This document was too large to scan as a single document. It has been divided into smaller sections.

Section 1 of 2

Document Information			
Document #	**HNF-2863**	**Revision**	**2**
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ENGINEERING CHANGE NOTICE

Page 1 of 2

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Proj. ECN

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13a. Description of Change

13b. Design Baseline Document? ☐ Yes ☒ No

This Revision 2 is a complete revision of and supercedes Revision 1. A RAM model was developed for an additional tank (241-AN-102) that was not included in Revision 1. The RAM models in Revision 1 for tanks 241-AZ-101 and tank 241-AN-105 were updated. New analyses were run and documented.

14a. Justification (mark one)	14b. Justification Details
Criteria Change ☒ Design Improvement ☐ Environmental ☐ Facility Deactivation ☐ As-Found ☐ Facilitate Const. ☐ Const. Error/Omission ☐ Design Error/Omission ☐	This revision provides updated RAM models that replace the RAM models documented in the previous revision for tanks 241-AZ-101 and 241-AN-105, and documents analyses performed since the release of the previous revision. A RAM model for tank 241-AN-102 is added in this revision.

15. Distribution (include name, MSIN, and no. of copies)

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☒ No	Savings ☐ $ N/A	Savings ☐ $ N/A	Delay ☐

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

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

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Cog. Mgr. PJ Certa	Paul J. Certa	10/11/2000	QA		
QA			Safety		
Safety			Design		
Environ.			Environ.		
Other			Other		

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HNF-2863 Rev 2 Title: *Waste Feed Delivery System Phase 1 RAM Analysis*		ECN No.: 660461

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Waste Feed Delivery System Phase 1 Preliminary RAM Analysis

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Abstract: This document presents updated results of the preliminary reliability, availability, and maintainability analysis performed for delivery of waste feed from tanks 241-AZ-101, 241-AN-102, and 241-AN-105 to the waste delivery plant. The operational schedule delay risk is estimated, and contributing factors are discussed.

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Waste Feed Delivery System
Phase 1
Preliminary RAM Analysis

Prepared for:

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Prepared by:

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Executive Summary

Objectives

This report presents the updated results of the preliminary reliability, availability, and maintainability (RAM) analysis of selected waste feed delivery (WFD) operations to be performed by the Tank Farm Contractor (TFC) during Phase I activities in support of the Waste Treatment and Immobilization Plant (WTP). For planning purposes, waste feed tanks are being divided into five classes in accordance with the type of waste in each tank and the activities required to retrieve, qualify, and transfer waste feed. This report reflects the baseline design and operating concept, as of the beginning of Fiscal Year 2000, for the delivery of feed from three of these classes, represented by source tanks 241-AN-102, 241-AZ-101 and 241-AN-105. The preliminary RAM analysis quantifies the potential schedule delay associated with operations and maintenance (O&M) field activities needed to accomplish these operations. The RAM analysis is preliminary because the system design, process definition, and activity planning are in a state of evolution.

The results are being used to support the continuing development of an O&M Concept tailored to the unique requirements of the WFD Program, which is being documented in various volumes of the *Waste Feed Delivery Technical Basis* (Carlson, 1999, Rasmussen 1999, and Orme 2000). The waste feed provided to the WTP must: (1) meet limits for chemical and radioactive constituents based on pre-established compositional envelopes (i.e., feed quality); (2) be in acceptable quantities within a prescribed sequence to meet feed quantities; and (3) meet schedule requirements (i.e., feed timing). In the absence of new criteria related to acceptable schedule performance due to the termination of the TWRS Privatization Contract, the original criteria from the *Tank Waste Remediation System (TWRS) Privatization Contract* (DOE 1998) will continue to be used for this analysis.

Approach

The WFD activities considered in the preliminary RAM analysis are those associated with the functions of waste preparation, waste staging, waste qualification, and waste transfer. The lead-time provided by the schedule for waste preparation, staging, and batch qualification sampling and analysis makes it highly unlikely that delays associated with these activities will prevent a batch transfer from beginning on the scheduled waste transfer date (WTD). This is also confirmed through the preliminary RAM analysis. Although the preliminary RAM analysis quantified the potential delay associated with these activities, the analysis focuses on the final transfers where the risk for WTP idle facilities costs are the greatest.

The RAM model quantification produces both "expected value" results and probabilistic simulation results of individual transfers. Expected value calculations evaluate the average RAM performance over a large number of transfers based on mean values of

RAM parameters. Expected value results provide information that permits one to identify and rank system, sub-system, or component contribution to schedule delay.

The simulation results provide an estimate of the distribution of completion times that result from the combinations of delaying events that might occur during any given batch transfer. These completion times are then compared to a goal of completing a transfer within 30 days of the WTD. Delays that extend the completion of a batch transfer past 30 days may result in idle WTP facilities due to lack of waste feed. The average of the days that simulated batch completion times extend beyond the 30-day goal during all the simulations is an important Figure-of Merit (FOM) for judging how well the system design and O&M Concept will meet the schedule requirements. The term used for this average value is *Integrated Idle Facility "Days."* Using the current FOM criteria, a sum of the Integrated Idle Facility "Days" of all batches from a given source tank of less than 2 "days" would validate the ability to meet the schedule requirements for delivery of the waste contained in that tank.

Results

Source tank 241-AN-102 is representative of Class 1 tanks. It contains LAW in concentrated supernate form with a very low amount of insoluble solids. The major activities associated with the retrieval of this waste, and which are included in this analysis, include qualification of the feed and delivery of the contents in two batches using in-line dilution in accordance with Interface Control Document (ICD-19) (BNFL, 2000a).

The RAM model simulation produced the following results for the two waste feed batches from source tank 241-AN-102:

	Completion Given No Delay Events (Days After WTD)	Probability of Idle Facilities	Average Idle Days, Given WTP is Idled	Integrated Idle Facility "Days"
AN-102 1st Transfer	3.4	5.7%	25	1.4
AN-102 2nd Transfer	3.4	5.3%	24	1.3
Figure of Merit for All Waste Feed Batches from Source Tank 241-AN-102				2.7

The Class 2 (241-AZ-101) HLW transfers are accomplished in five batches. In preparation for batch transfers, the waste is mobilized, sampled and certified. Prior to each HLW batch transfer, the waste feed is resuspended and transferred directly to the WTP. It is expected that the mixing operation for resuspension will continue during the waste transfer process as well in order to counteract the effects of particle settling within the waste during the actual transfer operation.

The RAM model simulation produced the following results for a typical waste feed batch from source tank 241-AZ-101:

	Completion Given No Delay Events (Days After WTD)	Probability of Idle Facilities	Average Idle Days, Given WTP is Idled	Integrated Idle Facility "Days"
One AZ-101 Batch	1.1	1.7 %	28	0.45
Figure of Merit for Five Waste Feed Batches from Source Tank 241-AZ-101				2.3

Class 3 LAW batch delivery from 241-AN-105 is performed in two deliveries. The first batch follows decanting the supernatant from tank 241-AN-105 to tank 241-AN-102 using in-line dilution. Tank 241-AN-102 serves as an interim waste staging tank for the supernate, where samples are taken for final certification to meet delivery specifications. Following qualification, the supernate is transferred to the WTP directly from 241-AN-102 without requiring further in-line dilution. The remaining salt solids within tank 241-AN-105 are dissolved by the addition of raw water. Following certification, the dissolved salt is transferred to the WTP directly from 241-AN-105 without requiring in-line dilution or interim staging.

The RAM simulation of the final batch transfers produced the following results for the two waste feed batches from source tank 241-AN-105:

	Completion Given No Delay Events (Days After WTD)	Probability of Idle Facilities	Average Idle Days, Given WTP is Idled	Integrated Idle Facility "Days"
Supernate Batch Transfer from AN-102	4.7	5.1%	25	1.3
Dissolved Salts Batch Transfer from AN-105	4.0	3.3%	27	0.9
Figure of Merit for All Waste Feed Batches from Source Tank 241-AN-105				2.2

RAM Insights Regarding the Risk of Idle Facilities

The mixer pumps and transfer pumps are major contributors to batch transfer risk. Although the chance of a catastrophic pump failure can be made small through design, a catastrophic pump failure has the potential for creating a significant delay. A method to reduce risk would be to ensure that a second source of qualified waste feed is available for delivery from an alternate tank. A case study based on the FY99 WFDS RAM model (Penwell, 2000) showed that this strategy produces a significant decrease in schedule risk.

The RAM results indicate that most failures occur infrequently during batch deliveries, but require relatively long recovery times. The recovery times were developed by experienced Hanford maintenance personnel and reflect uncertainties they have

experienced. The large uncertainties in the recovery times suggest that efforts to reduce recovery times will have a significant impact on the risk of idling the WTP due to lack of qualified feed. Methods that would help keep recovery times short include:
(1) preplanning and expedited review of work packages to the greatest extent possible; (2) organizing specific recovery teams and providing hands-on certification training for the equipment that fails most often over the long term; (3) constructing mock-ups of critical recoveries and locations so that recovery actions can be rehearsed and evaluated before they are performed in the field; (4) assuring spares and equipment needed for the recovery will be available. Although spares were assumed available when the recovery distributions were estimated, this assumption will be valid only if a program exists that assures that spares are either onsite or are readily obtainable so that recovery actions and associated delay times will not be controlled by spares procurement.

The need for using motor-operated valves (MOVs) in waste transfer paths should be evaluated carefully. In general, valves within the WFDS will be operated relatively infrequently, so the efficiency provided by remote operation should be evaluated against the increased maintenance requirements and unreliability of MOVs. Although the MOVs are being designed so that they may be manually positioned in the event of motor operator failure, manual valves generally have lower failure rates and less maintenance demand. For those paths that will not be subjected to frequent routing changes, manual valves provide a straightforward means of both aligning and controlling the waste transfer path. Valve position indicators can provide direct indication to the operators for verification of positioning, and the valves can be locked in place.

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1. Introduction

This report presents the updated results of the preliminary reliability, availability, and maintainability (RAM) analysis of selected waste feed delivery (WFD) operations to be performed by the River Protection Project (RPP) during Phase I activities of the Tank Farm Contractor (TFC) in support of the Waste Treatment and Immobilization Plant (WTP). It reflects the baseline design and operating concept, as of the beginning of Fiscal Year 2000, for the delivery of feed from source tanks 241-AN-102, 241-AZ-101 and 241-AN-105, which have been selected as representative of Class 1, 2, and 3 (see Section 1.2) waste feed tanks, respectively. The preliminary RAM analysis quantifies the potential schedule delay associated with operations and maintenance (O&M) field activities needed to accomplish these operations. The RAM analysis is preliminary because the system design is in a state of evolution. The results are being used to support the continuing development of an O&M Concept tailored to the unique requirements of the WFD Program.

1.1 Background

Underground storage tanks have been used at Hanford to process and store radioactive and chemical-mixed waste. The tank farms are located in the 200 East and 200 West areas of Hanford. They consist of 28 underground double-shell tanks (DSTs) with a capacity of 118,400 m^3 and 149 single-shell tanks (SSTs) with a capacity of approximately 139,000 m^3. The tanks store highly radioactive sludge, salt cake, and supernatant consisting of a variety of chemical components.

The TFC is responsible for maintaining the tanks in a safe configuration and readying them for decommissioning. The current operation for DSTs focuses on ensuring safe storage, providing surveillance to comply with U.S. Department of Energy (DOE) Order 5820.2A requirements, and evaporating condensate to store a concentrated slurry in the least amount of space. Similarly, there is a program for the surveillance, interim storage, stabilization, and isolation of the SST waste. Waste characterization and assessment are also being conducted to support decisions for future remedial action. The retrieval and delivery of SSTs is not discussed in this document.

In 1996, the DOE proposed a strategy to retrieve and treat the waste in the Hanford Site's tanks using existing DOE contractors and privatization contractor teams in combination. DOE divided the treatment of the tank waste into a demonstration phase, called Phase 1, and a full-scale production phase, called Phase 2. During both phases the TFC will have the mission of retrieving wastes from the waste storage tanks and providing it as feed to the WTP. In 2000, the DOE cancelled its privatization contract and issued a Request for Proposal to perform the design and construction of the WTP. Although the contract was terminated, the waste feed provided to the WTP must still: (1) meet limits for chemical and radioactive constituents based on pre-established compositional envelopes (i.e., feed quality); (2) be in acceptable quantities within a prescribed sequence to meet feed quantities; and (3) meet schedule requirements (i.e., feed timing). Therefore, in the absence of new criteria related to acceptable

schedule performance due to the pending request for proposal for the design and construction of the WTP, the original criteria from the *Tank Waste Remediation System (TWRS) Privatization Contract* (DOE 1998) will continue to be used for this analysis.

For planning purposes, waste feed tanks are being divided into five classes in accordance with the type of waste in each tank and the activities required to retrieve, qualify and transfer waste feed. This analysis addresses three representative tanks for Classes 1 through 3.

1.2 Objectives

Consistent with the FY 2000 baseline planning guidance (DOE 1999a, DOE 1999b), the immediate objectives of the preliminary RAM analysis are to:

- Support evaluating the ability of the FY 2000 baseline system design and O&M concept to meet the WFD schedule requirements for three representative Phase 1 source tanks:
  - Low Activity Waste (LAW) in tank 241-AN-102 (representative Class 1 Tank)
  - High-Level Waste (HLW) in tank 241-AZ-101 (representative Class 2 Tank)
  - LAW in tank 241-AN-105 (representative Class 3 Tank)
- Estimate the likelihood and magnitude of delivery delays associated with the tank farm O&M activities.
- Identify preliminary RAM-related design and O&M concept changes to enhance operating margins for meeting waste delivery schedules.
- Provide feedback and input to requirements in the DST System and Subsystem specifications

The ultimate objective of the preliminary RAM analysis is to guide the collection and use of site-specific RAM performance data to provide practical information that will support the allocation of resources for the O&M Concept. This will assist the RPP organization to optimize the system's capability for meeting the planned requirements within the budget available, while maintaining an acceptable margin of operating flexibility.

1.3 Scope

The three tanks addressed in this report were selected as representative of three classes of tanks within the tank farm inventory. The classes of tanks are grouped primarily according to waste contents and retrieval strategy. Overall, there are five classes of tanks, with Class 1 and Class 2 tanks generally the simplest to deliver, and Classes 3, 4, and 5 being more complex. Only Classes 1 through 3 are addressed in this analysis. All SSTs are either Class 4 or Class 5 tanks.

Source tank 241-AN-102 is representative of Class 1 tanks. It contains low activity waste in concentrated supernate form with a very low amount of insoluble solids. The major activities associated with the retrieval of this waste and which are included in this analysis include qualification of the feed and delivery of the contents in two batches using in-line dilution, in accordance with Interface Control Document (ICD-19) (BNFL 2000a). Mixing is not required for this tank to prepare the waste for delivery, since prior sampling and historical evidence supports the assumption that the tank contents are homogeneous enough for delivery without mixing. Additional activities for other tanks within this class include chemical adjustment of the feed and mixing of the tank contents. These activities are not required for the source tank 241-AN-102 analysis.

Source tank 241-AZ-101 is representative of Class 2 tanks. It contains HLW in a consolidated layer of particulate solids at the bottom of the tank. The major activities associated with delivery of waste feed from source tank to the WTP consist of mobilization of the solids, qualification of the feed, and subsequent delivery of five, roughly equal, incremental lots of the tank's contents to the WTP HLW receipt tank in accordance with Interface Control Document (ICD-20) (BNFL 2000b).

Source tank 241-AN-105 is representative of Class 3 tanks. It contains LAW as both supernatant and precipitated salts. The major activities associated with delivery of waste feed from that source tank to the WTP consist of transferring the supernatant to staging tank 241-AN-102 using in-line dilution and qualifying the resulting waste in 241-AN-102, dissolving the precipitated salts present in the source tank and qualifying the resulting waste in 241-AN-105. Once qualified, the LAW in each tank is sent directly to the WTP's LAW feed receipt tank as separate batch transfers in accordance with Interface Control Document (ICD-19) (BNFL 2000a).

The preliminary RAM analysis addresses the field activities of tank farm O&M organizations necessary to achieve the activities stated above once the TFC has been given the approval to commence operations. This assumes that issues and uncertainties identified during the development process that could delay field activities have been resolved. Specifically:

- To the extent possible, the design has been analyzed and tested to demonstrate that the system design and O&M Concept are capable of accomplishing their intended functions in accordance with the process flowsheets.

- The Operational Readiness Review (ORR) has verified that O&M planning has been effective.

- The project development and ORR will be successful in eliminating process and construction related problems that could stop waste transfer operations because a physical condition occurs that the development did not anticipate.

- All the resources and administrative systems necessary to sustain O&M activities to successfully complete the mission are in place.

The preliminary RAM analysis accounts for the fact that interruption of the operation of any system involved in supporting the transfer may cause schedule delay. It addresses random failures of hardware in the system and other off-normal events that typically

occur during operations in the field. These include human error during the execution of procedural tasks, weather-related delays, and random non-catastrophic external events. Its output includes the expected frequency and duration of schedule delay due to random off-normal events, and a ranking of the contributors to those delays.

This revision of the RAM analysis focuses on the potential for incurring idle facility costs because of delays in transferring waste feed batches within the acceptable delivery window.

1.4 Relationship of the Preliminary RAM Analysis to the Waste Feed Delivery System (WFDS) Technical Basis

The preliminary RAM analysis complements the project development and design work being accomplished by the TFC in preparation for WTP operations. The technical approach and data for delivering feed from individual source tanks is defined in separate volumes of HNF-1939, *Waste Feed Delivery Technical Basis* (Rasmussen 1999, Orme 2000, and Carlson 1999). HNF-1939 consists of a process concept and flowsheets in Volume II, system description and equipment concept in Volume III, and O&M Concept in Volume IV.

The process flowsheets in Volume II provide material and partial energy balance and process flow information for each source tank. The system description describes the existing physical system in the tank farms, and the retrieval and transfer system being designed and constructed by various projects that will support waste feed delivery. The O&M concept describes the operational activities associated with delivering waste feed to the privatization contractor once active waste processing has begun. The preliminary RAM analysis assists quantifying the expected performance of that system by addressing failure modes and recovery times for random equipment failures, human error, and off-normal external events during scheduled WFD activities. Uncertainties associated with the technical approach and programmatic issues are documented in HNF-5318, *Risk Assessment of Operations and Maintenance Concept* (Fitzpatrick 1999).

The preliminary RAM analysis supports the policy stated in DOE O 430.1, *Life Cycle Asset Management*, and implemented in the Good Practice Guides (see *Guide to the Guides*, GPG-FM-000). The development of an O&M Concept and the preparation of a preliminary RAM analysis form a significant part of the iterative process of developing and validating the technical approach for achieving the WFD mission. The operational figures-of-merit (FOM) and supporting metrics generated by the RAM analysis assist the project development team in anticipating and prioritizing risks. This systematic evaluation of anticipated performance during the operational phase of the life-cycle is assisting planners to recognize and address problems in the technical basis of the facility before they become engrained in the system.

1.5 Organization of this Report

Section 2, "Structure of the RAM Model," discusses the general approach used to accomplish the preliminary RAM analysis and summarizes the scope and overall structure of the RAM model of the current TFC processing and operating concept for the

three source tanks being addressed. The processing logic is derived from the most recent version of the process flowsheets available and represents a no-problem, no-failure (NPNF) scenario. This section also includes a summary of assumptions used for the analysis. Appendices A, E, F and G support Section 2.

Section 3, "Frequency of Off-Normal Events," describes the development of the RAM parameters needed to quantify the frequency of off-normal events that can lead to delays during the transfer activities addressed by the analysis. Off-normal events that stop progress on critical path activities in the Primavera schedule for the transfers become the basic events of the RAM model. Section 3 then cites the available evidence and summarizes how that evidence has been interpreted to establish appropriate RAM parameters for the analysis. Appendices B through D provide more detailed information regarding these parameters.

Section 4, "Time Required to Restore to Normal Activities," discusses the recovery from off-normal events. The duration of recovery activities is defined to be the total time between the cessation of progress on scheduled activities and the point at which scheduled activities will move the transfer process beyond the condition that existed when the off-normal event occurred. This section is based on the analysis described in Section 4 of the O&M Concept Document, HNF-1939, Volume IV (Carlson 1999).

Section 5, "Results of Preliminary RAM Quantification," summarizes the results of the preliminary RAM analysis of the qualification and batch transfer of waste in source tanks 241-AN-102, 241-AZ-101 and 241-AN-105. It presents the overall conclusions and discusses some of the insights derived from the study. It also suggests areas for further applications of RAM model to support more detailed planning and development. Appendices E through G support Section 5.

All numbered tables and figures are at the back of the major sections listed above.

Appendix A provides a summary of the structure of the RAM model, definitions of RAM database fields, and an example list of component failure modes considered.

Appendix B contains the generic hardware failure rate database used to quantify the RAM model.

Appendix C contains the results of evaluations of the Occurrence Reporting and Processing System (ORPS) and Job Control System (JCS) for generating site-specific failure rate and recovery time parameters for use in the preliminary RAM analysis.

Appendix D contains the tables generated to support the evaluation of human reliability during the performance of procedural tasks.

Appendix E provides selected detailed reports from the RAM database generated from the evaluation of WFD activities associated with source tank 241-AN-102 (Representative Class I Tank).

Appendix F provides selected detailed reports from the RAM database generated from the evaluation of WFD activities associated with source tank 241-AZ-101 (Representative Class 2 Tank).

Appendix G provides selected detailed reports from the RAM database generated from the evaluation of WFD activities associated with source tank 241-AN-105 (Representative Class 3 Tank).

2. Structure of the Preliminary RAM Model

This preliminary RAM analysis quantitatively estimates the likelihood and impact of potential schedule-delaying events during the qualification and transfer of waste to the WTP operator. Waste transfers from source tanks 241-AN-102, 241-AZ-101 and 241-AN-105 were selected to define the representative waste transfer activities for Classes 1, 2, and 3, respectively. Rather than measure the average operational availability, a typical metric for a system designed to operate continuously over a specific mission time, this preliminary RAM analysis addresses specific well-defined batch transfer activities encompassing both single "batch"-related functions and continuous safe storage during the mission. This is accomplished via the definition and quantification of system exposure to specific transfer schedule-delaying events, which can be a mix of demand-related functions and continuous operation functions.

The preliminary RAM analysis methodology and approach is presented in Section 2.1. Section 2.2 then describes the WFDS configuration addressed by the preliminary RAM analysis. Section 2.3 discusses selected methods used to develop the RAM model for this analysis. Section 2.4 develops the FOM used to evaluate the potential for idle facility penalties during the qualification and transfer of waste feed from the source tanks to the WTP operator. Section 2.5 provides a table consolidating the assumptions used during the preliminary RAM analysis.

2.1 Overview of the RAM Analysis Methodology

The general approach for developing the preliminary RAM analysis is shown in Figure 2-1 and described below. Although the description indicates a linear progression of analysis steps, it should be recognized that the tasks are interrelated. The items represented by dashed lines in Figure 2-1 are not within the content of this preliminary RAM analysis.

- **Describe Facility/Process**

  This step establishes the context for the RAM analysis by describing the overall extent of the facility(ies) and/or process(es) to be analyzed. Experience has shown that widening and fine-tuning the definition of the facility to be analyzed can have a significant impact on subsequent capability to adequately define and appropriately evaluate the metrics for efficient and cost-effective facility O&M decisions throughout the facility life cycle. Section 2.2.1 describes the facilities and processes addressed by the preliminary RAM analysis.

- **Define Specific Process Functions**

  Define specific processes to be analyzed by breaking down the overall process into functions that have identifiable physical and temporal limits. This is the first step that leads to measurable process success criteria. As an example, for this model the general processes are those related to waste feed preparation and batch delivery to

the WTP. Sections 2.2.2, 2.2.3 and 2.2.4 present and describe the Class 1, 2, and 3 WFD activity logic, respectively.

- **Define Functional Requirements/Figures-of-Merit**

  Functional requirements are derived from the objectives of the process functions, which are discussed in detail in the process flowsheets (Orme 2000). The functional requirements are derived from the physical changes that must be achieved to move a process from its initial state to the objective. Waste transfer batch volumes summarized in Tables E-1, F-1, and G-1 for Classes 1, 2, and 3 tanks, respectively, are the primary functional requirements addressed in the preliminary RAM analysis. The functional requirements will then be used to delineate the number and duration of activities necessary to achieve the desired results.

  A FOM is a measure selected to evaluate and understand the effectiveness of a system for accomplishing its mission. In this preliminary evaluation, the FOM quantifies the confidence that waste feed qualification and batch transfer operations can assure that the WTP operator will not have to idle its facilities due to lack of waste feed. This is accomplished by quantifying the frequency and duration of off-normal events that interrupt and delay the execution of schedule critical waste feed delivery activities. Early definition of FOMs will assist to focus the RAM analysis's utility for improving the waste feed delivery O&M concept. Section 2.4 discusses the FOM for the preliminary RAM analysis in more detail.

- **Delineate Required Activities**

  This step breaks down the functional requirements into activities having specific physical and temporal boundaries suitable for defining a quantitative mission for preliminary RAM analysis. The activities are generally best defined with a process or logic diagram. The TFC Primavera Project Planner (P3) logic diagram, the TFC logic simulation model, and existing process flowsheets are good examples of tools that support the clear definition of activity functional boundaries. Figures 2-4, 2-6 and 2-8, which summarize the P3 logic, delineate the activities associated with Classes 1, 2, and 3 waste transfers, respectively. Section 2.2.4 explains what is included and excluded from the preliminary RAM model.

  Specific human actions for setting up and controlling the process functions are included in the preliminary RAM. Candidate actions are extracted from existing operational procedures similar to the planned activities. Section 2.2.5.2 discusses the criteria for including actions in the RAM model. Those actions retained for quantification are listed in Appendix D, Tables D-2, D-3, and D-4 for Classes 1, 2, and 3 waste, respectively.

- **Identify Required Hardware**

  This step identifies the structures, systems, and components (SSCs) required for accomplishing the activities that will achieve the functional requirements. Consideration must be given to not only "frontline" systems that participate directly in the process activity, but also to utility and support systems that the frontline systems depend upon to operate. It also includes the instruments and control systems

needed to assure that the activities are performed safely and in accordance with process specifications.

Clear delineation of the boundaries between systems and hardware is necessary to assure all SSCs required for mission success are included in the preliminary RAM analysis, while also avoiding overlap and duplication. The hardware boundaries should be specific, readily identifiable, and coordinated with the data evaluation task. Typically, SSC boundaries are broken down only to the level at which operational and failure experience is available.

For completeness and to avoid duplication, it is necessary to define explicit boundaries between SSCs. Typical hardware boundaries include: designated pipe flanges, nozzles, or weld boundaries, jumper nozzles, flanges, or weld boundaries, valve flanges or weld boundaries, pump flanges or weld boundaries, junctions with tanks, electrical breaker connections, circuit lead connections, instrument lead connections, etc.

Hardware required for the qualification and transfer of Class 1 waste in source tank 241-AN-102, Class 2 in source tank 241-AZ-101, and Class 3 waste in source tank 241-AN-105 are summarized in Sections 2.2.2.2, 2.2.3.2, and 2.2.4.2, respectively. A complete listing of the hardware by Equipment Identification Number (EIN) is contained in the RAM database. General system schematics are provided in Figures 2-5, 2-7, and 2-9 for Class 1 through Class 3 tanks, respectively.

- **Assign Success Criteria**

Success criteria define specific operational requirements for hardware and personnel participating in a specific activity. Examples include the number of alignments, startups, and operational transitions that must be accomplished as well as the total operating time that hardware must operate to complete the mission functions. The success criteria provide the basis for defining exposure of the system to hardware and non-hardware failure modes.

Hardware success criteria are assigned to each SSC that will be quantified individually within the RAM model for a given process activity. Tables 2-1, 2-2, and 2-3 delineate the specific hardware success criteria associated with the Classes 1, 2, and 3 waste feed delivery activities, respectively.

Human action success criteria are assigned to specific procedural steps that must be completed to enable hardware to accomplish the next process activity. A common human action falling into this category is aligning the system for a waste transfer between two tanks. The operational procedures listed in Appendix D, Tables D-2, D-3 and D-4 of Appendix D for Classes 1, 2, and 3 waste feed delivery activities, respectively, define the tasks upon which the human success criteria are based.

- **Define Off-Normal Events and Failure Modes**

This step defines process, system, and component failure modes and their effects on the entire facility process. A failure mode is a deviation of a process, system, or individual piece of hardware from a state needed to complete the current activity. The functions may be active (e.g., safety and process related) or passive (e.g.,

providing containment, protection, or structural support). A variety of deviations may occur to any one item, and their effects may impact an activity in a variety of ways. This preliminary RAM analysis focuses on failure modes producing off-normal events that interrupt and delay waste feed delivery schedule critical activities. Failure modes with effects that do not produce waste transfer delays such as failures of non-critical items and regulatory incidents not requiring transfer cessation are not quantified in the analysis.

Failure modes can be defined at the system, functional, or individual hardware level. The level normally depends on the resolution of information available on the off-normal event. External events, such as forced stoppage due to weather conditions, generally produce system level failure modes. Site wide support functions are evaluated at a system level. Human action failure modes are keyed to the specific activities being accomplished and consider the capability of the personnel involved to react to correct an error before it evolves into an off-normal event that interrupts the activity. For process related hardware, failure modes are developed for the SSCs designated when required hardware was identified and their boundaries were defined. The tables generated for the failure modes and effects analysis step provide a convenient format for listing and categorizing all off-normal events for RAM quantification and reporting of results. These tables may be regenerated by querying the RAM database.

- **Develop RAM Logic Models**

The RAM logic model is the vehicle used for organizing combinations of failure modes into a structure that represents a complete set of off-normal events that impact the waste feed delivery schedule. Depending on complexity and redundancy of the system, RAM logic models can be developed in a variety of formats.

The model selected to organize off-normal events for this preliminary RAM analysis flows from the fact that there is limited redundancy available for active waste transfer operations. Typically, operations are stopped following any failure mode that could impact the safe and compliant completion of the operation. O&M personnel then verify that safe conditions exist, and recover from the failure mode prior to resuming active waste handling. Consequently, a list of all the individual failure modes that can interrupt the process activity will constitute a valid logic model of off-normal events that produce schedule delay.

Where, backup components, such as secondary Heating, Ventilation, and Air-conditioning (HVAC) fans and filters in ventilation systems, exist that provide an automatic or manual backup capability, the redundancy is modeled with a "Failure of Backup" factor that is used in the calculation of the failure mode frequency. This factor is equivalent to an "AND" logic gate that generates a delay event only if both the primary and backup redundant trains fail. It is discussed in greater detail in Section 2.3.2.

Section 2.3.1 discusses the development of the preliminary RAM computer model used to assemble the information needed to define a complete set of failure modes for quantification. Table 3-1 summarizes the hardware failure modes, while Appendix A provides a detailed breakdown of the process used to assemble the failure modes and generate the RAM quantification tables.

- **Collect RAM Data**

  The analysis of RAM data involves the collection of generic industry evidence, vendor supplied data, and TFC-specific historical RAM performance data. Generic industry evidence is generally in the form of failure rate and recovery time distributions. Frequently the detailed raw data supporting these derived parameters are not readily available. Consequently, their applicability to Hanford must be evaluated based on the reputation of the source and the similarities between the original application and the conditions at Hanford.

  Applicable failures are those that produce a cessation of the desired component function that can be attributed to a fault in that component, as opposed to an induced failure caused by an external event that is out of the design envelope. (Induced failures should be also be recorded, but would be included in an external events analysis.) Applicable information on total exposure is obtained from the operational history of SSCs under conditions similar to the mission of interest. Exposure data is typically recorded as hours of run time for "running" failures or the total number of demands for operation in the case of "transition" failures. Repair and restoration times relate to the total clock time required to make the component and the system it supports fully functional.

  Site-specific data supporting calculation of RAM parameters is collected from experience with the WFDS equipment or similar equipment that will be used for a specific activity. This raw RAM data includes time-based or "running" failures, demand-based or "transition" failures, their associated repair and restoration times, and the total operational exposure that produced those failures. The results of the Hanford site-specific data collection effort is presented in Section 3.2.

- **Develop Failure Rate and Recovery Parameters**

  During this step, the RAM data is converted into failure rates and recovery durations that can be applied to the failure modes in the RAM logic model. Failure rates are developed for individual hardware failure modes, support system outage rates, human error rates, and external event frequencies.

  A failure rate is an estimate of the likelihood that a failure mode will occur per unit of exposure. The exposure is directly related to the function performed during a process activity. Failure rates are represented by distributions that reflect on one's confidence in the available evidence. Processing involves assessing the applicability and relative weight of both the generic failure rate parameters and failure rates calculated from samples of actual experience similar to the activities addressed by the preliminary RAM analysis. If a generic failure rate distribution is judged to be applicable, it can be used directly. If site-specific data is also found to be applicable, Bayesian statistics may be used to produce an updated distribution that properly reflects the relative strength of the two sources of evidence. See Section 3 for a further discussion of failure rate development.

  There are two aspects to the recovery process, 1) restoration of function and 2) repair or replacement activities necessary to recover full design capability. Restoration of function pertains to the total elapsed clock time from the interruption of normal process activities to the point at which the system resumes mission-related

process activities past the point of the interruption. The preliminary RAM analysis uses restoration time to calculate schedule delay resulting from off-normal events. However, the recovery to full design capability is important for maintaining long-term reliable operations. The differences between restoration and full recovery are discussed more fully in Section 4.

Both restoration and repair time distributions are assigned to every SSC included in the preliminary RAM model. When a means to manually switch to a backup method of providing the required function exists, the restoration time will reflect the estimate of the time needed to accomplish the switchover and resume waste transfer operations. The repair distribution provides an estimate of the time and effort needed to recover full operability of the failed SSC. The preliminary RAM assumes that the manual backup SSC will not fail while repair to the failed SSC is underway. When an SSC does not have a manual backup, the repair time distribution also represents the restoration time.

For non-hardware failures that do not result in physical damage to the system, the delay is directly tied to the duration of the condition that caused the interruption. Weather related work stoppages are an example. The duration of delays caused by support system failures and external events are estimated using the experience from past outages, tempered by provisions of corrective actions taken to prevent a repeat of long delays. See Section 4 for a further discussion of recovery durations.

- **Quantify the RAM Model**

  During this step, the RAM failure rates and recovery times are assigned to the components in the RAM logic model(s) to quantify the frequency and durations of RAM-related delays. Because any failure mode can occur more than once during a given activity, the quantitative system model is straightforward. The failure frequency of each off-normal event during a specific activity is quantified by multiplying its failure rate per unit of exposure by its total exposure to that failure mode during that activity. Once generated, the complete set of off-normal event failure frequencies can then be used with their associated restoration times to generate output metrics to evaluate the RAM FOM. Section 2.3.1.4 describes the generation of the quantification tables in the RAM computer model.

- **Evaluate RAM Figures-of-Merit**

  Two approaches are used in this preliminary RAM analysis to support the evaluation of the FOM.

  To estimate the risk of idle facility penalties for failing to deliver a batch of waste feed to the WTP operator, a distribution of total schedule delay is generated using a Monte Carlo simulation. The results of this simulation are then used to develop distributions of activity completion times for comparison to the allowable waste feed delivery window. This process is fully explained in Section 2.4.

  The output of the RAM quantification is also used to develop critical item lists (CILs) that rank the relative contribution of off-normal events to process interruption and associated schedule delay. The expected values of failure frequency and delay time of all the off-normal events are used for ranking. An expected delay time of an

off-normal event is obtained by multiplying the failure frequency by the mean value of the restoration time distribution. The failure frequency and resulting expected delay time of the individual off-normal events may then be selectively summed to obtain the expected number of off-normal events and total expected delay time by various categories. To support decision making, this information may be generated at several levels of indenture relative to the waste feed delivery system, including: processing function, system type group, component type group, individual component, and individual component failure. The results of the preliminary RAM quantification are presented in Section 5.

2.2 Facility and Process Definition

This section provides a brief system description of the functions and components needed to accomplish the WFD program mission; these form the basis for the mission success criteria of the RAM analysis. It outlines the basic functional requirements for the transfers, the systems designated to meet those requirements, and relates them via the operational activities contained within the RAM model.

The DST facility includes six tank farms containing 28 DSTs. Five of the DST farms are located in the 200 East Area (241-AN, 241-AP, 241-AW, 241-AY, and 241-AZ), and one is located in the 200 West Area (241-SY). Currently, the preliminary RAM analysis involves only tanks 241-AN-102, 241-AN-105, and 241-AZ-101, and their supporting systems.

2.2.1 Facility and Process Functions Addressed by the Preliminary RAM Analysis

The WFD Program mission is to retrieve low-activity and high-level tank waste and deliver it to the WTP for immobilization through a vitrification process. Waste is moved among DSTs by transfer systems using transfer pumps, valve manifolds, jumpers, and underground pipelines. The waste is routed through valve and pump pits to its destination. A set of functions have been determined within DST functional analysis (Smith 2000) for operation of the DST system. Figure 2-2 shows those functions addressed within this preliminary RAM analysis.

Some functions in the system specification, such as blending waste and transferring HLW to interim staging tanks, are not required for the three tanks considered in this analysis and are have not been modeled. Other facility systems that compose the overall DST system are not applicable to this preliminary RAM analysis for the same reason stated for the WFD functions above. These include the maintenance and recovery system and the currently undefined waste sampling system.

For this RAM analysis, the Class 1 WFD activities involve qualifying the LAW in the source tank and delivering the waste feed batch using in-line dilution to the WTP. Additional activities for other Class 1 tanks might include chemical feed adjustment and waste mixing. These additional activities are not included in this analysis as they are not needed for the delivery of the AN-102 LAW. The batch transfer must be completed within 30 days of the WTD requested by the WTP.

The Class 2 WFD activities involve mixing and sampling HLW in source tank 241-AZ-101 for analysis and certification. Once agreement regarding certification is achieved, the waste is transferred in five batches directly to the WTP. Each batch transfer must be completed within 30 days of the WTD requested by WTP.

The Class 3 WFD activities involve transferring the supernate portion of the LAW in 241-AN-105 to interim waste feed storage in tank 241-AN-102 using in-line dilution. The remaining salt sludge solids are dissolved in place. Each of these tanks is then sampled for analysis and certification. Other activities required by some Class 3 tanks include chemical adjustment and mixing. These last activities are not included in this analysis as they are not required for the delivery of waste from tank 241-AN-105. Once agreement regarding certification is achieved for the waste in a tank, the waste in that tank must be transferred in one batch to the WTP within 30 days of the requested WTD.

For all tank classes, the safe storage function and adequate utility distribution must also be maintained during the qualification and delivery activities.

2.2.2 *Class 1 (241-AN-102) Low Activity Waste Certification and Delivery Process Activities*

2.2.2.1 *Activities Required for Class 1 (241-AN-102) LAW Feed Delivery*

The RAM analysis performed and described herein includes activities necessary to accomplish the waste transfers from tank 241-AN-102 to the WTP. Supporting equipment functions for the Class 1 waste transfer are assumed to be the same as that for a Class 3 transfer presented in Section 2.2.4

The starting and ending point of the waste transfer activities are derived from the *Waste Feed Delivery Technical Basis*, HNF-1939-Vol. II, Appendix A, Revision 1, Waste Feed Delivery Flowsheet for Tank 241-AN-102, (Orme 2000). This document describes the latest process information to meet delivery requirements for tank 241-AN-102 to meet Envelope C constraints. The basic outline of activities requires delivering the first half of the supernate waste from the source tank to the WTP receiver tank using in-line dilution. The second transfer is a duplicate of the first. Both batches are sampled and analyzed to verify Envelope C certification. This sampling and certification can occur up to a year before the waste transfers begin.

The activity boundaries for the Class 1 LAW feed delivery process from 241-AN-102 are shown in Figure 2-4. This figure shows the expected activities to accomplish the various feed delivery functions. Table 2-1 shows the activities with their associated no-problem/no-failure times and how they are modeled within the RAM model. The P3 column shows the planned schedule duration and is followed by the RAM no-problem/no-failure duration. The latter gives an actual mission time that the required SSCs must operate in order to accomplish the activity assuming no failures occur. Additional columns also show if there are any required pump and valve demands required specifically to the activity. A description of the basic activities follows.

Mixing and Sampling

The waste in tank 241-AN-102 will be sampled for final feed certification. Mixing is not required prior to sampling because the LAW ICD (BNFL 2000a) assumed this tank waste is already homogeneous.

Feed Delivery

Once the batch has been certified, the first half of the supernate will be transferred to the WTP LAW feed receipt tank according to the contract requirements and the transfer schedule. The second batch is transferred at a later date according to the contract requirements and transfer schedule. Both batches are transferred using in-line dilution. The volumes for each batch are located in Appendix E, Table E-1.

2.2.2.2 *Hardware Required for Class 1 (241-AN-102) LAW Feed Delivery*

The hardware required for the Class 1 LAW feed delivery from 241-AN-102 is a subset of that needed for the Class 3 feed delivery from 241-AN-105, which is presented in Section 2.2.4. This is because the feed delivery from 241-AN-105 uses tank 241-AN-102 as a staging tank. Figure 2-5 provides an overview of the transfer route and the systems involved in the Class 1 waste feed delivery activities for 241-AN-102. The major difference between the 241-AN-102 batch transfer mission for Class 3 waste (staged from 241-AN-105) and Class 1 waste is the use of in-line dilution during the batch transfers. The Class 1 waste currently in 241-AN-102 requires in-line dilution during the batch transfer to the WTP, while the 241-AN-105 Class 3 supernate is diluted during the staging process to 241-AN-102. Refer to Section 2.2.4 for a description of the systems. Figure 2-3 provides a high-level breakdown of the systems required to accomplish the various functions. This system architecture is derived from the overall DST system architecture tree (Peck 2000).

2.2.3 *Class 2 (241-AZ-101) High-Level Waste Qualification and Delivery Process Activities*

2.2.3.1 *Activities Required for Class 2 (241-AZ-101) Feed Delivery*

The delivery of the entire 241-AZ-101 tank contents involves one certification process and five separate batch preparations and deliveries. Figure 2-6 shows the expected activities required to accomplish the various feed delivery functions. Table 2-2 shows the activities with their associated no-problem/no-failure times and how they are modeled within the preliminary RAM model. A description of the basic activities follows.

Feed Certification

Feed certification involves initial mixing of the high-level liquid and solid fraction utilizing two mixer pumps installed in the tank. The mixing operation will mobilize the sludge layer into the liquid fraction to create a well-mixed feed batch. The process flowsheet assumes this mixing operation lasts 5 days, and that both of the mixer pumps will run for the entire 5-day time period. Only one set of samples will be taken for the entire

241-AZ-101 delivery, and these samples will be used to certify the waste for all five batch transfers.

Feed Delivery

Prior to each HLW batch transfer, the waste feed in the tank will be mixed for a 24-hour period with two mixer pumps. This will resuspend the solids and provide a well-mixed feed for transfer operations. The resuspension requires a shorter mixing duration than the initial mobilization that was done for sampling purposes. This is because interim mixing operations within the tank are planned occur on a frequency that prevents recompaction of solids on the bottom of the tank during the time between the sampling effort and the feed delivery effort. Waste feed is pumped from tank 241-AZ-101 through the 241-AZ-01A central pump pit, through the new AZ and AP valve pits directly to the WTP. It is expected that the mixing operation will continue during the waste transfer process as well in order to counteract the effects of particle settling within the waste during the actual transfer operation. The primary equipment required for the initial batch delivery includes the waste transfer pump and piping, in-line valves, piping and valve instrumentation, leak detectors, and other various I&C components. After each batch transfer operation, the line is flushed with at least one line volume, and no more than two line volumes of water that has been chemically adjusted to prevent corrosion.

Maintain Safe Storage

Safe storage functional requirements are maintained at all times. A particular function important to HLW feed delivery is to maintain waste temperature limits. The process flowsheet (Orme 2000) shows that the addition of heat from the mixer pumps to the waste results in the bulk waste temperature potentially exceeding the FSAR limit. Based on the results of the HLW Heat Removal Study (Crea 2000) the preliminary RAM analysis models the use of the existing ventilation systems with no requirement for periods of supplemental cooling after mixing operations. As succeeding batches are delivered, a smaller remaining volume of liquid waste and sludge may eventually result in the ability to transfer waste with no need for cooling. The need for cooling is also supported by the completion of testing of the mixer pumps in AZ-101 (Carlson 2000). This test showed that solid particles within the tank settled reasonably quickly. This implies that heated solids sustain the need for continuing cooling from all of the ventilation subsystems while the mixer pumps are running.

Other safety support items must function in the background to remain compliant with the safety basis published in the FSAR (CHG 2000b). This includes the primary HVAC, the annulus HVAC, continuous air monitors, level instrumentation, and other related components. These components operate at all times and, if they fail, may delay schedule-related activities that are underway.

Support Utilities

Support equipment includes those systems that provide general utilities and services to allow other major items to function but do not necessarily provide a safety function. For this analysis, this includes electrical supply, raw water, process air, and instrument air. It

is conservatively assumed that these systems must operate at all times, similar to safety support equipment. If they fail, may delay schedule-related activities that are underway.

2.2.3.2 *Hardware Required for Class 2 (241-AZ-101) HLW Feed Delivery*

This section provides a brief system description of the hardware required for completing HLW feed deliveries, maintaining safe storage, and providing supporting utility needs. Figure 2-7 provides an overview of the system configuration.

Waste Transfer System

The waste transfer system is composed of the following:

- Transfer Pump – Tank 241-AZ-101 will be equipped with one 60-hp transfer pump capable of pumping tank waste at 140 gallons per minute through a fixed intake. This pump provides the motive force for transporting waste materials from one tank to another. It is mounted in the central pump pit with a shaft and impeller unit extending into the tank. It is equipped with a variable frequency drive and performance monitoring equipment. It is also monitored and controlled by the master pump shutdown system. The transfer pump has a connection to the flush/dilution system to support flushing the pump after use, delivering flush solutions into transfer lines after completed transfers, and performing in-line dilution. In-line dilution is not modeled as required for the 241-AZ-101 delivery. The pump is supported by the electrical system for motor drive and the nitrogen system for pump seal containment.

- Valving – Transfer system valves provide the means to contain waste and route it to the intended location. They also support the controlled movement of flushing and dilution fluids within the transfer system. Valves are primarily three-inch ball valves and may be either manual or motor-operated (MOV). The valves are equipped with position switches and/or indicators mounted above grade. MOVs may also be operated manually if the motor should fail. The transfer system valves are connected to the master pump shutdown system to monitor misrouting of waste should they inadvertently change position. MOVs are supported by the electrical system.

- Piping – Transfer system piping consists of three-inch stainless steel pipe runs in length up to 4,800 feet and pipe jumper segments within process valve pits. Jumper segments provide the mechanism to connect transfer pipe runs to transfer system components, flush/dilution system components, and other jumper segments through the use of jumper connectors. The piping system provides the confinement and route control mechanism to transport waste materials and flush/dilution fluids throughout the transfer system. Piping outside of valve pits is double contained with leak detection capability. Within valve pits, jumpers are single wall segments with the pit itself acting as the secondary containment. Within jumper segments there are various process control interfaces such as flow meters, pressure sensors, rupture disks, and densitometers. Piping for supporting systems (e.g., raw/service water) is modeled as belonging to those systems.

- Mixer Pumps – Tank 241-AZ-101 is provided with two mixer pumps. The mixer pumps provide the mechanism for mobilizing the solids in this tank. Each pump is

provided with a 300-hp motor and turntable assembly mounted above the tank. A shaft and impeller unit extends into the waste with the center intake seven inches above the tank bottom and the discharge nozzles approximately 17 inches above the tank bottom. The pump has the capacity to discharge at 5,000 gallons per minute through each of two nozzles. The turntable assembly allows the pump to be rotated so that complete mixing can be achieved. During operations, the mixer pumps are monitored for vibration, bearing temperature, motor speed and amperage, column pressure, and nozzle position. The 241-AZ-101 mixer pumps are operated and monitored from a remote location in building 241-AZ-156. They do not directly interface with other primary systems and are not connected to the master pump shutdown system. They are supported by the electrical system for motor power and monitoring and treated water from building 801-AZ for filling the pump column with filtered water and for seal containment.

- Dilution/Flush – The AZ flush dilution system provides both service water and chemically-adjusted water for waste dilution and transfer system flushing. The system also provides the means to provide caustic delivery in order to adjust the chemical composition of the tank wastes, if required. Waste dilution or chemical composition adjustment is not required for the delivery of 241-AZ-101 tank wastes. The system is composed of a service water skid to supply filtered raw water to a local boiler for heating as required. Water is pumped from the boiler to into a 5,000-gallon lag storage tank where the required temperature is maintained until the solution is required. If chemicals are needed, they are supplied through a chemical metering pump skid into the lag storage tank as well. When needed, flush/dilution solutions are delivered with a 40-hp pump. The flush/dilution system is operated from the 241-AZ-156 building and provides flush/dilution support to the AZ, AY, and AN tank farms.

Confinement System (Specific to Class 2 HLW Feed Delivery)

The confinement system is composed of the 241-AZ-101 tank itself and its associated pump and valve pits. For the purposes of this preliminary RAM analysis, confinement means confinement of liquid waste materials and does not include HVAC confinement. Also included in this system are the valve pits along the transfer path. Within the RAM model, only the waste tank is modeled. Conductivity probes designed to detect fluid on the floor of the annulus provide leak detection for the primary waste storage tank. The valve pits provide secondary confinement, which is not challenged unless leakage from the primary boundary occurs. For the purpose of schedule delay estimation, operations are modeled to be halted if the primary boundary is breached.

Ventilation System

The ventilation system consists of the following:

- *HVAC Primary* – The 241-AZ-101 Primary HVAC system provides air flow through the tank to control radiological air emissions and serves as the primary mechanism for removing heat from the dome space of the tank. The primary ventilation system consists of individual tank air inlets and filters, an exhaust condenser and high-efficiency mist eliminator, redundant primary exhaust fans and filter banks, and

an exhaust stack with radiological sampling equipment. Each filtration bank contains an electric heater, high-efficiency particulate filters, and a high-efficiency gas absorber filter. The exhaust fans pull exhaust air from the recirculation condenser cooling exhaust. The redundant exhaust fans and filter banks provide an automatic switchover redundancy capability in case of a loss of one train of exhaust filters or exhaust fan. All waste disturbing activities such as mixing and transfers are also halted upon loss of primary HVAC.

- *HVAC Annulus* – The annulus HVAC system provides a waste cooling function and a radiological emissions detection function should a leak into the annulus occur. Much of the heat generation within tank 241-AZ-101 occurs in the solids layer that has settled to the bottom of the tank. When the waste is in this settled configuration, annulus ventilation air passing through slots in the concrete under the tank provides cooling of the settled solids to ensure the waste remains below FSAR temperature limits.
- *Recirculation Condenser Cooling* – In the high heat configuration, the recirculation condenser cooling system cools primary ventilation air exiting the tank and returns a portion to the source tank. The remaining portion of the air is diverted to the primary ventilation exhaust. If the heat generation in the tank is low enough so that cooling is not needed, the recirculation fan is cycled to the off position.
- *Exhaust Condenser Cooling* – The exhaust condenser cooling system provides the cooling and moisture removal from the primary ventilation stream prior to discharge through the exhaust filter bank. This subsystem is modeled as part of the HVAC Primary.
- *Exhaust Filter Banks* – The exhaust filter banks remove radioactive materials that might be entrained in the exhaust air prior discharge to the atmosphere. This subsystem is modeled as part of the HVAC Primary.

Instrumentation and Control

Instrumentation and control consists of the following:

- *Monitoring Instrumentation* – The I&C system provides monitoring capabilities within the tank system for safe storage capabilities. This primarily includes waste temperature, tank pressure, tank level, leak detection, and radiation monitors. All monitors and detectors are monitored from a central control station or farm-specific control building. The leak detection system interface with the transfer system also provides an input to the master pump shutdown system. Instrumentation is modeled as part of the overall system it supports.
- *Monitoring and Control (Process Related Instrumentation)* – The monitoring and control system contains process-related instrumentation related to the transfer of waste materials. This includes flow meters, pressure monitors, rupture disks, and densitometers. These indicators are monitored from either a central control room or a farm-specific control building. The majority of this instrumentation is included with the waste transfer system.

Utility Systems

The following utilities are modeled in the preliminary RAM analysis. When the system is an integral part of a supported tank system, such as a service water connection to a mixer pump, the individual components are modeled as part of the supported system. Components within the utility systems that support multiple systems are modeled as part of the basic utility supply function. An example of this type of component would be the service air compressors.

Utility System	Systems Supported
Electric Power	All Systems
Instrument Air	I&C; Ventilation; Monitoring Instrumentation
Nitrogen	Transfer Pump
Process Air	Instrument Air
Raw/Service Water	Flush/Dilution Mixer Pumps; Ventilation Condenser Cooling

2.2.4 *Class 3 (241-AN-105) Low Activity Waste Qualification and Delivery Process Activities*

2.2.4.1 *Activities Required for Class 3 (241-AN-105) LAW Feed Delivery*

The RAM analysis performed and described herein includes activities necessary to accomplish the waste transfers from tank 241-AN-105 to the WTP. The starting and ending point of these activities are derived from the *Waste Feed Delivery Technical Basis*, HNF-1939-Vol. II, Appendix C, Revision 1, Waste Feed Delivery Flowsheet for Tank 241-AN-105, (Orme 2000). This document describes the latest process information to meet delivery requirements for tank 241-AN-105 to meet Envelope A constraints. The basic outline of activities requires delivering the supernate portion of the waste from the source tank to an interim staging tank using in-line dilution. The second transfer is made with a diluent addition and salt dissolution process as its preparatory step. The waste in both tanks is sampled and analyzed to certify to Envelope A specifications and then transferred in two separate transfers to the WTP.

The activity boundaries for the Class 3 LAW feed delivery process from 241-AN-105 are shown in Figure 2-8. This figure shows the expected activities to accomplish the various feed delivery functions. Activities have been circled to show the grouping for quantification purposes. Table 2-3 shows the activities with their associated no-problem/no-failure times and how they are modeled within the RAM model. A description of the basic activities follows.

Decanting

Decanting the waste involves transferring the supernatant from tank 241-AN-105 to tank 241-AN-102 using in-line dilution. Tank 241-AN-102 serves as an interim waste staging tank, where samples are taken for final certification to meet delivery specifications. Appendix G, Table G-1, shows estimates of waste volumes involved in the decanting

operations, based on the process flowsheet (Orme 2000). Based on the flowsheet, approximately 790,000 gallons are decanted to 241-AN-102.

Salt Sludge Dissolution

The remaining salt sludge solids within tank 241-AN-105 are dissolved by the addition of raw water followed by a 24-hour mixing period. The RAM analysis assumes that waste temperature limits as outlined in the FSAR (CHG 2000b) will not be exceeded by this mixing operation. This is also consistent with the current draft of the process flowsheet.

Mixing and Sampling

The waste in both tanks 241-AN-102 and 241-AN-105 will be mixed for a short period to and then sampled for final feed specification qualification.

Feed Delivery

Once the waste has been certified to meet specifications, the contents of each tank will be transferred to the WTP LAW feed receipt tank according to the transfer schedule. This is accomplished in one batch transfer for each tank with no further dilution.

Maintain Safe Storage

Safe storage functional requirements are maintained at all times. This includes monitoring tanks for leaks, level, temperature, pressure, and other parameters. Other safety support items are those components that must function in the background to remain compliant with the safety basis published in the FSAR (CHG 2000b). These components operate at all times, and if they fail, may delay schedule-related activities that are underway.

Support Utilities

Support equipment includes those systems that provide general utilities and services to allow other major items to function but do not necessarily provide a safety function. For this analysis, this includes electrical supply, raw water, process air, and instrument air. It is conservatively assumed that these systems must operate at all times, similar to safety support equipment. If they fail, may delay schedule-related activities that are underway.

2.2.4.2 *Hardware Required for Class 3 (241-AN-105) LAW Feed Delivery*

This section provides a brief system description for completing Class 3 (241-AN-105) LAW feed deliveries, maintaining safe storage, and providing supporting utility needs. Figure 2-9 provides an overview of the system configuration.

Waste Transfer System

The waste transfer system consists of the following:

- *Transfer Pump* – Tank 241-AN-105 will be equipped with one 60-hp transfer pump capable of pumping tank waste at 140 gallons per minute through a flexible intake. This pump provides the motive force for transporting waste materials from one tank

to another. It is mounted in the central pump pit with a shaft and impeller unit extending into the tank. The pump is equipped with a flexible suction intake that allows positioning of the pump intake at a level that avoids transferring solids during the initial saturated supernatant decanting. The intake is positioned with a winch and cable assembly mounted above the central pump pit. The pump is equipped with a variable frequency drive and performance monitoring equipment. It is also monitored and controlled by the master pump shutdown system. The transfer pump has a connection to the flush/dilution system to support flushing the pump after use, delivering flush solutions into transfer lines after completed transfers, and performing in-line dilution. The pump is supported by the electrical system for motor drive and nitrogen system for pump seal containment.

- *Valving* – Transfer system valves provide the means to contain waste and route it to the intended location. They also support the controlled movement of flushing and dilution fluids within the transfer system. Valves are primarily three-inch ball valves and may be either manual or motor-operated. The valves are equipped with position switches and/or indicators mounted above grade. MOVs may also be operated manually if the motor should fail. The transfer system valves are connected to the master pump shutdown system to monitor misrouting of waste should they inadvertently change position. MOVs are supported by the electrical system.
- *Piping* – Transfer system piping consists of three-inch carbon and stainless steel pipe runs in lengths near 3,500 feet, and pipe jumper segments within process valve pits. Jumper segments provide the mechanism to connect transfer pipe runs to transfer system components, flush/dilution system components, and other jumper segments through the use of jumper connectors. The piping system provides the confinement and route control mechanism to transport waste materials and flush/dilution fluids throughout the transfer system. Piping outside of valve pits is double contained with leak detection capability. Within valve pits, jumpers are single wall segments with the pit itself acting as the secondary containment. Within jumper segments there are various process control interfaces such as flow meters, pressure sensors, rupture disks, and densitometers. Piping for supporting systems is modeled as belonging to those systems.
- *Mixer Pumps* – Tank 241-AN-105 is provided with two mixer pumps. The mixer pumps provide the mechanism for mobilizing and dissolving solids within the tanks. Each pump is provided with a 300-hp motor and turntable assembly mounted above the tank. A shaft and impeller unit extends into the waste with the intake seven inches above the tank bottom and the discharge unit centered approximately 17 inches above the tank bottom. The pump has the capacity to discharge at 5,000 gallons per minute through each of two nozzles. The turntable assembly allows the pump to be rotated so that complete mixing can be achieved. During operations, the mixer pumps are monitored for vibration, bearing temperature, motor speed and amperage, and nozzle position. The 241-AN-105 mixer pumps are operated and monitored from a remote location in building 241-AZ-156. They do not directly interface with other primary systems and are not connected to the master pump shutdown system. They are supported by the electrical system for motor power and monitoring and the flush dilution system for filling the pump column with filtered water and for seal containment.
- *Dilution/Flush* – The AN flush dilution system is the same system used for the AZ tank farm and is described in Section 2.2.3.

Confinement System (Specific to LAW Feed Delivery)

The confinement system is composed of the 241-AN-105 and 241-AN-102 tanks and their associated pump pits. Also included in this system are the valve pits along the transfer path. As with the HLW system, the confinement system is meant to address liquid waste confinement, and the HVAC system is not included here. Conductivity probes designed to detect fluid on the floor of the annulus provide leak detection for the primary waste storage tank.

Ventilation System

The ventilation system consists of the following:

- *HVAC Primary* – The 241-AN-105 primary HVAC system maintain air flow through the tank to control radiological air emissions and serves as the primary motive force for removing heat from the dome space of the tank. The primary ventilation system consists of individual tank air inlets and filters, redundant primary exhaust fans and filter banks, and an exhaust stack with radiological sampling equipment. The fans and filter banks provide an automatic switchover redundancy capability in case of a loss of one train of exhaust. All waste disturbing activities such as mixing and transfers are also halted upon loss of primary HVAC.
- *HVAC Annulus* – The AN farm annulus HVAC system provides a radiological emissions function should a leak into the annulus occur.

Instrumentation and Control

Instrumentation and control consists of the following:

- *Monitoring Instrumentation* – The I&C system provides monitoring capabilities within the tank system for safe storage capabilities. This primarily includes waste temperature and tank pressure, and leak detection, radiation monitors, flammable gas monitors and tank level monitors. All monitors and detectors are monitored from a central control station or farm-specific control building. The leak detection system interface with the transfer system also provides an input to the master pump shutdown system.
- *Monitoring and Control (Process)* – The monitoring and control system contains process-related instrumentation related to the transfer of waste materials. This includes flow meters, pressure monitors, rupture disks, and densitometers. These indicators are monitored from either a central control room or a farm-specific control building.

Utility Systems

The following utilities are modeled in the preliminary RAM analysis. When a utility component is an integral part of a supported system and supports only that system, such as a service water connection to a mixer pump, the individual components are modeled as part of the supported system. Components within the utility systems that support multiple systems are modeled as part of the basic utility supply function. An example of this type of component would be the service air compressors.

Utility System	Systems Supported
Electric Power	All Systems
Instrument Air	I&C; Ventilation; Monitoring Instrumentation
Nitrogen	Transfer Pump
Process Air	Instrument Air
Raw/Service Water	Flush/Dilution Mixer Pumps

2.2.5 *Definition of Quantitative RAM Model Scope*

2.2.5.1 *Activities and Equipment Included*

A graded approach is used to focus the quantification on equipment and activities that influence the system's ability to deliver waste to the WTP within the specified timeframe. Activities and equipment that satisfy the following criteria are quantitatively modeled in the preliminary RAM analysis:

- "Front line" equipment in the transfer path that performs specific functions during the transfer process.
- Support systems that must be available in order for the front line equipment to function successfully, as delineated in Section 2.2.2, 2.2.3, and 2.2.4.
- Process control activities, including equipment, instruments, and operator actions, for which an associated failure or error will lead directly to shutdown of a time-critical function.
- External SSCs and signals that must be verified to be operating in order to justify acceptable conditions for operation. Equipment and activities not directly associated with the transfer, but that are judged to have more than a negligible impact on the schedule and are under the responsibility of the TFC Operations and Maintenance organizations. However, it is assumed in the preliminary RAM that double valve isolation will be in effect since an amendment to the current authorization basis allowing its use has been submitted for approval. Consequently, failures and spurious signals in leak and level detectors not directly associated with the transfer will not require shutdown of waste transfers and are not included in the preliminary RAM model.
- External events that prevent operations and/or recovery activities from proceeding at the planned rate.

The analysis does not explicitly model individual components of systems that are not under the control of TFC Operations and Maintenance organizations. However, it does recognize the potential influence of these systems by assessing their overall availability to provide necessary support to TFC systems.

2.2.5.2 *Human Actions Explicitly Modeled in the Preliminary RAM Analysis*

Human error rates are explicitly modeled if they can cause the system to be shut down for a significant period. These generally occur if the system transitions into an irretrievable failed state that requires some explicit action outside the normal procedure recovery. The duration of the no-problem/no-failure scenario accounts for human errors that can be caught and corrected before such a transition occurs.

The exact operational activities have not yet been developed. In their absence an initial draft procedure for LAW transfers was used as the general model for human error impacts. The values obtained during this analysis were also applied to the HLW transfer since the greater number of activities required for LAW qualification and delivery make it a bounding case.

Examples of errors that are explicitly modeled in the preliminary RAM analysis include:

- Misalignments not corrected before a transfer begins, resulting in waste being transported to the wrong location.
- Actions that cause a limiting condition for operation (LCO) to be violated.
- Actions that cause false alarms when an LCO is not violated, but must be investigated and cleared, if warranted by historical data.
- Actions that cause transfer equipment failure or unavailability.

Those actions retained for quantification are listed in Appendix D, Tables D-2, D-3, and D-4 of Appendix D for Classes 1, 2, and 3 waste feed delivery activities, respectively.

2.2.5.3 *Activities and Equipment Not Explicitly Quantified*

The graded approach identifies activities and equipment for which there is sufficient flexibility and resources built into the organization to handle both normal and anticipated off-normal conditions without impacting the overall mission. Typically, these activities can be performed in advance of a critical operation. If off-normal conditions are detected, resources can be made available to address the situation and complete the task without impacting the schedule or workload requirements of the site. In other words, these activities are not time and resource critical. Therefore, it is assumed that failures and off-normal events during these activities will have insignificant influence on the RAM figures of merit that relate to the risk of schedule delay.

Activities screened from explicit quantification during quantitative analysis are listed in Tables 2-1, 2-2 and 2-3 for source tanks 241-AZ-101, 241-AN-105 and 241-AN-102, respectively. They are divided into two groups, (1) those within the responsibility of TFC, which are not time-critical, and (2) those outside the responsibility of TFC.

Many activities within the responsibility of the TFC could indirectly impact schedule delay. Even though activities and equipment may be classified as not time-critical, the effort required to accomplish them is identified. In addition, the bounds of failures and off-normal events that are screened from quantitative evaluation are recorded.

"Boot strap" transfers to qualify waste for one of the transfer envelopes are not quantified as part of the analysis. Opportunities exist for preparing, conditioning, and pre-staging waste can begin far ahead of the formal transfer activities defined in this analysis. Thus, they are currently judged to fall into the "not time-critical" category described below. Currently, a wide variety of boot strap transfer strategies are being considered, and as the baseline quantification of the HLW and LAW tank transfers is refined, the influence of the boot strap transfers on the feed availability efficiency will become more evident. If warranted, selected boot strap transfers can be added to the RAM quantification as the retrieval strategy matures.

2.3 Implementation of the Preliminary RAM Analysis

2.3.1 Development of the RAM Computer Model

The RAM model consists of a number of different tables linked together in the Microsoft® Access relational database and associated Microsoft® Excel spreadsheet tables. Each table of the model focuses on a separate element of the RAM evaluation. The development of these elements is outlined below. Figures 2-10 and 2-11 illustrate the general structure of the model and identify the major structural elements. Appendix A also provides example tables of output from the RAM model.

2.3.1.1 Classification of Facility SSCs and Process Activities

The first step involves reviewing the transfer schedule activity logic diagrams developed for the waste transfers of interest in this study. The transfer activities are then discussed with key process engineers involved with the design of the transfer systems to identify those required for waste transfer activity success.

Piping and instrumentation diagrams (P&IDs) for these systems provides the process flowpaths and identified key support system interfaces required for waste transfer success. The P&IDs associated with the target transfers are the primary source of information for the unique components table, which contains basic descriptive data identifying all the unique systems and components associated with the transfers. Selected fields from these tables are reproduced in Appendices E, F, and G as part of the system breakdown and individual component CILs.

Within the RAM database, two tables reflect the information in the P&IDs.

- PandID table records the component information contained on the P&ID,
- PandID System table records the assignment of the components to a system breakdown structure established by the RAM analysis team to assist in determining their functions for the various WFD activities

The content of these tables and definitions for their data fields are described in Appendix A.

2.3.1.2 *Development of Mission-Related Off-Normal Events and Their Effects*

Once the overall system and its components are defined, the next step involves defining the major activities required to complete the particular feed delivery activities. A major activity establishes the mission boundaries within which the major elements of the system perform different sets of well defined functions. The objective of establishing major activities is to establish the points at which the participation of the various systems change, so that the duration of specific mission functions can be estimated and the effects of component failures can be logically established. For example, during mixing operations, the mixer pump and its associated support and instrumentation must work, as well as safe storage systems such as ventilation and confinement. However, the transfer pump does not participate. The mission profiles for each of the tanks summarized in Section 2.2 are a result of the major activity definition process.

The next step involves developing tables linking the system elements to the respective transfer activities and determining if they perform a function whose failure could result in delay during a given activity. To accomplish this, the PandID and PandID System tables are linked and sorted by system breakdown structure. Then the functions of each system for that activity are examined from the top-down by asking what each system, major element, and sub-system did to contribute to that activity. A person experienced in the operation of tank farm system participates in this process. Based on the discussion of how these functions are accomplished, the effect of the failures of sub-systems and the components within them can be readily identified.

The component failure effects analysis is accomplished by entering judgments into two fields for each activity.

- The Applicable for Delay field is a YES/NO logic field, which simply records whether the failure of the component would cause a delay in the activity. As many subsystems on the P&IDs are not critical to various activities and would not stop that activity, a NO answer eliminated it from the RAM model for quantification of schedule delay of that activity. (Note, however, that if the component is performing some non-critical function and fails, it will generate the need for corrective maintenance at some time in the future. The failure effects evaluation within RAM model would have to be done a second time to address this O&M resource allocation question.)

