System Event Probabilities.

Issues	Possible future events			
	Possibility	Probability	Possibility	Probability
SY Farm	Available	0.78	Transfers only	0.20
	Totally unavail	0.01	Storage only	0.01
New cross-site	Fully available	0.79	Fails in service	0.01
	Not built	0.20	--	--
Old cross-site	Fully available	0.24/0.04	Fails in service	0.16
	Out of service	0.60/0.80	--	--
Transport	Pump/no transfer	0.80/0.60/0.20	--	--
	Truck/rail	0.20/0.40/0.80	--	--

There are two basic possibilities for transport of facility-generated waste: that it can be transported by tanker car or truck or that it cannot. If it cannot be, there is a possibility it can be transferred (pumped) via the cross-site transfer line. If it cannot be pumped via the cross-site line, no transfer is possible. In cases where a new cross-site line is built but later fails, there is some doubt that tanker transport would be kept available. Therefore, in these cases the possibility of transport by truck or rail is assigned a probability of 0.20. In cases where the new line was not built and the old line was kept in service, there is a greater chance that the tanker transport option would be retained. Accordingly, in these cases the possibility of transport by truck or rail is assigned a probability of 0.40. In the one case where the new line is not built and the old line is not kept in service, there is a compelling need for tanker transport. Therefore, the possibility of transport by truck or rail is assigned a probability of 0.80. The probability of no transfer or transfer by pumping across site is the complement of the transport by truck or rail. These are probabilities of 0.80, 0.60, and 0.20.

2.3 OPERATIONAL SCENARIO GROUPING

A set of operational scenarios was developed for two time periods: 1995 through 1998 and 1999 to 2005. Three changes could occur approximately at the interface between the two time periods. New tanks or a new cross-site line, if they are built, are scheduled to come into service in 1998. Also, if salt well pumping continues according to schedule, it will be almost complete by 1999. Because of these and other differences, the grouping of operational scenarios is different and is discussed in separate sections. Section 2.3.1 discusses grouping of operational scenarios in 1995 through 1998. Section 2.3.2 discusses the operational scenarios in the 1999 to 2005 time frame.

2.3.1 Operational Scenario Grouping, 1995 Through 1998

The combination of 5 different waste volumes bins combined with 14 different waste handling configurations led to 70 possible outcomes. These outcomes are collected into a number of different operational scenario groups with similar characteristics. Salt well pumping based on the present schedule, and/or dilution of 101-SY or 103-SY, cannot be supported without the cross-site transfer line because of the limited space in the 200 West Area. Because of this, only Bin 1, in which the cross-site line is available, contains nearly all desirable outcomes. Because the 200 West Area has such limited storage capacity and because the capacity to store waste in the 200 East Area is not analyzed in this assessment, the groupings are based mainly on handling system configuration differences. The groupings are defined as follows.

<u>Group 1</u> Cross-site transfer of waste to the 200 East Area is fully successful and it is assumed that the 200 East Area can accept whatever is sent (for the purposes of this analysis). This is true whether or not facility-generated waste is transported by truck, rail, or pump or whether space in the SY tanks is used. Contingency leaks are managed.

<u>Group 2</u> The SY tanks are unavailable. Transfer from 102-SY is not possible because of the unavailability of SY pumps, lines, or cross-site transfer line. There is no room for any generated waste or contingency leak volume.

<u>Group 3</u> The SY tanks are unavailable. Transfer from 102-SY is not possible because of the unavailability of SY pumps, lines, or cross-site transfer line. Normally, facility-generated waste is transferred by truck or rail to the 200 East Area. There is no room for any other generated waste or contingency leak volume.

<u>Group 4</u> The SY tanks are available for limited storage. Transfer from 102-SY is not possible because of the unavailability of SY pumps, lines, or cross-site transfer line. There is no room for any generated waste. However, contingency leak volume volumes might be managed if SY space is reserved for that purpose.

<u>Group 5</u> The SY tanks are available for limited storage. Transfer from 102-SY is not possible because of the unavailability of SY pumps, lines, or cross-site transfer line. Normally, facility-generated waste is transferred by truck or rail to the 200 East Area. There is no room for any other generated waste volume. However, contingency leak volume volumes might be managed if SY space is reserved for that purpose.

<u>Group 6</u> The SY tanks are available for limited storage. Transfer from 102-SY is administratively restricted to emergencies only, which include SST and DST leaks and facility upsets. Normally, facility-generated waste is transferred by truck or rail to the 200 East Area. There is no room for any other generated waste volumes. Whether space is available in the SY tanks is not important because it is not enough to handle anything but contingency volumes.

<u>Group 7</u> Routinely generated facility waste is the only waste generated. It is being safety transported by tanker truck or rail. There is no room for contingency leak volumes.

<u>Group 7a</u> Routinely generated facility waste is the only waste generated. Contingency leak volumes might be managed if SY space is reserved for that purpose.

2.3.2 Operational Scenario Grouping, 1999 to 2005

The combination of 4 different waste volume bins and 21 different waste handling configurations led to 84 possible outcomes. These outcomes are collected into a number of different operational scenario groups with similar characteristics. Salt well pumping based on the present schedule, and/or dilution of 101-SY or 103-SY, cannot be supported without the cross-site transfer line because of the limited space in the 200 West Area. Because of this, only Bin 1, in which the cross-site line is available, contains desirable outcomes. The operational scenario groupings are based mainly on handling system operability differences because the 200 West Area has such limited storage capacity and because the capacity to store waste in the 200 East Area is not analyzed is this assessment. The groupings are defined as follows.

Group 1 Cross-site transfer of waste to the 200 East Area is fully successful and it is assumed that the 200 East Area can accept whatever is sent (for the purposes of this analysis). This is accomplished via the new cross-site line or in extreme cases the old line. Transfer of facility waste by tanker truck or rail is possible but not needed. Space in 102-SY is also possible but not needed. Contingency leaks are likely to be managed.

Group 2 Both the new and old cross-site transfer lines have either failed or are not in service, or the new line has failed and the SY Farm is unavailable to access the old line. None of the demands on tank space can be met. Contingency leaks might be managed.

Group 3 The new cross-site line is not built or fails. The old line is available but the SY Farm fails and waste cannot be pumped. None of the demands on tank space can be met. The SY Farm is available, however, to receive contingency waste.

Group 4 Routinely generated facility waste is the only waste generated, and it is being transported by tanker truck or rail. In some cases, there is no room for contingency leak volumes, and in some there is SY Farm space reserved for that purpose.

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3.0 RESULTS AND INSIGHTS

This section discuses the final operational scenarios, their likelihoods, and impacts on key concerns. Certain sensitivity analyses were performed on the results. Accordingly, Section 3.1 reports results, Section 3.2 discusses sensitivities, and Section 3.3 provides insights and conclusions.

3.1 RESULTS

The operational scenarios were grouped as described in Sections 2.3.1 and 2.3.2. The results are discussed accordingly. Section 3.1.1 discusses operational scenario results for the 1995 through 1998 time period. Section 3.1.2 discusses operational scenario results for the 1999 to 2005 time period.

3.1.1 Results, 1995 Through 1998

Each operational scenario grouping has a particular character and probability. The probability is based on the probability of the handling system configuration combined with the probability of the volume (bins) that placed a demand on the system. Table 3-1 summarizes those probabilities for the operational scenarios in the 1995 through 1998 time period.

Operational scenario groups are defined in detail in this section. Only Group 1 is considered successful (i.e., aside from the CC issue). Success is defined as enough free tank space and access to that space to handle created waste volumes. All other groups are unsuccessful in some way.

Table 3-1. Probability of Each Group Based on Volume Bin and Configuration Probability, 1995 Through 1998.

Probability of each volume bin						
Vol Bin 1	Vol Bin 2	Vol Bin 3	Vol Bin 4	Vol Bin 5	--	--
0.7910	0.0011	0.0918	0.0950	0.0089	--	--
Probability of each configuration						
Config A	Config B	Config C	Config D	Config E	Config F	Config G
0.3280	0.2180	0.0780	0.0936	0.0624	0.0840	0.0560
Config H	Config I	Config J	Config K	Config L	Config M	Config N
0.0200	0.0240	0.0160	0.0060	0.0040	0.0060	0.0040
Probability of each group						
Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
0.675	0.022	0.027	0.068	0.096	0.096	0.004

Operational scenario groupings are primarily based on how scheduled and contingency waste volumes are handled. The need to safely handle contingency volumes (i.e., leaks and upsets) is an urgent concern. In the scenarios of Group 1, contingency waste tank space demands can be managed because the cross-site line is operable. In Groups 2 and 3, contingency waste tank space demands cannot be met because the cross-site line and SY Farm are unavailable. In Groups 4 and 5, contingency waste demands could be met if the volume required does not exceed the free volume in 102-SY. In Group 6, contingency waste demands are managed because the cross-site line is operable and reserved for emergency purposes. In Group 7, contingency waste demands might be managed and the cross-site line might be available. More detailed descriptions of the operational scenario groupings follow.

Group 1

In general, operational scenario Group 1 contributes about 68% to the total probability. In this group, the cross-site line is successful and all waste is successfully handled except waste from leaking CC waste tanks. There is about an 80% chance that the waste volume generated in this 4-year span will exceed 5 million gal, but this is not an issue for this group as long as the 200 East Area can receive it. Accordingly, potential program or Tri-Party Agreement milestone commitments are met or are presumably pre-accepted or renegotiated.

There is one exception to the successful handling that applies to all operational scenario groups regardless of volume or handling operability. Concentrated complexant waste cannot be transferred via 102-SY or stored there.

Group 2

Operational scenarios in Group 2 contribute about 2% to the total probability. In these scenarios, transfer to the 200 East Area or to the SY Farm is not possible. Accordingly, it will be difficult or not possible to manage any contingency volume whether or not it is classified as CC waste. There is about an 89% chance that there will be some contingency event in the next 4 years. Also, normal facility-generated waste may be difficult to manage depending on how difficult it is to reinstate the use of tanker tanks or rail cars.

Any program or Tri-Party Agreement milestone commitments are not met (e.g., 101/103-SY dilution, salt well pumping, other programs that require tank space).

Group 3

Operational scenarios in Group 3 contribute about 3% to the total probability. Again, in these scenarios, transfer cross-site or to the SY Farm is not possible. Accordingly, it will be difficult or not possible to manage any contingency volume whether or not it is classified as CC waste. There is about an 89% chance that there will be some contingency event in the next 4 years. Normal facility-generated waste continues to be transferred by truck or rail.

Any program or Tri-Party Agreement milestone commitments are not met (e.g., 101/103-SY dilution, salt well pumping, other programs that require tank space). Normal facility waste continues to be managed.

Group 4

Operational scenarios in Group 4 contribute about 7% to the total probability. In these scenarios, storage in SY Farm is available, but the cross-site transfer line is unavailable. Accordingly, contingency volumes might be managed if the space is reserved for the purpose. There is about a 34% chance that the volume left in 102-SY (380 kgal) will not be adequate (see Appendix A for basis). As in other cases, CC waste cannot be managed. Also, normal facility-generated waste may be difficult to manage depending on how difficult it is to reinstate the use of tanker tanks or rail cars.

Any program or Tri-Party Agreement milestone commitments are not met (e.g., 101/103-SY dilution, salt well pumping, other programs that require tank space).

Group 5

Operational scenarios in Group 5 contribute about 10% to the total probability. In these scenarios, storage in SY Farm is available, but the cross-site transfer line is unavailable. Accordingly, contingency volumes might be managed if the space is reserved for the purpose. There is about a 34% chance that the volume left in 102-SY (380 kgal) will be inadequate (see Appendix A for basis). As in other cases, CC waste cannot be managed. Normal facility-generated waste continues to be transferred by truck or rail.

Any program or Tri-Party Agreement milestone commitments are not met (e.g., 101/103-SY dilution, salt well pumping, other programs that require tank space). Normal facility waste continues to be managed.

Group 6

Operational scenarios in Group 6 contribute about 10% to the total probability. In these scenarios, SY tanks available for limited storage and transfer from 102-SY are administratively restricted to emergency-use only including SST and DST leaks and facility upsets. Normally, facility-generated waste is transferred by truck or rail to the 200 East Area. Although some space is available in 102-SY, it is not enough to have a meaningful impact on dilution or salt well volumes. The major effect is that most contingency volumes are managed but salt well pumping and/or dilution work must be halted. As in other cases, CC waste cannot be managed.

Any program or Tri-Party Agreement milestone commitments are not met (e.g., 101/103-SY dilution, salt well pumping, other programs that require tank space). Normal facility waste continues to be managed.

Group 7

Operational scenarios in Group 7 contribute about 0.4% to the total probability. Routinely generated facility waste is the only waste generated. For a portion of scenarios in this group, there is no room for contingency leak volumes. For some of the scenarios, contingency leak volumes might be managed if SY space is reserved for that purpose. As in other cases, CC waste cannot be managed.

Common to all operational scenario groups regardless of waste volume or handling system operability is the issue of CC waste handling in the 200 West Area. This is, however, a near-term problem and will be solved regardless of whether or not new multiwaste tanks or a cross-site transfer line are built. Currently, there is no procedure for handling CC waste from a leaking SST. The 102-SY tank is classified as containing a relatively large amount of PFP TRU solids (Hanlon 1994). Restrictions disallow the mixing of CC with TRU waste. Accordingly, CC waste cannot be transferred via 102-SY or stored there as long as the TRU remains.

Of the 28 tanks in the 200 West Area with appreciable amounts of drainable liquid, up to two-thirds could be CC waste. About 40% of the SST waste is CC waste. The chance of at least one SST leaking in the next 4 years is about 70%. Accordingly, the chance of a leak in a CC tank is high.

In general, for this set of operational scenario groups, the magnitude of the volume demand on the waste handling system is not a key factor. Therefore, each operational scenario group contains about the same proportion of possible volumes; for Volume Bin 1, volumes >5,000 gal, there is about a 79% chance; for Volume Bin 2, volumes >4,600 gal but <5,000 gal, there is less than a 1% chance; for Volume Bin 3, volumes >3,000 gal but <4,600 gal, there is a 9% chance; for Volume Bin 4, volumes >2,600 gal but <3,600 gal, there is about a 9.5% chance; for Volume Bin 5 volumes >2,600 gal, there is about a 1% chance. There are only 380 kgal of free space in the 200 West Area.

Table 3-2 summarizes the likelihood and impacts from the operational scenario groups.

Different volumes correspond to different management commitments. Failing these commitments has different implications, but as noted these implications are spread out among the operational scenario groups. For the 1995 through 1998 time frame, the following volumes and combinations of those volumes were considered:

- Volume from facility (S Plant, T Plant, and PFP) generated waste, (Vn).
- Volume from dilution of 101-SY and 103-SY, (Vd).
- Volume from salt well pumping 200 West Area SSTs, (Vs).
- Volume from future activity that is presently unscheduled, (Vf).

Table 3-2. Operational Scenario Group Likelihood and Impact, 1995 Through 1998.

Operational scenario and likelihood		Handles scheduled waste	Handles contingency waste		Cross-site line available	Facility waste by truck/rail
Group	Prob.		NCPLX	DSSF		
1	68%	Yes	Yes	No	Yes	Either
2	2%	No	No	No	No	No
3	3%	No	No	No	No	Yes
4	7%	No	Maybe	No	No	No
5	10%	No	Maybe	No	No	Yes
6	10%	No	Yes	No	Limited	Yes
7	0.4%	Yes	Maybe	No	Maybe	Yes
		Program/ or TPA impacts	Safety/ environment impacts		Program financial impacts	Program financial impacts

DSSF = Double-shell slurry feed
NCPLX = Noncomplexed
TPA = Tri-Party Agreement

Not handling these created waste volumes produces impacts of different degrees:

- Minor - Does not affect Tri-Party Agreement commitments but does have significant impact on project logistics or cost
- Severe - Tri-Party Agreement commitments are missed and/or major unplanned contingency activities result
- Major - Potential insult to environment or human safety and/or major program impacts result.

Results indicate that the magnitude of a volume demand on the waste handling system is not as significant as the status of the system. This is largely because the 200 West Area tank farm has little free storage capacity and new tanks cannot be brought into service until 1999. Therefore, all unsuccessful groups (i.e., groups except Group 1) represent severe and major impacts. Groups 2 and 3 represent major impacts. Groups 4, 5, and 6 represent primarily severe impacts and some major impacts. Group 7 is probabilistic insignificant but includes all three impacts.

In Groups 2 and 3, the cross-site line and storage space in the SY Farm is unavailable so there is no free tank space to handle contingencies such as confirmed tank leaks in any of the operational scenarios in this group. There is no free tank space to handle unscheduled volumes which may or may not have safety significance. There is no room to handle dilution waste from mitigation of 103-SY if needed. Most operational scenarios in Groups 2 and 3 include unscheduled volumes and/or dilution volumes.

In Groups 4, 5, and 6 the cross-site line is unavailable (Group 6 is available for emergencies only) but the SY Farm is available, so contingencies not exceeding the free tank volume in 102-SY could be handled. However, no other waste volumes with the exception of facility waste in Group 5 can be handled. Inability to handle facility waste primarily jeopardizes the tank characterization effort and decontamination activities at T Plant. Inability to handle salt well pumping effluent jeopardizes Tri-Party Agreement commitments and waste retrieval schedules, and increases the chance of a leak to the environment. Inability to handle unplanned and unscheduled volumes could represent a major or severe impact depending on the safety implications. About one-half of the operational scenarios include this kind of volume. Inability to handle dilution volume from possible mitigation of 101-SY represents a major impact.

The facility-generated waste streams, Vn, would be difficult to eliminate. The majority of the volume is a by-product of waste sampling. Elimination is likely to have major program implications.

The waste volume, Vd, could be eliminated by committing to active mitigation of 101-SY and 103-SY. Safety risk from active mitigation is acceptable and currently has an authorization basis (Leach and Stahl 1993). Operating and replacement costs for mixer pumps would continue, but could be offset by the cost of installing new dilution/mixing pumps. Continuing to actively mitigate defers demonstration of DST retrieval.

The waste volume, Vs, could be deferred by renegotiating the Tri-Party Agreement milestones, which involves a financial and political cost. Additionally, it increases the chance of an SST leak by increasing the time a tank is exposed (not pumped out).

The waste volume, Vf, could be eliminated with tight controls of all waste streams. However, history suggests that there is a great deal of uncertainty about projecting potential future waste streams. This projection is negatively impacted by changing budgets and programs.

3.1.2 Results, 1999 to 2005

Each operational scenario grouping has a particular character and probability. The probability is based on the probability of the handling system configuration combined with the probability of the volume (bins) that placed a demand on the system. Table 3-3 summarizes those probabilities for the 1999 to 2005 case.

Operational scenario groups are defined in detail in this section. Only Group 1 is considered successful (i.e., aside from the CC issue). Success is defined as enough free tank space and access to that space to handle created waste volumes. All other groups are unsuccessful in some way.

Table 3-3. Probability of Each Group Based on Volume Bin and Configuration Probability, 1999 to 2005.

Probability of each volume bin						
Vol Bin 1	Vol Bin 2	Vol Bin 3	Vol Bin 4			
0.0907	0.1823	0.6450	0.0765	--	--	--
Probability of each configuration						
Config A	Config B	Config C	Config D	Config E	Config F	Config G
0.790000	0.000312	0.000080	0.000003	0.000000	0.000003	0.000000
Config H	Config I	Config J	Config K	Config L	Config M	Config N
0.001280	0.000320	0.006400	0.001600	0.037400	0.009600	0.000288
Config O	Config P	Config Q	Config R	Config S	Config T	Config U
0.000192	0.000288	0.000192	0.019200	0.012800	0.024000	0.096000
Probability of each group						
Group 1	Group 2	Group 3	Group 4	--	--	--
0.8327	0.1524	0.0003	0.0085	--	--	--

Operational scenario groupings are primarily based on how scheduled and contingency waste volumes are handled. The need to safely handle contingency volumes (i.e., leaks and upsets) is an urgent concern. In the scenarios of Group 1, contingency waste tank space demands can be managed because cross-site capability is available. In Group 2, contingency waste tank space demands cannot be met because the cross-site line and SY Farm tank space are unavailable. In Group 3, contingency waste demands could be met if the volume required does not exceed the free volume in 102-SY, but it is not a probabilistically significant group. In Group 4, contingency waste demands might be managed and the cross-site line might be available but again this group is not probabilistically significant. More detailed descriptions of the operational scenario groupings follow.

<u>Group 1</u>

In general, operational scenario Group 1 contributes about 83% to the total probability. Cross-site transfer is always successful via the new line or in rare cases the old line, and all waste is successfully handled except waste from leaking CC waste tanks. As long as the 200 East Area is able to receive any waste sent, scheduled operations are successful. Accordingly, potential program or Tri-Party Agreement milestone commitments are met or are presumably pre-accepted or renegotiated.

There is one exception to successful handling that applies to all operational scenario groups regardless of volume or handling operability. Concentrated complexant waste cannot be transferred via 102-SY or stored there.

Group 2

Operational scenarios in Group 2 contribute about 15% to the total probability. In these scenarios, the ability to transfer waste to the 200 East Area via the cross-site line and the ability to receive waste in the SY Farm is failed. Because space in the 200 West Area is extremely limited, scheduled transfers relying on the cross-site transfer line cannot be made. Also, it might be difficult or not possible to manage any contingency volume whether or not it is classified as CC waste. There is about an 89% chance that there will be some contingency event in the next 4 years. Also, normal facility-generated waste may be difficult to manage depending on how difficult it is to reinstate the use of tanker tanks or rail cars.

Any program or Tri-Party Agreement milestone commitments are not met (e.g., 101/103-SY dilution, salt well pumping, other programs that require tank space).

Group 3

Operational scenarios in Group 3 contribute about 0.3% to the total probability. In these scenarios, the cross-site line is either not built or fails. The old line is available but the SY Farm fails and waste cannot be pumped across site. However, tank space available in the SY Farm is accessible for contingencies if reserved for that purpose.

Any program or Tri-Party Agreement milestone commitments are not met (e.g., 101/103-SY dilution, salt well pumping, other programs that require tank space).

Group 4

Operational scenarios in Group 4 contribute about 0.9% to the total probability. Routinely generated facility waste is the only waste generated, and it is being transported by tanker truck or car. Contingency leak volume volumes might be managed if SY space is reserved for that purpose. As in other cases, CC waste cannot be managed.

One problem is common to all operational scenario groups regardless of waste volume or handling system operability. It is, though, a near-term problem and will be solved regardless of whether or not new multiwaste tanks or a cross-site transfer line are built. Currently, there is no procedure for handling CC waste from a leaking SST. The 102-SY tank is classified as containing a relatively large amount of PFP TRU solids (Hanlon 1994). Restrictions disallow the mixing of CC with TRU waste. Accordingly, CC waste cannot be transferred via 102-SY or stored there as long as the TRU remains.

Common to all operational scenario groups regardless of waste volume or handling system operability is the issue of CC waste handling in the 200 West Area. This is, however, a near-term problem that will be solved in the near future. Also, it is somewhat independent of whether or not new multiwaste tanks or a cross-site transfer line are built. Currently, there is no procedure for handling CC waste from a leaking SST. The 102-SY tank is classified as containing a relatively large amount of PFP TRU solids (Hanlon 1994). Restrictions disallow the mixing of CC with TRU waste.

Accordingly, CC waste cannot be transferred via 102-SY or stored there as long as the TRU remains.

Of the 28 tanks in the 200 West Area with appreciable amounts of drainable liquid, up to two-thirds could be CC waste. About 40% of the SST waste is CC waste. The chance of at least one SST leaking in the next 10 years is almost certain. Accordingly, the chance of a leak in a CC tank is high.

Table 3-4 summarizes the likelihood and impacts from the operational scenario groups.