- If the answer to the Applicable for Delay field is a "YES," the FC field assigns a function code that relates what the component is expected to do during that activity. The function codes link to the failure modes that can interrupt the mission being performed by the component. Function codes are assigned by component type and the physical activity it accomplishes. The functions are both active (e.g., pump fluid, operate to sense parameters) and passive (e.g., maintain integrity, structurally support). The function codes defined for the preliminary RAM model are presented in Table 3-1 and discussed further in Section 3.1.1.

Once the mission requirements and the hardware needed to complete the mission requirements are identified, the role of the human in operating the equipment is evaluated, and individual failure modes added to reflect the off-normal events that can be generated by human error. The evaluation of human actions is discussed in Section 3.4, with the results presented in Appendix D. Within the RAM model breakdown structure, human actions carry a system classification of "Human" so that

they may be distinguished from hardware failures. The system breakdown below that level provides information on where and when the human error is taking place.

External off-normal events that can generate stoppage of WFD activities are entered into the RAM model structure in a manner similar to human actions. In this case the system classification is "External Events" with the system breakdown providing information on the type of event generating the delay. The evaluation of external events is discussed in Section 3.5.

2.3.1.3 Accounting for Backup Trains and Recovery Without Creating a Schedule Delay

The tank farms systems, most notably the primary ventilation systems, contain redundant trains to maintain selected ventilation and cooling functions should a failure occur in the active train. The preliminary RAM model accounts for this capability through the use of a "Failure of Backup" factor that addresses the question, "If this failure mode occurs, what is the likelihood that it will produce a delay?" When backup is not available, the answer is "1" or a guaranteed delay. When backup is available, the factor will be below "1" and reflect the failure of the backup to align and complete the mission. The use of the backup factor in the calculation of frequency of delay events is discussed in Section 2.3.2.

2.3.1.4 Generation of Quantification Tables

When all the information regarding the mission are entered into the database, a series of queries link the database tables to generate a quantification table for export to an Excel spreadsheet. One quantification query is generated for each major activity needed to accomplish the activities for a particular waste class, corresponding to those activities defined in Section 2.2 for each representative source tank. The breakout of the quantification tables is discussed in detail in Appendix A.

Each spreadsheet is then individually quantified to determine individual (based on mean values of failure rate and recovery duration) off-normal event failure frequencies and associated expected transfer time delays. The off-normal event frequencies and expected time delays are then summed to create the overall transfer delay frequency and expected total delay time. These quantification tables in Microsoft® Excel are then imported into the Microsoft® Access databases to facilitate easy analysis of grouped results (i.e., the activity type, system type, component type, and EIN group results) for custom CIL development.

2.3.1.5 Simulation of Qualification and Transfer Activities

The completed quantification tables formed the basis for the simulation of schedule delay. The failure frequency, fraction of failures impacting schedule delay (see Section 2.3.3), and restoration time distribution associated with every off-normal event are exported to a spreadsheet for simulation. The simulation process is discussed in detail in Section 2.4.

The layout of a simulation follows the activity logic established for each source tank established in Section 2.2. Delay events are generated using a random number generator within each major activity. The total number of delay events and the resulting schedule delay for each simulation trial is collected in a series of forecasts in a summary

sheet, such as that illustrated in Table 2-4, which was taken from the 241-AN-105 simulation file.

Table 2-4 contains two sub-tables. The top sub-table shows both the results of the model quantification with mean values of schedule during each activity and the values returned for an individual trial of the simulation. The forecast function of Crystal Ball collects these trial values to produce the distributions seen in Section 5. The bottom sub-table shows the capability of the simulation to calculate impact on project schedule. The start date for each successive schedule activity occurs on the later of either the simulated completion of the predecessor activity, or upon the availability of resources, as reflected in the current P3 schedule. The distribution of milestone dates can also be tracked using Crystal Ball forecasts.

2.3.2 *Delay Time of Off-Normal Events*

The basic formulation for calculating the delay time of off-normal events is the triplet formulation of risk, which is answered by addressing three questions:

1. What can go wrong? The answer to this question describes an initiating event, the off-normal condition it produces, and the resulting activities needed to recover to an acceptable state. In this preliminary RAM evaluation, the recovery involves returning to a point where progress toward delivery can again move forward. The off-normal condition is described in sufficient detail to estimate the time and effort needed to recover. The most common off-normal events are hardware failure, external events that damage the system or make conditions unacceptable for work, human error, and the discovery of discrepancies between anticipated and actual process performance. For this preliminary RAM analysis, the answer to this question is provided by the FMEA for each transfer activity.

2. What is the likelihood that it could go wrong? The answer to this question depends on the type of event. For hardware, it is answered by determining the exposure of the hardware to potential failure modes and using historical performance data for the type of hardware regarding failure rates to calculate a failure frequency. The estimation of the frequency of other events follows similar reasoning, but the evidence supporting the estimation of occurrence frequency tends to be inferential and more uncertain. These events are usually addressed using risk analysis techniques tailored to the potential events being considered.

3. What are the consequences of it going wrong? The primary measure of consequence used for this preliminary RAM analysis is schedule delay resulting from the actions needed to recover so progress toward waste feed delivery can continue. (It should be noted that a variety of consequences can be evaluated. For example, health effects and environmental damage are two consequences that are important in safety analyses and obtaining permits for operation.)

The expected number of hardware failures and the resulting total delay time is calculated directly in the preliminary RAM analysis, based on four parameters that are determined for each failure mode event.

Four quantitative parameters describe a specific off-normal (basic) event:

E Magnitude of the exposure of a component or person to a given failure mode as they participate in an activity (expressed as either demands or hours).

λ Rate at which the failure mode can be expected to occur (expressed in units of per-demand or per-hour).

P_D Probability that the off-normal event will produce a schedule delay event , P(Failure of Backup)

T Time required to recover from the off-normal event and accomplish the actions necessary to bring the system back to a state at which scheduled transfer operations can resume.

The first two parameters calculate the frequency (F_{event}) of off-normal events for the activity due to the failure mode.

$$F_{event} = (\lambda)(E) \text{ per activity}$$

The third parameter, P_D, models the effect of redundancy and/or flexibility to respond to failures provided by technical specifications. The tank farms systems, most notably the primary ventilation systems, contain redundant trains to maintain selected ventilation and cooling functions should a failure occur in the active train. The preliminary RAM model accounts for this capability through the use of a "Failure of Backup" factor, P_D, that addresses the question, "If this off-normal event occurs, what is the likelihood that it will produce a delay?". This factor represents the results of an AND gate in a fault tree system logic format, or an additional branch in an event tree logic format. The answer to the question above is equivalent to the failure of the backup train to align and complete the mission. Within the context of the preliminary RAM, four potential backup conditions can be modeled:

Condition	Interpretation	Contributors to "Failure of Backup"
No Backup Available	Given an off-normal event occurs, a delay will result	Failure Likelihood = 1 (Guaranteed Delay)
Automatic Switchover to Parallel Train	Delay will occur if realignment and startup of redundant train fails.	Sum of (OR gate) 1) Failure modes that could fail during transition. 2) Common cause failures that make the backup train unavailable.
Manual Switchover to Backup Train or Function	Delay will occur if switchover is not successfully completed within a specified time limit.	Sum of (OR gate) 1) Failure modes that could fail during transition. 2) Common cause failures that make the backup train unavailable. 3) Likelihood human will fail to accomplish switchover within time limit.
Components with Allowed Outage Times	Delay will occur if condition is not cleared or repaired within time limit.	Sum of (OR gate) 1) Failure modes that can not be cleared or repaired within time limit. 2) Likelihood human will fail to clear or repair within time limit.

The product of the frequency (F_{event}) of off-normal events and the "Failure of Backup" factor, P_D produces the frequency of delay events for the activity due to the failure mode.

$$F = (F_{event})(P_D) = (\lambda)(E)(P_D) \text{ per activity}$$

F is unit-less mathematically, but represents the probability or relative frequency that the failure mode being evaluated is expected to occur per performance of the associated schedule activity evolution. The term "relative" is used because units of λ and E are coupled and depend on the failure mode being analyzed. For example, if we are quantifying the relative frequency of a valve failing to open on demand, then the units of λ are failure events per demand, and the units of E are demands per activity. If we are quantifying the relative frequency of a pump to run for its specified mission time, the units of λ are failure events per operating hour, and the units of E are operating hours per activity.

Depending on the off-normal event and the resulting physical, environmental, and management-related conditions, schedule delays of varying length and uncertainty may occur. The duration of the additional time needed to recover from the off-normal event is influenced by conditions affecting the ability to work productively, availability of spare parts, maintenance resources, etc. For example, if the waste transfer process is interrupted by one type of equipment failure, repair or replacement of that equipment may be required. If it is located in a valve pit, considerable effort is required to gain access and protect personnel during the recovery. For other equipment failures, an option may be available to revert to a backup system or alternate means of delivering the required waste. This can reduce the time needed to resume the process considerably.

Since time will be required to recover from every failure or off-normal event, the expected delay (D) caused by that event is equal to the relative frequency of failures times the associated restoration time. This expected delay time (generally expressed herein in units of hours) is calculated using the following equation:

$$D = (F)(T).$$

The four input parameters for the expected delay time are directly tied to the process definition and system design.

- The exposure to failure reflects the hazards associated with the process strategy, the configuration of the system that will accomplish the required activities, and the capability of the SSCs participating in the process.

- The failure rate is directly related to the design of the SSC and the conditions under which it will operate.

- The probability of schedule delays, given an off-normal event, is related to the redundant system configuration and its mode of operations.

- The time required to restore reflects the response capability that is being provided by the O&M Concept. The primary metric developed by this analysis is the expected delay time due to equipment failure, human error, and external events during the

activities required for waste batch transfer. The expected delay time is the amount of time TFC management can anticipate the minimum transfer time period to be extended beyond the "no-problem/no-failure" time estimated via calculation of waste volume divided by pumping rate, plus any additional required waste transfer evolution time.

2.3.3 *Dynamic Calculation of Exposure and Shadowing Factor*

In practice, in the current preliminary RAM models developed to support the prediction of potential waste transfer delay penalty risk, refinements are made to the exposure of hardware to failure. Specifically, the exposure, E, is dependent not only upon the initial no-problem/no-failure time and equipment demand profiles, but also what happens during recovery. When SSCs must continue to operate during recovery, the delay time adds to their exposure to time-related failure modes. If SSCs are shut down during the recovery, the requirement to restart increases demand-related exposures. Therefore, an iterative calculation must be performed in the RAM model to adjust E based on predicted delaying event occurrence and associated delay time.

An example of this requirement arises when an HVAC fan is required to run continuously to support safe transfer and storage operations, and a failure of another component delays the transfer pumping operation (for instance, a transfer pump failure). Since HVAC continues to operate during recovery, this requires the HVAC fan to run longer than the activity's no-problem/no-failure run time, thus extending its total exposure to run time failure. Similarly, when a spurious leak detector alarm occurs and halts the transfer process while troubleshooting and repairs are performed, the transfer pump is required to be shut down and restarted upon completion of leak detector repairs or recovery, thus increasing the transfer pump demands for that transfer cycle. This iterative impact on modeled exposure, called "dynamic exposure," is taken into account in the current RAM model quantification calculations.

The dynamic exposure for a component failure mode can be characterized by the following equation:

$$E = E_p + E_o + E_a$$

In this equation,

E_o is the exposure directly associated with the original no-problem/no-failure time or demand profile associated with the activity of interest.

E_p accounts for the exposure prior to the start of the activity of interest during which the failures of an SSC can result in a delay of the initiation of the activity. Systems that have been operating immediately prior to the first activity included in the RAM model are candidates for use of E_p in order to capture potential delays. For these components, E_p is estimated to be equal to that one-half failure mode's mean time to restore time. This reflects the judgment that some portion of the recovery will be accomplished before the activity in question has to start. In cases where a basic event has no exposure other than during the activity of interest, such as systems that are started up for the activity, E_p is zero.

E_a is the additional exposure incurred by SSCs that must continue to operate while the mission activity is being restored, or must be realigned or restarted to resume the mission activity.

Because recovery activities can proceed in parallel, there is also a "shadowing effect" associated with multiple equipment failures during a waste batch transfer process. Demand failures are generally associated with pump starts or valve alignment demands directly associated with the waste transfer activity and thus have a direct delaying effect on the transfer. Therefore demand failures are not shadowed. However, "running" failures may be shadowed by other failure recoveries. For example, if a continuously running HVAC fan fails during the recovery from a transfer pump failure, that fan failure does not cause a critical path delay of the transfer process while restoration can be accomplished in parallel with the recovery of the pump.

Although shadowing can occur, the evaluation of preliminary results has led to the decision to not take credit for shadowing in the Revision 2 RAM model. This was done for several reasons;

- A major contributor to the number of delay events is external events. It is highly unlikely that recovery actions can proceed while an external event is causing a cessation of other activities.

- The ability to accomplish parallel recoveries may be resource limited. In addition, the occurrence of one failure may result in local conditions that prevent the capability to work safely on a second failure.

- Recoveries are shadowed only when they actually overlap. The evaluation of the number of internal delay events indicates that not many events are expected to occur during any given transfer. As the shadow factor model assumed that there would "always" be some overlap (based on expected value calculations), it is judged that the use of the shadow factor is non-conservative.

Since additional exposure will result in additional failures, the calculation of dynamic exposure is iterative. Failures due to no-problem/no-failure activity exposure produce an expected delay time. This delay time produces additional exposure, resulting in more failures, whose delay times propagate to the next iteration. For the calculations herein, the iterations were stopped when schedule delay time changed by less than 0.01 hours between steps.

2.3.4 Generation of Critical Items Lists

Because the two primary metrics, F and D, are developed for each component failure mode, they can be sorted and/or summed in a wide variety of ways. Summing the relative failure frequencies for all the failure events that might occur in all components participating in all transfer activities produces expected total number of off-normal events per complete transfer evolution, which is the first consolidated RAM metric. Summing the expected delay for all the failure events will produce an estimate of the total expected schedule delay over the complete set of transfer activities, which is the second consolidated RAM metric. From the data used to calculate the expected delay time, one may also categorize the expected delay time by specific component, component type

category, or TFC waste transfer schedule activity category. The expected delay time metrics are primarily used to focus management attention on components and component types that contribute significantly to TFC waste transfer schedule delay.

In addition to the "absolute" metrics defined above, the individual basic event metrics are divided by their respective transfer total sums to create two relative metrics: "frequency fraction" and "delay fraction." These metrics provide a measure of the relative importance of each basic event. Other relative importance metrics can similarly be calculated at higher levels of indenture in the model (i.e., for component EINs, component type categories, system type categories, schedule activity categories, etc.). This allows the formation of CILs using a decreasing value FOM ranking of items. The CILs provide valuable decision-making support, and are primary products of this preliminary RAM analysis.

2.4 Idle Facilities Figure of Merit

An FOM is a measure selected to evaluate and understand the effectiveness of a system for accomplishing a mission. This section describes the FOM quantified by the preliminary RAM analysis to validate the capability of meeting the waste feed delivery schedule. This FOM is defined to be:

> *"Risk that DOE will incur idle facility penalties for failing to deliver a batch of waste feed to the WTP operator, in accordance with Special Contract Requirement H.30 of the TWRS Privatization Contract" (Carlson 1999)*

The metric used to quantify the Idle Facilities FOM is based on a simulation of the batch transfers using the preliminary RAM analysis of WFDS activities for the three tanks. The metric is generated using the estimates of the duration of the planned O&M activities to accomplish the delivery, the likelihood of off-normal events that could interrupt and delay those activities, and the duration of recovery actions needed to resume the batch transfer. The specific success criteria are defined in Section 2.4.1, and successive sections show how the FOM is developed.

While this analysis was underway, the DOE cancelled the TWRS Privatization Contract and issued a new Request for Proposal for the design and construction of the Waste Treatment and Immobilization Plant. Since it is not known what new operating requirements might be placed on the operations of the WTP, the existing criteria in the TWRS PC will continue to be used as the primary FOM for this analysis. Although there are not likely to be financial penalties involved with idling the WTP, it should be noted that there will still be idle facility costs incurred. The idle facility costs will no longer contain the element of interest expense recovery that was a part of the original financial penalty calculations but will still encompass the costs of continuing plant operations while it is not possible to treat waste.

2.4.1 *Success Criteria for a Waste Feed Batch Transfer*

(Note: In the delineation of the ICD requirements below, except for the actual reference cites, the term "BNFL" has been changed to "the WTP operator.")

The success criterion for the Idle Facilities Penalty FOM was established in the System Specification for the Double-Shell Tank System (CHG 2000a). The criterion is:

> *"The integrated schedule risk associated with reliability, availability, and maintainability of the total hardware and operating and maintenance system used to accomplish preparation and transfer of feed batches shall not exceed 2 days per batch[1]." This criterion is annotated with the acronym TBR (to be refined).*

Waste feed is actually transferred to the WTP in batches that are keyed to individual waste transfer dates (WTD). Table 2-5 identifies and discusses in detail the terms of the TWRS Privatization Contract (DOE, 1998) and associated ICDs (BNFL 2000a, 2000b) that define a batch and the success criterion for completing a waste feed batch to the WTP. Based on the contractual documents, a batch is defined to be the quantity of waste feed of a given type and its associated diluent requested by the WTP operator, for transfer to its receiving tank at one time. The time is established by the WTD, which is requested in writing by the WTP operator and agreed to by DOE. A batch has been successfully transferred when (a) the planned quantity[2] of feed has been transferred to the WTP operator, (b) the transfer line flush has been completed, and (c) agreement has been reached between DOE and the WTP operator on the volume of waste transferred and received.

The acceptable window for delivery of a feed batch begins[3] on the WTD and ends 30 days later. DOE becomes susceptible to idle facility penalties if the WTP operator's facilities are idle due solely to DOE not completing the feed delivery transfer within this 30-day window.

The waste in high-level waste source tank 241-AZ-101 will be qualified and delivered to the WTP operator in a series of five deliveries. Each of the five deliveries is considered a batch for the purpose of delivering waste feed to the WTP operator, and each has the potential of producing idle facility delay penalties. Therefore, the sum of the integrated delay from all five batches constitutes the metrics of the FOM for the 241-AZ-101 source tank.

The waste in low-activity waste source tanks 241-AN-102 and 241-AN-105 will each be qualified and delivered to the WTP in two separate batches. Therefore, the sum of the integrated delay from both batches constitutes the metrics of the FOM for each LAW source tank.

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[1] The term "batch" as used in PHMC 1998a refers to the quantity of waste prepared in a waste feed cycle. A waste feed cycle consists of (1) preparing feed to meet specifications and (2) pumping prepared feed to the private contractor's facility. In this context, one batch refers to all waste delivered to the private contractor from one source tank. This is *not* the same as the definition of batch used in the ICDs.

[2] In general, it is possible to deliver less than the planned quantity of feed for a given batch and still satisfy the requirements in DOE's contract with the WTP operator and the corresponding interface control documents.

[3] The window actually begins on the later of the WTD or the date on which the WTP operator is actually ready to receive the feed batch. It is conservatively assumed that the WTP operator will be ready to receive the feed batch on the WTD.

2.4.2 *RAM Model Application and Interpretation in Regard to the FOM*

As stated previously, although the privatization contract has been terminated and contract penalties do not apply, the basis of the FOM and the metrics are still applicable because delays in feed transfer could still result in idle facility costs. The TWRS Privatization Contract, Clause H.30, Idle Facilities, states that the WTP operator would not be eligible for idle facilities payments until, (1) 30 days after the WTD specified in the contractors notice, or (2) the date the privatization contractor is ready to receive and process waste, whichever is later. For estimating idle facility penalties, it is assumed that the batch must be successfully transferred to the WTP operator by the end of a 30-day window that starts on the assumed WTD; the calculation of the FOM does not take credit for potential delays on the WTP operator's part.

Figures 2-11 and 2-12 illustrate the modeling process used to calculate the idle facility penalty FOM. The heavy lines at the top of Figure 2-11 reflect the nominal duration of the planned activities needed to complete staging, certification, and transfer activities, given there are no significant problems or failures during the required sequence of waste transfer evolutions. This duration is estimated by considering the tasks that have to be done and the constraints under which they must be accomplished, as described in Section 3.2. This duration is the same as the shortest duration that would be obtained from a project management schedule when the times to complete individual tasks are estimated without providing contingency for potential delays. It can be seen in Figure 2-11 that the nominal or "no-problem/no-failure" duration is split into two distinct parts: one for staging and qualification, and one for batch transfer activities. This results from the fact that no matter when waste is certified as a qualified batch, it cannot be transferred until the agreed-upon WTD.

In Figure 2-11, the "Planned Activity Schedule Duration" is shown at the top of the figure. Below that is shown an example "Impact of Off-Normal Events on Schedule" with two events occurring during the staging and batch qualification activities and a third event occurring during the batch transfer activities. Each off-normal event requires the expenditure of resources to recover to the point where progress toward completion of the activity can resume. The "Simulation of Off-Normal Events" can calculate the combined planned activity schedule duration plus the recovery time for the off-normal events associated with the particular trial. This is repeated many times to create a distribution of completion times for the combined planned activity schedule duration and recovery time for off-normal events.

The distribution of total delay that might occur during the qualification and transfer of waste from a given DST is developed by generating delay events based on the preliminary RAM analysis. First, the failure frequency and recovery time estimates of every representative off-normal event in the RAM model for the transfer activities are assembled into a set. Random sampling (Monte Carlo) techniques are then used to generate a group of delay events that might occur during the setup and transfer of one actual batch of waste feed. The sum of the recovery times from those failures produces the total delay for one batch transfer trial scenario. The total delay is then added to the nominal duration to obtain the total duration of the batch transfer, considering both normal and off-normal conditions. As this process is repeated, the simulation produces a series of scenario results that contain different combinations of events and resulting delays, three of which are illustrated in the lower part of Figure 2-11. When the simulation is repeated a sufficient number of times, a probability distribution of the

transfer activity duration is produced. This distribution is then compared to the time available to transfer based on the contractual schedule, as illustrated in Figure 2-12.

The development of the FOM used to validate the ability to meet the contractual schedule requirements is shown in Table 2-6 and described below:

- First, the total delay is obtained from a Monte Carlo simulation of every failure mode that might occur during the activities required to complete the mission. A random number is generated to determine whether each susceptible failure mode occurs during the trial in question. If it does, the recovery distribution associated with that failure mode is then randomly sampled to generate a delay associated with the failure. After all failure modes have been questioned, the delay times generated by the simulation are summed to produce the total delay for that trial scenario.

- The total delay is then added to the planned (no-problem/no-failure) completion date (here expressed as a number of days after the WTD) to obtain a completion date that accounts for delays. This completion date is compared to the WTD plus the 30-day deadline to determine if the trial scenario incurred penalty days.

- The number of days of penalty incurred for each trial scenario that resulted in completion of the batch transfer after the deadline date is multiplied by the probability of that scenario. The simulation accomplished for this document contains 10,000 transfer scenarios. If a given scenario produced a delay of 20 days past the delivery deadline, the contribution of that trial scenario to the FOM would be 20 days multiplied by 1/10,000 trials, or 0.002 equivalent "days."

- The equivalent "days" of delay past the delivery deadline generated by all the trials are then added together to obtain the integrated days referred to in the definition of the FOM. For example, in Table 2-6, two scenarios that are completed after the deadline combine to produce 0.0023 "days" of integrated penalties. The result is the expected number of penalty days that would be incurred per batch transfer, when averaged over a large number of batch transfers. It reflects the probability-weighted contribution of all delay events of various lengths to the total risk of idle facility penalties.

- When more than one waste feed batch must be transferred to empty a source tank, the penalty "days" from all the individual batches are added to obtain the overall FOM for the source tank.

Based on the initial criteria in the System Specification for the Double-Shell Tank System, a FOM of less than two" days" would validate the ability to meet the contractual schedule requirements for delivery of the waste contained in one source tank. The use of 2 days is an initial goal based on a preliminary estimate, which hypothesized that no more than one percent of the budget for Phase 1 (approximately $10 billion) should be paid as idle facility penalties. As a planning tool, the amount allocated for idle facility penalties was divided equally among 15 source tanks. When a $2.5 million penalty per day of idle facilities was assumed, it resulted in the allocation per source tank of approximately 2 days of delay. Although contract penalties are no longer a factor in planning, the 2-day FOM will be used as a reasonable criteria for validating the ability to avoid idle facilities costs until an alternate is defined.

The term "2-day delay" does not refer to the maximum acceptable delay, but to the statistical expectation of a vast combination of possibilities. The FOM for the WFD operations and the impact of off-normal events that have been identified are presented in Section 5.

2.5 Summary of TFC Waste Feed Delivery Key Bases and Assumptions

Table 2-7 contains a summary of the key bases and assumptions used in this preliminary RAM analysis. This table is cross-referenced to the appropriate section where the assumption is used. The table discusses the basis for the assumption and, where appropriate, the implications of the assumptions.

Table 2-1. Summary Description of Class 1 Waste Feed Delivery Activities (241-AN-102)

Activity code	Activity title	P3 schedule duration (days)	RAM NPNF duration (hours)	Tank Farm Safety and Support Function Hours/Comments	RAM delay contributor (yes/no)	Active NPNF Time (hours)	Active NPNF Pump Demands	Active NPNF Valve Demands	Remarks
AN-102 Batch Qualification Activities									
100.N51A	Obtain AN-102 Feed Certification Samples	5	96	96	Yes	96	0	0	All samples can be obtained in 4 days. Safety and support system failures can stop sampling activities. Assumes sampling to occur one year before WTD.
100.N51B	Analyze AN-102 Feed Certification Samples	270	6480	RAM failures do not impact schedule	No				Non-TFC activity
150.L25	Provide AN-102 Feed Batch Information to DOE-ORP	14	336	RAM failures do not impact schedule	No				
10S.N51	Provide AN-102 Samples to the WTP	7	168	Do not include in duration - parallel with other tasks	No				
100.NWTP1	WTP AN-102 LAW Certification Confirmation	60	1440	Do not include in duration - parallel with other tasks	No				Non-TFC activity
150.L30	Provide Approval to Deliver AN-102 Feed	30	720	RAM failures do not impact schedule	No				Non-TFC activity
		319 NPNF days							

Table 2-1. Summary Description of Class 1 Waste Feed Delivery Activities (241-AN-102) (Continued)

Activity code	Activity title	P3 schedule duration (days)	RAM NPNF duration (hours)	Tank Farm Safety and Support Function Hours/Comments	RAM delay contributor (yes/no)	Active NPNF Time (hours)	Active NPNF Pump Demands	Active NPNF Valve Demands	Remarks
Transfer Activities Pinned to the WTD for AN-102 LAW Batch									
150.L0X	Update AN-102 Waste Transfer Procedure	8	Parallel Activity	RAM failures do not impact schedule	No				
150.L35A	Perform Prerequisites for AN-102 Waste Transfer	5	120	Allow for failures of safety and support systems where recovery can delay the start of an O&M field activity	Yes	Safety/Support Failure Carryover	0	1	Most valves aligned during transfer preparations
150.L35B	Transfer AN-102 LAW Feed to the WTP (Batch 1)	4	81	81	Yes	81	1	1	A limited number of valves aligned just before transfer
			9	NPNF days					

Note: See section 2.2.2.1 for additional information regarding column heading descriptions

Table 2-2. Summary Description of Class 2 Waste Feed Deliveries Activities (241-AZ-101)

Activity code	Activity title	P3 schedule duration (days)	RAM NPNF duration (hours)	Tank Farm Safety and Support Function Hours/Comments	RAM delay contributor (yes/no)	Active NPNF Time (hours)	Active NPNF Pump Demands	Active NPNF Valve Demands	Remarks
AZ-101 Batch Qualification Activities									
16A64AX	Update AZ-101 Process Control Plan	3	72	RAM failures do not impact schedule	No				
16A64B	Mix AZ-101 Feed to Mobilize Solids	5	120	120	Yes	120 for each pump	1 for each pump	0	2 pumps operate for 5 days
160.A66	Obtain AZ-101 Feed Certification Samples	5	96	96	Yes	0	0	0	All samples can be obtained in 4 days. Safety and support system failures can stop sampling activities.
160.A68	Analyze AZ-101 HLW Feed Certification Samples	270	6480	RAM failures do not impact schedule	No				Non-TFC activity
160.A76	Provide AZ-101 Composition Results to TFC/ WTP operator	14	336	RAM failures do not impact schedule	No				
160.A74	Provide AZ-101 Separate Sample to the WTP	7	Parallel Activity	Do not include in duration - in parallel with sample analysis	No				
160.WTP	WTP AZ-101 Waste Certification Confirmation	60	Parallel Activity	Do not include in duration - in parallel with sample analysis	No				Non-TFC activity
160.A70	Provide Approval to Deliver AZ-101 Feed	30	720	RAM failures do not impact schedule	No				Non-TFC activity
			324	**NPNF days**					

Table 2-2. Summary Description of Class 2 Waste Feed Deliveries Activities (241-AZ-101) (Continued)

Activity code	Activity title	P3 schedule duration (days)	RAM NPNF duration (hours)	Tank Farm Safety and Support Function Hours/Comments	RAM delay contributor (yes/no)	Active NPNF Time (hours)	Active NPNF Pump Demands	Active NPNF Valve Demands	Remarks
Transfer Activities Pinned to the WTD									
16010A	Update AZ-101 Waste Transfer Procedure	8	Parallel Activity	RAM failures do not impact schedule	No				
16010B1	Perform Transfer Prerequisites for AZ-101 Waste Transfer	5	120	Allow for failures of safety and support systems where recovery can delay the start of an O&M field activity	Yes	Safety/Support Failure Carryover	0	1	Most valves aligned during transfer preparations
16010B2	Resuspend Solids in AZ-101 Using Mixer Pumps	1	24	24	Yes	24 hours for each pump	1 for each pump	0	24 hours of remobilization time followed by 19 hours of operation with transfer pumps
16010B3	Transfer AZ-101 HLW Feed to the WTP (Batch 1)	1	19	19	Yes	19 hours for each pump	1	1	A limited number of valves aligned just before transfer
16010B4	Perform Flush Operations for AZ-101 Batch Delivery	Within Transfer Duration	1	1	Yes	1	1	0	
			7	**NPNF days**					

Note: See section 2.2.2.1 for additional information regarding column heading descriptions

Table 2-3. Summary Description of Class 3 Waste Feed Delivery Activities (241-AN-105)

Activity code	Activity title	P3 schedule duration (days)	RAM NPNF duration (hours)	Tank Farm Safety and Support Function Hours/Comments	RAM delay contributor (yes/no)	Active NPNF Time (hours)	Active NPNF Pump Demands	Active NPNF Valve Demands	Remarks
Stage Supernate Batch to AN-102 Activities									
130.B25A	Update AN-105 to AN-102 Transfer Procedure	8	192	Do not include in duration - parallel with other tasks	No				
130.B25B	Perform Prerequisites for AN-105 LAW Transfer from AN-105	5	120	Allow for failures of safety and support systems where recovery can delay the start of an O&M field activity	Yes	Safety/Support Failure Carryover	0	1	Most valves aligned during transfer preparations
130.B25C	Decant AN-105 Supernatant to AN-102	5	111	111	Yes	111	1	1	A limited number of valves aligned just before transfer
			10	**NPNF days**					
LAW Salt Sludge Dissolution Activities									
130.B46A	Update AN-105 Process Control Plan	8	192	Do not include in duration - parallel with other tasks	No				Assumes startdate 2 months after mixer pump installation
130.B46B	Add Diluent to Tank AN-105	2	47	47	Yes	47	1	1	Flush/Diluent Pump
130.B46C	Mix AN-105 to Dissolve Salt Sludge	6	120	120	Yes	120	1	0	
			8	**NPNF days**					

Table 2-3. Summary Description of Class 3 Waste Feed Delivery Activities (241-AN-105) (Continued)

Activity code	Activity title	P3 schedule duration (days)	RAM NPNF duration (hours)	Tank Farm Safety and Support Function Hours/Comments	RAM delay contributor (yes/no)	Active NPNF Time (hours)	Active NPNF Pump Demands	Active NPNF Valve Demands	Remarks
AN-105 Supernate Batch Qualification Activities									
150.B49	Perform Mixing Operation in AN-102	1	24	24	Yes	24	1	0	Assumes sampling to occur one year before WTD.
100.N49A	Perform Certification Sampling of AN-105 LAW in AN-102	5	96	96	Yes	96	0	0	All samples can be obtained in 4 days. Safety and support system failures can stop sampling activities.
100.N49B	Analyze AN-105 Feed Certification Samples from AN-102	270	6480	RAM failures do not impact schedule	No				Non-TFC activity
150.B40	Provide AN-105 Feed Batch Information (from AN-102) to DOE-ORP	14	336	RAM failures do not impact schedule	No				
10S.N49	Provide AN-105 Samples from AN-102 to the WTP	7	168	Do not include in duration - parallel with other tasks	No				
100.WTP2	WTP AN-105 LAW from AN-102 Certification Confirmation	60	1440	Do not include in duration - parallel with other tasks	No				Non-TFC activity
150.B30	Provide Approval to Deliver AN-105 Feed from AN-102	30	720	RAM failures do not impact schedule	No				Non-TFC activity
			320	**NPNF days**					

Table 2-3. Summary Description of Class 3 Waste Feed Delivery Activities (241-AN-105) (Continued)

Activity code	Activity title	P3 schedule duration (days)	RAM NPNF duration (hours)	Tank Farm Safety and Support Function Hours/Comments	RAM delay contributor (yes/no)	Active NPNF Time (hours)	Active NPNF Pump Demands	Active NPNF Valve Demands	Remarks
AN-105 Dissolved Salt Batch Qualification Activities									
150.B50	Perform Mixing Operation in AN-105	1	24	24	Yes	24	1	0	Assumes sampling to occur one year before WTD.
100.N50A	Perform Certification Sampling of LAW in AN-105	5	96	96	Yes	96	0	0	All samples can be obtained in 4 days. Safety and support system failures can stop sampling activities.
100.N50B	Analyze AN-105 Feed Certification Samples	270	6480	RAM failures do not impact schedule	No				Non-TFC activity
150.B56	Provide AN-105 Feed Batch Information (from AN-102) to DOE-ORP	14	336	RAM failures do not impact schedule	No				
10S.N50	Provide AN-105 Samples from AN-105 to the WTP	7	168	Do not include in duration - parallel with other tasks	No				
100.WTP1	WTP AN-105 LAW Certification Confirmation	60	1440	Do not include in duration - parallel with other tasks	No				Non-TFC activity
150.B65	Provide Approval to Deliver AN-105 Feed from AN-105	30	720	RAM failures do not impact schedule	No				Non-TFC activity
			320	**NPNF days**					

Table 2-3. Summary Description of Class 3 Waste Feed Delivery Activities (241-AN-105) (Continued)

Activity code	Activity title	P3 schedule duration (days)	RAM NPNF duration (hours)	Tank Farm Safety and Support Function Hours/Comments	RAM delay contributor (yes/no)	Active NPNF Time (hours)	Active NPNF Pump Demands	Active NPNF Valve Demands	Remarks
Transfer Activities Pinned to the WTD for AN-105 LAW Supernate Staged in AN-102									
150.B44A	Update AN-102 to WTP Transfer Procedure	8	Parallel Activity	RAM failures do not impact schedule	No				
150.B44B	Perform Prerequisites for AN-105 LAW Transfer from AN-102	5	120	Allow for failures of safety and support systems where recovery can delay the start of an O&M field activity	Yes	Safety/Support Failure Carryover	0	1	Most valves aligned during transfer preparations
150.B44C	Transfer AN-105 LAW Feed from AN-102 to the WTP	5	112	96	Yes	112	1	1	A limited number of valves aligned just before transfer
			10	**NPNF days**					
Transfer Activities Pinned to the WTD for AN-105 Dissolved Salt LAW in AN-105									
150.B60A	Update AN-105 to WTP Transfer Procedure	8	Parallel Activity	RAM failures do not impact schedule	No				
150.B60B	Perform Prerequisites for AN-105 LAW Transfer from AN-105	5	120	Allow for failures of safety and support systems where recovery can delay the start of an O&M field activity	Yes	Safety/Support Failure Carryover	0	1	Most valves aligned during transfer preparations
150.B60C	Transfer AN-105 LAW Feed from AN-105 to the WTP	4	95	96	Yes	95	1	1	A limited number of valves aligned just before transfer
			9	**NPNF days**					

Note: See section 2.2.2.1 for additional information regarding column heading descriptions

Table 2-4. Summary of Simulation Results for 241-AN-105 Waste Feed Delivery Activities

RAM Model Calculations

Major Activity	Model Quantification Based on Mean Value Calculations		Results from One Simulation Trial			
	Frequency of Delay	Expected Schedule Delay (hours)	Number of Off-Normal Events	Number of Schedule Delay Events	NPNF Duration (hours)	Trial Schedule Delay (hours)
Pre-Staging	1.62	73.3	1	0	120	0
Staging	0.91	42.4	0	0	111	0
AN-102 Pre-Transfer	1.58	79.7	0	0	120	0
AN-102 Transfer	0.84	42.3	2	1	112	60
AN-105 Diluent Addition	0.37	11.4	1	1	47	4
AN-105 Mixing	0.56	25.1	1	1	24	2
AN-105 Pre-Transfer	1.56	77.0	2	2	120	33
AN-105 Transfer	0.71	30.9	3	2	95	151

Impact on Project Schedule

Activity Milestones	Results from One Simulation Trial					
	Earliest Resource Available Date	Begin Date	NPNF Duration (days)	Delay (days)	Total Duration (days)	End Date
Stage Supernate to AN-102	28-Mar-10	28-Mar-10	9.6	0.0	9.6	06-Apr-10
Certify AN-105 Supernate Batch in AN-102	02-Apr-11	02-Apr-11			225.1	13-Nov-11
Transfer Supernate Batch from AN-102 to WTP	01-Apr-12	01-Apr-12	9.7	2.5	12.2	13-Apr-12
Dissolve Salts in AN-105	01-Jun-10	01-Jun-10	3.0	0.3	3.2	04-Jun-10
Certify Dissolved Salts Batch in AN-105	22-Aug-11	22-Aug-11			198.2	07-Mar-12
Transfer AN-105 Dissolved Salts Batch to WTP	21-Aug-12	21-Aug-12	9.0	7.7	16.6	06-Sep-12

Note: Certification Duration is modeled with a normal distribution having a mean value of nine months and a standard deviation of 30 days.

Table 2-5. Source and Interpretation of Terms Important for Defining Batch Delivery Success Criteria

Term	Definition	Contract Reference and Interpretation
Batch	The quantity of waste feed and its associated diluent requested by the WTP operator for transfer to its receiving tank at one time.	For LAW and HLW, the contractor shall provide written notice to the DOE Contracting Officer specifying: 1) the type of waste requested, hereinafter referred to as a batch, and 2) the date the Contractor requests the transfer of the batch, hereinafter referred to as the waste transfer day (WTD). The written notice should be provided to the Contracting Officer 60 calendar days prior to the requested WTD. (Privatization Contract, Clause H.9e) The specific boundaries of LAW and HLW batches are not specifically defined, but clauses imply that a batch is the amount of material sent to the WTP operator at one time. (See citations listed for LAW and HLW.) Since the contractor receives both the waste feed in the staging tank and the flush solution added after transfer, the batch will consist of a mixture of both feed and flush solution. However, the qualification of the batch is certified before the flush solution is added.
LAW Batch	The LAW feed in one source (AN-105 first, AN-104 later) is pumped to two separate IWFST for qualification. LAW supernatant transferred to AP-102 for qualification and further transfer to AP-106 will constitute one batch. LAW dissolved salt sludge transferred to AP-104 for qualification and further transfer to AP-106 will constitute a second batch.	Additional batches (beyond the first feed batch of Envelope C) of LAW feed will be delivered in quantities of no less than 100 units of LAW. (ICD-19, Section 4.1.1, p. 3). The actual size and frequency of transfers will be arranged at the time of delivery. Interpretation: The contract is set up to provide guidance for all transfers. For the purposes of O&M Concept planning we are defining the batch size to be the total quantity of liquid transferred to the WTP in each batch delivered from each IWFST. This results in four batches.
HLW Batch	The HLW in AZ-101 will be transferred directly to the WTP receiver tanks in 5 batches.	DOE will deliver an initial feed batch (including flush water) of HLW slurry per Specification 8, High-Level Waste Envelope Definition, in a quantity of at least 600,000 liters, but no more than 675,000 liters, with an unwashed solids content of between 10 and 200 grams per liter. (ICD-20, Section 4.1.1) Multiple batch transfers of this certified HLW feed are allowed without re-certifying the feed. (ICD-20, Section 4.3.1, p. 7) Current plans indicate the waste in AZ-101 will be transferred to the WTP in five batches.

Table 2-5. Source and Interpretation of Terms Important for Defining Batch Delivery Success Criteria (continued)

Term	Definition	Contract Reference and Interpretation
Certification of a Batch for Transfer	DOE and the WTP operator must agree that the batch is acceptable for transfer 15 days prior to the WTD.	Both LAW and HLW: DOE provides a certification of conformance to appropriate waste envelope at least 30 days prior to WTD, and the WTP operator provides a written acceptance and authorization to DOE to transfer the batch within 15 calendar days of receipt of the certification documentation. (ICD-19 and ICD-20, Section 4.1.3, p. 5) LAW: DOE must certify that LAW meets specifications before each batch transfer. The WTP operator may observe the certification process. (ICD-19, Section 4.3.1, pp. 6-8) HLW: DOE is required to certify that the tank from which the batches will be drawn meet the appropriate waste envelope specification. However, if a batch of HLW is not within specification, the WTP operator will accept and treat out of specification HLW feed in accordance with contract Specification H.43, Processing Out of Specification Waste. (ICD-20, Section 4.3.2, p. 8)
Waste Transfer Day (WTD)	The WTD is the earliest day that the WTP operator will accept the transfer of the waste in a given batch into its receiving tank. It is formally agreed to in accordance with the appropriate ICD.	**ICD-19:** In accordance with contract Clause H.9, the WTP operator Inc. will provide written notice to the DOE Contracting Officer when requesting a transfer of LAW feed. The written request for LAW feed transfer will identify: (a) the type (LAW feed) of waste requested, hereinafter referred to as a batch, and (b) the date the WTP operator requests the transfer of the batch, hereinafter referred to as the waste transfer day (WTD). (Section 4.1.3, pp. 4-5) **ICD-20:** In accordance with contract Clause H.9, the WTP operator Inc. will provide written notice to the DOE Contracting Officer when requesting a HLW feed batch transfer. the WTP operator shall provide to the DOE Contracting Officer a written request that includes the available feed receipt tank volume (200,000 to 600,000 liters) of HLW feed and the desired WTD prior to the requested WTD. The WTP operator shall promptly notify the DOE Contracting Officer in writing of any changes to the WTD and the reason for the change. (Section 4.1.3, p. 5)
Criteria for Successful Completion of a Batch Transfer	A batch has been successfully transferred when: 1. The following is present in the WTP receiver tank: a) the entire amount of feed requested by the WTP operator and agreed upon by DOE, b) the specified amount of diluent added to it during transfer, and c) the WTP operator's share of the flush water used to clean the transfer line, and 2. Agreement has been reached between DOE and the WTP operator on the volume of waste transferred and received.	This definition of success criteria for a batch transfer are not defined in the contract documents. The two conditions stated here recognize that 1. Typically the WTP operator will request only that quantity of waste that it can accept, and that it will expect to get all of the requested quantity. 2. Material balance calculations have been completed and the WTP operator and DOE have reconciled any differences in the volume of waste transferred and received. The definition assumes that the batch will not be transferred if it does not meet minimum authorization basis and permit requirements established for the WTP facilities.

Table 2-5. Source and Interpretation of Terms Important for Defining Batch Delivery Success Criteria (continued)

Term	Definition	Contract Reference and Interpretation
Idle Facility Penalties	DOE becomes susceptible to idle facility penalties at the end of 30th day of the window during which the WTP operator will accept the transfer of the batch into its receiving tank.	*For any given batch, idle facility payment will not start until 30 days after the WTD specified in the contractors notice under H.9.G, or the date the contractor is ready to receive and process waste, whichever is later. (Contract Clause H.30).* For estimating idle facility penalties, it is assumed that the batch must be successfully transferred to the WTP operator by the end of the 30-day window that is started on the assumed Waste Transfer Day; we do not take any credit for potential delays on the WTP operator's part.

Table 2-6. Illustration* of the Calculation of FOM from Simulation Results for a Waste Feed Delivery Window of 30 Days

Scheduled Completion (days past WTD)	Simulation Delay (days)	Simulated Completion (days past WTD)	Penalty Days	Probability Weighted Penalty Days	Cumulative Risk ("Integrated Days")
3.5	46.5	50.0	20.0	0.0020	0.0020
3.5	6.1	9.6	0.0	0.0	0.0020
3.5	0.5	4.0	0.0	0.0	0.0020
3.5	29.5	33.0	3.0	0.0003	0.0023
3.5	24.0	27.5	0.0	0.0	0.0023
3.5	20.0	23.5	0.0	0.0	0.0023

*Note: This table is for illustration purposes only and does not depict actual results from the WFDS Preliminary RAM Model

Table 2-7. Assumptions Used in the Preliminary RAM Analysis

Category	RAM Doc. Paragraph	Description of Assumption	Basis	Implications for Waste Feed Delivery
Scope, Baseline Date	1.2	This version of the Preliminary RAM Analysis is based upon the technical and programmatic baseline that existed on October 1, 1999.	Although the design concept is evolving, a freeze point is necessary to establish a structure for developing the RAM analysis.	The baseline evaluates activities that completely empty a specific source tank following one alignment of installed equipment. This approach explicitly excludes fallback options to deliver waste through alternate alignments or from other tanks that might also contain qualified waste.
System Functional Capability	1.2	The system as designed is technically capable of performing the physical processes required to achieve the mission requirements of each activity. The system operational envelope is robust enough to respond to credible process transients and perturbations without suffering induced equipment failure.	The preliminary RAM requires that the design has the capability to assure their equipment is operating within its design envelope.	The preliminary RAM relies on the process engineers and system designers to specify the equipment and activities that are capable of performing the required mission. Documented system evaluation and testing is required to demonstrate this capability.
RAM Baseline Boundary	2.2	Batch certification process can be scheduled far enough in advance of delivery so any off-normal events occurring during certification do not have an effect on waste feed batch delivery activities.	Potential issues regarding sampling and certification (e.g., agreement on waste feed certification between operating organizations and DOE) could introduce delays that are beyond the scope of the current RAM analysis	This assumption is especially important for the first batch of each waste envelope, because issues regarding the interpretation of sample results will most likely arise at that time.
RAM Baseline Boundary	2.2	A fully manned and qualified O&M organization will be available to accomplish transfer operations as well as all necessary safe storage and support activities.	The preliminary RAM models the capability of the equipment meet the mission schedule requirements in delivering waste feed to the WTP. Manning requirements are determined as part of the O&M Concept development process.	Resource allocation will be an important part of meeting the schedule, but can be accomplished only when a more detailed definition of all WFD activities is developed.
RAM Front Line Systems	2.2.2.1 2.2.3.1	No-problem/no-failure exposures to failure modes are based primarily on the number and duration of the activities obtained from the Primavera schedules.		For components that change state during the activities (e.g., valves opening and closing, pumps starting, etc.) the number of demands considered the number of cycles that might be required during the operation.

Table 2-7. Assumptions Used in the Preliminary RAM Analysis (Continued)

Category	RAM Doc. Paragraph	Description of Assumption	Basis	Implications for Waste Feed Delivery
RAM Scope	2.2.4	The preliminary RAM analysis is not intended to be a complete assessment of the risk to the Waste Feed Delivery mission. It only addresses certain hardware, human reliability and external events during the operational phase of the mission.	This assumption was made to limit the initial scope of the RAM so that it could focus on "standard" RAM hardware failure modes common to many operating systems as well as human factors and external events. This forms a baseline for the development process. However, the structure of the RAM model can accommodate non-hardware uncertainties to address as needed any other sources of delay, which are being tracked in the risk assessment.	The RAM does not address programmatic risks such as (1) delays in the turnover of systems, structures, and components from projects to operations for beneficial use or delays in completion of readiness activities, (2) the risk that off-specification feed will be not be accepted by the WTP operator, (3) the risk that HAZOP or Safety Analysis of the planned operations may identify significant new controls, or (4) the risk of failure to deliver the required quantities of waste feed. A WFDS Risk Assessment was performed in 1999 to identify programmatic risks.
RAM Support Systems	2.2.4	The 241-AZ HVAC annulus system is required in order to start a transfer but its continuing operation may not be necessary to complete an ongoing waste transfer.	The WDOE has indicated its desire to leave the annulus CAMs operational as a verification mechanism for the annulus leak detector, which are the primary leak detection method. However, it was not worded as a requirement.	The 241-AZ annulus ventilation system will be made operational prior to its required use for waste feed delivery.
Backup systems availability	2.3.1	When backup systems can be employed to avoid delaying WFD operations, failure of the backup train to complete the mission is accounted for by a backup factor. The backup factor quantifies the failure to realign to the backup train and continue the function. However, once the alignment is successfully completed and the function continues, it is assumed that the backup train will complete the mission.	This is a simplification of the model to permit first order estimates. The RAM model includes both systems and produces an off-normal event when either fails, but assumes that common cause failures will not results in both failing at the same time. Independent failures at the same time are rare enough to ignore as a first approximation.	Repair effort to make a failed system is tracked separately from the time required to bring a function back on line.
RAM Failure Rates	2.3.1	The preliminary RAM analysis assumes that all equipment is properly designed for its intended application and environment, and that the technology will function at the assumed levels of performance.	Required to allow use of generic failure rates for the preliminary RAM estimates.	This assumption should be confirmed by testing of equipment during the development process. It should also be evaluated against the results of ongoing system assessments.
RAM Front Line Systems	2.3.3	The RAM analysis accounts for the requirement to restart following failures by increasing the number of demands associated with selected critical equipment, and the additional time of exposure by adding non-overlapping recovery time to components that continue to operate during recovery of other components..	For this quantification, the increase was based on assuming that a new demand is required every time a delaying failure occurs. This conservative approach was considered appropriate given the preliminary state of some of the designs.	

Table 2-7. Assumptions Used in the Preliminary RAM Analysis (Continued)

Category	RAM Doc. Paragraph	Description of Assumption	Basis	Implications for Waste Feed Delivery
RAM Failure Rate Development	3	All pipe and jumper segments were assumed to have an equivalent length of 50 feet for purposes of failure probability estimation.	The very low generic passive failure rates for pipe and jumper segments make the accurate estimate of length relatively unimportant. Lacking detailed information on specific piping segments, the analysis team used a graded approach to select a value of 50 feet as representative of the average of all pipes and jumpers.	
RAM Failure Rate Development	3.3	Generic component failure rates are taken primarily from SRS data for chemical systems, since these systems typically exhibit higher failure rates than similar water system.	Component failure data for Hanford events recorded in the JCS were very difficult to determine, as less than 3% of the corrective maintenance events had clearly encoded target components.	In order for the Hanford data to be used for component failure rate data development, a detailed event by event evaluation would have to be performed, at great expense and duration, far outside the scope of this analysis.
RAM Failure Rates	3.3	All required equipment is in "useful life" condition. The equipment has been properly tested or otherwise evaluated and found to satisfy its functional requirements and remains within its useful life span for the duration of its use.	Required to allow use of generic failure rates for the preliminary RAM estimates.	This assumption should be confirmed by testing of equipment during the development process.
RAM Failure Rates	3.3.1	The failure modes and effect data was obtained from the Savannah River Site or other generic databases; only the data for transfer pumps, weather, and external events is specific to Hanford.	Required because of the lack of consistent data from past activities that will be applicable to the WFDS production mode.	
Weather Related Delays	3.5	Seasonal variations in the probability of weather related delays were not considered; uniform annual frequencies were used.	At this stage of project development, uncertainty in future scheduled activities make consideration of seasonal variations less important than many other uncertainties.	
Recovery time, Basis for Estimates	4	Recovery from off-normal events is based on task analysis by maintenance personnel rather than historical recovery time evidence.	Hanford historical restoration time data was deemed inappropriate for direct use in this analysis, as it is a result of operating in a "safety-only" environment, where production schedule was not a major concern.	Under the new "production philosophy" environment of the WFD transfer operations, safety will still be paramount, but the O&M Concept will be designed to meet reasonable transfer mission accomplishment goals.

Table 2-7. Assumptions Used in the Preliminary RAM Analysis (Continued)

Category	RAM Doc. Paragraph	Description of Assumption	Basis	Implications for the O&M Concept
Resources, personnel availability	4	Staffing limitations do not impact estimates of either normal or off-normal activities. Specifically, personnel required to support the estimation of recovery times are assumed to be available, or can be readily recalled to duty, whenever an off-normal events occurs that requires their skills.	The initial estimates are being developed to identify requirements. Section 5 shows the peaking of resource requirements to accomplish WFD activities without schedule leveling. The use of P-3 for normal operations identifies COCS loading peaks for the specific activities being modeled.	Resource requirements for both normal and off-normal WFD activities will have to be superimposed on safe storage activities, as well as TFC mission commitments to ensure that commitments can be met commensurate with their priorities.
Maintenance, Corrective	4	Pre-approved "Corrective Maintenance" procedures are in place	Provides a basis for limiting the time required to prepare a corrective maintenance package. Preparation time focuses on final coordination of package.	Generic maintenance categories can be used as a starting point for maintenance planning actives during the next phase of project development
Maintenance, Corrective	4	Commercial Grade Item (CGI) "Like-For-Like" replacement practice can be accomplished without formal dedication requirements.	Verification that the part or component is a "Like-for-Like" (same OEM with same part/model no.) is all that is required. Verification of components are completed up front through review of existing design documents or in the field during replacement. Alternate components (brand X/brand Y substitutes) still require a design change and would still require formal dedication.	Safety Significant and Safety Class commercial grade items in use and that were part of the original design should NOT require a formal dedication process.
Maintenance, Corrective	4	Replacement component and spare parts fully identified prior to the operations.	Whether the component/part is warehoused on site or not, a full Bill-Of-Material (BOM) for every replacement assembly, component and/or part is available and accessible. This should be completed "up-front".	Each replacement component identified should include the OEM part number, local or OEM sourcing information, lead times and warehousing status.
Maintenance, Corrective	4	Corrective maintenance will be supported by dedicated craft technical (engineering) support	Avoidance of excessive planning delays requires individuals having the authority to implement minor changes to drawings/procedures/engineering files, identify/implement new and coordinate the condition based monitoring routines, insure adequate/appropriate tools and references are available and acts as a liaison between the craft and facility engineering.	An engineering support group that works with the craft on a day-to-day basis and reports directly to the 1st line supervisor can provide the required capability.
Maintenance, Corrective	4	Weather delays were implicitly considered in the estimation of the recovery distributions. The uncertainty range factors account for the potential that weather could influence recovery operations.	The uncertainty range factors account for the potential that weather could influence recovery operations.	

Table 2-7. Assumptions Used in the Preliminary RAM Analysis (Continued)

Category	RAM Doc. Paragraph	Description of Assumption	Basis	Implications for the O&M Concept
Maintenance, Corrective	4	Corrective maintenance effort can be estimated using generic maintenance categories.	Each TFC WFDS system contains similar components that can be subjected to categories of corrective maintenance.	Generic maintenance categories can be used as a starting point for maintenance planning actives during the next phase of project development
Restoration Time and Schedule Delay	4	All TFC organizations, that is, all organizations that impact transfer time, will be thoroughly trained regarding the importance of timely restoration of transfer operations upon any delaying or potentially delaying event.		This is a very important assumption, requiring support from top management down through the operating and maintenance technicians, as well as laboratory analysts.
Jumper Fabrication	4	The capability to fabricate jumpers as part of site fabrication services and will be available to support corrective maintenance activities during WFD activities.	Assumes a status for a capability that must exist somewhere in order to estimate the time required for recovery activities in valve and pump pits.	Implementation of the maintenance concept should validate this capability
Authorization Basis, Inter-connected Systems	2.2.4	Only failures of equipment and instrumentation having a function directly associated with the planned transfers are explicitly modeled as requiring the shutdown of waste feed delivery activities.		Before transfer operations start, the FSAR will be revised and approved by appropriate authorities so that failures of leak detectors and other equipment (i.e., spurious alarms) not associated with the planned transfer will not require an immediate shutdown of the analyzed transfer operations.

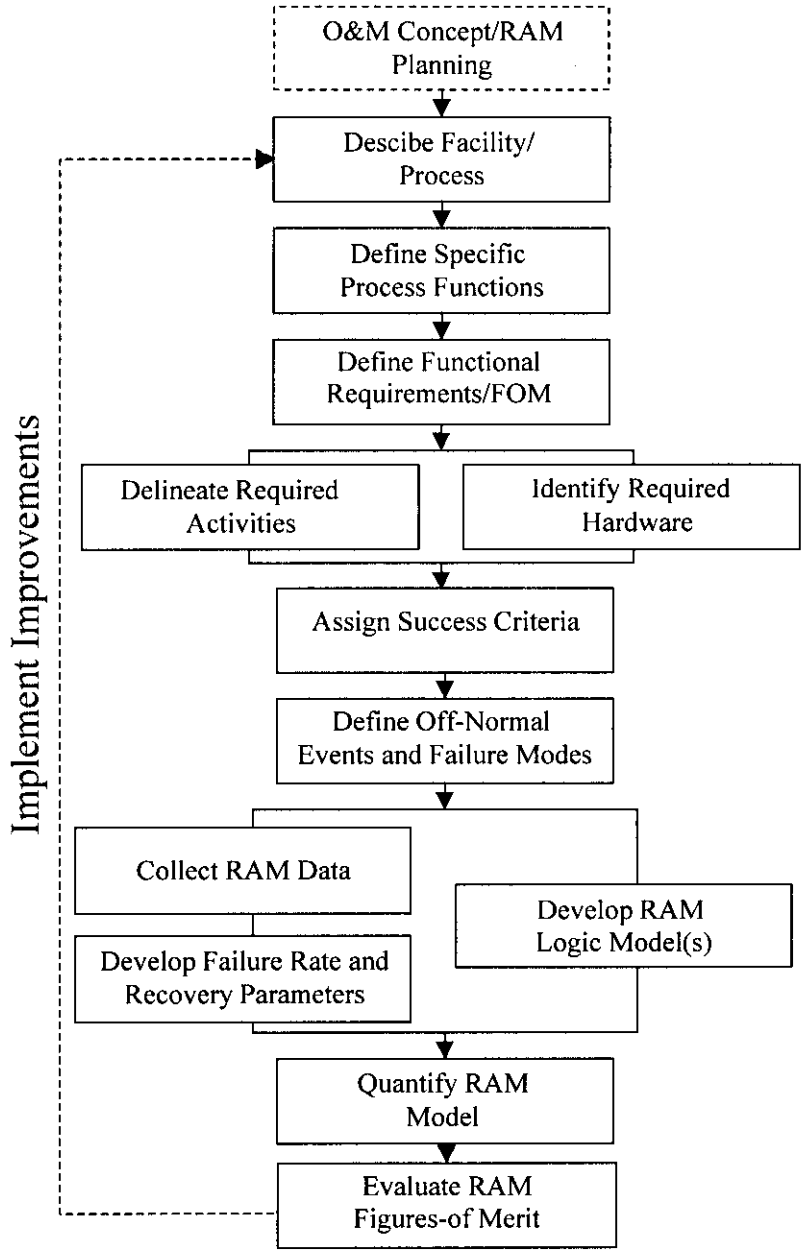

Figure 2-1. Steps for Performing a Reliability, Availability, and Maintainability Analysis

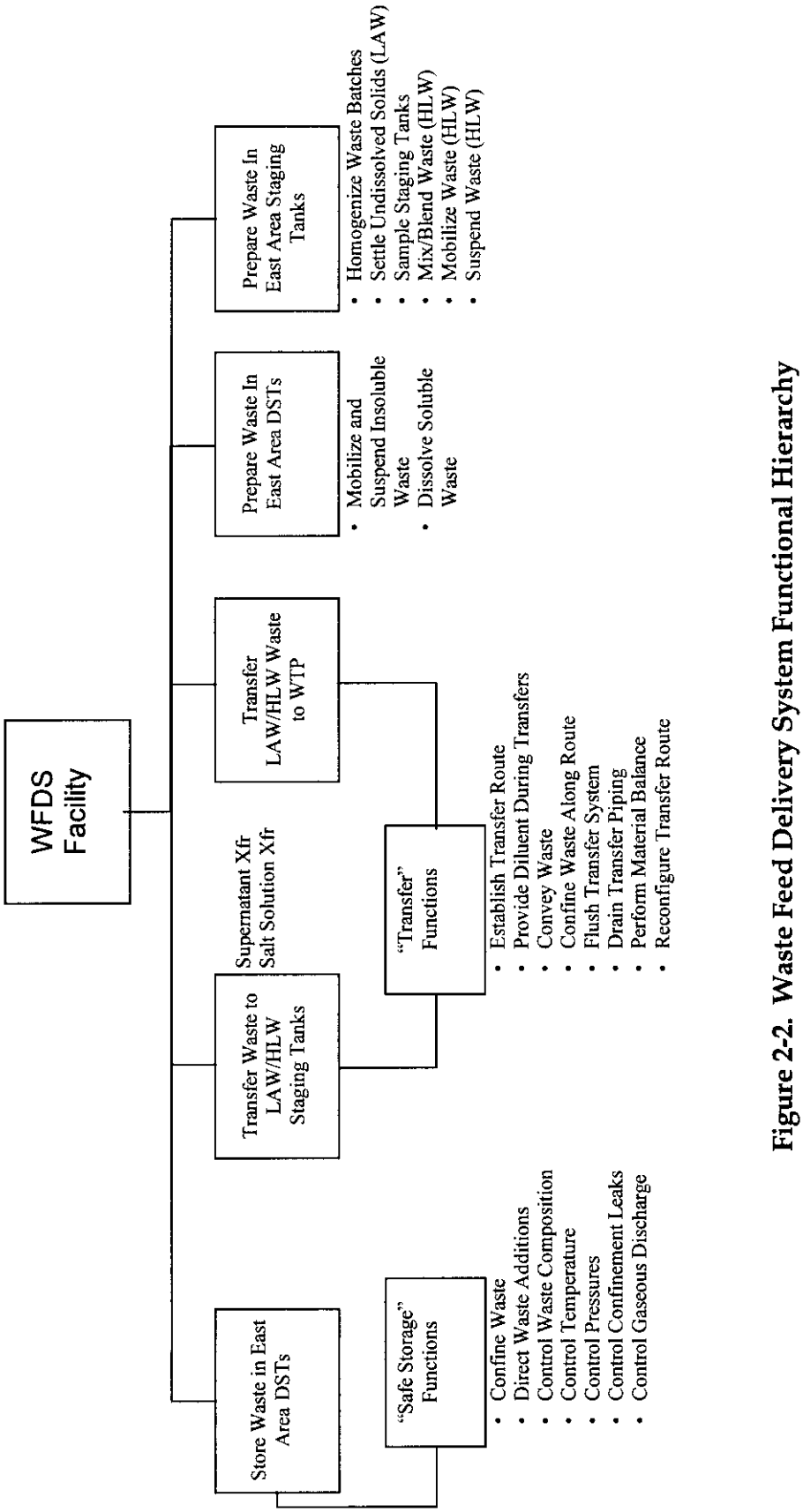

Figure 2-2. Waste Feed Delivery System Functional Hierarchy

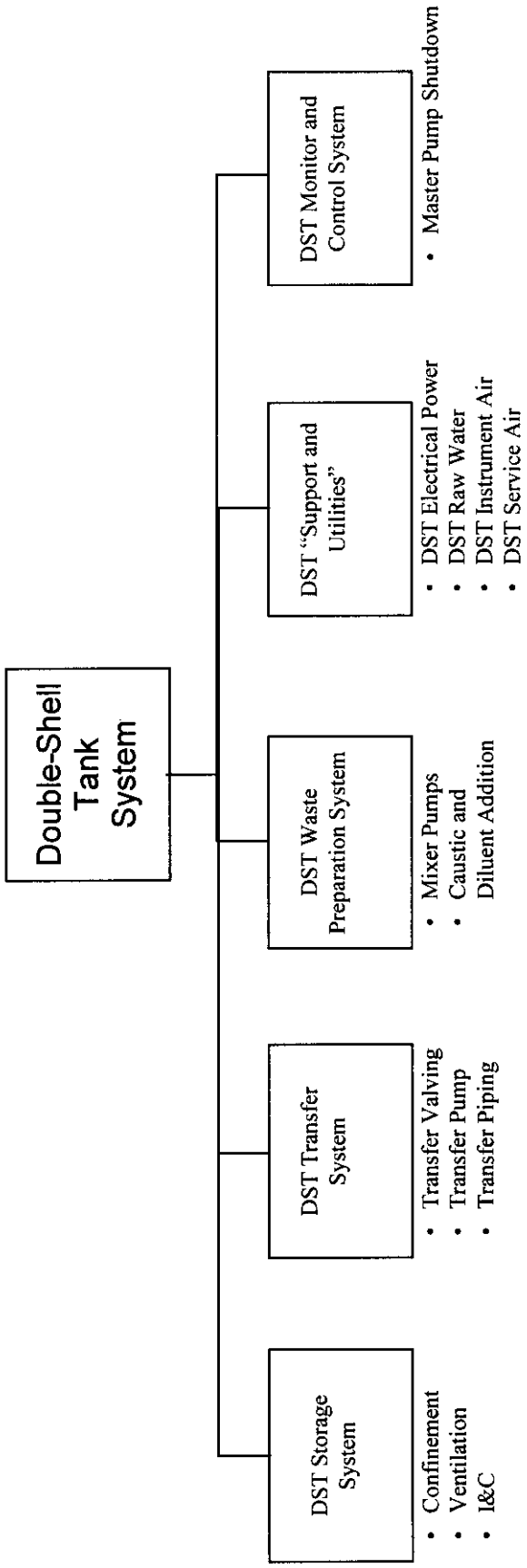

Figure 2-3. Waste Feed Delivery System Architecture Breakdown

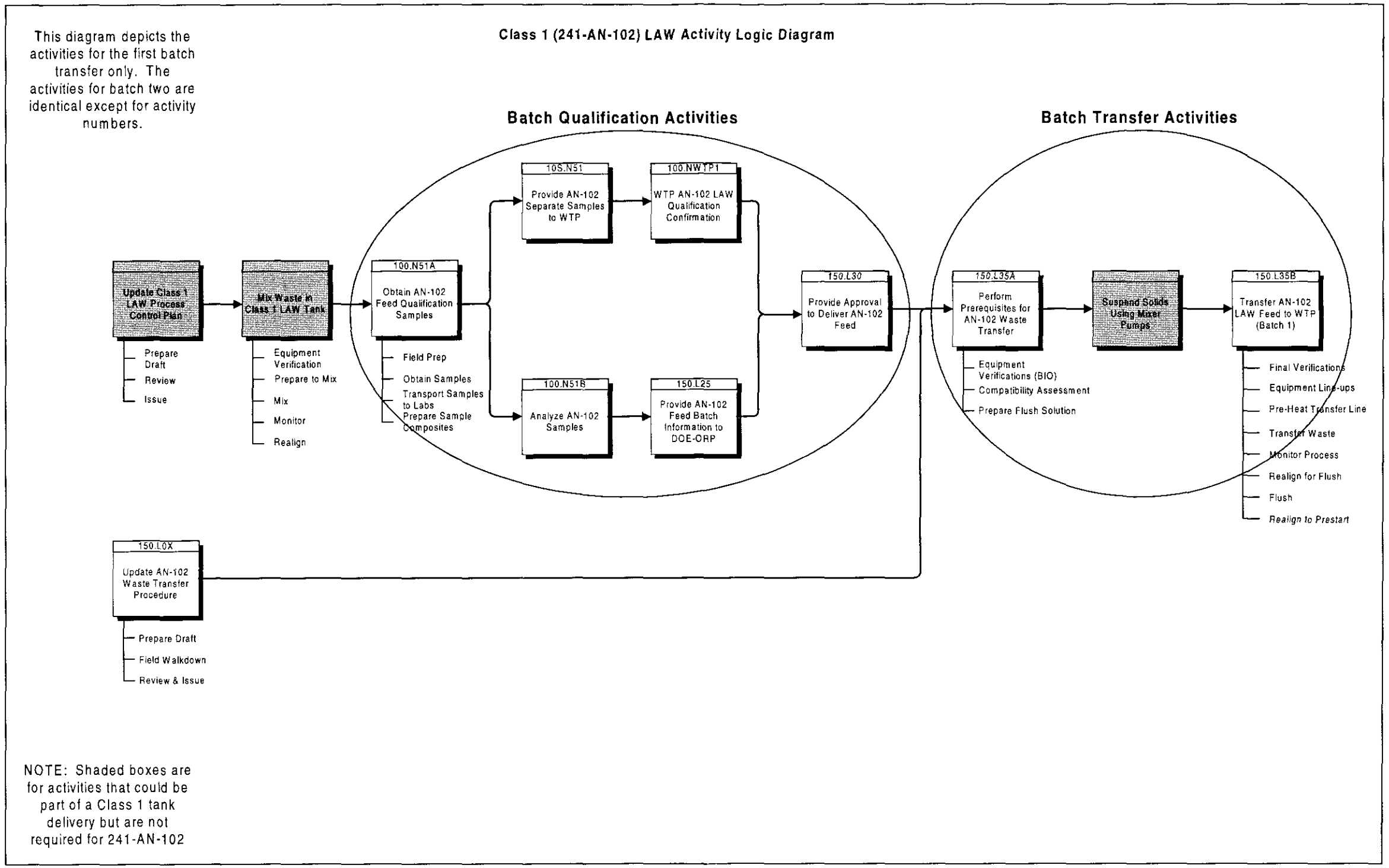

Figure 2-4. Activity Logic Diagram for Class 1 Waste Feed Delivery Activities (241-AN-102)