For the operational scenarios in this time period (1999 to 2005), about 65% of the expected volumes lay between 4,200 and 5,800 kgal (Volume Bin 3). This is different from the earlier time period (1995 through 1998); due primarily to the chance that salt well pumping will have already occurred (salt well represents the greatest single volume source). In that time period, 80% of the expected volumes were >5,000 kgal. If the facility-generated waste can be transferred by tanker (about 3,800 kgal over the 6 years), the two new MWTF tanks would hold most of the remaining volumes. This is fortuitous because the tanks cannot be in service until this later time period. Contrarily, this is also the time that the new cross-site line will be put into service. It is not as likely to fail as the old one so the effect of the new tanks is minimized.

As in the early time frame, different volumes correspond to different management commitments. These commitments have different implications, but as noted these implications are spread out among the operational scenario groups. For the 1999 to 2005 time frame, the following volumes and combinations were considered:

- Volume from facility (S Plant, T Plant, and PFP) generated waste, (Vn)
- Volume from dilution of 101-SY and 103-SY, (Vd).
- Volume from salt well pumping of the 200 West Area SSTs, (Vs).
- Volume from future activity that is presently unscheduled, (Vf).
- Volume from retrieval of 107-TX and 118-TX, (Vr)

Not handling these created waste volumes produces impacts of different degrees:

- Minor - Does not affect Tri-Party Agreement commitments but does have significant impact on project logistics or cost
- Severe - Tri-Party Agreement commitments are missed and/or major unplanned contingency activities result
- Major - Potential insult to environment or human safety and/or major program impacts result.

Table 3-4. Operational Scenario Group Likelihood and Impact, 1999 to 2005.

Operational scenario and likelihood		Handles scheduled waste	Handles contingency waste		Cross-site line available	Facility waste by truck/rail
Group	Prob.		NCPLX	DSSF		
1	83%	Yes	Yes	No	Yes	Either
2	15%	No	No	No	No	No
3	0%	No	Maybe	No	No	No
4	1%	Yes	Maybe	No	No	Yes
		Program/ or TPA impacts	Safety/ environment impacts		Program financial impacts	Program financial impacts

DSSF = Double-shell slurry feed
NCPLX = Noncomplexed
TPA = Tri-Party Agreement

Results indicate that the magnitude of a volume demand on the waste handling system is not as significant as the status of the system. This is largely because the 200 West Area tank farm has little free storage capacity other than new tanks that could be brought into service in 1999. Therefore, all unsuccessful groups (i.e., groups except Group 1) represent severe and major impacts. Group 2 represents major impacts. Groups 3 and 4 are probabilistic insignificant but include all three impacts.

In Group 2, the cross-site line and storage space in the SY Farm are unavailable, so there is no free tank space to handle contingencies such as confirmed tank leaks in any of the operational scenarios in this group. There is no free tank space to handle unscheduled volumes which may or may not have safety significance. There is no room to handle dilution waste from mitigation of 103-SY if needed. Most operational scenarios in Groups 2 and 3 include unscheduled volumes and/or dilution volumes.

Additionally in Group 4, besides contingency volumes, no other waste volumes can be handled. Inability to handle facility waste primarily jeopardizes the tank characterization effort and decontamination activities at T Plant. Inability to handle salt well pumping effluent jeopardizes Tri-Party Agreement commitments and waste retrieval schedules and increases the chance of a leak to the environment. Inability to handle unplanned and unscheduled volumes could represent a major or severe impact depending on the safety implications. About one-half of the operational scenarios include this kind of volume. Inability to support the SST retrieval schedule has a significant impact on many other programs. Inability to handle dilution volume from possible mitigation of 101-SY represents a major impact.

The facility-generated waste stream, Vn, would be difficult to eliminate. The majority of the volume is a by-product of waste sampling. Elimination is likely to have major program implications.

The waste volume, Vd, could be eliminated by committing to active mitigation of 101-SY and 103-SY. Safety risk from active mitigation is acceptable and currently has an authorization basis (Leach and Stahl 1993). Operating and replacement costs for mixer pumps would continue, but would be offset by the cost of installing new dilution/mixing pumps. Continuing to actively mitigate defers demonstration of DST retrieval.

The waste volume, Vs, could be deferred by renegotiating the Tri-Party Agreement milestones, which involves a financial and political cost. Additionally, it increases the chance of an SST leak by increasing the time a tank is exposed (not pumped out). These tanks presumably must be salt well pumped before they can be remediated. All issues considered, it is not reasonable to expect that the commitment to salt well pump all SSTs could be deferred beyond 2005.

The waste volume, Vf, could be eliminated with tight controls of all waste streams. However, history suggests that there is a great deal of uncertainty about projecting potential future waste streams. This projection is negatively impacted by changing budgets and programs.

The waste volume, Vr, from retrieval of two SSTs could be delayed with some impact on the entire retrieval plan.

3.2 SENSITIVITY ANALYSIS

This section discusses how sensitive the results are to certain selected changes in the input data or assumptions. Three important key issues are addressed: the effect of uncertainty in the waste volume projection, the effect of uncertainty on the availability of the cross-site line, and the effect of building two new waste tanks.

3.2.1 General Volume Uncertainty Sensitivity

The waste volume projection uncertainty analysis in Appendix A represents the projected waste volume as a range of probable values. The results reported in Section 3.2 are based on the mean values from those ranges. Assessing the 90 percentile values from those computed ranges would provide a more bounding estimate of the potential volumes.

Tables 3-5 and 3-6 show the combined generated and contingency volumes 90 percentile values for the early (1995 through 1998) and late (1999 to 2005) time period, respectively. Values reported for the early case are about 500 to 1,000 kgal greater than the mean values depending on the volumes. Values reported in the late case are about 500 to 1,500 kgal greater than the mean. The 95 percentile values are greater still. They appear to be about twice the increase shown for the 90 percentile cases.

Table 3-5. Combined Generated and Contingency 90 Percentile Volume Totals, 1995 Through 1998.

Generated waste volumes (kgal)		Contingency leak and upset volume (kgal)			
		C0	C1	C2	C3
		0	Vsl	Vul	VslVul
G1	VnVdVsVf	9,844	10,196	9,952	10,304
G2	VnVdVs	8,823	9,175	8,931	9,283
G3	VnVdVf	4,896	5,248	5,004	5,356
G4	VnVd	3,865	4,217	3,973	4,325
G5	VnVsVf	9,650	10,002	9,758	10,110
G6	VnVs	8,055	8,407	8,163	8,515
G7	VnVf	4,054	4,406	4,162	4,514
G8	Vn	2,996	3,348	3,104	3,456
G0	0	0	352	108	460

These more conservative volumes would not appear to have a great deal of impact on the results. The volumes are higher but operational success is more of a function of the handling system, particularly because nearly all waste must be transferred across site to the 200 East Area. There is one exception. The 90 percentile contingency volume is greater in both cases than the 380 kgal of tank space in 102-SY. Appendix D shows that 380 kgal would be exceeded at about the 80 percentile for the early case and at about the 50 percentile for the late case. This indicates that the head space in 102-SY may not be adequate to handle contingency volumes.

3.2.2 Operability of Cross-Site Line Sensitivity

The operability of the cross-site line plays a key role in the success of 200 West Farm tank operations. Changes in estimates of reliability would significantly change results. This is true for the new and old line. For the old line, the uncertainty is related to its expected reliability which is questionable. For the new line, the uncertainty is not related to its expected reliability but to when or if it is built. Changes in program direction and actual performed work, particularly over expected periods, are much more predictable than the reliability of well-engineered systems.

In the new or old lines the chance of plugging caused by sedimentation or crystallization is not totally dispelled. Four of six lines were failed in the 1960's from these causes. Recent analysis (McKay et al. 1994) recommends that this issue be given further analysis.

Table 3-6. Combined Generated and Contingency 90 Percentile Volume Totals, 1999 to 2005.

Generated waste volumes (kgal)		Contingency leak and upset volume (kgal)			
		C0	C1	C2	C3
		0	Vsl	Vul	VslVul
G1	VnVdVslVfVr	6,737	7,162	6,861	7,383
G2	VnVdVslVf	6,488	6,913	6,612	7,134
G3	VnVdVslVr	5,718	6,143	5,842	6,364
G4	VnVdVsl	5,463	5,888	5,587	6,109
G5	VnVdVf	5,834	6,259	5,958	6,480
G6	VnVd	4,807	5,232	4,931	5,453
G7	VnVdVs2Vf	12,085	12,510	12,209	12,731
G8	VnVdVs2	11,058	11,483	11,182	11,704
G9	VnVslVfVr	6,233	6,658	6,357	6,879
G10	VnVslVf	5,979	6,404	6,103	6,625
G11	VnVslVr	5,193	5,618	5,317	5,839
G12	VnVsl	4,935	5,360	5,059	5,581
G13	VnVf	5,322	5,747	5,446	5,968
G14	Vn	4,278	4,703	4,402	4,924
G15	VnVs2Vf	11,599	12,024	11,723	12,245
G16	VnVs2	10,581	11,006	10,705	11,227
G0	0	0	425	124	549

Table 3-7 compares the probability of each operational scenario for both time periods if the availability and reliability of the cross-site line are increased to 95%. As shown, the chance of success increases proportionately.

3.2.3 Effect of Building New Waste Tanks Sensitivity

It is proposed that two 1-million gal waste tanks be constructed in the 200 West Area and put into service in 1998. If constructed, this would have a positive impact on the projected operational risk. Accordingly, this impact is assessed in this section.

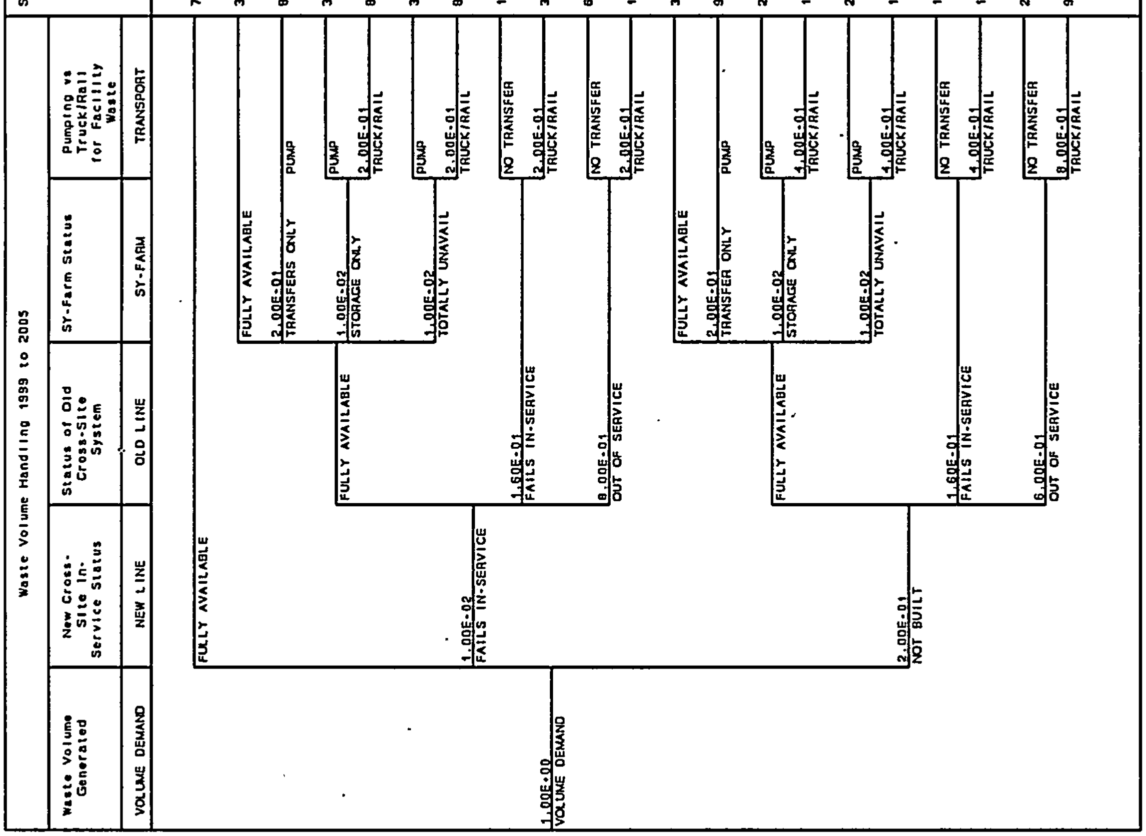
Table 3-7. Change in Group Probability from when Cross-Site Line is 95% Successful.

Operational scenarios grouping probability, 1995 through 1998							
	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7
As is case	0.682	0.022	0.028	0.068	0.097	0.097	0.004
0.95 case	0.842	0.012	0.008	0.029	0.019	0.078	0.004
Operational scenario grouping probability, 1999 to 2005							
	Group 1	Group 2	Group 3	Group 4	--	--	--
As is case	7.833	0.152	0.0003	0.009	--	--	--
0.95 case	0.947	0.045	0.000	0.002	--	--	--

Figure 3-1 shows how different waste handling scenarios handle different volumes of waste and how building two 1-million gal tanks affects the result. The combinations of different waste handling scenarios and volume bins are assigned to different groups. As described in earlier sections, combinations that are assigned to Group 1 mean that the tanks, lines, and pumps deal satisfactory with that volume. Group 4 includes scenarios in which only facility-generated waste is being produced and is satisfactorily handled, although contingency waste may get handled unsatisfactorily. However, the probability of a Group 4 operational scenario is <1%. In general, then, Groups 2 and 3 represent the unsatisfactory groups because waste is produced and there is no room available for storage. In Figure 2-8, an "X" is placed by the Group 2 or 3 designators where 2 million gal would alleviate that problem.

Table 3-8 shows the change in probability of constructing and putting into service 1-million gal waste tanks. The effect of putting two new tanks into service is marked in Figure 3-1 and the result is shown in Table 3-8. It means about a 50% decrease in the undesirable operational scenarios. If four new tanks were postulated, certain waste configurations in combination with Vol Bin 2, and a small subset of Vol Bin 1 would be further alleviated for Groups 2 and 3. Also, waste configurations in Groups 2 and 3 that do not include transfer of facility waste by tanker car or rail combined with Vol Bin 1 would be alleviated. The total effect, however, is small as shown in Table 3-8. New tanks are not needed unless the cross-site line fails. If the cross-site line does fail, the benefit of having 2 to 4 million gal of extra storage capacity is offset by the large volumes needed for salt well pumping and dilution of hydrogen-generating tanks. However, it would buy time for repair of the line if possible.

Figure 3-1. Waste Volume Handling after Two New Tanks are Built.



SEQ.PROB.	Config	Vol Bin 1	Vol Bin 2	Vol Bin 3	Vol Bin 4
7.90E-01	A	Group 1	Group 1	Group 1	Group 1
3.12E-04	B	Group 1	Group 1	Group 1	Group 1
8.00E-05	C	Group 1	Group 1	Group 1	Group 1
3.20E-06	D	Group 3	Group 3	Group 3	Group 3
8.00E-07	E	Group 3	Group 3X	Group 3X	Group 4
3.20E-06	F	Group 2	Group 2	Group 2	Group 2
8.00E-07	G	Group 2	Group 2	Group 2X	Group 4
1.28E-03	H	Group 2	Group 2	Group 2	Group 2
3.20E-04	I	Group 2	Group 2	Group 2X	Group 4
6.40E-03	J	Group 2	Group 2	Group 2	Group 2
1.60E-03	K	Group 2	Group 2	Group 2X	Group 4
3.74E-02	L	Group 1	Group 1	Group 1	Group 1
9.60E-03	M	Group 1	Group 1	Group 1	Group 1
2.88E-04	N	Group 3	Group 3	Group 3	Group 3
1.92E-04	O	Group 3	Group 3X	Group 3X	Group 4
2.88E-04	P	Group 2	Group 2	Group 2	Group 2
1.92E-04	Q	Group 2	Group 2	Group 2X	Group 4
1.92E-02	R	Group 2	Group 2	Group 2	Group 2
1.28E-02	S	Group 2	Group 2	Group 2X	Group 4
2.40E-02	T	Group 2	Group 2	Group 2	Group 2
9.60E-02	U	Group 2	Group 2	Group 2X	Group 4
		> 6200 K	> 5800 K	> 4200 K	> 3800 K

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Table 3-8. Change in Probability of Each Group if Two 1-Million Gallon Tanks are Built, 1999 to 2005.

Probability of each group						
	Group 1	Group 2	Group 2X	Group 3	Group 3X	Group 4
No new tanks	0.8327	0.1524	--	0.0003	--	0.0085
Two new tanks	0.8327	0.0809	0.0715	0.0002	0.0001	0.0085
Four new tanks	0.8327	0.0607	0.0917	0.0002	0.0001	0.0085

3.3 CONCLUSIONS AND INSIGHTS

For the 1995 through 1998 time period, the most likely situations (79% of the cases) will result in free-volume requirements in the 200 West Area in excess of 5,000 kgal. There is a 75% confidence that the free-volume requirements will be less than approximately 8,600 kgal and a 90% confidence that it will be less than 9,200 kgal. (Volume confidence level determination and bases are given in Appendix F.) The major contributors to the total waste volume in the 1995 to 1998 time period are normal facility-generated waste, salt well pumping of the SSTs, SST leaks, and facility upsets. This includes cases in which the tank farm facility does not have any flexibility to deal with waste generated by unplanned facility activities. In addition, dilution is not performed on the waste contained in the 101-SY and 103-SY tanks in these operational scenarios.

For the 1999 to 2005 time period, the most likely situations (65% of the cases) will result in mean free-volume requirements between 4,200 and 5,800 kgal. There is a 75% confidence that the generated waste will not exceed 5,500 kgal and a 90% confidence that the free volume will not exceed 5,800 kgal. The major contributors to these totals in the 1999 to 2005 time frame are normal facility-generated waste, salt well pumping of the remaining SSTs, no flexibility for dealing with waste generated by unplanned facility activities, the retrieval of the TX-107 and TX-118 solids, SST leaks, and facility upsets. Dilution is not performed in the waste contained in the 101-SY and 103-SY tanks in these operational scenarios.

Unsuccessful scenarios range from 31% to 17% chance of occurrence for the 1995 through 1998 and 1999 to 2005 time periods, respectively. Success is defined as having enough existing free tank space in the 200 West Area or the ability to transfer the volume to the 200 East Area. Given the degree of uncertainty of particular input parameters in this assessment, this position is not operationally favorable. The situation is even less favorable if free tank space in the 200 East Area is limited and, therefore, unavailable for transfers from the 200 West Area. Some of the potentially major and severe impacts of the unsuccessful scenarios are as follows.

- Minor - Does not affect Tri-Party Agreement commitments but does have significant impact on project logistics or cost
- Severe - Tri-Party Agreement commitments are missed and/or major unplanned contingency activities result
- Major - Potential insult to environment or human safety and/or major program impacts result.

Key major impacts include: (1) no free tank space to handle contingencies such as confirmed tank leaks; (2) no free tank space to handle unscheduled volumes, which may or may not have safety significance; and (3) no room to handle dilution waste from mitigation of 103-SY if needed.

Key severe impacts include: (1) inability to accommodate facility waste which primarily jeopardizes the tank characterization effort and decontamination activities at T Plant, (2) inability to accommodate salt well pumping effluent which jeopardizes Tri-Party Agreement commitments and waste retrieval schedules and increases the chance of a leak to the environment, (3) inability to accommodate unplanned and unscheduled volumes which could represent a major or severe impact depending on the safety implications, and (4) inability to support the SST retrieval schedule which has a significant impact on many other programs.

As in all probabilistic risk assessments, the absolute probabilities reported as the results should be used with caution. This is particularly true in this study because knowledge about waste volume issues continues to evolve. Probabilities change because risk prediction is based on present information. Also, scenarios will evolve as contingency planning progresses. The main values of a risk assessment are the engineering insights, the capability to highlight significant risk issues, and the ability to establish a framework that can be used to assess future changes. The following are key insights.

- Success of 200 West Area tank farm operations is highly correlated to the success of the cross-site transfer line and the ability of the 200 East Area to receive it.
- There is a high likelihood of a leak in a complexed SST in the next 4 years (sampling pending).
- There is a strong likelihood, in the next 4 years, that some combination of tank leaks, facility upsets, and cross-site line failure will require more free tank space than is currently available in 102-SY.
- In the next 4 to 10 years, there is some likelihood that a combination of a cross-site line failure and the need to accommodate some unscheduled waste volume will require more free tank space than is presently available in 102-SY.

- The inherent uncertainty in volume projections is in the range of 3 million gal. This uncertainty needs to be seriously considered if plans are to operate with a marginal free tank space volume with less than this amount.

- New million gallon tanks increase the ability to manage contingencies and unplanned events. In the 1999 to 2005 time frame it significantly reduces risks of scenarios with major impacts (contingencies and unplanned events) which represent potential environmental and safety threats. However, they do not significantly decrease certain risks with severe impacts (significant affects on operational programs).

4.0 REFERENCES

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APPENDIX A

OPERATIONALLY GENERATED WASTE VOLUMES AND BASES

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APPENDIX A

OPERATIONALLY GENERATED WASTE VOLUMES AND BASES

A1.0 INTRODUCTION

This appendix contains the bases for the operationally generated waste volumes used in this assessment. Shown are values for facility-generated waste, salt well pumping, and estimates about tank space requirements for operational flexibility.

A2.0 FACILITY WASTE

Volumes generated from the 200 West Area facilities for 1995 through 1998 are given in Tables A-1, A-2, and A-3. Volumes for 1999 to 2005 are given in Tables A-4, A-5, and A-6. These volumes are taken from volume projections reported in WHC-SD-WM-029 (Koreski and Strode 1994) with one exception. Presently, facility waste is being transferred from the S Plant and T Plant to the 200 East Area by tanker truck and rail, respectively. Flush volume needed to clean the tankers is about 40% of the transferred volume. This volume is not reported in WHC-SD-WM-029. Three cases are given for each time period, referred to in WHC-SD-WM-029 as the baseline, upper planning, and lower planning case. These were taken to be the 5 percentile, best estimate, and 95 percentile cases.

Table A-1. Facility-Generated Volume Mean Values through 1998.

Facility	1995	1996	1997	1998	Total
S Plant	216	216	216	216	864.00
S Plant flush (0.06)	13	13	13	13	52.00
Truck flush (0.40)	86	86	86	86	344.00
T Plant	180	180	180	180	720.00
T Plant flush (0.06)	11	11	11	11	44.00
Rail car flush (0.40)	72	72	72	72	288.00
PFP	36	36	36	36	144.00
PFP flush	2	2	2	2	8.00
PFP stabilization/flush	0	0	31	278	309.00
Total	616.00	616.00	647.00	894.00	2,773.00

Table A-2. Facility-Generated Volume 5 Percentile Values through 1998.

Facility	1995	1996	1997	1998	Total
S Plant	144	144	144	144	576.00
S Plant flush (0.06)	9	9	9	9	36.00
Truck flush (0.40)	58	58	58	58	232.00
T Plant	114	114	114	114	456.00
T Plant flush (0.06)	9	9	9	9	36.00
Rail car flush (0.40)	58	58	58	58	232.00
PFP	36	36	36	36	144.00
PFP flush	2	2	2	2	8.00
PFP stabilization/flush	0	0	31	278	309.00
Total	430.00	430.00	461.00	708.00	2,029.00

Table A-3. Facility-Generated Volume 95 Percentile Values through 1998.

Facility	1995	1996	1997	1998	Total
S Plant	216	216	216	216	864.00
S Plant flush (0.06)	13	13	13	13	52.00
Truck flush (0.40)	86	86	86	86	344.00
T Plant	240	240	240	240	960.00
T Plant flush (0.06)	14	14	14	14	56.00
Rail car flush (0.40)	96	96	96	96	384.00
PFP	36	36	36	36	144.00
PFP flush	2	2	2	2	8.00
PFP stabilization/flush	0	0	31	278	309.00
Total	703.00	703.00	734.00	981.00	3,121.00

Table A-4. Facility-Generated Volume Mean Values, 1999 to 2005.

Facility	1999	2000	2001	2002	2003	2004	Total
S Plant	216	216	216	216	216	216	1,296
S Plant flush (0.06)	13	13	13	13	13	13	78
Truck flush (0.40)	86	86	86	86	86	86	516
T Plant	180	180	180	180	180	180	1,080
T Plant flush (0.06)	11	11	11	11	11	11	66
Rail car flush (0.40)	72	72	72	72	72	72	432
PFP	36	36	36	36	36	36	216
PFP flush	2	2	2	2	2	2	12
PFP stabilization/flush	210	42	0	0	0	0	252
Total	826	658	616	616	616	616	3,948

Table A-5. Facility-Generated Volumes 5 Percentile Values, 1999 to 2005.

Facility	1999	2000	2001	2002	2003	2004	Total
S Plant	144	144	144	144	144	144	864
S Plant flush (0.06)	9	9	9	9	9	9	54
Truck flush (0.40)	58	58	58	58	58	56	346
T Plant	114	114	114	114	114	114	684
T Plant flush (0.06)	9	9	9	9	9	9	54
Rail car flush (0.40)	58	58	58	58	58	58	348
PFP	36	36	36	36	36	36	216
PFP flush	2	2	2	2	2	2	12
PFP stabilization/flush	210	42	0	0	0	0	252
Total	640	472	430	430	430	428	2,830

Table A-6. Facility-Generated Volume 95 Percentile Values, 1999 to 2005.

Facility	1999	2000	2001	2002	2003	2004	Total
S Plant	216	216	216	216	216	216	1,296
S Plant flush (0.06)	13	13	13	13	13	13	78
Truck flush (0.40)	86	86	86	86	86	86	516
T Plant	240	240	240	240	240	240	1,440
T Plant flush (0.06)	14	14	14	14	14	14	84
Rail car flush (0.40)	96	96	96	96	96	96	576
PFP	36	36	36	36	36	36	216
PFP flush	2	2	2	2	2	2	12
PFP stabilization/flush	210	42	0	0	0	0	252
Total	913	745	703	703	703	703	4,470

A3.0 SALT WELL PUMPING VOLUME

Volumes from salt well pumping 200 West Area single-shell tanks (SST) for 1995 through 1998 are given in Tables A-7, A-8, and A-9 based on 35%, 45%, and 65% porosity, respectively. Volumes for 1999 to 2005 are given in Tables A-11, A-12, and A-13 based on the same porosities. The 35% porosity value is used in WHC-SD-WM-029 (Koreski and Strode 1994) to calculate volume projections. The 45% porosity value is used in WHC-EP-0182-79 (Hanlon 1994) to calculate drainable liquid contents in SSTs. The 65% porosity value is based on recent experience. All projected volumes include flush water.

Recent pumping and analysis indicate that the average porosity for salt cake could be 65% and salt slurry could be 17.25. Tables A-9 and A-12 use these porosities and waste characterization information found in (Gaddis). In some cases certain parameters, such as amount of salt cake, vary between (Gaddis) and Hanlon. Table A-10 shows calculated porosities in the BY and BX Farm based on recent pumping experience and different calculational methods.

Table A-7. Salt Well Pumping Volumes Based on 35% Porosity Values through 1998.

Facility	1995	1996	1997	1998	Total
200 West Area SWL (35% porosity)	111	736	534	809	2,190.00
200 West Area SWL flush (0.19)	21	140	101	153	415.00
Total	132.00	876.00	635.00	962.00	2,605.00

Table A-8. Salt Well Pumping Volumes Based on 45% Porosity Values through 1998.

Facility	1995	1996	1997	1998	Total
200 West Area SWL (45% porosity)	138	1,202	805	1,031	3,176.00
200 West Area SWL flush (0.19)	26	228	153	196	603.00
Total	164.00	1,430.00	958.00	1,227.00	3,779.00

Table A-9. Salt Well Pumping Volumes Based on 65% Porosity Values through 1998.

Facility	1995	1996	1997	1998	Total
200 West Area SWL (65% porosity)	165	1,666	1,075	1,251	4,157.00
200 West Area SWL flush (0.20)	31	317	204	238	790.00
Total	196.00	1,983.00	1,279.00	1,489.00	4,947.00

Table A-10. Corrected and Measured Single-Shell Tank Salt Cake Porosities.

Corrected porosities						Measured porosities			
BY-101	BY-104	BY-107	BY-110	BY-111	BY-112	BX-111	BY-102	BY-103	BY-109
25	57	85	89	89	59	88	61	70	53
Corrected porosities									
SX-104	S-105	S-106	S-108	S-109	S-110	S-111	S-112	Mean	SD
85	34	61	50	49	100	39	43	63.6	21.3

Table A-11. Salt Well Pumping Volumes Based on 35% Porosity Values, 1999 to 2005.

Facility	1995	1996	1997	1998	Total
200 West Area SWL (35% porosity)	258	26	0	0	284
200 West Area SWL flush (0.19)	49	5	0	0	54
Total	307	31	0	0	338

Table A-12. Salt Well Pumping Volumes Based on 45% Porosity Values, 1999 to 2005.

Facility	1995	1996	1997	1998	Total
200 West Area SWL (45% porosity)	367	43	0	0	410
200 West Area SWL flush (0.19)	70	8	0	0	78
Total	437	51	0	0	488

Table A-13. Salt Well Pumping Volumes Based on 65% Porosity Values, 1999 to 2005.

Facility	1995	1996	1997	1998	Total
200 West Area SWL (65% porosity)	476	55	0	0	531
200 West Area SWL flush (0.20)	94	11	0	0	105
Total	570	66	0	0	636

A4.0 REQUIREMENTS FOR OPERATIONAL FLEXIBILITY

The need for operational flexibility is related the need to accommodate future activity that is presently unscheduled. This is different from variation in actual waste volume generated from year to year. Also, this is does not include contingency concerns such as leaks and upsets, which are addressed separately. Operational flexibility is meant to address the fact that programs, management, and operations change and evolve over time (e.g., the decision to build or not build two new waste tanks has changed from being a near certainty to being seriously reconsidered).

To measure possible operational flexibility requirements, the last 5 years of volume projections (Koreski and Strode 1994) were examined to see what changed. The Waste Volume Projection (WVP) Reports from April 1991, October 1992, September 1993, May 1994, and September 1994, were reviewed. There are two types of changes: (1) changes in the normally generated volumes based on projected needs and plans, and (2) major swings in programs.

Major program swings affecting tank space include termination of the grout facility, restart of evaporator restart, and dilution of 101-SY and 103-SY. The grout facility and evaporator relate to making up tank space. The decision to dilute the 101-SY and 103-SY as a passive mitigation measure would add to the volume demand. Management pressure to conserve tank space affects the desire to have operational flexibility. It is theoretically possible that the need may arrive to dilute some troublesome SST or even a miscellaneous underground storage tank as more is discovered. This would presumably require at least one extra tank because there is only a partial tank now available in the 200 West Area.

Additionally, changes in the normally generated volumes based on evolving needs and plans no doubt occur. Table A-14 summarizes changes in the projected volumes from these sources. It shows that changes cause the projections to go up and down from year to year. Totals vary between 2,268 to 2,644 kgal.

One way to view operational flexibility is to assume that at least one tank space (1 million gal) is needed plus or minus the variation in the year-to-year volume projections.

A5.0 REFERENCES

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Table A-14. Changes in Year-to-Year Volume Projections.

Facility	Rev 15 4/91	Rev 16 10/92	Rev 18 9/93	Rev 19 5/94	Rev 20 9/94 (Baseline case)
PUREX	28.6 kgal/mon	23 kgal/mon	23 kgal/mon	23 kgal/mon	400 kgal
U03	--	0	0	0	0
B Plant	Check below	39 kgal/mon	39 kgal/mon	23 kgal/mon	562 kgal
*S Plant	48 kgal/mon	5 kgal/mon	18 kgal/mon	18 kgal/mon	18 kgal/mon
*T Plant	75.5 kgal/mon	20 kgal/mon	20 kgal/mon	20 kgal/mon	15 kgal/mon
100 Area	--	571 kgal	571 kgal	571 kgal	571 kgal
300 Area	48 kgal/mon	5 kgal/mon	5 kgal/mon	5 kgal/mon	5 kgal/mon
400 Area	--	8 kgal/yr	12 kgal/yr	1 kgal/mon	1 kgal/mon
*Waste Sampling & Characterization Facility	--	--	8 kgal/yr	0.7 kgal/mon	0.7 kgal/mon
*Tank Farms	33 kgal/mon	30 kgal/mon	30 kgal/mon	30 kgal/mon	30 kgal/mon
105-F, and 105-H Cleanout	225 kgal	225 kgal	225 kgal	225 kgal	225 kgal
107-AN Caustic addition	--	--	50 kgal	50 kgal	50 kgal
B Plant NCPLX	46.5 kgal/mon	--	--	--	--
B Plant complexed	4 kgal/yr	--	--	--	--
B Plant cell cleanout	40 kgal/mon	--	--	--	--
*PFP-PRF operation	65 kgal/yr	--	--	--	--
*PFP-RMC operation	20 kgal/yr	--	--	--	--
*PFP-lab operation	9.3 kgal/yr	--	--	--	--
Evaporator cleanout	400	--	--	--	--
Total	2,328.8 kgal	2,268 kgal	2,486 kgal	2,294.4 kgal	2,644.4 kgal
Annual steady flows	1,703.8 kgal	1,472 kgal	1,640 kgal	1,448.4 kgal	836.4 kgal
One-time flows	625 kgal	796 kgal	846 kgal	846 kgal	1246 kgal

*Pertains to the 200 West Area.

APPENDIX B

CONTINGENCY WASTE VOLUMES AND BASES

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APPENDIX B

CONTINGENCY WASTE VOLUMES AND BASES

B1.0 INTRODUCTION

This appendix contains the bases for the contingency waste volumes used in this assessment. It describes how the frequency for single-shell tank (SST) and double-shell tank (DST) leaks and facility upsets were derived. Supporting tank farm records and information are given.

B2.0 FACILITY UPSETS

Facility upsets have occurred in contaminated areas that have required quantities of liquid to be transferred to a waste tank. Twenty years of unusual occurrence and occurrence records report that a few dozen spills, leaks, and misrouting have occurred that resulted in these kinds of events. Mitigation of many of these resulted in transfer of liquids to a waste tank. The volume of these upsets ranges from a few thousand gallons to tens of thousands of gallons.

The occurrence reporting and processing system (ORPS) database was queried to see what events had occurred in the 200 West Area in the last 4 years (which is the length of time that ORPS has been operational). One major event occurred on March 6, 1991, at the 242-A evaporator in which a large volume of liquid accumulated in the pump, condenser, and evaporator room. About 3,600 gal flowed through an uncapped transfer line to 102-SY before it was noticed. This event was caused by damage from frozen fire system piping and subsequent mistaken pressurization of the fire control system. About 56,600 total gal had to be managed in the cleanup process. This event was documented as RL-WHC-TANKFARM-1991-0192.

Accordingly, one major facility upset occurred in 4 years at the facilities of interest. The average rate for the 1995 through 1998 time period is 1.0 event in 4 years. Similarly, the expected frequency for leaks in the 1999 to 2005 time period is 1.5 events in 6 years. Using the Poisson distribution, the probability of certain combinations of failures happening in each time period can be determined. For example, the probability of one and only one upset facility happening in the next 4 years is about 37%. The chance of exactly two leaks occurring in the next 4 years is about 18%. See Table B-1 for probabilities.

Table B-1. Probability of a Major Facility Upset.

Time period, year	Probability of X number of failures in time period					
	1	2	3	4	5	6
1995 through 1998	0.368	0.184	0.061	0.015	0.003	0.0005
1999 to 2005	0.298	0.268	0.161	0.072	0.026	0.008

* Prob = $e^{-lambda} lambda^X / X!$, where X = 1,2,3... failures and lambda = failure rate

B3.0 SST LEAKS

Leaks in SSTs require that emergency salt well be pumped (Wiggins 1994). This volume eventually is pumped to a double containment receiver tank (DCRT) and then by batches to a DST. The Hanlon document reports the month and year in which SSTs were discovered to be leaking. These are shown in Figure B-1.

Figure B-1 shows that a large number of leaks occurred in the 1970's in the 200 West Area tank farm. Beginning, however, in 1980, the frequency of leaking tanks per year decreased. This coincides with the initiation of salt well pumping. Since 1980, the frequency of leaking tanks per year has been roughly the same. This seems to be true even though the number of tanks that can leak steadily decreased in the 1980's because of salt well pumping. Five leaks occurred between 1980 and 1995.

Accordingly, one SST leak occurs about every 3 years at the 200 West Area. The expected frequency for leaks in the 1995 through 1998 time period is 1.2 events in 4 years. Similarly, the expected frequency for leaks in the 1999 to 2005 time period is 1.8 events in 6 years. Using the Poisson distribution, the probability of certain combinations of failures happening in each time period can be determined. For example, the chance of one and only one SST leak happening in the next 4 years is about 36%. See Table B-2 for probabilities.

B4.0 DST LEAK

For DSTs, the failure rate cannot be quantitatively derived because no failures have occurred nor have the tanks been examined to determine if any general degradation has occurred. Post-weld stress relief and special chemistry controls have increased the reliability of these vessels at the Hanford and Savannah River sites but the base of experience is too low to make a reliable estimate. Instead, an estimate is made based on the failure rates experienced in non-nuclear pressure vessels, where the database is extensive but not as representative. Specific data collected by Phillips and Warwick and presented in "Pressure-Vessel-Failure Statistics and Probabilities" (AEC 1974) are the basis for the DST failure rate estimate.

Figure B-1. History of Single-Shell Tank Leaks.

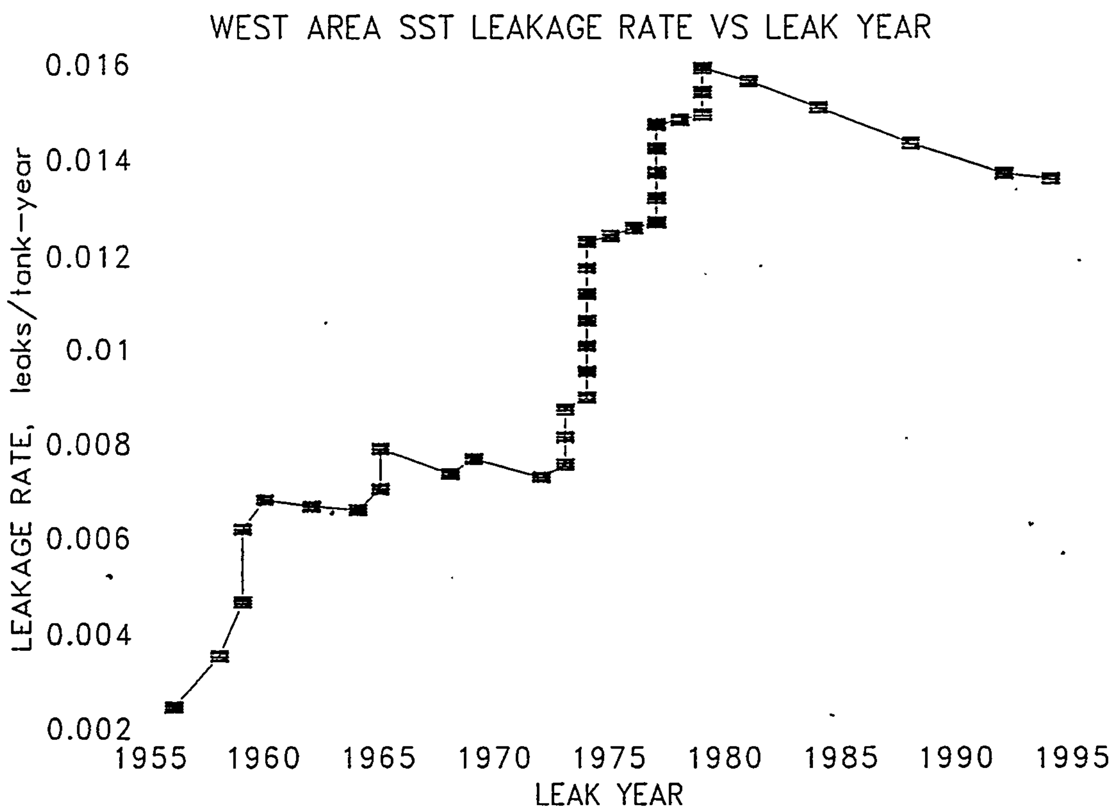

Table B-2. Probability of a Single-Shell Tank Leak.

Time period, year	Probability of X number of failures in time period					
	1	2	3	4	5	6
1995 through 1998	0.361	0.217	0.087	0.026	0.006	0.001
1999 to 2005	0.298	0.268	0.161	0.072	0.026	0.008

* Prob = $e^{-lambda} lambda^X/X!$, where X = 1,2,3... failures and lambda = failure rate

Of the 132 service failures reported by Phillips and Warwick in the 100,300 vessels-years of service, about 80 failures could be relevant to DSTs. Failures related to fatigue and creep were considered important here. Of the 80 failures, only about 10% resulted in leaks or disruptive failures. Hence, the rate of leak or disruptive failures is calculated to be 8E-05 per vessel-year.

There is a significant range of numbers reported in "Pressure-Vessel-Failure Statistics and Probabilities" (AEC 1974) and a variety of definitions of failure. With these added uncertainties, a range of failures is appropriate. Based on engineering judgement, an error factor of 5 was determined to be representative of the 5 and 95 percentile cases. This failure rate range is between about 4E-04 and 1.6E-05 per vessel-year.

B5.0 REFERENCES

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APPENDIX C

WASTE HANDLING SYSTEM OPERABILITY BASES

CONTENTS

APPENDIX C

WASTE HANDLING SYSTEM OPERABILITY BASES

C1.0 INTRODUCTION

This appendix contains the bases for the branch probabilities on the waste handling system event tree that are related to equipment dependability. It describes how the reliability and availability of certain lines, tanks and pumps were determined.

C2.0 NEAR-TERM WASTE HANDLING

The following branches are part of the waste handling event tree for 1995 through 1998 and require an estimate of the likelihood of failure of certain equipment.

- Available (SY Farm) (0.88)
- Transfers Only (SY Farm) (2E-1)
- Storage Only (SY Farm) (1E-2)
- Totally Unavailable (SY Farm) (1E-2).

The first branch, Available, is a success state and the following three are failures. The branch 'Transfers Only' represents the possibility that the cross-site transfer capability is intact but storage in 102-SY is not possible. The branch 'Storage Only' represents the possibility that the capability to store volume in the head space of 102-SY is intact but transfer capability from the tank is failed. The branch 'Totally Unavailable' represents the possibility that both capabilities are lost.

The cross-site transfer line is not considered part of the SY farm, so, if the lines into the 102-SY tank are good but the transfer pump is failed, it is still possible to store waste. The transfer pump is a 30 ft, vertical turbine-type rated at 400 ft head and 80 to 100 gpm. It is also referred to as a flex pump, meaning that the pump intake is flexible and mounted on floats. In this arrangement, liquid is always drawn from near the surface of the liquid in the tank.

The number of hours that this pump is required to operate, or mission, can be conservatively estimated based on the highest possible waste volume generated. From Table 2-3 this is about 9 million gal for 1995 through 1998. Pumping at a rate of 100 gpm, it would require about 1,500 hours to pump this volume.

The likelihood of catastrophic failure can now be determined based on the mission time and some failure rate. A failure rate for this kind of pump operating in a chemical processing environment is given in WSRC-TR-93-262 (SRS 1993) as 6.0E-05/h. However, F30602-91-C-0002 (RAC 1991) reports that only 8.5% of pump failures are catastrophic. In this analysis, the interest is in a catastrophic failure where the pump needs to be replaced or taken out of service for a significant period of time. Accordingly, the chance of this kind of event is 0.0076 or about 1%. This is the probability assigned to branch, Storage Only. It is conservative because it is assumed that negative consequences will occur before repair of replacement is done.

There are times when 102-SY is nearly full because waste is continuously being staged there and transferred; if the cross-site line transfer fails when the tank is full, it is not possible to store additional volume in the tank. From the above calculations, it is estimated that the pumping mission is about 1,500 hours. Assuming the total time the tank is nearly full is a factor of 4 greater than the pumping time (accounting for filling the tank, emptying the tank, and dead time), the chance it is unavailable during the 4 years is about 0.171 or 20%. This is the probability assigned to branch, Transfer Only.

The transfer and storage ability function of 102-SY can both fail if the lines into the tank fail or if the transfer pump fails when the tank is full. The primary feed lines into the SY Farm are from the 244-S double-contained receiver tank (DCRT). It is fairly unlikely that both double-encased lines will fail at the same time. However, given the close proximity and service of these lines, it is assumed that common-mode failure of these lines is the dominate contributor to the probability of branch, Totally Unavailable. It is assumed that if a line leaks that it will be taken out of service, even though the second encasement will contain the leak.

The 244-S DCRT is located at about W75400 and N35939 per drawing H-2-71042, *Civil Plot of 244-S DCRT*; and the SY pump is located at about W75500 and N36358 per drawing H-2-37778, *Piping Plan 241-SY Tank Farm*. Therefore, the length of the lines in question (V561 and V562) is about 500 ft. Using failure data cited in WHC-SD-WM-RPT-048 (Stahl 1992), 1E-08/ft, and a 4-year mission, the probability of one leak (contained) is 0.176. Common-cause factors known as Beta factors are cited in (Fullwood) in the range of 0.01 to 0.10. Using a factor of 0.5 yields a probability of about 0.0088 or about 1%. This is the probability assigned to branch, Totally Unavail.

The probability of the SY Farm being available is the probability 1.0 minus the failure probabilities or 88%.

C3.0 FAR-TERM WASTE HANDLING

The following branches are part of the waste handling event tree for 1999 to 2005 and require an estimate of the likelihood of failure of certain equipment.

- Fails In-Service (New Line) (1E-2)
- Fails In-Service (Old Line) (1.6E-1)
- Available (SY Farm) (0.88)
- Transfers Only (SY Farm) (2E-1)

- Storage Only (SY Farm) (1E-2)
- Totally Unavailable (SY Farm) (1E-2).

The probabilities related to SY Farm operability were assumed to be like those for the 1995 through 1998 time period.

The probability of the new line failing is represented by branch, Fail In-Service (New Line). The new cross-site line will be stainless steel and about 6.5 miles long. Failure rates given in WSRC-TR-93-262 (SRS 1993) recommend 1E-10/h/ft for a line rupturing and 1E-10/h/ft for a line plugging. Plugging of transfer lines has occurred in the past so should be considered here. Using the same mission as the transfer pumps (1,500 h) results in a calculated probability of 0.0103 or about 1%.

The probability of the old line failing is represented by branch, Fail In-Service (Old Line). The old line is about 5.7 miles long. Failure rates in WSRC-TR-93-262 for failing and plugging lines list an error factor of about 30. A degraded failure rate for the old line is appropriate; therefore it is assumed that the line will fail at the 80 or 90 percentile of the probability distribution. This yields about 0.16 or 16% failure probability.

C4.0 REFERENCES

RAC, 1991, *Failure Mode/Mechanism Distributions*, F30602-91-C-0002, Reliability Analysis Center, Rome Laboratory, Griffiss AFB, New York.

SRS, 1993, *Savannah River Site Generic Data Base Development*, WSRC-TR-93-262, Westinghouse Savannah River Company, Aiken, South Carolina.

Stahl S. M., 1992, *Stabilization Safety Study of Non-Watch List Tanks*, WHC-SD-WM-RPT-048, Westinghouse Hanford Company, Richland, Washington.

WHC, *Piping Plan 241-SY Tank Farm*, Drawing H-2-37778, Westinghouse Hanford Company, Richland, Washington.

WHC, *Civil Plot of 244-S DCRT*, Drawing H-2-71042, Westinghouse Hanford Company, Richland, Washington.