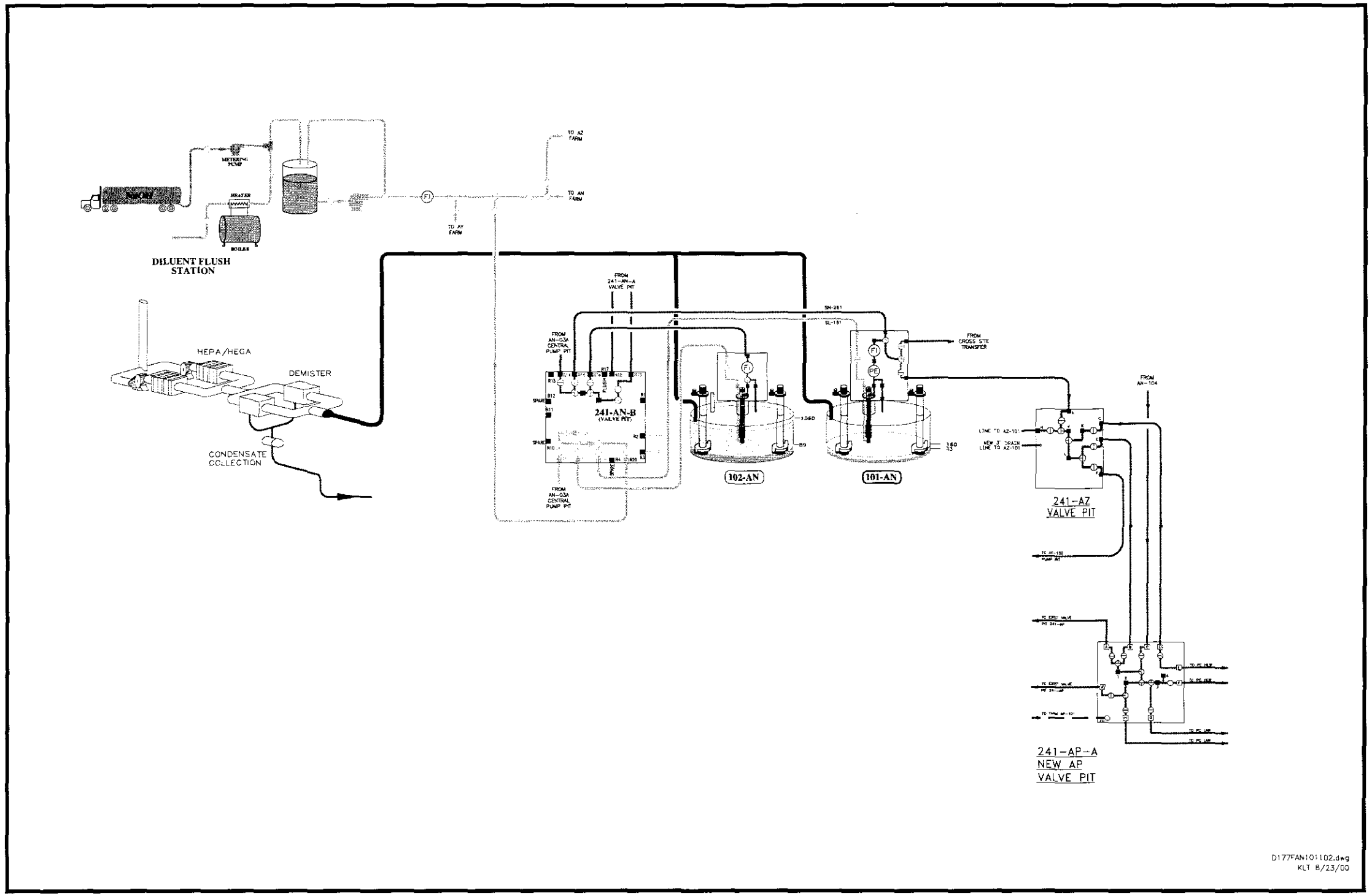

Figure 2-5. Schematic Depiction of the Systems Involved Class 1 Feed Delivery Activities (241-AN-102)

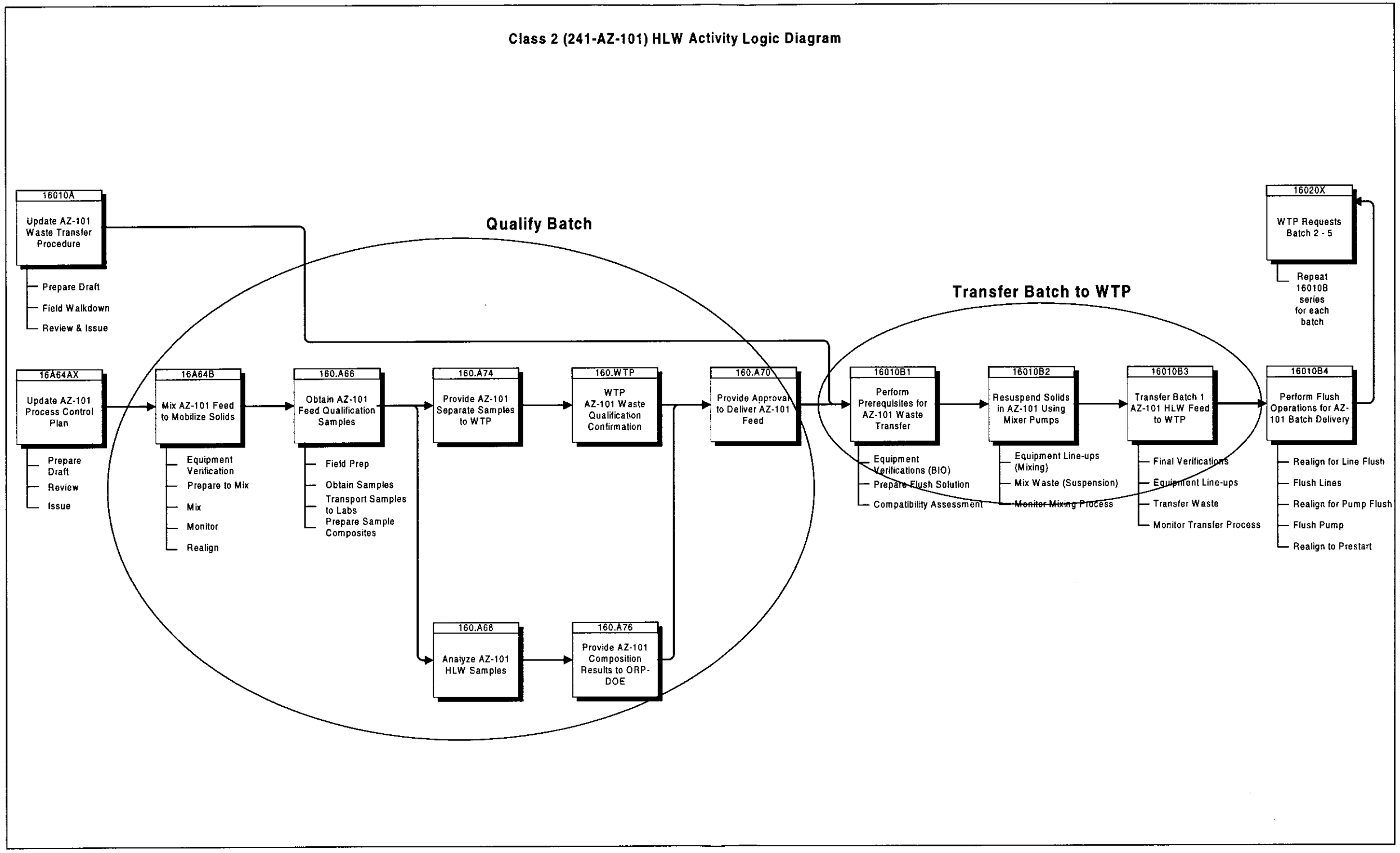

Figure 2-6. Activity Logic Diagram for Class 2 Waste Feed Delivery Activities (241-AZ-101)

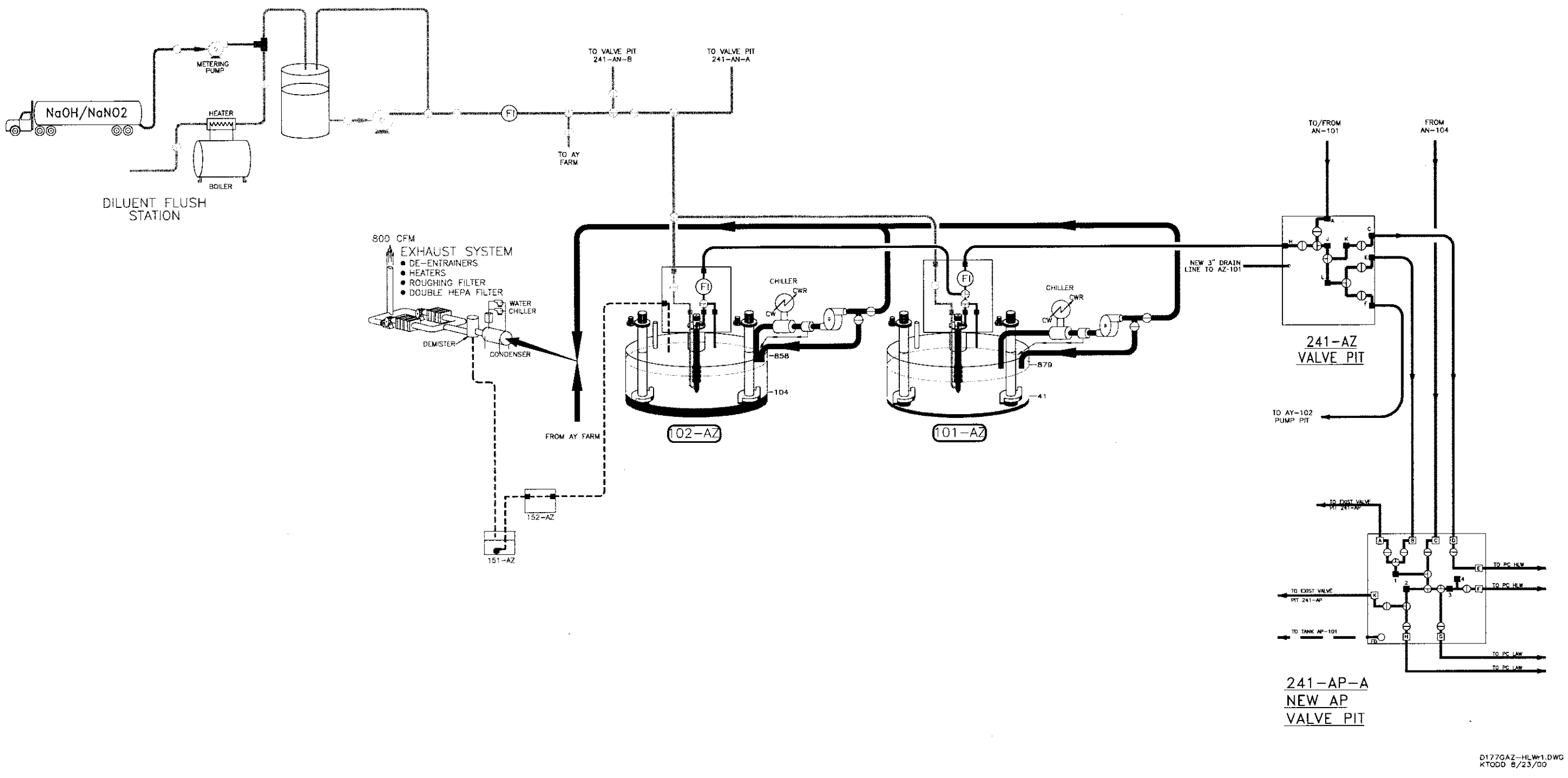

Figure 2-7. Schematic Depiction of the Systems Involved in Class 2 Feed Delivery Activities (241-AZ-101)

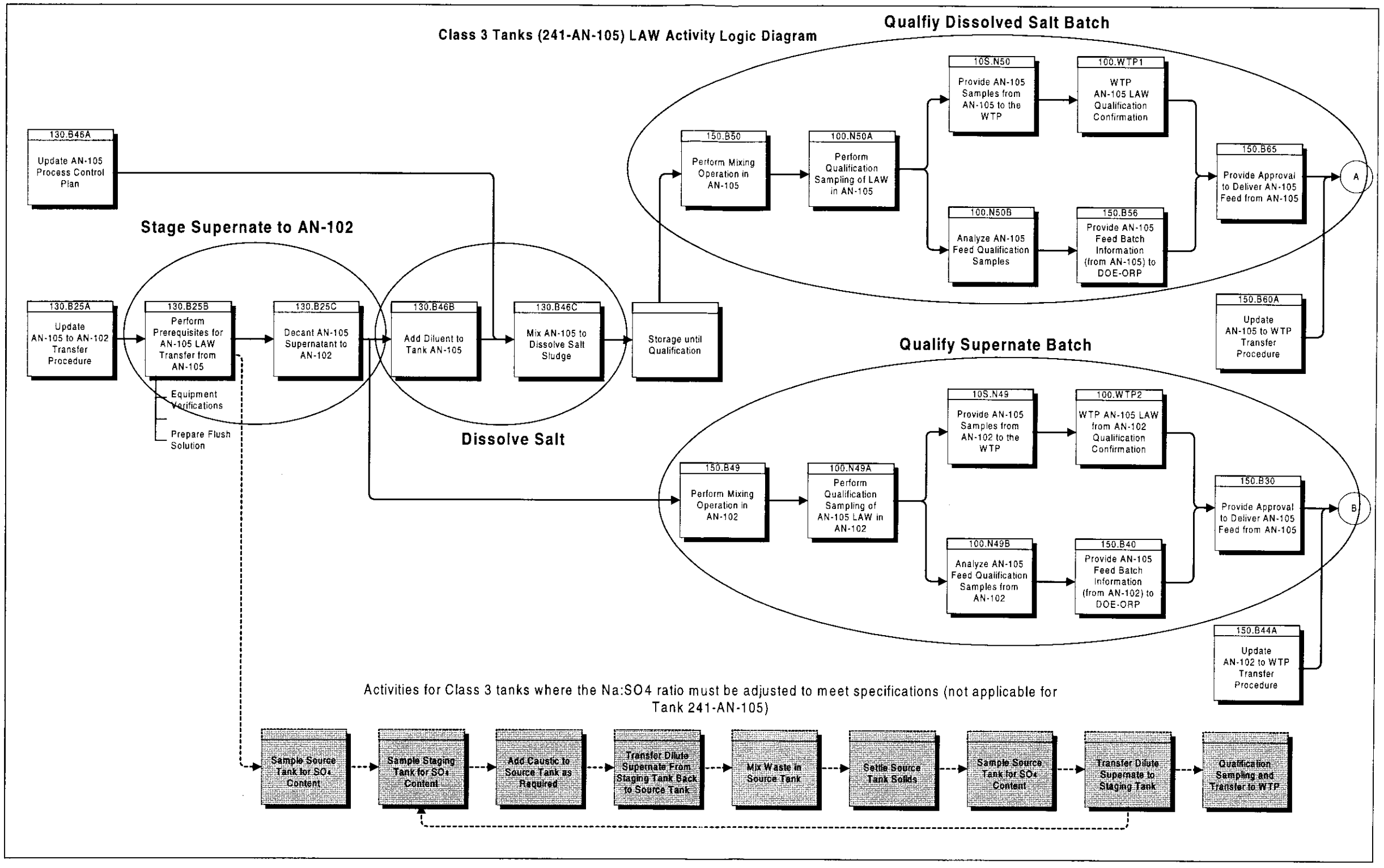

Figure 2-8 Activity Logic Diagram for Class 3 Waste Feed Delivery Activities (241-AN-105)

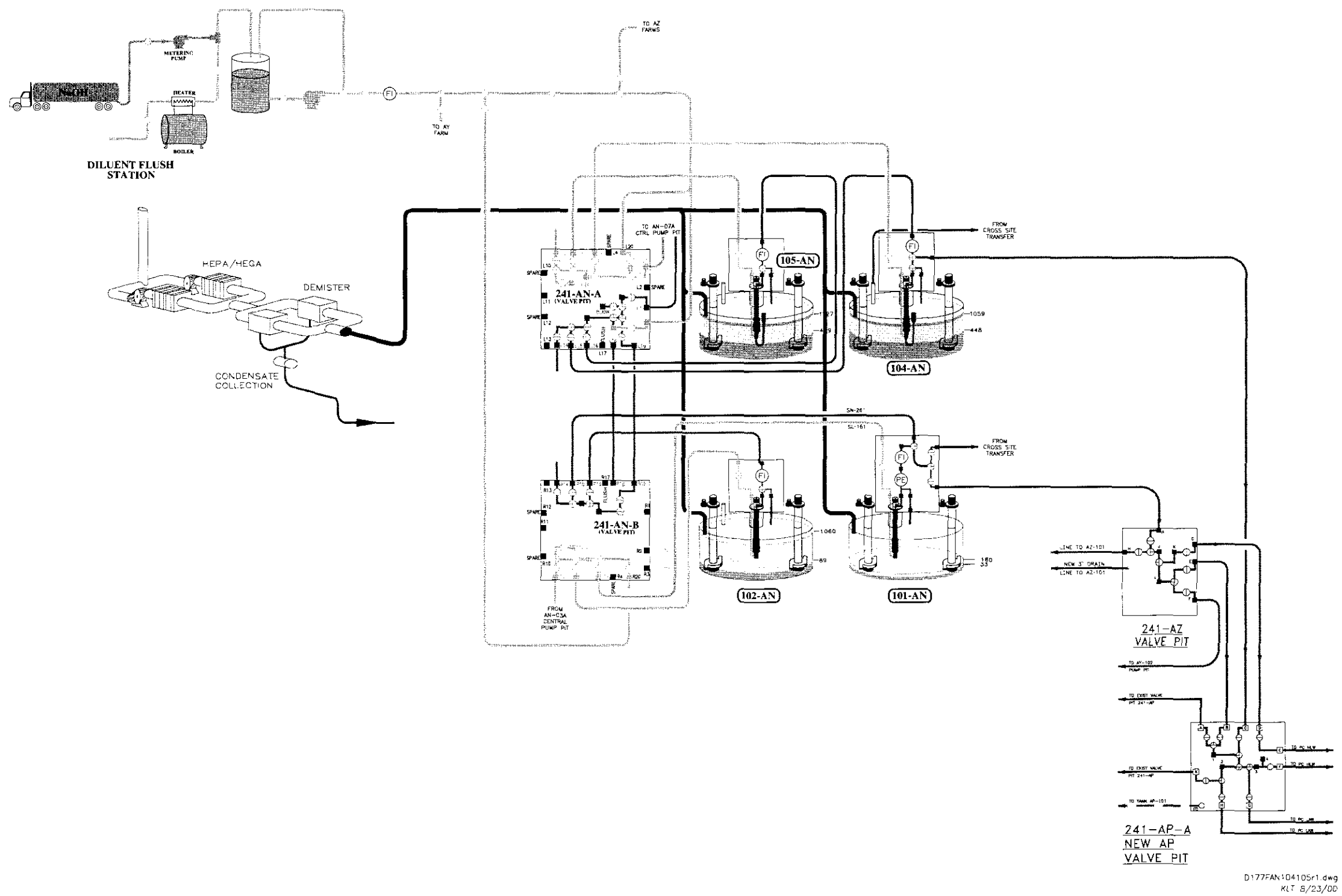

Figure 2-9. Schematic Depiction of the Systems Involved Class 3 Feed Delivery Activities (241-AN-105)

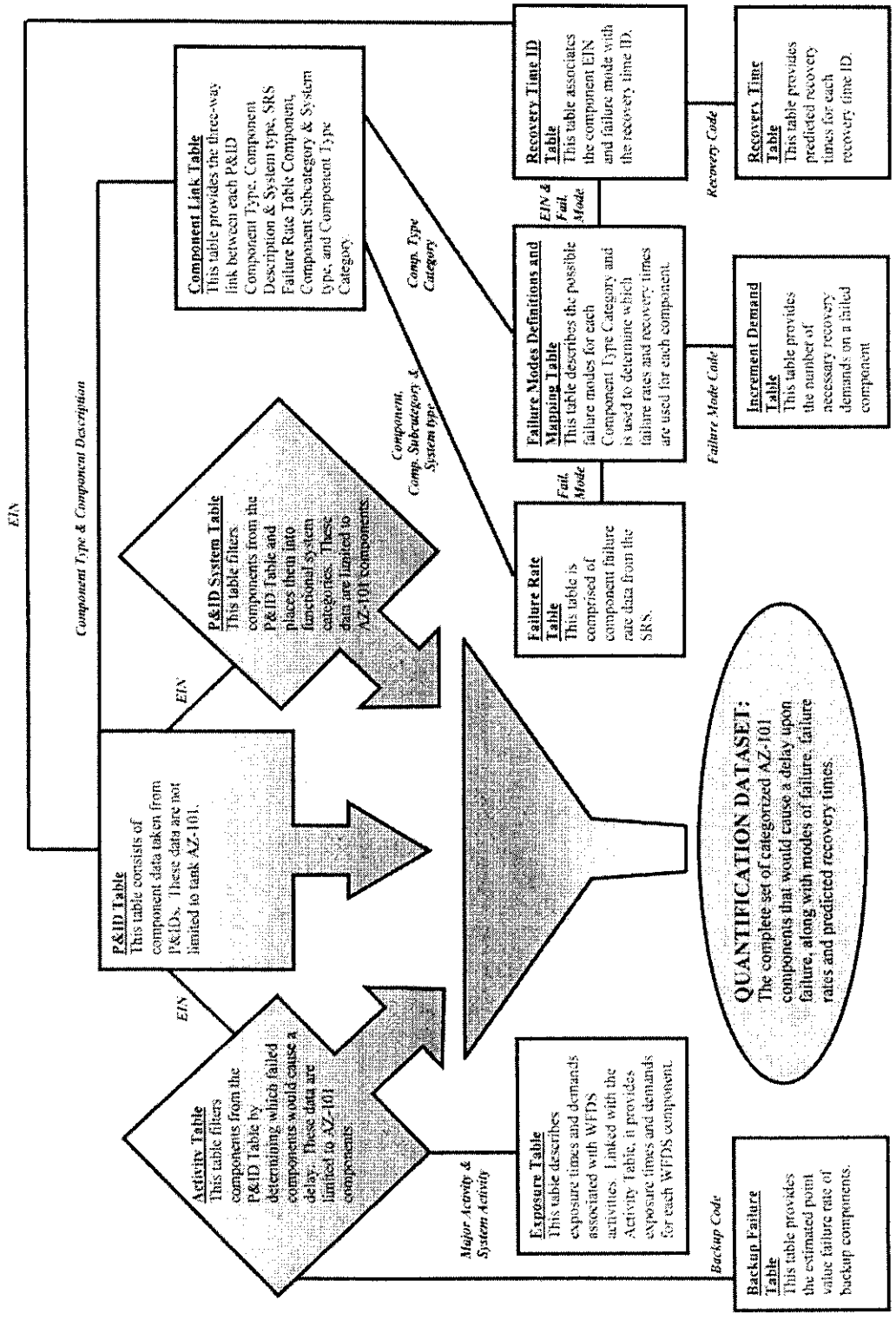

Figure 2-10. Process Used to Develop the Idle Facility Penalty FOM (example for Class 2 Tank 241-AZ-101)

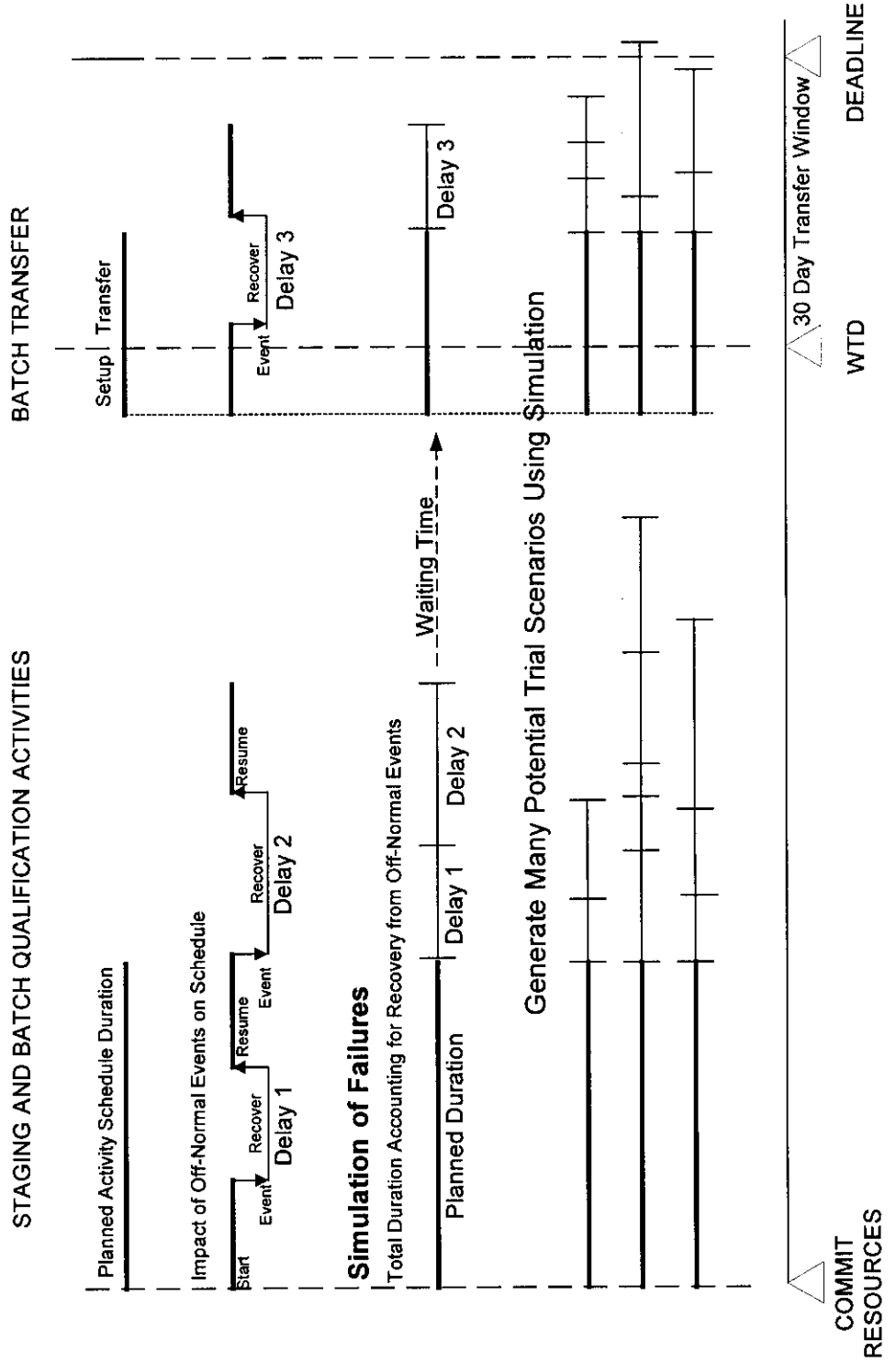

Figure 2-11. Calculation Methodology of the Total Duration of Waste Transfer Activities Including Impact of Off-Normal Events

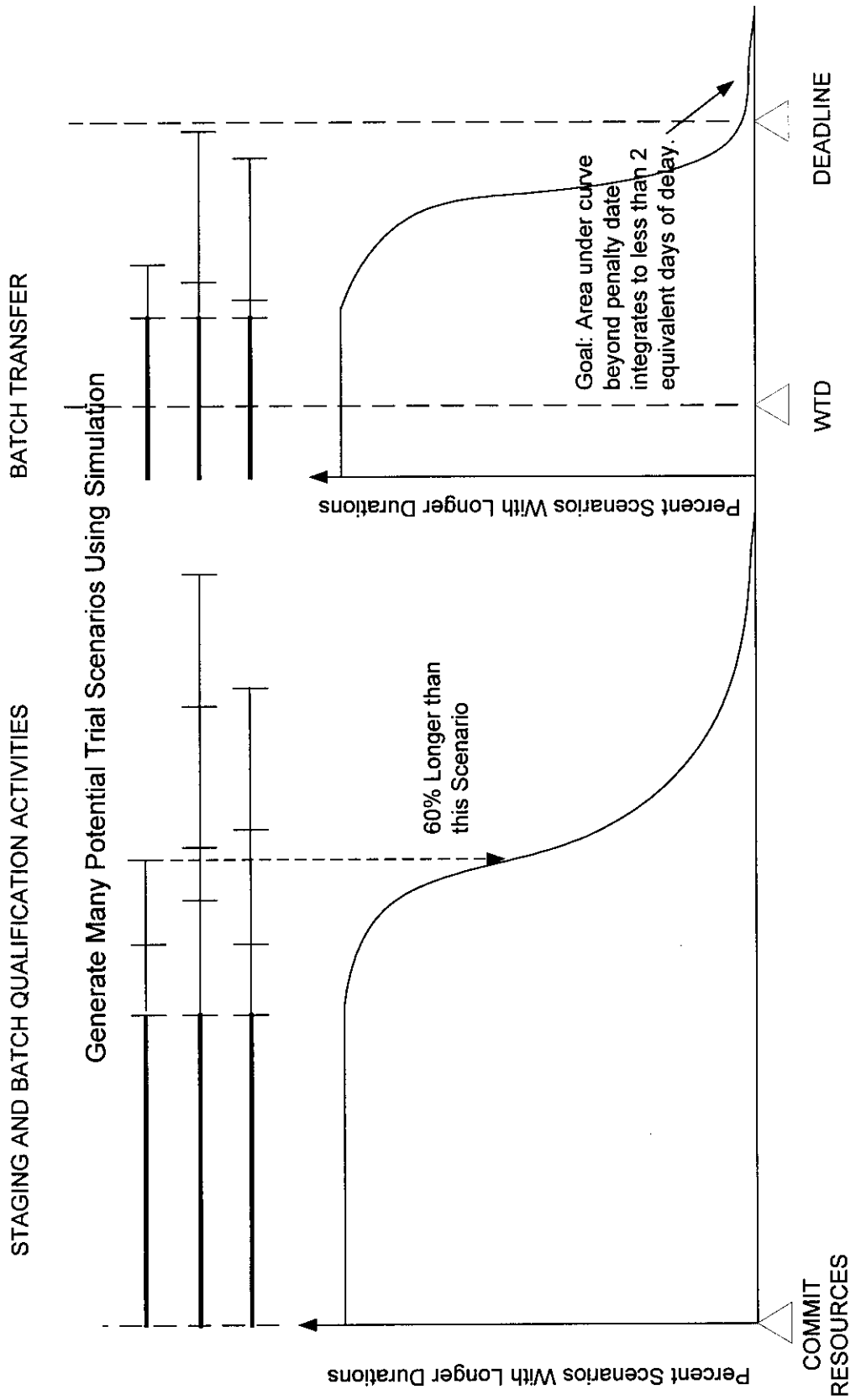

Figure 2-12. Estimation of the Risk of Delays Resulting in Idle Facility Penalties

3. Frequency of Off-Normal Events

In this section, the frequency of events that could result in a potential delay of waste transfer activities is discussed. These events are called potential schedule-delaying events, or simply "off-normal events."

3.1 Categories of Off-Normal Events

The preliminary RAM analysis accounts for off-normal events of three general types:

- Hardware failures.
- Human errors that result in conditions that require termination of transfer activities.
- External events that result in conditions that require termination of transfer activities.

3.1.1 Hardware Failures

3.1.1.1 Hardware Failure Modes

Hardware failure modes quantified in the RAM model are those that produce cessation of functions necessary for waste feed delivery activities to proceed. In order to avoid surprises, all potentially relevant waste transfer schedule delays need to be identified and accounted for. To fulfill these objectives, the preliminary RAM model encompasses the following hardware:

- Hardware Directly Involved in Transfers - The identification of transfer equipment is straightforward because the functions required to transfer the waste have been a primary focus of the design effort.
- Instrumentation and Control - In the case of control or safety instrumentation and equipment, the requirements of the FSAR (CHG 2000b) may link some instrumentation to the preliminary RAM model that is not directly related to the transfer function. These instruments monitor conditions that have to be satisfied in order to accomplish transfer functions. The preliminary RAM model addresses failures of the instruments associated with the safe storage function of the tanks and the ventilation of the tank farm involved in the transfer are evaluated for potential to stop WFDS activities.
- Support Systems - Support equipment provides the power, cooling, and operating fluids that enable "front line" systems to accomplish their functions. Support systems generally provide their services to a variety of equipment, some of which may not be directly related to the WFDS functions.
- Other Hardware - To the extent that other equipment external to the WFDS may influence the availability of support systems, it must also be considered. As these

failures are outside the current boundaries of preliminary RAM model, their influences are assumed to be encompassed by the external events analysis contained in Section 3.5.

The failure modes included in the model depend on the general function of the component and its role in completing the mission at hand. Table 3-1 summarizes the failure modes hypothesized for categories of components participating in waste feed delivery activities. The following points pertain to Table 3-1:

- The selection of failure modes depends on whether a component is performing active or passive functions. Some components, such as pumps, are required to perform both types of functions. For example, a pump must startup and operate, which are both active functions. However, while doing so it must also continue to maintain its integrity so that the pumped fluid remains contained. The preliminary RAM model quantifies every applicable failure mode.

- The failure modes listed in the table are a consolidated list of those used in previous revisions of the preliminary RAM model. For example, the failure mode "Leakage/Rupture (all modes)" includes up to four more specific failure modes: "Leakage (internal), Leakage (external), and Rupture (internal) and Rupture (external)." As all failure modes will require stoppage of transfer operations and will present similar recovery problems (it is assumed that internal leakage/rupture will require similar precautions for component access as external leakage/rupture), the failure rates are summed into the composite failure mode.

- Because the time needed for recovery is important, some failure modes have been broken down to reflect options for recovery. For example, pumps and fans have both catastrophic and non-catastrophic failure modes, relating the condition of the equipment following failure. This failure mode has been applied to the large mixer and transfer pumps to differentiate between failures where an in-place repair (e.g., flushing the inlet) will allow completion of the mission, versus those that would require replacement of the pump in order to complete the mission.

3.1.1.2 Hardware Failure Rates

Hardware failure rates are quantified in accordance with two general classes of exposure; namely, time-related and demand-related exposure.

- Time-related failures might occur at any time during a mission when the component of interest must successfully maintain a given state, such as active operation, sensing capability, or structural integrity for a specified duration. The mission time depends on the function being accomplished, and this time may vary between equipment participating in the same activity. For example, safety-monitoring equipment must operate essentially all the time, and calendar time is an appropriate measure of exposure to failure. Transfer pumps actively operate only for the period required to pump the quantity of waste being transferred.

- Demand-related failures generally occur during an activity requiring a change in component state. The challenge occurs when the transition is made and is over once it is successfully completed. The most common transitions are starting,

stopping, and changing position. In addition, some short duration operations may be assessed on a per-mission basis.

Failure rates may be obtained from both generic and site-specific sources. For reasons discussed in Section 3.2, the preliminary RAM model uses generic component failure rates for quantification. The only exception is the failure rate for large pumps, which is based on a Bayesian update of generic failure rates with Hanford site-specific experience with waste transfer pumps. Bayesian analysis and its application to the waste transfer pumps are discussed in Section 3.3.2.

3.1.2 Human Actions

Existing and planned waste transfer procedures have been examined during previous revisions to the preliminary RAM model to identify opportunities for the first category of off-normal events. Section 3.4 discusses these actions.

The frequency of the second category of events is estimated by examining ORPS data and querying experienced TFC personnel to identify concerns. Examples of the second type of off-normal events are requirements to temporarily evacuate an area following an accident not associated with the ongoing activity, or a stand-down for retraining following such an accident. Section 3.5 discusses the results of the ORPS evaluation and develops a failure rate and duration for delays caused by human errors outside the responsibility of the TFC.

3.1.3 External Events

External events are events that result in conditions requiring shutdown account that are not under the control of TFC personnel. These events include severe weather, incidents (such as range fires) and accidents that interrupt services. Severe weather may include extreme atmospheric temperatures (cold or heat), high winds, or excessive precipitation.

The frequency and duration of weather-related events are estimated using weather data supplemented by event reports from ORPS and engineering judgment derived from the experiences of TFC personnel. This evidence and its interpretation are discussed in Section 3.5.

The frequency and impact of incidents outside the control of TFC personnel are of interest to the preliminary RAM analysis to the extent that TFC management decides that a threat is significant enough to proactively take action. Options could encompass allowing more time for the activity, or influencing the conditions that prevent the incident or mitigate its consequences.

3.2 Evaluation of Off-Normal Events Within TFC Operations

Records of the historical performance of TFC equipment similar to that which will be used for the WFDS provides the most direct evidence for updating generic failure rates to better reflect those anticipated for WFDS components. Two sources of information are available, occurrence reports involving the TFC in the DOE Occurrence Reporting

and Processing System, and the TFC Job Control System. Since the mission is changing from one of safe storage to one of active qualification and transfer of waste to the WTP operator for vitrification, the experience must be evaluated for applicability to the new operating conditions. Therefore, there are no readily available well-defined rules for the use of the existing historical data. Rather, the historical records are being used to understand the problems that have existed in the past and to provide a sample against which to adjust the generic failure rates as necessary to reflect the anticipated operating conditions for WFDS components.

The initial RAM analysis examined the 757 occurrence reports involving TFC in the DOE Occurrence Reporting and Processing System during the period from the beginning of 1990 to the end of 1997. In addition, it has collected over 5,000 records from the TFC Job Control System to identify trends in maintenance and repair of generic component types and specific components.

Two of the primary component-related measures for the study are failure rate and recovery time. To determine a failure rate, one must consider when the component was installed, under what conditions it operated, and how often it failed during that time. Success information is not generally available in ORPS, JCS, or any other TFC database and has to be constructed from general knowledge of activities during the period and logs, if available. This labor-intensive effort is restricted to components that are important with respect to commitment of O&M resources.

The following subsections are repeated from the Rev. 1 preliminary RAM report without change. No effort was made during the Rev. 2 RAM model update to generate site-specific failure rates based on either ORPS or JCS data.

3.2.1 ORPS Evaluation Results

The evaluation of the ORPS events is documented in a Microsoft® Access relational database. A summary of the results is presented in Appendix C. Tables C-1 and C-2 describe the criteria used for the evaluation and define the fields used in the database to assist in the categorization process. Table C-3 presents a report from the database illustrating the assessments that were accomplished.

The evaluation determined whether the event was related to a component known to be associated with WFDS operations. The failure mode that was exhibited was then assessed and the resulting failed condition was categorized with respect to safety concerns and impact on the primary tank boundary. Differentiation within these two categories provides good correlation to recovery duration. Recovery of safety-related equipment generally involves more formal reporting and quality assurance, while restoration activities that are intrusive to the primary tank boundary require more training, preparation, and execution time to insure proper worker safety. Finally, if adequate information was available, the evaluation estimated the time to restore operations to a normal condition.

The evaluation sought to identify any discernable pattern that would assist to establish a component's failure rate, but failed to find trends in the database. The ORPS information is reported to different levels of detail, as well as varying degrees of completeness. Examples of the ORPS evaluations are shown in Table C-3.

Except for the valves, the reported delay by component is less than 2.5 hours, which can be translated into repairs manageable within a single shift. The recovery times reported in the ORPS reports do not seem to agree with the opinions of maintenance personnel queried during the update of the component repair and recovery times for the Operations and Maintenance Concept (Carlson 1999). Based on their experience, it requires at least a shift to coordinate and release a work package to accomplish repairs. Before ORPS data can be used to assist in making site-specific estimates of failure rate and recovery duration, the circumstances and applicability of individual reports would have to be investigated in more detail.

3.2.2 JCS Evaluation Results

Corrective maintenance data from the Hanford Job Control System provides useful information about maintenance and repair activities. Over 5,000 Hanford site corrective maintenance actions were reviewed in this study. However, due to its sheer volume and the available format of its records, the evaluation of JCS has been only cursory to this point and is ongoing. Tables C-4 and C-5 provide examples of raw data obtained from the JCS database, and a preliminary effort to evaluate that data.

The JCS is of value in determining recovery times for failed components by providing a good indication of the activities needed to restore the equipment. However, since waste transfers were accomplished only infrequently and there were few external drivers to complete them within a specified time period, many corrective maintenance evolutions could be delayed for months with no appreciable mission impacts. Using this data in the WFDS preliminary RAM analysis would require interpretation to estimate future delay.

3.2.3 General Observations Regarding JCS and ORPS

As a result of the review of both the ORPS and JCS databases, the following general observations are offered that could potentially influence the preliminary RAM analysis of the WFDS:

- Based on the recovery times inferred from the review of the event reports, it appears wise to institute some type of prioritization effort as part of the O&M Concept that guarantees expedient processing for WFDS work packages. There was an instance in ORPS where an Operating Safety Requirement (OSR) related preventive maintenance evolution was missed even though management knew they were approaching the deadline for performance. This was an instance of "failure to prioritize."

- Much of the information needed for identifying and trending problems that might need corrective action is buried in the narratives. Less than 3% of the JCS corrective maintenance event records include a direct link to a specific component or component type. This does not take best advantage of the capabilities of a relational database. If a new work management database will be developed, it is recommended that it be examined to insure that the content and use of each record and field within the database is clearly defined and verified against past and anticipated practices. It is important to avoid requiring the entry of information that is of no use, however, data entry for useful information (i.e., information required to

support Hanford strategic resource management throughout the facility life cycle) should be made a firm requirement.

- The JCS has been used as a tool for scheduling and planning corrective maintenance and preventative maintenance work. Although the software is not user-friendly in all its applications, it has significant capabilities that are under-utilized. Those capabilities include tracking and trending tools and the ability to tie into component databases, master equipment lists, drawing databases, and other configuration management tools. However, since its implementation, it has been primarily used in these capacities for preventative maintenance and calibrations and not for corrective maintenance. The TFC should consider an integrated maintenance management system that ties together work management and configuration management in a manner that allows for future analysis in improving systems.

- Upon implementation of any new integrated work control system the TFC should seek to ensure that the historical data within the current Advanced Revelation software-based JCS system is retained in a usable format for future use.

3.3 Hardware Failure Rates

The exposure conditions to which components are subjected in association with the failure modes identified in the preliminary RAM model provide the context for hardware failure rates for the evaluation of potential WFDS delays. It is important that each failure rate be evaluated for the mission that the component must perform. This evaluation considers the nature of the exposure of equipment to failure modes and source of information that can be used to quantify the response of the equipment to these failure modes.

For this preliminary RAM model quantification, the analysis uses primarily generic hardware failure rates. The sources of these rates are described in Section 3.3.1 below. In conjunction with this quantification, the preliminary RAM analysis evaluates and categorizes the evidence available in the ORPS and JCS databases to identify trends in off-normal events, failures, and faults observed during TFC operations in the past. Where a significant trend is identified, Bayesian methods are used to update the generic failure rates with this site-specific information. Currently, the only component for which a Bayesian update has been performed is the waste transfer pump. The update process is described in Section 3.3.2, and the evidence and results are presented in Appendix C.

3.3.1 Generic Component Failure Rates

Table B-1 in Appendix B summarizes the generic data used for the preliminary RAM model. The failure rate data is taken primarily from component generic failure rates developed for the Savannah River Site (SRS) (Blanton, 1993). The generic failure rates are expressed as lognormal distributions that may be uniquely specified by a mean value and a range factor (RF). The mean value is the "best estimate" of the failure rate, but the RF relates the fact that the failure rates of actual equipment might vary considerably from the stated mean. The RF is formally defined as:

$$RF = SQRT(95^{th} \text{ Percentile}/5^{th} \text{ Percentile})$$

As a rule of thumb, one may state that there is only a 5% chance that the failure rate might be more than a factor of the RF above the median (that is close to the mean for RF < 5). RF values for generic failure rates are generally greater than or equal to 3. This reflects the potential variability that can exist from site to site and from exposure condition to exposure condition. When suitable operating experience becomes available, updating of the baseline generic data applied in this analysis, using site-specific experience, should narrow this uncertainty throughout the remaining facility life cycle.

3.3.2 TFC-Specific Component Failure Rates

This section presents the evidence and reasoning used to generate the site-specific failure rates used in the preliminary RAM quantification.

Bayesian methods are used to update the generic failure rates with this site-specific information. The formal method for accomplishing a Bayesian update requires that a valid sample of component failures over a given exposure duration (either time in hours, or a known quantity of demands) be identified and validated. This sample is then used with Bayes' Theorem to update the uncertainty distribution of the generic failure rate. Bayes' Theorem accounts for size of the sample (and thus its uncertainty in representing the failure rates of the site-specific equipment) and the uncertainty of the generic distribution. This methodology is described fully in a number of sources, three of which are referenced here: *RISKMAN® Release 3.0, PRA Workstation Software, User Manual I: Data Analysis, (Appendix B, Methodology for One-Stage and Two-Stage Bayesian Updating* (PLG, 1991); *On the Use of a [sic] Bayesian Reasoning in Safety and Reliability Decisions – Three Examples* (Kaplan, 1979); and *Probability Theory: The Logic of Science* (Jaynes, 1994).

The key to a correct estimate is a valid sample of performance that is directly applicable to the anticipated WFDS functions. This requires both a good understanding of the circumstances and effect of the failures and a reasonable knowledge of the operating history under which the failures occurred, such as radiological and thermal cycling and other severe environments. In addition, there should be some confidence that the combination of experience and failures in the representative sample is complete. The sample itself need not be a complete history of operations, but it should reflect the conditions expected during WFDS operations. Based on the review of the ORPS and JCS databases and the operating logs from the TFC, it is difficult to establish a valid sample for estimating site-specific failure rates.

Despite the above difficulties, a Bayesian approach can be used to update generic failure rate distributions. In essence, the evaluation performed by the application of Bayes' Theorem can be translated into a discussion that addresses two questions that form the essence of a Bayesian update:

1. Could the events recorded in ORPS and records of maintenance activities listed in JCS for this component type and failure mode have occurred if the generic failure rate is representative of this failure mode?

2. If the answer to this question is "no," by how much should the failure be adjusted to reflect the evidence from the ORPS and the JCS? (This adjustment should not reduce the uncertainty of the failure rate unless a formal update is accomplished.)

When warranted by the importance of the failure mode and the availability of evidence, the formal method of quantitative updating using Bayes' Theorem can be performed. In this case, evidence that supports the establishment of a valid quantitative sample of failures over a defined exposure history is presented.

Based on the review of events reported in the ORPS and JCS databases, the generic failure rates of the failure modes for the waste transfer and mixer pumps have been adjusted to better reflect the anticipated operating conditions for the WFDS. Since the waste mixer pumps perform their tasks under similar conditions to the waste transfer pumps, it is judged that the sample based on the various waste transfer pumps is reasonably representative of how the mixer pumps might perform. Therefore, the failure rates obtained for the waste transfer pumps are applied to both large pumps in lieu of the generic failure rates, which encompass pumps of all sizes and operating profiles.

The available data is for waste transfer pumps. There are a large number of differing models of installed pumps. For this reliability analysis, all models of transfer pumps are assumed to have a similar susceptibility to failure. Two failure modes are quantified:

- Pump failure to start: documented in Appendix C, Table C-6.
- Pump failure to run: documented in Appendix C, Table C-6.

Table C-6 presents the Bayesian update of generic pump failure rates to reflect experience with waste transfer pumps at Hanford. The information is organized into four sub-tables as follows:

Table C-6a presents a summary of the prior distributions and the site-specific data used to accomplish the Bayesian update.

Table C-6b contains the characteristic parameters of the resultant probability distributions from the Bayesian update, which was accomplished using the data module of PLG's RISKMAN® program (PLG, 1991).

Table C-6c summarizes available plant-specific data regarding transfer pumps used to generate the input for the Bayesian update. This data was taken from historical records of completed transfer procedures since 1990. Information on failed pumps was excluded unless it failed since 1990 and logged a transfer in that period. These records are maintained in the Hanford Records Storage Facility in Seattle and were retrieved back to Richland to accomplish this review. Seventeen boxes of records were reviewed to extract the necessary data. The table is sorted by pump number/location and shows the number of transfers attempted, the number of total starts required to complete or finally abandon the transfer, and the calculated or logged pump running time. The comments section indicates that most of the restarts were driven by leak detection master pump shutdown signals and other various alarm signals. Therefore, these events are not counted as pump failures in the Bayesian update. In many instances, it was not clear exactly when the pumps were restarted to complete the transfer after a shutdown occurred. In those cases, the total mission time over all restarts was

calculated based on an assumed a transfer rate of 140 gallons per minute (which corresponds to WFDS specifications) and the total volume transferred.

Table C-6d provides the complete set of data obtained during the review of relevant plant logs. This sub-table includes information on all transfers including the 204-AR offload facility, catch tanks, PUREX transfers, and other smaller tanks: more than 700 completed transfers in all.

3.3.3 *Specialized RAM Parameters*

In the current preliminary RAM analysis, some refinements were made to the failure modes of specific components and determination of basic event data required for RAM model quantification.

3.3.3.1 *Recovery of Plugged Components*

The "plugging" failure mode for all affected components (i.e., pipes, jumpers, valves, etc.) was split into two subset failure modes, one for catastrophic plugging which cannot be recovered via a non-intrusive flushing action, and one which can be recovered via a non-intrusive flushing action. In the absence of evidence, the overall plugging failure rate obtained from the Savanna River Site generic database was split equally among the two new subset failure mode categories.

The recovery time for plugging that can be recovered by flushing reflects the time necessary to plan, set up, and execute the flushing action. Recovery from catastrophic plugging would require replacement of the line, or routing the waste transfer to bypass the plug.

3.3.3.2 *Manual Backup of Motor Operated Valves*

MOV failure modes associated with valve position transition failures (i.e., failure to open on demand, failure to close on demand) were also split into two subset failure modes. The first can be recovered via simple non-intrusive manual positioning of the valve using a manual valve hand-wheel or similar manual valve operator as an installed backup to the valve motor. The second accounts for catastrophic failures, which cannot be recovered via non-intrusive manual positioning of the valve.

For the MOV transition failure modes, the original failure rate was split such that 10% of the MOV failure rate was applied to the catastrophic subset, and the remaining 90% of the original failure rate was applied to the non-catastrophic subset. This reflects the ratio of failure modes that would fail the actual valve (which can be manually operated) to those associated with the motor operator. It is assumed that if the motor operator portion of the valve fails, it can still be rotated to the proper position by manual backup. As a result, the delay time associated with 90% of the MOV failure rate is associated with the time necessary to accomplish the alignment manually.

3.4 Reliability of Human Actions

The purpose of the human action analysis is to identify activities in which a human error can lead directly to a delay of the progress of scheduled transfer activities. Human actions fall into two categories:

- Mishaps during procedural activities that cause a cessation of progress toward the activity's goal and require recovery activity before work can proceed forward.
- Accidents or mishaps not directly associated with the ongoing activity that generates a requirement to cease the activity.

In defining actions for quantification, the evaluation recognizes that not every human error or slip will lead to a delay in WFDS operations. Operations and maintenance personnel work in teams. Activities are planned with the recognition that individuals within these teams may sometimes make errors or slips that, if left uncorrected, will lead to a delay. A good procedure ensures time is provided for checking and independent verification so that misalignments and incorrect settings may be recognized and corrected before they produce a condition that requires termination of the WFDS activity.

Procedural steps that involve verifying the operability of equipment are an example of one of these special circumstances for RAM evaluations. If the equipment is operable, an error in following the procedural step will have no impact on its performance. If it is not operable, the verification step will reveal that fact during the verification, as opposed to being revealed during actual transfer operations. However, when the equipment is found not operable, it is reported in ORPS and/or JCS. Therefore, the hardware failure rates account for the rate at which equipment is found inoperable.

If the hardware failure is revealed during a verification activity rather than active operation, the delay in critical path activities will most likely be reduced. Access to the failed equipment will most likely be less intrusive, and some of recovery may be able to be done in parallel with other tasks, thus lessening the WFDS schedule delay. This effect has been observed during the review of ORPS data and can be reflected in recovery time distributions of specific equipment if warranted. However, for this quantification, recovery times are modeled with distributions designed to reflect a range of circumstances under which recovery might be accomplished.

3.4.1 Procedural Activities

The preliminary RAM analysis has examined existing and planned waste transfer procedures to identify opportunities for the first category of off-normal events. Draft TO-270-019A0, *Transfer Waste From TK-105-AN To TK-102-AP* (PHMC 1997), was the only procedure that addressed anticipated WFDS operations during the initial RAM model quantification. Because many human actions are similar for the transfers addressed in this preliminary RAM analysis, this procedure was used as a surrogate to evaluate the potential for delays due to mishaps during human activities.

When analyzing Draft TO-270-019A0 this analysis accounted for team checking and follow-up by assigning failure effect codes that indicate that a critical path schedule delay will not directly result. It also recognized that this process would extend over the set of

steps focused on achieving a stated goal. Only the combinations of human errors that end up producing a delay are explicitly included in the preliminary RAM quantification.

For the Rev. 2 RAM model, the human action analysis associated with WFDS activities was limited to a review of the tables in Appendix D for the Rev. 1 RAM model. The reasoning for including specific sets of procedural steps in the preliminary RAM quantification is presented in Appendix D, Table D-1. The list of human actions quantified in the preliminary RAM analysis is given in tables D-2 through D-4. The frequency of mishaps during WFDS activities are estimated using human error rates developed at the SRS (Benhardt 1994). The application of those error rates is described in Appendix D, Table D-5.

It should be recognized that the current set of human actions is essentially surrogate place keepers. It is anticipated that the human element in waste feed delivery activities will be subject to closer scrutiny as planning progresses. The objective of that process should be to make the operator's job as clear and straightforward as possible. This can be done if proper attention is given to problems the operators will face during the transfers and human machine interfaces available to them to do their job. One of the goals of the Operations and Maintenance Concept is to better define the conditions under which the operator must function and suggest ways to improve it.

3.4.2 Accidents or Mishaps not Directly Associated with the Ongoing Activity

Human actions not directly associated with the ongoing activity that produces accidents or mishaps that require temporary cessation of transfer activities are currently handled as external events. Appendix D, Table D-6, lists ORPS reports that could potentially cause delays of TFC transfer-related activities. In addition, human errors involving activities external to the under the control of TFC personnel are accounted for in Section 3.5 by designation of an external event associated with human error.

Events that may arise during a broader set of TFC activities can be addressed by either the programmatic risk analysis or they can be added to the human action analysis. These types of human activities should be addressed as the scope of the preliminary RAM analysis is broadened to address more of the TFC waste feed delivery system life cycle.

3.5 Frequency and Duration of Delays Related to External Events

The purpose of the external events analysis is to identify those events that significantly contribute to delay in field operations. The set of external events examined in the preliminary RAM analysis includes severe weather and disruptive external events reported in ORPS.

Severe weather may include severe heat, cold, high winds, or excessive precipitation. The frequency and duration of weather-related events are estimated using weather data (current through the end of 1998) provided by the Hanford Meteorological Station (Hoitink 1999a) supplemented by event reports from the ORPS database and engineering judgment derived from the experience of TFC personnel.

The frequency and duration of disruptive external events is estimated from incidents reported in ORPS. Because external events occur independently of the activities associated with transfer operations, their frequencies are reported on an annual basis (and are converted to an hourly rate for quantification). The data taken from the ORPS database includes reports made from the beginning of 1991 through the end of 1999, or 9 years.

3.5.1 Weather Related Delay

The estimations of delays due to weather are based on summary data reported in *Hanford Site Climatological Data Summary 1998 With Historical Data* [Hoitink 1999a], using the latest available 40 years of data (1959-1998). The actual decision to stop or limit work is based on industrial hygiene monitoring in the field. This evaluation makes the assumption that industrial hygiene considerations such as wet bulb temperature or wind chill factors are closely correlated to the summary data used to make the estimates presented below.

The frequencies developed below are derived from the actual readings averaged over a typical year. The frequency at which weather related events might actually occur during transfer operations depend on the season and time of day of the operation. The annual frequency is currently used because scheduling of activities for the waste transfers of interest is still very preliminary, and transfers will occur throughout the year.

3.5.1.1 High Temperature

The ambient temperature has a major influence on work mission duration as it affects the worker. Aside from obvious work place dangers, the frequency of accidents, in general, is higher in hot environments than in more moderate environmental conditions. One reason is that working in a hot environment lowers the mental alertness and physical performance of an individual. In addition, increased body temperature and physical discomfort promote irritability, anger, and other emotional states that sometimes cause workers to overlook safety procedures or to divert attention from hazardous tasks.

Heat stress, which can occur even in relatively moderate temperatures, is a major hazard, especially with workers wearing protective clothing. Reduced work tolerance and the increased risk of excessive heat stress are directly influenced by the amount and type of personal protection equipment (PPE) worn. The PPE adds weight and bulk, and severely limits the dissipation of body heat and moisture, and increases energy expenditure. The magnitude of this effect varies considerably, depending on both the individual and the PPE ensemble used. Thus, personal protective clothing can create a hazardous condition that must be evaluated and managed.

Heat stress is caused by a number of factors, including environmental conditions, clothing, workload, and the individual characteristics of the worker. Because heat stress is probably one of the most common (and potentially serious) illnesses at hazardous waste sites, regular monitoring and other preventive precautions are vital. Two documents, *Tank Farm Health and Safety Plan (HASP)*, HNF-SD-WM-HSP-002, and *Heat Stress Control*, HNF-PRO-121, Rev. 0 outline Hanford policies and guidelines in detail. Specific provisions of the guidelines are not reproduced here, but the estimates

of delay events given below attempt to account for these necessary policies for protecting the heath of workers.

The maximum temperature days (≥ 100°F) have occurred as early as May 7th and as late as September 6th at the Hanford site. The annual number of days with maximum temperatures ≥ 100°F range from 1 to 28 days. The greatest number of consecutive days with maximum temperatures ≥ 100°F is 11, which has occurred on three occasions.

The frequency and duration of severe heat-related events are estimated by examining the Hanford site-specific data for temperature. The results are summarized below. For purposes of estimation, the durations of delay are divided into three groups. The conditional likelihood of delay reflects both the chance that work might be stopped entirely, or that the schedule would have to be extended to compensate for the severe weather. The low likelihoods reflect the fact that many activities might not be sensitive to heat-related problems. The 24-hour delay reflects the likelihood that some work may not be able to be done during back shifts.

Highest Temperature, 100°≥ T_{MAX} ≥ 90°F

Lost Work Time (Hours)	Likelihood of Delay Given $90 \leq T_{max} < 100°F$	Number of days Temperature $90 \leq T_{max} < 100°F$	Frequency of Delays per Year
24	0	40	0
12	0	40	0
6	0.05	40	2.0
0	0.95	40	N/A

Highest Temperature, T_{MAX} ≥ 100°F

Lost Work Time (Hours)	Likelihood of Delay Given $T_{max} \geq 100°F$	Number of days Temperature $T_{max} \geq 100°F$	Frequency of Delays per Year
24	0.01	13	0.1
12	0.04	13	0.5
6	0.20	13	2.6
0	0.75	13	N/A

The estimated frequency of delays is obtained by summing the frequencies of the same duration.

Failure Mode Code	Duration of Delay	Frequency of Delays per Year	Frequency of Delays per Hour (Mean)
EXTHTEMP24	24	0.1	1.5E-05
EXTHTEMP12	12	0.5	6.0E-05
EXTHTEMP06	6	4.6	5.3E-04

Thus, one might expect to see delays of about 6 hours about five times per year, but the loss of an entire day is estimated to occur only once in 10 years.

3.5.1.2 *Low Temperature*

Environmental conditions that cause cold-related stresses also need to be considered. Cold-related stress is caused by a combination of low temperature, cool high winds, dampness, and/or cold water. Wind chill is an important factor to evaluate when working outside. A dangerous situation of rapid heat loss may arise for any individual exposed to high winds and cold temperatures.

At the Hanford site, the seasonal average of the number of days with minimum temperatures ≤ 32°F is 106. However, the seasonal number ranges from 70 to 143 days. The greatest number of consecutive days with minimum temperatures of ≤ 32°F has been 93.

On average, 3 days per winter season have a minimum temperature ≤ 0°F. Nearly half of all winters, however, have no minimum temperatures ≤ 0°F. The most days ≤ 0°F in any one season was 18, while the greatest number of consecutive days with minimum temperatures ≤ 0°F is 11 days.

The frequency and duration of severe cold-related events is estimated by considering the impact on the tasks necessary to setup and execute the delivery of waste feed batches. The table below identifies the likelihood of a work delay occurring in any given 24-hour work period. The conditional likelihood of delay reflects the judgment that the cold temperature will make it too difficult to accomplish some of the out-of-doors tasks required to set up and operate the transfer activities.

Lowest Temperature, T < 0°F

Lost Work Time (Hours)	Likelihood of Delay Given T_{min}<0°F	Number of days Temperature T_{min}<0°F	Frequency of Delays per Year
24	0.1	2.4	0.2
12	0.2	2.4	0.5
6	0.4	2.4	1.0
0	0.3	2.4	N/A

Lowest Temperature, 0°F < T < 32°F

Lost Work Time (Hours)	Likelihood of Delay Given 0°F <T_{min}<32°F	Number of days Temperature 0°F <T_{min}<32°F	Frequency of Delays per Year
24	0	101.9	0.0
12	0.01	101.9	1.0
6	0.04	101.9	4.1
0	0.95	101.9	N/A

Combining these values, the annual frequencies of 6, 12, and 24-hour delays due to cold temperatures are:

Failure Mode Code	Lost Work Time (Hours)	Frequency of Delays per Year	Frequency of Delays per Hour (Mean)
EXTLTEMP24	24	0.2	2.7E-05
EXTLTEMP12	12	1.5	1.7E-04
EXTLTEMP06	6	5.1	5.7E-04

3.5.1.3 Wind

Wind can be a significant cause of delays of work in the tank farms. Maintenance and repair work involving cranes and access to pits are particularly susceptible to stoppage due to high winds. These delays are accounted for in the recovery time distributions, which are based on both the type of equipment and conditions under which repair is accomplished (see Section 4). The estimate made here is for normal setup activities and routine O&M duties needed to monitor and control active mixing and transfer operations. Therefore, the onset of delays due to wind should occur at a higher threshold.

The most restrictive policies involve work that involves the potential for radiological contamination, where work may be restricted on days when wind gusts exceed 15 mph. For the Hanford site, 25 mph has been established as this threshold limit where all crane work is to be stopped. For wind speeds between 25 to 40 mph, other work may be continued at the discretion of the Shift Supervisor.

The highest monthly average wind speed at the Hanford site occurs in June and the lowest in December. The variability in monthly average wind speed, however, is greater in the winter months than during the remainder of the year. During an average year, 155 days can be expected to produce wind gusts $\geq$25 mph, thus stopping all crane activity. June and July have the highest number of days with gusts $\geq$25 mph, with nearly 20 days each.

In a given year, about 5 days would be expected to have a peak wind gust with a speed of greater than 50 mph, with no one month having a significantly higher frequency than any other. However, the winter months do have a slightly higher average of days with wind gusts greater than 50 mph. When the wind reaches speeds of 50 mph, the tank farms are to be evacuated.

The likelihood of work delays of various durations due to high winds is estimated below. When wind gusts reach over 50 mph, it is assumed that there will be at least some work stoppage, since the tank farm is to be evacuated. It was judged that work stoppage for gusts between 25 and 50 mph is less likely, being judged to occur on 10% of the days. This reflects the fact that only some activities would be affected by the wind, and cessation of operations may be at the discretion of the shift supervisor. The duration of stoppage depends on the duration of the gusts, and this information was not available in the data. The minimum duration is assumed to be 6 hours to account for the time that might be required to recover from the disruption.

Wind ≥ 50 mph

Lost Work Time (Hours)	Likelihood of Delay Given Wind Gusts ≥ 50 mph	Number of Days Having Wind Gusts ≥ 50 mph	Frequency of Delays per Year
24	0.1	4.9	0.5
12	0.4	4.9	2.0
6	0.5	4.9	2.5
0	0	4.9	N/A

Wind Between 40 and 50 mph

Lost Work Time (Hours)	Likelihood of Delay Given Wind Gusts between 40 & 50 mph	Number of Days Having Wind Gusts between 40 & 50 mph	Frequency of Delays per Year
24	0	21.4	0.0
12	0.01	21.4	0.2
6	0.09	21.4	1.9
0	0.9	21.4	N/A

Wind Between 25 and 40 mph

Lost Work Time (Hours)	Likelihood of Delay Given Wind Gusts between 25 & 40 mph	Number of Days Having Wind Gusts between 25 & 40 mph	Frequency of Delays per Year
24	0	129	0.0
12	0.01	129	1.3
6	0.09	129	11.6
0	0.9	129	N/A

Combining these values, the annual frequencies of 6, 12, and 24-hour delays due to wind gusts are:

Failure Mode Code	Mean Delay Time (Hours)	Frequency of Delays per Year	Frequency of Delays per Hour (Mean)
EXTWIND24	24	0.5	5.6E-05
EXTWIND12	12	3.5	3.9E-04
EXTWIND06	6	16	1.8E-03

3.5.1.4 *Precipitation*

Normal annual precipitation for the Hanford site is 6.26 inches. The wettest year on record had 12.31 inches. The months of November through February provide 3.35 inches (54%) of the normal annual precipitation. December is the wettest month, receiving 1.03 inches.

Nine periods have been recorded when precipitation has been abnormally high at Hanford. For example, precipitation for 1973 was 8.27 inches (132% of normal). During the period of October through December 1973, 6.38 inches of precipitation was recorded (289% of normal for those months). Precipitation of 6.36 inches was received in November and December 1996, representing 328% of the normal precipitation amount for the 2 months.

Snowfall at Hanford has varied from a seasonal total of 0.3 inches to 56.1 inches. The average date of the first measurable snow is November 29; while the last measurable snowfall date is February 11. The record snow depth at any one time is 15.6 inches and the record number of days in a season with snow depth $\geq$ 6 inches is 43.

An estimation of the frequency and length of delay associated with precipitation events was calculated based on the probability of inadvertently setting off alarms in the retention sumps at the storage tanks. The downtime expected to investigate and reset the alarm(s) is estimated to be 8 hours. This accounts for the continued duration of precipitation plus the time required to clear the alarm. The likelihood of work delays due to alarm failure as a result of precipitation is estimated below.

Precipitation

Precipitation Amount (inches)	Likelihood of Delay Due to Alarm Failure	Number of Days Having Given Precipitation	Frequency of Delays per Year
$0.10 \leq x < 0.25$	0.33	16	5.3
$0.25 \leq x < 0.50$	0.67	5.6	3.7
$0.50 \leq x$	1.0	1.4	1.4
Total		23	10.4

Failure Mode Code	Mean Delay Time (Hours)	Frequency of Delays Per Year	Frequency of Delays per Hour (Mean)
EXTPRECIP	8	10.4	1.2E-03

The above estimates do not include delays due to damage of equipment. The frequency of those types of events may be estimated by examining reports from the ORPS and JCS databases and would be included in Section 3.5.2, Other Extensive Events.

3.5.1.5 *Thunderstorms*

An estimation of the frequency and length of delay associated with avoiding lightning-induced events was calculated based on the frequency of thunderstorm days in the region. Loss of power events due to lightning strikes is accounted for in the loss of power estimation in Section 3.5.2.1. By definition, a thunderstorm day is one on which thunder is heard at the observing station one or more times during a calendar day, Hanford [Hoitink 1999a]. When a thunderstorm is within 30 miles of the Hanford site, all waste-disturbing activities are stopped. When the thunderstorm is within 5 miles, the tank farms are evacuated, per the Tank Farms Health and Safety Plan. For the purposes of this estimate, it is assumed that if a thunderstorm is heard, it is within 30 miles of Hanford.

Thunderstorms occur in every month except January. The typical thunderstorm season is from April through September. The average number of thunderstorm days per year is 10. However, the total in a given year varies from a low of 3 days to a high of 23 days.

An estimation of the frequency and length of delay associated with lightning was calculated based on the frequency of thunderstorms in the region. As more than one thunderstorm may pass through the area in a given day, a correction factor of 1.25 was applied to reflect the estimate that one out of four of the recorded days will have two thunderstorm delays during the day. The downtime expected due to a lightning storm is judged to be 3 hours. The likelihood of work delays due to lightning is estimated below.

Lightning

Failure Mode Code	Mean Delay Time (Hours)	Frequency of Delay per Year	Frequency of Delay per Hour (Mean)
EXTLIGHT	3	10 x 1.25 = 12.5	1.4E-03

3.5.2 *Other External Events*

Instances of loss of power are reported through ORPS, and ORPS reports for the period from January 1993 though December 1999 were used to generate the estimates of external events frequencies.

3.5.2.1 *Loss of Power Events*

Loss of power events include those due to lightning strikes during thunderstorms and losses of power from the external source. The duration of work stoppage may be greater than the outage produced by the loss of power. Depending on the transfer operations underway, actual loss of work time will depend on the effort needed to verify that conditions for continued operation remain satisfactory for restart. The delay estimates associated with the loss of power events in the ORPS are assumed to account for this additional time.

Table 3-2 lists the loss of power events that have been identified in the ORPS database that could cause a delay to transfer operations should they occur during transfer operations. Several events were identified during the review that were technically loss of

power events but were not included in this section. These events were the result of either miscoordination with a sub-contractor as to general safety concerns or inattention to safety in day-to-day activities. They are included in a separate category associated with human error under "other initiating events" in the following section.

For the period from January 1990 through December 1999 a total of twelve loss of power events resulting from either lightning or loss of the external source were identified in the ORPS database. The duration of these twelve events, loss of power events ranged from 0.75 hours to 4.5 hours, with a mean outage time of 2 hours. It is estimated that 4 additional hours will be needed to recover equipment once power is restored. This results in a mean combined outage plus recovery time of 6 hours following a lognormal distribution with a range factor of 3. The values of all the events fall within the 5%/95% confidence interval. This information is summarized as follows:

Failure Mode Code	Number of Events	Mean Delay Time (Hours)	Frequency of Delays per Year	Frequency of Delays per Hour
EXTLOSP	18	2+4 = 6	2	2.3 E-04

3.5.2.2 *Other External Events*

Table 3-3 lists other external events from the ORPS that are judged to have the potential to produce delays to transfer operations. These events account for various events, that range from severed cables to evacuations resulting from alarms (that may or may not be valid, but still stop work). The work stoppage time for these events ranged from less than 2 hours to 11 days. In order to accurately reflect the observed frequency and duration of the events and to characterize them in an attempt to identify potential strategies to reduce their future occurrence, the events were divided into three categories. Grouping them all into one category tends to bias the results towards the two long duration events. The categories selected are defined as follows:

- EXTSHORT – Non-weather Hanford Site work stoppage for other than human caused accidents, short duration (< 24 hours) (Weather related delays that do not involve damage to infrastructure are addressed in Section 3.5.1 above.)

- EXTLONG – Hanford Site work stoppage for other than human caused accidents, long duration (> 24 hours). This category includes delays required for the repair of infrastructure damage due to severe weather events.

- EXTHUMAN – Hanford Site work stoppage, due to human induced accidents or mishaps not associated with the ongoing activity (< 24 hours).

- EXTOTHER – Non-Hanford events that could potentially impact operations.

The results are summarized below:

Failure Mode Code	Number of Events	Mean Lost Work Time (hours)	Lognormal Range Factor	Frequency of Delays per Year	Frequency of Delays per Hour
EXTSHORT	7	4.3	5.2	0.78	8.9 E-05
EXTLONG	2	242	5	0.22	2.5 E-05
EXTHUMAN	3	4.2	3	0.33	3.8 E-05
EXTOTHER	0	24	3	0.16	1.8 E-05

As shown in Table 3-2 and the summary above, the ORPS database did not contain any non-Hanford events that impacted Hanford operations between 1990 and 1999. In the absence of an event, a frequency for future occurrences can be estimated using the 50 %-ile of Chi-squared distribution (0 events in 9 years) yielding a frequency of 0.16 events/year.

For the three categories of external events having occurrences, the mean duration of delay is the average duration of the observed events within each of the categories. Similar to the previous section, the spread of the delay times suggest a lognormal distribution with the average value of the times selected as the mean value. The range factors judged to be most representative of the data are shown in the table. The values of all the events fall within the 5%/95% confidence interval for the distributions. The estimate of a delay due to non-Hanford events is based on the judgment that Hanford has resources to restore operations within a day if onsite facilities are not damaged by the event. Delays involving on site damage would be accounted for in the EXTLONG category.

One of the events in the category EXTLONG resulted from a frozen transfer line due to cold weather. This event was considered to be infrastructure damage sufficiently long to be included explicitly with this category of events. Since that event directly delayed a transfer event, it was important to explicitly include it here. The EXTLTEMP events account for delays due to unsuitable work conditions not involving damage to equipment and infrastructure.

3.5.3 *Summary of External Events Variables*

After collecting all external events discussed in previous sections, a total of 16 external events are included in the quantitative model. They are summarized in Table 3-4.

Table 3-1. Failure Modes Associated with Various Types of Components and Operational Requirements

Component Type Category	Required Functions or Component Breakdown	Function Code	Failure Modes Associated with Components and Their Functions					Units of Mission Exposure
Pumps/Fans	Start and operate	DO	Fails to start/stop	Fails to run	Leakage/rupture (all modes)			Demands & time
	Start and operate	DO1	Fails to start/stop (non-catastrophic)	Fails to run (non-catastrophic)	Fails to start/stop (catastrophic)	Fails to run (catastrophic)	Leakage/rupture (all modes)	Demands & time
	Actively operate	O	Fails to run	Leakage/rupture (all modes)				Time
	Maintain integrity	P	Leakage/rupture (all modes)					Time
Power Operated Valves	Transfer open and remain open (closed, fails closed)	CC	Fails to open/close	Spurious operation	Plugs	Leakage/rupture (all modes)		Demands & time
	Transfer open and remain open (closed, fails closed)	CC1	Fails to open/close (manual backup)	Fails to open/close (no manual backup)	Spurious operation	Plugs	Leakage/rupture (all modes)	Demands & time
	Transfer closed and remain closed (open, fails open)	OO	Fails to open/close	Spurious operation	Leakage/rupture (all modes)			Demands & time
	Transfer open and remain open (closed, fails closed)	OO1	Fails to open/close (manual backup)	Fails to open/close (no manual backup)	Spurious operation	Leakage/rupture (all modes)		Demands & time
	Maintain required state (normally open {NO})	NO	Spurious operation	Plugs	Leakage/rupture (all modes)			Time
	Maintain required state (normally closed {NC})	NC	Spurious operation	Leakage/rupture (all modes)				Time
	Control	O	Fails to respond	Leakage/rupture (all modes)				Time

Table 3-1. Failure Modes Associated with Various Types of Components and Operational Requirements (Continued)

Component Type Category	Required Functions or Component Breakdown	Function Code	Failure Modes Associated with Components and Their Functions					Units of Mission Exposure
Check/Manual Valves	Transfer open and remain open (closed, fails closed)	CC	Fails to open	Plugs	Leakage/rupture (all modes)			Demands & time
	Transfer closed and remain closed (open, fails open)	OO	Fails to close	Leakage/rupture (all modes)				Demands & time
	Maintain required state (normally open {NO})	NO	Plugs	Leakage/rupture (all modes)				Time
	Maintain required state (normally closed {NC})	NC	Leakage/Rupture (all modes)					Time
Electrical/Instruments	Monitor/control/alarm (active)	O	Failure	Spurious operation				Time
	Switches that change position	D	Fails to open/close	Failure	Spurious operation			Demands & time
	Conductors and Switches that do not change position	P	Spurious operation (Includes failing shorted or open)					Time
	Heaters	O	Fails to heat	Overheats				Time
Pipes, Filters, Containers, Structures	Maintain required state (normally open {NO} or a filter)	P	Plugs	Plugs/fouls	Leakage/rupture (all modes)			Time
	Maintain required state (normally open {NO} or a filter)	P1	Plugs (catastrophically)	Plugs (non-catastrophically)	Plugs/fouls	Leakage/rupture (all modes)		Time
	Maintain integrity	P	Leakage/rupture (all modes)					Time
Miscellaneous	Other actively powered	O	Failure					Time
	Structural components	P	Failure					Time
	HEME/moisture separators	P	Failure					Time
	Other non-active	P	Failure					Time

Table 3-2. Loss of Power Events Identified in the ORPS Database that Cause Delays to Waste Feed Delivery Activities

ORPS Number 01	Discovery Date 10a	System/ Building 07	Title of Occurrence 14	Failure Mode Code	Rationale	Restoration Time	Time Rationale
RL--WHC-TANKFARM1991-1029	7/20/1991	242-A evaporator	Loss of electrical power to the 242-A evaporator	EXTLOSP	Unplanned power outage, back-up ventilation system (steam driven) could not be put into service due to scheduled steam outage.	4	Time required to troubleshoot and repair primary system.
RL--WHC-TANKFARM1991-1031	8/6/1991	Momentary power loss for 200 east and 200 west tank farms	External loss of power lightning strike	EXTLOSP		0.75	Based on ORPS report to investigate event and restart equipment.
RL--WHC-TANKFARM1991-1063	11/16/1991	200 west	Loss of power to 200 west tank farms	EXTLOSP	Loss of ventilation possible OSR violation.	3	Power restored within 1 min. System checkout continued for ~3 hrs.
RL--WHC-TANKFARM-1992-0028	3/16/1992	Tank farm facilities	200 east/200 west power outage	EXTLOSP	Power lost to west tank farm for ~ 30 min. and east tank farm ~ 2 hrs. 242-S evaporator evacuated due to exhauster shutdown. All tank farms put on fresh air.	2	Operations personnel obtained pressure readings from magnetic gauges in AW, AP, and AN tank farms. HP personnel surveyed AW, AP, and AN farms and take air samples. Primary exhauster in AW, AP, and AN farms restarted. East farm unable to restored immediately.
RL--WHC-TANKFARM-1992-0051	6/28/1992	200 west area	Electrical storm disrupts 200 west area power, resulting in temporary tank farm exhauster and alarm failures	EXTLOSP	Loss of ventilation possible OSR violation.	2	Due to the brief power outage, CASS substations de-energized and failed to reset when power was restored. Loss of alarm signals from the substations slowed process of identifying and resetting de-energized equipment.

Table 3-2. Loss of Power Events Identified in the ORPS Database that Cause Delays to Waste Feed Delivery Activities (Continued)

ORPS Number 01	Discovery Date 10a	System/ Building 07	Title of Occurrence 14	Failure Mode Code	Rationale	Restoration Time	Time Rationale
RL--WHC-TANKFARM-1996-0044	7/1/1996	241-AN/AW/ AP/AY/ AZ, 272-AW AND 244-AR	Unplanned electrical outage	EXTLOSP	Personnel evacuated from 241-AN, AW, and AP tank farms due to loss of ventilation. Personnel evacuated from AZ tank farm due to loss of power to pressure alarm circuits.	4.5	Blown line fuses identified and replaced. Normal power restored in approximately 4 hrs. Respective farms surveyed for contamination release.
RL--PHMC-TANKFARM-1997-0049	5/31/1997	241-SY, 241-SX, 242-T and 244-TX exhausters 242-S compressor	Momentary power loss at 200 west tank farms causes exhausters to unexpectedly shutdown	EXTLOSP	Momentary power loss, resulting in shutdown of 241-SY primary exhauster, 241-SY annulus exhauster, 241-SX exhauster, 242-T building exhauster 244-TX exhauster, and 242-S air compressor.	1	All equipment restarted, no damage noted. No release of contamination.
RL--PHMC-TANKFARM-1998-0067	6/21/1998	702-AZ primary ventilation system	Loss of 702-AZ primary ventilation	EXTLOSP	Alarm received for loss of UPS to primary ventilation system. Breakers reset causing cycling of controller closing dampers.	1	Immediate action was to restart ventilation system, unlikely that the system was out longer than 1 hour.
RL--PHMC-TANKFARM-1998-0092	7/30/1998	241-AW, Breaker #10	Unplanned entry into LCO 3.2.1 and 3.2.6 caused by inadvertent tripping of breaker #10	EXTLOSP	Nearby maintenance caused breaker #10 to be spuriously opened.	0.67	Time based on ORPS report to clear alarms and exit LCO.
RL--PHMC-TANKFARM-1998-0136	11/6/1998	Various systems throughout east and west tank farms, 200 east area	Power spike caused unplanned shutdown of several components	EXTLOSP	Light plane crashed into the power grid causing a power spike that caused trips of a large amount of equipment.	1	No outage time available. Outage time is an estimate based on knowledge of response. The immediate action was to restart equipment, unlikely that the out of service time was longer than 1 hour.

Table 3-2. Loss of Power Events Identified in the ORPS Database that Cause Delays to Waste Feed Delivery Activities (Continued)

ORPS Number 01	Discovery Date 10a	System/ Building 07	Title of Occurrence 14	Failure Mode Code	Rationale	Restoration Time	Time Rationale
RL--PHMC-TANKFARM-1998-0144	12/5/1998	702-AZ ventilation system	Loss of 702-AZ ventilation	EXTLOSP	Loss of power to the Uninterruptible Power Supply (UPS) #2 directly affected the loss of the primary ventilation system. Loss attributed to a significant amount of dust that had shorted out the emergency shutdown switch.	2.5	Time based on ORPS report to troubleshoot and exit LCO.
RL--PHMC-TANKFARM-1999-0058	8/5/1999	Tank farm facilities/loss of power/monitoring systems	Loss of power due to lightning storm	EXTLOSP		1	Estimate

Table 3-3. Other External Events Identified in the ORPS Database that Can Cause Delays to Waste Feed Delivery Activities

ORPS Number 01	Discovery Date 10a	System/ Building 07	Title of Occurrence 14	Failure Mode Code	Rationale	Restoration Time	Time Rationale
RL – WHC-TANKFARM-1991-0050	1/16/1991		Low-level contamination (8000 dpm) discovered in 272-aw men's change room.	EXTSHORT	Uncontrolled contamination in an operational area creates delays as the contamination is investigated and brought under control.	1.25	Based on ORPS report to clean up the contaminated area.
RL–WHC-TANKFARM-1992-0023	2/28/1992	244-TX DCRT LL	Exceeded maximum operating limit in 244-TX double contained receiver Tank and overflowed a small volume to the secondary containment sump.	EXTSHORT	Diesel fuel spill required remediation.	11	Took 5 hrs before steps initiated to locate and position drip pan. Portable compressor shut down 6 hrs later until a more efficient method/ system for fueling obtained.
RL--WHC-TANKFARM-19920039	5/11/1992	241-AY tank farm	Gasoline spill at 241-AY tank farm due to a faulty fuel pump.	EXTSHORT	Fuel leak from faulty fuel pump, gravel and soil required remediation.	2	Time required to remove affected soil/gravel and have van transported to garage.
RL--WHC-TANKFARM-1993-0008	1/15/1993	204-AR	Waste transfer delayed because the transfer pump deadheaded; frozen line suspected in AX-B valve pit; no injuries or environmental releases.	EXTLONG	Transfer pump appeared deadheaded, valve line-up verified. Second attempt terminated. Suspected that pipe jumpers in A-B and/or AX-B Valve Pit may be frozen blocking transfer line.	264	PLG estimate based on: three days after the failed transfer attempt, temporary heaters were placed in valve pit to thaw out pipe jumper. The transfer was completed 11 days later. A leak occurred in the AX-B valve pit during the transfer, (which the cold weather is assumed to contribute to).

Table 3-3. Other External Events Identified in the ORPS Database that Can Cause Delays to Waste Feed Delivery Activities (Continued)

ORPS Number 01	Discovery Date 10a	System/ Building 07	Title of Occurrence 14	Failure Mode Code	Rationale	Restoration Time	Time Rationale
RL–WHC-TANKFARM1993-0057	6/22/1993	Crane\lifting block\wire rope	KEH crane activities in 241-SY tank farm result in two-blocking main hoist block, severing wire rope and block falling to ground.	EXTLONG	Stop work issued, crane necessary transfer operations. While violation resulted from subcontractor crew, TFC personnel also affected.	220	Retraining required subcontractor and TFC personnel, stop work lifted after training completed.
RL–WHC-TANKFARM-1993-0072	8/11/1993		Loss of primary AC power to AP, AW, and AN tank farms resulted in the loss of primary exhaust fans to AP, AW, AN, and C tank farms.	EXTSHORT	This event could occur during Phase 1 operations with similar effects.	2	Based on ORPS report time to restart HVAC equipment.
RL–WHC-TANKFARM-1993-0089	9/27/1993	Computer automated surveillance system (CASS)	Instrument cable severed during contractor excavation work results in loss of remote alarm signals from east tank farm facilities.	EXTHUMAN	Computer Automated Surveillance System (CASS) cable severed, resulting in loss of remote alarm signals from east tank farm facilities.	2	Continuous monitoring of local alarms was established per CASS contingency backup procedure.
RL–WHC-TANKFARM-1993-0114	12/15/1993	Waste tank 241-C-103	Operations personnel performing liquid sampling of waste tank 241-C-103 on supplied air evacuated due to a carbon monoxide alarm.	EXTSHORT	Personnel directed to evacuate tank farm. Source of carbon monoxide was a truck parked to close to breathing air compressor intake.	1.5	Carbon monoxide monitor remained at a reading of 0 PPM for 1 hour, levels were within limits. Personnel were allowed to resume sampling work.

Table 3-3. Other External Events Identified in the ORPS Database that Can Cause Delays to Waste Feed Delivery Activities (Continued)

ORPS Number 01	Discovery Date 10a	System/ Building 07	Title of Occurrence 14	Failure Mode Code	Rationale	Restoration Time	Time Rationale
RL–WHC-TANKFARM-1994-0040	8/5/1994	Ventilation/east area tank farms	Loss of ventilation to east area tank farms due to subcontractor severing a power line	EXTHUMAN	Electric cable severed by sub-contractor performing excavation work. The loss of power resulted in loss of ventilation in 241-AN, AW, AP, C, 244-BX, and 244-CR. Also lost all remote tank monitoring capabilities.	1.5	Power restored, ventilation restored to all facilities. HPT performed surveys of affected farms, no spread of contamination.
RL–WHC-TANKFARM-1995-0044	5/3/1995	242-A evaporator/ AW-tank farm	241-AW tank farm "pressurization alarm" results in evacuation of personnel	EXTSHORT	In accordance with procedure ALL personnel evacuated from tank farm. Prior to returning to work, crews briefed to only perform inspections on one tank at a time.	8	Alarm was cleared with 10 min., however, second alarm an hour later forced a work stoppage until a critique could be held to discuss work options.
RL–PHMC-TANKFARM-1997-0064	8/6/1997	241-SY, 241-SX, 242-S, 244-TX, 242-T exhausters	Loss of tank farm ventilation power	EXTHUMAN	Vehicle caught utility pole guy wire, severing electrical wires. Disrupted power supply to 241-SY tank farm, shutting down 241-SY exhausters, 244-TX exhauster, 244- T exhauster, 241-SX exhauster and "S" and "T" CASS substations.	9	Driver removed from vehicle and electrical hazard eliminated. 241-SY back-up exhauster started using alternate power source. 244-TX exhauster, 242-T exhauster, 241-SX exhauster, and "S" and "T" CASS substations restarted. Power restored to 241-SY tank farm.

Table 3-4. Summary of External Events That Cause Delays to WFD Activities

System	Major Element	Subsystem 1	Subsystem 2	Component Type	EIN (External Event Designator)	Component Description	Failure Mode	Failure Rate	Unit	RECOVERY TIME ID	Mean Recovery Time (hours)
External events	Electrical distribution	Electrical distribution	Electrical distribution	EXT	EXTLOSP	Loss of power to tank farms	Stoppage	2.3E-04	H	EXTLOSP	6
External events	Hanford	Miscellaneous events	Work stoppage	EXT	EXTLONG	Hanford Site work stoppage, long	Stoppage	2.5E-05	H	EXTLONG	242
External events	Hanford	Miscellaneous events	Work stoppage	EXT	EXTSHORT	Hanford site work stoppage, short	Stoppage	8.9E-05	H	EXTSHORT	4
External events	Hanford	Non-tank farm human error	Non-tank farm human error	EXT	EXTHUMAN	Hanford site work stoppage, due to human	Stoppage	3.8E-05	H	EXTHUMAN	4
External events	Off Site	Miscellaneous events	Work stoppage	EXT	EXTOTHER	Other non-Hanford events	Stoppage	1.8E-05	H	EXTOTHER	24
External events	Weather	Lighting	Lighting	EXT	EXTLIGHT	Lightning within 30 miles	Stoppage	1.4E-03	H	EXTLIGHT	3
External events	Weather	Precipitation	Precipitation	EXT	EXTPRECIP	Precipitation caused delays	Stoppage	1.2E-03	H	EXTPRECIP	8
External events	Weather	Temperature	Temperature high	EXT	EXTHTEMP24	Temperature high 24 hr delay	Stoppage	1.5E-05	H	EXTHTEMP24	24
External events	Weather	Temperature	Temperature high	EXT	EXTHTEMP06	Temperature high 6 hr delay	Stoppage	5.3E-04	H	EXTHTEMP06	6
External events	Weather	Temperature	Temperature high	EXT	EXTHTEMP12	Temperature high 12 hr delay	Stoppage	6.0E-05	H	EXTHTEMP12	12
External events	Weather	Temperature	Temperature low	EXT	EXTLTEMP12	Temperature low 12 hr delay	Stoppage	1.7E-04	H	EXTLTEMP12	12
External events	Weather	Temperature	Temperature low	EXT	EXTLTEMP24	Temperature low 24 hr delay	Stoppage	2.7E-05	H	EXTLTEMP24	24
External events	Weather	Temperature	Temperature low	EXT	EXTLTEMP06	Temperature low 6 hr delay	Stoppage	5.7E-04	H	EXTLTEMP06	6
External events	Weather	Wind	Wind gusts	EXT	EXTWIND06	Wind gusts 6 hr delay	Stoppage	1.8E-03	H	EXTWIND06	6
External events	Weather	Wind	Wind gusts	EXT	EXTWIND24	Wind gusts 24 hr delay	Stoppage	5.6E-05	H	EXTWIND24	24
External events	Weather	Wind	Wind gusts	EXT	EXTWIND12	Wind gusts 12 hr delay	Stoppage	4.0E-04	H	EXTWIND12	12

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4. Recovery from Off-Normal Events

This section summarizes the approach used to quantify the time needed to recover from the off-normal events modeled in the preliminary RAM analysis. These include hardware failures, human errors, and external events (i.e., all schedule-delaying events included in the RAM model quantification). The approach makes a distinction between the actions required to resume the scheduled WFD activities and those needed to bring the WFDS back to its normal operating condition. The restoration time associated with each off-normal event is used for calculations of schedule delay and the idle facilities penalty FOM. Section 4.1 defines the term "restoration time" and discusses how it is related to recovery activities that bring the system back to its fully operational configuration. It then summarizes how these times are estimated in the preliminary RAM analysis. Section 4.2 addresses the recovery of system hardware (SSCs) following an off-normal event, while Sections 4.3 and 4.4 present the restoration times associated with human errors and external events.

4.1 Approach for Estimating Recovery

The primary objective of the recovery analysis is the quantification of the time to restore WFD activities after each off-normal event. In this section, recovery analysis terms are defined and the approach used for the waste feed delivery system RAM recovery time analysis is described.

4.1.1 Definition and Interpretation of Recovery Activities

The preliminary RAM analysis makes a distinction between the time needed to restore the system functionality so that an interrupted waste transfer activity may be resumed following an off-normal event, and the time needed to repair SSCs that may have failed or been damaged. These concepts are encompassed by the following definitions:

- Time to Restore. For the preliminary RAM analysis, the "time to restore" is defined as the total clock time from the occurrence of the off-normal event until the interrupted WFD activity resumes. This term can be applied to both hardware and non-hardware interruptions.

  Hardware recovery options include both manual switchover to a backup and repair of the failed SSC. If an SSC has a redundant backup or an alternate operational mode that can be brought into operation, the time to restore will reflect the time required to complete realignment and startup of the backup. Otherwise, the SSC will have to be repaired to restore the function.

  Restoration time following non-hardware related off-normal events can reflect a number of delaying circumstances. These include site conditions that are too severe for active operations, need for revision of inadequate procedures, retraining of the

workforce, or time required to recover facilities that are not under the control of TFC O&M organizations.

- Time to Repair refers to an SSC's downtime until it can be brought back to full operation. In the context described here, the term "repair" includes either actual repair or replacement of the SSC. The operative requirement is that the failed hardware's functional capabilities be fully recovered.

- Recovery is the term used to encompass all the actions involved in both restoration and repair.

Figure 4-1 illustrates the variety of recovery activities that might take place following an off-normal event to resume scheduled waste feed activities. As shown in the figure, Operation's first responsibility is to assure the facility has transitioned to a safe state that will enable recovery to proceed. If this condition is not met, emergency response procedures are entered. Design features and controls to minimize the occurrence of off-normal events are addressed in the authorization basis. Because emergency response activities are safety related, and would take immediate precedence over WFD activities aimed at resuming operations, any delays resulting from emergency response are considered to generate special circumstances that are not within the scope of the preliminary RAM analysis.

When hardware failures have caused the off-normal event, recovery actions may restore the system function either by switchover to a backup, or repair of the failed SSC. For most single-train (i.e., non-redundant) components without some type of manual bypass capability, time to restore is the same as time to repair, but for redundant components, time to restore generally differs significantly from the time to repair. In the case of SSCs having manual bypass or secondary manual operation, the time to restore will be the time required to realign the system, in effect, bypassing the failed component function to restore process function. For example, when an HVAC system fan in a one-out-of-two redundant HVAC train system fails, the ventilation can be restored relatively quickly by isolating the failed fan, realigning flow paths as necessary, and placing the failed fan's redundant (standby) fan in operation. After the failed SSC is bypassed, it should be repaired expeditiously to restore the backup capability.

Recovery from human errors and external events does not generally have a fallback option. The issues that produced the off-normal event must be addressed directly and resolved prior to resuming scheduled operations. In the case of human error, recovery involves investigation of the cause of the error and corrective action to assure that the error will not occur again. In the case of external events, it involves waiting for the unfavorable conditions that generated the off-normal event to clear or be corrected. Sections 4.3 and 4.4 briefly discuss the approach used in the preliminary RAM analysis to quantify delays due to human error and external events, respectively.

4.1.2 Approach

Typical "generic" recovery times for SSCs available from other sources do not apply at the Hanford tank farms. Furthermore, the historical evidence of restoration time available from ORPS and JCS data does not reflect the more focused operational environment that is expected to exist when waste transfer activities commence. Therefore, the preliminary RAM analysis used the judgment of personnel familiar with

site operations to estimate recovery times based on their knowledge of the location, potential for intrusion, and magnitude of anticipated repair activity.

In general, two sets of estimates were generated for use in the preliminary RAM analysis.

- The first set provides estimates of restoration times. Section 4.2.1 presents estimates of SSC restoration times for conditions where full repair is not required to regain functionality and resume operations. Restoration times associated with human error and external events are addressed in Sections 4.3 and 4.4, respectively.

- The second set provides estimates of the repair time and effort for SSCs that have suffered a material failure. These estimates were generated as part of the O&M Concept development and are documented in Appendix H of the "O&M Concept Document" (Carlson, 1999). They provide an estimate of not only the time to plan and complete repair activities, but also the breakdown of engineering and crafts resources needed to accomplish those activities. These are addressed in Section 4.2.2.

Formal elicitation methods were not used to generate the restoration and repair time distributions used to quantify the preliminary RAM analysis. These methods require a very rigorous methodology and time-consuming approach involving a large group of experts who review multiple data sources and provide expert opinions. The basis and evidence for each opinion and assumption is then carefully documented and analyzed. Given the developmental stage of the preliminary RAM analysis, it was judged that the structured, but informal discussions that produced the estimates would be adequate to reflect our current knowledge regarding the problems associated with the recovery of the WFDS from off-normal events. The generic categorization of recovery actions contained in the preliminary RAM analysis will provide TFC personnel with the capability of reviewing and refining the results to reflect known problems and examine the impact of anticipated delays.

4.2 Recovery from Hardware Failures

This section focuses on the recovery from hardware failures. Hardware failures were addressed using three categories.

- Restoration from failure modes that do not require repair.

- Times to repair categories of equipment, grouped by component type and the conditions under which the repair is accomplished.

- Recovery times for large pumps in DST tanks are presented that account for the recent estimates made by Shaw (Shaw, 1998).

4.2.1 *Time to Restore Functions Not Requiring SSC Repair*

Active WFD operations are interrupted upon the functional failure of any SSC needed for either the WFD activity underway or continued safe storage. However, some systems do provide for a manual restoration of function prior to repairing the failed SSC. Examples of DST systems that meet this description are:

- MOVs being installed in some valve pits will have the capability for manually changing the valve position if the motor operator fails. MOVs that fall into this category have been identified with a special function code (see Table 3-1) so that the fraction of failures that cannot be manually overridden can be accounted for.

- Some equipment failure modes may be able to be cleared without having to fully repair an item of equipment. Examples are instances of spurious signals from instruments, or minor plugging incidents that can be eliminated by flushing. Pipes for which plugging would cause very long delays have been identified with a special function code (see Table 3-1) so that the fraction of plugs that cannot be flushed can be accounted for. (It is assumed that plugged valves will require repair.)

- Some DST HVAC systems have backup that can be manually aligned in time to restore safe conditions in accordance with the authorization basis and permit resumption of WFD activities.

The preliminary RAM analysis accounts for these capabilities to restore system function without immediate repair by assigning a restoration time that reflects the time required for problem investigation, manual switchover, and resumption of WFD activities. Table 4-1 identifies the restoration time distributions used when repair is not required. They are modeled with a triangular distribution, having a firm minimum and maximum duration, with a point of maximum probability (mode) somewhere between. These distributions represent the judgment that manual switchover to redundant SSCs should not involve large uncertainties. Table 4-2 defines the categories used to assign variable names for the recovery distributions. The objective of the coding is to assist the identification of restoration activities having similar problems.

The preliminary RAM analysis currently assumes that if switchover to a backup train has been made, the backup train will function without failure until repairs to the failed component are completed. This assumption is based on the judgment that the likelihood of a random independent failure in the backup component is small during the time required to complete the mission, so a long outage should not be required to complete a repair because both the primary and standby trains are failed. Since the frequency of failure of the component has been calculated for the entire mission duration, the RAM model is not undercounting the total number of failures. Common cause failures and unusual or out-of-envelope operating conditions can precipitate additional failures at a higher rate, but the additional model complexity and the unavailability of evidence to support these evaluations would require effort not warranted by the current state of the system design. (This same assumption applies to failures following successful automatic switchover to a backup train, which is discussed in Section 2.3.2.)

4.2.2 *Generic Repair Time Distributions for Hardware*

The preliminary RAM evaluation uses knowledge of the location, potential for intrusion into the primary tank boundary, radiation working conditions, and magnitude of anticipated repair activity to estimate the time required to repair SSCs.

4.2.2.1 *Assumptions Used for the Repair Time Estimate*

Table 2-7, "Assumptions Used in the RAM Analysis," contains a number of the assumptions relating to the conduct of corrective maintenance and recovery actions extracted from the O&M concept document (Carlson, 1999). The recovery durations reflect two important assumptions that have been made regarding the availability of personnel and spares that should be emphasized here.

Staffing limitations are assumed to not be controlling factors in time/effort estimates for either normal or off-normal activities in this analysis. Specifically, personnel required to support the estimation of recovery times are assumed to be available, or can be readily recalled to duty, whenever an off-normal event occurs that requires their skills.

The recovery time estimates for corrective maintenance assume that the required spare parts and special equipment can be made available within the time required to review and coordinate the recovery work packages. Specifically, the lack of spares and specialized equipment will not become a critical path source of delay in the recovery. To be valid, this assumption requires the implementation of a spare parts program that provides for both spares stocking levels for likely failures and contingency plans for procurement of equipment that is not stocked. The specifics of this program will depend on the characteristics of components and equipment that still have to be procured.

4.2.2.2 *Repair Time Task Analysis*

The execution of repair on an SSC is controlled by use of a maintenance work package. The steps needed to plan and execute a typical work package are summarized in Table 4-3. These nine steps provided the template by which time and effort were estimated by craft to accomplish corrective maintenance for a variety of generic component types and maintenance conditions.

4.2.2.3 *Component Categorization for Generic Repair Time Analysis*

Recovery performance for corrective maintenance is based on several requirements that affect the mean time to repair values. Because of the large number of individual components comprising the WFDS and several requirements affecting the repair time, it is necessary to combine similar types of actions for similar types of components into a manageable set of generic recovery actions with similar attributes. The most important attributes are as follows:

1. Component types with similar corrective maintenance activities (e.g., general instrumentation and control, specialized instrumentation and control, TFC electrical, non-TFC electrical, minor mechanical, vent and balance, computer control, major mechanical, landlord-related).

2. Component location (e.g., within a pit or enclosure, within a tank farm, in a non-radiation area).

3. Radiation working conditions (e.g., remote or contact operation and/or maintenance).

4. Work relative to the primary tank boundary (intrusive or non-intrusive).

5. Planning involved (simple, moderate, or extensive).

6. Lead time for parts and equipment (e.g., no parts or equipment, spares available, short time, long time).

Figure 4-2 provides the results of the application of the six factors identified above to developing the recovery conditions. This results in 12 categories of recovery conditions.

To more easily model the large number and variety of components within the WFDS, components were grouped into categories based on the mix of crafts required to complete a repair. This grouping is shown in Table 4-4.

4.2.2.4 Results of Generic Repair Time Analysis

The 12 categories were combined with the component groupings to derive the overall set of generic recovery actions to be subjected to the task analysis. The examination of the 12 recovery conditions in combination with the general WFDS component groupings resulted in the quantification of 39 generic recovery paths for corrective maintenance activities that reflect the range of situations that field personnel can anticipate facing when failures occur. Based on their knowledge of the working conditions that might exist under the conditions established for each generic action, experienced field personnel then estimated the resources, time, and effort that would be typically required for each step. The estimates for the individual steps are then combined to develop a reasonable distribution of resources and time needed to recover from failures falling into each of the 39 categories.

The results of the repair time analysis are illustrated in Figure 4-3. Mean repair durations ranged from a low of nine hours for utility electrical maintenance to a high of 3,097 hours for major mechanical pit work.

4.2.2.5 Generic Mapping of Failure Modes to Recovery Distribution

To enable consistent quantification of failure modes delay for the preliminary RAM analysis, the above concepts and rules have been consolidated within two linkage tables in the RAM database. The linkage tables are then used to interpret information provided by the P&IDs and the definition of failure modes by the RAM analysis to categorize the generic conditions illustrated in Figure 4-2 sufficiently to assign a generic recovery distribution to an individual failure mode.

Location to Radiation Area Table: This table assigns a Radiation Area Code to each unique Location ID and Location Description cited in the P&IDs of the systems. The Radiation Area Code identifies the branch of Figure 4-2 from which a recovery code will be selected.

Recovery Time ID Table: This table uses the Radiation Area Code with the Component Type Code and the Component Description to characterize the general working conditions encompassed by the next four branches of the recovery tree illustrated in Figure 4-2. For example, it is assumed that the sensor elements of systems located in radiation areas will be located in the most intrusive areas, whereas transmitters and indicators will be offset from those locations. In addition, the combination of component type code and component description provides a good indication of the potential magnitude and complexity of the recovery. The failure mode is linked to this table from the Component Link Table that assembles the RAM quantification conditions.

The failure mode is used to adjust judgments regarding effort. For example, it is generally assumed that the failure mode "Spurious Operation" refers to off-normal events that can be cleared by cleaning, adjusting, resetting, or realigning the component in order to complete the immediate mission. As no component has just a "Spurious Operation" failure mode, those failures that require more significant repairs will be categorized under an outright "Failure" failure mode.

As a result of this logic, a generic recovery distribution is assigned to each unique combination of the following:

- Radiation Area Code (which may encompass many locations identified in the P&IDs.
- Component Type Code – as listed on the P&IDs.
- Component Description – as listed on the PI&D diagrams (if stated on the diagram) or obtained from the Component Type Code definitions on the P&ID legend (if not stated on the diagram).
- Failure Mode.

Within the database, these assignments are tagged as "generic" so that they may be overridden for systems and components that are known to not conform to these general guidelines. This provides both an efficient means of assigning recovery codes as P&IDs are changed, while providing flexibility to properly represent specific configuration that may not conform to the generic rule set. The structure of the RAM database that implements the reasoning summarized in this section is described in more detail in Appendix A.

4.2.3 Recovery from Failures Associated with Large Pumps in DSTs

A review of the generic repair distributions that would be associated with mixer pumps and waste transfers pumps indicates that the repair times involving complete replacement of a pump could be extremely long. However, the need for being prepared to replace the large pumps in DSTs if one should fail during WFD activities is widely recognized. The problem has been addressed by Shaw for a specific pump configuration in the document, *First Spare Mixer Pump and Installation Equipment System Design Description for 241-SY-101 Waste Tank* (Shaw, 1998). In that document, Shaw discussed in detail the resources necessary for replacement of a pump

and developed a schedule for the overall replacement activity. He also developed assumptions that would enable these recovery actions to proceed.

Shaw's estimates are judged to be the best available information for the repair of large pumps following a catastrophic failure. However, the evaluation of the site-specific operating data available for transfer pumps, presented in Table C-6 of Appendix C, has indicated that waste transfer pumps have experienced off-normal events that did not require complex and lengthy repair activities. Therefore, the failure rate associated with large pumps in the DSTs (both the mixer pumps and the transfer pumps) have been broken into two failure modes, non-catastrophic and catastrophic, in order to properly reflect the shorter duration restoration time as well as the longer repair time. This section discusses the recovery times associated with each of these failure modes.

4.2.3.1 Non-Catastrophic Failure Modes

The review of the site-specific data in Table C-6 of Appendix C indicated that recovery from the non-catastrophic failure modes involved restoration tasks, such as clearing signals, rather than repair tasks. Based on discussions with O&M personnel regarding this evidence, the triangular distribution whose properties are shown in Table 4-4 was developed to represent the duration of these restoration activities.

4.2.3.2 Catastrophic Failure Modes

Given that the insights developed in Shaw's report are implemented, the durations reported by Shaw are judged to be more tailored to the situation that would be faced with either mixer or transfer pumps. Consequently, a triangular repair distribution was generated in coordination with the Shaw and other O&M staff to represent that replacement time following a catastrophic failure of the pump. The properties of this distribution are presented in Table 4-5.

4.3 Delays Associated with Human Errors

The purpose of human action analysis is to identify activities in which a human error can lead directly to a delay of the progress of waste feed delivery activities. In defining these human actions, waste transfer procedures, the FSAR (CHG 2000b), and other standards were reviewed, as illustrated in Appendix D. The estimation of the error rates associated with human errors was discussed in Section 3. To assist in estimating recovery time, the Technical Safety Requirements (TSRs) were also used to identify appropriate off-normal condition response actions and completion times. This information was then assessed to generate restoration times that reflect the total time required to complete all necessary corrective actions, restore the system to proper operating state, and receive approval to resume operations. Table 4-6 provides the resulting distributions of delays that might result from human error. It should be recognized that, prior to the completion of the safety analyses of the planned waste feed delivery activities and the development of procedures based on updated TSRs, estimates of delays due to human error are very preliminary.

4.4 Delays Associated with External Events

The delays arising from external events fall into two categories, those resulting from weather-related delays, and those associated with off-normal events that are outside the responsibility and control of the TFC. The duration of delays associated with weather have been hypothesized in conjunction with the estimation of the frequency of weather-related delays in Section 3.5. The duration of delays associated with loss of power and off-normal events that are outside the responsibility and control of the TFC have been estimated from a review of ORPS reports. Both the frequency and duration of these events are summarized in Tables 3-2 and 3-3 and 3-4 with their associated restoration time estimates.

Table 4-1. Distributions Used to Model Restoration Times

Recovery Time ID	Clock Hours (Low)	Clock Hours (Mode)	Clock Hours (High)	Location	Containment Tank Intrusive?	Procure Parts?	Plan Package?	Typical Rationale	Use for Restoration of WFD Function
Recoveries Involving Work Impacting the Primary Tank Boundary								Tasks involving repair/replacement of smaller items.	
RTPTBSML01	2	24	72	Outside Pits	Yes	No	No	Non-maintenance operational response; routine maintenance, no planning required.	This distribution was applied primarily to leak detector response and resetting.
RTPTBSML02	120	144	168	Inside pits/tank enclosures.	Yes	Yes	Yes	Maintenance requiring planning, 2-day package preparation, 2 day coverblock removal and procurement, 1 - 3 day maintenance; outside support; SCBA and waste management required.	This distribution was applied primarily to instrumentation that is contained within valve pits such as valve position switches and leak detectors that only require a manual adjustment to recover a normal operating configuration.
Recoveries Involving Work Inside a Tank Farm Fence								Tasks involving repair/replacement of smaller items	
RTFRMSML01	1	4	12	Farm	No	No	No	*Routine maintenance, no planning required; simple* troubleshoot and repair, no parts required; routine alarm response; redundant/backed up equipment failure.	
RTFRMSML02	2	6	48	Farm	No	No	No	Routine maintenance, no planning required; simple/moderately complex troubleshoot and repair, *parts available; non-routine alarm response; SCA entry* required.	
RTFRMSML03	12	24	120	Farm	Maybe	No	Yes	Maintenance requiring planning, spares probably available, 1 day package preparation; SCA entry and waste management required.	This distribution was assigned for plugging events where a flush was likely to recover the failure.
RTFRMLRG01	4	24	168	Farm	No	No	No	Routine maintenance, no planning required; moderately complex troubleshoot and repair, parts available.	
Recoveries Involving Work Outside a Tank Farm Fence								Tasks involving repair/replacement of smaller items	
RTOTHSML01	1	2	6	Outside farm	No	No	No	Routine maintenance, no planning required; simple troubleshoot and repair, no parts required.	This code was applied primarily to redundant components whose recover required a manual restart of the standby system.
RTOTHSML02	6	12	24	Outside farm	No	No	No	Routine maintenance, no planning required; moderately complex troubleshoot and repair, parts available; non-routine alarm response	This code applied primarily to leak detectors in supporting systems such as the flush/ dilution system and to other supporting components that could have a rapid recovery such as a plugging of a flush/dilution system valve.
RTOTHSML03	12	24	72	Outside farm	No	No	Yes	Maintenance requiring planning, spares probably available, 1 day package preparation	This code was applied in error to 9 components in LAW systems. They should have been encoded RTOTHSML02.
RTOTHLRG01	2	60	120	Outside farm	No	No	No	Routine maintenance, no planning required; simple/moderately complex troubleshoot and repair, parts available; routine alarm response	
RTXXXDWN01		10000						Special circumstances in which waste transfer operations would be reevaluated; other programmatic impacts	

Table 4-2. Interpretation of Restoration Time (RT) Variable Names

Restoration Time Variable Definition	
Format: RTAAABBB##	
RT	Restoration time identifier
AAA	General category of restoration activity
BBB	Focus of restoration activity
##	Index number to differentiate activities as necessary for planning
Current Codes	
AAA	Equipment failures are distinguished by:
PTB	Hardware failure that requires work that affects the primary tank boundary
FRM	Hardware failure that requires work inside a tank farm restricted area fence
OTH	Hardware failure outside the tank farm restricted area fence having no potential radiation or contamination problems
HUM	Recovery from human mishaps that cause work stoppage for cause
EXT	Recovery from external events
XXX	Special category of events placeholder; these events are either so severe or so remote that they should be considered individually
BBB	Focus of restoration activity
LRG	Hardware: tasks involving repair/replacement of larger items
LRG	Human and external: unusual events that require special assessments or high-level management involvement to resolve
SML	Hardware: tasks involving repair/replacement of smaller items
SML	Human and external: events that can be resolved within the TFC supervisory/management structure
##	Index number
01-04	Generic distributions from shortest to longest anticipated restoration time
05, etc.	Identifies a specific restoration time distribution

Table 4-3. Task Breakdown for Generic Repair Time Estimation

Recovery Action Step	Recovery Action Description
Troubleshoot Work Release	Provides a quick work release to perform troubleshooting in the field. This step can be more extensive if the troubleshooting requires lock and tag.
Determine Problem Cause	Perform in-field troubleshooting to determine the recovery scope.
Plan Maintenance Package	Perform work planning to the required level of detail for the complexity of the job. Assemble work package.
Establish Administrative and Physical Boundaries	Establish lock and tag boundaries and other administrative boundaries.
Establish Access to Component	As applicable, take those actions necessary to gain direct access to component (e.g., remove cover blocks, perform excavation, remove barriers).
Repair or Replace Component	Prepare for and perform the required maintenance activity.
Restore Access	Re-establish original access conditions.
Preliminary Testing	Perform any necessary preliminary equipment checks to validate key aspects of the maintenance action.
Restore System Lineup and Perform Functional Tests	Re-establish original lock and tag boundaries, system lineups and perform the necessary functional testing.

Table 4-4. Restoration Time Distributions Used in Lieu of Generic Repair Variables for Mixer and Waste Transfer Pump Failure Modes

		Triangular Distribution Parameters (Hours)			
Failure Mode	Recovery code	Low	Mode	High	Mean
Non-Catastrophic	RTTMPSML01	4	72	120	65.3
Catastrophic	RTTMPLRG01	200	1900	2400	1500.0

Table 4-5. Component Categories Based on Craft Effort for Corrective and Preventive Maintenance

Component Repair Category	Types of Components Included
1 - I&C General	Monitoring device - flow
	Monitoring device - leak
	Monitoring device - level
	Monitoring device - pressure
	Monitoring device - temp
	Valve (control and indication)
2 - I&C Special	Control loops
	Gas monitoring assembly
	Radiation monitoring assembly
3 - Electrical Onsite	Alarms (general, panels, relays, etc.)
	Electric power - onsite (TWRS WFDS)
	Fan speed control
	Heaters
	Pump speed controls
4 - Electrical Offsite	Electric power - offsite
5 - Mechanical General	Air systems - compressors
	Air systems - dryers
	Fans
	Filters
	Heat exchangers
	Jumpers
	Manually operated valves
	Nitrogen supply
	Pipes
	Relief valves
	Remotely operated MOVs and SOVs
	Risers
	Rupture disks
	Service water (RAW)
	Support system pumps
6 - HVAC Special	Absorbers
	Dampers
	De-entrainers/mist eliminators
	Ducting, expansion joints
7 - Computer	Computer monitoring
	Control stations (computer/automated)
8 - Mechanical Major	Tanks
	Waste contacted pumps - external motor
	Waste contacted pumps - internal motor
9 - Support Facilities	Misc. support facilities
0 - Special	None yet identified

Table 4-6. Distribution Used to Model Delay Times Following Human Error

Recovery Time ID	Clock Hours (Low)	Clock Hours (Mode)	Clock Hours (High)	Location	Primary Tank Boundary Intrusive	Procure Parts	Plan Package	Typical Rationale	Use for Human Error
RTHUMSML01	1	2	6	N/A	No	N/A	N/A	Able to identify and recover transfer without major self evaluation	
RTHUMSML02	6	12	24	N/A	Maybe	N/A	N/A	Shutdown time to reconcile discrepancies in measurements. This estimate assumes that a capability to measure exists on site, but some checking of the first measurement must be accomplished.	Accounts for slips that require recheck and do not involve safety
RTHUMSML03	12	24	48	N/A	Maybe	N/A	N/A	Two-shift stand-down to review why existing procedures and controls did not work in this case.	
RTHUMLRG01	120	240	480	N/A	Maybe	N/A	N/A	Requirement to add one additional mixing cycle for AN-104/105 when sampling error made.	
RTHUMLRG02	168	336	672	N/A	Maybe	N/A	N/A	Two week stand-down to update policies, procedures, and controls. Personnel are retrained on appropriate procedures and an external review is conducted. Requirement to add one additional mixing cycle.	Misaligning transfer path and starting transfer. Waste sampling or processing discrepancy

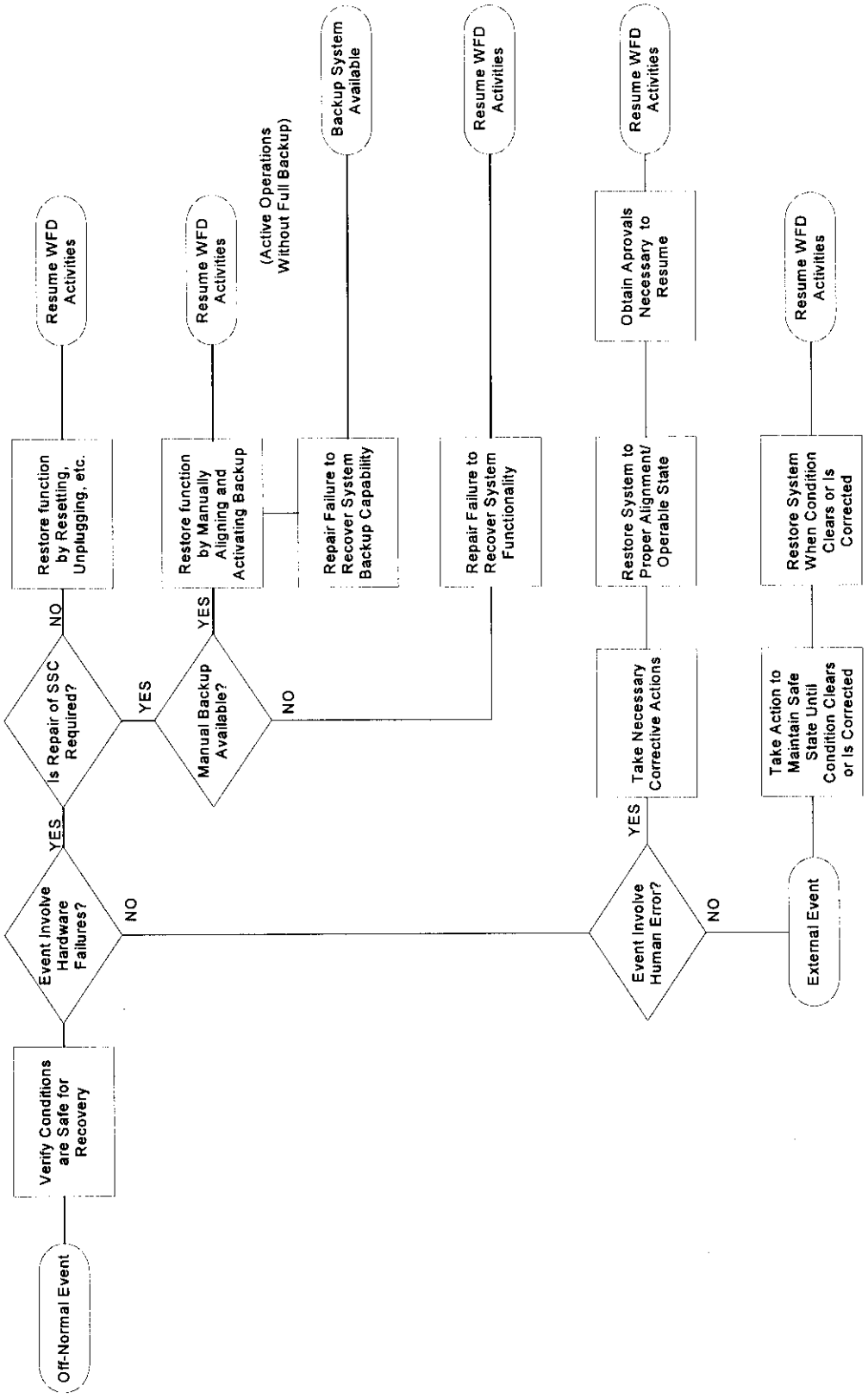

Figure 4-1. Recovery Actions Following an Off-Normal Event

ACTIVITY (COMPONENT)	LOCATION	RADIATION WORKING CONDITIONS	PRIMARY TANK BOUNDARY	PLANNING EFFORT	PARTS & EQUIPMENT LEAD TIMES	RECOVERY TIME IDENTIFIER
	INSIDE PIT ENCLOSURE (RADIATION AREA)	REMOTE	INTRUSIVE	SIMPLE	NONE	
					AVAILABLE	
				MODERATE	SHORT	
					LONG	PRIML*
				EXTENSIVE	SHORT	
					LONG	PRIEL
		CONTACT	INTRUSIVE	SIMPLE	NONE	
					AVAILABLE	
				MODERATE	SHORT	
					LONG	PCIML
				EXTENSIVE	SHORT	
					LONG	PCIEL
	INSIDE OF THE TANK FARM (RADIATION AREA)	REMOTE	INTRUSIVE	SIMPLE	NONE	
					AVAILABLE	TRISA
				MODERATE	SHORT	
					LONG	
				EXTENSIVE	SHORT	
					LONG	TRIEL
		CONTACT	INTRUSIVE	SIMPLE	NONE	
					AVAILABLE	TCISA
				MODERATE	SHORT	
					LONG	
				EXTENSIVE	SHORT	
					LONG	TCIEL
			NON-INTRUSIVE	SIMPLE	NONE	
					AVAILABLE	TCNSA
				MODERATE	SHORT	
					LONG	
				EXTENSIVE	SHORT	
					LONG	TCNEL
	NON-RADIATON AREA	CONTACT	NON-INTRUSIVE	NEGLIGIBLE	NONE	
					AVAILABLE	NCNNA
				SIMPLE	AVAILABLE	
					SHORT	
				MODERATE	SHORT	
					LONG	
				EXTENSIVE	SHORT	
					LONG	NCNEL

Figure 4-2. Application of Factors to WFDS Recovery Conditions

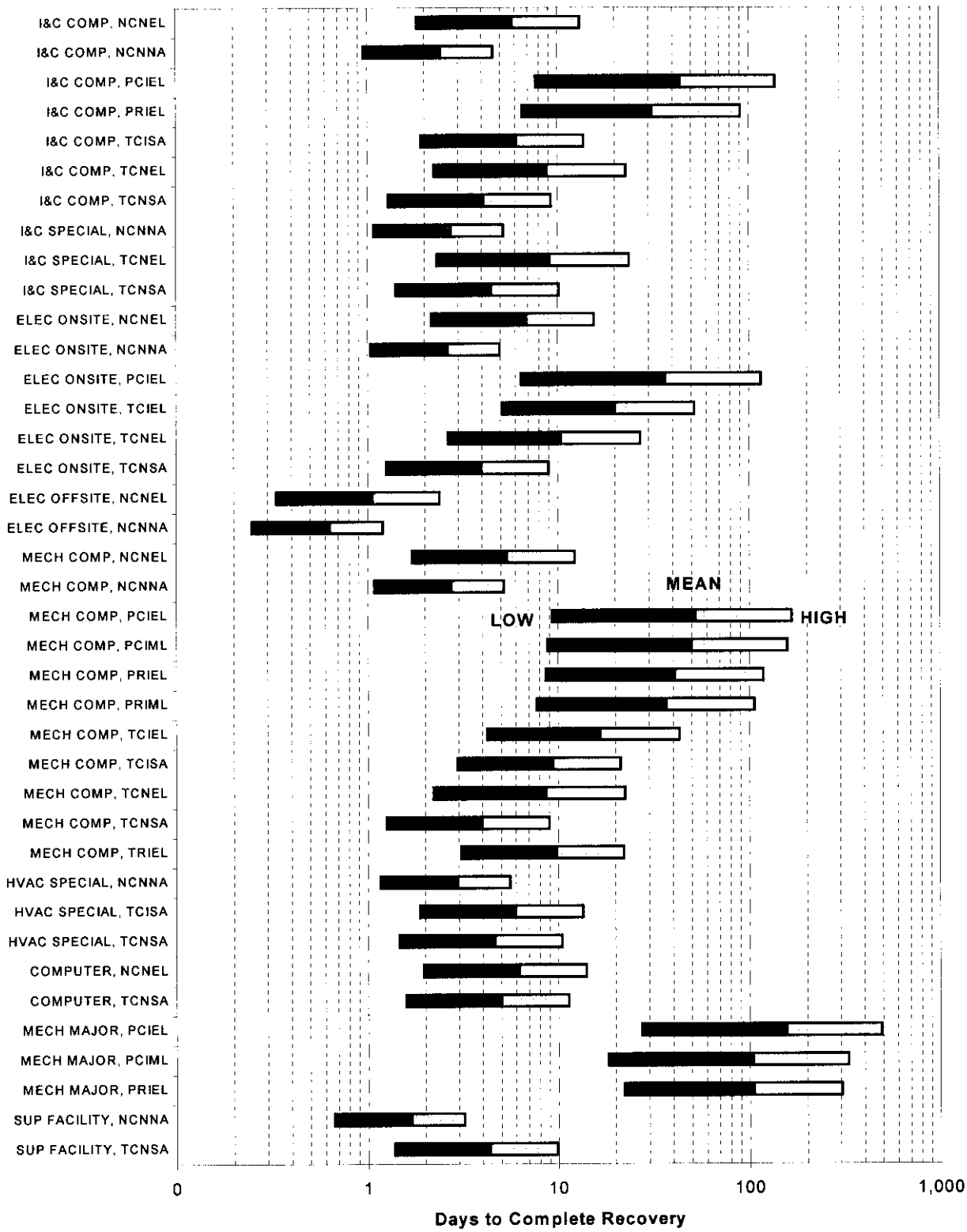

Figure 4-3. Time to Repair Distributions Associated with Generic Component Types and Conditions

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5. Results of Preliminary RAM Assessment

This section discusses the results of the preliminary RAM assessment for the operations concept for three classes of tank waste. It presents the FOM for incurring idle facility penalties and also ranks contributors to schedule delay for waste feed batch delivery to the WTP. Insights from the preliminary RAM assessment regarding penalty risk are also presented.

Results are provided for Class 1 (241-AN-102) LAW, Class 2 (241-AZ-101) HLW and Class 3 (241-AN-105) LAW feed deliveries to the WTP. The results should be representative for other tanks in the same class that require performing similar functions. Class 1 and Class 2 feed delivery activities are divided into two distinct sets of activities: (1) qualification of waste feed for delivery, and (2) transfer of qualified waste feed batch to the WTP on an agreed upon WTD. The Class 3 LAW feed delivery activities are divided into four distinct sets of activities: (1) decanting the supernatant to a staging tank and qualifying the waste feed for delivery; (2) transfer of qualified supernatant to the WTP on an agreed upon WTD; (3) dissolving solid salts in the source tank and qualifying the waste feed for delivery; and (4) transfer of qualified dissolved salts batch to the WTP on an agreed upon WTD.

As discussed in Section 2, the RAM model quantification is accomplished in two steps. First the model is quantified using the mean values of the failure rate and recovery time of every failure mode in the model that contributes to the delay of schedule critical path activities. This quantification produces a mean (also called "expected value") delay frequency and (frequency weighted) schedule delay contribution for each failure mode. Next, the simulation uses the failure mode mean delay frequencies obtained from the mean value quantification and the recovery time distributions to generate sample total delay times during batch transfer cases. The simulation accounts for the fact that, although over the long run (the mean or "expected value" quantification) every failure can be expected to occur at some frequency, during an individual batch transfer none or many failures can occur, and the time to recover from them can vary as well. For the purposes of characterizing the range of possibility, the simulation generates 10,000 batch transfer trials.

The results of the two quantification steps presented in this section are organized as follows:

First, the distribution of batch transfer duration based on the simulation is presented. The duration is then used to generate a distribution of batch transfer completion times that can be compared to the acceptable waste transfer window to generate the Idle Facilities FOM. This FOM expresses the risk that the WTP could be idled due to lack of qualified waste feed. Section 2.4 discusses the development and interpretation of the Idle Facilities FOM in detail.

Next, the contribution of the individual failure modes based on the mean or "expected value" quantification are grouped by category and ranked in the form of CILs. Each CIL sums the mean frequency and expected delay (i.e., the mean contribution over an

infinite number of transfers) of schedule delaying events for every failure mode that falls into a given category. A CIL can partition the mean total delay into any combination of categories that is included in the RAM model structure. The categories by which the failure modes have been grouped are summarized below. This section discusses significant points derived from this ranking. The detailed results are presented in the form of CILs in Appendices E, F, and G.

Critical Items List	Description
System	The system designation follows those used on the P&ID drawings. This CIL allows a reasonably direct comparison with the RAM Revision 1 results.
System and Major Element	Groups delay in accordance with the major systems that participate in the batch transfer. It further breaks down the systems into their major functional elements. Each system has between one and five major functional elements.
System Breakdown	Carries the system breakdown to the super-component level. A super-component collects all the individual components needed to accomplish one specific task into one item.
Breakdown by EIN	Ranks components that have individual Equipment Identification Numbers. This CIL correlates closely with the higher level, indicating which components are the most important within the systems.
Activity	Shows the delay that can be expected in each of the three major activities accomplished in the field to transfer a waste feed batch to the WTP.
Component Type Category	Ranks the delay caused by generic component type categories established to consolidate the long list of Component Type Codes (e.g., DP, DI, EI, I, MOV, P, V, etc) into categories that can be related better to failure modes and generic failure rates.

It should be noted that although qualification activities are discussed and all the equipment needed to support sampling are included in the RAM model, delays during the qualification process are not quantified and the resulting qualification completion curves are not presented on a timeline similar to that shown in the Rev. 1 RAM report (PLG, 1999). Sampling for qualification may begin a year ahead of the planned WTD. The actual preparation and sampling process takes on the order of a few days. The major uncertainty in qualification is the analysis of the sample, which is currently scheduled to last a period of 9 months. The analysis process could be subject to considerable uncertainty, and the assessment of this uncertainty is currently beyond the scope of the RAM model. As lab analysis uncertainty dominates the impact of any delay that could be introduced by the sampling, a display of the completion time distribution for qualification would purport to convey information that is not included in the current models. The provision to include analysis uncertainty is already in the RAM model, as shown in Table 2-4. When the analysis duration is modeled with a mean duration of 9

months and a standard deviation of one month, except for a very few outliers, qualification delays do not extend beyond the WTD. Once suitable information is available, the simulation of each class of transfer can be rerun to include delays during the qualification sampling and analysis activities.

5.1 Schedule Delay for Delivery of Class 1 Waste Feed Batches (241-AN-102)

The Class 1 (2431-AN-102) LAW transfers involve two batch deliveries separated by an interval of 2 years. The two waste batches are delivered to the WTP using in-line dilution and are essentially identical. Both batches have been analyzed to allow for future changes where the amounts delivered in each batch might change for other tanks in the class.

Table 2-1 contains the details regarding mission profile for both batch certification and batch transfer. The batch volumes upon which the profile is based are summarized in Appendix E, Table E-1. Other assumptions used to generate the RAM case for idle facility penalties are discussed in Sections 2.4 and 2.5.

The RAM model has quantified delays during the activity sequences necessary to complete the batch deliveries. Delays in completing transfer preparation and transfer activities are quantified to include uncertainties regarding the recovery time of potential failures. A synopsis of the RAM model results is provided in the following paragraphs.

5.1.1 Simulation Results

Figure 5-1 shows the plot of the completion times of the simulation of the first transfer activity keyed to the WTD. This transfer is scheduled to start in April of 2008. The second transfer from 241-AN-102 is identical to the first transfer except for a small increase in pumping time needed for a slightly larger volume of waste to be transferred. The second transfer is scheduled to start approximately 2 years later in March of 2010. Figure 5-2 shows the results for the second transfer. The vertical line on the charts indicates the end of the transfer window and the start of penalty inducing delays.

Examination of the two figures indicates there is a small initial vertical drop in the plot of transfer completion times at about the 3 days after the WTD. This represents the likelihood that about 5% of the time, the transfer will be completed without schedule delaying events. (It should be noted that with external events, primarily weather related delays, are excluded about 70% of the transfers would be completed without delays.)

The detailed summary report of the simulation of the RAM model for the qualification and transfer activities is presented in Appendix E. A synopsis of these results is provided below in tabular form. The following summary presents the results of the simulations. The first summarizes the distribution statistics associated with each distribution of completion times. The second summarizes the relationship between the distribution and the FOM goal of completing a batch transfer within 30 days after the WTD. It can be seen that most trial scenarios produce relatively short delays, but there is a small chance of incurring considerable schedule delay. Short delays are a result of the relatively short recovery times for most components while the long delays result from the low probability of long recovery actions due to specific component failures such as large pumps and

valve pit failures. Scenarios where there are multiple failures requiring a combination of short and long recovery times can also create long delays.

Total Activity Duration (Days), Including Delays Produced by Off-Normal Events During 10,000 Simulation Trials of Batch Transfer to the WTP

	NPNF Duration	Mean	50th %-ile	95th %-ile	99th %-ile	Longest Duration
AN-102 1st Transfer	8.4	16.5	12.8	37.4	83.8	197.3
AN-102 2nd Transfer	8.4	16.2	12.7	36.6	79.5	204.3

	Completion Given No Delay Events (Days After WTD)	Probability of Idle Facilities	Average Idle Days, Given WTP is Idled	Integrated Idle Facility "Days"
AN-102 1st Transfer	3.4	5.7%	25	1.4
AN-102 2nd Transfer	3.4	5.3%	24	1.3
Figure of Merit for All Waste Feed Batches from Source Tank 241-AN-102				2.7

The RAM model assumes that pre-transfer activities begin 5 days prior to the WTD, accounting for the difference between the NPNF duration and the earliest completion date relative to the WTD. Using the first transfer as an example, the simulation completion times are beyond the waste transfer window in 569 of the 10,000 trials, respectively, or about 5.7% of the time. These 569 trials represent transfers that could result in idle facility costs, with each day beyond the window being an idle facility day. Over the 10,000 trials, a total of 14,462 idle facility days were accumulated. In accordance with the description of the FOM in Section 2.4, the idle facilities FOM is approximately 1.4 "days." However, with the total averaged over the 569 trials that crossed the FOM goal, one can conclude that, if the WTP is idled, the average duration of idle facilities would be about 25 days.

5.1.2 *Major Contributors to Schedule Delay*

The CILs generated from quantification of the 241-AN-102 RAM model using mean values of failure rates and recovery time distributions are provided in Tables 5-1 and 5-2 and Appendix E. These CILs reflect the contribution of failures during the second batch transfer from 241-AN-102, which is essentially identical to the first batch. Only the final batch transfer activities are included in the CILs, because the batch preparation and qualification can be scheduled so that delays during those activities will not impact the availability of qualified waste feed on the WTD. The subparagraphs below provide further explanation of each CIL table.

5.1.2.1 System

The System CIL shows that the top contributors to schedule delay are the Waste Transfer Systems, equipment associated with the AN-102 tank contributing over 25% and the waste transfer routes about 15% of the delay. The system designator "Waste Transfer Routes" refers to components associated with the alignment and monitoring of the transfer paths. The latter is important because of the long recovery times associated with entering waste contaminated pits.

The Diluent/Flush System is the second largest contributor. Although the components associated with this system are generally in non-radiation zones and easily repaired there are a significant number of them and they must function both during the line preheat activity as well as the entire duration of the transfer. This system also has the greatest number of expected hardware failures.

External events are the highest contributors to the frequency of work stoppage. However, since the external events rarely inflict damage, the duration of outages is relatively short. Consequently, external events contribute only about 10% of the delay.

5.1.2.2 System and Major Element

The System and Major Element CIL is summarized here as Table 5-1 and provided in full in Appendix E, Table E-3. This CIL shows that the major contributors to delay are the waste transfer pumps and their supporting equipment. This is not surprising, since the transfer pump has no backup, and failures will most likely take a long time to repair. Transfer pump system failures are also the most frequently occurring failures. This is due to the number of supporting components and the long duration of operation. Note that the average delay time per off-normal event involving the transfer pumps is on the order of a week. This delay time weights the more frequent non-catastrophic shutdowns with the less frequent catastrophic failures that would require pump replacement.

The primary ventilation is the second highest contributor to schedule delay. As a safe storage system it must operate continually and is subject to failures even when other activities might be suspended during a recovery activity.

The third highest contributor is the delivery sub-system of the diluent/flush system. This sub-system participates in conjunction with the transfer pumps.

The major element breakdown also shows that most frequent work stoppage occurs because of weather related external events. This is consistent with historical tank farm operating experience. Weather related delays also account for 5% of the expected delay, which is the second ranking contributor at this level of breakdown.