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APPENDIX D

UNCERTAINTY DETERMINATION ON OPERATIONALLY GENERATED WASTE VOLUMES

CONTENTS

APPENDIX D

UNCERTAINTY DETERMINATION ON OPERATIONALLY GENERATED WASTE VOLUMES

D1.0 INTRODUCTION

This appendix contains the bases for probability distributions developed for the operationally generated waste volumes used in this assessment. This includes discussions for facility-generated waste, salt well pumping, 101-SY and 103-SY dilution, requirements for operational flexibility, and waste retrieval. Sections 2.0 and 3.0 describe probability distributions developed for the near term (1995 through 1998) and far term (1999 to 2005) case, respectively.

D2.0 NEAR-TERM CASE

Probability distributions for the 1995 through 1998 case are described here.

Facility-Generated Waste

Volumes generated from 200 West Area facilities are given in Appendix A. The volumes are primarily taken from volume projections reported in WHC-SD-WM-029 (Koreski and Strode 1994). Three cases are given for each time period, referred to in WHC-SD-WM-029 as the baseline, upper planning, and lower planning case. These were taken to be the 5 percentile, best estimate, and 95 percentile cases.

No particular shape could be justified for this distribution, so a bounding user-specified distribution was created. A triangle distribution with rectangular tails was created. The mode or peak of the triangle was set at 2,773 kgal, which corresponds to the best estimate. The 95 percentile or upper leg of the triangle was set at 3,121 kgal, which corresponds to the upper planning case. The 5 percentile or lower leg of the triangle was set at 2,029 kgal, which corresponds to the lower planning case. Five percent of the area was set to lay between 1,500 and 2,029 kgal and another 5% between 3,121 and 3,500 kgal.

Salt Well Pumping Waste

Recent pumping and analysis indicate an average porosity for salt cake of about 64% and for salt slurry of about 17%. Appendix A, Table A-10, shows calculated and recalculated porosities in the range of 25% to 100% with a standard deviation of about 21. This set is a significant fraction of the total tanks to be salt well pumped (18 of 43). Therefore, it can be assumed that the porosity of all the tanks is distributed similarly.

The porosity data look random with a lower bound of 0% and an upper bound near 100%, so the tank-by-tank porosities were assumed to be normally distributed around 65% with a standard deviation of 20%. Drainable liquid volume is a function of the porosity. A mean volume, 4,947 kgal, based on 65% and a deviation in gallons, 761 kgal, based on 20% was used to create a probability distribution of salt well pumping volume in gallons for 1995 through 1998.

101-SY and 103-SY Dilution

Estimates of the dilution ratio necessary to mitigate and transfer the contents of 101-SY and 103-SY are given in PNL-10417 (Hudson 1995). It stated that a 1:1 ratio should bound the case and 0.5:1 should be sufficient.

No particular shape could be justified for this probability distribution, so a bounding user-specificized distribution was created. A triangle distribution with a rectangular tail was created. The mode or peak of the triangle was set at the best guess, 0.5:1. The ratio 1:1 was assumed to lay at the 95 percentile while 5% percent of the area was assumed to lay between a 1:1 and 1.5:1 ratio. The 0 percentile was assumed to lay at 0.3:1.

These ratios correspond to a volume related to volume of waste in 101-SY. The total volume of waste in 101-SY is about 1,140 kgal. Accordingly, a 0.5:1 ratio means 570 kgal of dilution water would be needed. A 1:1, 1.5:1, and 0.3:1 ratio corresponds to 1,140, 1,710, and 342 kgal, respectively.

Operational Flexibility

The need for operational flexibility is related to the need to accommodate future activity that is presently unscheduled. Two types of potentialities were considered: (1) changes in the normally generated volumes based on projected needs and plans, and (2) major swings in programs. Based on information given in Appendix A, tank space needed to accommodate major changes is assumed to be at least 1 million gal. Based on historical data (also given in Appendix A), year-to-year changes were assumed to be the variance about the million gallons. Because the year-to-year changes can go up and down nearly equally, a normal distribution was selected to be representative, based on a mean of 1,000 kgal and a standard deviation of 142 kgal.

D3.0 FAR-TERM CASE

Probability distributions for the 1999 to 2005 case are described here.

Facility-Generated Waste

As in the near-term time period, the baseline, upper planning, and lower planning case referred to in WHC-SD-WM-029 (Koreski and Strode 1994) were used as best estimate, 5 percentile, and 95 percentile cases points of a probability distribution.

A triangle distribution with rectangular tails was created. The mode or peak of the triangle was set at 3,948 kgal which corresponds to the best estimate. The 95 percentile or upper leg of the triangle was set at 4,470 kgal, which corresponds to the upper planning case. The 5 percentile or lower leg of the triangle was set at 2,830 kgal, which corresponds to the lower planning case. Five percent of the area was set to lay between 2,000 and 2,830 kgal and another 5% between 4,470 and 5,000 kgal.

Salt Well Pumping Waste

As in the near-term case, tank-by-tank porosities were assumed to be normally distributed around 65% with a standard deviation of 20%. Drainable liquid volume is a function of the porosity. There are two possible volumes scenarios: the remaining drainable liquid in single-shell tanks (SST) given tanks are pumped on schedule, and all the drainable liquid assuming that pumping is delayed.

The distribution for all 200 West Area SST drainable liquid was assumed to be a normal distribution centered at a mean volume of 5,584 kgal with a standard deviation of 761 kgal based. The distribution for the remaining drainable SST liquid in the 200 West Area given salt well pumping proceeds at its current schedule is assumed to be a normal distribution centered at a mean volume of 636 kgal with a standard deviation of 98 kgal. The means are based on a 65% porosity and the standard deviation on a 20% porosity.

101-SY and 103-SY Dilution

The probability distribution for volume added because of dilution is the same as for the near-term case except that the tank mitigated is 103-SY rather than 101-SY which has a different volume. Assumptions about dilution volumes are the same.

A triangle distribution with a rectangular tail was created. The mode or peak of the triangle was set at the best guess, 0.5:1. The ratio 1:1 was assumed to lay at the 95 percentile while 5% of the area was assumed to lay between a 1:1 and 1.5:1 ratio. The 0 percentile was assumed to lay at 0.3:1.

These dilution ratios are the generated volume against the volume of waste in 103-SY. The total volume of waste in 101-SY is about 740 kgal. Accordingly, a 0.5:1 ratio means 370 kgal of dilution water would be needed. A 1:1, 1.5:1, and 0.3:1 ratio corresponds to 740, 1,100, and 3,220 kgal, respectively.

Operational Flexibility

The need for operational flexibility is related to the need to accommodate future activity that is presently unscheduled (the same as for the near-term case).

Retrieval of 107-TX and 118-TX

The additional volume created from retrieval of these tanks was assumed to have the same basis as for dilution of 101-SY and 103-SY. Triangle distributions with rectangular tails were created. The mode or peak of the triangle was set at the best guess, 0.5:1. The ratio 1:1 was assumed to lay at the 95 percentile while 5% of the area was assumed to lay between a 1:1 and 1.5:1 ratio. The 0 percentile was assumed to lay at 0.3:1.

These dilution ratios are the generated volume against the volume of waste in the tanks. The total volume of waste in 107-TX is about 36 kgal. Accordingly, a 0.5:1 ratio means 18 kgal of dilution water would be needed. A 1:1, 1.5:1, and 0.3:1 ratio corresponds to 36, 54, and 12 kgal, respectively. The total volume of waste in 118-TX is about 347 kgal. Accordingly, a 0.5:1 ratio means 174 kgal of dilution water would be needed. A 1:1, 1.5:1, and 0.3:1 ratio corresponds to 347, 520, and 104 kgal, respectively.

D4.0 REFERENCES

Hudson J. D., 1995, *An Assessment of the Dilution Required to Mitigate Hanford Tank 241-SY-101*, PNL-10417/UC-510, Pacific Northwest Laboratory, Richland, Washington.

Koreski, G. M., and J. N. Strode, 1994, *Operating Waste Volume Projections*, WHC-SD-WM-029, Rev. 20, Westinghouse Hanford Company, Richland, Washington.

Attachment D-1

Simulation of Combined Probability Distributions for Operationally Generated Waste Volumes for 1995 through 1998

Attachment D-2

Simulation of Combined Probability Distributions for Operationally Generated Waste Volumes for 1999 to 2005

APPENDIX E

UNCERTAINTY DETERMINATION FOR CONTINGENCY WASTE VOLUMES

CONTENTS

LIST OF TABLES

APPENDIX E

UNCERTAINTY DETERMINATION FOR CONTINGENCY WASTE VOLUMES

E1.0 INTRODUCTION

This appendix contains the bases for the probability distributions developed for the contingency waste volumes used in this assessment. This includes discussions on single-shell tank (SST) leaks and facility upsets. Section E2.0 describes probability distributions developed for SST leaks for near and far term, while Section E3.0 describes probability distributions for facility upsets for near- and far-term cases.

E2.0 SST PROBABILITY DISTRIBUTION

The probability distribution for the contingency volume related to leaking SSTs is based on the volume of drainable liquid remaining in SSTs. It is also related to the chance of having more than one leak in the time period. A histogram was created from drainable liquid estimates made by (Brown) using current information about projected porosities. The number of tanks that fall into various volume ranges is shown in Table E-1.

Because there is a significant probability that more than one leak will occur, the chance of combinations of leaks, up to ten leaks, was calculated. Leaks were assigned a probability distribution like the histogram represented by the data in Table E-1. These histograms are given as input in the simulations attached to this appendix. Each combination of leaks (e.g., two leaks in 4 years or three leaks in 4 years) is based on this histogram for each leak and the relative likelihood of the combination. All combinations were then combined into one distribution that represents the total likelihood and gallons of an SST contingency. Two key assumptions being made are: (1) the chance of a leak will remain about the same in the next 10 years, and (2) the distribution of the volume of drainable liquid remaining will stay about the same over the next 10 years.

Table E-1. Histogram Data of Estimates of Drainable Liquid Remaining.

kgal	Number of tanks in volume range						
	0 to 25	25 to 50	50 to 75	75 to 100	100 to 125	125 to 150	150 to 175
# of tanks	1	2	3	1	6	2	3
kgal	175 to 200	200 to 225	225 to 250	250 to 275	275 to 300	325 to 350	350 to 375
# of tanks	1	2	2	1	1	1	1

The only difference between the near- and far-term cases is the relative probability of different combinations of leaks. Because the near-term case covers 4 years and the far term case, 6 years, the chance of leaks in the 1999 to 2005 time period is a little higher.

The input and forecast distributions of the Monte Carlo simulation supporting this analysis are given as Attachment E-1 to this appendix.

E3.0 FACILITY UPSETS PROBABILITY DISTRIBUTION

The probability distribution for the contingency volume related to facility upsets is based on historical data. As stated in Appendix A, records show that the volume of facility upsets range from a few thousand gallons to tens of thousands of gallons. In the facilities of interest, an upset involving about 50 kgal occurred. No upsets exceeding 100 kgal were reported for any facilities.

The best estimate of the volume for a major facility upset was taken to be 50 kgal. It was assumed that mitigation efforts would prevent volumes from exceeding 100 kgal, as evidenced from historical data. So, 1 and 100 kgal were set as bounds of a triangle distribution with 50 kgal as the mode.

Similar to SST leaks, there is a relatively high chance that more than one upset will occur in each time period. However, each upset was assigned the same distribution regardless of how many occur in the combination (e.g., two upsets in 4 years or three upsets in 4 years). The likelihood of increasing numbers of upsets occurring in the same period decrease. Therefore, the probability distribution for combinations of upsets occurring is based on combining the same distribution and the relative likelihood of that combination. All combinations were then combined into one distribution that represents the total likelihood and gallons of a facility upset contingency. Two key assumptions being made are: (1) the chance of an upset will remain about the same in the next 10 years, and (2) the distribution of the volume of upsets will stay about the same over the next 10 years.

The only difference between the near- and far-term cases is the relative probability of different combinations of upsets. Because the near-term case covers 4 years and the far term case, 6 years, the chance of upsets in the 1999 to 2005 time period is a little higher.

The input and forecast distributions of the Monte Carlo simulation supporting this analysis are given as Attachment E-2 to this appendix.

Attachment E-1

Simulation of Combined Probability Distributions for Contingency Waste Volumes for 1995 through 1998

Attachment E-2

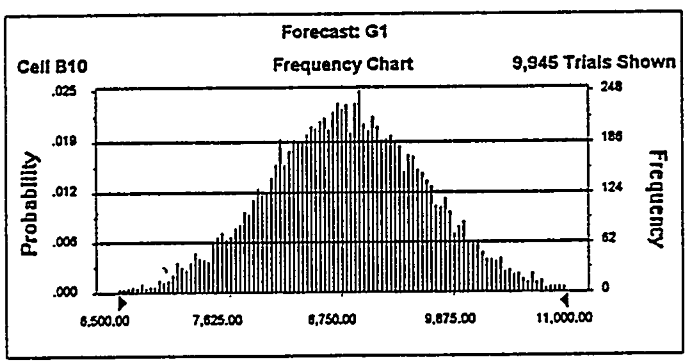
Simulation of Combined Probability Distributions for Contingency Waste Volumes for 1999 to 2005

Crystal Ball Report

Simulation started on 3/17/95 at 14:14:06
Simulation stopped on 3/17/95 at 14:23:42

Forecast: G1 **Cell: B10**

Statistics:	Value
Trials	10000
Mean	8,803.40
Median (approx.)	8,806.47
Mode (approx.)	8,953.29
Standard Deviation	806.00
Variance	649,642.63
Skewness	-0.04
Kurtosis	3.00
Coeff. of Variability	0.09
Range Minimum	5,260.97
Range Maximum	11,796.05
Range Width	6,535.08
Mean Std. Error	8.06



Percentiles:

Percentile	Value (approx.)
0%	5,260.97
10%	7,773.52
25%	8,260.02
50%	8,806.47
75%	9,350.60
90%	9,830.00
100%	11,796.05

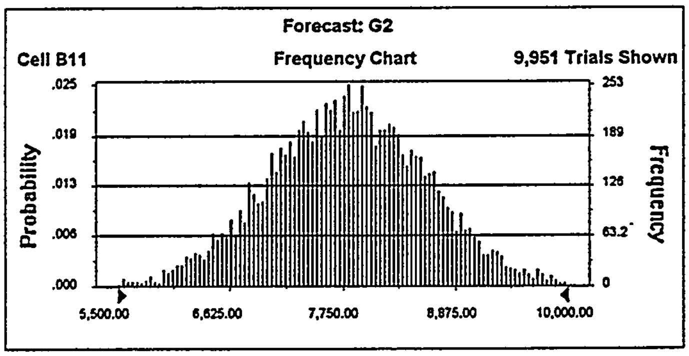
Forecast: G1 (cont'd) **Cell: B10**

End of Forecast

Forecast: G2 Cell: B11

Statistics:

Statistics	Value
Trials	10000
Mean	7,803.43
Median (approx.)	7,811.50
Mode (approx.)	7,808.69
Standard Deviation	795.15
Variance	632,256.33
Skewness	-0.04
Kurtosis	3.03
Coeff. of Variability	0.10
Range Minimum	4,283.04
Range Maximum	10,635.57
Range Width	6,352.53
Mean Std. Error	7.95



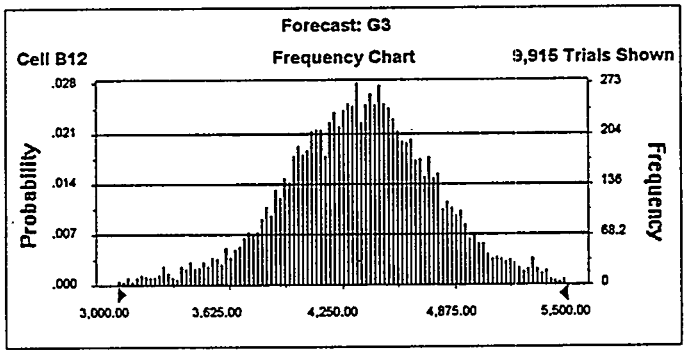
Percentiles:

Percentile	Value (approx.)
0%	4,283.04
10%	6,793.17
25%	7,266.42
50%	7,811.50
75%	8,339.33
90%	8,808.08
100%	10,635.57

End of Forecast

Forecast: G3 **Cell: B12**

Statistics:	Value
Trials	10000
Mean	4,351.36
Median (approx.)	4,356.30
Mode (approx.)	4,465.39
Standard Deviation	436.77
Variance	190,768.73
Skewness	-0.04
Kurtosis	3.54
Coeff. of Variability	0.10
Range Minimum	2,812.28
Range Maximum	6,151.89
Range Width	3,339.61
Mean Std. Error	4.37



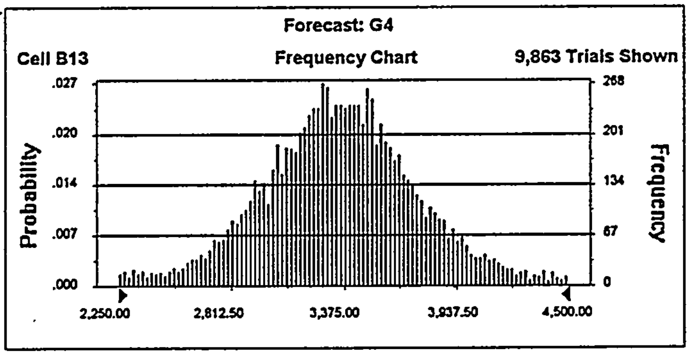
Percentiles:

Percentile	Value (approx.)
0%	2,812.28
10%	3,819.73
25%	4,077.62
50%	4,356.30
75%	4,626.31
90%	4,885.77
100%	6,151.89

End of Forecast

Forecast: G4 | Cell: B13

Statistics:	Value
Trials	10000
Mean	3,351.39
Median (approx.)	3,354.16
Mode (approx.)	3,287.56
Standard Deviation	413.37
Variance	170,878.06
Skewness	-0.04
Kurtosis	3.69
Coeff. of Variability	0.12
Range Minimum	1,900.84
Range Maximum	5,088.69
Range Width	3,187.85
Mean Std. Error	4.13



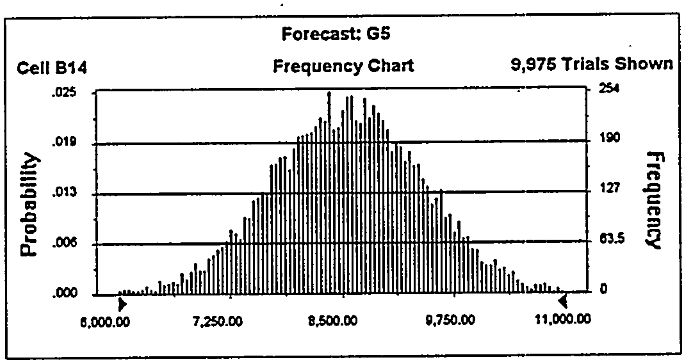
Percentiles:

Percentile	Value (approx.)
0%	1,900.84
10%	2,846.86
25%	3,102.84
50%	3,354.16
75%	3,601.03
90%	3,857.45
100%	5,088.69

End of Forecast

Forecast: G5 **Cell: B14**

Statistics:	Value
Trials	10000
Mean	8,568.58
Median (approx.)	8,578.43
Mode (approx.)	8,619.58
Standard Deviation	843.48
Variance	711,453.94
Skewness	-0.05
Kurtosis	2.97
Coeff. of Variability	0.10
Range Minimum	5,065.56
Range Maximum	11,586.71
Range Width	6,521.15
Mean Std. Error	8.43



Percentiles:

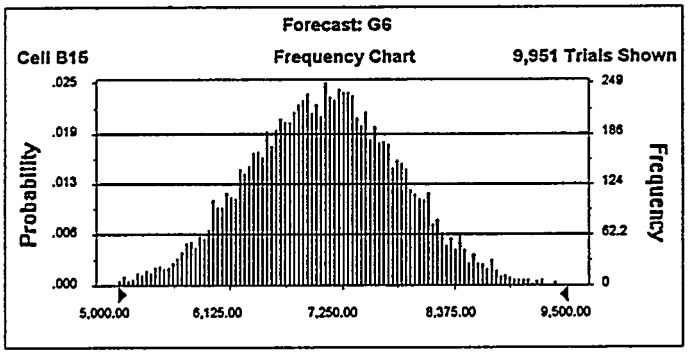
Percentile	Value (approx.)
0%	5,065.56
10%	7,495.88
25%	7,996.45
50%	8,578.43
75%	9,145.18
90%	9,645.28
100%	11,586.71

End of Forecast

Forecast: G6 **Cell: B15**

Statistics:

	Value
Trials	10000
Mean	7,073.95
Median (approx.)	7,086.02
Mode (approx.)	7,249.39
Standard Deviation	764.89
Variance	585,051.52
Skewness	-0.07
Kurtosis	2.99
Coeff. of Variability	0.11
Range Minimum	3,855.50
Range Maximum	9,757.92
Range Width	5,902.41
Mean Std. Error	7.65



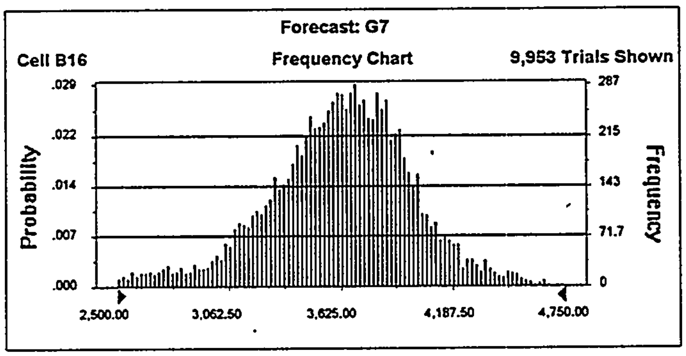
Percentiles:

Percentile	Value (approx.)
0%	3,855.50
10%	6,091.61
25%	6,555.73
50%	7,086.02
75%	7,595.97
90%	8,053.85
100%	9,757.92

End of Forecast

Forecast: G7 **Cell: B16**

Statistics:	Value
Trials	10000
Mean	3,621.88
Median (approx.)	3,647.55
Mode (approx.)	3,705.97
Standard Deviation	370.03
Variance	136,921.21
Skewness	-0.41
Kurtosis	3.66
Coeff. of Variability	0.10
Range Minimum	2,172.70
Range Maximum	4,749.62
Range Width	2,576.92
Mean Std. Error	3.70



Percentiles:

Percentile	Value (approx.)
0%	2,172.70
10%	3,151.24
25%	3,408.65
50%	3,647.55
75%	3,863.28
90%	4,049.56
100%	4,749.62

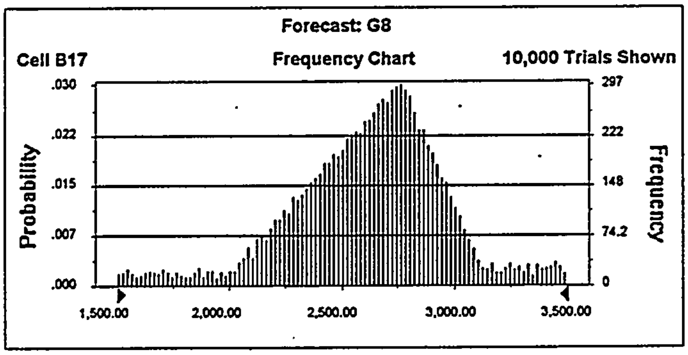
End of Forecast

Forecast: G8

Cell: B17

Statistics:

Statistics	Value
Trials	10000
Mean	2,621.91
Median (approx.)	2,658.16
Mode (approx.)	2,768.46
Standard Deviation	342.91
Variance	117,585.17
Skewness	-0.49
Kurtosis	3.87
Coeff. of Variability	0.13
Range Minimum	1,500.37
Range Maximum	3,497.36
Range Width	1,996.99
Mean Std. Error	3.43



Percentiles:

Percentile	Value (approx.)
0%	1,500.37
10%	2,199.31
25%	2,426.37
50%	2,658.16
75%	2,837.19
90%	2,995.81
100%	3,497.36

End of Forecast

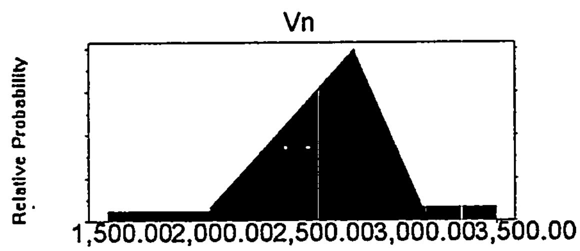
Assumptions

Assumption: Vn = **Cell: B5**

Custom distribution with parameters:

				Relative Prob.
Continuous range	1,500.00	to	2,029.00	0.050000
Continuous range	2,029.00	to	2,773.00	0.601247
Right/Left	11.48			
Continuous range	2,773.00	to	3,121.00	0.283782
Left/Right	10.31			
Continuous range	3,121.00	to	3,500.00	0.050000
Total Relative Probability				0.985029

Mean value in simulation was 2,621.91

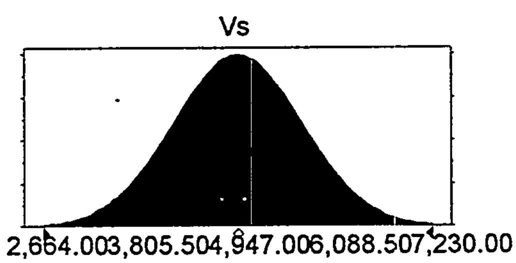


Assumption: Vs = **Cell: B7**

Normal distribution with parameters:

Mean	4,947.00
Standard Dev.	761.00

Selected range is from -Infinity to +Infinity
Mean value in simulation was 4,946.71

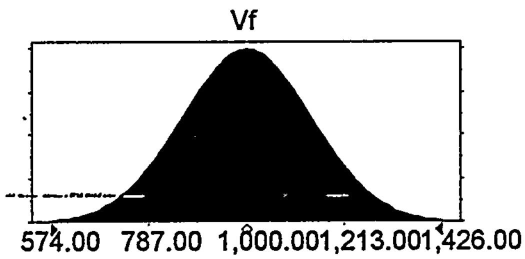


Assumption: Vf = **Cell: B8**

Normal distribution with parameters:

Mean	1,000.00
Standard Dev.	142.00

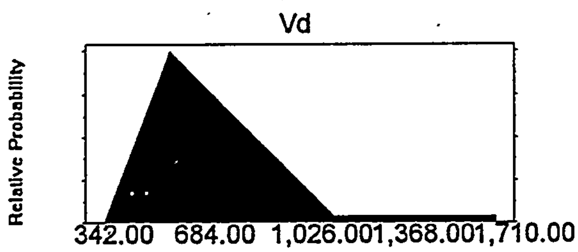
Selected range is from -Infinity to +Infinity
Mean value in simulation was 999.97



Assumption: Vd = **Cell: B6**

Custom distribution with parameters:				Relative Prob.
Continuous range	342.00	to	570.00	0.262108
Right/Left	+Infinity			
Continuous range	570.00	to	1,140.00	0.687544
Left/Right	20.30			
Continuous range	1,140.00	to	1,710.00	0.050000
Total Relative Probability				0.999652

Mean value in simulation was 729.49



End of Assumptions

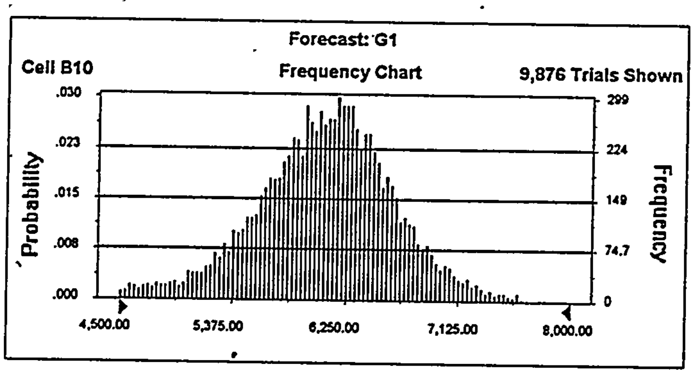
Crystal Ball Report

Simulation started on 3/17/95 at 14:34:01
Simulation stopped on 3/17/95 at 14:50:29

Forecast: G1 **Cell: B10**

Statistics:

	Value
Trials	10000
Mean	6,079.02
Median (approx.)	6,115.09
Mode (approx.)	6,230.50
Standard Deviation	567.34
Variance	321,871.28
Skewness	-0.42
Kurtosis	3.73
Coeff. of Variability	0.09
Range Minimum	3,714.33
Range Maximum	7,873.29
Range Width	4,158.96
Mean Std. Error	5.67



Percentiles:

Percentile	Value (approx.)
0%	3,714.33
10%	5,378.60
25%	5,756.25
50%	6,115.09
75%	6,442.44
90%	6,752.10
100%	7,873.29

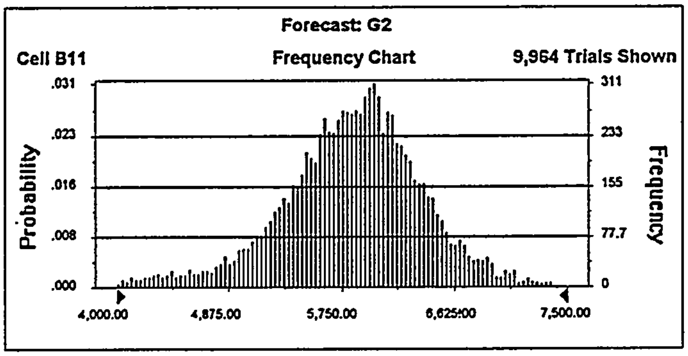
Forecast: G1 (cont'd) **Cell: B10**

End of Forecast

Forecast: G2 **Cell: B11**

Statistics:

Statistics	Value
Trials	10000
Mean	5,833.46
Median (approx.)	5,871.95
Mode (approx.)	5,980.13
Standard Deviation	562.93
Variance	316,891.92
Skewness	-0.44
Kurtosis	3.76
Coeff. of Variability	0.10
Range Minimum	3,536.96
Range Maximum	7,713.32
Range Width	4,176.37
Mean Std. Error	5.63



Percentiles:

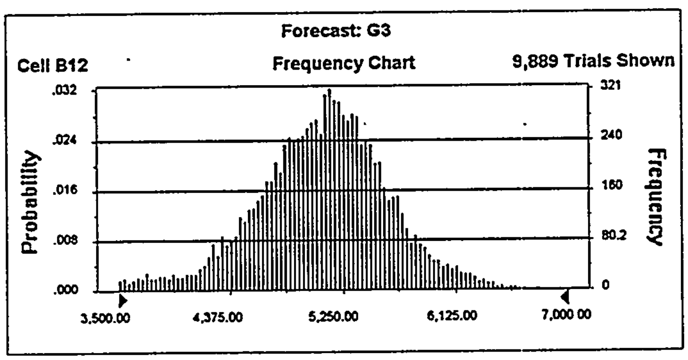
Percentile	Value (approx.)
0%	3,536.96
10%	5,135.98
25%	5,514.90
50%	5,871.95
75%	6,189.86
90%	6,491.20
100%	7,713.32

End of Forecast

Forecast: G3 **Cell: B12**

Statistics:

	Value
Trials	10000
Mean	5,078.96
Median (approx.)	5,123.34
Mode (approx.)	5,150.97
Standard Deviation	548.95
Variance	301,343.22
Skewness	-0.45
Kurtosis	3.84
Coeff. of Variability	0.11
Range Minimum	3,029.76
Range Maximum	6,994.63
Range Width	3,964.87
Mean Std. Error	5.49



Percentiles:

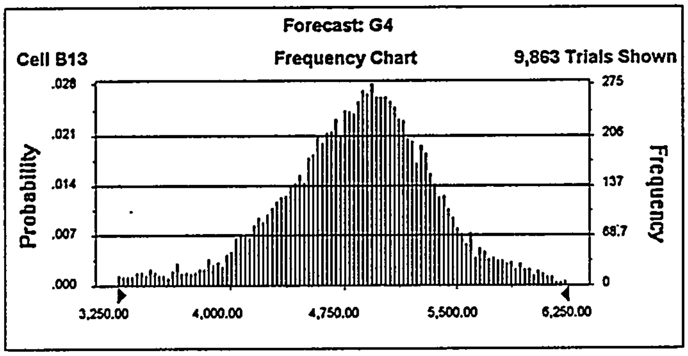
Percentile	Value (approx.)
0%	3,029.76
10%	4,405.57
25%	4,768.45
50%	5,123.34
75%	5,427.91
90%	5,716.12
100%	6,994.63

End of Forecast

Forecast: G4 **Cell: B13**

Statistics:

	Value
Trials	10000
Mean	4,833.41
Median (approx.)	4,876.98
Mode (approx.)	4,956.25
Standard Deviation	544.31
Variance	296,276.21
Skewness	-0.48
Kurtosis	3.88
Coeff. of Variability	0.11
Range Minimum	2,841.74
Range Maximum	6,651.67
Range Width	3,809.94
Mean Std. Error	5.44



Percentiles:

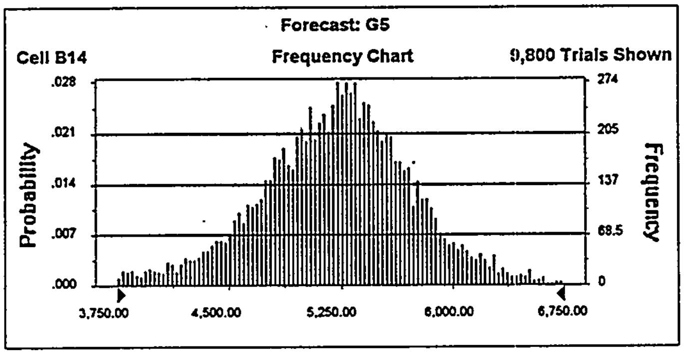
Percentile	Value (approx.)
0%	2,841.74
10%	4,162.83
25%	4,532.65
50%	4,876.98
75%	5,174.35
90%	5,458.45
100%	6,651.67

End of Forecast

Forecast: G5 **Cell: B14**

Statistics:

Statistics	Value
Trials	10000
Mean	5,197.42
Median (approx.)	5,240.06
Mode (approx.)	5,293.32
Standard Deviation	554.57
Variance	307,548.46
Skewness	-0.46
Kurtosis	3.81
Coeff. of Variability	0.11
Range Minimum	2,978.70
Range Maximum	7,075.37
Range Width	4,096.67
Mean Std. Error	5.55



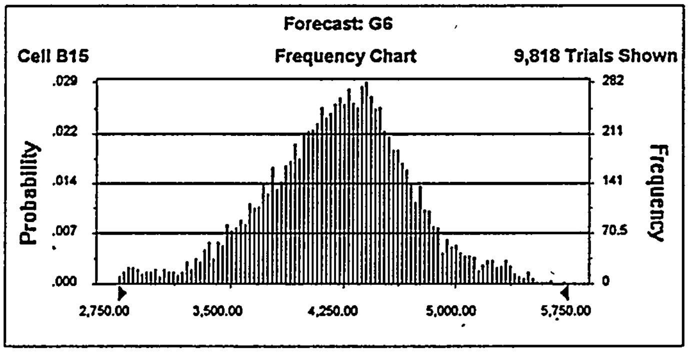
Percentiles:

Percentile	Value (approx.)
0%	2,978.70
10%	4,514.95
25%	4,879.41
50%	5,240.06
75%	5,550.89
90%	5,844.31
100%	7,075.37

End of Forecast

Forecast: G6 **Cell: B15**

Statistics:	Value
Trials	10000
Mean	4,197.36
Median (approx.)	4,241.56
Mode (approx.)	4,392.14
Standard Deviation	535.44
Variance	286,700.90
Skewness	-0.50
Kurtosis	3.92
Coeff. of Variability	0.13
Range Minimum	2,292.50
Range Maximum	5,944.05
Range Width	3,651.55
Mean Std. Error	5.35



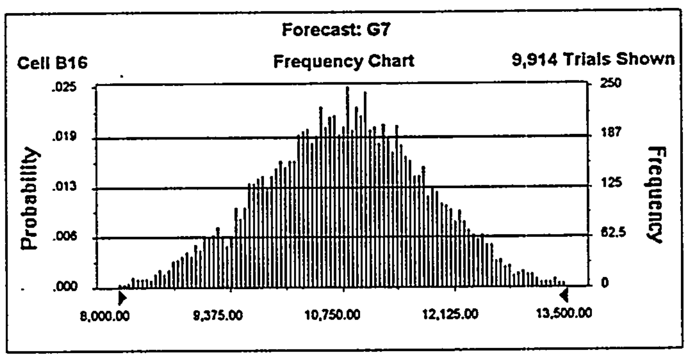
Percentiles:

Percentile	Value (approx.)
0%	2,292.50
10%	3,535.95
25%	3,902.14
50%	4,241.56
75%	4,530.77
90%	4,806.14
100%	5,944.05

End of Forecast

Forecast: G7 **Cell: B16**

Statistics:	Value
Trials	10000
Mean	10,781.37
Median (approx.)	10,805.62
Mode (approx.)	10,833.08
Standard Deviation	1,028.37
Variance	1,057,548.02
Skewness	-0.07
Kurtosis	2.99
Coeff. of Variability	0.10
Range Minimum	7,228.74
Range Maximum	14,510.24
Range Width	7,281.50
Mean Std. Error	10.28



Percentiles:

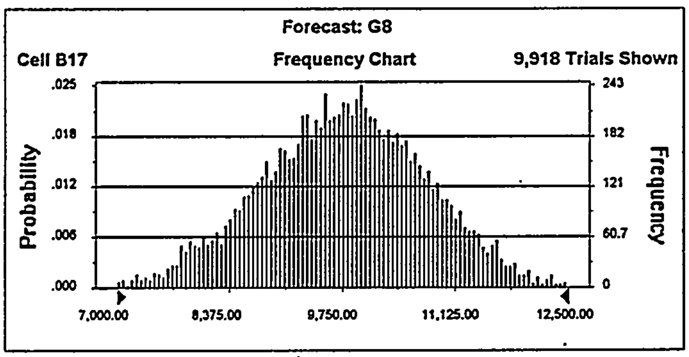
Percentile	Value (approx.)
0%	7,228.74
10%	9,460.11
25%	10,092.45
50%	10,805.62
75%	11,478.39
90%	12,097.15
100%	14,510.24

End of Forecast

Forecast: G8 Cell: B17

Statistics:

Statistics	Value
Trials	10000
Mean	9,781.32
Median (approx.)	9,799.74
Mode (approx.)	10,012.68
Standard Deviation	1,020.44
Variance	1,041,291.10
Skewness	-0.06
Kurtosis	2.99
Coeff. of Variability	0.10
Range Minimum	6,256.73
Range Maximum	13,549.84
Range Width	7,293.11
Mean Std. Error	10.20



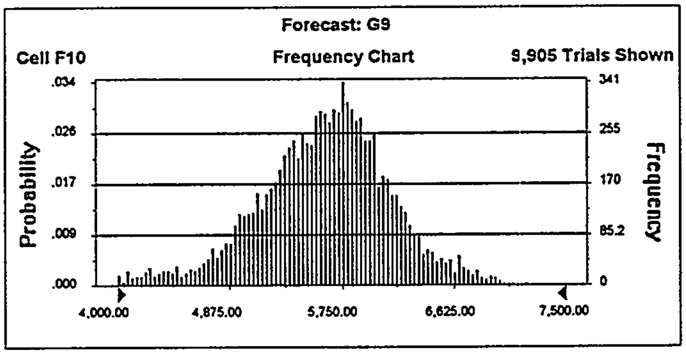
Percentiles:

Percentile	Value (approx.)
0%	6,256.73
10%	8,466.38
25%	9,098.90
50%	9,799.74
75%	10,477.82
90%	11,078.47
100%	13,549.84

End of Forecast

Forecast: G9 Cell: F10

Statistics:	Value
Trials	10000
Mean	5,606.40
Median (approx.)	5,651.25
Mode (approx.)	5,757.10
Standard Deviation	543.68
Variance	295,589.87
Skewness	-0.48
Kurtosis	3.79
Coeff. of Variability	0.10
Range Minimum	3,402.70
Range Maximum	7,294.27
Range Width	3,891.58
Mean Std. Error	5.44



Percentiles:

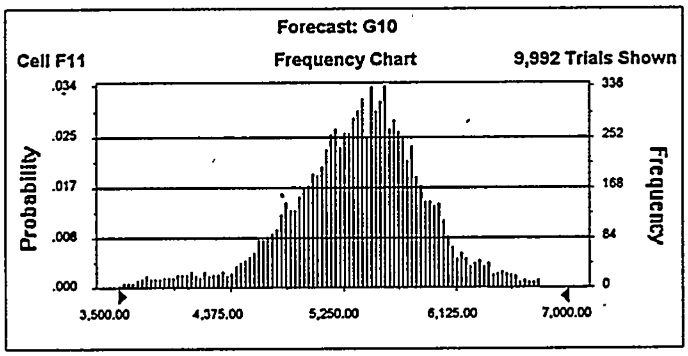
Percentile	Value (approx.)
0%	3,402.70
10%	4,939.39
25%	5,300.47
50%	5,651.25
75%	5,952.54
90%	6,238.10
100%	7,294.27

End of Forecast

Forecast: G10 **Cell: F11**

Statistics:

Statistics	Value
Trials	10000
Mean	5,360.85
Median (approx.)	5,406.68
Mode (approx.)	5,589.59
Standard Deviation	539.22
Variance	290,758.58
Skewness	-0.50
Kurtosis	3.82
Coeff. of Variability	0.10
Range Minimum	3,225.33
Range Maximum	6,948.57
Range Width	3,723.25
Mean Std. Error	5.39



Percentiles:

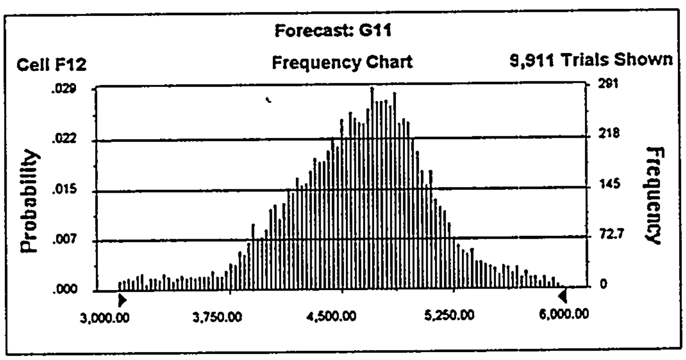
Percentile	Value (approx.)
0%	3,225.33
10%	4,691.58
25%	5,060.55
50%	5,406.68
75%	5,704.12
90%	5,984.66
100%	6,948.57

End of Forecast

Forecast: G11 Cell: F12

Statistics:

Statistics	Value
Trials	10000
Mean	4,606.35
Median (approx.)	4,655.48
Mode (approx.)	4,820.73
Standard Deviation	524.29
Variance	274,878.71
Skewness	-0.52
Kurtosis	3.94
Coeff. of Variability	0.11
Range Minimum	2,699.32
Range Maximum	6,264.71
Range Width	3,565.40
Mean Std. Error	5.24



Percentiles:

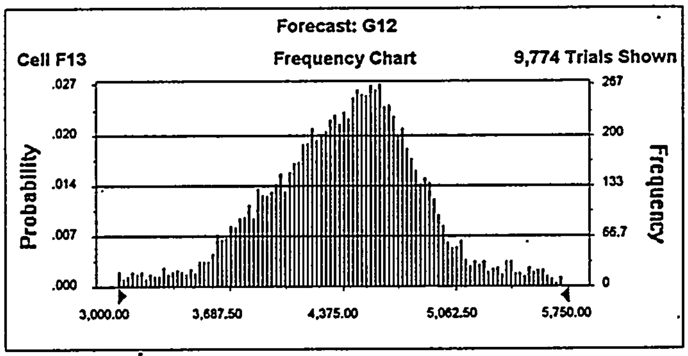
Percentile	Value (approx.)
0%	2,699.32
10%	3,964.64
25%	4,311.31
50%	4,655.48
75%	4,937.82
90%	5,193.93
100%	6,264.71

End of Forecast

Forecast: G12 **Cell: F13**

Statistics:

Statistics	Value
Trials	10000
Mean	4,360.79
Median (approx.)	4,414.92
Mode (approx.)	4,548.27
Standard Deviation	519.58
Variance	269,959.77
Skewness	-0.55
Kurtosis	3.98
Coeff. of Variability	0.12
Range Minimum	2,495.98
Range Maximum	5,833.04
Range Width	3,337.07
Mean Std. Error	5.20



Percentiles:

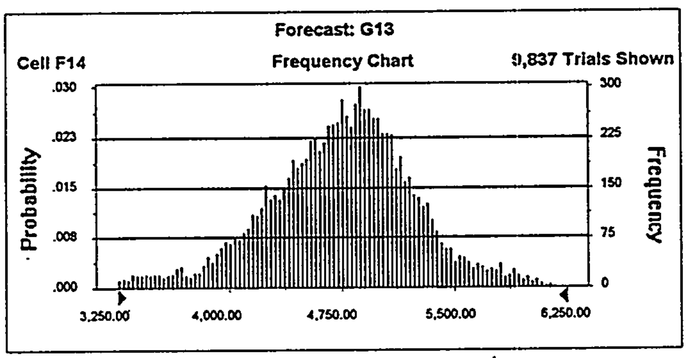
Percentile	Value (approx.)
0%	2,495.98
10%	3,728.02
25%	4,074.09
50%	4,414.92
75%	4,686.85
90%	4,933.01
100%	5,833.04

End of Forecast

Forecast: G13 **Cell: F14**

Statistics:

Statistics	Value
Trials	10000
Mean	4,724.80
Median (approx.)	4,772.44
Mode (approx.)	4,883.24
Standard Deviation	530.25
Variance	281,167.23
Skewness	-0.52
Kurtosis	3.88
Coeff. of Variability	0.11
Range Minimum	2,711.53
Range Maximum	6,361.47
Range Width	3,649.94
Mean Std. Error	5.30



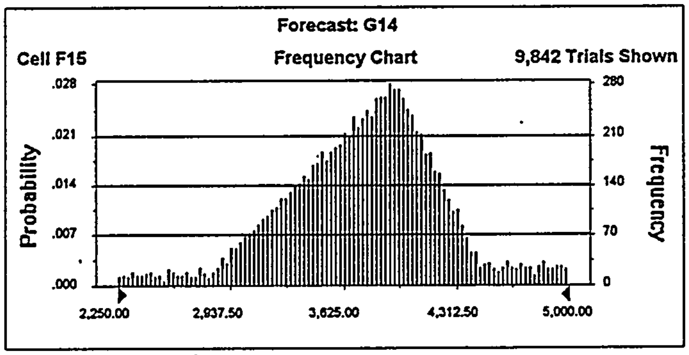
Percentiles:

Percentile	Value (approx.)
0%	2,711.53
10%	4,069.67
25%	4,429.84
50%	4,772.44
75%	5,060.92
90%	5,327.32
100%	6,361.47

End of Forecast

Forecast: G14 Cell: F15

Statistics:	Value
Trials	10000
Mean	3,724.75
Median (approx.)	3,781.71
Mode (approx.)	3,933.37
Standard Deviation	510.04
Variance	260,136.56
Skewness	-0.58
Kurtosis	4.04
Coeff. of Variability	0.14
Range Minimum	2,000.32
Range Maximum	4,997.29
Range Width	2,996.97
Mean Std. Error	5.10