5.1.2.3 System Breakdown

The System Breakdown CIL illustrates the quantification results down to the super-component level. The RAM team has defined super-components to collect all the individual components needed to accomplish one specific task into one descriptive item in order to provide a means to show what EINs are closely related. Typically, a super-component will consist of one specific item of equipment and the instrumentation/control components dedicated to it. The system breakdown shows all

the super-components organized into increasingly more general subsystems up to the broadest system designator.

The System Breakdown CIL presented here is sorted alphabetically by category from left to right. With this format, the CIL may be used to identify the specific equipment whose failure contributes to a system or major system element outage.

5.1.2.4 *EIN (All Failure Modes Associated with an Individual Component)*

This CIL sums the delays due to the individual failure modes of a specific EIN to provide a measure of the overall importance of that specific component. This CIL is most convenient for investigating the relative contribution of specific components listed on the system P&ID drawings. The results of this CIL are closely correlated to the System Breakdown CIL. However, the presentation here is sorted by contribution to schedule delay.

As expected from the discussion above, the top component is the transfer pump.

Comparison of the expected schedule delay for a specific EIN with the higher level system it is part of provides a measure of the relative importance of that component to the system function. In the case of the transfer pump, for example, the AN-102 transfer pump produces an expected schedule delay of about 27 hours, contributing about 60% of the transfer pump "major element" expected delay of about 46 hours. The other 40% include the contribution of instrumentation and assorted supporting components and system specific utility feeds.

Failure modes not associated with equipment having EINs (i.e., external events) are also included in the EIN Breakdown because each failure identified within the RAM model is assigned a unique identifier. Non-equipment failure modes beginning with HA refer to human actions, while those beginning with EXT refer to external events. The EIN field is the logical place to track these identities.

5.1.2.5 *Activity*

The RAM model generally followed the breakdown of WFDS activities described in the O&M Concept for the following three activities:

- Batch Transfer Prerequisites
- Line Preheat
- Batch Transfers

The CIL presented here shows that a majority of the delay actually occurs during the preparation period. This is reasonable since long outages associated with failures of active systems that may occur before the intended transfer time can delay the start of transfer activities. In addition, most of the alignment is accomplished during the preparation period, and system testing will reveal failures. Recall that the batch transfer activity refers to only that time when the transfer pump is started and is actively pumping.

5.1.2.6 *Component Type Category*

This CIL illustrates the ability of the RAM model to rank the importance of classifications in any set of categories that has been incorporated into the RAM model. In this case, the ranking is among generic component type categories established to consolidate the long list of Component Type Codes (e.g., DP, DI, EI, I, MOV, P, V, etc) into categories that can be related better to failure modes and generic failure rates. The specific set of Component Type Codes and Component Descriptions assigned to each Component Type Category is documented as a table in the RAM Model. The consolidation presented here provides a means to display generic expected delay within a more compact list of the component types. Table 5-2 summarizes the Component Type Category CIL, which is provided in full detail in Appendix E, Table E-7.

The top component type categories have appeared as identifiable major contributors in all the systems oriented CILs discussed previously. The top category is moving components, such and pumps and fans, which combine to produce about 36% of the total schedule delay. (The transfer pump is included with pumps and fans). Instruments/Electrical components appear high because there are so many of these types of components in the system. Although each may be highly reliable, the cumulative effect produces a significant contribution to schedule delay. The third and fourth categories involve components that change state such as waste transfer valves. The remaining hardware categories generally perform passive functions, which have lower failure rates or do not comprise a significant portion of the system.

5.1.3 *Conclusions and Recommendations*

The Revision 2 quantification of a waste LAW feed batch transfer from 241-AN-102 to the WTP estimates that the expected idle facility days incurred during the two LAW feed batch transfers is 1.4 + 1.3 = 2.7 "equivalent days." Delays that idle the WTP are expected to occur in about 5-6% of the batch transfers and will be long enough on average to deny the WTP adequate feed material for about one month.

The major contributor to schedule delay is the Waste Transfer System, mostly the transfer pumps. The diluent/flush system is also a large contributor. Particular attention should be given to this system because it will be a newly constructed facility and operations personnel will have little experience with its use. This is especially true for in-line dilution transfers where the operation of the transfer pump system and diluent/flush system must be closely coordinated. To eliminate this problem, at least for one batch transfer, it is recommended that diluent be added to 241-AN-102 after the completion of the first batch transfer to avoid the necessity of in-line dilution during the second batch transfer.

5.2 FOM and Ranking of Contributors to Schedule Delay for Delivery of Class 2 (241-AZ-101) HLW Feed Batches

The Class 2 (241-AZ-101) HLW transfers are accomplished in five batches subsequent to a qualification process. At this stage of planning, the activities required to accomplish the transfers are essentially identical. Therefore, the first batch transfer operation was evaluated to estimate the idle facility penalty FOM.

Table 2-2 contains the details regarding mission profile for both qualification and batch transfers. The batch volumes upon which the profile is based are summarized in Appendix F, Table F-1. Other assumptions used to generate the RAM case for idle facility penalties are discussed in Sections 2.4 and 2.5.

Sampling and qualification activities were also not addressed in the Class 2 analysis for the same reasons as cited in the Class 1 RAM analysis. Although the analysis evaluated the initial transfer the subsequent four batches are automatically decoupled from the qualification process, because the qualification accomplished prior to the first batch transfer is valid for all batch transfers.

5.2.1 Simulation Results

The results of the 241-AZ-101 simulation are shown in Figure 5-3. The initial vertical drop of transfer completion times shows that about 20% of the time, the transfer will be in 1 day, corresponding to no failures.

The detailed summary report of the simulation of the RAM model for the qualification and transfer activities is presented in Appendix F. A synopsis of these results is provided below in tabular form. The first table summarizes the distribution statistics associated with each distribution of completion times. It can be seen that most trial scenarios produce relatively short delays, but there is a small chance of incurring considerable schedule delay. This is due to the potential for low-probability failures of components with extremely long recovery times or for scenarios where a large number of failures occur.

Total Activity Duration (Days), Including Delays Produced by Off-Normal Events During 10,000 Simulation Trials of Batch Transfer to the WTP

	NPNF Duration	Mean	50th %-ile	95th %-ile	99th %-ile	Longest Duration
AZ-101 Transfer	7.1	10.9	8.4	14.2	49.2	133.5

The total schedule delay produced by the RAM model simulation is added to the nominal "no problem / no failure" duration to produce an overall duration for the transfer activities that accounts for off-normal events. The NPNF duration includes 5 days of pre-transfer preparations and 1 day of mixing. There are 6 hours allowed for final set up during the first allowable waste transfer day, plus the 19 hours needed to pump 600 m^3 of waste feed at the design rate of 140 gpm, or about 1 day.

The table below summarizes the relationship between the distribution and the FOM goal of completing a batch transfer within 30 days after the WTD.

	Completion Given No Delay Events (Days After WTD)	Probability of Idle Facilities	Average Idle Days, Given WTP is Idled	Integrated Idle Facility "Days"
One AZ-101 Batch	1.1	1.7 %	28	0.45
Figure of Merit for Five Waste Feed Batches from Source Tank 241-AZ-101				2.3

The simulation calculates that the batch transfer is completed beyond the waste transfer window in 166 of the trials, or about 1.7% of the 10,000 simulation trials. These trials represent the transfers that could result in idle facility penalties, with each day beyond the window being a penalty day. Summing the penalty days produced by all 166 trials produces a total of 4,542 penalty days. When these days are averaged all 10,000 Monte Carlo trials, the "expected" penalty for any random trial is approximately 0.45 days. However, for the 166 trials that generated penalty days, the average penalty is about 28 days. Therefore, one can conclude that, if the WTP is idled, the average duration of idle facilities would be about 28 days.

5.2.2 *Major Contributors to Schedule Delay*

The CILs generated from quantification of the 241-AZ-101 RAM model using mean values of failure rates and recovery time distributions are provided in Tables 5-3 and 5-4 and Appendix F. These CILs reflect the contribution of failures during a typical batch transfer from 241-AZ-101. The five batch transfers are essentially identical. Only the final batch transfer activities are included in the CILs, because the batch preparation and qualification can be scheduled so that delays during those activities will not impact the availability of qualified waste feed on the WTD. The subparagraphs below provide further explanation of each CIL table.

5.2.2.1 System

The System CIL shows that the top contributor to schedule delay is the Waste Transfer System, contributing just over 35% of the delay. Both the mixer pumps and the transfer pump are included in the Waste Transfer System, so its rank is not unexpected. However, this is a change from the Revision 1 RAM results, where the Primary Ventilation System and Annulus Ventilation were the top contributors to schedule delay. The reduction in schedule delays due to the ventilation systems results from:

- The elimination of the need for cooling by the airlift circulators.
- More realistic evaluation of the impact of failure of ancillary equipment, and
- Taking credit for the capability for switchover to the backup exhaust fan and HEPA filter bank without requiring a shutdown for manual realignment.

During the initial evaluation, the most conservative approach to modeling the impact of failures was used when information to the contrary was not available.

External events is a category established to track the relative importance of events that occur outside of the tank farms that influence the ability to continue WFDS work. External events are now the third highest contributor to schedule delay for two reasons. First, the external event distributions have been revised to better reflect the available information. There are now 16 unique failure modes describing external events, eleven of which involve weather delays. Second, because some of the extremely conservative assumptions regarding hardware were removed, the overall delay in the Revision 2 RAM model due to system hardware failures has been reduced to less than 30% of the delay in the Revision 1 RAM model. Consequently, the external event delays, whose frequency and duration increased, have become more important.

Among engineered systems, the Primary Ventilation System is now the second most important. The reduction in the contribution of the Primary Ventilation System is due to the more realistic modeling of its functions and the components that accomplish them. First, the Revision 1 RAM model required the airlift circulators to operate to achieve a successful homogenization and delivery. The airlift circulators are no longer required for cooling and are not in the Revision 2 model, assuming they do not perform a function during either mixing or waste feed delivery. Second, credit is now taken for the redundancies in the primary ventilation that allow switchover to a backup train without requiring interruption of waste feed delivery operations. These include the primary ventilation exhaust fan, inlet and exhaust HEPA filter banks, and the stack CAM pumps. The Revision 1 model assumed that waste feed delivery activities would have to be shutdown while these switchovers were being made.

5.2.2.2 *System and Major Element CIL*

The System and Major Element CIL is summarized here as Table 5-3 and provided in full in Appendix F, Table F-3. This CIL indicates that the major contributors to schedule delay are the mixer pumps and associated support components and the ventilation tank primary components each contributing approximately 23% of the expected schedule delay. The mixer pump hardware accounts for approximately 23% of the delay, and human actions associated with setting and controlling mixer pump speed contribute another 4% of the delay. (Recognize that the estimate of the human contribution is very preliminary.) The importance of the mixer pumps is not surprising since both mixer pumps must operate during activities to initially suspend the solids in the waste and to maintain a homogeneous mixture during the waste transfer. Furthermore, to enable the ENRAF level detector to check inventory, the mixer pumps must be turned off at least once every 24 hours. In the case of HLW waste transfers, this will require that each waste mixer pump be started twice, once for mixing and once just prior to the initiation of waste transfer. Consequently, the mixer pumps are subjected to the most exposure to failure.

The ventilation tank primary components make up the majority of the HVAC Primary system and are subject to failures over the entire duration of activities from transfer setup to completion of the transfer itself. The major component contributing to the high ranking is the high efficiency mist eliminator primary ventilation train. After a review of the model data, the generic failure rate data used in the analysis is probably too high at 1.0E-04/hr for passive component use.

The relative rank of other major system elements indicate reasons for the ranking of the systems discussed above.

5.2.2.3 *System Breakdown*

The System Breakdown CIL illustrates the quantification results down to the super-component level. The RAM team has defined super-components to collect all the individual components needed to accomplish one specific task into one descriptive item in order to provide a means to show what EINs are closely related. Typically, a super-component will consist of one specific item of equipment and the instrumentation / control components dedicated to it. The system breakdown shows all the super-components organized into increasingly more general subsystems up to the broadest system designator.

The System Breakdown CIL presented here is sorted alphabetically by category from left to right. With this format, the CIL may be used to identify the specific equipment whose failure contributes to a system or major system element outage.

5.2.2.4 *EIN (All Failure Modes Associated with an Individual Component)*

This CIL sums the delays due to the individual failure modes of a specific EIN to provide a measure of the overall importance of that specific component. This CIL is most convenient for investigating the relative contribution of specific components listed on the system P&ID drawings. The results of this CIL are closely correlated to the System Breakdown CIL. However, the presentation here is sorted by contribution to schedule delay.

As expected from the discussion above, the top components are the mixer pumps and the high efficiency mist eliminator in the primary ventilation train. For each pump, the delay contribution arises from a total of 14 demand and time-related failure modes during two separate activities. The third component is the transfer pump, which agrees with higher level CILs.

Comparison of the expected schedule delay for a specific EIN with the higher level system it is part of provides a measure of the relative importance of that component to the system function. For example, the two mixer pumps, producing an expected schedule delay of 8.9 hours each, contribute about 90% of the mixer pump "major element" expected delay of 19.9 hours. The other 10% includes the contribution of instrumentation and assorted supporting components and system specific utility feeds.

The high ranking of the high efficiency mist eliminators is based on a generic failure rate and a long recovery time. This item has the potential to accumulate fluids from the primary ventilation stream that make it a contaminated item with relatively high dose rates. Combined with its location in a building that requires the use of a crane to remove the roof cover block and its relative uniqueness for replacement purposes, the high ranking is understandable. The validity of the generic failure rate for this mostly passive function should be evaluated, and the next revision of the RAM model will more closely evaluate the actual historic performance of this component. The review of past historical operational performance should include the development of a component specific failure rates and recovery time duration for this unique item.

Failure modes not associated with equipment having EINs (i.e., external events) are also included in the EIN Breakdown because each failure identified within the RAM model is assigned a unique identifier. Non-equipment failure modes beginning with HA refer to human actions, while those beginning with EXT refer to external events. The EIN field is the logical place to track these identities.

5.2.2.5 *Activity*

The RAM model generally followed the breakdown of WFDS activities described in the O&M Concept for the following three activities:

16010B1 Batch Transfer Prerequisites

16010B2 Homogenize Waste Feed for Transfer

16010B3 Transfer HLW Waste Feed Batch to the WTP

The CIL presented here shows that the transfer setup activity produces the largest expected delay. This is reasonable since long outages associated with failures of active systems that may occur before the intended transfer time can delay the start of transfer activities. In addition, most of the alignment is accomplished during the preparation period, and system testing will reveal failures. Recall that the setup times for this activity are also much longer than the actual mixing and transfer times needed for the feed delivery.

It should be noted that activity 16010B2 (Homogenize Waste Feed for Transfer) was the highest delay contributor, in part, because of the way in which failures within the primary ventilation were modeled. Since they will delay the start of mixing, but not necessarily stop other preparation activities, primary ventilation failures during activity 16010B1 (Batch Transfer Prerequisites) were modeled via the E_p exposure parameter (delay due to failures during exposure during a previous activity) in 16010B2, rather than directly in 16010B1 With the reduction in the overall number of ventilation components that contribute to delay, there is a corresponding lower contribution from this activity.

5.2.2.6 *Component Type Category*

This CIL illustrates the ability of the RAM model to rank the importance of classifications in any set of categories that has been incorporated into the RAM model. In this case, the ranking is among generic component type categories established to consolidate the long list of Component Type Codes (e.g., DP, DI, EI, I, MOV, P, V, etc) into categories that can be related better to failure modes and generic failure rates. The specific set of Component Type Codes and Component Descriptions assigned to each Component Type Category is documented as a table in the RAM Model. However, the consolidation also provides a means to display generic expected delay within a more compact list of the component types. Table 5-4 summarizes the Component Type Category CIL, which is provided in full detail in Appendix F, Table F-7.

The top four hardware related component type categories have appeared as identifiable major contributors in all the systems oriented CILs discussed previously. Specifically, the two mixer pumps and single transfer pump combine to produce about 28% of the

total schedule delay, and they are the major contributor in "Pumps/Fans." All other pumps and fans contribute about 14% of the schedule delay.

The fifth category, Instruments/Electrical arises because there are so many of these types of components in the system. Although each may be highly reliable, the cumulative effect produces a significant contribution to schedule delay.

5.2.3 *Conclusions and Recommendations*

The Revision 2 quantification of a waste LAW feed batch transfer from 241-AZ-101 to the WTP estimates that the expected idle facility days incurred during a HLW feed batch transfers is 0.5 "equivalent days." Delays that idle the WTP are expected to occur in about 1 - 2% of the batch transfers and will be long enough on average to deny the WTP adequate feed material for about one month.

The major contributor to schedule delay is the Waste Transfer System, mostly the mixer pumps. The HVAC primary system is also a large contributor mostly due to the contribution of the high efficiency mist eliminator. It is recommended that efforts continue to determine if the mixing in preparation for transfer as well as that required during transfer can be accomplished with only one mixer pump with the other available as a backup. An evaluation of the historical performance of the high efficiency mist eliminator should also be performed to more accurately determine its significance to overall system reliability performance.

5.3 FOM and Ranking of Contributors to Schedule Delay for Delivery of Class 3 (241-AN-105) LAW Feed Batches

The Class 3 (241-AN-105) LAW transfers are accomplished with two batch deliveries with both staging and salt dissolution activities required to prepare the waste before the batch transfers. Both batch deliveries are evaluated against the figure of merit performance criteria. The salt dissolution activity and the supernate staging activity are also evaluated for expected delay purposes. This helps ensure that any future schedule changes to the batch delivery dates takes into account the uncertainty in completing the preparation activities to avoid potential interference. Sampling and qualification activities are not addressed in this analysis for the same reasons as cited in the Class 1 and Class 2 analyses.

The mission profile used to generate the RAM model case for the qualification and delivery of feed batches originating from Class 3 tanks (241-AN–105) is shown in Table 2-3. The following activity sets are quantified in the Class 3 (241-AN-105) RAM model.

5.3.1 *Simulation Results*

5.3.1.1 *Preparation and Qualification of Batches for Transfer*

The LAW stored in 241-AN-105 requires separation and preparation prior to qualification of waste for transfer to the WTP. Delays during these activities will not influence the

availability of qualified feed for the WTP if sufficient time can be scheduled to provide high assurance that recovery can be achieved in time to complete batch qualification prior to the WTD. The RAM model quantification investigates two important milestones, which are discussed in the following subparagraphs.

5.3.1.2 Complete Staging (Decanting) of AN-105 Supernate to AN-102.

The RAM model estimates the schedule delay during tasks necessary to complete an intra-farm transfer of the saturated liquid supernate in tank 241-AN-105 to 241-AN-102. The completion of staging is a critical milestone that will enable further preparation of waste feed batches from both 241-AN-102 and 241-AN-105.

Figure 5-4 shows the results of the simulation of the staging activities assuming that the activities proceed at the earliest scheduled date, March 28, 2010. Upon completion of the staging transfer, 241-AN-102 contains a batch of LAW feed suitable for qualification sampling and analysis. The vertical line on Figure 5-4 shows the earliest date that qualification sampling may proceed, assuming the qualification sample is valid for one year. It can be seen on the figure that 95% of the simulated transfers resulted in completion over 11 months prior to the earliest date that batch qualification sampling can proceed. The distribution of delay times experienced during the above activities is tabulated at the end of this section.

5.3.1.3 Complete Dissolution of Salts in AN-105

Completion of the staging transfer to 241-AN-102 is a prerequisite for the dissolution of salt cake in 241-AN-105. The supernate must be transferred out of 241-AN-105 in order to provide room to dissolve the salts currently in solid phase. Adding water to the tank with the Diluent/Flush System and running the mixer pumps dissolves the salt solids. The current schedule estimates that the earliest date resources will be available to dissolve the salts is June 10, 2010. However, the earliest day could be extended if the supernate in 241-AN-105 has not been staged to 241-AN-102.

Figure 5-5 shows the completion date for the dissolution that considers both prerequisites mentioned above as well as delays incurred during either the diluent addition or the mixing. It is assumed that mixing begins immediately after the completion of diluent addition, and that the resultant waste feed solution will be suitable for qualification sampling and analysis. The vertical line on Figure 5-5 shows the earliest date that qualification sampling may proceed, assuming the qualification sample is valid for one year. It can be seen on the figure that 95% of the simulated transfers resulted in completion over 11 months prior to the earliest date that batch qualification sampling can proceed.

The distribution of delay times experienced during the above activities is tabulated below.

Total Activity Duration (Days), Including Delays Produced by Off-Normal Events During 10,000 Simulation Trials of Batch Transfer to the WTP

	NPNF Duration	Mean	50th %-ile	95th %-ile	99th %-ile	Longest Duration
Stage Supernate to AN-102	9.6	16.5	13.3	32.4	79.8	261.5
Dissolve Salt in AN-105	3.0	4.8	3.2	9.8	20.7	101.5

5.3.1.4 Qualification Sampling and Analysis

Once the waste feed is ready for qualification, field operations that are influenced by RAM considerations have only a minor impact on schedule delay. Current planning provides for mixing the batch prior to sampling. The actual sampling process is done with specialized equipment that is outside the responsibility of the tank farms, and the entire sampling process can be completed within a day or so. It is judged that any uncertainty in the time necessary to extract qualification samples from the tank will be small compared to those associated with the analysis of the sample.

The major source of uncertainty and delay is in the suitability and analysis of the sample. Evaluation of these uncertainties is currently beyond the scope of the RAM model. However, the simulation model does contain the provision to incorporate the uncertainty in the qualification process by representing its duration as a distribution. As a place-holder, the schedule delay simulation has assigned a normal distribution having a mean duration of 90 days and a standard deviation of 30 days to represent the total time necessary to take and analyze the qualification sample.

5.3.1.5 Batch Transfers to the Waste Treatment Plant

The RAM models of the batch transfers address both the pre-transfer preparations and the actual transfer. Since line flushing is accomplished after the transfer is completed, failures during that activity will not prevent the WTP from being able to utilize the waste feed. Consequently, the flushing activity is not included in the model. However, it is assumed that the diluent/flush system must be demonstrated operable during the pretreatment activity, and failures at that time will delay the start of transfer, since flushing could not be accomplished with an out-of-service diluent/flush system.

The quantification and simulation of the two batch transfers produced the following delays:

Total Activity Duration (Days), Including Delays Produced by Off-Normal Events During 10,000 Simulation Trials of Batch Transfer to the WTP

	NPNF Duration	Mean	50th %-ile	95th %-ile	99th %-ile	Longest Duration
Supernate Batch Transfer	9.7	16.4	12.9	35.5	74.8	191.5
Dissolved Salt Batch Transfer	9.0	14.9	12.0	28.5	63.0	172.5

The total schedule delay produced by the RAM model simulation is added to the nominal "no problem / no failure" duration to produce an overall duration for the transfer activities that accounts for off-normal events. The results are shown in Figures 5-6 and 5-7. The initial vertical drop of transfer completion times shows that about 50% of the time, the transfer will be completed without schedule delaying events. Delays produce longer mission duration and later completion times. The table below presents the resulting WTP idle facility days for the two batch transfers:

	Completion Given No Delay Events (Days After WTD)	Probability of Idle Facilities	Average Idle Days, Given WTP is Idled	Integrated Idle Facility "Days"
Supernate Batch Transfer from AN-102	4.7	5.1%	25	1.3
Dissolved Salts Batch Transfer from AN-105	4.0	3.3%	27	0.9
Figure of Merit for All Waste Feed Batches from Source Tank 241-AN-105				2.2

The integrated idle facility day is a long-term average idle facility time considered over all 10,000 simulation trials including those where no delay occurred. It should not be taken to mean that there will be a delay of 1.3 days per transfer.

Since an idle facility delay either happens or it doesn't, it is useful to consider the average idle facility delay magnitude should one occur. For the 5% of the time that such events do occur, the average delay is approximately 30 days. This demonstrates the impact of the potential for long delays due to the failure of equipment that entails long recovery times such as transfer pumps and valve pit equipment.

The supernate transfer involves a larger volume of waste feed than the dissolved salt batch, accounting for the longer "no problem / no failure" duration. The other values reflect the impact of the "tail" of the batch completion day plot. The following discusses the supernate batch transfer, which is shown in Figure 5-6. For this transfer the simulation completion beyond the waste transfer window in 502 of the 10,000 trials, or

about 5.0% of the time. These trials represent the transfers that could result in idle facility costs, with each day beyond the window being an idle facility day. Summing the penalty days produced by all 502 trials produces a total of 14,819 idle facility days. When these days are averaged all 10,000 Monte Carlo trials, the "expected" idle facilities for any random trial is approximately 1.3 days. However, For the 502 trials that generated idle facility days, the average duration of idle facilities is about 30 days.

5.3.2 *Major Contributors to Schedule Delay*

The CILs generated from quantification of the 241-AN-105 RAM model using mean values of failure rates and recovery time distributions are provided in Tables 5-5 and 5-6 and Appendix G. These CILs reflect the contribution of failures during the batch transfer of dissolved salts from 241-AN-105. The supernate transfer from 241-AN-102 uses the same equipment as that analyzed for the Class 1 waste transfers discussed in Section 5.1 (except that no in-line dilution is required). Only the final batch transfer activities are included in the CILs, because the batch preparation and qualification can be scheduled so that delays during those activities will not impact the availability of qualified waste feed on the WTD. The subparagraphs below provide further explanation of each CIL table.

5.3.2.1 *System*

The System CIL shows that the top contributors to schedule delay are the Waste Transfer Systems, equipment associated with the AN-105 tank contributing over 26% and the waste transfer routes about 16% of the delay. The system designator "Waste Transfer Routes" refers to components associated with the alignment and monitoring of the transfer paths and associated pits. The latter is important because of the long recovery times associated with entering waste contaminated pits.

The next three systems in importance are the two HVAC systems and Support/Utilities. This ranking is reasonable since they are all continually operating systems that will be subject to increases in exposure when other systems fail. Together they contribute about 37% of the expected delay.

The Diluent/Flush system plays a less important roll in the final batch transfer of Class 3 241-AN-105 waste batches than the Class 1 batch transfers, because no in-line dilution is required.

External events are the highest contributors to the frequency of work stoppage. However, since the external events rarely inflict damage, the duration of outages is relatively short. Consequently, external events contribute only about 6% of the delay.

5.3.2.2 *System and Major Element*

The System and Major Element CIL is summarized here as Table 5-5 and provided in full in Appendix G, Table G-3. This CIL shows that the major contributors to delay are the waste transfer pumps and their supporting equipment. This is not surprising, since the transfer pump has no backup, and failures will most likely take a long time to repair. Note that the average delay time per off-normal event involving the transfer pumps is on the order of 5 days. This delay time weights the more frequent non-catastrophic

shutdowns with the less frequent catastrophic failures that would require pump replacement.

The primary ventilation is the second highest contributor to schedule delay. As a safe storage system it must operate continually and is subject failures even when other activities might be suspended during a recovery activity.

The third most important contributor is compressed air. This system supports tank farm instrumentation. Compressed air is the most frequent hardware failure, and it shows up as important because no credit was taken for redundant compressors and the compressed air reservoir. The model reflects the value of not relying on an air compressor pump to provide air continually. The RAM models will be updated to reflect the proper functioning of the Compressed Air system in the next update..

The major element breakdown also shows that most frequent work stoppage occurs because of weather related external events.

5.3.2.3 System Breakdown Structure

The System Breakdown CIL illustrates the quantification results down to the super-component level. The RAM team has defined super-components to collect all the individual components needed to accomplish one specific task into one descriptive item in order to provide a means to show what EINs are closely related. Typically, a super-component will consist of one specific item of equipment and the instrumentation / control components dedicated to it. The system breakdown shows all the super-components organized into increasingly more general subsystems up to the broadest system designator.

The System Breakdown CIL presented here is sorted alphabetically by category from left to right. With this format, the CIL may be used to identify the specific equipment whose failure contributes to a system or major system element outage.

5.3.2.4 EIN (All Failure Modes Associated with an Individual Component)

This CIL sums the delays due to the individual failure modes of a specific EIN to provide a measure of the overall importance of that specific component. This CIL is most convenient for investigating the relative contribution of specific components listed on the system P&ID drawings. The results of this CIL are closely correlated to the System Breakdown CIL. However, the presentation here is sorted by contribution to schedule delay.

As expected from the discussion above, the top component is the transfer pump.

Comparison of the expected schedule delay for a specific EIN with the higher level system it is part of provides a measure of the relative importance of that component to the system function. In the case of the transfer pumps, for example, the AN-105 transfer pump produces an expected schedule delay of 22 hours, contributing about 70% of the transfer pump "major element" expected delay of 31 hours. The other 30% include the contribution of instrumentation and assorted supporting components and system specific utility feeds.

Failure modes not associated with equipment having EINs (i.e., external events) are also included in the EIN Breakdown because each failure identified within the RAM model is assigned a unique identifier. Non-equipment failure modes beginning with HA refer to human actions, while those beginning with EXT refer to external events. The EIN field is the logical place to track these identities.

5.3.2.5 *Activity*

The RAM model generally followed the breakdown of WFDS activities described in the O&M Concept for the following two activities:

- Dissolved Salts Batch Transfer Prerequisites
- Dissolved Salts Batch Transfer

The CIL presented here shows that a majority of the delay actually occurs during the preparation period. This is reasonable since long outages associated with failures of active systems that may occur before the intended transfer time can delay the start of transfer activities. In addition, most of the alignment is accomplished during the preparation period, and system testing will reveal failures. Recall that the batch transfer activity refers to only that time when the transfer pump is started and is actively pumping.

5.3.2.6 *Component Type Category*

This CIL illustrates the ability of the RAM model to rank the importance of classifications in any set of categories that has been incorporated into the RAM model. In this case, the ranking is among generic component type categories established to consolidate the long list of Component Type Codes (e.g., DP, DI, EI, I, MOV, P, V, etc) into categories that can be related better to failure modes and generic failure rates. The specific set of Component Type Codes and Component Descriptions assigned to each Component Type Category is documented as a table in the RAM Model. However, the consolidation also provides a means to display generic expected delay within a more compact list of the component types. Table 5-6 summarizes the Component Type Category CIL, which is provided in full detail in Appendix G, Table G-7.

The top component type categories have appeared as identifiable major contributors in all the systems oriented CILs discussed previously. The top category is moving components, such and pumps and fans, which combine to produce about 37% of the total schedule delay. (The transfer pump is included with pumps and fans). Instruments/Electrical components, at 25%, appear high because there are so many of these types of components in the system. Although each may be highly reliable, the cumulative effect produces a significant contribution to schedule delay. The third and sixth categories involve components that change state such as waste transfer valves.

5.3.3 *Conclusions*

The Revision 2 quantification of a waste LAW feed batch transfer from 241-AN-105 to the WTP, estimates that the expected idle facility days incurred during the two LAW feed batch transfers is 1.3 + 1.0 = 2.3 "equivalent days." Delays that idle the WTP are

expected to occur in about 4-5% of the batch transfers and will be long enough on average to deny the WTP adequate feed material for about one month.

The major contributor to schedule delay is the Waste Transfer System, most the transfer pumps. Although the mixer pumps are used in LAW feed preparation, they are not employed during the time critical final batch transfers. Given the schedule can provide enough slack time to make up for failures during waste feed preparation and qualification, the mixer pumps will not become an important contributor to WTP idle facility time for LAW.

The new structure of the RAM model has enhanced the capability to represent the interactions of equipment performing essential missions during waste feed activities. A wide variety of Critical Items Lists and summations may now be generated to assist in identifying important components and systems, as well as identifying trends.

5.4 Human Reliability Assessment Results

This revision of the RAM assessment continued the screening assignment of human actions identified in the initial version of the RAM study to the activities identified in the recent revisions to the transfer process flowsheets. The quantification of procedure-related human actions that can lead directly to delays in HLW qualification and transfer activities is shown in Appendix D, Tables D-2 through D-4 for Classes 1, 2, and 3 waste, respectively. It should be recognized that, at the current time, the evolutions that the operators will be required to accomplish are still subject to considerable uncertainty, as the system design and operational procedure development processes are still underway. Given this state of flux, the actions identified for quantification are judged to be reasonable for estimating the relative impact of human actions on potential schedule delay.

For the Revision 2 RAM model, the human actions are fully integrated into the database structure used to build the quantification models. They appear and are discussed with other contributors in the CILs. Therefore, it is judged that separate presentation of the human reliability assessment results is unnecessary at this time.

5.5 Delays Due to External Events

Delays due to external events include those due to weather (primarily temperature and wind) and disruptive incidents that are not directly related to the WFDS transfer operations. As a result of the assessments in Section 3.5, a total of 16 external events have been integrated into the RAM database. Weather related delays are estimated primarily from annual weather reports of temperature extremes and high winds, as stated in Section 3.5.1. The occurrence of disruptive events is estimated from incidents reported in ORPS, and is summarized in Section 3.5.2.

For the Revision 2 RAM model, the external events are fully integrated into the database structure used to build the quantification models. They appear and are discussed with other contributors in the CILs. Therefore, it is judged that separate presentation of the human reliability assessment results is unnecessary at this time.

5.6 RAM-Based Insights Regarding Penalty Risk

Specific insights from the RAM assessment regarding penalty risk are discussed below.

5.6.1 Catastrophic Failures and Qualification of Alternate Staging Tanks.

The mixer pumps and transfer pumps are major contributors to batch transfer risk. The inherent reliability of mixer and transfer pumps will prevent a risk of a lengthy delay. Although the chance of a catastrophic pump failure can be made small through design, a catastrophic pump failure has the potential for creating a significant delay (Shaw, 1998) beyond the 30-day transfer window for batch delivery. A method to reduce risk would be to ensure that a second source of qualified waste feed is available for delivery from an alternate tank. A case study based on the FY99 WFDS RAM model showed that this strategy produced a significant decrease in schedule risk.

Although this is not a significant contributor to batch transfer risk, another potential catastrophic failure would be transfer line failure (e.g., line plugging). For example, redundant transfer paths do not exist between 241-AZ tank farm and the new AZ valve pit being installed by Project W-314. A transfer line failure of this single path could result in a potentially significant delay and eliminate the ability to deliver subsequent feed batches from 241-AZ tank farm until the path was re-established. Again, providing a second source of qualified waste feed from an alternate tank in a different tank farm would provide a method to reduce the risk.

5.6.2 Evaluation of the Requirements for Motor-Operated Valves

The need for using MOVs in waste transfer paths should be evaluated carefully. In general, valves within the WFDS will be operated relatively infrequently, so the efficiency provided by remote operation should be evaluated against the increased maintenance requirements and unreliability of MOVs. Although the MOVs are being designed to be manually positioned in the event of operator failure, manual valves generally have lower failure rates and less maintenance demand. For those paths that will not be subjected to frequent routing changes, manual valves provide a straightforward means of both aligning and controlling the waste transfer path. Valve position indicators can provide direct indication to the operators for verification of positioning, and the valves can be locked in place.

5.6.3 Reduction of Recovery Times

Reduction of recovery times provides an opportunity to reduce penalty risk and overall schedule delay. More importantly, they offer the opportunity to reduce the magnitude of penalties should such a scenario arise. Effort to reduce recovery times for specific failures should be focused on those items identified as the largest contributors to schedule delay and penalty risk. Two areas to consider are large pump replacement actions and valve and pump pit jumper replacements. Pump replacement activities are complex, intensive activities that require extensive planning. In general, waste transfer valves in valve pits and/or pump pits are components within jumper assemblies, and their failure necessitates a replacement of the entire jumper assembly. This effort is also

labor intensive, requiring the removal of cover blocks, and can result in radiation exposure to workers. Suggestions to reduce the recovery times include: (1) preplanning and expedited review of work packages to the greatest extent possible; (2) organizing specific recovery teams and providing hands-on certification training for accomplishing recovery actions; (3) constructing mock-ups of critical facilities and locations so that recovery actions can be rehearsed and evaluated before they are performed in the field; and (4) ensuring spares are readily obtainable so that recovery action and associated delay time will not be controlled by spares procurement.

5.7 Recommendations

The following recommendations, some of which were also made in the first revision of this document, apply as a result of this updated analysis:

1. Evaluate options to reduce the integrated schedule delay risk so that the success criteria are satisfied. Some of the options that should be considered are as follows:

   - Ensure that a second source of qualified waste feed is available for delivery from an alternate tank or provide redundant capability for critical components with long recovery times (e.g., have redundant transfer pumps within the staging tank).

   - Maximize the delivered HLW feed batch size, thus reducing the number of batches to be delivered from the source tank. This both reduces the number of opportunities to incur idle facilities penalties and provides additional time for recovery.

   - Increase the duration of the contractual 30-day feed delivery window.

   - Reduce recovery times for components on the critical item lists or use components with greater reliability.

2. Perform a study to determine the proper system configuration to reduce the overall schedule risk to the WFD program. The study should determine the number of staging tanks, their need dates and location (one or more farms); the number of transfer pumps in each staging tank; when and how backup and contingency feed sources will be made available; the transfer system topology for routing of waste between the source tanks, staging tanks, and the WTP; and other factors that impact system reliability. The study should consider interactions with other programs such as single-shell tank retrieval.

3. Salt sludge waste material in tank 241-AN-105 and other Class 3 tanks should be prepared as soon as possible after initial removal of the supernate top layer. This allows the dissolved salts to act as a backup source of feed for the initial supernate delivery.

4. From a preliminary RAM perspective, data from the Project W-151 mixer pump test should be used as applicable to establish a more site-specific failure rate for large pumps.

5. Because of the high idle facility costs associated with not delivering waste feed batches on time, tank farm operations should be planned to minimize potential impacts on starting WFD batch transfers. Maintenance activities to support waste transfers should focus on ensuring all mandatory maintenance is completed before the WTD for the required components, and the swift correction of deficiencies discovered during pre-transfer equipment verifications.

6. All activities associated with retrieval, transfer, staging, and qualification of the waste need to be accomplished well enough in advance of the WTD so waste feed batch delivery activities are not delayed. The schedule should provide sufficient slack time between qualification and delivery to insure that any off-normal events during field operations and maintenance occurring during qualification will not extend beyond the scheduled WTD.

7. An effort should be undertaken to better understand the risks involved in the qualification process, specifically, the potential for long delays in the laboratory analysis process.

8. Identify those specific items on the critical item lists whose recovery time estimates assumed the use of preplanned work packages. Include the development of these packages in the appropriate TBRs.

9. The TFC should consider an integrated maintenance management system that ties together work management and configuration management in a manner that allows for future analyses for improving TFC systems and the implementation of a Reliability Centered Maintenance program. This system should also seek to incorporate all of the useful data within the current JCS system.

10. Components should be standardized to the extent possible to preclude the need to maintain numerous vendor files, procedures, and training. Replacement of components after failure should be of like kind, except where upgrades are desired, to preclude the need to update vendor files, procedures, and training.

11. Components within high radiation areas or inaccessible areas should be designed to operate without hands-on preventive maintenance, testing, or calibration.

12. For some components, such as waste mixer pumps and waste transfer pumps, the technical feasibility and overall cost benefit of a predictive maintenance program should be considered. If such a predictive maintenance program is elected, it should be implemented from the point the pump has gone through run-in testing throughout its operational history.

13. The success criteria for the Idle Facilities Penalty FOM established in the System Specification for the Double-Shell Tank System should be refined to reflect the new operating scenario of the plant since the cancellation of the privatization approach. A possible example of a refinement to the FOM would be to allocate the integrated schedule risk per unit of LAW feed delivered or canister of HLW produced.

14. The preliminary RAM assessment should be updated next year to reflect new fiscal year 2001 baseline planning guidance and emerging changes to the technical baseline. The revised preliminary RAM assessment should examine in greater detail

the exposure rates and the failure modes of the various components and systems identified on the critical items lists. Determine methods to reduce the expected delay time associated with these critical items.

15. Consider using the preliminary RAM assessment as key input to other new, broadly encompassing project performance FOM analyses, such as lowest life cycle cost analysis, with specific goals, requirements, or constraints on safety, reliability (including schedule risk), and transferred waste quality.

16. Upgrade the RAM model human reliability analysis after better resolution of specific operations and maintenance procedures for the WFD processes have been defined and documented.

17. Investigate potential alternate success paths for waste transfer, in addition to those already defined in the formally scheduled waste transfer activities. Incorporate these potential alternate success paths into a refined RAM assessment.

18. Perform more Hanford site-specific data analysis to support refining component failure rates and restoration times applied in the RAM assessment. This would also assist in the development of component specifications.

19. Use the preliminary RAM assessment to provide key input to the development and improvement processes associated with configuration management for the WFDS design and implementation (i.e., as an aid to any new work control management system development and implementation). To take best advantage of the capabilities of the model structure, it is recommended that the results be examined for not only the overall RAM results, but also for the configuration control in defining component types, physical characteristics, location, and system assignments.

20. Revaluate the RAM-related assumptions and recommendations in the O&M Concept (Carlson 1999) such as the effect of spare parts availability the use of maintenance outages.

Other recommendations can and should be developed throughout the WFDS design, development, and implementation life cycle via continuous updating of these and other supporting RAM analyses.

Table 5-1. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

System	Major Element	Percent Contribution to Schedule Delay
Waste Transfer AN-102	Transfer Pump	23%
Primary HVAC	Ventilation Tank Primary	11%
Diluent/Flush System	Diluent/Flush Delivery	9%
External Events	Weather	8%
Support/Utilities	Compressed Air	7%
Waste Transfer Route	Waste Transfer AN-105/AN-102	7%
Annulus HVAC	Ventilation Tank Annulus	7%
Diluent/Flush System	Diluent/Flush Preparation	7%
Waste Transfer Route	Waste Transfer AN-102/Stage	6%
Confinement System	Waste Storage Tank	3%
Waste Transfer Route	Diluent/Flush System	2%
Waste Transfer Route	Waste Transfer AN-105/AN-102/Stage	2%
Waste Transfer Route	Waste Transfer AN-102	1%
External Events	Hanford	1%
Confinement System	Primary Monitoring	1%
Human Actions	Transfer Pump	1%
	Other*	3%

**Each contributing less than 1%; rounded percentages may not add up to 100%.*

Table 5-2. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

Component Type Category	Percent of Schedule Delay Hours
Pumps/Fans	23%
Instruments/Electrical	21%
Check and Manual Valves	14%
Power Operated Valves	14%
Transfer Pump	14%
External Events	10%
Pipes, Filters, Containers, Structure	3%
Human Actions	1%
Other*	<1%

**Each contributing less than 1%; rounded percentages may not add up to 100%.*

Table 5-3. Critical Items List for Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

System	Major Element	Percent of Schedule Delay Hours
HVAC Primary	Ventilation Tank Primary	23%
Waste Transfer System	Mixer Pumps	23%
External Events	Weather	12%
Waste Transfer System	Transfer Pump	7%
Waste Transfer System	Transfer Route	5%
HVAC Primary	Recirculation Condenser Cooling	5%
Diluent/Flush System	Diluent/Flush Delivery	5%
Human Actions	Mixer Pumps	4%
Diluent/Flush System	Diluent/Flush Preparation	4%
HVAC Annulus	Ventilation Tank Annulus	3%
Human Actions	Transfer Pump	2%
Confinement System	Ventilation Tank Annulus	2%
External Events	Hanford	2%
HVAC Primary	Exhaust Condenser Cooling	1%
Confinement System	Waste Tank	1%
	Other*	2%

**Each contributing less than 1%; rounded percentages may not add up to 100%.*

Table 5-4. Critical Items List for Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

Component Type Category	Percent of Schedule Delay Hours
Pumps/Fans	42%
Instruments/Electrical	15%
External Events	14%
Miscellaneous/HEME/Moisture Separators	10%
Check and Manual Valves	7%
Human Actions	7%
Pipes, Filters, Containers, Structure	2%
Miscellaneous/Switches/Breakers	1%
Power Operated Valves	1%
Other*	< 1%

**Each contributing less than 1%; rounded percentages may not add up to 100%.*

Table 5-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

System	Major Element	Percent of Schedule Delay Hours
Waste Transfer AN-105	Transfer Pump	22%
Primary HVAC	Ventilation Tank Primary	14%
Support/Utilities	Compressed Air	14%
Annulus HVAC	Ventilation Tank Annulus	9%
Waste Transfer Route	Waste Transfer AN-105/AN-102	8%
Waste Transfer Route	Waste Transfer AN-105/Stage	6%
External Events	Weather	5%
Diluent/Flush System	Diluent/Flush Preparation	5%
Waste Transfer Route	Waste Transfer AN-105	4%
Confinement System	Primary Monitoring	4%
Diluent/Flush System	Diluent/Flush Delivery	3%
Waste Transfer Route	Waste Transfer AN-105/AN-102/Stage	2%
Human Actions	Transfer Pump	1%
	Other*	3%

**Each contributing less than 1%; rounded percentages may not add up to 100%.*

Table 5-6. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

Component Type Category	Percent of Schedule Delay Hours
Instruments/Electrical	25%
Pumps/Fans	22%
Check and Manual Valves	18%
Transfer Pump	15%
External Events	6%
Power Operated Valves	6%
Pipes, Filters, Containers, Structure	5%
Human Actions	2%
Other*	< 1%

**Each contributing less than 1%; rounded percentages may not add up to 100%.*

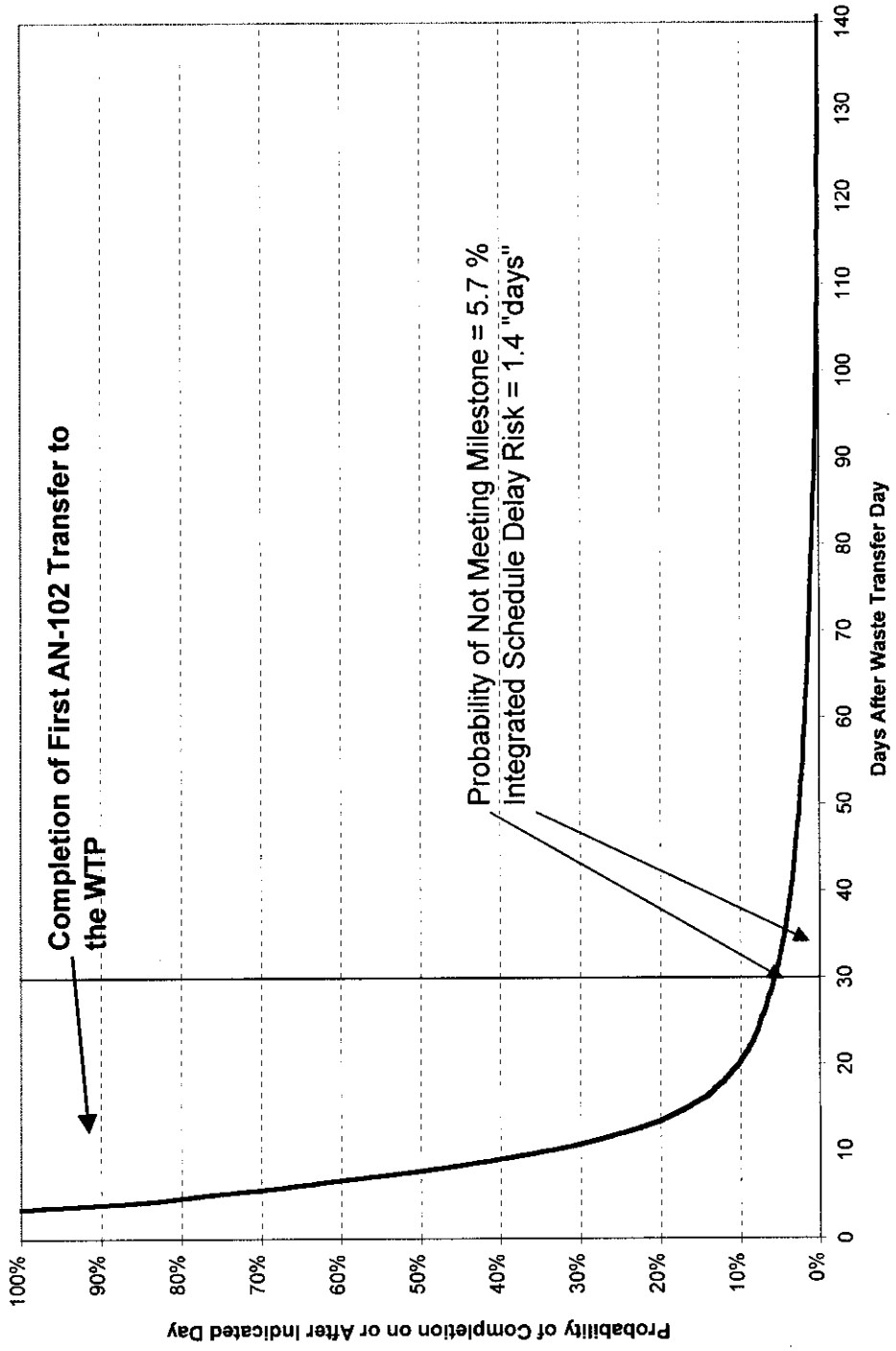

Figure 5-1. Risk of Idle Facility Costs, First Batch Transfer from Class 1 Tank 241-AN-102

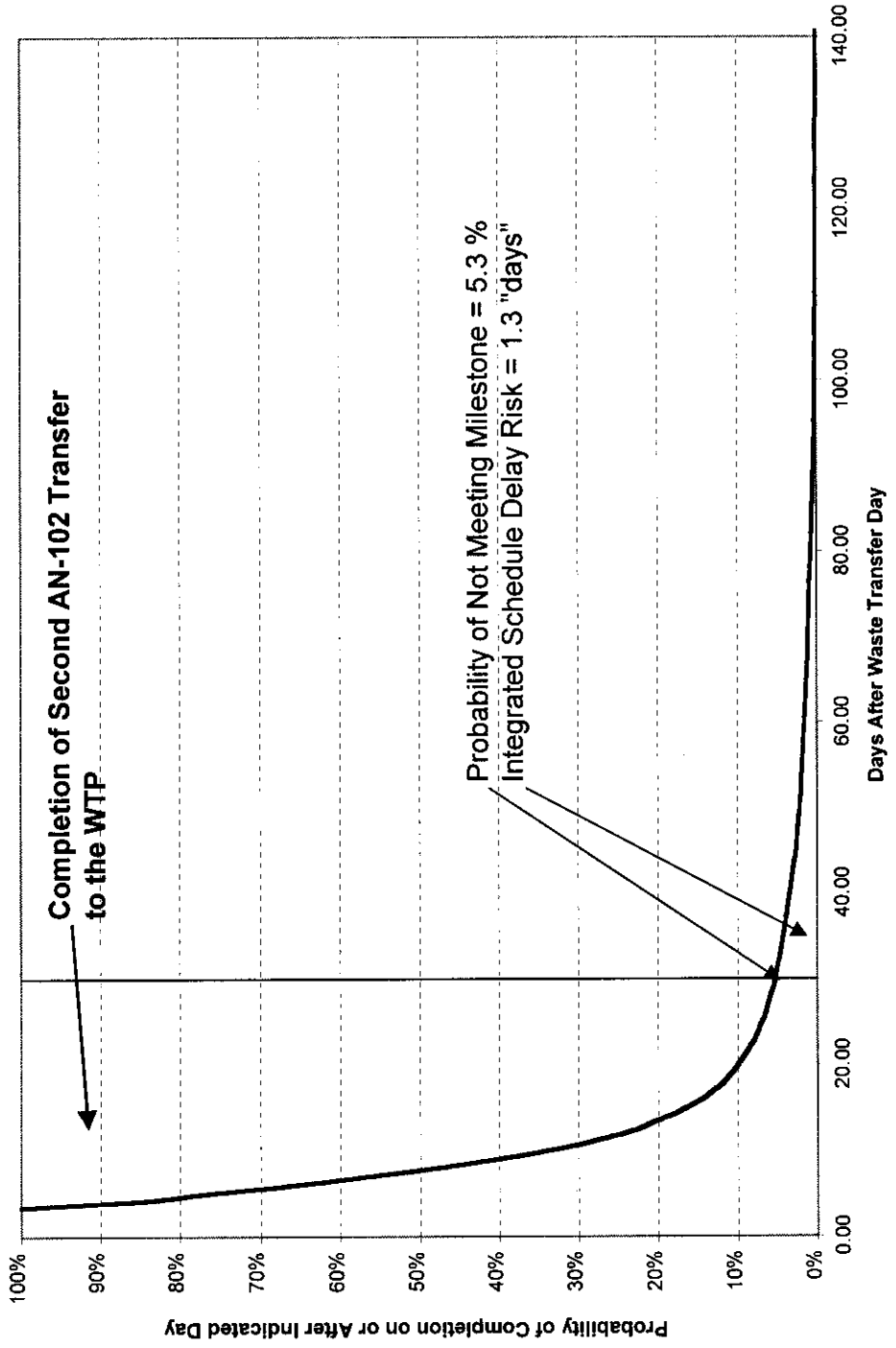

Figure 5-2. Risk of Idle Facility Costs, Second Batch Transfer from Class 1 Tank 241-AN-102

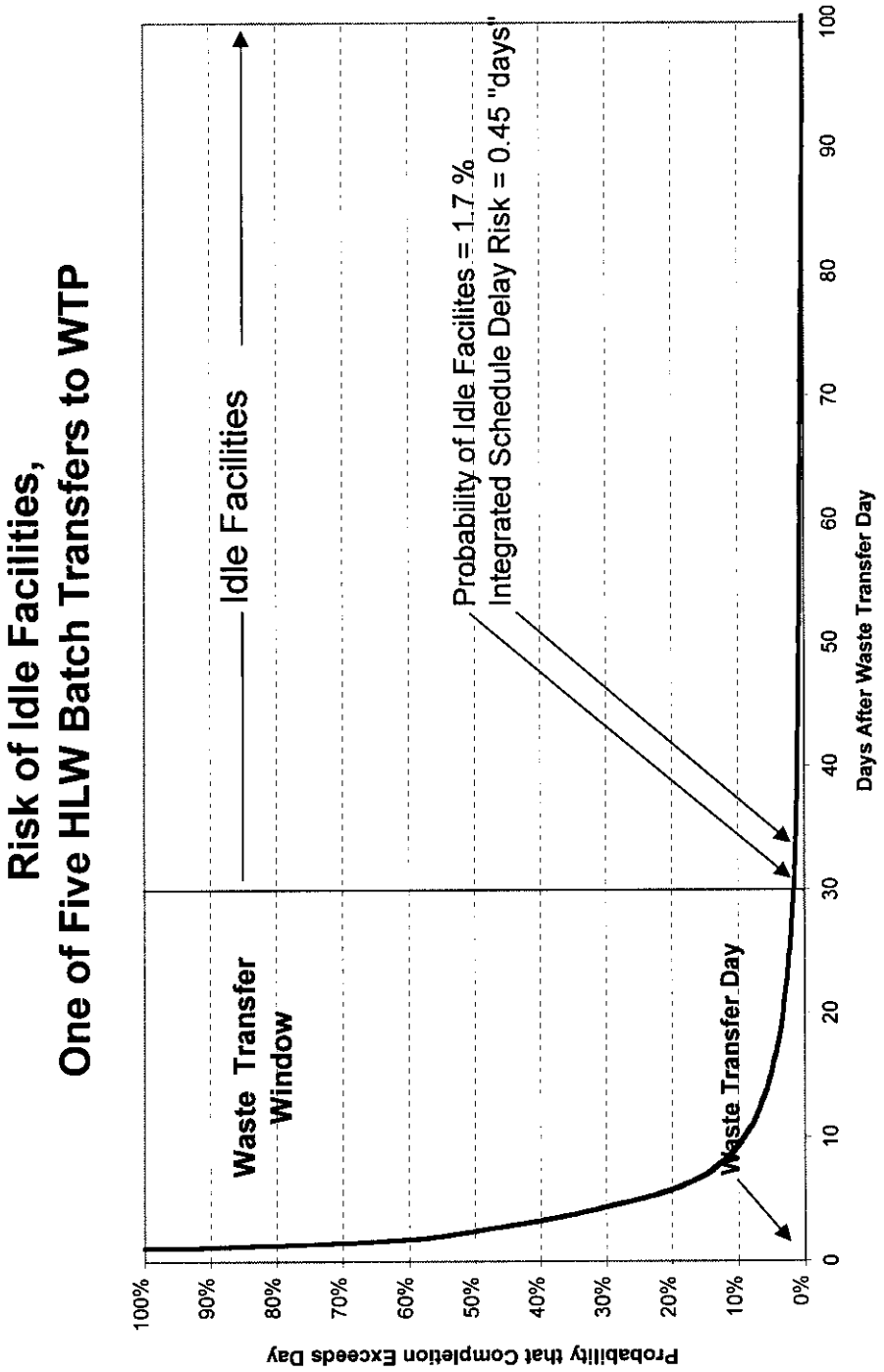

Figure 5-3. Risk of Idle Facility Costs, One of Five Class 2 HLW Batch Transfers to the WTP

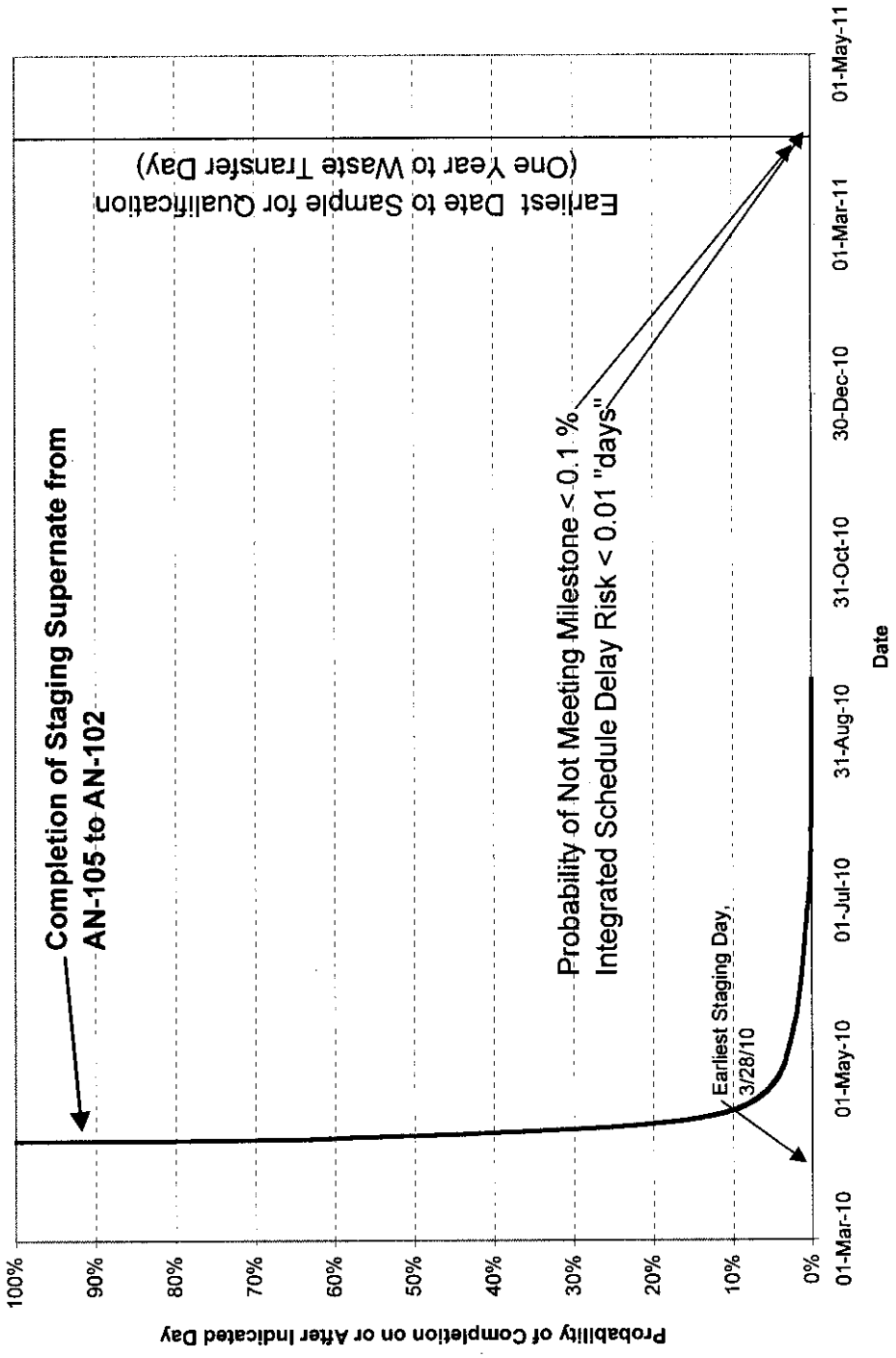

Figure 5-4. Distribution of Completion Dates for Staging (Decanting) AN-105 Supernate to 241-AN-102, Given Staging is Accomplished at the Earliest Scheduled Date

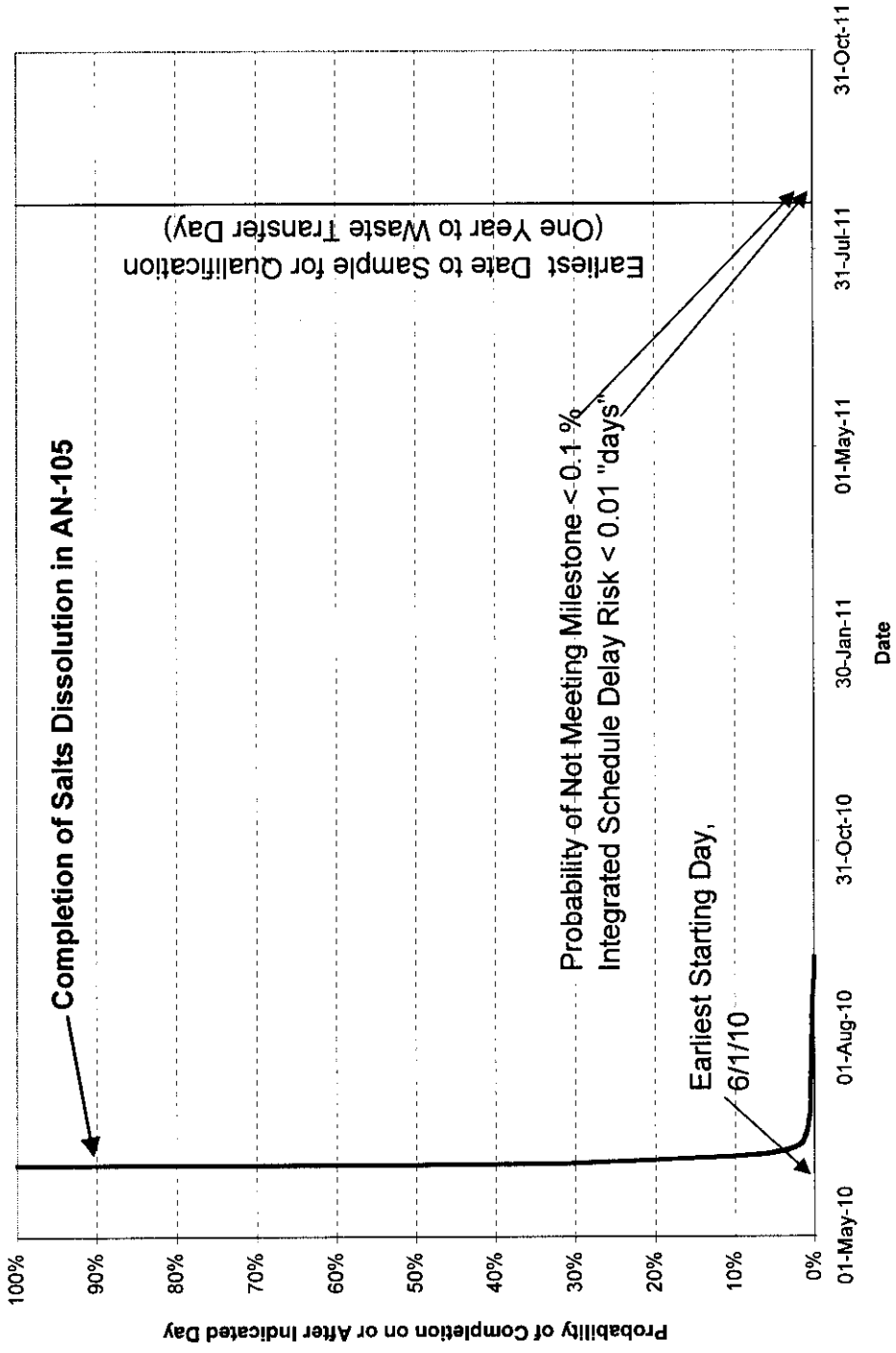

Figure 5-5. Distribution of Completion Dates for Dissolving Salt in 241-AN-105, Given Dissolution is Accomplished at the Earliest Scheduled Date

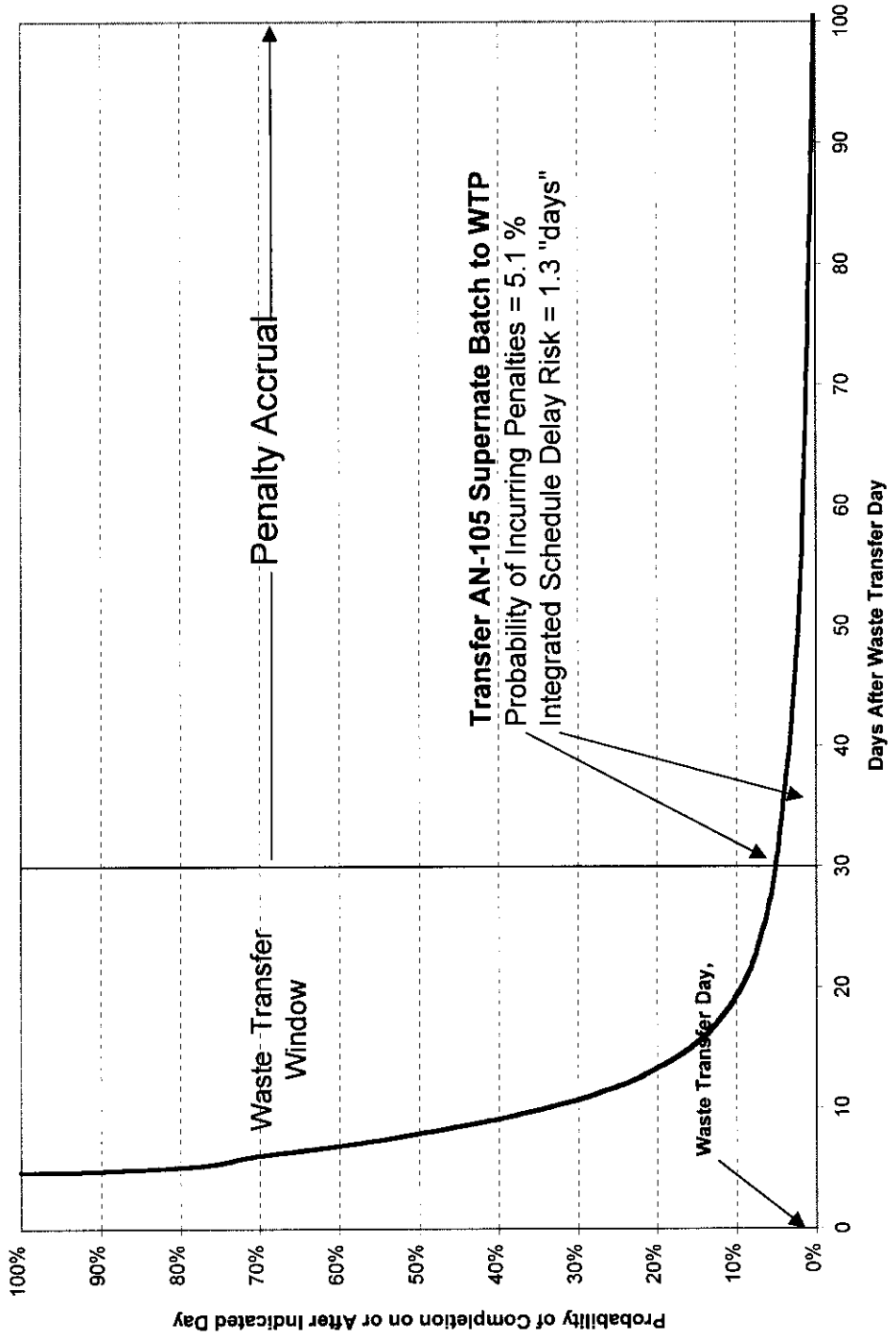

Figure 5-6. Risk of Idle Facility Costs, Transfer of the 241-AN-105 Supernate Batch from Staging Tank 214-AN-102 to the Waste Treatment Plant

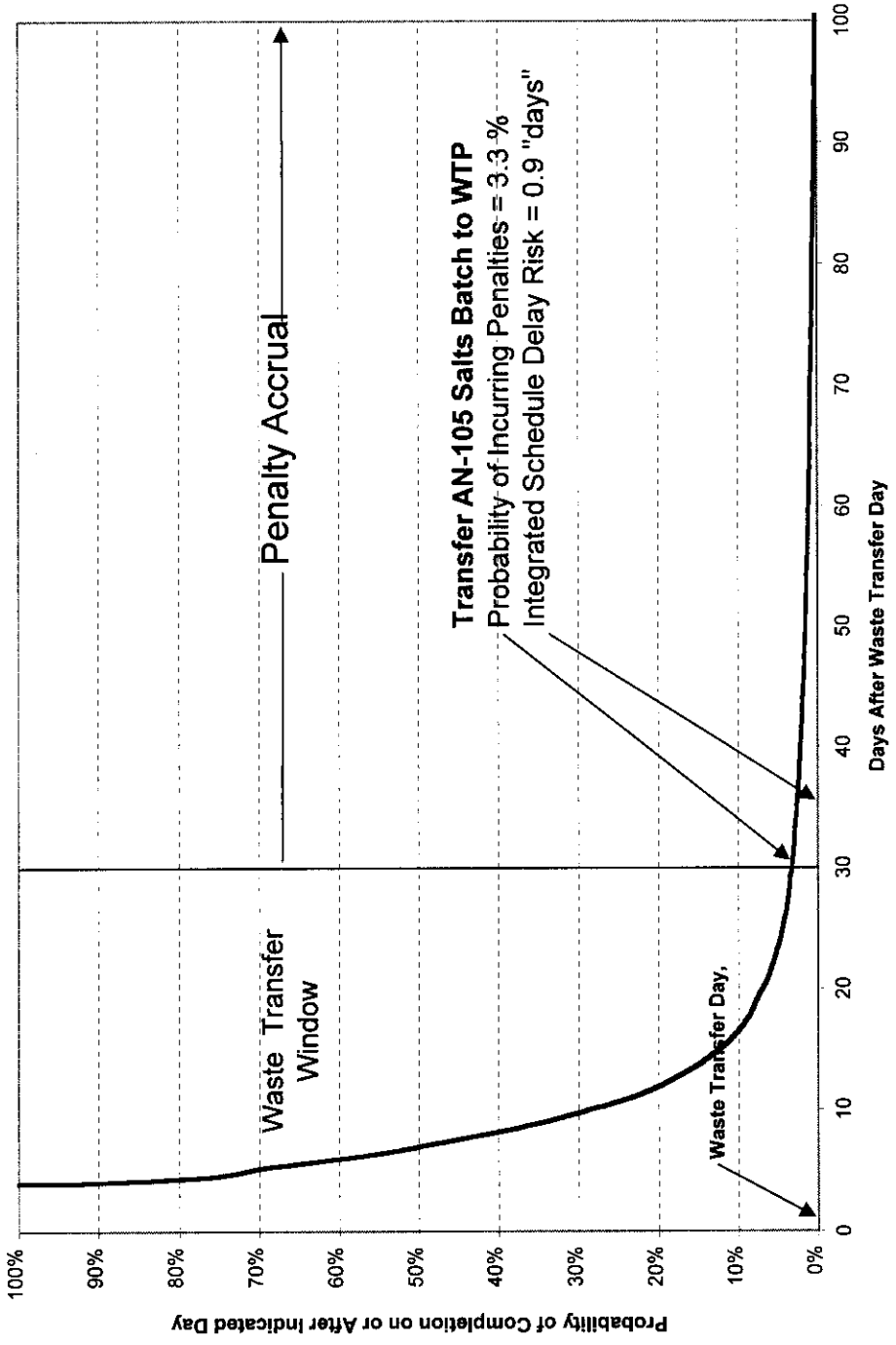

Figure 5-7. Risk of Idle Facility Costs, Transfer of the 241-AN-105 Dissolved Salt Batch to the Waste Treatment Plant

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Appendix A. RAM Model Structure

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A.1. Introduction

This appendix contains a description of the tables used to build the Revision 2 RAM models. The tables are presented in the following format.