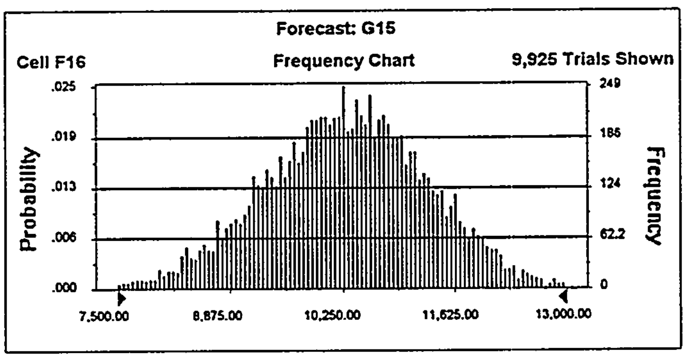
Percentiles:

Percentile	Value (approx.)
0%	2,000.32
10%	3,102.74
25%	3,440.87
50%	3,781.71
75%	4,044.68
90%	4,277.60
100%	4,997.29

End of Forecast

Forecast: G15 **Cell: F16**

Statistics:	Value
Trials	10000
Mean	10,308.76
Median (approx.)	10,324.40
Mode (approx.)	10,202.39
Standard Deviation	1,014.75
Variance	1,029,717.65
Skewness	-0.08
Kurtosis	2.98
Coeff. of Variability	0.10
Range Minimum	6,744.82
Range Maximum	13,873.83
Range Width	7,129.00
Mean Std. Error	10.15



Percentiles:

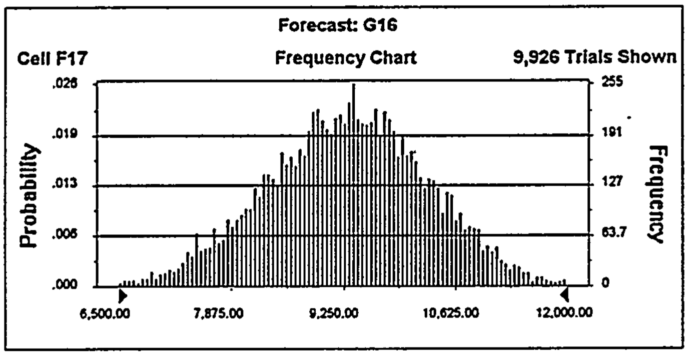
Percentile	Value (approx.)
0%	6,744.82
10%	8,991.78
25%	9,635.54
50%	10,324.40
75%	10,992.96
90%	11,608.78
100%	13,873.83

End of Forecast

Forecast: G16 **Cell: F17**

Statistics:

Statistics	Value
Trials	10000
Mean	9,308.70
Median (approx.)	9,329.70
Mode (approx.)	9,401.21
Standard Deviation	1,006.62
Variance	1,013,277.63
Skewness	-0.07
Kurtosis	2.98
Coeff. of Variability	0.11
Range Minimum	5,933.20
Range Maximum	12,800.54
Range Width	6,867.34
Mean Std. Error	10.07



Percentiles:

Percentile	Value (approx.)
0%	5,933.20
10%	8,002.21
25%	8,637.43
50%	9,329.70
75%	9,993.05
90%	10,589.53
100%	12,800.54

End of Forecast

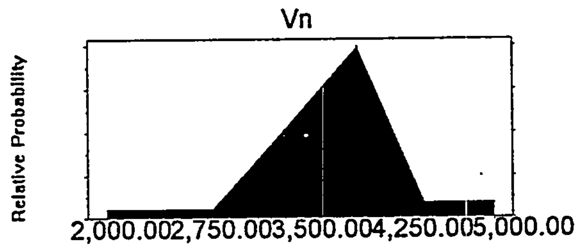
Assumptions

Assumption: Vn = **Cell: B3**

Custom distribution with parameters:

				Relative Prob.
Continuous range	2,000.00	to	2,830.00	0.050000
Continuous range	2,830.00	to	3,948.00	0.608612
Right/Left	15.48			
Continuous range	3,948.00	to	4,470.00	0.292050
Left/Right	12.13			
Continuous range	4,470.00	to	5,000.00	0.050000
Total Relative Probability				1.000662

Mean value in simulation was 3,724.75

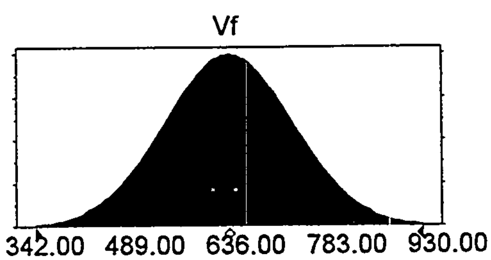


Assumption: Vf = **Cell: B5**

Normal distribution with parameters:

Mean	636.00
Standard Dev.	98.00

Selected range is from -Infinity to +Infinity
Mean value in simulation was 636.05

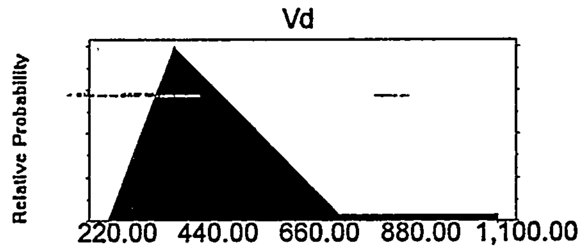


Assumption: Vd = **Cell: B4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	220.00	to	370.00	0.265142
Right/Left	+Infinity			
Continuous range	370.00	to	740.00	0.683061
Left/Right	20.61			
Continuous range	740.00	to	1,100.00	0.050000
Total Relative Probability				0.998203

Mean value in simulation was 472.61

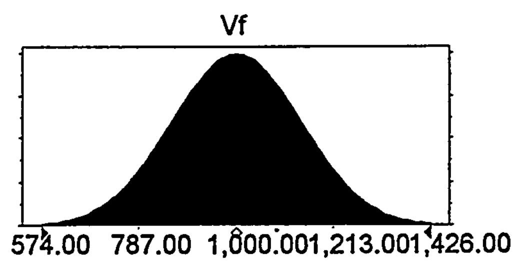


Assumption: Vf = **Cell: B7**

Normal distribution with parameters:

Mean	1,000.00
Standard Dev.	142.00

Selected range is from -Infinity to +Infinity
Mean value in simulation was 1,000.06

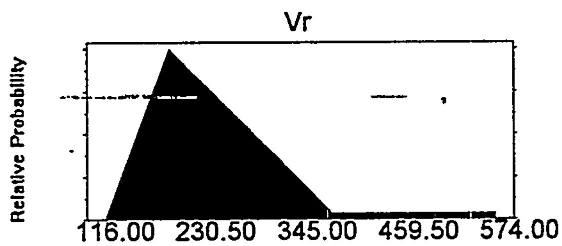


Assumption: Vr = **Cell: B8**

Custom distribution with parameters:

				Relative Prob.
Continuous range	116.00	to	192.00	0.260982
Right/Left	+Infinity			
Continuous range	192.00	to	383.00	0.686821
Left/Right	21.20			
Continuous range	383.00	to	574.00	0.050000
Total Relative Probability				0.997804

Mean value in simulation was 245.55

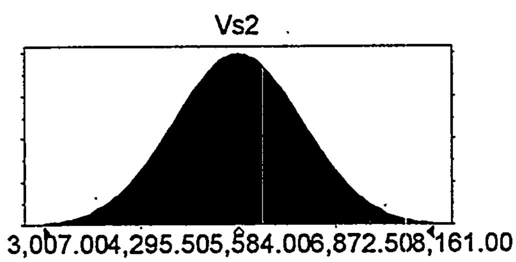


Assumption: Vs2 = **Cell: B6**

Normal distribution with parameters:

Mean	5,584.00
Standard Dev.	859.00

Selected range is from -Infinity to +Infinity
Mean value in simulation was 5,583.96



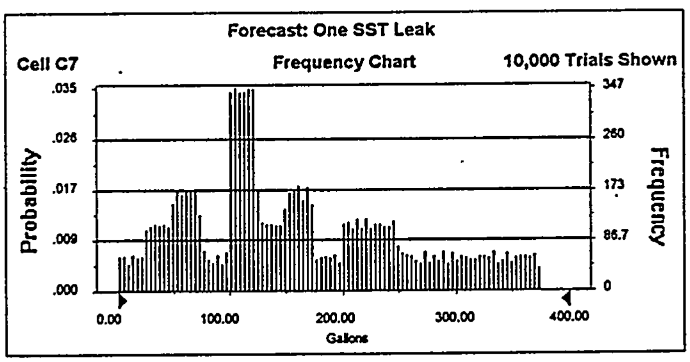
End of Assumptions

Crystal Ball Report

Simulation started on 3/17/95 at 13:35:14
Simulation stopped on 3/17/95 at 13:52:53

Forecast: One SST Leak **Cell: C7**

Statistics:	Value
Trials	10000
Mean	158.93
Median (approx.)	137.50
Mode (approx.)	121.88
Standard Deviation	93.04
Variance	8,655.66
Skewness	0.53
Kurtosis	2.41
Coeff. of Variability	0.59
Range Minimum	0.01
Range Maximum	374.99
Range Width	374.97
Mean Std. Error	0.93



Percentiles:

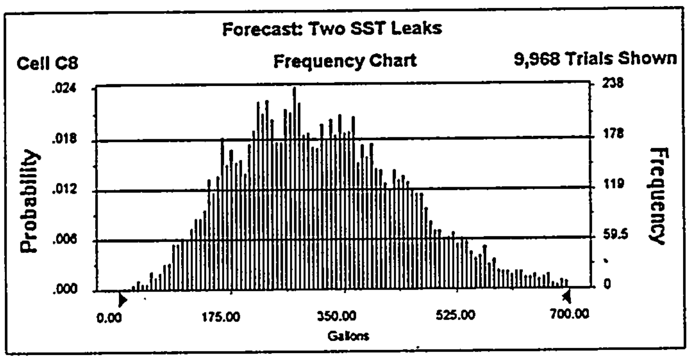
Percentile	Gallons (approx.)
0%	0.01
10%	47.51
25%	100.01
50%	137.50
75%	225.00
90%	304.99
100%	374.99

Forecast: One SST Leak (cont'd) **Cell: C7**

End of Forecast

Forecast: Two SST Leaks **Cell: C8**

Statistics:	Value
Trials	10000
Mean	317.87
Median (approx.)	307.15
Mode (approx.)	277.92
Standard Deviation	131.20
Variance	17,214.43
Skewness	0.39
Kurtosis	2.78
Coeff. of Variability	0.41
Range Minimum	11.44
Range Maximum	741.53
Range Width	730.10
Mean Std. Error	1.31



Percentiles:

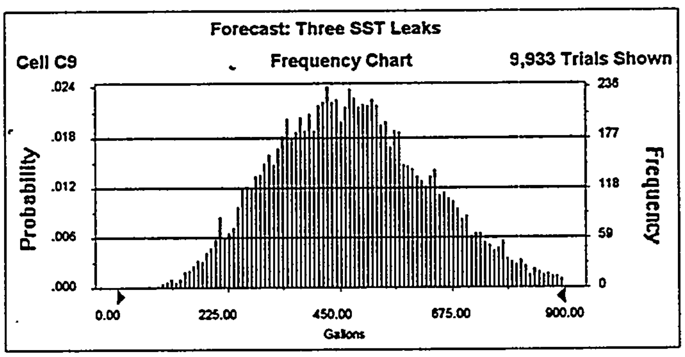
Percentile	Gallons (approx.)
0%	11.44
10%	155.92
25%	220.86
50%	307.15
75%	405.15
90%	493.21
100%	741.53

End of Forecast

Forecast: Three SST Leaks **Cell: C9**

Statistics:

	Value
Trials	10000
Mean	476.80
Median (approx.)	469.24
Mode (approx.)	434.63
Standard Deviation	160.25
Variance	25,680.74
Skewness	0.31
Kurtosis	2.88
Coeff. of Variability	0.34
Range Minimum	52.80
Range Maximum	1,098.91
Range Width	1,046.11
Mean Std. Error	1.60



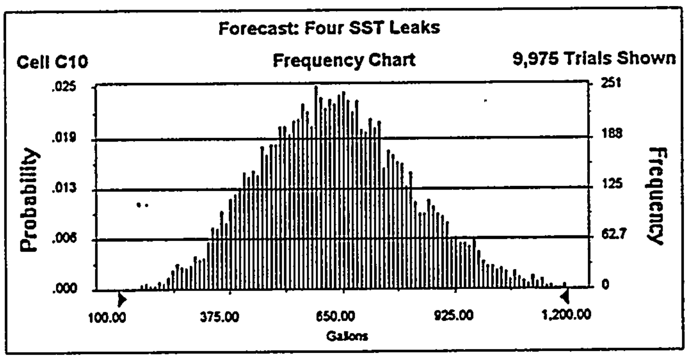
Percentiles:

Percentile	Gallons (approx.)
0%	52.80
10%	274.91
25%	360.47
50%	469.24
75%	579.69
90%	689.93
100%	1,098.91

End of Forecast

Forecast: Four SST Leaks **Cell: C10**

Statistics:	Value
Trials	10000
Mean	635.74
Median (approx.)	628.91
Mode (approx.)	596.01
Standard Deviation	185.03
Variance	34,237.33
Skewness	0.26
Kurtosis	2.94
Coeff. of Variability	0.29
Range Minimum	78.80
Range Maximum	1,388.20
Range Width	1,309.40
Mean Std. Error	1.85



Percentiles:

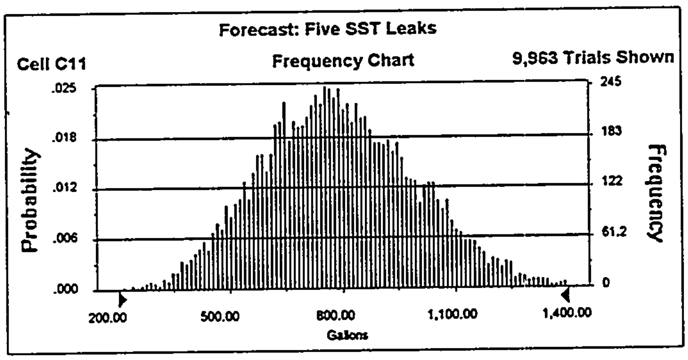
Percentile	Gallons (approx.)
0%	78.80
10%	401.52
25%	503.41
50%	628.91
75%	755.27
90%	881.60
100%	1,388.20

End of Forecast

Forecast: Five SST Leaks **Cell: C11**

Statistics:

Statistics	Value
Trials	10000
Mean	794.64
Median (approx.)	785.25
Mode (approx.)	799.13
Standard Deviation	207.85
Variance	43,199.73
Skewness	0.24
Kurtosis	2.96
Coeff. of Variability	0.26
Range Minimum	167.32
Range Maximum	1,653.94
Range Width	1,486.63
Mean Std. Error	2.08



Percentiles:

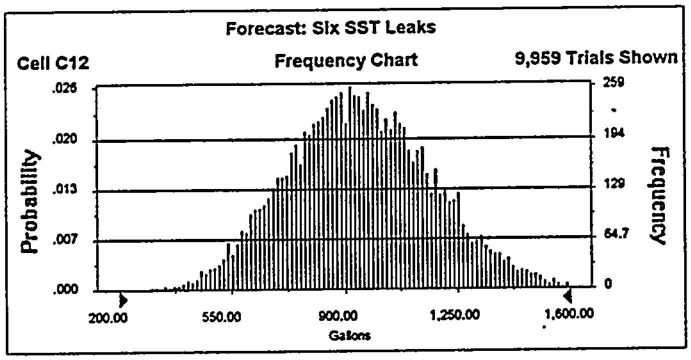
Percentile	Gallons (approx.)
0%	167.32
10%	532.24
25%	647.47
50%	785.25
75%	933.83
90%	1,068.80
100%	1,653.94

End of Forecast

Forecast: Six SST Leaks **Cell: C12**

Statistics:

Statistics	Value
Trials	10000
Mean	953.57
Median (approx.)	945.40
Mode (approx.)	920.59
Standard Deviation	226.18
Variance	51,155.93
Skewness	0.21
Kurtosis	2.97
Coeff. of Variability	0.24
Range Minimum	244.78
Range Maximum	1,913.46
Range Width	1,668.68
Mean Std. Error	2.26



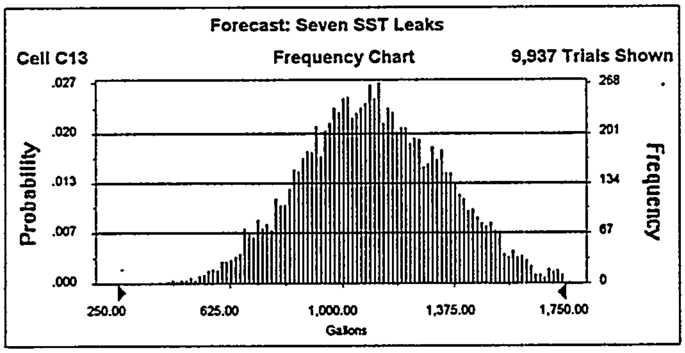
Percentiles:

Percentile	Gallons (approx.)
0%	244.78
10%	664.92
25%	796.17
50%	945.40
75%	1,103.20
90%	1,247.04
100%	1,913.46

End of Forecast

Forecast: Seven SST Leaks **Cell: C13**

Statistics:	Value
Trials	10000
Mean	1,112.50
Median (approx.)	1,103.66
Mode (approx.)	1,096.78
Standard Deviation	244.79
Variance	59,922.10
Skewness	0.19
Kurtosis	2.98
Coeff. of Variability	0.22
Range Minimum	328.96
Range Maximum	2,272.80
Range Width	1,943.83
Mean Std. Error	2.45



Percentiles:

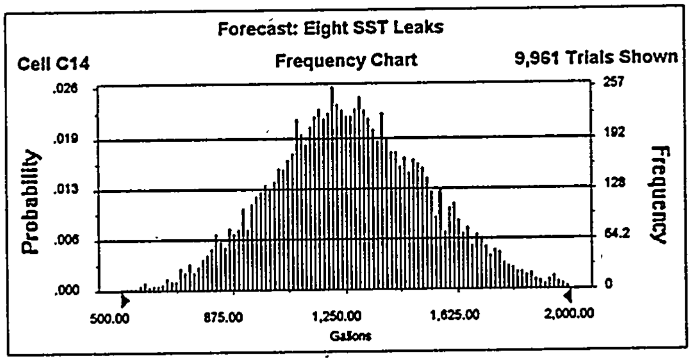
Percentile	Gallons (approx.)
0%	328.96
10%	803.31
25%	944.23
50%	1,103.66
75%	1,277.71
90%	1,432.32
100%	2,272.80

End of Forecast

Forecast: Eight SST Leaks **Cell: C14**

Statistics:

	Value
Trials	10000
Mean	1,271.41
Median (approx.)	1,263.04
Mode (approx.)	1,215.86
Standard Deviation	263.32
Variance	69,335.21
Skewness	0.16
Kurtosis	2.99
Coeff. of Variability	0.21
Range Minimum	399.82
Range Maximum	2,414.73
Range Width	2,014.91
Mean Std. Error	2.63



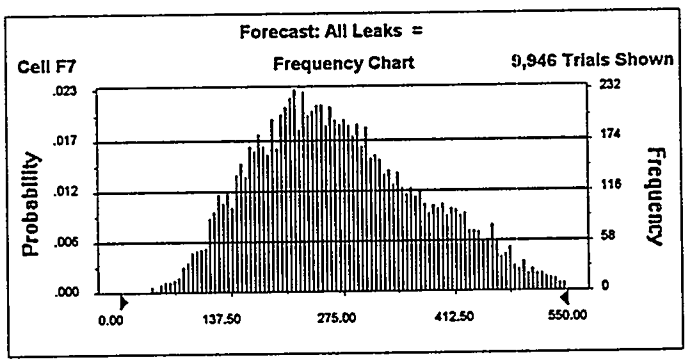
Percentiles:

Percentile	Gallons (approx.)
0%	399.82
10%	937.51
25%	1,092.95
50%	1,263.04
75%	1,447.39
90%	1,616.03
100%	2,414.73

End of Forecast

Forecast: All Leaks = **Cell: F7**

Statistics:	Value
Trials	10000
Mean	273.56
Median (approx.)	261.47
Mode (approx.)	210.67
Standard Deviation	104.57
Variance	10,934.13
Skewness	0.42
Kurtosis	2.65
Coeff. of Variability	0.38
Range Minimum	32.39
Range Maximum	616.93
Range Width	584.54
Mean Std. Error	1.05



Percentiles:

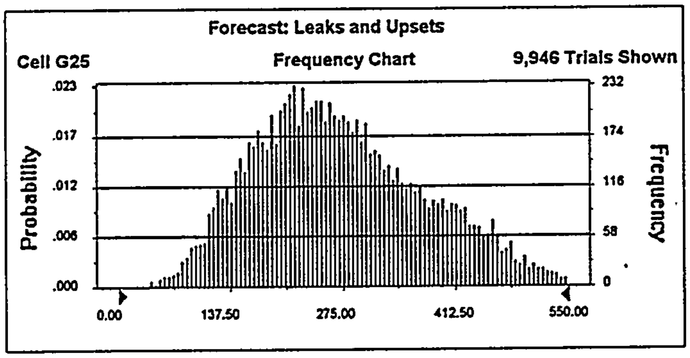
Percentile	Value (approx.)
0%	32.39
10%	145.00
25%	196.16
50%	261.47
75%	343.23
90%	422.93
100%	616.93

End of Forecast

Forecast: Leaks and Upsets

Cell: G25

Statistics:	Value
Trials	10000
Mean	273.56
Median (approx.)	261.47
Mode (approx.)	210.67
Standard Deviation	104.57
Variance	10,934.13
Skewness	0.42
Kurtosis	2.65
Coeff. of Variability	0.38
Range Minimum	32.39
Range Maximum	616.93
Range Width	584.54
Mean Std. Error	1.05



Percentiles:

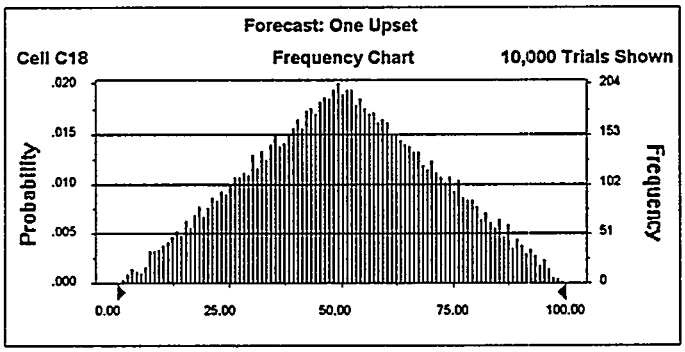
Percentile	Value (approx.)
0%	32.39
10%	145.00
25%	196.16
50%	261.47
75%	343.23
90%	422.93
100%	616.93

End of Forecast

Forecast: One Upset **Cell: C18**

Statistics:

	Value
Trials	10000
Mean	50.33
Median (approx.)	50.27
Mode (approx.)	50.85
Standard Deviation	20.21
Variance	408.64
Skewness	0.01
Kurtosis	2.40
Coeff. of Variability	0.40
Range Minimum	1.47
Range Maximum	99.27
Range Width	97.80
Mean Std. Error	0.20



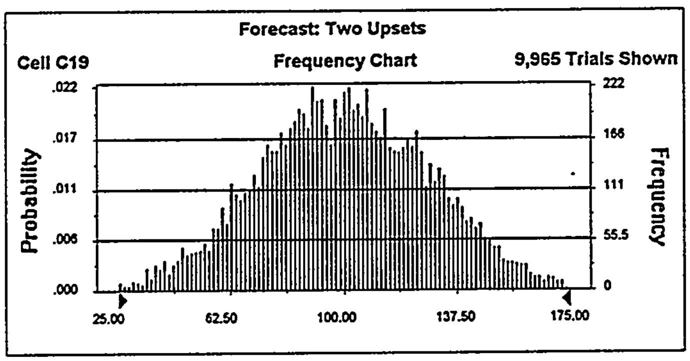
Percentiles:

Percentile	Value (approx.)
0%	1.47
10%	23.04
25%	35.78
50%	50.27
75%	64.83
90%	77.75
100%	99.27

End of Forecast

Forecast: Two Upsets **Cell: C19**

Statistics:	Value
Trials	10000
Mean	100.66
Median (approx.)	100.61
Mode (approx.)	101.88
Standard Deviation	28.28
Variance	799.86
Skewness	0.01
Kurtosis	2.69
Coeff. of Variability	0.28
Range Minimum	15.82
Range Maximum	197.00
Range Width	181.18
Mean Std. Error	0.28



Percentiles:

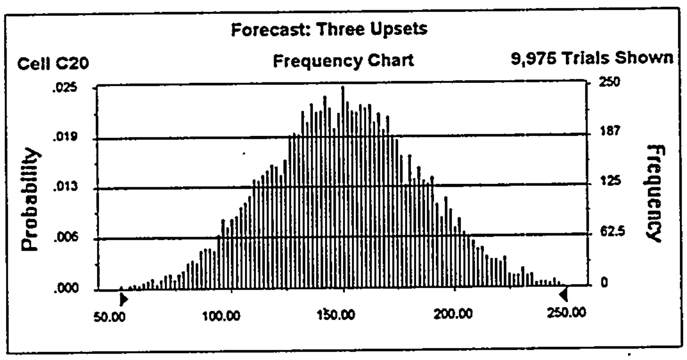
Percentile	Value (approx.)
0%	15.82
10%	63.97
25%	80.91
50%	100.61
75%	120.93
90%	137.77
100%	197.00

End of Forecast

Forecast: Three Upsets **Cell: C20**

Statistics:

Statistics	Value
Trials	10000
Mean	151.00
Median (approx.)	150.96
Mode (approx.)	152.44
Standard Deviation	34.45
Variance	1,186.72
Skewness	0.02
Kurtosis	2.87
Coeff. of Variability	0.23
Range Minimum	37.45
Range Maximum	274.54
Range Width	237.09
Mean Std. Error	0.34



Percentiles:

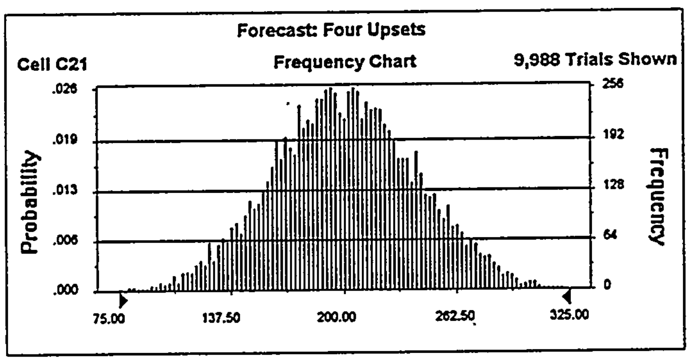
Percentile	Value (approx.)
0%	37.45
10%	106.52
25%	127.77
50%	150.96
75%	174.08
90%	195.96
100%	274.54

End of Forecast

Forecast: Four Upsets **Cell: C21**

Statistics:

Statistics	Value
Trials	10000
Mean	201.33
Median (approx.)	201.11
Mode (approx.)	191.87
Standard Deviation	40.01
Variance	1,601.14
Skewness	0.00
Kurtosis	2.85
Coeff. of Variability	0.20
Range Minimum	51.36
Range Maximum	360.18
Range Width	308.81
Mean Std. Error	0.40



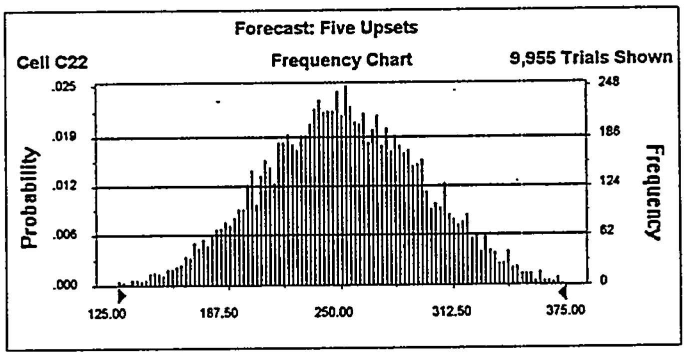
Percentiles:

Percentile	Value (approx.)
0%	51.36
10%	149.64
25%	174.17
50%	201.11
75%	228.30
90%	253.65
100%	360.18

End of Forecast

Forecast: Five Upsets **Cell: C22**

Statistics:	Value
Trials	10000
Mean	251.67
Median (approx.)	251.38
Mode (approx.)	253.73
Standard Deviation	44.93
Variance	2,018.92
Skewness	0.00
Kurtosis	2.89
Coeff. of Variability	0.18
Range Minimum	76.26
Range Maximum	407.98
Range Width	331.72
Mean Std. Error	0.45



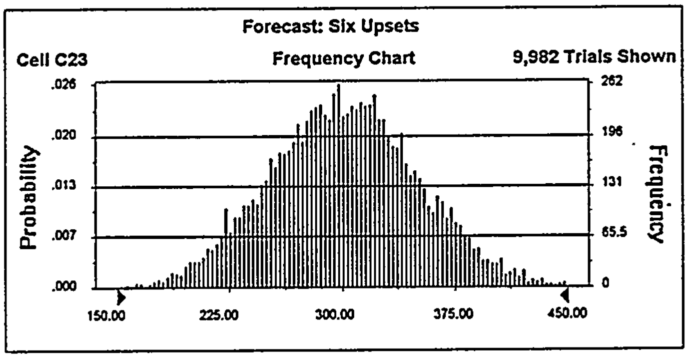
Percentiles:

Percentile	Value (approx.)
0%	76.26
10%	194.16
25%	221.09
50%	251.38
75%	282.34
90%	309.86
100%	407.98

End of Forecast

Forecast: Six Upsets **Cell: C23**

Statistics:	Value
Trials	10000
Mean	302.00
Median (approx.)	301.69
Mode (approx.)	297.91
Standard Deviation	49.40
Variance	2,440.07
Skewness	0.03
Kurtosis	2.89
Coeff. of Variability	0.16
Range Minimum	106.53
Range Maximum	478.14
Range Width	371.61
Mean Std. Error	0.49



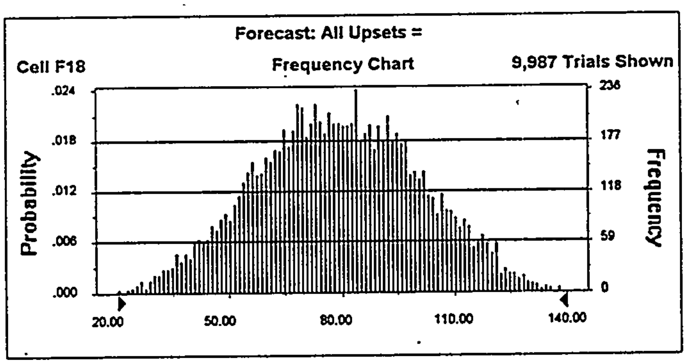
Percentiles:

Percentile	Value (approx.)
0%	106.53
10%	237.84
25%	268.17
50%	301.69
75%	335.12
90%	366.47
100%	478.14

End of Forecast

Forecast: All Upsets = **Cell: F18**

Statistics:	Value
Trials	10000
Mean	79.23
Median (approx.)	79.05
Mode (approx.)	83.81
Standard Deviation	21.81
Variance	475.83
Skewness	0.00
Kurtosis	2.58
Coeff. of Variability	0.28
Range Minimum	14.90
Range Maximum	151.36
Range Width	136.46
Mean Std. Error	0.22



Percentiles:

Percentile	Value (approx.)
0%	14.90
10%	50.76
25%	63.89
50%	79.05
75%	94.78
90%	108.20
100%	151.36

End of Forecast

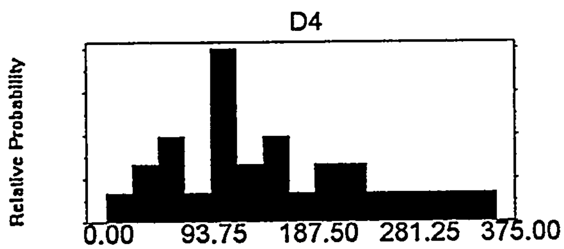
Assumptions

Assumption: D4 **Cell: D4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93



Assumption: E4 **Cell: E4**

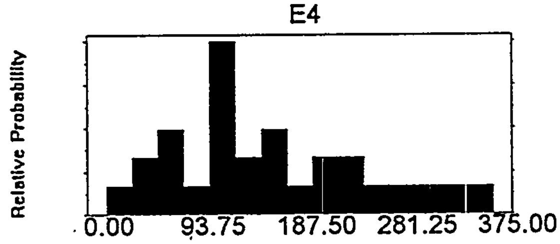
Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400

Assumption: E4 (cont'd) **Cell: E4**

Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93



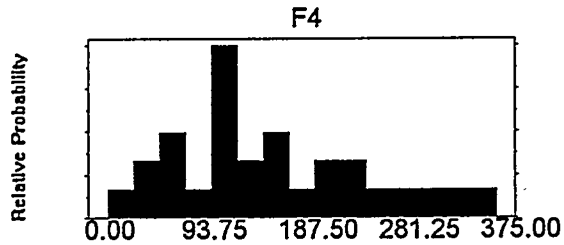
Assumption: F4 **Cell: F4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Assumption: F4 (cont'd) **Cell: F4**

Mean value in simulation was 158.90



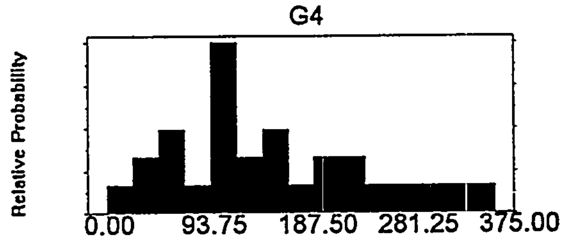
Assumption: G4 **Cell: G4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93

Assumption: G4 (cont'd) **Cell: G4**

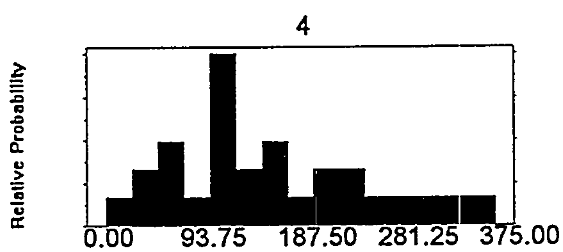


Assumption: H4 **Cell: H4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93

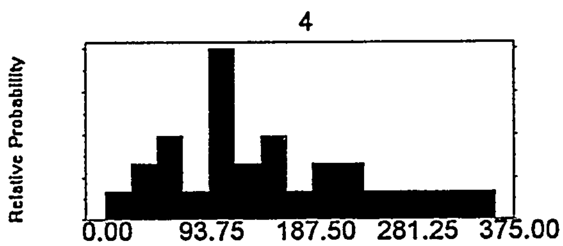


Assumption: I4 **Cell: I4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.91



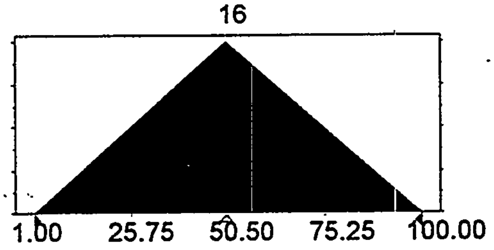
Assumption: B16 **Cell: B16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.33

Assumption: B16 (cont'd) **Cell: B16**

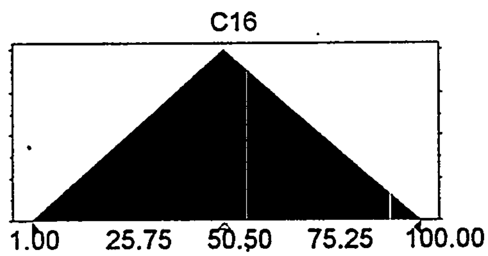


Assumption: C16 **Cell: C16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.33



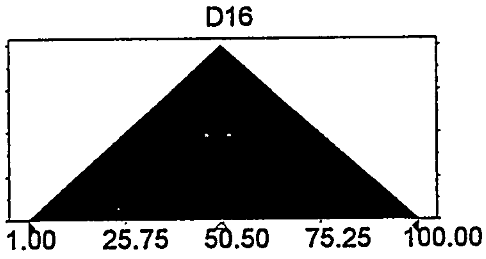
Assumption: D16 **Cell: D16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.33

Assumption: D16 (cont'd) **Cell: D16**

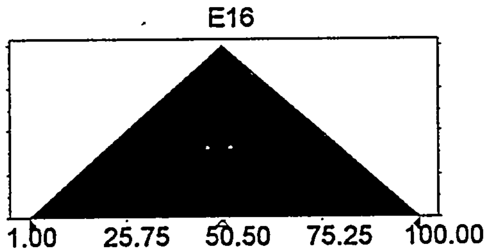


Assumption: E16 **Cell: E16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.33



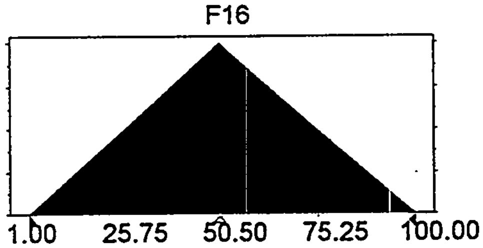
Assumption: F16 **Cell: F16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.34

Assumption: F16 (cont'd) **Cell: F16**

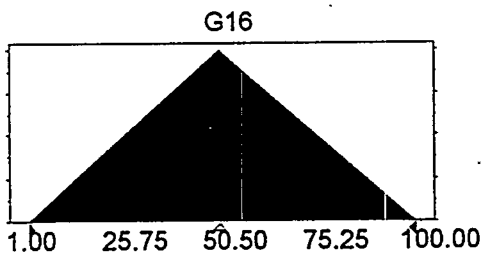


Assumption: G16 **Cell: G16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.34



Assumption: B4 **Cell: B4**

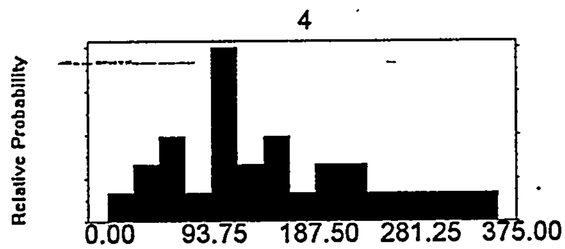
Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700

Assumption: B4 (cont'd) **Cell: B4**

Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93



Assumption: C4 **Cell: C4**

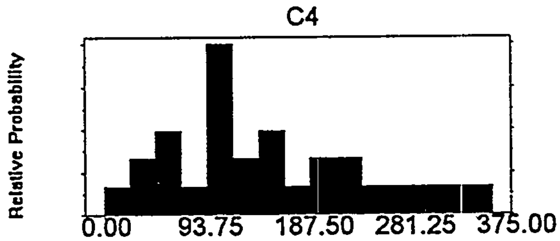
Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.94

Assumption: C4 (cont'd)

Cell: C4

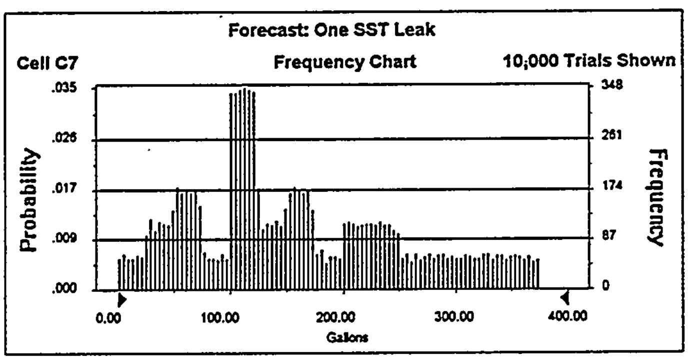


End of Assumptions

Crystal Ball Report
Simulation started on 3/17/95 at 12:41:37
Simulation stopped on 3/17/95 at 13:03:58

Forecast: One SST Leak **Cell: C7**

Statistics:	Value
Trials	10000
Mean	158.91
Median (approx.)	137.47
Mode (approx.)	110.72
Standard Deviation	93.03
Variance	8,654.18
Skewness	0.53
Kurtosis	2.41
Coeff. of Variability	0.59
Range Minimum	0.15
Range Maximum	374.96
Range Width	374.81
Mean Std. Error	0.93



Percentiles:

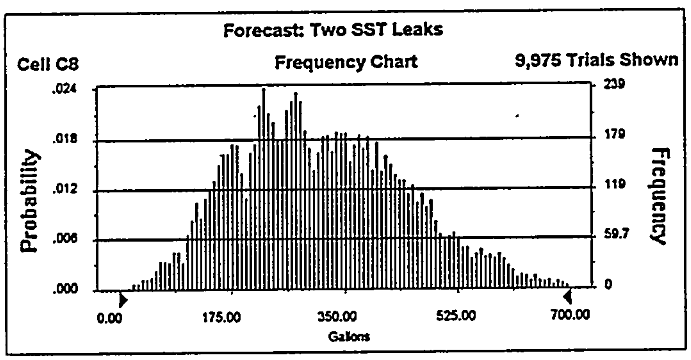
Percentile	Gallons (approx.)
0%	0.15
10%	47.49
25%	99.61
50%	137.47
75%	225.00
90%	305.00
100%	374.96

Forecast: One SST Leak (cont'd) **Cell: C7**

End of Forecast

Forecast: Two SST Leaks **Cell: C8**

Statistics:	Value
Trials	10000
Mean	317.82
Median (approx.)	306.47
Mode (approx.)	277.61
Standard Deviation	131.69
Variance	17,343.28
Skewness	0.35
Kurtosis	2.67
Coeff. of Variability	0.41
Range Minimum	8.50
Range Maximum	745.79
Range Width	737.29
Mean Std. Error	1.32



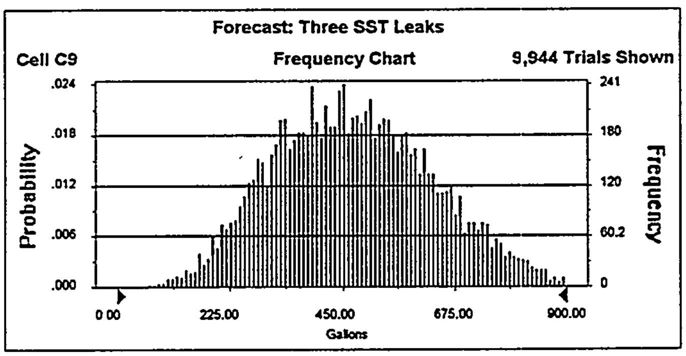
Percentiles:

Percentile	Gallons (approx.)
0%	8.50
10%	153.96
25%	220.31
50%	306.47
75%	407.92
90%	493.19
100%	745.79

End of Forecast

Forecast: Three SST Leaks **Cell: C9**

Statistics:	Value
Trials	10000
Mean	476.76
Median (approx.)	468.81
Mode (approx.)	449.09
Standard Deviation	160.94
Variance	25,900.97
Skewness	0.27
Kurtosis	2.72
Coeff. of Variability	0.34
Range Minimum	58.13
Range Maximum	1,047.91
Range Width	989.77
Mean Std. Error	1.61



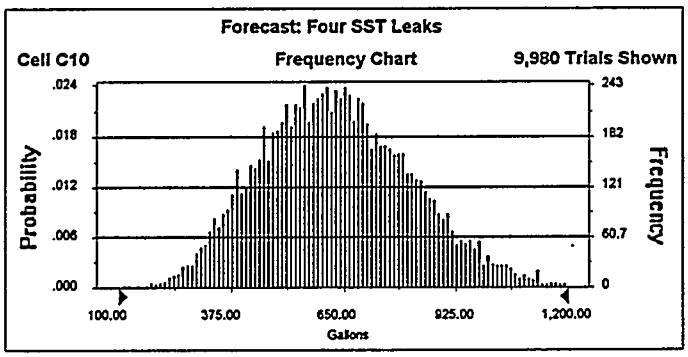
Percentiles:

Percentile	Gallons (approx.)
0%	58.13
10%	273.35
25%	356.40
50%	468.81
75%	586.11
90%	690.94
100%	1,047.91

End of Forecast

Forecast: Four SST Leaks **Cell: C10**

Statistics:	Value
Trials	10000
Mean	635.69
Median (approx.)	627.22
Mode (approx.)	640.48
Standard Deviation	184.85
Variance	34,171.07
Skewness	0.27
Kurtosis	2.85
Coeff. of Variability	0.29
Range Minimum	80.94
Range Maximum	1,367.23
Range Width	1,286.29
Mean Std. Error	1.85



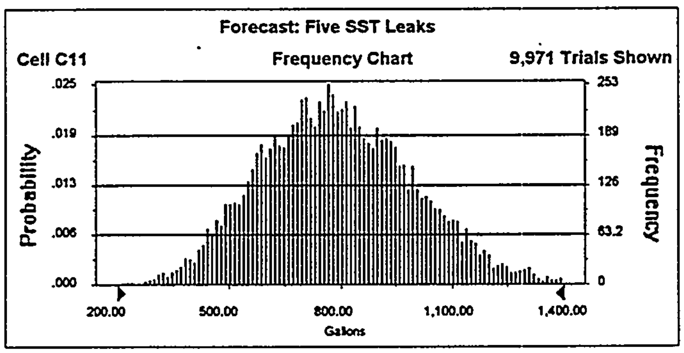
Percentiles:

Percentile	Gallons (approx.)
0%	80.94
10%	399.94
25%	502.37
50%	627.22
75%	760.31
90%	880.00
100%	1,367.23

End of Forecast

Forecast: Five SST Leaks **Cell: C11**

Statistics:	Value
Trials	10000
Mean	794.63
Median (approx.)	783.75
Mode (approx.)	766.43
Standard Deviation	207.34
Variance	42,988.95
Skewness	0.24
Kurtosis	2.88
Coeff. of Variability	0.26
Range Minimum	165.45
Range Maximum	1,613.59
Range Width	1,448.14
Mean Std. Error	2.07



Percentiles:

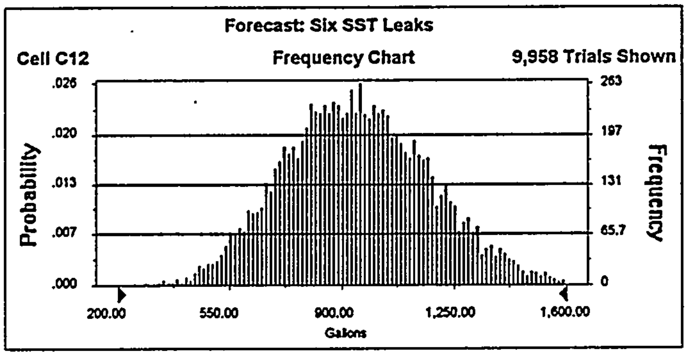
Percentile	Gallons (approx.)
0%	165.45
10%	531.61
25%	645.96
50%	783.75
75%	933.83
90%	1,069.92
100%	1,613.59

End of Forecast

Forecast: Six SST Leaks **Cell: C12**

Statistics:

Statistics	Value
Trials	10000
Mean	953.56
Median (approx.)	945.11
Mode (approx.)	963.58
Standard Deviation	227.85
Variance	51,914.94
Skewness	0.21
Kurtosis	2.89
Coeff. of Variability	0.24
Range Minimum	182.21
Range Maximum	1,827.20
Range Width	1,644.99
Mean Std. Error	2.28