Table Column	Description of Information Contained in Column
Data Field Name	Name assigned to the field in the database.
Data Field Description	Statement of what the field contains. Currently, other than conforming to the data type format (text, number, logic), there are no restrictions placed on acceptable entries.
Example Data Entry	One record selected from the database serves as the example for all the fields.
TFC Data?	Logic field stating whether or not this field part of a database that is being shared with other Tank Farm Contractor organizations.
Query Usage	Identifies the queries, by name in the database, that utilize this field.
Related Table(s)	Identifies other data tables that are related to this field via the queries identified in "Query Usage".

For ease of reference, the description of each table and query in the database begins on a separate page of this appendix.

A.2. Baseline Tables

A.2.1. PandID

The PandID Table was developed from information found on piping and instrumentation diagrams or process flow diagrams. It contains 17 fields that collectively describe each component found on the P&IDs. Information such a drawing number, equipment location, and size of component are included in this table. The fields used during the quantification process are limited to Equipment Identification Number (EIN), Component Type, and Component Description.

The EIN is used as the unique identifier to each component in the table. The EIN field was created by a concatenation of four fields also found in the PandID Table; Farm, Location ID, System ID, and Component ID. The makeup of the EIN is "Farm/Location ID-System ID-Component ID". An example EIN is AZ101-WST-P-701A, where AZ is the Farm, 101 is the Location ID, WST is the System ID, and P-701A is the Component ID.

Component Type and Component Description are used in determining failure rates.

PandID Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	***TFC Data?***	**Query Usage**	**Related Table(s)**
Index Number	Database record reference number used primarily for sorting or record identification. In most cases, the number was created prior to this analysis and is unique to the corresponding component.	3911	Yes	N/A	N/A
EIN	The unique identifier to each component in the database. Created by a concatenation of Farm, Location ID, System ID, and Component ID.	AZ101-PA-PCV-AZ101PA-1	Yes	Component List	Activity
Drawing Number	The drawing number of the P&ID identified as the primary documentation record of the corresponding component (1 of 3 fields). The drawing may refer to multiple sheets.	H-14-020307	Yes	N/A	N/A
Drawing Sheet	The sheet number within one drawing number set identified as the primary documentation record of the corresponding component (2 of 3 fields).	2	Yes	N/A	N/A
Drawing Revision	The revision number of the sheet number within one drawing number set identified as the primary documentation record of the corresponding component (3 of 3 fields).	0	Yes	N/A	N/A
FORMERLY KNOWN AS	Provides explanation if the component was formerly known under a different name or description in a previous analysis.	PCV-AZ101PA-1	Yes	N/A	N/A
Farm	Designates the waste tank farm that utilizes the system within which the corresponding component resides.	AZ	Yes	N/A	N/A

PandID Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	***TFC Data?***	**Query Usage**	**Related Table(s)**
Farm-Tank	Designates the waste tank farm and specific tank that utilizes the system within which the corresponding component resides.	AZ-101	Yes	N/A	N/A
Equipment Location	Additional delineation not provided by the Location ID Code.	Process Air Panel	Yes	Component List	Location Matrix
System ID	Code obtained from Drawing H-14-020000, Sheet 1 of 2, called SYSTEM IDENTIFICATION. Describes type of system within which the component resides.	PA	Yes	N/A	N/A
System	Type of operating medium or environment (selected from the SRS failure rate database) associated with the Component Type and Component Description.	Compressed Gas	No	Component List	Component Link
Location ID	An identification number taken from the component's associated P&ID that gives the major location of the component within a farm.	101	Yes	Component List	Location Matrix
Component ID	EIN third element - exact identification given on the P&ID (also, see Equipment Location Field description)	PCV-AZ101PA-1	Yes	N/A	N/A
Component Type	Code obtained from Drawing H-14-020000, Sheet 1 of 2, called EQUIPMENT IDENTIFICATION	PCV	Yes	Component List	Component Link
Component Description	Name associated with component type, or some other appropriate description.	Pressure Control Valve	Yes	Component List	Component Link
Size of Component	Pipe size of valves, or any other information that will allow establishing like components for purpose of spares analysis	1/4"	Yes	N/A	N/A
General Comments	Original RPP Component Database comments field.	Changed from H-2-131064 to H-2-68335 sh 12 10/20/99 changed dwg, sheet,equip loc	Yes	N/A	N/A
New Comments	Field provided for comments.	No new comments.	No	N/A	N/A
Major System Element	Identifies major functional elements when the system ID codes do not provide a reasonable description.	HVAC	Yes	N/A	N/A

A.2.2. PandID System

This table links to components in the PandID Table and places them into functional system categories.

PandID System Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	**TFC Data?**	**Query Usage**	**Related Table(s)**
EIN	Unique identifier to each component in the database.	AN241-VTP-EF-001	Yes	Component List with Applicable Failure Modes	PandID
System	General functional system within which the component resides.	Primary HVAC	No	Component List with Applicable Failure Modes	N/A
Major Element	Initial breakdown of the very broad System designations into large groups of components designed to provide a system level function.	Ventilation Tank Primary	No	Component List with Applicable Failure Modes	N/A
Subsystem 1	Group of components that together perform a single function. Generally, these components would be located in one place and be closely associated.	Exhaust Fan	No	Component List with Applicable Failure Modes	N/A
Subsystem 2	Further breakdown of components that together perform a single function within the Subsystem 1. Generally, these components would be located in one place and be closely associated.	Train A Exhaust	No	Component List with Applicable Failure Modes	N/A
Super-component	A collection of the components listed on a P&ID that contribute to one specific functional element; e.g., all the individual components in a temperature alarm, or a pump with the control and diagnostic instrumentation associated with it.	Exhaust Fan 1	No	Component List with Applicable Failure Modes	N/A
Issues	Field provided for "flagging" potential errors in data or other concerns.		No	N/A	N/A

A.2.3. *Activity Table Data Field Descriptions*

The Activity Table relates the function of components in major activities. It is developed from the top-down definition of activity functions and the determination of the systems, sub-systems, and components in which a functional failure can result in the delay of the activity. This table is linked to the PandID and the PandID System tables so that functional requirements may be flowed down to the individual components via the system breakdown structure. Each component is assigned function codes for each activity.

Activity Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Major Activity	Name or code of transfer activity.	16010B1	No	Component List	Exposure
System Activity	Functional system, as specified in the PandID System table, within which the component resides.	Confinement System	No	Component List	Exposure
EIN	Unique identifier to each component in the database.	AZ-101-WST-TE-101-AZ-102	Yes	Component List	PandID
Required Action	General function of the component.	Monitor/Control	No	N/A	N/A
Applicable for Delay	Indicates whether or not a failure of the specified component would contribute to the delay of a transfer activity.	Yes	No	Component List	N/A
Failure Mode Code	Also known as a function code, this code determines the possible failures modes of the component based on its function.	O	No	Component List	
Required Response	Description of actions necessary upon failure of component.	Shutdown mixer pump.	No	N/A	N/A
Backup Code	Code necessary for considering failure rates of applicable backup trains or backup components.	REP	No	Component List	Backup Failure
Assumptions	Field provided for noting assumptions made during the failure modes and effects analysis.	Failure creates hi alarm and procedure will require mixer pump shutdown.	No	N/A	N/A
Comments	Field provided for comments.	ARP-T-261-00001 does not state this. It is anticipated it will be changed to do so for WFD.	No	N/A	N/A
Issues	Field provided for "flagging" potential errors in data or other concerns.	Since there are multiple sensors, are there options to recover without shutting down mixer or transfer pumps?	No	N/A	N/A

A.2.4. Component Link

The Component Link Table is used to link components with their failure modes and failure rates. It does this by providing the three-way link between each PandID Component Type and Component Description, SRS Failure Rate Table Component and Component Subcategory, and Component Type Category.

Component Link Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Component Type	Unique equipment identification code taken from the PandID table.	V	Yes	Component Type Failure Rates, Component Type Failure Modes	PandID
Component Description	Unique name associated with component type.	Globe Valve	Yes	Component Type Failure Rates, Component Type Failure Modes	PandID
System	Type of operating medium or environment (selected from the SRS failure rate database) associated with the Component Type and Component Description.	Chemical Process	Yes	Component Type Failure Rates, Component Type Failure Modes	PandID
Component	Unique component group within the SRS failure rate database that corresponds to the Component Type and Component Description.	Valve (Standby or Safety)	No	N/A	Failure Rate
Component Subcategory	Unique description/sub-group of the Component within the SRS failure rate database that corresponds to the Component Type and Component Description.	Manual	No	N/A	Failure Rate
Component Type Category	Category designation for groups of unique component types and descriptions.	Check and Manual Valves	No	Component Type Failure Modes	FM Defs and Map
Comments	Field provided for comments.	No comments.	No	N/A	N/A

A.2.5. *FM Defs and Map*

This table describes the possible failure modes for each Component Type Category, which are given in Table 3-1 of the main report.

FM Defs and Map Table Data Field Descriptions					
Data Field Name	**Example Data Entry**	**Data Field Description**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Component Type Category	Pipes, Filters, Containers, Structure	Category designation for groups of unique component types and descriptions.	No	Component Type Failure Modes	Component Link
Failure Mode Code*	P1	Function Code delineator for the possible failure modes within the Component Type Category.	No	Component Type Failure Modes	Activity
Failure Mode	Plugs Catastrophic	Mode of failure.	No	Component Type Failure Modes	Failure Rate
Comments	Underground waste transfer piping.	Field provided for comments.	No	N/A	N/A

**Although named Failure Mode Code this data field is actually used for function code linking with failure modes.*

A.2.6. Exposure

This table describes exposure times and demands associated with WFDS activities. Linked with the Activity Table, it provides exposure times and demands for each WFDS component.

During the RAM quantification process, the exposure of a component to failure modes is established in the following way. First, an initial exposure is set up for each WFDS system within each WFDS activity. Each component within each WFDS system is given the exposure that was established for its associated system and corresponding activity. The exposure is related to the function codes assigned to the component. For example, a pump that must start and run is assigned a function code of DO. It is then exposed to a demand to start and a run period corresponding to the mission duration. A pump that is already running is assigned a function code of O, meaning that it is exposed only to running failures.

Exposure Table Data Field Descriptions					
Data Field Name	**Example Data Entry**	**Data Field Description**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Major Activity	16010B2	Name or code of transfer activity.	No	Component List with Exposure	Activity
System Activity	HVAC Primary	Unique functional system as specified in the PandID System table.	No	Component List with Exposure	Activity
Safety	Yes	"Yes or No" field to indicate whether or not the System Activity is required to continually operate through the duration of the activity.	No	Component List with Exposure	N/A
E_p	Yes	"Yes or No" field to indicate whether or not the System Activity will have an increased exposure as a result of a delay during a previous Major Activity.	No	Component List with Exposure	N/A
Pump Demands	0	Number of demands on pumps (or similar) in the system activity during the Major Activity.	No	Component List with Exposure	N/A
Valve Demands	0	Number of demands on valves (or similar) in the system activity during the Major Activity.	No	Component List with Exposure	N/A
Hour	24	Duration (in hours) that components in the System Activity will be exposed to potential failure modes during the Major Activity.	No	Component List with Exposure	N/A
Comments	E_p accounts for carryover repair of failures during 16010B1 that could delay the start of 16010B2.	Field provided for comments.	No	N/A	N/A
Issues	No issues.	Field provided for "flagging" potential errors in data or other concerns.	No	N/A	N/A

A.2.7. Increment Demand

Upon failure of a component, a prescribed number of recovery demands may be placed on a component. There may be zero to two recovery demands, based on the designated failure mode of the component. For example, a valve that has been assigned a failure mode of "CC" will require two demands for recovery; the valve is cycled during recovery and then repositioned. A valve that has been assigned an "NC" failure mode will not require any recovery demands since the valve remains closed during repair.

Increment Demand Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Generic FC	Unique function code also known as Failure Mode Code.	CC	No	Component List with Failure Rates	Activity
Increment	Number of demand increments for the Generic FC.	2	No	Component List with Failure Rates	N/A
Comment	Field provided for comments.	Valve Cycled during recovery, then repositioned	No	N/A	N/A

A.2.8. Failure Rate

This table is comprised of component failure rate data from all sources that may be used for both equipment failures and other off-normal events. Non-hardware event failure rates are identified appropriately as either Human or External Event related in the System, Component, and Sub-component fields. The values are presented in Appendix B.

Failure Rate Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	**TFC Data?**	**Query Usage**	**Related Table(s)**
System	Type of operating medium or environment associated with the Component Type and Component Description.	HVAC/Exhaust	No	Component Type Failure Rates	Component Link
Component	Unique component group that corresponds to the Component Type and Component Description.	Fan/Blower	No	N/A	Component Link
Component Subcategory	Unique description/sub-group of the Component that corresponds to the Component Type and Component Description.	Motor-driven	No	N/A	Component Link
Failure Mode	Mode of failure.	Fails to start/stop	No	Component Type Failure Rates	FM Defs and Map
Failure Rate Distribution	Failure rate distribution for equipment failure mode.	cb.lognormal(0.005 ,0.006333391843317 87)	No	N/A	N/A
Failure Rate Mean	Mean failure rate for equipment failure mode.	5.0E-03	No	Component Type Failure Rates	N/A
Unit	Unit of measure for component failure rate. H = Hour; H-FT = Hour-Foot; PD = Pump Demand; VD = Valve Demand	PD	No	Component Type Failure Rates	N/A
Range Factor	Failure rate uncertainty distribution range or error factor.	5.0	No	N/A	N/A
Data References	Reference source of information for failure rate data.	WSRC-TR-93-262, Table 1d	No	N/A	N/A
FM Identifier	Failure mode identification identifier.	MDF-FS-H	No	N/A	N/A
Comments	Field provided for comments.	No comments.	No	N/A	N/A

A.2.9. Backup Failure

The table "Backup Failure" contains a summary of the "Failure to Backup" likelihood for redundant trains in the model that can prevent a delay should a failure occur.

Backup Failure Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Backup Code	Code to identify backup train or components that would be utilized upon primary failure.	A02	No	Component List	Activity
Backup Failure	Failure rate of backup train or backup components.	0.56	No	Component List	N/A
Description	Description of backup train or backup components.	VTP exhaust HEPA filter backup train	No	N/A	N/A
Comments	Field provided for comments.	Reflects high common cause failure rate that conditions that plug the primary filter will also plug the backup filter.	No	N/A	N/A

A.2.10. Location Matrix

A table that categorizes the location specified on the P&ID into a code that describes the generic work conditions that might be experienced at that location during a recovery operation. The code is used to select a generic recovery code for failed components at that location

Location Matrix Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Location ID	An identification number taken from the component's associated P&ID that gives the major location of the component within a farm.	O2C	Yes	Component List	PandID
Equipment Location	Additional delineation not provided by the Location ID Code.	AN-105	Yes	Component List	PandID
Radiation Area	Code that specifies the type of radiation at the component's location. TR = Tank Radiation; PR = Pit Radiation; NR = No Radiation.	TR	No	Component List	RT Codes
Comments	Field provided for comments.		No	N/A	N/A

A.2.11. Recovery Time

This table provides predicted recovery times for failed components or site outages.

Recovery Time Table Data Field Descriptions					
Data Field Name	**Data Field Description**	**Example Data Entry**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Recovery Time ID	Recovery time code determined by craft, radiation location, size of component, and repair difficulty.	1TCNEL	No	Output to Excel	RT Codes
Recovery Time Description	Describes recovery code.	I&C COMP, TCNEL	No	N/A	N/A
Recovery Time Distribution	Recovery time distribution for recovery code.	cb.lognormal (157.65,95.09)	No	Output to Excel	N/A
Recovery Time Mean	Mean recovery time for recovery code.	158	No	Output to Excel	N/A
Recovery Time SD	Recovery time standard deviation.	95	No	N/A	N/A
Man-Hours (Mean)	Mean of required man hours for recovery.	382	No	N/A	N/A
Man-Hours (Std Dev)	Standard deviation of required man hours for recovery.	231	No	N/A	N/A
MTTR (Mean) for Quant	Mean time to repair.	158	No	N/A	N/A
Range Factor	Recovery time uncertainty distribution range or error factor.	2.5	No	N/A	N/A
Ln Std	Lognormal Standard Deviation.	0.55701564247669	No	N/A	N/A

A.2.12. RT Codes (Recovery Time Codes)

This table links generic component types and description and the radiation area designation to a generic recovery time code that reflects the screening estimate of the time and effort required to recover a component of that type under the given radiation conditions. The table may be easily expanded to reflect more specific estimates as well.

RT Codes Table Data Field Descriptions					
Data Field Name	**Example Data Entry**	**Data Field Description**	**TFC Data?**	**Query Usage**	**Related Table(s)**
Rad Area Code	PR	Code that specifies the type of radiation at the component's location. TR = Tank Radiation; PR = Pit Radiation; NR = No Radiation.	No	Output to Excel	Location Matrix
Component Type	HV	Unique equipment identification code taken from the PandID table.	Yes	Output to Excel	
Component Description	3-Way Ball Valve	Unique name associated with component type.	Yes	Output to Excel	
Failure Mode	Fails to open/close	Mode of component failure.	No	Output to Excel	
RT Code	5PRIEL	Recovery time code determined by craft, radiation location, size of component, and repair difficulty.	No	Output to Excel	Recovery Time

A.3. Independent Queries

Independent queries link component required for specific activities with information that is related to component types and categories. These queries are used to build the final queries that result in the quantification spreadsheets. Most of these tables are very long in their complete form and are provided here as extracts from the original tables.

A.3.1. Component Type Failure Rates

This query provides a listing of all of the WFDS component types derived from the P&IDs and links them with the SRS component failure rate database in order to assign a failure rate to the entire set of WFDS component types. This query will be used in later queries to easily assign failure rates to the components actually used to perform the various WFD activities. The tables linked in the query are the Component Link table and the Failure Rate table.

Component Type Failure Rates Query (Extract of Output)

Component Type	Component Description	Failure Mode	Failure Rate	Unit
(DT)	Digital Transmitter	Failure	0.00001	H
(PVC)	Primary Vent Cell	Leakage/Rupture (all)	0.000000105	H
ABS	HEGA Filter	Leakage/Rupture (all)	0.0000035	H
ABS	HEGA Filter	Plugs	0.000003	H
AC	Air Conditioner	Fails to run	0.00003	H
AC	HVAC Unit	Fails to run	0.00003	H
AC	Air Condition Unit	Fails to run	0.00003	H
AC	Air Conditioning Unit	Fails to run	0.00003	H
AC	Air Conditioner	Fails to start	0.01	PD
AC	HVAC Unit	Fails to start	0.01	PD
AC	Air Condition Unit	Fails to start	0.01	PD
AC	Air Conditioning Unit	Fails to start	0.01	PD

A.3.2. Component Type Failure Modes

This query provides a listing of all of the WFDS component types derived from the P&IDs and links them with the SRS component failure modes and applicable EQE assigned codes for those failure modes in order to assign a failure mode code to the entire set of WFDS component types. This query will be used in later queries to easily assign failure modes and demand profiles to the components actually used to perform the various WFD activities. The tables linked in the query are the Component Link table and the FM Defs and Map table.

Component Type Failure Modes Query (Extract of Output)

Component Type	Component Description	Failure Mode Code	Failure Mode
(DT)	Digital Transmitter	D	Fails to open/close
(DT)	Digital Transmitter	D	Failure
(DT)	Digital Transmitter	D	Spurious operation
(DT)	Digital Transmitter	N	N/A
(DT)	Digital Transmitter	O	Failure
(DT)	Digital Transmitter	O	Spurious operation
(DT)	Digital Transmitter	P	Spurious operation
(PVC)	Primary Vent Cell	N	N/A
(PVC)	Primary Vent Cell	P	Leakage/Rupture (all)
(PVC)	Primary Vent Cell	P	Plugs
(PVC)	Primary Vent Cell	P	Plugs/Fouls
(PVC)	Primary Vent Cell	P1	Leakage/Rupture (all)
(PVC)	Primary Vent Cell	P1	Plugs Catastrophic
(PVC)	Primary Vent Cell	P1	Plugs Non-Catastrophic
(PVC)	Primary Vent Cell	P1	Plugs/Fouls
ABS	HEGA Filter	N	N/A
ABS	HEGA Filter	P	Leakage/Rupture (all)
ABS	HEGA Filter	P	Plugs
ABS	HEGA Filter	P	Plugs/Fouls
ABS	HEGA Filter	P1	Leakage/Rupture (all)
ABS	HEGA Filter	P1	Plugs Catastrophic
ABS	HEGA Filter	P1	Plugs Non-Catastrophic
ABS	HEGA Filter	P1	Plugs/Fouls

A.4. Cascade Queries

The cascade queries take all of the required system and component level information and combines them into a series of tables that build on each other. The general steps are to assemble the applicable list of components with their associated system breakdown for each activity. The component list is then assigned failure rates, failure modes, and exposure profiles is a series of queries that build on each other in the order given. The final query produces a table of components sorted filtered by activity that is exported to MS Excel in order to perform the RAM expected value quantification and delay time distribution simulation.

A.4.1. Component List

This query produces a table of all of the components and system breakdown structure for all of the activities associated with delivering the tank contents. It is based on the following tables. It is the starting point of linking all of the mission critical components with RAM related information needed for quantification.

- Activity
- PandID
- Backup Failure
- Location Matrix

Component Link Query (Extract of Output)

Major Activity	System Activity	EIN	Location ID	Equipment Location	Rad Area Code	Align FC	Generic FC	Transfer FC	Backup Failure	Component Type	Component Description
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(1,4&5)	05A	AN-05A Pump Pit	PR	P	P	P	1	JMP	AN-05A Pump Pit Jumper Assembly
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(5&6)	05A	AN-05A Pump Pit	PR	P	P	P	1	JMP	AN-05A Valve Pit Jumper Assembly
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(6,7&8)	05A	AN-05A Pump Pit	PR	P	P	P	1	JMP	AN-05A Valve Pit Jumper Assembly
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-1	05A	AN-05A Pump Pit	PR	P	P	P	1	NOZ	AN-05A Pump Pit Jumper Connection
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-5	05A	AN-05A Pump Pit	PR	P	P	P	1	NOZ	AN-05A Pump Pit Jumper Connection
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-6	05A	AN-05A Pump Pit	PR	P	P	P	1	NOZ	AN-05A Pump Pit Jumper Connection
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-7	05A	AN-05A Pump Pit	PR	P	P	P	1	NOZ	AN-05A Pump Pit Jumper Connection

A.4.2. *Component List with Failure Rates*

This query builds on the component list query and adds failure rates and recovery demand increments for each component as applicable. It utilizes the following tables and queries.

- Component List
- Component Type Failure Rates
- Increment Demand

Component List with Failure Rates Query (Extract of Output)

Major Activity	System Activity	EIN	Location ID	Equipment Location	Rad Area Code	Align FC	Generic FC	Transfer FC	Backup Failure	Component Type	Component Description	Failure Mode	Failure Rate	Unit	Increment Demand
AN-105 Transfer	Annulus HVAC	AN242A-VTA-CASS-C-1364	242A	Bldg 2750E	NR	O	O	O	1	CASS	Computer Automated Surveillance Station	Failure	0.00003	H	N/A
AN-105 Transfer	Annulus HVAC	AN271-VTA-RAH-910	271	Instr Bldg 241-AN-271	NR	O	O	O	1	RAH	Radiation Alarm High	Failure	0.00003	H	N/A
AN-105 Transfer	Annulus HVAC	AN271-VTA-RAH-910	271	Instr Bldg 241-AN-271	NR	O	O	O	1	RAH	Radiation Alarm High	Spurious operation	0.000005	H	N/A
AN-105 Transfer	Annulus HVAC	AN271-VTA-XA-910	271	Instr Bldg 241-AN-271	NR	O	O	O	1	XA	Failure Alarm	Failure	0.00003	H	N/A
AN-105 Transfer	Annulus HVAC	AN271-VTA-XA-910	271	Instr Bldg 241-AN-271	NR	O	O	O	1	XA	Failure Alarm	Spurious operation	0.000005	H	N/A
AN-105 Transfer	Annulus HVAC	AN296-VTA-RAH-910A	296	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	TR	O	O	O	1	RAH	Radiation Alarm High	Failure	0.00003	H	N/A
AN-105 Transfer	Annulus HVAC	AN296-VTA-RAH-910A	296	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	TR	O	O	O	1	RAH	Radiation Alarm High	Spurious operation	0.000005	H	N/A
AN-105 Transfer	Annulus HVAC	AN296-VTA-XA-910A	296	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	TR	O	O	O	1	XA	Failure Alarm	Failure	0.00003	H	N/A
AN-105 Transfer	Annulus HVAC	AN296-VTA-XA-910A	296	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	TR	O	O	O	1	XA	Failure Alarm	Spurious operation	0.000005	H	N/A
AN-105 Transfer	Confinement AN-105	AN05C-WSTA-PI-115	05C	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	TR	O	O	O	1	PI	Pressure Indicator	Failure	0.00001	H	N/A
AN-105 Transfer	Confinement AN-105	AN05C-WST-FIV-102	05C	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	TR	O	O	O	1	FIV	Flow Indicating Valve	Fails to open/close	0.0003	VD	0

A.4.3. *Component List with Applicable Failure Modes*

This query builds on the component list with failure rates query and adds failure modes for each component as applicable. It utilizes the following tables and queries.

- Component List with Failure Rates
- Component Type Failure Modes
- PandID System

Component List with Applicable Failure Modes Query (Extract of Output)

Major Activity	System Activity	EIN	Location ID	Equipment Location	Rad Area Code	System	Major Element	Sub system 1	Sub system 2	Super-component	Backup Failure	Component Type	Component Description	Failure Mode	Failure Rate	Unit	Increment Demand
AN-105 Transfer	Waste Transfer AN-105/AN-102	AN01A-WT-A	01A	AN-01A Central Pump Pit	PR	Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Transfer Line	1	NOZ	AN-01A Central Pump Pit Jumper Connection	Plugs	1E-10	H-FT	N/A
AN-105 Transfer	Waste Transfer AN-105/AN-102	AN01A-WT-A	01A	AN-01A Central Pump Pit	PR	Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Transfer Line	1	NOZ	AN-01A Central Pump Pit Jumper Connection	Leakage/Rupture (all)	3.1E-09	H-FT	N/A
AN-105 Transfer	Waste Transfer AN-105/AN-102	AN01A-WT-D	01A	AN-01A Central Pump Pit	PR	Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Transfer Line	1	NOZ	AN-01A Central Pump Pit Jumper Connection	Plugs	1E-10	H-FT	N/A
AN-105 Transfer	Waste Transfer AN-105/AN-102	AN01A-WT-D	01A	AN-01A Central Pump Pit	PR	Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Transfer Line	1	NOZ	AN-01A Central Pump Pit Jumper Connection	Leakage/Rupture (all)	3.1E-09	H-FT	N/A
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(1,4&5)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Pump Pit Jumper Assembly	Leakage/Rupture (all)	1.01E-06	H	N/A
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(1,4&5)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Pump Pit Jumper Assembly	Plugs	5E-08	H	N/A
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(5&6)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Valve Pit Jumper Assembly	Plugs	5E-08	H	N/A
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(5&6)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Valve Pit Jumper Assembly	Leakage/Rupture (all)	1.01E-06	H	N/A
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(6,7&8)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Valve Pit Jumper Assembly	Plugs	5E-08	H	N/A
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(6,7&8)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Valve Pit Jumper Assembly	Leakage/Rupture (all)	1.01E-06	H	N/A

A.4.4. *Component List with Exposure*

This query builds on the component list with failure modes query and adds exposure related information for each component as applicable. The exposure related information includes whether the components are safely related, are subject to failure carryover from previous activities and the mission exposure duration for that component. It utilizes the following tables and queries.

- Component List with Applicable Failure Modes
- Exposure

Component List with Exposure Query (Extract of Output)

Major Activity	System Activity	EIN	Location ID	Equipment Location	Rad Area Code	System	Major Element	Sub system 1	Sub system 2	Super-component	Backup Failure	Component Type	Component Description	Failure Mode	Failure Rate	Unit	Increment Demand	Safety	Ep	Exposure
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(1,4&5)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Pump Pit Jumper Assembly	Leakage/Rupture (all)	1.01E-06	H	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(1,4&5)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Pump Pit Jumper Assembly	Plugs	5E-08	H	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(5&6)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Valve Pit Jumper Assembly	Plugs	5E-08	H	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(5&6)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Valve Pit Jumper Assembly	Leakage/Rupture (all)	1.01E-06	H	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(6,7&8)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Valve Pit Jumper Assembly	Plugs	5E-08	H	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-(6,7&8)	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	1	JMP	AN-05A Valve Pit Jumper Assembly	Leakage/Rupture (all)	1.01E-06	H	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-1	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	1	NOZ	AN-05A Pump Pit Jumper Connection	Leakage/Rupture (all)	3.1E-09	H-FT	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-1	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	1	NOZ	AN-05A Pump Pit Jumper Connection	Plugs	1E-10	H-FT	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-5	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	1	NOZ	AN-05A Pump Pit Jumper Connection	Leakage/Rupture (all)	3.1E-09	H-FT	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-5	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	1	NOZ	AN-05A Pump Pit Jumper Connection	Plugs	1E-10	H-FT	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-6	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	1	NOZ	AN-05A Pump Pit Jumper Connection	Leakage/Rupture (all)	3.1E-09	H-FT	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-6	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	1	NOZ	AN-05A Pump Pit Jumper Connection	Plugs	1E-10	H-FT	N/A	FALSE	FALSE	95
AN-105 Transfer	Waste Transfer AN-105	AN05A-WT-7	05A	AN-05A Pump Pit	PR	Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	1	NOZ	AN-05A Pump Pit Jumper Connection	Leakage/Rupture (all)	3.1E-09	H-FT	N/A	FALSE	FALSE	95

A.4.5. Output to Excel

This query builds on the component list with exposure query and adds recovery time information for each component as applicable. The recovery time information includes the recovery time code, recovery time distribution parameters and the mean recovery time value. This table provides the final output to MS Excel that is used for the RAM expected value quantification. It utilizes the following tables and queries.

- Component List with Exposure
- RT Code
- Recovery Time

Output to Excel Query (Extract of Output)

Major Activity	System Activity	EIN	Location ID	Equipment Location	Rad Area Code	System	Major Element	Sub system 1	Sub system 2	Super-component	Backup Failure	Component Type	Component Description	Failure Mode	Failure Rate	Unit	Increment Demand	Safety	Ep	Exposure	RECOVERY TIME ID	Recovery Time Distribution	Recovery Time
AN-105 Transfer	Annulus HVAC	AN271-VTA-XA-910	271	Instr Bldg 241-AN-271	NR	Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	1	XA	Failure Alarm	Failure	0.00003	H	N/A	FALSE	FALSE	95	1NCNNA	cb.lognormal(35.56,8.9)	35.56408728
AN-105 Transfer	Annulus HVAC	AN296-VTA-RAH-910A	296	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	TR	Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	1	RAH	Radiation Alarm High	Spurious operation	0.000005	H	N/A	FALSE	FALSE	95	2TCNEL	cb.lognormal(163.49,98.61)	163.4938926
AN-105 Transfer	Annulus HVAC	AN296-VTA-RAH-910A	296	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	TR	Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	1	RAH	Radiation Alarm High	Failure	0.00003	H	N/A	FALSE	FALSE	95	2TCNEL	cb.lognormal(163.49,98.61)	163.4938926
AN-105 Transfer	Annulus HVAC	AN296-VTA-XA-910A	296	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	TR	Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	1	XA	Failure Alarm	Failure	0.00003	H	N/A	FALSE	FALSE	95	1TCNSA	cb.lognormal(67.76,29.87)	67.75573234
AN-105 Transfer	Annulus HVAC	AN296-VTA-XA-910A	296	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	TR	Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	1	XA	Failure Alarm	Spurious operation	0.000005	H	N/A	FALSE	FALSE	95	1TCNSA	cb.lognormal(67.76,29.87)	67.75573234
AN-105 Transfer	Annulus HVAC	AN271-VTA-XA-910	271	Instr Bldg 241-AN-271	NR	Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	1	XA	Failure Alarm	Spurious operation	0.000005	H	N/A	FALSE	FALSE	95	RTOTHSML02	cb.triangular(6,12,24)	14
AN-105 Transfer	Annulus HVAC	AN271-VTA-RAH-910	271	Instr Bldg 241-AN-271	NR	Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	1	RAH	Radiation Alarm High	Failure	0.00003	H	N/A	FALSE	FALSE	95	2NCNNA	cb.lognormal(40.2,10.06)	40.20288128
AN-105 Transfer	Annulus HVAC	AN271-VTA-RAH-910	271	Instr Bldg 241-AN-271	NR	Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	1	RAH	Radiation Alarm High	Spurious operation	0.000005	H	N/A	FALSE	FALSE	95	RTOTHSML02	cb.triangular(6,12,24)	14

Appendix B. RAM Analysis Generic Failure Rates (From WSRC-TR-93-262)

Tables

B-1. Water System Recommended Generic Failure Rates

B-2. Chemical Process System Recommended Generic Failure Rates

B-3. Compressed Gas System Recommended Generic Failure Rates

B-4. HVAC/Exhaust System Recommended Generic Failure Rates

B-5. Electrical Distribution System Recommended Generic Failure Rates

B-6. Instrumentation and Control System Recommended Generic Failure Rates

B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification

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Table B-1. Water System Recommended Generic Failure Rates

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Water	Valve (Standby or Safety)	Manual	Fails to Open/Close	XVM-CC-W	3.00E-04	D	10
Water	Valve (Standby or Safety)	Manual	Fails to Open/Close	XVM-OO-W	3.00E-04	D	10
Water	Valve (Standby or Safety)	Manual	Plugs	XVM-PG-W	5.00E-08	H	10
Water	Valve (Standby or Safety)	Manual	Leakage (internal)	XVM-LI-W	1.00E-06	H	10
Water	Valve (Standby or Safety)	Manual	Rupture (internal)	XVM-RI-W	5.00E-08	H	30
Water	Valve (Standby or Safety)	Manual	Leakage (external)	XVM-LE-W	1.00E-08	H	10
Water	Valve (Standby or Safety)	Manual	Rupture (external)	XVM-RE-W	5.00E-10	H	30
Water	Valve (Standby or Safety)	Check	Fails to Open/Close	CKV-CC-W	5.00E-05	D	10
Water	Valve (Standby or Safety)	Check	Fails to Open/Close	CKV-00-W	1.00E-03	D	5
Water	Valve (Standby or Safety)	Check	Plugs	CKV-PG-W	5.00E-08	H	10
Water	Valve (Standby or Safety)	Check	Leakage (internal)	CKV-LI-W	1.00E-06	H	10
Water	Valve (Standby or Safety)	Check	Rupture (internal)	CKV-RI-W	5.00E-08	H	30
Water	Valve (Standby or Safety)	Check	Leakage (external)	CKV-LE-W	1.00E-08	H	10
Water	Valve (Standby or Safety)	Check	Rupture (external)	CKV-RE-W	5.00E-10	H	30
Water	Valve (Standby or Safety)	Motor-Operated	Fails to Open/Close	MOV-CC-W	3.00E-03	D	5
Water	Valve (Standby or Safety)	Motor-Operated	Fails to Open/Close	MOV-OO-W	3.00E-03	D	5
Water	Valve (Standby or Safety)	Motor-Operated	Spurious Operation	MOV-CO-W	3.00E-07	H	5
Water	Valve (Standby or Safety)	Motor-Operated	Spurious Operation	MOV-OC-W	3.00E-07	H	5
Water	Valve (Standby or Safety)	Motor-Operated	Plugs	MOV-PG-W	5.00E-08	H	10
Water	Valve (Standby or Safety)	Motor-Operated	Leakage (internal)	MOV-LI-W	1.00E-06	H	10
Water	Valve (Standby or Safety)	Motor-Operated	Rupture (internal)	MOV-RI-W	5.00E-08	H	30
Water	Valve (Standby or Safety)	Motor-Operated	Leakage (external)	MOV-LE-W	1.00E-08	H	10
Water	Valve (Standby or Safety)	Motor-Operated	Rupture (external)	MOV-RE-W	5.00E-10	H	30
Water	Valve (Standby or Safety)	Air-Operated	Fails to Open/Close	AOV-CC-W	1.00E-03	D	30
Water	Valve (Standby or Safety)	Air-Operated	Fails to Open/Close	AOV-OO-W	1.00E-03	D	30
Water	Valve (Standby or Safety)	Air-Operated	Spurious Operation	AOV-CO-W	1.00E-06	H	5
Water	Valve (Standby or Safety)	Air-Operated	Spurious Operation	AOV-OC-W	1.00E-06	H	5
Water	Valve (Standby or Safety)	Air-Operated	Plugs	AOV-PG-W	5.00E-08	H	10
Water	Valve (Standby or Safety)	Air-Operated	Leakage (internal)	AOV-LI-W	1.00E-06	H	10
Water	Valve (Standby or Safety)	Air-Operated	Rupture (internal)	AOV-RI-W	5.00E-08	H	30
Water	Valve (Standby or Safety)	Air-Operated	Leakage (external)	AOV-LE-W	1.00E-08	H	10

Table B-1. Water System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Water	Valve (Standby or Safety)	Air-Operated	Rupture (external)	AOV-RE-W	5.00E-10	H	30
Water	Valve (Standby or Safety)	Solenoid-Operated	Fails to Open/Close	SOV-CC-W	1.00E-03	D	10
Water	Valve (Standby or Safety)	Solenoid-Operated	Fails to Open/Close	SOV-OO-W	1.00E-03	D	10
Water	Valve (Standby or Safety)	Solenoid-Operated	Spurious operation	SOV-CO-W	5.00E-07	H	10
Water	Valve (Standby or Safety)	Solenoid-Operated	Plugs	SOV-PG-W	5.00E-08	H	10
Water	Valve (Standby or Safety)	Solenoid-Operated	Leakage (internal)	SOV-LI-W	1.00E-06	H	10
Water	Valve (Standby or Safety)	Solenoid-Operated	Rupture (internal)	SOV-RI-W	5.00E-08	H	30
Water	Valve (Standby or Safety)	Solenoid-Operated	Leakage (external)	SOV-LE-W	1.00E-08	H	10
Water	Valve (Standby or Safety)	Solenoid-Operated	Rupture (external)	SOV-RE-W	5.00E-10	H	30
Water	Valve (Standby or Safety)	Safety/Relief	Fails to Open	SRV-CC-W	3.00E-03	D	3
Water	Valve (Standby or Safety)	Safety/Relief	Fails to reclose	SRV-OO-W	3.00E-03	D	3
Water	Valve (Standby or Safety)	Safety/Relief	Leakage (internal)	SRV-LI-W	1.00E-06	H	10
Water	Valve (Standby or Safety)	Safety/Relief	Rupture (internal)	SRV-RI-W	5.00E-08	H	30
Water	Valve (Standby or Safety)	Safety/Relief	Leakage (external	SRV-LE-W	1.00E-08	H	10
Water	Valve (Standby or Safety)	Safety/Relief	Rupture (external)	SRV-RE-W	5.00E-10	H	30
Water	Valve (Standby or Safety)	Vacuum-Breaker	Fails to Open	VBV-CC-W	1.00E-02	D	10
Water	Valve (Standby or Safety)	Vacuum-Breaker	Fails to reclose	VBV-OO-W	1.00E-02	D	10
Water	Valve (Standby or Safety)	Vacuum-Breaker	Leakage (internal)	VBV-LI-W	1.00E-06	H	10
Water	Valve (Standby or Safety)	Vacuum-Breaker	Rupture (internal)	VBV-RI-W	5.00E-08	H	30
Water	Valve (Standby or Safety)	Vacuum-Breaker	Leakage (external)	VBV-LE-W	1.00E-08	H	10
Water	Valve (Standby or Safety)	Vacuum-Breaker	Rupture (external)	VBV-RE-W	5.00E-10	H	30
Water	Valve (Standby or Safety)	Explosive	Fails to open	EXV-CC-W	1.00E-04	D	10
Water	Valve (Standby or Safety)	Explosive	Leakage (internal)	EXV-LI-W	1.00E-06	H	10
Water	Valve (Standby or Safety)	Explosive	Rupture (internal)	EXV-RI-W	5.00E-08	H	30
Water	Valve (Standby or Safety)	Explosive	Leakage (external)	EXV-LE-W	1.00E-08	H	10
Water	Valve (Standby or Safety)	Explosive	Rupture (external)	EXV-RE-W	5.00E-10	H	30
Water	Valve (Control)	Motor-Operated	Fails open	CMV-FO-W	3.00E-06	H	10
Water	Valve (Control)	Motor-Operated	Fails closed	CMV-FC-W	3.00E-06	H	10
Water	Valve (Control)	Motor-Operated	Fails to respond	CMV-NR-W	3.00E-06	H	10
Water	Valve (Control)	Motor-Operated	Plugs	CMV-PG-W	5.00E-08	H	10
Water	Valve (Control)	Motor-Operated	Leakage (external)	CMV-LE-W	1.00E-08	H	10

Table B-1. Water System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Water	Valve (Control)	Motor-Operated	Rupture (external)	CMV-RE-W	5.00E-10	H	30
Water	Valve (Control)	Air-Operated	Fails open	CAV-FO-W	3.00E-06	H	10
Water	Valve (Control)	Air-Operated	Fails closed	CAV-FC-W	3.00E-06	H	10
Water	Valve (Control)	Air-Operated	Fails to respond	CAV-NR-W	3.00E-06	H	10
Water	Valve (Control)	Air-Operated	Plugs	CAV-PG-W	5.00E-08	H	10
Water	Valve (Control)	Air-Operated	Leakage (external)	CAV-LE-W	1.00E-08	H	10
Water	Valve (Control)	Air-Operated	Rupture (external)	CAV-RE-W	5.00E-10	H	30
Water	Valve (Control)	Solenoid-Operated	Fails open	CSV-FO-W	3.00E-06	H	10
Water	Valve (Control)	Solenoid-Operated	Fails closed	CSV-FC-W	3.00E-06	H	10
Water	Valve (Control)	Solenoid-Operated	Fails to respond	CSV-FO-W	3.00E-06	H	10
Water	Valve (Control)	Solenoid-Operated	Plugs	CSV-PG-W	5.00E-08	H	10
Water	Valve (Control)	Solenoid-Operated	Leakage (external)	CSV-LE-W	1.00E-08	H	10
Water	Valve (Control)	Solenoid-Operated	Rupture (external)	CSV-RE-W	5.00E-10	H	30
Water	Pump	Motor-Driven	Fails to start	MDP-FS-W	3.00E-03	D	5
Water	Pump	Motor-Driven	Fails to run	MDP-FR-W	3.00E-05	H	10
Water	Pump	Motor-Driven	Overspeed	MDP-OS-W	5.00E-06	H	10
Water	Pump	Motor-Driven	Fails to stop	MDP-NS-W	3.00E-03	D	5
Water	Pump	Motor-Driven	Leakage (external)	MDP-LE-W	3.00E-08	H	10
Water	Pump	Motor-Driven	Rupture (external)	MDP-RE-W	1.00E-09	H	30
Water	Pump	Turbine-Driven	Fails to start	TDP-FS-W	3.00E-02	D	3
Water	Pump	Turbine-Driven	Fails to run	TDP-FR-W	1.00E-04	H	30
Water	Pump	Turbine-Driven	Overspeed	TDP-OS-W	3.00E-05	H	10
Water	Pump	Turbine-Driven	Fails to stop	TDP-NS-W	3.00E-02	D	3
Water	Pump	Turbine-Driven	Leakage (external)	TDP-LE-W	3.00E-08	H	10
Water	Pump	Turbine-Driven	Rupture (external)	TDP-RE-W	1.00E-09	H	30
Water	Pump	Diesel-Driven	Fails to start	DDP-FS-W	1.00E-02	D	5
Water	Pump	Diesel-Driven	Fails to run	DDP-FR-W	5.00E-03	H	5
Water	Pump	Diesel-Driven	Overspeed	DDP-OS-W	1.00E-03	H	5
Water	Pump	Diesel-Driven	Fails to stop	DDP-NS-W	1.00E-02	D	5
Water	Pump	Diesel-Driven	Leakage (external)	DDP-LE-W	3.00E-08	H	10
Water	Pump	Diesel-Driven	Rupture (external)	DDP-RE-W	1.00E-09	H	30

Table B-1. Water System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Water	Piping/Hose/Jumper	Piping	Leakage (external)	PIP-LE-W	3.00E-09	H-FT	10
Water	Piping/Hose/Jumper	Piping	Rupture (external)	PIP-RE-W	1.00E-10	H-FT	30
Water	Piping/Hose/Jumper	Piping	Plugs	PIP-PF-W	1.00E-10	H-FT	30
Water	Piping/Hose/Jumper	Hose	Leakage (external)	HOS-LE-W	1.00E-09	H-FT	10
Water	Piping/Hose/Jumper	Hose	Rupture (external)	HOS-RE-W	1.00E-08	H-FT	10
Water	Piping/Hose/Jumper	Hose	Plugs	HOS-PG-W	1.00E-08	H-FT	10
Water	Piping/Hose/Jumper	Jumper	Leakage (external	JPR-LE-W	1.00E-06	H	10
Water	Piping/Hose/Jumper	Jumper	Rupture (external)	JPR-RE-W	1.00E-08	H	30
Water	Piping/Hose/Jumper	Jumper	Plugs	JPR-PG-W	5.00E-08	H	10
Water	Vessel	Tank (Unpressurized)	Leakage (external)	TKU-LE-W	1.00E-08	H	10
Water	Vessel	Tank (Unpressurized)	Rupture (external)	TKU-RE-W	5.00E-10	H	30
Water	Vessel	Tank (Pressurized)	Leakage (external)	TKP-LE-W	1.00E-08	H	10
Water	Vessel	Tank (Pressurized)	Rupture (external)	TKP-RE-W	5.00E-10	H	30
Water	Vessel	Flange/Gasket	Leakage (external)	FLG-LE-W	1.00E-08	H	10
Water	Vessel	Flange/Gasket	Rupture (external)	FLG-RE-W	1.00E-10	H	30
Water	Heat Exchanger	Shell/Tube	Fouling (tubes)	HTX-FL-W	1.00E-07	H	10
Water	Heat Exchanger	Shell/Tube	Plugs (tubes)	HTX-PG-W	3.00E-08	H	10
Water	Heat Exchanger	Shell/Tube	Leakage (tubes)	HTX-LI-W	1.00E-07	H	10
Water	Heat Exchanger	Shell/Tube	Rupture (tubes)	HTX-RI-W	5.00E-09	H	30
Water	Heat Exchanger	Shell/Tube	Leakage (shell)	HTX-LE-W	1.00E-08	H	10
Water	Heat Exchanger	Shell/Tube	Rupture (shell)	HTX-RE-W	5.00E-10	H	30
Water	Heat Exchanger	Heater (Electrical)	Fails to heat	HTE-FH-W	1.00E-06	H	10
Water	Heat Exchanger	Heater (Electrical)	Overheats	HTE-OH-W	3.00E-07	H	10
Water	Heat Exchanger	Heater (Electrical)	Leakage (external)	HTE-LE-W	1.00E-07	H	10
Water	Heat Exchanger	Heater (Electrical)	Rupture (external)	HTE-RE-W	5.00E-09	H	30
Water	Strainer/Filter		Plugs	FLT-PG-W	3.00E-06	H	10
Water	Strainer/Filter		Leakage (internal)	FLT-LI-W	3.00E-06	H	10
Water	Strainer/Filter		Rupture (internal)	FLT-RI-W	5.00E-07	H	10
Water	Orifice		Plugs	ORF-PG-W	1.00E-06	H	3
Water	Miscellaneous	Traveling Screen	Plugs	TRS-PG-W	5.00E-07	H	10

Table B-2. Chemical Process System Recommended Generic Failure Rates

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Chemical Process	Valve (Standby or Safety)	Manual	Fails to open	XVM-CC-C	3.00E-04	D	10
Chemical Process	Valve (Standby or Safety)	Manual	Fails to close	XVM-OO-C	3.00E-04	D	10
Chemical Process	Valve (Standby or Safety)	Manual	Plugs	XVM-PG-C	5.00E-08	H	10
Chemical Process	Valve (Standby or Safety)	Manual	Leakage (internal)	XVM-LI-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Manual	Rupture (internal)	XVM-RI-C	5.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Manual	Leakage (external)	XVM-LE-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Manual	Rupture (external)	XVM-RE-C	3.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Check	Fails to open	CKV-CC-C	5.00E-05	D	10
Chemical Process	Valve (Standby or Safety)	Check	Fails to close	CKV-OO-C	1.00E-03	D	10
Chemical Process	Valve (Standby or Safety)	Check	Plugs	CKV-PG-C	5.00E-08	H	10
Chemical Process	Valve (Standby or Safety)	Check	Leakage (internal)	CKV-LI-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Check	Rupture (internal)	CKV-RI-C	5.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Check	Leakage (external)	CKV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Check	Rupture (external)	CKV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Fails to open	MOV-CC-C	3.00E-03	D	10
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Fails to close	MOV-OO-C	3.00E-03	D	10
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Spurious operation	MOV-CO-C or MOV-OC-C	3.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Plugs	MOV-PG-C	5.00E-08	H	10
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Leakage (internal)	MOV-LI-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Rupture (internal)	MOV-RI-C	5.00E-08	H	10
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Leakage (external)	MOV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Rupture (external)	MOV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Air-Operated	Fails to open	AOV-CC-C	1.00E-03	D	30
Chemical Process	Valve (Standby or Safety)	Air-Operated	Fails to close	AOV-OO-C	1.00E-03	D	30
Chemical Process	Valve (Standby or Safety)	Air-Operated	Spurious operation	AOV-CO-C or AOV-OC-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Air-Operated	Plugs	AVO-CO-C or AOV-OC-C	5.00E-08	H	10
Chemical Process	Valve (Standby or Safety)	Air-Operated	Leakage (internal)	AOV-LI-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Air-Operated	Rupture (internal)	AOV-RI-C	5.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Air-Operated	Leakage (external)	AOV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Air-Operated	Rupture (external)	AOV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Fails to open	SOV-CC-C	1.00E-03	D	10

Table B-2. Chemical Process System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Fails to close	SOV-OO-C	1.00E-03	D	10
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Spurious operation	SOV-CO-C or SOV-OC-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Plugs	SOV-PG-C	5.00E-08	H	10
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Leakage (internal)	SOV-LI-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Rupture (internal)	SOV-RI-C	5.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Leakage (external)	SOV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Rupture (external)	SOV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Safety/Relief	Fails to open	SRV-CC-C	3 .0E-3	D	10
Chemical Process	Valve (Standby or Safety)	Safety/Relief	Fails to reclose	SRV-OO-C	3.00E-03	D	10
Chemical Process	Valve (Standby or Safety)	Safety/Relief	Leakage (internal)	SRV-LI-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Safety/Relief	Rupture (internal)	SRV-RI-C	5.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Safety/Relief	Leakage (external)	SRV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Safety/Relief	Rupture (external)	SRV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Vacuum-Breaker	Fails to open	VBV-CC-C	1.00E-02	D	10
Chemical Process	Valve (Standby or Safety)	Vacuum-Breaker	Fails to reclose	VBV-OO-C	1.00E-02	D	10
Chemical Process	Valve (Standby or Safety)	Vacuum-Breaker	Leakage (internal)	VBV-LI-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Vacuum-Breaker	Rupture (internal)	VBV-RI-C	5.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Vacuum-Breaker	Leakage (external)	VBV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Vacuum-Breaker	Rupture (external)	VBV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Standby or Safety)	Explosive	Fails to open	EXV-CC-C	1.00E-04	D	10
Chemical Process	Valve (Standby or Safety)	Explosive	Leakage (internal)	EXV-LI-C	1.00E-06	H	10
Chemical Process	Valve (Standby or Safety)	Explosive	Rupture (internal)	EXV-RI-C	5.00E-08	H	10
Chemical Process	Valve (Standby or Safety)	Explosive	Leakage (external)	EXV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Standby or Safety)	Explosive	Rupture (external)	EXV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Control)	Motor-Operated	Fails open	CMV-FO-C	3.00E-06	H	10
Chemical Process	Valve (Control)	Motor-Operated	Fails closed	CMV-FC-C	3.00E-06	H	10
Chemical Process	Valve (Control)	Motor-Operated	Fails to respond	CMV-NR-C	3.00E-06	H	10
Chemical Process	Valve (Control)	Motor-Operated	Plugs	CMV-PG-C	5.00E-08	H	10
Chemical Process	Valve (Control)	Motor-Operated	Leakage (external)	CMV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Control)	Motor-Operated	Rupture (external)	CMV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Control)	Air-Operated	Fails open	CAV-FO-C	3.00E-06	H	10

Table B-2. Chemical Process System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Chemical Process	Valve (Control)	Air-Operated	Fails closed	CAV-FC-C	3.00E-06	H	10
Chemical Process	Valve (Control)	Air-Operated	Fails to respond	CAV-NR-C	3.00E-06	H	10
Chemical Process	Valve (Control)	Air-Operated	Plugs	CAV-PG-C	5.00E-08	H	10
Chemical Process	Valve (Control)	Air-Operated	Leakage (external)	CAV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Control)	Air-Operated	Rupture (external)	CAV-RE-C	3.00E-08	H	30
Chemical Process	Valve (Control)	Solenoid-Operated	Fails open	CSV-FO-C	3.00E-06	H	10
Chemical Process	Valve (Control)	Solenoid-Operated	Fails closed	CSV-FC-C	3.00E-06	H	10
Chemical Process	Valve (Control)	Solenoid-Operated	Fails to respond	CSV-NR-C	3.00E-06	H	10
Chemical Process	Valve (Control)	Solenoid-Operated	Plugs	CSV-PG-C	5.00E-08	H	10
Chemical Process	Valve (Control)	Solenoid-Operated	Leakage (external)	CSV-LE-C	5.00E-07	H	10
Chemical Process	Valve (Control)	Solenoid-Operated	Rupture (external)	CSV-RE-C	3.00E-08	H	30
Chemical Process	Pump	Motor-Driven	Fails to start	MDP-FS-C	1.00E-02	D	10
Chemical Process	Pump	Motor-Driven	Fails to run	MDP-FR-C	1.00E-04	H	10
Chemical Process	Pump	Motor-Driven	Overspeed	MDP-OS-C	3.00E-05	H	10
Chemical Process	Pump	Motor-Driven	Fails to stop	MDP-NS-C	1.00E-02	D	10
Chemical Process	Pump	Motor-Driven	Leakage (external)	MDP-LE-C	1.00E-06	H	10
Chemical Process	Pump	Motor-Driven	Rupture (external)	MDP-RE-C	5.00E-08	H	30
Chemical Process	Pump	Turbine-Driven	Fails to start	TDP-FS-C	3.00E-02	D	10
Chemical Process	Pump	Turbine-Driven	Fails to run	TDP-FR-C	1.00E-04	H	30
Chemical Process	Pump	Turbine-Driven	Overspeed	TDP-OS-C	3.00E-05	H	10
Chemical Process	Pump	Turbine-Driven	Fails to stop	TDP-NS-C	3.00E-02	D	10
Chemical Process	Pump	Turbine-Driven	Leakage (external)	TDP-LE-C	1.00E-06	H	10
Chemical Process	Pump	Turbine-Driven	Rupture (external)	TDP-RE-C	5.00E-08	H	30
Chemical Process	Pump	Diesel-Driven	Fails to start	DDP-FS-C	1.00E-02	D	10
Chemical Process	Pump	Diesel-Driven	Fails to run	DDP-FR-C	5.00E-03	H	10
Chemical Process	Pump	Diesel-Driven	Overspeed	DDP-OS-C	1.00E-03	H	10
Chemical Process	Pump	Diesel-Driven	Fails to Stop	DDP-NS-C	1.00E-02	D	10
Chemical Process	Pump	Diesel-Driven	Leakage (external)	DDP-LE-C	1.00E-06	H	10
Chemical Process	Pump	Diesel-Driven	Rupture (external)	DDP-RE-C	5.00E-08	H	30
Chemical Process	Piping/Hose/Jumper	Piping	Leakage (external)	PIP-LE-C	3.00E-09	H-FT	10

Table B-2. Chemical Process System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Chemical Process	Piping/Hose/Jumper	Piping	Rupture (external)	PIP-RE-C	1.00E-10	H-FT	30
Chemical Process	Piping/Hose/Jumper	Piping	Plugs	PIP-PG-C	1.00E-10	H-FT	30
Chemical Process	Piping/Hose/Jumper	Hose	Leakage (external)	HOS-LE-C	1.00E-09	H-FT	10
Chemical Process	Piping/Hose/Jumper	Hose	Rupture (external)	HOS-RE-C	1.00E-08	H-FT	10
Chemical Process	Piping/Hose/Jumper	Hose	Plugs	HOS-PG-C	1.00E-08	H-FT	10
Chemical Process	Piping/Hose/Jumper	Jumper	Leakage (external)	JPR-LE-C	1.00E-06	H	10
Chemical Process	Piping/Hose/Jumper	Jumper	Rupture (external)	JPR-RE-C	1.00E-08	H	30
Chemical Process	Piping/Hose/Jumper	Jumper	Plugs	JPR-PG-C	5.00E-08	H	10
Chemical Process	Vessel	Tank (unpressurized)	Leakage (external)	TKU-LE-C	1.00E-07	H	10
Chemical Process	Vessel	Tank (unpressurized)	Rupture (external)	TKU-RE-C	5.00E-09	H	30
Chemical Process	Vessel	Tank (pressurized)	Leakage (external)	TKP-LE-C	1.00E-07	H	10
Chemical Process	Vessel	Tank (pressurized)	Rupture (external)	TKP-RE-C	5.00E-09	H	30
Chemical Process	Vessel	Flange/Gasket	Leakage (external)	FLG-LE-C	1.00E-07	H	10
Chemical Process	Vessel	Flange/Gasket	Rupture (external)	FLG-RE-C	1.00E-09	H	10
Chemical Process	Heat Exchanger	Shell/Tube	Fouling (tubes)	HTX-FL-C	1.00E-06	H	10
Chemical Process	Heat Exchanger	Shell/Tube	Plugs (tubes)	HTX-PG-C	3.00E-07	H	10
Chemical Process	Heat Exchanger	Shell/Tube	Leakage (tubes)	HTX-LI-C	1.00E-06	H	10
Chemical Process	Heat Exchanger	Shell/Tube	Rupture (tubes)	HTX-RI-C	5.00E-08	H	30
Chemical Process	Heat Exchanger	Shell/Tube	Leakage (shell)	HTX-LE-C	1.00E-07	H	10
Chemical Process	Heat Exchanger	Shell/Tube	Rupture (shell)	HTX-RE-C	5.00E-09	H	30
Chemical Process	Heat Exchanger	Heater (Electrical)	Fails to heat	HTE-FH-C	1.00E-05	H	10
Chemical Process	Heat Exchanger	Heater (Electrical)	Overheats	HTE-OH-C	3.00E-06	H	10
Chemical Process	Heat Exchanger	Heater (Electrical)	Leakage (external)	HTE-LE-C	1.00E-06	H	10
Chemical Process	Heat Exchanger	Heater (Electrical)	Rupture (external)	HTE-RE-C	5.00E-08	H	30
Chemical Process	Heat Exchanger	Strainer/ Filter	Plugs	FLT-PG-C	3.00E-06	H	10
Chemical Process	Heat Exchanger	Strainer/ Filter	Leakage (internal)	FLT-LI-C	3.00E-06	H	10
Chemical Process	Heat Exchanger	Strainer/ Filter	Rupture (internal)	FLT-RI-C	5.00E-07	H	10
Chemical Process	Heat Exchanger	Orifice	Plugs	ORF-PG-C	1.00E-06	H	10
Chemical Process	Miscellaneous	Mixer/Blender	Failure	MIX-FA-C	5.00E-06	H	10
Chemical Process	Miscellaneous	Agitator	Failure	AGI-FA-C	5.00E-06	H	10
Chemical Process	Miscellaneous	Centrifuge	Failure	CTF-FA-C	5.00E-06	H	10

Table B-3. Compressed Gas System Recommended Generic Failure Rates

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Compressed Gas	Valve (Standby or Safety)	Manual	Fails to open	XVM-CC-G	1.0E-03	D	10
Compressed Gas	Valve (Standby or Safety)	Manual	Fails to close	XVM-OO-G	1.0E-03	D	10
Compressed Gas	Valve (Standby or Safety)	Manual	Plugs	XVM-PG-G	5.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Manual	Leakage (internal)	XVM-LI-G	1.0E-05	H	10
Compressed Gas	Valve (Standby or Safety)	Manual	Rupture (internal)	XVM-RI-G	5.0E-07	H	30
Compressed Gas	Valve (Standby or Safety)	Manual	Leakage (external)	XVM-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Manual	Rupture (external)	XVM-RE-G	5.0E-09	H	30
Compressed Gas	Valve (Standby or Safety)	Check	Fails to open	CKV-CC-G	1.0E-04	D	10
Compressed Gas	Valve (Standby or Safety)	Check	Fails to close	CKV-OO-G	3.0E-03	D	10
Compressed Gas	Valve (Standby or Safety)	Check	Plugs	CKV-PG-G	5.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Check	Leakage (internal)	CKV-LI-G	1.0E-05	H	10
Compressed Gas	Valve (Standby or Safety)	Check	Rupture (internal)	CKV-RI-G	5.0E-07	H	30
Compressed Gas	Valve (Standby or Safety)	Check	Leakage (external)	CKV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Check	Rupture (external)	CKV-RE-G	5.0E-09	H	30
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Fails to open	MOV-CC-G	1.0E-02	D	10
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Fails to close	MOV-OO-G	1.0E-02	D	10
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Spurious operation	MOV-CO-G or MOV-OC-G	3.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Plugs	MOV-PG-G	5.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Leakage (internal)	MOV-LI-G	1.0E-05	H	10
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Rupture (internal)	MOV-RI-G	5.0E-07	H	30
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Leakage (external)	MOV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Rupture (external)	MOV-RE-G	5.0E-09	H	30
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Fails to open	AOV-CC-G	3.0E-03	D	30
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Fails to close	AOV-OO-G	3.0E-03	D	30
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Spurious operation	AOV-CO-G or AOV-OC-G	1.0E-06	H	10
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Plugs	AOV-PG-G	5.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Leakage (internal)	AOV-LI-G	1.0E-05	H	10
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Rupture (internal)	AOV-RI-G	5.0E-07	H	30
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Leakage (external)	AOV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Rupture (external)	AOV-RE-G	5.0E-09	H	30
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Fails to open	SOV-CC-G	3.0E-03	D	10

Table B-3. Compressed Gas System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Fails to close	SOV-OO-G	3.0E-03	D	10
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Spurious operation	SOV-CO-G or SOV-OC-G	5.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Plugs	SOV-PG-G	5.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Leakage (internal)	SOV-LI-G	1.0E-05	H	10
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Rupture (internal)	SOV-RI-G	5.0E-07	H	30
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Leakage (external)	SOV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Rupture (external)	SOV-RE-G	5.0E-09	H	30
Compressed Gas	Valve (Standby or Safety)	Safety/Relief	Fails to open	SRV-CC-G	1.0E-02	D	10
Compressed Gas	Valve (Standby or Safety)	Safety/Relief	Fails to reclose	SRV-OO-G	1.0E-02	D	10
Compressed Gas	Valve (Standby or Safety)	Safety/Relief	Leakage (internal)	SRV-LI-G	1.0E-05	H	10
Compressed Gas	Valve (Standby or Safety)	Safety/Relief	Rupture (internal)	SRV-RI-G	5.0E-07	H	30
Compressed Gas	Valve (Standby or Safety)	Safety/Relief	Leakage (external)	SRV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Safety/Relief	Rupture (external)	SRV-RE-G	5.0E-09	H	30
Compressed Gas	Valve (Standby or Safety)	Vacuum-Breaker	Fails to open	VBV-CC-G	3.0E-02	D	10
Compressed Gas	Valve (Standby or Safety)	Vacuum-Breaker	Fails to reclose	VBV-OO-G	3.0E-02	D	10
Compressed Gas	Valve (Standby or Safety)	Vacuum-Breaker	Leakage (internal)	VBV-LI-G	1.0E-05	H	10
Compressed Gas	Valve (Standby or Safety)	Vacuum-Breaker	Rupture (internal)	VBV-RI-G	5.0E-07	H	30
Compressed Gas	Valve (Standby or Safety)	Vacuum-Breaker	Leakage (external)	VBV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Standby or Safety)	Vacuum-Breaker	Rupture (external)	VBV-RE-G	5.0E-09	H	30
Compressed Gas	Valve (Control)	Motor-Operated	Fails open	CMV-FO-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Motor-Operated	Fails closed	CMV-FC-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Motor-Operated	Fails to respond	CMV-NR-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Motor-Operated	Plugs	CMV-PG-G	5.0E-07	H	10
Compressed Gas	Valve (Control)	Motor-Operated	Leakage (external)	CMV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Control)	Motor-Operated	Rupture (external)	CMV-RE-G	5.0E-09	H	30
Compressed Gas	Valve (Control)	Air-Operated	Fails open	CAV-FO-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Air-Operated	Fails closed	CAV-FC-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Air-Operated	Fails to respond	CAV-NR-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Air-Operated	Plugs	CAV-PG-G	5.0E-07	H	10
Compressed Gas	Valve (Control)	Air-Operated	Leakage (external)	CAV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Control)	Air-Operated	Rupture (external)	CAV-RE-G	5.0E-09	H	30