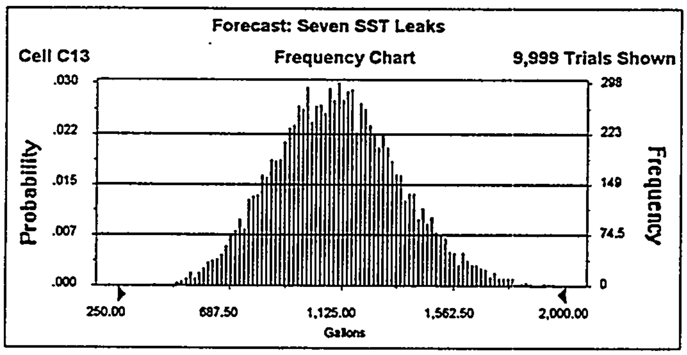
Percentiles:

Percentile	Gallons (approx.)
0%	182.21
10%	666.81
25%	793.54
50%	945.11
75%	1,107.23
90%	1,251.33
100%	1,827.20

End of Forecast

Forecast: Seven SST Leaks **Cell: C13**

Statistics:	Value
Trials	10000
Mean	1,112.49
Median (approx.)	1,106.06
Mode (approx.)	1,141.71
Standard Deviation	245.61
Variance	60,325.44
Skewness	0.20
Kurtosis	2.91
Coeff. of Variability	0.22
Range Minimum	359.98
Range Maximum	2,116.68
Range Width	1,756.70
Mean Std. Error	2.46



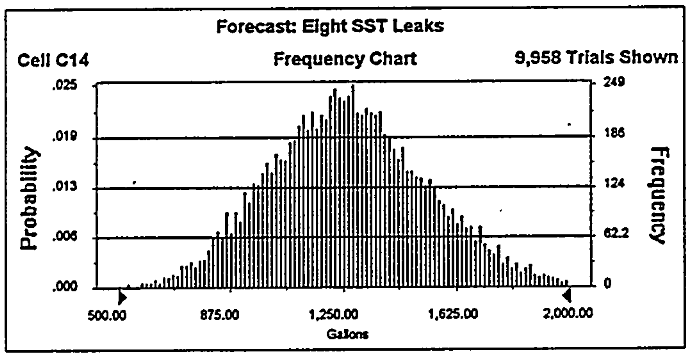
Percentiles:

Percentile	Gallons (approx.)
0%	359.98
10%	801.61
25%	940.39
50%	1,106.06
75%	1,275.47
90%	1,435.33
100%	2,116.68

End of Forecast

Forecast: Eight SST Leaks **Cell: C14**

Statistics:	Value
Trials	10000
Mean	1,271.41
Median (approx.)	1,263.11
Mode (approx.)	1,226.31
Standard Deviation	263.59
Variance	69,479.48
Skewness	0.19
Kurtosis	2.92
Coeff. of Variability	0.21
Range Minimum	477.78
Range Maximum	2,326.00
Range Width	1,848.21
Mean Std. Error	2.64



Percentiles:

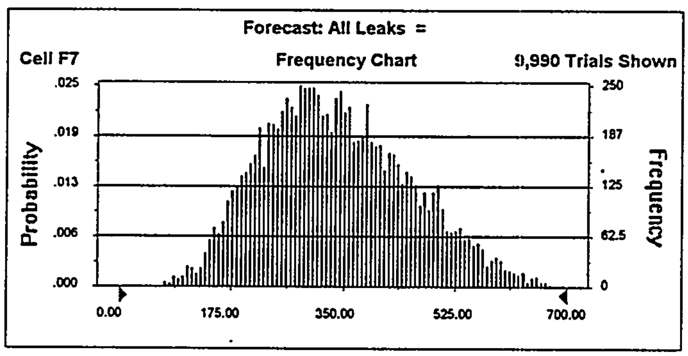
Percentile	Gallons (approx.)
0%	477.78
10%	937.43
25%	1,088.45
50%	1,263.11
75%	1,443.97
90%	1,620.92
100%	2,326.00

End of Forecast

Forecast: All Leaks = **Cell: F7**

Statistics:

Statistics	Value
Trials	10000
Mean	342.19
Median (approx.)	333.00
Mode (approx.)	302.69
Standard Deviation	115.11
Variance	13,250.00
Skewness	0.34
Kurtosis	2.64
Coeff. of Variability	0.34
Range Minimum	45.06
Range Maximum	732.08
Range Width	687.01
Mean Std. Error	1.15



Percentiles:

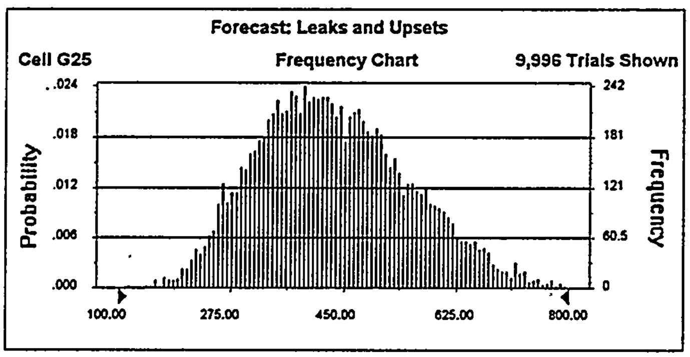
Percentile	Value (approx.)
0%	45.06
10%	198.59
25%	256.88
50%	333.00
75%	421.38
90%	501.46
100%	732.08

End of Forecast

Forecast: Leaks and Upsets **Cell: G25**

Statistics:

Statistics	Value
Trials	10000
Mean	436.52
Median (approx.)	426.95
Mode (approx.)	401.12
Standard Deviation	117.42
Variance	13,787.60
Skewness	0.32
Kurtosis	2.68
Coeff. of Variability	0.27
Range Minimum	115.98
Range Maximum	820.02
Range Width	704.03
Mean Std. Error	1.17



Percentiles:

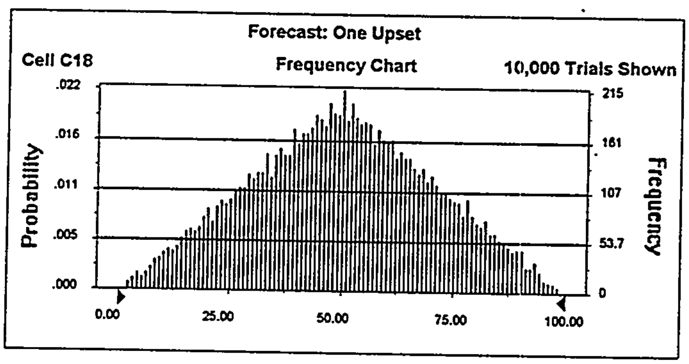
Percentile	Value (approx.)
0%	115.98
10%	290.03
25%	349.04
50%	426.95
75%	514.80
90%	598.35
100%	820.02

End of Forecast

Forecast: One Upset **Cell: C18**

Statistics:

	Value
Trials	10000
Mean	50.33
Median (approx.)	50.24
Mode (approx.)	50.24
Standard Deviation	20.21
Variance	408.38
Skewness	0.01
Kurtosis	2.40
Coeff. of Variability	0.40
Range Minimum	2.43
Range Maximum	99.02
Range Width	96.59
Mean Std. Error	0.20



Percentiles:

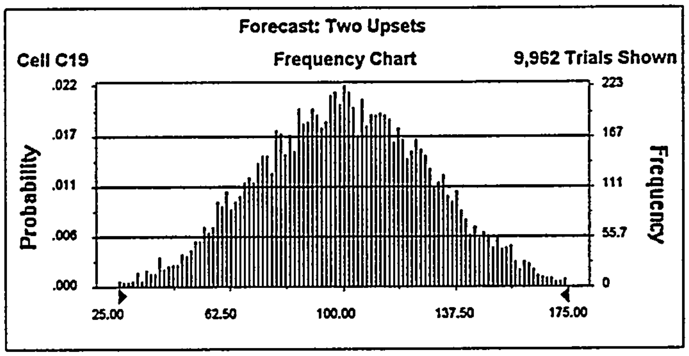
Percentile	Value (approx.)
0%	2.43
10%	23.02
25%	35.79
50%	50.24
75%	64.83
90%	77.75
100%	99.02

End of Forecast

Forecast: Two Upsets **Cell: C19**

Statistics:

Statistics	Value
Trials	10000
Mean	100.66
Median (approx.)	100.61
Mode (approx.)	97.18
Standard Deviation	28.42
Variance	807.95
Skewness	0.00
Kurtosis	2.68
Coeff. of Variability	0.28
Range Minimum	8.45
Range Maximum	191.39
Range Width	182.94
Mean Std. Error	0.28



Percentiles:

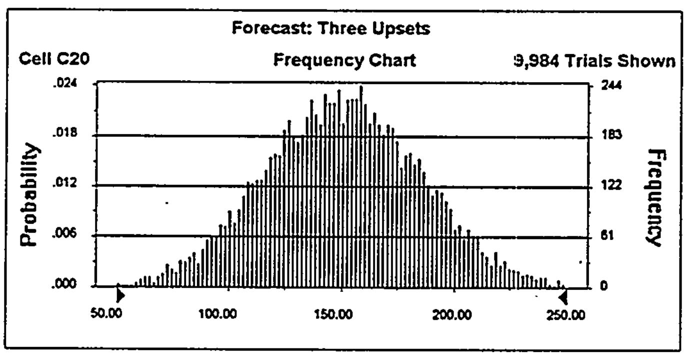
Percentile	Value (approx.)
0%	8.45
10%	63.33
25%	80.56
50%	100.61
75%	120.55
90%	137.67
100%	191.39

End of Forecast

Forecast: Three Upsets **Cell: C20**

Statistics:

Statistics	Value
Trials	10000
Mean	151.00
Median (approx.)	150.78
Mode (approx.)	154.34
Standard Deviation	34.75
Variance	1,207.59
Skewness	0.02
Kurtosis	2.81
Coeff. of Variability	0.23
Range Minimum	40.82
Range Maximum	265.60
Range Width	224.79
Mean Std. Error	0.35



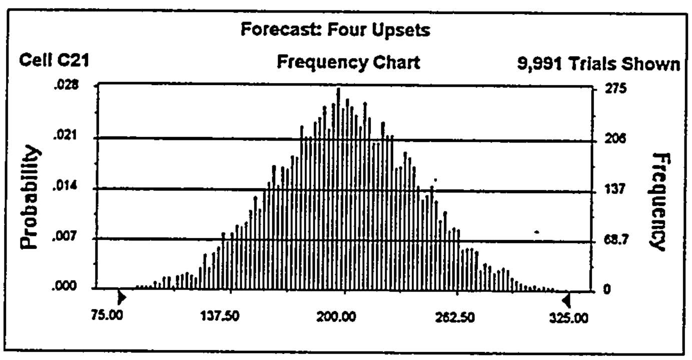
Percentiles:

Percentile	Value (approx.)
0%	40.82
10%	106.39
25%	126.93
50%	150.78
75%	174.68
90%	195.96
100%	265.60

End of Forecast

Forecast: Four Upsets **Cell: C21**

Statistics:	Value
Trials	10000
Mean	201.33
Median (approx.)	200.93
Mode (approx.)	196.33
Standard Deviation	40.21
Variance	1,616.50
Skewness	0.03
Kurtosis	2.88
Coeff. of Variability	0.20
Range Minimum	63.93
Range Maximum	336.92
Range Width	272.99
Mean Std. Error	0.40



Percentiles:

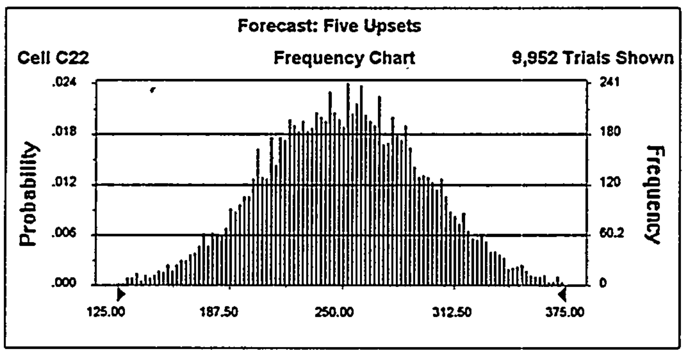
Percentile	Value (approx.)
0%	63.93
10%	149.62
25%	174.22
50%	200.93
75%	228.43
90%	253.23
100%	336.92

End of Forecast

Forecast: Five Upsets **Cell: C22**

Statistics:

Statistics	Value
Trials	10000
Mean	251.67
Median (approx.)	251.93
Mode (approx.)	260.82
Standard Deviation	45.28
Variance	2,050.38
Skewness	0.00
Kurtosis	2.86
Coeff. of Variability	0.18
Range Minimum	103.06
Range Maximum	397.94
Range Width	294.88
Mean Std. Error	0.45



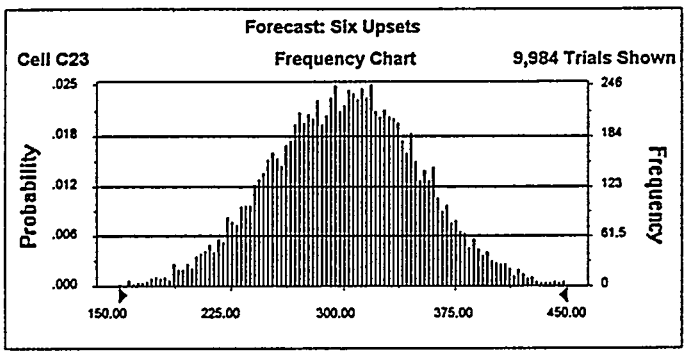
Percentiles:

Percentile	Value (approx.)
0%	103.06
10%	194.08
25%	220.39
50%	251.93
75%	282.92
90%	309.84
100%	397.94

End of Forecast

Forecast: Six Upsets **Cell: C23**

Statistics:	Value
Trials	10000
Mean	302.00
Median (approx.)	302.66
Mode (approx.)	318.18
Standard Deviation	49.70
Variance	2,470.22
Skewness	-0.01
Kurtosis	2.88
Coeff. of Variability	0.16
Range Minimum	124.74
Range Maximum	479.68
Range Width	354.94
Mean Std. Error	0.50



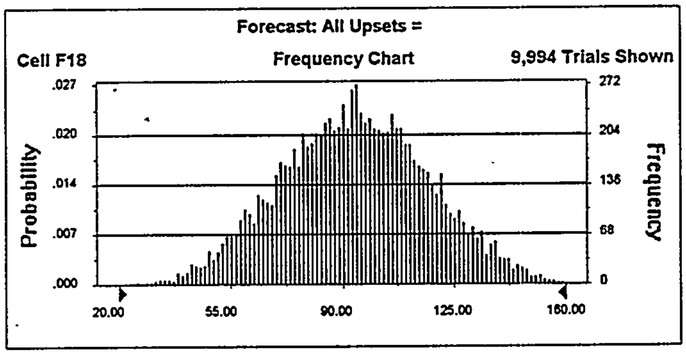
Percentiles:

Percentile	Value (approx.)
0%	124.74
10%	237.85
25%	267.87
50%	302.66
75%	336.04
90%	365.18
100%	479.68

End of Forecast

Forecast: All Upsets = **Cell: F18**

Statistics:	Value
Trials	10000
Mean	94.32
Median (approx.)	94.34
Mode (approx.)	94.68
Standard Deviation	23.05
Variance	531.36
Skewness	0.01
Kurtosis	2.67
Coeff. of Variability	0.24
Range Minimum	19.92
Range Maximum	165.09
Range Width	145.16
Mean Std. Error	0.23



Percentiles:

Percentile	Value (approx.)
0%	19.92
10%	63.88
25%	78.25
50%	94.34
75%	110.23
90%	124.43
100%	165.09

End of Forecast

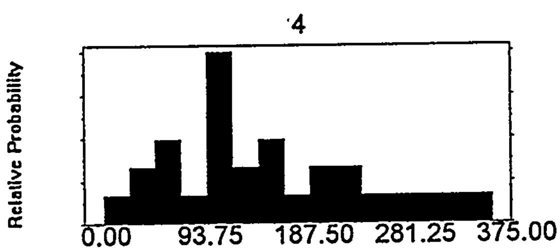
Assumptions

Assumption: B4 **Cell: B4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.91



Assumption: C4 **Cell: C4**

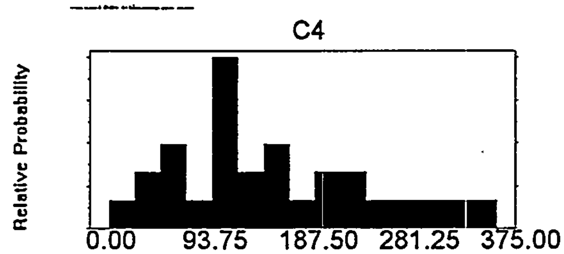
Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400

Assumption: C4 (cont'd) **Cell: C4**

Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.91



Assumption: D4 **Cell: D4**

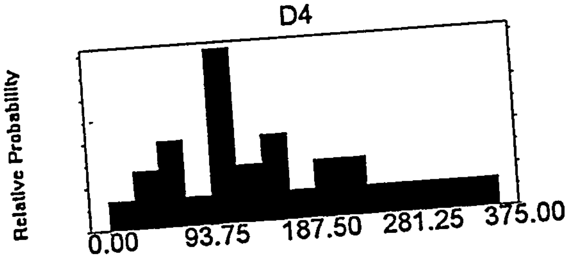
Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Cell: D4

Assumption: D4 (cont'd)

Mean value in simulation was 158.94



Cell: E4

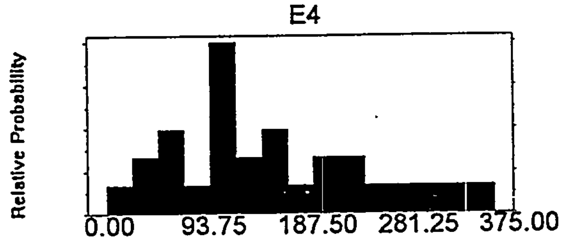
Assumption: E4

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93

Assumption: E4 (cont'd) **Cell: E4**

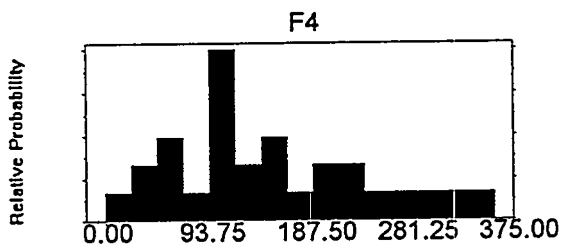


Assumption: F4 **Cell: F4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93

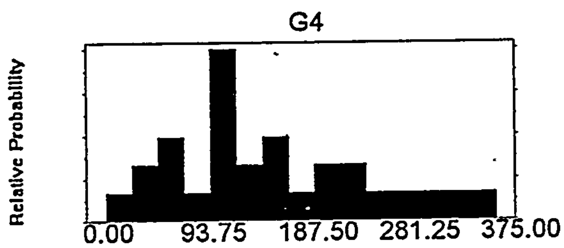


Assumption: G4 **Cell: G4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93



Assumption: H4 **Cell: H4**

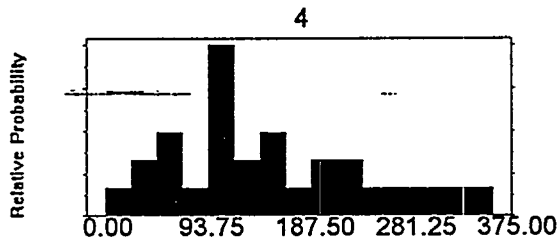
Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400

Assumption: H4 (cont'd) **Cell: H4**

Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.93



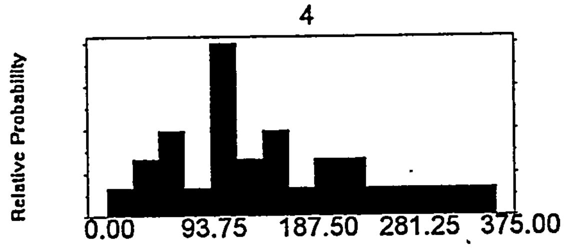
Assumption: I4 **Cell: I4**

Custom distribution with parameters:

				Relative Prob.
Continuous range	0.00	to	25.00	0.035700
Continuous range	25.00	to	50.00	0.071400
Continuous range	50.00	to	75.00	0.107100
Continuous range	75.00	to	100.00	0.035700
Continuous range	100.00	to	125.00	0.214300
Continuous range	125.00	to	150.00	0.071400
Continuous range	150.00	to	175.00	0.107100
Continuous range	175.00	to	200.00	0.035700
Continuous range	200.00	to	225.00	0.071400
Continuous range	225.00	to	250.00	0.071400
Continuous range	250.00	to	275.00	0.035700
Continuous range	275.00	to	300.00	0.035700
Continuous range	300.00	to	325.00	0.035700
Continuous range	325.00	to	350.00	0.035700
Continuous range	350.00	to	375.00	0.035700
Total Relative Probability				0.999700

Mean value in simulation was 158.92

Assumption: I4 (cont'd) **Cell: I4**

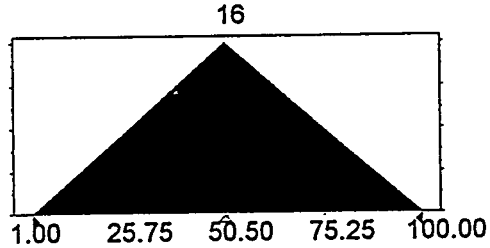


Assumption: B16 **Cell: B16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.33



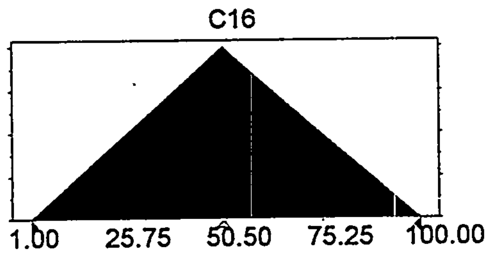
Assumption: C16 **Cell: C16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.33

Assumption: C16 (cont'd) **Cell: C16**

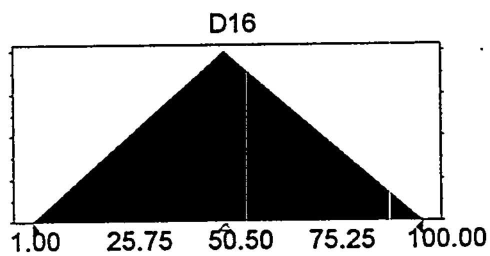


Assumption: D16 **Cell: D16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.34



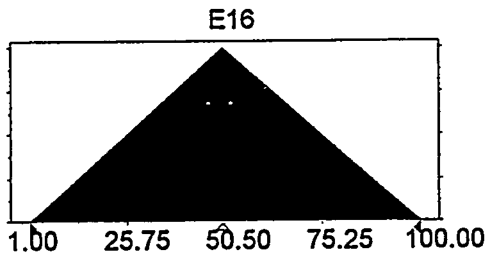
Assumption: E16 **Cell: E16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.33

Assumption: E16 (cont'd) **Cell: E16**

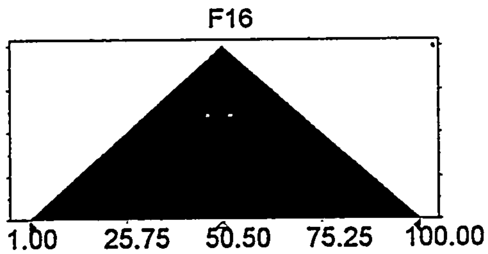


Assumption: F16 **Cell: F16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.34



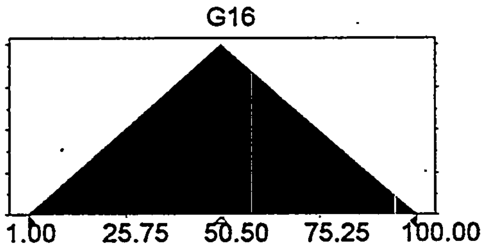
Assumption: G16 **Cell: G16**

Triangular distribution with parameters:

Minimum	1.00
Likeliest	50.00
Maximum	100.00

Selected range is from 1.00 to 100.00
Mean value in simulation was 50.33

Assumption: G16 (cont'd) **Cell: G16**



End of Assumptions