Table B-3. Compressed Gas System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Compressed Gas	Valve (Control)	Solenoid-Operated	Fails open	CSV-FO-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Solenoid-Operated	Fails closed	CSV-FC-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Solenoid-Operated	Fails to respond	CSV-NR-G	3.0E-06	H	10
Compressed Gas	Valve (Control)	Solenoid-Operated	Plugs	CSV-PG-G	5.0E-07	H	10
Compressed Gas	Valve (Control)	Solenoid-Operated	Leakage (external)	CSV-LE-G	1.0E-07	H	10
Compressed Gas	Valve (Control)	Solenoid-Operated	Rupture (external)	CSV-RE-G	5.0E-09	H	30
Compressed Gas	Compressor	Motor-Driven	Fails to start	MDC-FS-G	5.0E-03	D	5
Compressed Gas	Compressor	Motor-Driven	Fails to run	MDC-FR-G	5.0E-05	H	3
Compressed Gas	Compressor	Motor-Driven	Overspeed	MDC-OS-G	1.0E-05	H	5
Compressed Gas	Compressor	Motor-Driven	Fails to stop	MDC-NS-G	5.0E-03	D	5
Compressed Gas	Compressor	Motor-Driven	Leakage (external)	MDC-LE-G	3.0E-07	H	10
Compressed Gas	Compressor	Motor-Driven	Rupture (external)	MDC-RE-G	1.0E-08	H	30
Compressed Gas	Piping/Hose/Jumper/Tube	Piping	Leakage (external)	PIP-LE-G	3.0E-08	H-FT	10
Compressed Gas	Piping/Hose/Jumper/Tube	Piping	Rupture (external)	PIP-RE-G	1.0E-09	H-FT	30
Compressed Gas	Piping/Hose/Jumper/Tube	Piping	Plugs	PIP-PG-G	1.0E-09	H-FT	30
Compressed Gas	Piping/Hose/Jumper/Tube	Hose	Leakage (external)	HOS-LE-G	1.0E-08	H-FT	10
Compressed Gas	Piping/Hose/Jumper/Tube	Hose	Rupture (external)	HOS-RE-G	1.0E-07	H-FT	10
Compressed Gas	Piping/Hose/Jumper/Tube	Hose	Plugs	HOS-PG-G	1.0E-07	H-FT	10
Compressed Gas	Piping/Hose/Jumper/Tube	Jumper	Leakage (external)	JPR-LE-G	1.0E-05	H	10
Compressed Gas	Piping/Hose/Jumper/Tube	Jumper	Rupture (external)	JPR-RE-G	1.0E-07	H	30
Compressed Gas	Piping/Hose/Jumper/Tube	Jumper	Plugs	JPR-PG-G	1.0E-07	H	30
Compressed Gas	Piping/Hose/Jumper/Tube	Tube	Leakage (external)	TUB-LE-G	3.0E-07	H-FT	10

Table B-3. Compressed Gas System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Compressed Gas	Piping/Hose/Jumper/Tube	Tube	Rupture (external)	TUB-RE-G	1.0E-08	H-FT	30
Compressed Gas	Piping/Hose/Jumper/Tube	Tube	Plugs	TUB-PG-G	1.0E-08	H-FT	30
Compressed Gas	Vessel	Tank (Pressurized)	Leakage (external)	TKP-LE-G	1.0E-07	H	10
Compressed Gas	Vessel	Tank (Pressurized)	Rupture (external)	TKP-RE-G	5.0E-09	H	30
Compressed Gas	Vessel	Cylinder (Pressurized)	Leakage (external)	CYL-LE-G	1.0E-07	H	10
Compressed Gas	Vessel	Cylinder (Pressurized)	Rupture (external)	CYL-RE-G	5.0E-09	H	30
Compressed Gas	Vessel	Flange/Gasket	Leakage (external)	FLG-LE-G	1.0E-07	H	10
Compressed Gas	Vessel	Flange/Gasket	Rupture (external)	FLG-RE-G	1.0E-09	H	10
Compressed Gas	Heat Exchanger	Shell/Tube	Fouling (tubes)	HTX-FL-G	1.0E-05	H	10
Compressed Gas	Heat Exchanger	Shell/Tube	Plugs (tubes)	HTX-PG-G	3.0E-06	H	10
Compressed Gas	Heat Exchanger	Shell/Tube	Leakage (tubes)	HTX-LI-G	1.0E-05	H	10
Compressed Gas	Heat Exchanger	Shell/Tube	Rupture (tubes)	HTX-RI-G	5.0E-07	H	30
Compressed Gas	Heat Exchanger	Shell/Tube	Leakage (shell)	HTX-LE-G	1.0E-06	H	10
Compressed Gas	Heat Exchanger	Shell/Tube	Rupture (shell)	HTX-RE-G	5.0E-08	H	30
Compressed Gas	Heat Exchanger	Heater (Electrical)	Fails to heat	HTE-FH-G	1.0E-06	H	10
Compressed Gas	Heat Exchanger	Heater (Electrical)	Overheats	HTE-OH-G	3.0E-07	H	10
Compressed Gas	Heat Exchanger	Heater (Electrical)	Leakage (external)	HTE-LE-G	1.0E-06	H	10
Compressed Gas	Heat Exchanger	Heater (Electrical)	Rupture (external)	HTE-RE-G	5.0E-08	H	30
Compressed Gas	Heat Exchanger	Vaporizer	Failure	VAP-FA-G	1.0E-04	H	10
Compressed Gas	Heat Exchanger	Air Dryer	Failure	ADR-FA-G	5.0E-06	H	10
Compressed Gas	Heat Exchanger	Filter	Plugs	FLT-PG-G	3 .00E-6	H	10
Compressed Gas	Heat Exchanger	Filter	Leakage (internal)	FLT-LI-G	3.0E-06	H	10
Compressed Gas	Heat Exchanger	Filter	Rupture (internal)	FLT-RI-G	5.0E-07	H	10
Compressed Gas	Heat Exchanger	Orifice	Plugs	ORF-PG-G	1.0E-06	H	10

Table B-4. HVAC/Exhaust System Recommended Generic Failure Rates

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Fails to open	XDM-CC-H	3.0E-03	D	10
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Fails to close	XDM-OO-H	3.0E-03	D	10
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Plugs	XDM-PG-H	5.0E-07	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Leakage (internal)	XDM-LI-H	1.0E-05	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Rupture (internal)	XDM-RI-H	5.0E-07	H	30
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Leakage (external)	XDM-LE-H	1.0E-07	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Rupture (external)	XDM-RE-H	5.0E-09	H	30
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Fails to open	MOD-CC-H	3.0E-02	D	10
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Fails to close	MOD-OO-H	3.0E-02	D	10
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Spurious operation	MOD-CO-H or MOD-OC-H	3.0E-06	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Plugs	MOD-PG-H	5.0E-07	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Leakage (internal)	MOD-LI-H	1.0E-05	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Rupture (internal)	MOD-RI-H	5.0E-07	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Leakage (external)	MOD-LE-H	1.0E-07	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Rupture (external)	MOD-RE-H	5.0E-09	H	30
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Fails to open	AOD-CC-H	1.0E-02	D	30
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Fails to close	AOD-OO-H	1.0E-02	D	30
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Spurious operation	AOD-CO-H or AOD-OC-H	1.0E-05	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Plugs	AOD-PG-H	5.0E-07	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Leakage (internal)	AOD-LI-H	1.0E-05	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Rupture (internal)	AOD-RI-H	5.0E-07	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Leakage (external)	AOD-LE-H	1.0E-07	H	10
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Rupture (external)	AOD-RE-H	5.0E-09	H	30
HVAC/Exhaust	Damper (Control)	Motor-Operated	Fails open	CMD-FO-H	3.0E-06	H	10
HVAC/Exhaust	Damper (Control)	Motor-Operated	Fails closed	CMD-FC-H	3.0E-06	H	10
HVAC/Exhaust	Damper (Control)	Motor-Operated	Fails to respond	CMD-NR-H	3.0E-06	H	10
HVAC/Exhaust	Damper (Control)	Motor-Operated	Plugs	CMD-PG-H	5.0E-07	H	10
HVAC/Exhaust	Damper (Control)	Motor-Operated	Leakage (external)	CMD-LE-H	1.0E-07	H	10

Table B-4. HVAC/Exhaust System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
HVAC/Exhaust	Damper (Control)	Motor-Operated	Rupture (external)	CMD-RE-H	5.0E-09	H	30
HVAC/Exhaust	Damper (Control)	Air-Operated	Fails open	CAD-FO-H	3.0E-06	H	10
HVAC/Exhaust	Damper (Control)	Air-Operated	Fails closed	CAD-FC-H	3.0E-06	H	10
HVAC/Exhaust	Damper (Control)	Air-Operated	Fails to respond	CAD-NR-H	3.0E-06	H	10
HVAC/Exhaust	Damper (Control)	Air-Operated	Plugs	CAD-PG-H	5.0E-07	H	10
HVAC/Exhaust	Damper (Control)	Air-Operated	Leakage (external)	CAD-LE-H	1.0E-07	H	10
HVAC/Exhaust	Damper (Control)	Air-Operated	Rupture (external)	CAD-RE-H	5.0E-09	H	30
HVAC/Exhaust	Fan/Blower	Motor-Driven	Fails to start	MDF-FS-H	5.0E-03	D	5
HVAC/Exhaust	Fan/Blower	Motor-Driven	Fails to run	MDF-FR-H	3.0E-05	H	3
HVAC/Exhaust	Fan/Blower	Motor-Driven	Overspeed	MDF-OS-H	5.0E-06	H	10
HVAC/Exhaust	Fan/Blower	Motor-Driven	Fails to stop	MDF-NS-H	5.0E-03	D	10
HVAC/Exhaust	Fan/Blower	Motor-Driven	Leakage (external)	MDF-LE-H	3.0E-07	H	10
HVAC/Exhaust	Fan/Blower	Motor-Driven	Rupture (external)	MDF-RE-H	1.0E-08	H	30
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Fails to start	DDF-FS-H	1.0E-02	D	10
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Fails to run	DDF-FR-H	5.0E-03	H	10
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Overspeed	DDF-OS-H	1.0E-03	H	10
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Fails to stop	DDF-NS-H	1.0E-02	D	10
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Leakage (external)	DDF-LE-H	3.0E-07	H	10
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Rupture (external)	DDF-RE-H	1.0E-08	H	10
HVAC/Exhaust	Fan/Blower	Ducting	Leakage (external)	DCT-LE-H	3.0E-07	H-FT	10
HVAC/Exhaust	Fan/Blower	Ducting	Rupture (external)	DCT-RE-H	1.0E-08	H-FT	30
HVAC/Exhaust	Fan/Blower	Ducting	Plugs	DCT-PG-H	1.0E-08	H-FT	30
HVAC/Exhaust	Heat Exchanger	Air Conditioning Unit/Chiller	Fails to start	ACU-FS-H	1.0E-02	D	10
HVAC/Exhaust	Heat Exchanger	Air Conditioning Unit/Chiller	Fails to run	ACU-FR-H	3.0E-05	H	10
HVAC/Exhaust	Heat Exchanger	Fan Cooler Unit	Fails to start	FCU-FS-H	1.0E-02	D	5
HVAC/Exhaust	Heat Exchanger	Fan Cooler Unit	Fails to run	FCU-FR-H	1.0E-05	H	3
HVAC/Exhaust	Heat Exchanger	Heater (Electrical)	Fails to heat	HTE-FH-H	1.0E-06	H	3
HVAC/Exhaust	Heat Exchanger	Heater (Electrical)	Overheats	HTE-OH-H	3.0E-07	H	10
HVAC/Exhaust	Heat Exchanger	Heater (Gas)	Fails to heat	HTG-FH-H	1.0E-03	H	10

Table B-4. HVAC/Exhaust System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
HVAC/Exhaust	Heat Exchanger	Heater (Gas)	Overheats	HTG-OH-H	3.0E-04	H	10
HVAC/Exhaust	Filter	Normal	Plugs	FLT-PG-H	3.0E-06	H	10
HVAC/Exhaust	Filter	Normal	Leakage (internal)	FLT-LI-H	3.0E-06	H	10
HVAC/Exhaust	Filter	Normal	Rupture (internal)	FLT-RI-H	5.0E-07	H	10
HVAC/Exhaust	Filter	Low-Efficiency	Plugs	FLL-PG-H	3.0E-06	H	10
HVAC/Exhaust	Filter	Low-Efficiency	Leakage (internal)	FLL-LI-H	3.0E-06	H	10
HVAC/Exhaust	Filter	Low-Efficiency	Rupture (internal)	FLL-RI-H	5.0E-07	H	10
HVAC/Exhaust	Filter	HEPA	Plugs	HPA-PG-H	3.0E-06	H	10
HVAC/Exhaust	Filter	HEPA	Leakage (internal)	HPA-LI-H	3.0E-06	H	10
HVAC/Exhaust	Filter	HEPA	Rupture (internal)	HPA-RI-H	5.0E-07	H	10
HVAC/Exhaust	Filter	Sand	Plugs	FLS-PG-H	3.0E-06	H	10
HVAC/Exhaust	Filter	Sand	Leakage (internal)	FLS-LI-H	3.0E-06	H	10
HVAC/Exhaust	Filter	Sand	Rupture (internal)	FLS-RI-H	5.0E-07	H	10
HVAC/Exhaust	Filter	Baghouse	Plugs	BAG-PG-H	3.0E-05	H	10
HVAC/Exhaust	Filter	Baghouse	Leakage (internal)	BAG-LI-H	3.0E-05	H	10
HVAC/Exhaust	Filter	Baghouse	Rupture (internal)	BAG-RI-H	5.0E-06	H	10
HVAC/Exhaust	Miscellaneous	Mist Eliminator	Failure	MTE-FA-H	1.0E-04	H	10
HVAC/Exhaust	Miscellaneous	Scrubber	Failure	SBR-FA-H	1.0E-06	H	10
HVAC/Exhaust	Miscellaneous	Precipitator	Failure	PCP-FA-H	5.0E-05	H	10

Table B-5. Electrical Distribution System Recommended Generic Failure Rates

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Electric Power	Generator	Diesel-Driven	Fails to start	DDG-FS-E	1.00E-02	D	3
Electric Power	Generator	Diesel-Driven	Fails to run	DDG-FR-E	5.00E-03	H	3
Electric Power	Generator	Motor-Driven (ac to dc)	Fails to start	MDG-FS-E	1.00E-05	H	10
Electric Power	Generator	Motor-Driven (ac to dc)	Fails to run	MDG-FR-E	3.00E-05	H	10
Electric Power	Generator	Gas-Turbine-Driven	Fails to start	GTG-FS-E	3.00E-02	D	10
Electric Power	Generator	Gas-Turbine-Driven	Fails to run	GTG-FR-E	3.00E-04	H	10
Electric Power	Generator	Hydro-Turbine-Driven	Fails to start	HDG-FS-E	3.00E-03	D	10
Electric Power	Generator	Hydro-Turbine-Driven	Fails to run	HDG-FR-E	3.00E-04	H	10
Electric Power	Generator	Battery	Failure	BAT-FA-E	1.00E-05	H	3
Electric Power	Charger	Rectifier	Failure	RCT-FA-E	1.00E-05	H	3
Electric Power	Bus	Metal-Enclosed	Failure	BUM-FA-E	1.00E-07	H	5
Electric Power	Bus	Bare	Failure	BUB-FA-E	1.00E-06	H	10
Electric Power	Cable/Joint/Termination/Jumper	Cable (Copper, 1000ft)	Failure	CBL-FA-E	3.00E-06	H	3
Electric Power	Cable/Joint/Termination/Jumper	Joint (Copper)	Failure	JNT-FA-E	3.00E-06	H	30
Electric Power	Cable/Joint/Termination/Jumper	Termination (Copper)	Failure	TMN-FA-E	3.00E-07	H	10
Electric Power	Cable/Joint/Termination/Jumper	Jumper (Power)	Failure	JPR-FA-E	5.00E-06	H	10
Electric Power	Circuit Breaker	General	Fails to open	CBR CC-E or	5.00E-04	D	5
Electric Power	Circuit Breaker	General	Fails to close	CBR-OO-E or CBR-NR-E	5.00E-04	D	5
Electric Power	Circuit Breaker	General	Spurious operation	CBR-CO-E or	3.00E-07	H	10
Electric Power	Circuit Breaker	General	Spurious operation	CBR-OC-E or CBR-SO-E	3.00E-07	H	10
Electric Power	Circuit Breaker	Reactor Trip	Fails to open	RTB-CC-E	5.00E-03	D	5
Electric Power	Circuit Breaker	Reactor Trip	Spurious operation	RTB-CO-E	3.00E-06	H	10
Electric Power	Relay	Protective	Fails to open	RLP-CC-E	1.00E-03	D	10
Electric Power	Relay	Protective	Fails to close	RLP-OO-E or RLP-NR-E	1.00E-03	D	10
Electric Power	Relay	Protective	Spurious operation	RLP-CO-E or	1.00E-07	H	10
Electric Power	Relay	Protective	Spurious operation	RLP-OC-E or RLP-SO-E	1.00E-07	H	10

Table B-5. Electrical Distribution System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Electric Power	Relay	Control	Fails to open	RLC-CC-E	1.00E-04	D	10
Electric Power	Relay	Control	Fails to close	RLC-OO-E or RLC-NR-E	1.00E-04	D	10
Electric Power	Relay	Control	Spurious operation	RLC-CO-E or	3.00E-07	H	30
Electric Power	Relay	Control	Spurious operation	RLC-OC-E or RLC-SO-E	3.00E-07	H	30
Electric Power	Relay	Bistable	Fails to open	BIS-CC-E	1.00E-05	D	10
Electric Power	Relay	Bistable	Fails to close	BIS-OO-E or BIS-NR-E	1.00E-05	D	10
Electric Power	Relay	Bistable	Spurious operation	BIS-CO-E or	3.00E-07	H	10
Electric Power	Relay	Bistable	Spurious operation	BIS-OC-E or BIS-SO-E	3.00E-07	H	10
Electric Power	Switch	Push-Button (Manual)	Fails to open	XSP-CC-E	1.00E-06	H	10
Electric Power	Switch	Push-Button (Manual)	Fails to close	XSP-OO-E or XSP-NR-E	1.00E-06	H	10
Electric Power	Switch	Push-Button (Manual)	Spurious operation	XSP-CO-E or	1.00E-06	H	10
Electric Power	Switch	Push-Button (Manual)	Spurious operation	XSP-OC-E or XSP-SO-E	1.00E-06	H	10
Electric Power	Switch	Rotary (Manual)	Fails to open	XSR-CC-E or	5.00E-08	H	10
Electric Power	Switch	Rotary (Manual)	Fails to close	XSR-OO-E or XSR-NR-E	5.00E-08	H	10
Electric Power	Switch	Rotary (Manual)	Spurious operation	XSR-CO-E or	5.00E-07	H	10
Electric Power	Switch	Rotary (Manual)	Spurious operation	XSR-OC-E or XSR-SO-E	5.00E-07	H	10
Electric Power	Switch	Key-Operated (Manual)	Fails to open	XSK-CC-E or	3.00E-07	H	10
Electric Power	Switch	Key-Operated (Manual)	Fails to close	XSK-OO-E or XSK-NR-E	3.00E-07	H	10
Electric Power	Switch	Key-Operated (Manual)	Spurious operation	XSK-CO-E or XSK-OC-E	1.00E-06	H	10
Electric Power	Switch	Key-Operated (Manual)	Spurious operation	XSK-SO-E	1.00E-06	H	10
Electric Power	Switch	Automatic-Transfer	Fails to open	ATS-CC-E or	1.00E-06	H	10
Electric Power	Switch	Automatic-Transfer	Fails to close	ATS-OO-E or ATS-NR-E	1.00E-06	H	10
Electric Power	Switch	Automatic-Transfer	Spurious operation	ATS-CO-E or	1.00E-06	H	10
Electric Power	Switch	Automatic-Transfer+C20	Spurious operation	ATS-OC-E or ATS-SO-E	1.00E-06	H	10
Electric Power	Switch	Limit	Fails to open	LMS-CC-E or	1.00E-06	H	10
Electric Power	Switch	Limit	Fails to close	LMS-OO-E or LMS-NR-E	1.00E-06	H	10
Electric Power	Switch	Limit	Spurious operation	LMS-CO-E or	1.00E-06	H	5
Electric Power	Switch	Limit	Spurious operation	LMS-OC-E or LMS-SO-E	1.00E-06	H	5
Electric Power	Switch	Fuse	Fail to open	FUS-CC-E	1.00E-07	H	10
Electric Power	Switch	Fuse	Premature opening	FUS-SO-E	1.00E-08	H	10
Electric Power	Switch	Inverter	Failure	INV-FA-E	1.00E-05	H	3

Table B-5. Electrical Distribution System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
Electric Power	Motor	AC	Fails to start	MRA-FS-E	3.00E-04	D	3
Electric Power	Motor	AC	Fails to run	MRA-FR-E	5.00E-06	H	3
Electric Power	Motor	DC	Fails to start	MRD-FS-E	3.00E-04	D	3
Electric Power	Motor	DC	Fails to run	MRD-FR-E	1.00E-05	H	3
Electric Power	Motor	Synchro	Failure	SYN-FA-E	1.00E-05	H	10
Electric Power	Transformer	Power	Failure	TFP-FA-E	1.00E-06	H	10
Electric Power	Transformer	Instrumentation/Control	Failure	TFI-FA-E	1.00E-06	H	10

Table B-6. Instrumentation and Control System Recommended Generic Failure Rates

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Instrumentation and Control	Alarm/Annunciator		Fails to alarm	ALR-NR-I	3.00E-05	H	10
Instrumentation and Control	Alarm/Annunciator		Spurious operation	ALR-SO-I	5.00E-06	H	10
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Temperature	Failure	TST-FA-I	1.00E-06	H	3
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Pressure	Failure	PST-FA-I	1.00E-06	H	3
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Differential Pressure	Failure	DPS-FA-I	3.00E-06	H	10
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Flow	Failure	FST-FA-I	3.00E-06	H	3
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Level	Failure	LST-FA-I	5.00E-07	H	3
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Humidity	Failure	UST-FA-I	1.00E-05	H	10
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	pH	Failure	HST-FA-I	5.00E-07	H	5
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Oxygen Concentration	Failure	OXC-FA-I	1.00E-05	H	10
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	CO2 Concentration	Failure	COC-FA-I	1.00E-04	H	10
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Hydrogen Concentration	Failure	HYC-FA-I	1.00E-05	H	3
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Nitrogen Concentration	Failure	NIC-FA-I	1.00E-05	H	3
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Hydrocarbon Concentration	Failure	HCC-FA-I	1.00E-05	H	3
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Helium Concentration	Failure	HEC-FA-I	1.00E-05	H	3
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Speed	Failure	SST-FA-I	1.00E-06	H	10

Table B-6. Instrumentation and Control System Recommended Generic Failure Rates (Continued)

System	Component	Sub-Component	Failure Mode Description	Failure Mode Identifier	Recommended Failure Rate Distribution (lognormal)		
					Mean	Unit	Error Factor
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Seismic	Failure	SET-FA-I	1.00E-06	H	5
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Radiation	Failure	RST-FA-I	5.00E-06	H	5
Instrumentation and Control	Indicator	N/A	Failure	IND-FA-I	1.00E-05	H	10
Instrumentation and Control	Amplifier	N/A	Failure	AMP-FA-I	5.00E-06	H	10
Instrumentation and Control	Modifier/Signal Conditioner	N/A	Failure	SCR-FA-I	3.00E-07	H	3
Instrumentation and Control	Logic Module	N/A	Failure	LOG-FA-I	3.00E-06	H	5
Instrumentation and Control	Recorder	N/A	Failure	REC-FA-I	3.00E-05	H	30
Instrumentation and Control	Sampler	N/A	Failure	SAM-FA-I	1.00E-05	H	10
Instrumentation and Control	Analyzer	N/A	Failure	ANA-FA-I	5.00E-06	H	10
Instrumentation and Control	Timer	N/A	Failure	TMR-FA-I	5.00E-06	H	10
Instrumentation and Control	Gas Chromatograph	N/A	Failure	GCR-FA-I	5.00E-05	H	10
Instrumentation and Control	Voltage Regulator	N/A	Failure	VRG-FA-I	3.00E-06	H	10
Instrumentation and Control	Transmitter	N/A	Failure	TRM-FA-I	3.00E-06	H	10
Instrumentation and Control	Transducer	N/A	Failure	TRD-FA-I	1.00E-06	H	10
Instrumentation and Control	Programmable Logic Controller	N/A	Failure	PLC-FA-I	3.00E-05	H	10

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Chemical Process	Heat Exchanger	Heater (Electrical)	Fails to heat	HTE-FH-C	1.0E-05	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Heat Exchanger	Heater (Electrical)	Leakage/Rupture (all)	HTE-LR-C	1.1E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Heat Exchanger	Heater (Electrical)	Overheats	HTE-OH-C	3.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Heat Exchanger	Orifice	Plugs	ORF-PG-C	1.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Heat Exchanger	Shell/Tube	Leakage/Rupture (all)	HTX-LR-C	1.2E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Heat Exchanger	Shell/Tube	Plugs	HTX-PG-C	1.3E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Heat Exchanger	Shell/Tube	Plugs/Fouls	HTX-PG-C	1.3E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Heat Exchanger	Strainer/ Filter	Leakage/Rupture (all)	FLT-LR-C	3.5E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Heat Exchanger	Strainer/ Filter	Plugs	FLT-PG-C	3.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Miscellaneous	Agitator	Failure	AGI-FA-C	5.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Miscellaneous	Centrifuge	Failure	CTF-FA-C	5.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Miscellaneous	Mixer/Blender	Failure	MIX-FA-C	5.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Piping/Hose/Jumper	Hose	Leakage/Rupture (all)	HOS-LR-C	1.1E-08	H-FT	10	WSRC-TR-93-262, Table 1b
Chemical Process	Piping/Hose/Jumper	Hose	Plugs	HOS-PG-C	1.0E-08	H-FT	10	WSRC-TR-93-262, Table 1b
Chemical Process	Piping/Hose/Jumper	Jumper	Leakage/Rupture (all)	JPR-LR-C	1.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Piping/Hose/Jumper	Jumper	Plugs	JPR-PG-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Piping/Hose/Jumper	Piping	Leakage/Rupture (all)	PIP-LR-C	3.1E-09	H-FT	10	WSRC-TR-93-262, Table 1b
Chemical Process	Piping/Hose/Jumper	Piping	Plugs	PIP-PG-C	1.0E-10	H-FT	30	WSRC-TR-93-262, Table 1b
Chemical Process	Piping/Hose/Jumper	Piping	Plugs Catastrophic	PIP-PF-C1	5.0E-11	H-FT	30	WSRC-TR-93-262, Table 1b
Chemical Process	Piping/Hose/Jumper	Piping	Plugs Non-Catastrophic	PIP-PF-C2	5.0E-11	H-FT	30	WSRC-TR-93-262, Table 1b
Chemical Process	Pump	Diesel-Driven	Fails to run	DDP-FR-C	5.0E-03	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Pump	Diesel-Driven	Fails to start/stop	DDP-FS-C	1.0E-02	PD	10	WSRC-TR-93-262, Table 1b
Chemical Process	Pump	Diesel-Driven	Leakage/Rupture (all)	DDP-LR-C	1.1E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Pump	Motor-Driven	Fails to run	MDP-FR-C	1.0E-04	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Pump	Motor-Driven	Fails to start/stop	MDP-FS-C	1.0E-02	PD	10	WSRC-TR-93-262, Table 1b

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Chemical Process	Pump	Motor-Driven	Leakage/Rupture (all)	MDP-LR-C	1.1E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Pump	Turbine-Driven	Fails to run	TDP-FR-C	1.0E-04	H	30	WSRC-TR-93-262, Table 1b
Chemical Process	Pump	Turbine-Driven	Fails to start/stop	TDP-FS-C	3.0E-02	PD	10	WSRC-TR-93-262, Table 1b
Chemical Process	Pump	Turbine-Driven	Leakage/Rupture (all)	TDP-LR-C	1.1E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Pump, Transfer	Motor-Driven	Fails to run (catastrophic)	MDP-FR-C2	1.7E-05	H	10	HNF-2863, Rev 1, App C, Table C-6 Update
Chemical Process	Pump, Transfer	Motor-Driven	Fails to run (non-catastrophic)	MDP-FR-C1	3.8E-04	H	4	HNF-2863, Rev 1, App C, Table C-6 Update
Chemical Process	Pump, Transfer	Motor-Driven	Fails to start/stop (catastrophic)	MDP-FS-C2	1.1E-03	PD	2	HNF-2863, Rev 1, App C, Table C-6 Update
Chemical Process	Pump, Transfer	Motor-Driven	Fails to start/stop (non-catastrophic)	MDP-FS-C1	2.2E-02	PD	2	HNF-2863, Rev 1, App C, Table C-6 Update
Chemical Process	Transfer Pump	Motor-Driven	Fails to run (catastrophic)	MDP-FR-C2	1.7E-05	H	10	HNF-2863, Rev 1, App C, Table C-6 Update
Chemical Process	Transfer Pump	Motor-Driven	Fails to run (non-catastrophic)	MDP-FR-C1	3.8E-04	H	4	HNF-2863, Rev 1, App C, Table C-6 Update
Chemical Process	Transfer Pump	Motor-Driven	Fails to start/stop (catastrophic)	MDP-FS-C2	1.1E-03	PD	2	HNF-2863, Rev 1, App C, Table C-6 Update
Chemical Process	Transfer Pump	Motor-Driven	Fails to start/stop (non-catastrophic)	MDP-FS-C1	2.2E-02	PD	2	HNF-2863, Rev 1, App C, Table C-6 Update
Chemical Process	Transfer Pump	Motor-Driven	Leakage/Rupture (all)	MDP-LR-C	1.1E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Control)	Air-Operated	Fails to respond	CAV-NR-C	3.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Control)	Air-Operated	Leakage/Rupture (all)	CAV-LR-C	5.3E-07	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Control)	Air-Operated	Plugs	CAV-PG-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Control)	Motor-Operated	Fails to respond	CMV-NR-C	3.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Control)	Motor-Operated	Leakage/Rupture (all)	CMV-LR-C	5.3E-07	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Control)	Motor-Operated	Plugs	CMV-PG-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1b

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Chemical Process	Valve (Control)	Solenoid-Operated	Fails to respond	CSV-NR-C	3.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Control)	Solenoid-Operated	Leakage/Rupture (all)	CSV-LR-C	5.3E-07	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Control)	Solenoid-Operated	Plugs	CSV-PG-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Air-Operated	Fails to open/close	AOV-TR-C	1.0E-03	VD	30	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Air-Operated	Leakage/Rupture (all)	AOV-LR-C	1.6E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Air-Operated	Plugs	AVO-CO-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Air-Operated	Spurious operation	AOV-SO-C	1.0E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Check	Fails to close	CKV-OO-C	1.0E-03	VD	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Check	Fails to open	CKV-CC-C	5.0E-05	VD	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Check	Leakage/Rupture (all)	CKV-LR-C	1.6E-06	H	10	WSRC-TR-93-262, Table 1c
Chemical Process	Valve (Standby or Safety)	Check	Plugs	CKV-PG-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1a
Chemical Process	Valve (Standby or Safety)	Explosive	Fails to open	EXV-CC-C	1.0E-04	VD	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Explosive	Leakage/Rupture (all)	EXV-LR-C	1.6E-06	H	10	WSRC-TR-93-262, Table 1c
Chemical Process	Valve (Standby or Safety)	Manual	Fails to open/close	XVM-TR-C	3.0E-04	VD	10	WSRC-TR-93-262, Table 1c
Chemical Process	Valve (Standby or Safety)	Manual	Leakage/Rupture (all)	XVM-LR-C	1.6E-06	H	10	WSRC-TR-93-262, Table 1a

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Chemical Process	Valve (Standby or Safety)	Manual	Plugs	XVM-PG-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1c
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Fails to open/close	MOV-TR-C	3.0E-03	VD	10	WSRC-TR-93-262, Table 1c
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Fails to open/close (manual backup)	MOV-TR-C	2.7E-03	VD	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Fails to open/close (no manual backup)	MOV-TR-C	3.0E-04	VD	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Leakage/Rupture (all)	MOV-LR-C	1.6E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Plugs	MOV-PG-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Motor-Operated	Spurious operation	MOV-SO-C	3.0E-07	H	10	WSRC-TR-93-262, Table 1a
Chemical Process	Valve (Standby or Safety)	Safety/Relief	Fails to open/close	SRV-TR-C	3.0E-03	VD	10	WSRC-TR-93-262, Table 1c
Chemical Process	Valve (Standby or Safety)	Safety/Relief	Leakage/Rupture (all)	SRV-LR-C	1.6E-06	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Fails to open/close	SOV-TR-C	1.0E-03	VD	10	WSRC-TR-93-262, Table 1b
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Leakage/Rupture (all)	SOV-LR-C	1.6E-06	H	10	WSRC-TR-93-262, Table 1a
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Plugs	SOV-PG-C	5.0E-08	H	10	WSRC-TR-93-262, Table 1c
Chemical Process	Valve (Standby or Safety)	Solenoid-Operated	Spurious operation	SOV-SO-C	5.0E-07	H	10	WSRC-TR-93-262, Table 1a
Chemical Process	Valve (Standby or Safety)	Vacuum-Breaker	Fails to open/close	VBV-TR-C	1.0E-02	VD	10	WSRC-TR-93-262, Table 1a

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Chemical Process	Valve (Standby or Safety)	Vacuum-Breaker	Leakage/Rupture (all)	VBV-LR-C	1.6E-06	H	10	WSRC-TR-93-262, Table 1a
Chemical Process	Vessel	Flange/Gasket	Leakage/Rupture (all)	FLG-LR-C	1.0E-07	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Vessel	Tank (pressurized)	Leakage/Rupture (all)	TKP-LR-C	1.1E-07	H	10	WSRC-TR-93-262, Table 1b
Chemical Process	Vessel	Tank (Unpressurized)	Leakage/Rupture (all)	TKU-LR-C	1.1E-07	H	10	WSRC-TR-93-262, Table 1b
Compressed Gas	Compressor	Motor-Driven	Fails to run	MDC-FR-G	5.0E-05	H	3	WSRC-TR-93-262, Table 1c
Compressed Gas	Compressor	Motor-Driven	Fails to start/stop	MDC-FS-G	5.0E-03	PD	5	WSRC-TR-93-262, Table 1c
Compressed Gas	Compressor	Motor-Driven	Leakage/Rupture (all)	MDC-LR-G	3.1E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Air Dryer	Failure	ADR-FA-G	5.0E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Filter	Leakage/Rupture (all)	FLT-LR-G	3.5E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Filter	Plugs	FLT-PG-G	3.0E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Heater (Electrical)	Fails to heat	HTE-FH-G	1.0E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Heater (Electrical)	Leakage/Rupture (all)	HTE-LR-G	1.1E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Heater (Electrical)	Overheats	HTE-OH-G	3.0E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Orifice	Plugs	ORF-PG-G	1.0E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Shell/Tube	Leakage/Rupture (all)	HTX-LR-G	1.2E-05	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Shell/Tube	Plugs/Fouls	HTX-PG-G	1.3E-05	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Heat Exchanger	Vaporizer	Failure	VAP-FA-G	1.0E-04	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Piping/Hose/Jumper/Tube	Hose	Leakage/Rupture (all)	HOS-LR-G	1.1E-07	H-FT	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Piping/Hose/Jumper/Tube	Hose	Plugs	HOS-PG-G	1.0E-07	H-FT	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Piping/Hose/Jumper/Tube	Jumper	Leakage/Rupture (all)	JPR-LR-G	1.0E-05	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Piping/Hose/Jumper/Tube	Jumper	Plugs	JPR-PG-G	1.0E-07	H	30	WSRC-TR-93-262, Table 1c

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Compressed Gas	Piping/Hose/Jumper/Tube	Piping	Leakage/Rupture (all)	PIP-LR-G	3.1E-08	H-FT	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Piping/Hose/Jumper/Tube	Piping	Plugs	PIP-PG-G	1.0E-09	H-FT	30	WSRC-TR-93-262, Table 1c
Compressed Gas	Piping/Hose/Jumper/Tube	Tube	Leakage/Rupture (all)	TUB-LR-G	3.1E-07	H-FT	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Piping/Hose/Jumper/Tube	Tube	Plugs	TUB-PG-G	1.0E-08	H-FT	30	WSRC-TR-93-262, Table 1c
Compressed Gas	Process Air System	Process Air	Failure	PAS-FS-O	1.0E-05	H	10	PLG Scoping Estimate
Compressed Gas	Valve (Control)	Air-Operated	Fails to respond	CAV-NR-G	3.0E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Control)	Air-Operated	Leakage/Rupture (all)	CAV-LR-G	1.1E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Control)	Air-Operated	Plugs	CAV-PG-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Control)	Motor-Operated	Fails to respond	CMV-NR-G	3.0E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Control)	Motor-Operated	Leakage/Rupture (all)	CMV-LR-G	1.1E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Control)	Motor-Operated	Plugs	CMV-PG-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Control)	Solenoid-Operated	Fails to respond	CSV-NR-G	3.0E-06	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Control)	Solenoid-Operated	Leakage/Rupture (all)	CSV-LR-G	1.1E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Control)	Solenoid-Operated	Plugs	CSV-PG-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Fails to open/close	AOV-TR-G	3.0E-03	VD	30	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Leakage/Rupture (all)	AOV-LR-G	1.1E-05	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Plugs	AOV-PG-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Air-Operated	Spurious operation	AOV-SO-G	1.0E-06	H	10	WSRC-TR-93-262, Table 1c

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Compressed Gas	Valve (Standby or Safety)	Check	Fails to close	CKV-OO-G	3.0E-03	VD	10	WSRC-TR-93-262, Table 1a
Compressed Gas	Valve (Standby or Safety)	Check	Fails to open	CKV-CC-G	1.0E-04	VD	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Check	Leakage/Rupture (all)	CKV-LR-G	1.1E-05	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Check	Plugs	CKV-PG-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1b
Compressed Gas	Valve (Standby or Safety)	Manual	Fails to open/close	XVM-TR-G	1.0E-03	VD	10	WSRC-TR-93-262, Table 1a
Compressed Gas	Valve (Standby or Safety)	Manual	Leakage/Rupture (all)	XVM-LR-G	1.1E-05	H	10	WSRC-TR-93-262, Table 1b
Compressed Gas	Valve (Standby or Safety)	Manual	Plugs	XVM-PG-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Fails to open/close	MOV-TR-G	1.0E-02	VD	10	WSRC-TR-93-262, Table 1b
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Leakage/Rupture (all)	MOV-LR-G	1.1E-05	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Plugs	MOV-PG-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1a
Compressed Gas	Valve (Standby or Safety)	Motor-Operated	Spurious operation	MOV-SO-G	3.0E-07	H	10	WSRC-TR-93-262, Table 1a
Compressed Gas	Valve (Standby or Safety)	Safety/Relief	Fails to open/close	SRV-TR-G	1.0E-02	VD	10	WSRC-TR-93-262, Table 1a
Compressed Gas	Valve (Standby or Safety)	Safety/Relief	Leakage/Rupture (all)	SRV-LR-G	1.1E-05	H	10	WSRC-TR-93-262, Table 1b
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Fails to open/close	SOV-TR-G	3.0E-03	VD	10	WSRC-TR-93-262, Table 1c

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Leakage/Rupture (all)	SOV-LR-G	1.1E-05	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Plugs	SOV-PG-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1b
Compressed Gas	Valve (Standby or Safety)	Solenoid-Operated	Spurious operation	SOV-SO-G	5.0E-07	H	10	WSRC-TR-93-262, Table 1b
Compressed Gas	Valve (Standby or Safety)	Vacuum-Breaker	Fails to open/close	VBV-TR-G	3.0E-02	VD	10	WSRC-TR-93-262, Table 1a
Compressed Gas	Valve (Standby or Safety)	Vacuum-Breaker	Leakage/Rupture (all)	VBV-LR-G	1.1E-05	H	10	WSRC-TR-93-262, Table 1a
Compressed Gas	Vessel	Cylinder (Pressurized)	Leakage/Rupture (all)	CYL-LR-G	1.1E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Vessel	Flange/Gasket	Leakage/Rupture (all)	FLG-LR-G	1.0E-07	H	10	WSRC-TR-93-262, Table 1c
Compressed Gas	Vessel	Tank (Pressurized)	Leakage/Rupture (all)	TKP-LR-G	1.1E-07	H	10	WSRC-TR-93-262, Table 1c
Electric Power	Bus	Bare	Failure	BUB-FA-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Bus	Metal-Enclosed	Failure	BUM-FA-E	1.0E-07	H	5	WSRC-TR-93-262, Table 1e
Electric Power	Cable/Joint/Terminati on/Jumper	Cable (Copper, 1000ft)	Failure	CBL-FA-E	3.0E-06	H	3	WSRC-TR-93-262, Table 1e
Electric Power	Cable/Joint/Terminati on/Jumper	Joint (Copper)	Failure	JNT-FA-E	3.0E-06	H	30	WSRC-TR-93-262, Table 1e
Electric Power	Cable/Joint/Terminati on/Jumper	Jumper (Power)	Failure	JPR-FA-E	5.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Cable/Joint/Terminati on/Jumper	Termination (Copper)	Failure	TMN-FA-E	3.0E-07	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Charger	Rectifier	Failure	RCT-FA-E	1.0E-05	H	3	WSRC-TR-93-262, Table 1e
Electric Power	Circuit Breaker	General	Fails to open/close	CBR-TR-E	5.0E-04	VD	5	WSRC-TR-93-262, Table 1e
Electric Power	Circuit Breaker	General	Spurious operation	CBR-SO-E	3.0E-07	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Circuit Breaker	Reactor Trip	Fails to open	RTB-TR-E	5.0E-03	VD	5	WSRC-TR-93-262, Table 1e

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Electric Power	Circuit Breaker	Reactor Trip	Spurious operation	RTB-SO-E	3.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Electrical System	Electrical System	Failure	ELEC-FA-F	1.0E-05	H	30	PLG Scoping Estimate
Electric Power	Generator	Battery	Failure	BAT-FA-E	1.0E-05	H	3	WSRC-TR-93-262, Table 1e
Electric Power	Generator	Diesel-Driven	Fails to run	DDG-FR-E	5.0E-03	H	3	WSRC-TR-93-262, Table 1e
Electric Power	Generator	Diesel-Driven	Fails to start	DDG-FS-E	1.0E-02	PD	3	WSRC-TR-93-262, Table 1e
Electric Power	Generator	Gas-Turbine-Driven	Fails to run	GTG-FR-E	3.0E-04	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Generator	Gas-Turbine-Driven	Fails to start	GTG-FS-E	3.0E-02	PD	10	WSRC-TR-93-262, Table 1e
Electric Power	Generator	Hydro-Turbine-Driven	Fails to run	HDG-FR-E	3.0E-04	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Generator	Hydro-Turbine-Driven	Fails to start	HDG-FS-E	3.0E-03	PD	10	WSRC-TR-93-262, Table 1e
Electric Power	Generator	Motor-Driven (ac to dc)	Fails to run	MDG-FR-E	3.0E-05	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Generator	Motor-Driven (ac to dc)	Fails to start	MDG-FS-E	1.0E-05	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Motor	AC	Fails to run	MRA-FR-E	5.0E-06	H	3	WSRC-TR-93-262, Table 1e
Electric Power	Motor	AC	Fails to start	MRA-FS-E	3.0E-04	PD	3	WSRC-TR-93-262, Table 1e
Electric Power	Motor	DC	Fails to run	MRD-FR-E	1.0E-05	H	3	WSRC-TR-93-262, Table 1e
Electric Power	Motor	DC	Fails to start	MRD-FS-E	3.0E-04	PD	3	WSRC-TR-93-262, Table 1e
Electric Power	Motor	Synchro	Failure	SYN-FA-E	1.0E-05	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Relay	Bistable	Fails to open/close	BIS-TR-E	1.0E-05	VD	10	WSRC-TR-93-262, Table 1e
Electric Power	Relay	Bistable	Spurious operation	BIS-SO-E	3.0E-07	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Relay	Control	Fails to open/close	RLC-TR-E	1.0E-04	VD	10	WSRC-TR-93-262, Table 1e
Electric Power	Relay	Control	Spurious operation	RLC-SO-E	3.0E-07	H	30	WSRC-TR-93-262, Table 1e
Electric Power	Relay	Protective	Fails to open/close	RLP-CC-E	1.0E-03	VD	10	WSRC-TR-93-262, Table 1e
Electric Power	Relay	Protective	Spurious operation	RLP-SO-E	1.0E-07	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Automatic-Transfer	Fails to open/close	ATS-TR-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Automatic-Transfer+C20	Spurious operation	ATS-SO-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Electric Power	Switch	Fuse	Fails to open	FUS-CC-E	1.0E-07	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Fuse	Spurious operation	FUS-SO-E	1.0E-08	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Inverter	Failure	INV-FA-E	1.0E-05	H	3	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Key-Operated (Manual)	Fails to open/close	XSK-TR-E	3.0E-07	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Key-Operated (Manual)	Spurious operation	XSK-SO-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Limit	Fails to open/close	LMS-TR-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Limit	Spurious operation	LMS-SO-E	1.0E-06	H	5	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Push-Button (Manual)	Fails to open/close	XSP-TR-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Push-Button (Manual)	Spurious operation	XSP-SO-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Rotary (Manual)	Fails to open/close	XSR-TR-E	5.0E-08	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Switch	Rotary (Manual)	Spurious operation	XSR-SO-E	5.0E-07	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Transformer	Instrumentation/Control	Failure	TFI-FA-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e
Electric Power	Transformer	Power	Failure	TFP-FA-E	1.0E-06	H	10	WSRC-TR-93-262, Table 1e
External Events	Ext	Hanford Site work stoppage, due to human	Stoppage	EXTHUMAN	3.8E-05	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Hanford Site work stoppage, long	Stoppage	EXTLONG	2.5E-05	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Hanford Site work stoppage, short	Stoppage	EXTSHORT	8.9E-05	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Lightning Within 30 Miles	Stoppage	EXTLIGHT	1.4E-03	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Loss of Power to Tank Farms	Stoppage	EXTLOSP	2.3E-04	H	3	HNF-2863, Rev 2, Section 3.5

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
External Events	Ext	Other Non-Hanford Events	Stoppage	EXTOTHER	1.8E-05	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Precipitation Caused Delays	Stoppage	EXTPRECIP	1.2E-03	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Temperature High 12 hr Delay	Stoppage	EXTHTEMP12	6.0E-05	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Temperature High 24 hr Delay	Stoppage	EXTHTEMP24	1.5E-05	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Temperature High 6 hr Delay	Stoppage	EXTHTEMP06	5.3E-04	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Temperature Low 12 hr Delay	Stoppage	EXTLTEMP12	1.7E-04	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Temperature Low 24 hr Delay	Stoppage	EXTLTEMP24	2.7E-05	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Temperature Low 6 hr Delay	Stoppage	EXTLTEMP06	5.7E-04	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Wind Gusts 12 hr Delay	Stoppage	EXTWIND12	3.9E-04	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Wind Gusts 24 hr Delay	Stoppage	EXTWIND24	5.6E-05	H	3	HNF-2863, Rev 2, Section 3.5
External Events	Ext	Wind Gusts 6 hr Delay	Stoppage	EXTWIND06	1.8E-03	H	3	HNF-2863, Rev 2, Section 3.5
Human Actions	HUMAN	Align Transfer Valving	Failure	HAFACXXXL	5.0E-04	VD	10	WSRC-TR-93-581
Human Actions	HUMAN	Control Transfer Mission	Failure	HACADEXXN	3.0E-03	PD	10	WSRC-TR-93-581
Human Actions	HUMAN	Flush Transfer Lines	Failure	HAFACXXXL	5.0E-04	VD	10	WSRC-TR-93-581
Human Actions	HUMAN	Startup and Control Diluent Addition	Failure	HAFACXXXN	5.0E-03	VD	10	WSRC-TR-93-581
Human Actions	HUMAN	Startup and Control Mixer Pump	Failure	HAFACXXXN	5.0E-03	PD	10	WSRC-TR-93-581

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Human Actions	HUMAN	Startup Transfer Pump	Failure	HAFACXXXN	5.0E-03	VD	10	WSRC-TR-93-581
HVAC/Exhaust	Damper (Control)	Air-Operated	Fails to respond	CAD-NR-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Control)	Air-Operated	Leakage/Rupture (all)	CAD-LR-H	1.1E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Control)	Air-Operated	Plugs	CAD-PG-H	5.0E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Control)	Air-Operated	Spurious operation	CAD-SO-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Control)	Motor-Operated	Fails to respond	CMD-NR-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Control)	Motor-Operated	Leakage/Rupture (all)	CMD-LR-H	1.1E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Control)	Motor-Operated	Plugs	CMD-PG-H	5.0E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Control)	Motor-Operated	Spurious operation	CMD-SO-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Fails to open/close	AOD-TR-H	1.0E-02	VD	30	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Leakage/Rupture (all)	AOD-LR-H	1.1E-05	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Plugs	AOD-PG-H	5.0E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Air-Operated	Spurious operation	AOD-SO-H	1.0E-05	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Leakage/Rupture (all)	XDM-LE-H	1.1E-05	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Manual	Plugs	XDM-PG-H	5.0E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Fails to open/close	MOD-TR-H	3.0E-02	VD	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Leakage/Rupture (all)	MOD-LR-H	1.1E-05	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Plugs	MOD-PG-H	5.0E-07	H	10	WSRC-TR-93-262, Table 1d

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
HVAC/Exhaust	Damper (Standby or Safety)	Motor-Operated	Spurious operation	MOD-SO-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Fails to run	DDF-FR-H	5.0E-03	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Fails to start/stop	DDF-FS-H	1.0E-02	PD	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Fan/Blower	Diesel-Driven	Leakage/Rupture (all)	DDF-LR-H	3.1E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Fan/Blower	Ducting	Leakage/Rupture (all)	DCT-LR-H	3.1E-07	H-FT	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Fan/Blower	Ducting	Plugs	DCT-PG-H	1.0E-08	H-FT	30	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Fan/Blower	Motor-Driven	Fails to run	MDF-FR-H	3.0E-05	H	3	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Fan/Blower	Motor-Driven	Fails to start/stop	MDF-FS-H	5.0E-03	PD	5	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Fan/Blower	Motor-Driven	Leakage/Rupture (all)	MDF-LR-H	3.1E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	Baghouse	Leakage/Rupture (all)	BAG-LR-H	3.5E-05	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	Baghouse	Plugs	BAG-PG-H	3.0E-05	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	HEPA	Leakage/Rupture (all)	HPA-LR-H	3.5E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	HEPA	Plugs	HPA-PG-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	Low-Efficiency	Leakage/Rupture (all)	FLL-LR-H	3.5E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	Low-Efficiency	Plugs	FLL-PG-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	Normal	Leakage/Rupture (all)	FLT-LR-H	3.5E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	Normal	Plugs	FLT-PG-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	Sand	Leakage/Rupture (all)	FLS-LR-H	3.5E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Filter	Sand	Plugs	FLS-PG-H	3.0E-06	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Heat Exchanger	Air Conditioning Unit/Chiller	Fails to run	ACU-FR-H	3.0E-05	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Heat Exchanger	Air Conditioning Unit/Chiller	Fails to start	ACU-FS-H	1.0E-02	PD	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Heat Exchanger	Fan Cooler Unit	Fails to run	FCU-FR-H	1.0E-05	H	3	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Heat Exchanger	Fan Cooler Unit	Fails to start	FCU-FS-H	1.0E-02	PD	5	WSRC-TR-93-262, Table 1d

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
HVAC/Exhaust	Heat Exchanger	Heater (Electrical)	Fails to heat	HTE-FH-H	1.0E-06	H	3	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Heat Exchanger	Heater (Electrical)	Overheats	HTE-OH-H	3.0E-07	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Heat Exchanger	Heater (Gas)	Fails to heat	HTG-FH-H	1.0E-03	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Heat Exchanger	Heater (Gas)	Overheats	HTG-OH-H	3.0E-04	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	HVAC System	HVAC System	Failure	HVAC-FA-F	1.0E-05	H	10	PLG Scoping Estimate
HVAC/Exhaust	HVAC System	Stack	Failure	STK-FA-F	1.0E-06	H	10	PLG Scoping Estimate
HVAC/Exhaust	Miscellaneous	Mist Eliminator	Failure	MTE-FA-H	1.0E-04	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Miscellaneous	Precipitator	Failure	PCP-FA-H	5.0E-05	H	10	WSRC-TR-93-262, Table 1d
HVAC/Exhaust	Miscellaneous	Scrubber	Failure	SBR-FA-H	1.0E-06	H	10	WSRC-TR-93-262, Table 1d
Instrument Air	Instrument Air System	Instrument Air System	Failure	IAS-FA-F	1.0E-05	H	30	PLG Scoping Estimate
Instrumentation and Control	Alarm/Annunciator	Alarm/Annunciator	Failure	ALR-NR-I	3.0E-05	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Alarm/Annunciator	Alarm/Annunciator	Spurious operation	ALR-SO-I	5.0E-06	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Amplifier	Failure	AMP-FA-I	5.0E-06	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Analyzer	Failure	ANA-FA-I	5.0E-06	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	CO2 Concentration	Failure	COC-FA-I	1.0E-04	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Differential Pressure	Failure	DPS-FA-I	3.0E-06	H	10	WSRC-TR-93-262, Table 1f

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Flow	Failure	FST-FA-I	3.0E-06	H	3	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Gas Chromatograph	Failure	GCR-FA-I	5.0E-05	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Helium Concentration	Failure	HEC-FA-I	1.0E-05	H	3	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Humidity	Failure	UST-FA-I	1.0E-05	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Hydrocarbon Concentration	Failure	HCC-FA-I	1.0E-05	H	3	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Hydrogen Concentration	Failure	HYC-FA-I	1.0E-05	H	3	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Indicator	Failure	IND-FA-I	1.0E-05	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Level	Failure	LST-FA-I	5.0E-07	H	3	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Logic Module	Failure	LOG-FA-I	3.0E-06	H	5	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Modifier/Signal Conditioner	Failure	SCR-FA-I	3.0E-07	H	3	WSRC-TR-93-262, Table 1f

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Nitrogen Concentration	Failure	NIC-FA-I	1.0E-05	H	3	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Oxygen Concentration	Failure	OXC-FA-I	1.0E-05	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	pH	Failure	HST-FA-I	5.0E-07	H	5	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Pressure	Failure	PST-FA-I	1.0E-06	H	3	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Programmable Logic Controller	Failure	PLC-FA-I	3.0E-05	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Radiation	Failure	RST-FA-I	5.0E-06	H	5	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Recorder	Failure	REC-FA-I	3.0E-05	H	30	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Sampler	Failure	SAM-FA-I	1.0E-05	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Seismic	Failure	SET-FA-I	1.0E-06	H	5	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Speed	Failure	SST-FA-I	1.0E-06	H	10	WSRC-TR-93-262, Table 1f

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Temperature	Failure	TST-FA-I	1.0E-06	H	3	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Timer	Failure	TMR-FA-I	5.0E-06	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Transducer	Failure	TRD-FA-I	1.0E-06	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Transmitter	Failure	TRM-FA-I	3.0E-06	H	10	WSRC-TR-93-262, Table 1f
Instrumentation and Control	Sensor/Transmitter/Transducer/Process Switch	Voltage Regulator	Failure	VRG-FA-I	3.0E-06	H	10	WSRC-TR-93-262, Table 1f
Nitrogen	Nitrogen System	Nitrogen System	Failure	N2S-FA-F	1.0E-05	H	30	PLG Scoping Estimate
Water	Heat Exchanger	Heater (Electrical)	Fails to heat	HTE-FH-W	1.0E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Heat Exchanger	Heater (Electrical)	Leakage/Rupture (all)	HTE-LR-W	1.1E-07	H	10	WSRC-TR-93-262, Table 1a
Water	Heat Exchanger	Heater (Electrical)	Overheats	HTE-OH-W	3.0E-07	H	10	WSRC-TR-93-262, Table 1a
Water	Heat Exchanger	Shell/Tube	Leakage/Rupture (all)	HTX-LR-W	1.2E-07	H	10	WSRC-TR-93-262, Table 1a
Water	Heat Exchanger	Shell/Tube	Plugs/Fouls	HTX-PG-W	1.3E-07	H	10	WSRC-TR-93-262, Table 1a
Water	Miscellaneous	Traveling Screen	Plugs	TRS-PG-W	5.0E-07	H	10	WSRC-TR-93-262, Table 1a
Water	Orifice	Orifice	Plugs	ORF-PG-W	1.0E-06	H	3	WSRC-TR-93-262, Table 1a
Water	Piping/Hose/Jumper	Hose	Leakage/Rupture (all)	HOS-LR-W	1.1E-08	H-FT	10	WSRC-TR-93-262, Table 1a
Water	Piping/Hose/Jumper	Hose	Plugs	HOS-PG-W	1.0E-08	H-FT	10	WSRC-TR-93-262, Table 1a
Water	Piping/Hose/Jumper	Jumper	Leakage/Rupture (all)	JPR-LR-W	1.0E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Piping/Hose/Jumper	Jumper	Plugs	JPR-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Piping/Hose/Jumper	Piping	Leakage/Rupture (all)	PIP-LR-W	3.1E-09	H-FT	10	WSRC-TR-93-262, Table 1a

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Water	Piping/Hose/Jumper	Piping	Plugs	PIP-PF-W	1.0E-10	H-FT	30	WSRC-TR-93-262, Table 1a
Water	Pump	Diesel-Driven	Fails to run	DDP-FR-W	5.0E-03	H	5	WSRC-TR-93-262, Table 1a
Water	Pump	Diesel-Driven	Fails to start/stop	DDP-FS-W	1.0E-02	PD	5	WSRC-TR-93-262, Table 1a
Water	Pump	Diesel-Driven	Leakage/Rupture (all)	DDP-LR-W	3.1E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Pump	Motor-Driven	Fails to run	MDP-FR-W	3.0E-05	H	10	WSRC-TR-93-262, Table 1a
Water	Pump	Motor-Driven	Fails to start/stop	MDP-FS-W	3.0E-03	PD	5	WSRC-TR-93-262, Table 1a
Water	Pump	Motor-Driven	Leakage/Rupture (all)	MDP-LR-W	3.1E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Pump	Turbine-Driven	Fails to run	TDP-FR-W	1.0E-04	H	30	WSRC-TR-93-262, Table 1a
Water	Pump	Turbine-Driven	Fails to start/stop	TDP-FS-W	3.0E-02	PD	3	WSRC-TR-93-262, Table 1a
Water	Pump	Turbine-Driven	Leakage/Rupture (all)	TDP-LR-W	3.1E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Raw Water System	Raw Water System	Failure	RW-FA-F	1.0E-05	H	30	PLG Scoping Estimate
Water	Service Water System	Service Water System	Failure	SWS-FA-F	1.0E-05	H	10	PLG Scoping Estimate
Water	Strainer/Filter	Strainer/Filter	Leakage/Rupture (all)	FLT-LR-W	3.5E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Strainer/Filter	Strainer/Filter	Plugs	FLT-PG-W	3.0E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Air-Operated	Fails to respond	CAV-NR-W	3.0E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Air-Operated	Leakage/Rupture (all)	CAV-LR-W	1.1E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Air-Operated	Plugs	CAV-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Motor-Operated	Fails to respond	CMV-NR-W	3.0E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Motor-Operated	Leakage/Rupture (all)	CMV-LR-W	1.1E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Motor-Operated	Plugs	CMV-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Solenoid-Operated	Fails to respond	CSV-FO-W	3.0E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Solenoid-Operated	Leakage/Rupture (all)	CSV-LR-W	1.1E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Control)	Solenoid-Operated	Plugs	CSV-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Air-Operated	Fails to open/close	AOV-TR-W	1.0E-03	VD	30	WSRC-TR-93-262, Table 1a

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Water	Valve (Standby or Safety)	Air-Operated	Leakage/Rupture (all)	AOV-LR-W	1.1E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Air-Operated	Plugs	AOV-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Air-Operated	Spurious operation	AOV-SO-W	1.0E-06	H	5	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Check	Fails to close	CKV-OO-W	1.0E-03	VD	5	WSRC-TR-93-262, Table 1b
Water	Valve (Standby or Safety)	Check	Fails to open	CKV-CC-W	5.0E-05	VD	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Check	Leakage/Rupture (all)	CKV-LR-W	1.1E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Check	Plugs	CKV-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1b
Water	Valve (Standby or Safety)	Explosive	Fails to open	EXV-CC-W	1.0E-04	VD	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Explosive	Leakage/Rupture (all)	EXV-LR-W	1.1E-06	H	10	WSRC-TR-93-262, Table 1c
Water	Valve (Standby or Safety)	Manual	Fails to open/close	XVM-TR-W	3.0E-04	VD	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Manual	Leakage/Rupture (all)	XVM-LR-W	1.1E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Manual	Plugs	XVM-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1b
Water	Valve (Standby or Safety)	Motor-Operated	Fails to open/close	MOV-TR-W	3.0E-03	VD	5	WSRC-TR-93-262, Table 1b
Water	Valve (Standby or Safety)	Motor-Operated	Leakage/Rupture (all)	MOV-LR-W	1.1E-06	H	10	WSRC-TR-93-262, Table 1c
Water	Valve (Standby or Safety)	Motor-Operated	Plugs	MOV-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1b

Table B-7. Consolidated Listing of Failure Rates and Off-Normal Event Frequencies Used in the RAM Model Quantification (This table includes all rates used to quantify delay, including generic hardware failure rates, results of Bayesian updates, external event frequencies, and human error probabilities) (Continued)

System	Component	Component Sub-Category	Failure Mode	FM Identifier	Failure Rate Mean	Unit	Range Factor	Data References
Water	Valve (Standby or Safety)	Motor-Operated	Spurious operation	MOV-SO-W	3.0E-07	H	5	WSRC-TR-93-262, Table 1c
Water	Valve (Standby or Safety)	Safety/Relief	Fails to open/close	SRV-TR-W	3.0E-03	VD	3	WSRC-TR-93-262, Table 1b
Water	Valve (Standby or Safety)	Safety/Relief	Leakage/Rupture (all)	SRV-LR-W	1.1E-06	H	10	WSRC-TR-93-262, Table 1b
Water	Valve (Standby or Safety)	Solenoid-Operated	Fails to open/close	SOV-CC-W	1.0E-03	VD	10	WSRC-TR-93-262, Table 1c
Water	Valve (Standby or Safety)	Solenoid-Operated	Leakage/Rupture (all)	SOV-LR-W	1.1E-06	H	10	WSRC-TR-93-262, Table 1b
Water	Valve (Standby or Safety)	Solenoid-Operated	Plugs	SOV-PG-W	5.0E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Solenoid-Operated	Spurious operation	SOV-SO-W	5.0E-07	H	10	WSRC-TR-93-262, Table 1a
Water	Valve (Standby or Safety)	Vacuum-Breaker	Fails to open/close	VBV-TR-W	1.0E-02	VD	10	WSRC-TR-93-262, Table 1c
Water	Valve (Standby or Safety)	Vacuum-Breaker	Leakage/Rupture (all)	VBV-LR-W	1.1E-06	H	10	WSRC-TR-93-262, Table 1a
Water	Vessel	Flange/Gasket	Leakage/Rupture (all)	FLG-LR-W	1.0E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Vessel	Tank (Pressurized)	Leakage/Rupture (all)	TKP-LR-W	1.1E-08	H	10	WSRC-TR-93-262, Table 1a
Water	Vessel	Tank (Unpressurized)	Leakage/Rupture (all)	TKU-LR-W	1.1E-08	H	10	WSRC-TR-93-262, Table 1a

Appendix C. Evaluation of Hanford Site Specific Data

Tables

C-1 Definition of Failure Effect Codes

C-2 Definition of RAM Applicability Codes

C-3 Sample Evaluations of ORPS Database for Applicability to WFDS Activities

C-4 Example of Information Available in JCS Database

C-5 Sample Evaluations of JCS Database for Applicability to WFDS Activities

C-6a Summary of Input for Bayesian Update of Waste Transfer Pump Hanford Specific Failure Rates

C-6b Results of Bayesian Update of Waste Transfer Pump Hanford Specific Failure Rates

C-6c Transfer History Supporting Waste Transfer Pump Site Specific Evidence for Bayesian Update

C-6d Available Waste Transfer Pump History

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C.1. Criteria and Guidelines for ORPS and JCS Evaluations

C.1.1. Sources of TFC Specific Data

TFC specific data evaluated for use in the RAM analysis is primarily located in two databases. These are the Job Control System (JCS) and Occurrence Reporting and Processing System (ORPS) databases. The JCS contains maintenance records for the past eight years for both corrective maintenance and preventative maintenance and/or calibrations. The ORPS data contains events that are reportable under DOE Order 232.1A.

Other sources of TFC specific data include waste transfer history data and Operations Shift Manger Logbooks. Waste transfer data was retrieved from completed waste transfer procedures and manually entered into a Microsoft Excel spreadsheet table to develop the site-specific failure rate parameters for the waste transfer pumps.

C.1.2. Evaluation of Occurrence Reports and Maintenance Records

The JCS database is structured in Advanced Revelation format, but was available to PLG only in text form. To the maximum extent possible, the data was converted to Microsoft Access format for sorting and evaluation. However, evaluation of over 5,000 corrective maintenance work package data records showed that less than 3% were properly encoded with a specific component cross-reference. Therefore, these data records were not useful in calculating component failure rates and recovery times. Since the preliminary RAM analysis was performed as a screening analysis, it was deemed to be unnecessary to perform a more detailed review of the JCS data within the scope of this project.

ORPS data was also provided to the RAM analysis team in text format. Based on the limited number of fields in the database and the stricter guidelines for entering information, the data was easily converted to MS Access format. The ORPS reports were screened for those incidents that could potentially cause delays during a waste transfer operation. The information gained from the review was used to assist the team in validating the chosen failure rates for equipment and human error probabilities for human actions.

The criteria for reviewing the data is outlined below and example ORPS and JCS evaluations are contained in Tables C-2 and C-3, respectively. Results of the data evaluations are discussed in Section 3 of the main report.

Because the ORPS and JCS databases were not designed for automated generation of success and failure data, the following fields are used to evaluate reports from the ORPS and JCS.

Field Name	Definition
Failure Mode	Indicates the observed failure condition that must be corrected or recovered from in order to return the waste transfer activity to an operational condition. Although they are closely related and interdependent, the failure mode should not be confused with the failure cause.
Failure Effect	Categorizes the impact on waste transfer operations. Table C-1 summarizes the failure effect categories used for the preliminary RAM analysis.
Recovery Time	Time required to bring the process or activity back to an operating condition for waste transfer. Types of recovery activities include repair, replacement with like equipment, or realignment to an alternate system. In the case of replacement or realignment, additional action will be required to insure that spares or backup functions become available again.
Effect Rationale	Reasoning for assigning the failure effect based on discussion of impact in the report or evaluation of relation of the failure to the RAM model.
RAM Applicability	Assessment of the usefulness of the event for quantifying the failure mode. The purpose of this field is to enable the analyst to retain events that have occurred to equipment, or under circumstances, that are not directly related to waste transfer operations, but are evidence that could provide insights relative to waste transfers. Table C-2 summarizes the RAM applicability categories used for the preliminary RAM analysis.

Table C-1. Definition of Failure Effect Codes

Failure Effect	Definition	Examples
None	Not a failure associated with the waste transfer process. This event will not divert resources that would be used for process-related operations.	▪ Gasoline spills in parking lots ▪ Violation of an administrative requirement that is not associated with a transfer ▪ Contamination in general areas
Availability Impact	If the failure occurred during a transfer, it would create a delay. However, it was found before it caused a direct delay. The major impact would be a delay in starting an operation while the condition is being corrected.	▪ Failures observed during pre-operational testing ▪ Periodic reviews of equipment status ▪ Failures revealed by surveillance testing
Insignificant Impact	TFC can recover from the failure without delaying transfer activities, but the effort can require resources that would be used for process-related activities.	Failure of items not involved in waste transfer
Potential Delay	The failure occurred under circumstances that would cause a delay if a transfer operation were underway.	Failures revealed during operations

Table C-2. Definition of RAM Applicability Codes

Applicability	Definition	Examples
None	Not a failure associated with the waste transfer process. This event will not divert resources that would be used for process related operations.	▪ Unrelated monitoring equipment ▪ Unrelated surveillances/ housekeeping
Direct	**Equipment** – The failure occurred in equipment that is used in waste transfer operations. The item that failed performs similar functions and is required to operate under similar conditions to that anticipated for the WFDS. **Human Action** – The action is associated with TFC activities and would produce a condition that would stop transfer activities.	▪ Waste transfer valves, MOVs ▪ Leak Detectors ▪ Valve misalignments
Indirect	**Equipment** - A failure occurred on equipment that has similar functions, but operate under different conditions than those in waste transfer operations. **Human Action** – TFC personnel involved in a non-transfer related activity that is similar to those accomplished as part of the WFDS.	▪ Unrelated HVAC components ▪ Unrelated electrical equipment ▪ Equipment verifications

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities

Sheet 1 of 28

ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-199 0-0384	**_20_dir_cause code**	1A	**_10a_discovery date**	12/25/90
Component_Type	CAM	**Failure Mode Code**	GCR-FA-I	**_07_sys/building**	242-S

_14_title of occurrence FAILURE OF P-AS-1 VACUUM PUMP AT 242-S FACILITY RESULTS IN LOSS OF AIRBORNE RADIATION MONITORING

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 12/25/90 at 1310 hours, an operator discovered thatthe room air radiation monitoring vacuum pump (P-AS-1)was not operating. The pump was restarted at that time. On12/25/90 at 1400 hours, the pump shut down again. Visualinspection of the vacuum pump indicated that the coolingwater seal had failed, allowing water to enter the airreceiver side of the pump which caused the pump to shutdown.

On 12/25/90, at 1310 hours, it was discovered that the P-AS-1 vacuum pump was not operating. The vacuum pump was immediately restarted and the shift manager was notified.The shift manager initiated a J-1 work request to performrepairs of the vacuum pump.On 12/25/90, at 1400 hours, the vacuum pump was found shutdown again. The condenser room area was placed "On Mask".HPT's were notified and requested to install portable airmonitoring sampler in the control room and AMU areas. On 12/25/90, at 1650 hours, the portable air samplermonitors were installed.On 12/25/90, at 2330 hours, the event was categorized andthe shift manager commenced notification.

Supporting Document WHC-SD-SQA-TA-20012, "TechnicalAssessment of Compliance with Workplace Air Sampling Requirements West Tank Farm Facilities," lists the 242-SEvaporator as being exempt from workplace air samplingbecause there is "no potential to exceed 10 percent DAC(Derived Air Content)." Therefore, Waste Treatment SystemsEngineering has initiated a work package to remove fromservice the sample pump and associated alarms.Distribute this report to Facility Managers for review todetermine if this event is applicable to their facility.Action: R. Flint, Tank Farms Occurrenc Reporting *26b#1 TARGETED ACTION COMPLETION DATE1992/12/04*26c#1 ACTUAL ACTION COMPLETION DATE 1992/09/30*26d#1 REVISED ACTION COMPLETION DATE

The cooling water seal for vacuum pump P-AS-1 failed,allowing water to enter the air receiver side of the pump.This caused it to shut down. The direct cause is adefective or failed part.The root cause of this event is the fact that vacuum pump P-AS-1 was not on a Preventive Maintenance (PM) schedule. Hadit been on a PM schedule, it is likely the appropriatepreventive maintenance could have been performed before theseals failed.

PLG EVALUATION

Failure_Effect	Potential Delay	Air radiation monitoring vacuum pump required replacement seals
RAM_Applicability	Direct	
Safety Related	Yes	Actual recovery time to install portable air montoring samplers
Intrusive	Yes	
Restoration_Time	3	
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

Sheet 2 of 28

ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1991-0085		**_20_dir_cause code**	1E		**_10a_discovery date**	1/28/91
Component_Type	PNL	**Failure Mode Code**	ALR-NR-I		**_07_sys/building**	241-AP Control Room	

_14_title of occurrence Loss of Power to 241-AP Panel-4 Annunciators

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 1/29/91 at 1348 hours, the Computer AutomatedSurveillance System (CASS) received six alarms associatedwith Panel-4 in the 271-AP Control Room. The operator in271-AP was notified, and he indicated that no alarms hadbeen received in the facility. On 1/28/91 at 1920 hours,during a walk-through of the facility by the shift manager,he discovered that the Panel-4 annunciators had lost power.The following alarms were received by CASS:a. 241-AP Farm Alarm Panel 104 Power Offb. TK-104-AP Pressure Highc. TK-104-AP Pressure Lowd. TK-104-AP Liquid Level Highe. TK-104-AP Annulus Leak Detector-Leak Detectedf. TK-104-AP Annulus Vent Duct Radiation Flow Low

1) On 1/28/91 at 1348 hours, CASS received six alarms fromthe 241-AP-271 control room, panel 4 annunciator.2) On 1/28/91 at 1350 hours, the shift supervisordispatched an operator to verify the alarms which werereceived at CASS. No alarms on the annunciator in questionwere activated.3) On 1/28/91 at 1920 hours, the shift supervisordiscovered that panel 4 had lost power.4) On 1/28/91 at 1935 hours, the 104-AP Annulus CAM waverified as operational by the Health Physics Technician5) On 1/28/91 at 1937 hours, the 104-AP liquid level wasverified at 7.7 inches.6) On 1/28/91 at 1940 hours, the 271-AP Control room wasconstantly manned and the equipment associated with theeffected annunciators were periodically verified as operational.7) On 1/28/91 at 2000 hours, the Shift Manager commencednotifications to the On-Call Plant Manager, DOE-RL and theONC.8) On 1/28/91 at 2045 hours, the On-Call MaintenanceManager was contacted to have an electrician restore powerto Panel-4.9) On 1/28/91 at 2100 hours, a Priority-1 Work Package wasgenerated to troubleshoot and repair the system.10) On 1/28/91 at 2156 hours, power was restored to thePanel-4 Annunciators, and the 6 alarms associated with Tank 102-AP were reset and verified at CASS. Electricians hadfound a loose wire behind the annunciator panel.

Quality Control/Assurance personnel will be made aware ofthis incident and its association with inspection techniquesutilized. Action: J. A. Peltier*26b#1 TARGETED ACTION COMPLETION DATE1991/05/15*26c#1 ACTUAL ACTION COMPLETION DATE1991/04/15*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTION QA/QC personnel will be made aware of this incident and itsassociation with inspection techniques utilized.Action: E. L. Adamson *26b#2 TARGETED ACTION COMPLETION DATE1991/05/30*26c#2 ACTUAL ACTION COMPLETION DATE 1991/05/30*26d#2 REVISED ACTION COMPLETION DATE*26a#3 CORRECTIVE ACTIONThe Shift Manager will discuss the incident with ShiftSupervisors. Emphasis will be directed towardscommunications in an annunciator alarm response. Action: J. J. Badden*26b#3 TARGETED ACTION COMPLETION DATE1991/03/06*26c#3 ACTUAL ACTION COMPLETION DATE1991/03/06*26d#3 REVISED ACTION COMPLETION DATE*26a#4 CORRECTIVE ACTION Discuss event with craft personnel concerning improperinstallation and possible contribution to the event.Action: D. P. Kerwick *26b#4 TARGETED ACTION COMPLETION DATE1991/04/15*26c#4 ACTUAL ACTION COMPLETION DATE 1993/04/15*26d#4 REVISED ACTION COMPLETION DATE

An electrician had found a wire which had backed out of aone way terminal on the annunciator panel. It appears thewire had not been fully inserted into the receptacle and hadvibrated it's way out.

PLG EVALUATION

Failure_Effect	Potential Delay	The panel failure was caused by a disconnected wire. This could happen in panels associated with Phase 1 tanks.
RAM_Applicability	Direct	
Safety Related	Yes	Based on ORPS report to generate work package and make repairs.
Intrusive	No	
Restoration_Time	7	
Comments	None	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

Sheet 3 of 28

ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-199 1-1008	**_20_dir_cause code**	1A	**_10a_discovery date**	4/18/91
Component_Type		**Failure Mode Code**	Diesel spill	**_07_sys/building**	241-SY Tank Farm

_14_title of occurrence "DIESEL FUEL SPILL FROM THE EMERGENCY GENERATOR AT 241-SY TANK FARM"

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On April 18th, 1991 at 2000 hours, the shift manager and theshift supervisor found diesel fuel on the ground under the emergency generator while conducting a tour.

a. On 04/18/91 at 2000 hours, the shift manager and theshift supervisor observed discolored soil under theemergency generator fuel fill cap. It was assumed that fuelhad leaked out through the fill cap seal.b. On 04/18/91 at 2015 hours, the shift manager andsupervisor exited 241-SY Tank Farm and dispatched operatorsto clean up the area.c. On 04/18/91 at 2120 hours, notified On-Call manager toassist in categorizing the fuel spill.d. On 04/18/91 at 2125 hours, the On-Call manager and themanager of Environmental Safety designated the event as anunusual occurrence, category group 2.B.a, per MRP 5.14.e. On 04/18/91 at 2140 hours, notifications began to ONC,DOE and Waste Tank Safety Assurance.f. On 04/18/91 at 2200 hours, operators completed placingthe fuel soaked dirt in a plastic bag and wiped off theemergency generator.

Where practical, place spill containers underneath fillspouts on equipment.Action: J. S. Lee, Manager, West Facilities, Org 76310Action: R. W. Jacobson, Manager, East Facilities, Org 76240*26b#1 TARGETED ACTION COMPLETION DATE 1991/05/31*26c#1 ACTUAL ACTION COMPLETION DATE1991/05/31*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTIONSend an internal memo to the appropriate Power OperationsManager stressing the significance of the repetitive natureof this occurrence. Request an action plan to preventfuture incidents.Action: D. G. Hamrick, Manager, Facility Operations,Org. 76000*26b#2 TARGETED ACTION COMPLETION DATE1992/02/15 *26c#2 ACTUAL ACTION COMPLETION DATE1993/06/02*26d#2 REVISED ACTION COMPLETION DATE

A diesel fuel tank was overfilled and subsequently expandedout through the fill cap seal. Personnel topped off a fueltank on the emergency generator in 241-SY Tank Farm. Thelack of adequate ventilation forced the fuel in the tank toexpand, during warm weather, out through the fill cap seal.The re-fueling equipment configuration does not detect fullfuel tank conditions, which would normally shut off the fuelflow when a tank is full.

PLG EVALUATION

Failure_Effect	Potential Delay	Designated as an unusual occurrence, required removal of fuel soaked soil
RAM_Applicability	Direct	
Safety Related	Yes	Required time to complete clean-up
Intrusive	No	
Restoration_Time	2	
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1991-1026	**_20_dir_cause code**	1A	**_10a_discovery date**	6/29/91
Component_Type		**Failure Mode Code**	TFI-FA-E	**_07_sys/building**	Tank Farms

_14_title of occurrence LOSS OF ALL ELECTRICAL POWER TO TANK FARM FACILITIES

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On June 29, 1991 at 1510 hours, electrical power was lost toall East Tank Farm facilities for a period of two to threeminutes due to an electrical storm in the area.

On 6/29/91 at 1510 hours, power was lost to the 200 Eastarea, including all Tank Farm facilities, due to anelectrical storm in the area. Tank exhausters, theComputer Automated Surveillance System (CASS) and allmonitoring equipment was temporarily out of service.At approximately 1513 hours, power was restored to the TankFarm facilities. The 244-AR and 244-CR vault exhausterswere restarted. The CASS computer system remained inoperableand the contingency plan (TO-001-030, "CASS ContingencyBackup Procedures") was initiated.At 1540 hours, the 241-AP, AW, AN, AY and AZ exhauster fanswere restarted. A review of the tank pressurization dataindicated that the highest pressure reached in any tankduring the outage was a +0.25" water gauge (atmospheric) intank 241-AN-103.At 1540 hours, the vacuum pump to the 241-AW beta CAM wasfound damaged. At 2230 hours, the beta Cam was cross-connected with the record sampler, and a work authorizationwas written to troubleshoot the beta CAM/vacuum pump.At 1600 hours, the 241-C-105/106 exhauster was restarted.At 1610 hours, the 244-A lift station exhauster wasrestarted.At 1615 hours, the CASS computer system was brought back upand the substations were reset. However, CASScommunications from the substations were still impaired.Maintenance personnel were summoned to troubleshoot theproblem.At 1625 hours, the 244-BX exhauster was restarted.At 1630 hours, the 242-A Master Control System (MCS) programstatus and white alarm went down.At 1635 hours, a smoke detector alarm was discovered at254-BY. The fire department was notified and the alarm wasreset. No further complications occurred.At 1745 hours, all notifications were complete.At 1800 hours, the MCS system engineer returned the systemtonormal.At 1920 hours, the 244-AR vault auxiliary power was switchedback to primary power. The emergency diesel generator wasreturned to standby.At 2015 hours, the CASS system engineer begantroubleshooting the CASS communication problem.

Replace the I/O board in slot-4 of the Central Micro.Action: C. C. Scaief, Instrument Control & Engineering.*26b#1 TARGETED ACTION COMPLETION DATE1991/07/01*26c#1 ACTUAL ACTION COMPLETION DATE1991/07/01 *26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTIONComplete Work Package to troubleshoot the 241-AW betaCAM/vacuum pump.Action: R. J. Wurz, Manager, 242-A & AW Facilities*26b#2 TARGETED ACTION COMPLETION DATE1991/08/15*26c#2 ACTUAL ACTION COMPLETION DATE1991/08/07*26d#2 REVISED ACTION COMPLETION DATE

The apparent strike of a lightening bolt had apparentlycaused a voltage spike on the 200 East Area power system,and resulted in a brief outage to several facilitiesincluding tank farms.

PLG EVALUATION

Failure_Effect	Potential Delay	Loss of power caused Tank Exhausters, the Computer Automated Surveillance System (CASS), and all monitoring equipment to be out of service
RAM_Applicability	Direct	
Safety Related	Yes	Power returned after 3 min., complete system back to normal took 5 hrs
Intrusive	Yes	
Restoration_Time	1	
Comments	Similar reports: WHC-Grout-1991-1003, WHC-BPLANT-1991-1014, WHC-200EM-1991-1025	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

Sheet 5 of 28

ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-199 1-1029	**_20_dir_cause code**	1A	**_10a_discovery date**	7/20/91		
Component_Type	Motor and transformer	**Failure Mode Code**	External	**_07_sys/building**	242-A Evaporator		
_14_title of occurrence	"LOSS OF ELECTRICAL POWER TO THE 242-A EVAPORATOR"						

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On July 20, 1991, at 0400 hours, ventilation for the 242-AEvaporator was lost due to primary and backup powerfailures. The backup ventilation system (steam driven)could not be put in service due to a scheduled steam outage.

On 07-20-91 at 0401 hours, the shift manager was notified bythe 242-A control room operator that 242-A had lost power.On 07-20-91 at 0405 hours, the building emergency director(BED) verified the evacuation of all personnel from 242-A.On 07-20-91 at 0410 hours, the on-call maintenance managerwas called and asked to get an electrician to troubleshootthe problem. On 07-20-91 at 0430 hours, an electrician was sent toinvestigate the loss of power. The electrician found theground fault interrupter (GFI) for the 242-A primary motorcontrol center (MCC-1) in the fault mode. The electricianwas unable to reset the ground fault and continued withtroubleshooting the outage. The on-call maintenance managerwas informed that an additional electrician would berequired to complete troubleshooting and system repair.On 07-20-91 at 0830 hours, an electrician found a blownfuse. The fuse was replaced and primary power was restoredto the 242-A evaporator and the building ventilation placed back in service.On 07-20-91 at 0845 hours, radiological surveys of the coldside areas were completed and no contamination was detected.Normal access to the control room was restored.On 07-20-91 at 0910 hours, electricians found the T2transformer in the automatic transfer switch (ATS) hadfailed causing an electrical ground that tripped allbreakers in the power supply sub-station.On 07-20-91 at 1230 hours, the ATS was repaired by replacingthe ACME Electric control transformer (480-volt to 120-volt...rated @ VA-100) with a SQUARE-D controltransformer (480-volt to 120-volt...rated @ VA-150).

Repair the failed motor and transformer per work package2E-91-00874.Action: R. B. Wurz, Facility Manager, 242-A and 241-AWFacilities, Org. 76240*26b#1 TARGETED ACTION COMPLETION DATE1991/08/10*26c#1 ACTUAL ACTION COMPLETION DATE1991/08/19*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTIONInvestigate to determine if there is a design problem withthe ATS or a motor capacitor problem.Action: R.J. Nicklas, Manager of Single Shell Tanks -Electrical Engineers*26b#2 TARGETED ACTION COMPLETION DATE 1993/10/27*26c#2 ACTUAL ACTION COMPLETION DATE1993/10/27*26d#2 REVISED ACTION COMPLETION DATE

The unplanned electrical power outage was initially causedby a failed fuse (F4). Upon loss of the fuse, power waslost to the evaporator. This initiated the start of thestand-by diesel generator. The electrical load was notpicked up by the diesel generator because the transferswitch control power transformer failed. The direct androot causes of loss of power to the evaporator is a failedpart.The ATS is designed to transfer the flow, upon loss ofutility power, to stand-by diesel power and supply thispower to MCC-2. The T2 transformer within the ATS hadfailed which prevented the ATS from operating. The cause ofthe T2 transformer failure is unknown but has beendetermined not to be a design problem. The contributingcause is a failed part.

PLG EVALUATION

Failure_Effect	Potential Delay	Unplanned power outage, back-up ventilation system (steam driven) could not be put into service due to scheduled steam outage
RAM_Applicability	Direct	
Safety Related	Yes	Time required to trouble shoot and repair primary system
Intrusive	Yes	
Restoration_Time	4	
Comments	Similar reports: 91-0173, 91-0184, and 91-1023	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1991-1060		**_20_dir_cause code**	1A	**_10a_discovery date**		11/9/91
Component_Type	PS	**Failure Mode Code**	External		**_07_sys/building**	Ventilation/242-T	

_14_title of occurrence LOSS OF VENTILATION AT 242-T

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

A Health Physics Technician (HPT), during routine surveys,discovered the 242-T exhauster not running, as well as thestack record sampler. Priority/Severity Level D4.

On 11/09/91 at 1735 hours, an HPT notified the shiftsupervisor that the 242-T K2-5-1 Exhauster was no longeroperating. The HPT had verified that the stack recordsampler had shut down with the fan.On 11/09/91 at 1740 hours, upon notification of the event,the shift manager dispatched operations personnel to 242-T.The operator assigned to perform routine instrument readings at that facility had done so on or around 1645 hours. Thefan had been operating at that time.On 11/09/91 at 1800 hours, the K2-5-1 fan was restarted.There were no apparent reasons for the shutdown of the fan.On 11/09/91 at 1900 hours, the On-Call manager was informedof the ventilation loss at 242-T. The occurrence wasclassified as an Off-Normal, per Group 1.I.e of MRP 5.14On 11/09/91 at 1930 hours, notifications of the event werecompleted.On 11/09/91 at 2300 hours, the 242-T building was surveyedfor migration of radiological contaminants. The resultswere negative (no contamination found) and the area was released from on-mask restrictions.

There has been no recurrence of this event since the 242-Tventilation system control switches were replaced onDecember 28, 1991. Additional corrective actions ensuringventilation system modifications are completed aredocumented on RL--WHC-TANKFARM-1991-1081.*26b#1 TARGETED ACTION COMPLETION DATE1992/02/18*26c#1 ACTUAL ACTION COMPLETION DATE1992/02/18*26d#1 REVISED ACTION COMPLETION DATE

Severe winds caused a differential pressure switch tovibrate enough to "break" contact, thus triggering theexhauster shut-off interlock.The design of the ventilation system at 242-T exposescontrol switches, mounted in an unstable instrument panel,to the environment. Environmental conditions negativelyeffect the switchs in that they are disturbed enough to"break" contact, and thus a high vacuum alarm or exhaustershut-off occurrs.The number of past and recent events concerning the loss of ventilation at 242-T can be attributed to a lack ofresources necessary to perform timely modifications to thefacility.

PLG EVALUATION

Failure_Effect	None	Severe winds caused differential pressure switch to vibrate and break contact. 242-T design of ventilation system exposes control switches, mounted in unstable instrument panel.
RAM_Applicability	Indirect	
Safety Related	Yes	N/A Problem associated only with 242-T
Intrusive	Yes	
Restoration_Time		
Comments	Similar reports: 91-1057, 91-1027, 91-1024, and 91-0190	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1991-1066	**_20_dir_cause code**	3A	**_10a_discovery date**	11/25/91
Component_Type	PCV	**Failure Mode Code**	CMV-LE-C	**_07_sys/building**	242-A/241-AW

_14_title of occurrence ACTIVATION OF A SAFETY RELIEF VALVE IN THE RAW WATER SYSTEM RELEASES APPROXIMATELY 500 GALLONS OF WATER INTO DOUBLE-SHELL TANK 241-AW-102

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On November 25, at 1100 hours, while adjusting a 242-AEvaporator raw water pressure regulating valve (PRV), thesystem over-pressurized and a downstream safety relief valve(SRV) opened, releasing approximately 500 gallons of rawwater into the condenser room which drains into double-shelltank (DST) 241-AW-102.

On 11/25/91 at 1105 hours, the raw water to the 242-AEvaporator was shut off and sanitary water was valved in tomaintain cooling water to the air compressors.On 11/25/91 at 1110 hours, it was discovered that water fromthe condenser SRV was overflowing a drain line funnel andrunning onto the condenser room floor, both of which arepiped to DST 102-AW. A short time later, a screen wasremoved from the drain line funnel. The screen had acted asa large particle filter but in this case had restrictedwater flow to the funnel and caused water to spill onto thecondenser room floor.On 11/25/91 at 1120 hours, sanitary water to the compressorswas valved out.On 11/25/91 at 1130 hours, the raw water to the compressorswas valved back in.On 11/25/91 at 1300 hours, it was observed that the liquidlevel in DST 102-AW had not increased, using manual tape readings.On 11/25/91 at 1700 hours, the manual tape reading indicateda .25 inch (688 gallons) increase in DST 102-AW. It shouldbe noted however that the accuracy of manual tape readingsare within .25 inches.

Assure the occurrence report is distributed to the 242-Aengineering support organization for their review.M. S. Garrett, Plant Engineer, Occurrence ReportingOrg. 76510*26b#1 TARGETED ACTION COMPLETION DATE1992/01/31*26c#1 ACTUAL ACTION COMPLETION DATE1992/01/31*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTIONEnsure the OTP is revised to indicate the proper flowcontrol valve used in adjusting 242-A raw water PRVs.Action: D. Haring, 242-A Engineering Support, Org 7C241*26b#2 TARGETED ACTION COMPLETION DATE 1991/12/11*26c#2 ACTUAL ACTION COMPLETION DATE1991/12/11*26d#2 REVISED ACTION COMPLETION DATE

In an effort to adjust raw water PRVs, a downstream pressurecontrol valve (PCV) was utilized to adjust and maintainwater pressure necessary to make the adjustments. Thedecision to utilize this particular valve to perform thisfunction was inappropriate. The operational test procedure was inadequate in identifyingthe PCV as the method of pressure control for thisoperation.

PLG EVALUATION

Failure_Effect	Potential Delay	Tank storage space is limited, unnecessary water additions requires close evaluation
RAM_Applicability	Direct	
Safety Related	No	Time required to identify source of leak and to bring system back into compliance
Intrusive	Yes	
Restoration_Time	6	
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1992-0025	**_20_dir_cause code**	1A	**_10a_discovery date**	3/6/92		
Component_Type	FCV	**Failure Mode Code**	CMV-FO-C	**_07_sys/building**	242-A, Tank C-100		

_14_title of occurrence TANK C-100 (242-A) LIQUID LEVEL DECREASE AND CORRESPONDING LEVELINCREASE IN 241-AW-102 UNDERGROUND STORAGE TANK

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 03/06/92 at 0900 hours a level decrease of approximately1300 gallons from Tank C-100 was detected. An increase ofabout 0.5" in Tank 102-AW had been reported earlier andtroubleshooting activities determined that Tank C-100 wasthe source.

On 03/05/92 at 1730 hours a gradual rise in Tank 102-AWliquid level was noticed. Several possible sources werechecked but no potential leaks were discovered.On 03/06/92 at 0900 hours a computer printout was generatedthat showed that Tank C-100 level began to decrease on03/04/92 at 1500 hours. The printout also showed thedecrease stopping on 03/05/92 at 1200 hours. On 03/06/92 at 0925 hours the On call manager was notifiedand liquid level decrease was classified as an OFF-NORMALper Group 9 d.On 03/06/92 at 1000 hours the Tank C-100 drain valve wasverified as closed, and no leakage was observed in the area around the tank.On 03/06/92 at 1130 hours all notifications were complete.The Tank C-100 liquid level will be monitored at anincreased frequency for the next several days.

Submit a Work Package (#2E-92-0313) to initiate theinstallation of a second valve in each of the C-100 drainlines to provide double valve isolation capability.Actionee: R.B. Wurz, Manager, 241-AW, 241-AP, and 242-AFacilities*26b#1 TARGETED ACTION COMPLETION DATE1992/04/30*26c#1 ACTUAL ACTION COMPLETION DATE1992/06/01*26d#1 REVISED ACTION COMPLETION DATE

A level decrease of approximately 1300 gallons from TankC-100 was detected. An increase of about 0.5" in Tank102-AW had been reported earlier and troubleshootingactivities determined that Tank C-100 was the source. Thedirect cause was an equipment problem/defective or failedpart.No certain definitive root cause has been identified for theleak. However, based on a thorough study of the design, thefollowing scenario has been developed.There are two drain lines from the C-100 tank which couldresult in liquid additions to the 241-AW-102 tank. Eachdrain line has only a single isolation valve to preventleakage instead of the normal two valve isolation requiredto prevent inadvertent transfers. Both valves (valve #'s 1-3 and 1-3a) were found to be in the closed position. TheC-100 tank is known to contain a minor amount of settledsolids. It is believed that some of the solids had settledin one of the valve seats which prevented the valve gatefrom being fully closed, but also plugged the valve sufficiently to prevent leakage. The head pressure from thetank eventually pushed the debris out of the valve, andallowed the valve to leak until the seat plugged again withadditional solids. A more aggressive valve maintenanceprogram where the valves are periodically inspected mighthave prevented or lessened the severity of this event. Thepossible root cause was a design problem/inadequate ordefective design.

PLG EVALUATION

Failure_Effect	Potential Delay	Liquid level decrease and corresponding level increase, source unknown
RAM_Applicability	Direct	
Safety Related	Yes	Time required to check potential sources for the leak, no evidence was uncovered to indicate the source.
Intrusive	Yes	
Restoration_Time	16	
Comments	C-100 Tank drain line only has single isolation valve.	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1992-0051	**_20_dir_cause code**	7B	**_10a_discovery date**	6/28/92		
Component_Type	500 KVA Transformer	**Failure Mode Code**	External - Power Loss	**_07_sys/building**	200 West Area		
_14_title of occurrence	ELECTRICAL STORM DISRUPTS 200 WEST AREA POWER, RESULTING IN TEMPORARYTANK FARM EXHAUSTER AND ALARM FAILURES						

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

A lightning storm over the 200 West Tank Farms resulted ina brief power outage which tripped equipment protectioncircuitry. Most equipment and alarms were restarted andreset within 90 minutes.

On 06/28/92 at 2107 hours, a lightning strike on a 500 KVAtransformer caused a 45 second power loss on the C8-L3 andC8-L4 power lines serving the 200 West area. Power to thearea was restored after the 45 second outage without furtheroutage incidents. On 6/28/92 at 2150 hours, a survey of the area by operationspersonnel found the following equipment was de-energized by equipment protection circuitry: 242-S K1-5-3 Exhauster 242-T K2-5-1 Exhauster 241-SY Primary Exhauster 241-SY Annulus Exhauster 241-SX Primary Exhauster three 241-SY annulus leak detection vacuum pumpsOther equipment was found to be in a state of alarm: 241-SY Area Radiation Monitors 241-SX Area Radiation Monitors 241-U Area Radiation Monitors 242-S steam condensate radiation monitor 271-SY building radiation monitor 241-SY service pit radiation monitorAdditional equipment which was found to be malfunctioningincluded: S-304 catch tank remote level indicator (located at 242-S) S, T, and U substations for the Computer Automated Surveillance System (CASS)On 6/28/92 at 2240 hours, all of the alarms were reset andequipment returned to service except for the remote level indication for S-304 Catch Tank. A work order wasinitiated for it's repair. Local level indication for thecatch tank was functional.A review of the chart recorders monitoring the 241-SY tankpressures showed the tank pressure had not exceeded -0.1"water gauge. A review of the exhauster history for thistank farm showed a total of 4.5 hours accumulated exhausterdown time during the past year prior to this event. Withthe added time of this occurrence, the total is still wellbelow the 40 hour per year limitation established in Section11.6 of OSR-T-152-00001.On 6/28/92 at 2250 hours, the event was categorized as a Unusual Occurrence.On 6/28/92 at 2345 hours, all notifications were complete.

Instruct all CASS operators, via required reading, on theimportance of paying extra attention to alarms duringinclement weather. The instruction should explainmanagements expectations and the methods available to verifythe status of the CASS substations. Action: J. J. Badden, Manager, Shift Operations*26b#1 TARGETED ACTION COMPLETION DATE1992/08/21*26c#1 ACTUAL ACTION COMPLETION DATE1993/05/11*26d#1 REVISED ACTION COMPLETION DATE

The various equipment shutdowns were the result of a briefpower outage. The Direct Cause was a power failure ortransient. Weather or ambient condition was selected as the Root Causeof this event.

PLG EVALUATION

Failure_Effect	Potential Delay	Loss of ventilation possible OSR violation
RAM_Applicability	Direct	
Safety Related	Yes	Due to the brief power outage, CASS substations de-energized and failed to reset when power was restored. Loss of alarm signals from the substations slowed process of identifying and resetting de-energized equipment
Intrusive	No	
Restoration_Time	2	
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1992-0072		**_20_dir_cause code**	1A	**_10a_discovery date**		9/30/92
Component_Type	PIPE	**Failure Mode Code**	Unexpected level rise in		**_07_sys/building**	241-AW	

_14_title of occurrence UNEXPECTED LEVEL RISE IN INTERCONNECTED TANK 102-AW DURING A ROUTINEWASTE TRANSFER BETWEEN UNDERGROUND STORAGE TANKS 106-AN AND 102-AP.

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 9/30/92 at 0930, a transfer was started from Double ShellTank (DST) 106-AN to 102-AP.On 9/30/92 at 1145, an unexpected level rise was noted inDST 102-AW. This DST is interconnected to the transferroute via a drain line in the 241-AW-A valve pit. Thetransfer was immediately stopped to determine the source ofthe intrusion.On 9/30/92 at 1230, the 242-A Evaporator was eliminated as apossible source of the intrusion.On 9/30/92 at 1330, a limited visual inspection of the 241-AW-A valve pit was performed through an inspection port inthe cover block. During the inspection, it was observedthat the floor of the valve pit was wet.On 9/30/92 at 1415, the material balance for the transferwas checked which initially indicated a 3575 gallondiscrepancy in tank levels.On 9/30/92 at 1600, another inspection of the 241-AW-A valvepit was performed. During this inspection, liquid wasobserved to be flowing from the vicinity of a pipe jumperconnection to the floor of the pit. The pit floor drainleads to 102-AW. Also, the leak detector probe was observedto be positioned near the valve pit wall instead of over thefloor drain which is the low point in the pit.

On 9/30/92, a work package (2E-92-01299) was initiated toopen the valve pit and inspect/repair the jumper connection.This work has been delayed because the crane crew has beenassigned to work at 241-SY-101 to assist with "Window G"activities.On 9/30/92, the material balance discrepancy was carefullydetermined. The liquid level in DST 106-AN decreasedapproximately 5.7 inches. The liquid level in DST 102-APincreased approximately 4.5 inches. The liquid level in DST102-AW increased 1.2 inches or 3300 gallons which accountedfor the discrepancy between the sending and receiving tanks.(All of the DSTs involved are of the same nominal onemillion gallon capacity and contain 2750 gallons for eachinch of liquid level.)

Assure that work package 2E-92-01299, "241-AW-A Valve Pit-Repair Jumper Connection," is scheduled and completed assoon as resources become available.Action: R. W. Jacobson, Manager, East Tank Farm Facilities Org: 7C150*26b#1 TARGETED ACTION COMPLETION DATE1992/11/30*26c#1 ACTUAL ACTION COMPLETION DATE1994/01/20*26d#1 REVISED ACTION COMPLETION DATE

The direct cause of the leak was a failure of a pipe jumperin the valve pit.The leak detector probe was improperly positioned away fromthe lowest point in the valve pit. The probe was apparentlymoved when some jumpers were stacked on the floor of the pitfor storage. Inattention to detail was a contributingcause.The 102-AW level indicator (FIC) had been giving erratic readings prior to the incident (a log entry noted .6"fluctuation). Another contributing cause was a defective orfailed part because the FIC appeared to be unreliable.The 102-AW FIC had been giving erratic readings for severaldays prior to the incident, yet no work package was in placeto troubleshoot and repair it. Another contributing causewas a work organization or planning deficiency.The root cause appears to be a defective or inadequateprocedure. The current procedure does not require double encased transfer lines to be leak tested after a jumperchange. This policy is based on the fact that pit and lineleak detectors normally would alarm during a leak, andresult in an immediate shutdown of the transfer.

PLG EVALUATION

Failure_Effect	Potential Delay	Transfer operation immediately stopped to determine source of intrusion
RAM_Applicability	Direct	
Safety Related	Yes	6.5 hrs needed before source of leak determined, required repair of jumper
Intrusive	Yes	
Restoration_Time	9	
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1993-0005	**_20_dir_cause code**	7A	**_10a_discovery date**	1/12/93		
Component_Type	105/106-C Exhausters	**Failure Mode Code**	External - Ice and snow fall	**_07_sys/building**	241-C TK-105/106		
_14_title of occurrence	MISSED SURVEILLANCE READING ON TK-105-C & TK-106-C VACUUMS RESULTS INA NON-CONFORMANCE TO OSR-T-152-00003, SECTION 11.4.1.1.						

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

Missed surveillance readings for the 105/106-C Exhausterresulted in an Operational Safety Requirement (OSR)Non-Conformance to OSR-T-152-00003, section 11.4.1.1 "SingleShell Tank Vapor Space Vacuum". The Section 11.4.1.1."Surveillance" requirement is for vacuum readingsto be obtained "Daily, not exceed 30-hours". Twelve hourselapsed beyond the 30-hour requirement, before vacuumreadings were obtained.On 01/11/93 at 1200, it was noted that the 105/106-Cexhauster readings could not be taken due to the inabilityto safely access the tank farm. The access stairway wascovered with ice and the farm had snow drifts up to waistdeep.On 01/11/93 at 1500, 100 pounds of deicer was ordered. Itwas delivered near the end of the shift. On 01/12/93 at 0430, the Shift Manager discovered the missedsurveillance.

On 01/12/93 at 0430 hours, the OSR recovery action wasinitiated.On 01/12/93 at 0445 hours, the entry steps to the 241-C tankfarm were cleared of snow and ice. Deicer was applied tothe steps as well.On 01/12/93 at 0500 hours, tank vacuums were obtained onTanks 105-C & 106-C. The vacuums were as follows:Tank 105-C [-.5" w.g.]Tank 106-C [-1.5" w.g.]On 01/12/92 at 0910 hours, all notifications were complete,including Conference call to DOE-HQ.NOTE: Attempts to reach the Emergency Control Center (ECC)in Washington, D.C. were unsuccessful.

This report will be distributed through the normal channelssostudied for lessons learned. Noadditional corrective actions*26b#1 TARGETED ACTION COMPLETION DATE1993/01/25*26c#1 ACTUAL ACTION COMPLETION DATE1993/01/25 *26d#1 REVISED ACTION COMPLETION DATE

Repeated snowfalls covered the stairway leading to the farmwith ice and snow. High winds resulted in snow driftsapproximately waist deep in the farm. The farm is in adepression relative to the surrounding terrain whichcontributed to the drifting problem. The direct cause wasweather.The 241-C tank farm requires supplied air for entry due toconcerns about potentially hazardous vapors emanating fromthe tanks. Normal farm entry is accomplished using SelfContained Breathing Apparatus (SCBA). The SCBA unitsutilize compressed air bottles on a backpack which containenough air for approximately 30 minutes of normal activity.Strenuous activity shortens this amount of timesubstantially. The wearer's center of gravity is shiftedwhen the SCBA backpacks are worn which increases the hazardwhen negotiating slippery surfaces. The SCBA face maskhampers vision somewhat which adds to this hazard. Theprotective equipment necessitated by the potential vaporhazard made the slipping hazard much more severe. Aninadequate work environment was a contributing cause.The OSR required readings could have been obtained on swingshift before the time limit expired. However, the readingswere not obtained until graveyard shift. The Shift Managerin charge on swing shift was preoccupied trying to clear upproblems which were preventing a much needed waste transfer.As a result, the missed OSR readings did not receiveadequate priority. The root cause was inadequatesupervision.

PLG EVALUATION

Failure_Effect	Maybe	241-C Tank Farm requires supplied air for entry. Access stairway was covered with ice and the Farm had snow drifts waste high
RAM_Applicability	Direct	
Safety Related	No	N/A - Twelve hrs elapsed beyond the 30-hour requirement before vacuum readings were taken. The vacuum readings were within the normal range
Intrusive	No	
Restoration_Time		
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1993-0011	**_20_dir_cause code**	3A	**_10a_discovery date**	1/21/93		
Component_Type	Magnetic motor starter	**Failure Mode Code**	HA - Inattention to	**_07_sys/building**	AY/AZ Farm Vent Fan		
_14_title of occurrence	TEMPORARY LOSS OF 241-AY&AZ PRIMARY TANK VENTILATION DUE TO PERSONNEL ERROR; NO CONTAMINATION SPREAD OR PERSONNEL INJURY RESULTED.						

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

While performing maintenance on the primary tank ventilationsystem for the AY and AZ Tank Farms, an electrician inadvertently bumped the magnetic motor starter for one ofthe isolated fans. As a result, the only operational fanfor the facility shutdown allowing the ventilation system togo stagnant. The two back-up fans were locked out formaintenance work. The A-Complex Tank Farms were immediatelyevacuated as per procedure. Personnel re-entered the farmin respiratory protection and restored the ventilation.Radiological surveys were performed and no contaminationspread was detected.The electricians were replacing the wire which supplies thepower to one of the two isolated exhaust fans. Theinsulation on the old wire had deteriorated to the pointwhere the reliability of the fans were in question.Both of the isolated exhaust fans are powered from the samepower source. As a result, both fans had to be locked outto perform the scheduled repair. It was necessary for the control circuit, which is common to all three exhaust fans,to be left in the energized state.The electricians were pulling the old wire from the conduitleading into the switch gear panel. The wire was beingpulled through the open door of the switch gear. A wirepulling winch was being utilized. The winch was beingdisconnected and reattached to the old wire. As the tensionon the wire slacked, the wire curled back into theelectrical cabinet and depressed the iron core on themagnetic motor starter for the isolated fan. The naturaltension in the heavy gauge wire was sufficient to keep theiron core depressed. The iron core made up a set ofcontacts which put the control circuit into theconfiguration required for running one of the isolated fans.The control circuit is interlocked to prevent more than oneexhaust fan from operating at a time. Thus, the onlyoperational fan shut down because the control circuit"thought" that one of the isolated fans was running.

On 1/21/93 at 1015 hours, the only operating exhaust fan forthe AY and AZ Tank Farm shutdown when an electrician inadvertently bumped a control switch.On 1/21/93 at 1017 hours, the AY and AZ Tank Farms wereevacuated.On 1/21/93 at 1027 hours, operations and maintenancepersonnel donned respiratory protection, reentered the farm,and restarted the exhauster. On 1/21/93 at 1040 hours, the operator assigned to the AYand AZ facility restarted the air lift circulators for 101-AZ and 102-AZ tanks. The procedure (TO-200-030) calls for asystematic 5 hour restart sequence but the restart was notperformed in accordance with this procedural requirement.On 1/21/93 at 1045 hours, the AY and AZ ventilation loss wasclassified as an Unusual Occurrence per Group 1.I.2.e.On 1/21/93 at 1115 hours, the Health Physics Technicianscompleted radiological surveys of the farms and detected nocontamination spread.On 1/21/93 at 1500 hours, all notifications were completed.

Provide Conduct of Operation trainings for operators andmaintenance personnel.*26b#1 TARGETED ACTION COMPLETION DATE1994/05/25*26c#1 ACTUAL ACTION COMPLETION DATE1994/05/25*26d#1 REVISED ACTION COMPLETION DATE
The electrician accidently depressed the magnetic motorstarter on the isolated fan which resulted in the shutdownof the only operational fan. The direct cause wasinattention to detail.In this case, the violation had no impact because of lowtemperature of the aging waste and the short period of timethat the ALCs were down. However, under other circumstancesthe procedural violation could have increased the severityof the event. A contributing cause was a procedureviolation.The work package for the repair had been through the normalJob Control System review and approval cycle. The potentialfor disabling the operable fan was not dealt with as a partof the review.The root cause was a work organization/planning deficiency.

PLG EVALUATION

Failure_Effect	Potential Delay	Tank Farm evacuated, personnel required to use respiratory protection to reenter the Farm
RAM_Applicability	Direct	
Safety Related	Yes	Exhauster restarted and radiological surveys of the Farms conducted
Intrusive	No	
Restoration_Time	1	

Comments

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1993-0027	**_20_dir_cause code**	1A	**_10a_discovery date**	3/5/93
Component_Type	LIT	**Failure Mode Code**	TRM-FA-I	**_07_sys/building**	241-AN TANK FARM

_14_title of occurrence TANK 101-AN LIQUID INDICATING TRANSMITTER (LIT) FAILURE. UNSUCCESSFUL REPAIR EFFORTS RESULT IN MISSED READING AND OSR NON-CONFORMANCE.

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 3/4/93, Tank Farms Personnel were unable to record alevel indication for waste storage tank 101-AN. Repairswere initiated during day shift on 3/4/93 and continued onswing shift. However, repair efforts were unsuccessful inreturning the equipment to service before the end of shift.Failure to obtain a daily liquid level on this tankconstitutes a non-conformance to the surveillance requirements of Operational Safety Requirement (OSR) 11.5,"Primary Tank Minimum Liquid Level", per OSR-T-152-00001.

On 3/4/93, a work order was initiated to repair the levelindicating device for tank 101-AN.On 3/4/93, at approximately 2130 hours, it was determinedthat repairs to the level indicating device could not becompleted before the end of the shift.On 3/4/93 at 2145 hours, efforts were initiated to obtain aliquid level reading by alternative methods.On 3/5/93 at 0001 hours, an Off-Normal event was declared,per Group 9.D.On 3/5/93 at 0710 hours, the event was re-categorized to anUnusual Occurrence, per Group 1.E.2.a.On 3/5/93 at 0730 hours, replacement parts were identifiedto support repairs and return the 101-AN liquid levelindicator to service.On 3/5/93 at 0848 hours, all notifications were completed.On 3/8/93 at approximately 1400 hours, repairs werecompleted and the level indicator was returned to service.

Schedule and track to completion the installation of manualtape liquid level measuring devices in 241-AN tank farm inaccordance with work package 2E-89-0334.Action: R. W. Jacobson, Manager, East Tank Farm FacilitiesOrg: 7C150*26b#1 TARGETED ACTION COMPLETION DATE1993/10/31*26c#1 ACTUAL ACTION COMPLETION DATE1995/01/31 *26d#1 REVISED ACTION COMPLETION DATE

The liquid level reading was missed because of a failedlevel indicator. The direct cause was defective or failedpart.The craft personnel who accepted the overtime assignmentwere called off of a general overtime list as per bargainingunit agreement. Those personnel were unfamiliar with thistype of level indicator, and as a result repairs weredelayed. A contributing cause was insufficient practice orhands-on experience.There is no installed back-up system for obtaining liquidlevels in the 241-AN tank farm. The 241-AN tank farm is theonly double shell tank farm without installed back-up levelindication for each tank. The root cause of the missedreading was inadequate or defective design.

PLG EVALUATION

Failure_Effect	Potential Delay	Non-conformance to surveillance requirements of OSR
RAM_Applicability	Direct	
Safety Related	Yes	Days? Replacement parts needed to be located and repair conducted
Intrusive	Yes	
Restoration_Time		
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-199 3-0064	**_20_dir_cause code**	1A	**_10a_discovery date**	7/28/93
Component_Type		**Failure Mode Code**	HA-MAINT	**_07_sys/building**	242-A Evaporator
_14_title of occurrence	INADEQUATE TEST PROCEDURE RESULTS IN FAILURE OF 242-A EVAPORATORCONDENSATE PUMP P-C100				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 07/27/93, at 2200 hours, the 242-A Evaporator Operatorwas preparing to transfer condensate from the C-100condensate tank to the evaporator vessel through a temporaryjumper installed for training. When the operator attemptedto start the P-C100 condensate pump, the 242-A Monitoringand Control System (MCS) control board indicated that it wasrunning but was not actually operating as indicated by zerocurrent and zero flow on the MCS control board. A visualinspection of the pump confirmed that it was not operating.A subsequent investigation revealed that the P-C100 pumpmotor controller overload contacts had not been reinstalledfollowing performance of Operation Test Procedure (OTP)TFPE-WP-0200 conducted on 07/06/93. A portion of this OTPrequired removal of the thermal overloads to allow softwareinterlock verification of pump shutdown following detectionof leakage into the encasement of the Liquid EffluentRetention Facility (LERF) transfer piping. The OTP failedto include a step to reinstall the thermal overloadsfollowing completion of testing.

On 07/28/93 at 0500 hours troubleshooting confirmed that thethermal overloads for P-C100 were not in place.On 07/28/93 at 0800 hours the overloads were installed.On 07/28/93 at 0835 hours P-C100 pump started successfully.On 07/28/93 at 1640 hours all notifications were completed.

Ensure the lessons learned are distributed to personnelresonsible for writing/revising procedures.Action: M. S. Garrett, Occurrence Reporting, Org. 7CA40*26b#1 TARGETED ACTION COMPLETION DATE1994/01/22*26c#1 ACTUAL ACTION COMPLETION DATE1994/01/22*26d#1 REVISED ACTION COMPLETION DATE

Direct Cause: Equipment/Material Problem.The P-C100 condensate pump was not functioning and appearedto have failed when operations personnel attempted totransfer condensate from the C-100 condensate tank to theevaporator vessel. AC power was not provided to the P-C100condensate pump due to unconnected overload contacts.Root Cause: Inadequate Procedure. Troubleshooting determined that the pump motor overloadcontacts were disconnected. A review of the OTP by theOperations Manager revealed that a step in the OTP requireddisconnecting the contacts to perform a specific test,however there was no step in the procedure to reconnect thecontacts.

PLG EVALUATION

Failure_Effect	Insignificant	242-A Evaporator test procedure restoration
RAM_Applicability	Indirect	
Safety Related		Night failure, reinstalled disconnected overloads
Intrusive		
Restoration_Time	10.5	
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1993-0067	**_20_dir_cause code**	1B	**_10a_discovery date**	7/30/93
Component_Type	ES	**Failure Mode Code**	ATS-NR-E	**_07_sys/building**	242-A BACKUP POWER DIESEL GENERATOR
_14_title of occurrence	LOSS OF POWER AT 242-A EVAPORATOR AS A RESULT OF AN AUTOMATIC TRANSFERSWITCH (ATS) FAILURE DURING DRILL				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 07/30/93 at 1630 hours, a drill was being conducted atthe 242-A Evaporator for training purposes. The drill wasinitiated to evaluate plant operators on their response to aloss of primary power to the facility. When primary powerwas disabled to 242-A, the backup diesel generator cameon-line as expected but would not accept the electricalload.An operator observing the Monitoring and Control System(MCS) indicators inconjunction with the backside operator,who was dispatched to check the diesel generator indicationsverified the non-acceptance of the electrical load. Thisindicated that the Automatic Transfer Switch (ATS) had notswitched from the normal power to the backup power asrequired.

On 07/30/93 at 1630 hours, a loss of primary power drill wasinitiated to 242-A. The Automatic Transfer Switch failed toswitch from normal power to the emergency backup dieselpower, therefore, the drill was terminated.On 07/30/93 at 1700 hours, 242-A was returned to normalpower and all conditions verified in a safe configuration.On 07/31/93 at 2330, The Shift Operations Manager receivedfinal approval for a priority 1 work package to repair theAutomatic Transfer Switch.On 08/01/93 at 0730 hours, two electricians startedtroubleshooting efforts on the Automatic Transfer Switch.Poor drawings and Certified Vendor Information (CVI) madetroubleshooting efforts difficult. After many hours oftroubleshooting and several attempts at transfer of loads,it was determined additional engineering and vendor supportwould be required for the Automatic Transfer Switch.On 10/26/93 and 10/27/93, the vendor arrived to aid in theresolution of the Automatic Transfer Switch problems.

Obtain vendor support to troubleshoot and repair theAutomatic Transfer Switch.Actionee: Geary, J. E. Manager 242-A EvaporatorOrg code: 7C150*26b#1 TARGETED ACTION COMPLETION DATE1993/10/29*26c#1 ACTUAL ACTION COMPLETION DATE1993/11/05*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTION Implement preventive maintenance for cleaning, operation,and inspection of the Automatic Transfer Switch. Preventive maintenance procedure #2E-22006 has been established for theswitch.*26b#2 TARGETED ACTION COMPLETION DATE 1993/11/05*26c#2 ACTUAL ACTION COMPLETION DATE1993/11/05*26d#2 REVISED ACTION COMPLETION DATE

The direct and root causes are failure of the AutomaticTransfer Switch.The following is offered by engineering and vendor supportas actions taken in response to the occurrence report indetermining the failure of the Automatic Transfer Switch.A loss of power by opening substation breaker 4D wasperformed three times. In all three cases the diesel cameon line and the transfer occurred as expected to emergencypower.During the two days the vendor was here (10/26/93 and10/27/93) a loss of power to the facility was performed inexcess of thirty times. In all these cases the generatoraccepted the load as expected. However, there were severalcases where the ATS would not transfer back to utility powerwhen the power became available. It was noted that therewere two separate problems with the transfer back to utilitypower.The first problem encountered only occurred once in thethirty plus transfers made. It appeared that time delayrelay TD-2 may have had a sticky contact and did not closewhen needed. In the several transfers that followed thisdid not happen again. It is assumed that with the numerous transfers this contact became clean. A new time delay relaywill be ordered and put in spares.The second and more serious problem encountered was theSPM-A Synchronizer located in the ATS was not sending theproper signal to the 2301 governor controller located in thegenerator controls unit. Without this signal workingproperly the generator cannot adjust its speed to allow itto match the voltage and frequency of the utility power.The transfer cannot take place until the loads aresyunchronized. The reason for this signal problem was amissing jumper on the SPM-A Synchronizer, caused by amanufacturing defect. Once the jumper was installed a lossof power test was performed seven times in a row and the ATStransferred to emergency power and back to utility power asexpected. The signal was monitored and found to be correct.The vendor also checked other setting and adjustments on theATS and confirmed that everything is now working properly.

PLG EVALUATION

Failure_Effect	Insignificant	This switch is located in the evaporator complex and would not effect Phase 1 operations. Similar devices do not appear to be in use for Phase 1.
RAM_Applicability	None	
Safety Related	No	Based on ORPS report time indicated for vendor to support site operations.

Intrusive	No
Restoration_Time	2136
Comments	This report indicates a need to ensure timely vendor support for Phase 1 equipment where needed.

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-199 3-0069	**_20_dir_cause code**	6B	**_10a_discovery date**	8/4/93		
Component_Type	P	**Failure Mode Code**	HAFLOXXXL	**_07_sys/building**	DOUBLE SHELL WASTE TANK 241-SY-101		
_14_title of occurrence	LOSS OF FACILITY CONTROL RESULTS IN AN INADVERTENT START OF WASTE TANK 241-SY-101 HYDROGEN MITIGATION PUMP						

1) _16_description 2) _19_immediate cor actn 3) _26_Corrective Action 4) _23_cause narrative

On 8/04/93 at 1522 hours, Waste Tank 241-SY-101 mixer pumpwas inadvertently started when it's disconnect switch (DS-101-25) was closed by an operator. The disconnect switchhad an "information only" tag installed to require the ShiftSupervisor's or Test Engineer's permission prior tooperation. The "information only" tag did not alert theoperator that an Acceptance Test Procedure (ATP) was inprogress, or that DS-101-25 closure would start the mixerpump. With DS-101-25 closed and the subsequent pump start,a violation of the safety analysis requirement resulted.The safety analysis requires that all personnel are nocloser than 300 meters to the tank farm when the pump isstarted due to potential ammonia and noxious vapors that maybe released.At the time of the pump start, Data Acquisition and ControlSystem (DACS) personnel were performing an ATP on the pumpsoftware when the independent speed/power/current monitorindicated positive readings. This indicated that DS-101-25in the tank farm was in the closed/on position and the pumpwas actually running. The ATP required DS-101-25 to be inthe open/off position to prevent pump operation during thesoftware testing. Upon realization of pump start, DACSpersonnel immediately pushed both *emergency stop buttonsresulting in the shut down of the pump.*242-S Shift Management was notified by DACS test personnelthat the 101-SY mixer pump was inadvertently started. DACSpersonnel proceeded to open the breaker in the motorcontroller center, which assured the pump would not restart.Historical data from the DACS computer indicated the pumphad run for 30 seconds with no indications of a gas release.The Hydrogen and Nitrous Oxide and Ammonia levels arenormal.

On 8/4/93 at 1515 hours, an operator had been directedby shift management to prepare for the pump start by takingpre-test pump data and to close the mixer pump motor localdisconnect. Testing was in progress per section 6.4 ofATP-062 for phase "B" test #25.6. At the same time asoperations personnel were performing pre "pump bump" rounds,the independent speed/power/current monitor was observed tobe reading high. This was an indication of actual pumpmotor operation not just ATP operation. The stop pumpbutton on station #8 screen was pressed as well as theemergency stop push button. DACS personnel notified ShiftManagement as well as the DACS Test Manager that the mixerpump had been inadvertently started.On 8/4/93 at 1522 hours, Shift Management was notified byDACS personnel of the inadvertent pump operation due to theclosing of DS-101-25.On 8/4/93 at 1525 hours, operators were notified to evacuate241-SY Tank Farm.On 8/4/93 at 1535 hours, Shift Management notified DACStest personnel to suspend ATP testing until investigation ofthe inadvertent 101-SY pump start. DACS personnel indicatedthat the pump started at 1515 hours and ran for 30 secondsbefore the emergency stop buttons were pushed.On 8/4/93 at 1555 hours, DACS personnel performed a historyon the pump bump and found that the RPM's went to 533 andthat there was no increases in the tank vapor space gases.(normal pump bump speeds are up to 1000 RPMs)On 8/4/93 at 1600 hours, following initial managementnotifications, a critique was conducted by OccurrenceReporting personnel and a review of the Safety Analysislevel I and II controls was conducted by DACS personnel.On 8/4/93 at 1655 hours, 241-SY Tank Farm was released forentry.On 8/4/93 at 1745 hours, following debriefs from critiquepersonnel, Tank Farms Operations Manager authorized thecontinuation of pump bumps.On 8/06/93 at 1115 hours, upon further review of theincident, it was upgraded to an Unusual Occurrence, pergroup 1.C.2.C.On 8/06/93 at 1115 hours, contacted Shift Operations Managerof occurrence upgrade.On 8/06/93 at 1121 hours, contacted Nuclear Safetyrepresentative of occurrence upgrade.On 8/06/93 at 1125 hours, contacted DOE-RL representative ofoccurrence upgrade.On 8/06/93 at 1127 hours, contacted WHC-ONC of occurrenceupgrade.On 8/06/93 at 1141 hours, contacted DOE-HQ EM program officeof occurrence upgrade.Remove "information only" tags on DS-101-25 and DS-101-26,and replace with Caution tags that require both the ShiftSupervisor's and ATP Test Director's concurrence prior tobreaker operation.*26b#1 TARGETED ACTION COMPLETION DATE1993/08/05*26c#1 ACTUAL ACTION COMPLETION DATE1993/08/05*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTIONRevise the pump start procedure to ensure permission isobtained specifically from both the Test Director and theSOM prior to any disconnect switch operation.*26b#2 TARGETED ACTION COMPLETION DATE1993/09/09*26c#2 ACTUAL ACTION COMPLETION DATE1993/09/09*26d#2 REVISED ACTION COMPLETION DATE

The Operations Shift Supervisor authorized the closure ofthe disconnect switch without knowing the impact of theoperator's action would have on the testing that was beingconducted. This inadequate work organization/planningdeficiency is the direct cause for this incident.A contributor to this incident was the lack of trainingprovided for operations personnel to understand the intentof the ATP, the impact the ATP had on the facility, or theimpact operator actions could have on the ATP.Another contributor was the poorly defined policy to ensurethere was an overall program to coordinate between tests, orbetween test personnel and operations personnel. This wasevident by which organization (Test Engineering orOperations) had control of testing was inconsistent betweendifferent levels of management as observed by theindependent review team.The inadequate procedural guidance to establish control overoperational activities in support of testing and othernon-routine activities also contributed to this incident.The procedure guidance did not exist for the practical (inthe field) control of the activities.The root cause to this incident was Management's failureto establish, communicate, and verify their expectationsconcerning control at the facility as conditions *changedwith time.The single decision by the Operations Shift Supervisor toclose the disconnect switch should not have caused thisevent.* Many chapters of the "Conduct of Operations" manualare designed to provide barriers to prevent loss of controlof the facility and to compensate for operator error. Thisevent represents a breakdown in this multi-barrier concept.

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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PLG EVALUATION

Failure_Effect	Potential Delay	A failure to lock out a system being tested or maintained would lead to at least an administrative hold on work to investigate.
RAM_Applicability	Indirect	
Safety Related	Yes	Based on ORPS report to investigate and implement corrective actions.
Intrusive	Yes	
Restoration_Time	864	
Comments	None	

ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1993-0072	**_20_dir_cause code**	1E	**_10a_discovery date**	8/11/93
Component_Type		**Failure Mode Code**	External	**_07_sys/building**	AC Power to AP, AW, AN, and C TANKFARMS Exhaust
_14_title of occurrence	LOSS OF PRIMARY AC POWER TO AP, AW, AND AN TANKFARMS RESULTED IN THELOSS OF PRIMARY EXHAUST FANS TO AP, AW, AN, AND C TANKFARMS				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 08/11/93 at 1802 hours, a momentary loss of power in theEast Tank Farms caused electrical equipment in AN, AP, AW,and C Tank Farms to shut off. The 204-AR, 244-AR and 244-CRfacilities were also effected. The power loss was due to ashort in the system. A bird apparently landed on a powerpole on Gable Mountain and made contact with a transformerand Power Supply Line 6, causing the short. The breaker forthat line opened and automatically reset after 10-15 secondsas designed, restoring power to the line.

On 8/11/93, at 1821 hours, the primary exhauster for AW TankFarm was restarted.On 8/11/93, at 1830 hours, the primary exhauster for AN TankFarm was restarted.On 8/11/93, at 1849 hours, the primary exhauster for AP TankFarm was restarted. On 8/11/93, at 1904 hours, the exhauster at 204-AR wasrestarted.On 8/11/93, at 1920 hours, the exhauster at 244-CR was restarted.On 8/11/93, at 1925 hours, the portable exhauster for105/106-C was restarted.On 8/11/93, at 2015 hours, the Shift Manager reviewedrecorded tank pressures and determined no instrumentsexceeded tolerance.On 8/11/93, at 2030 hours, HPTs reported no contaminationwas released in any facilities.

No further corrective actions are required by Tank Farms.Refer to Occurrence Report RL--WHC-WHC200EM-1993-0040. *26b#1 TARGETED ACTION COMPLETION DATE1993/08/18*26c#1 ACTUAL ACTION COMPLETION DATE 1993/08/18*26d#1 REVISED ACTION COMPLETION DATE

Direct Cause: Electrical Problem.The East Tank Farms lost outside Alternating Current (AC)which provided power to all electrical equipment in the AN,AP, AW, and C Tank Farms. The 204-AR, 244-AR and 244-CRfacilities also lost power.Root Cause: Power Failure or Transient.Power was lost to 13.8 KV line C8-L6 on Gable Mountain dueto short caused by a large bird. The corrective actionslisted in item #18 are adequate. No further correctiveactions are required by Tank Farms. Refer to OccurrenceReport RL--WHC-WHC200EM-1993-0040 for a further evaluation.

PLG EVALUATION

Failure_Effect	Potential Delay	This event could occur during Phase 1 operations with similar effects.
RAM_Applicability	Direct	
Safety Related	Yes	Based on ORPS report time to restart HVAC equipment.
Intrusive	No	
Restoration_Time	2	
Comments	Such an event would likely cause a longer delay during Phase 1 transfers in order to restart pumps and and make other necessary checks.	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1994-0023	**_20_dir_cause code**	IE	**_10a_discovery date**	4/27/94
Component_Type	RA	**Failure Mode Code**	ALR-SO-I	**_07_sys/building**	242-A Evaporator; vessel ventilation system
_14_title of occurrence	SPURIOUS TRIP OF VESSEL VENTILATION SYSTEM RESULTS IN EVAPORATOR SHUT-DOWN AND PARTIAL DUMP OF CA1 FEED TO TANK 241-AW-102				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

A routine setpoint test of the vessel ventilation beta/gammacontinuous air monitor (CAM) sent a spurious shutdown signalto the Monitor and Control System (MCS). This resulted inthe securing of vessel ventilation, breaking vacuum, thesecuring of reboiler steam and the shutting off the PB-1recirculation pump. Approximately 2000 gallons of the 25000gallons of CA1 vessel contents had dumped back to feed tank102-AW before the control room operator bypassed the PB-1shutdown interlock action to secure the dump.

On 4/27/94, at 1015, numerous facility alarms were receivedsimultaneously, indicating a complete facility shutdown hadoccurred. This included a rapid loss of CA1 vessel vacuumwhen the vacuum breaker opened on interlock. The controlroom operator took immediate action to bypass the PB-1recirculation pump shutdown interlock. This action stopsthe eight minute countdown timer to CA1 vessel dump back tothe feed tank. However, the command was not properly inputinto the computer and the countdown timer continued to run.This condition went unnoticed by the control room operatorfor 28 minutes, during which time follow up actions were inprogress. This delay resulted in a total of 2000 gallons ofCA1 vessel contents being dumped back to feed tank 102-AW.The facility was placed in a shutdown line-up and a critiquewas held to determine causes and possible corrective actions. The direct cause of the event was determined to bea loss of vessel ventilation caused by a spurious shutdownsignal. This signal was sent to the MCS during a routinetest of the beta/gamma CAM alarm setpoint.Prior to restart of the facility, the software interlockfunction associated with RI-VVB/G (beta/gamma CAM highradiation alarm, analog signal) was removed.The responsible Facility Manager for this report is W. E.Ross, (509) 373-4565. The name appearing on page one asFacility Manager is for data transmittal purposes only.

Provide Lessons Learned for Hanford personnel.*26b#1 TARGETED ACTION COMPLETION DATE1994/05/24*26c#1 ACTUAL ACTION COMPLETION DATE1994/05/24*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTIONReview PM/CBRS requirements on other instrumentation todetermine if similar problems exist.*26b#2 TARGETED ACTION COMPLETION DATE1994/05/28*26c#2 ACTUAL ACTION COMPLETION DATE1994/05/28 *26d#2 REVISED ACTION COMPLETION DATE*26a#3 CORRECTIVE ACTIONProvide training for Evaporator and Maintenance personnel sothat they may better understand the instruments and theassociated interlocks.*26b#3 TARGETED ACTION COMPLETION DATE1994/05/28*26c#3 ACTUAL ACTION COMPLETION DATE1994/05/28*26d#3 REVISED ACTION COMPLETION DATE

The direct cause of this event was an Equipment/MaterialProblem/Electrical or Instrument Noise. A spike on thebeta/gamma radiation alarm signal was caused by testing.Troubleshooting by an instrument technician indicated theactuation of the alarm setpoint test button resulted in anincrease in the MCS indication. The MCS indication exceededthe interlock setpoint which resulted in shutdown of theexhauster.The root cause of this event is an inadequate or defectivedesign. The MCS applies a smoothing or averaging functionto the incoming signal from the alarm setpoint test button.This prevents spurious shutdowns due to a spike in thesignal. This smoothing function takes the previous readingand the current reading and averages the two to obtain thenew value. Therefore, the longer the setpoint button isheld in, the closer the MCS value will approach the setpointvalue. Eventually, the MCS value will reach the setpointvalue and cause the interlock to activate, shutting down theexhauster.

PLG EVALUATION

Failure_Effect	Potential Delay	A spurious signal to the various tank ventilation system components is possible and would create some delay in the transfer process.
RAM_Applicability	Indirect	
Safety Related	Yes	Final actions including additional training needed one month to complete. It is likely that the evaporator was placed back into operations before then.
Intrusive	No	
Restoration_Time		

Comments None

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1994-0029	**_20_dir_cause code**	1A	**_10a_discovery date**	5/16/94
Component_Type		**Failure Mode Code**	HA-SAMPLE	**_07_sys/building**	241-AN-107/Riser 1A
_14_title of occurrence	GRAB SAMPLING DEVICE DROPPED IN AN-107 RISER DUE TO SUPPORT LINEBREAKING				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 05/04/94 at 1120 hours, during a sampling process, a grabsampling device was dropped in tank AN-107 riser #1A whenthe sampling device supporting line broke. This wasreported to plant management and DOE-RL on 05/04/94, but wasdetermined not to be a reportable condition at that time.The responsible Facility Manager for this report is R. Ni,(509) 373-0132. The name appearing as Facility Manager onpage one of this report is for data transmittal purposesonly.

On 5/4/94, a critique was held to determine causes andcorrective actions.On 5/12/94, the line supporting the sampling device wasredesigned in order to help prevent recurrence or thisevent. Also, the design of the mechanism for opening thesample bottle in deep sludge was redesigned.On 5/13/94, the dropped sampling device and connectingequipment were recovered, and the sampling task completed.On 5/16/94, after further deliberations, it was determinedthat the incident should be reported into the ORPS database.

Corrective actions beyond those listed in section #18 arenot required.*26b#1 TARGETED ACTION COMPLETION DATE 1994/05/16*26c#1 ACTUAL ACTION COMPLETION DATE1994/05/16*26d#1 REVISED ACTION COMPLETION DATE

The direct cause of this event is a failed part. The cableused to lower the sampling device parted, allowing thesampling device and a portion of the cable to fall into thetank.The root cause is an inadequate design. Sampling from deepsludge was not a factor in the design of the currentsampling device, which was designed for sampling of thelighter liquid above the layer of sludge. As a result, thecable used to lower the sampling device was not sufficientlystrong to be used for sampling in deep sludge.During a critique of the event, it was noted that the properwork plan (TFPE-YP-0168) was used and that it contained noapparent deficiencies. It was also noted that the samplingoperation in general was satisfactory. A sample was to betaken from deep within the sludge at the tank bottom. Dueto the depth from which the sample was to be taken, and theweight of the layer of sludge, it was difficult to removethe stopper of the sample bottle. Several attempts todislodge the stopper were made, one of which exerted enoughforce to sever the cord supporting the sample bottle.The sampling device has been redesigned using stronger cableand an opening mechanism that is easier to operate in deepsludge.

PLG EVALUATION

Failure_Effect	Insignificant	Sampler broke off and fell into tank. Sampling assumed to not be on the critical path, as report states no impact on operations.
RAM_Applicability	Indirect	
Safety Related	No	Time to recover the sampling device from the tank.
Intrusive	Yes	
Restoration_Time	216	
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1994-0033	**_20_dir_cause code**	1E	**_10a_discovery date**	6/3/94
Component_Type		**Failure Mode Code**	HAEDMXXXN	**_07_sys/building**	241-AP Tank Farm ventilation
_14_title of occurrence	241-AP PRIMARY EXHAUSTER SHUTDOWN DUE TO CONTROL POWER BREAKER TRIP				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 6/3/94, maintenance work was being performed per WorkPackage EE-94-580 to replace DPIS-18 and DPIS-20. These pressure switches are across the secondary HEPA filters forthe K2-5-1 and K2-5-2, respectively. Power to thesepressure switches is provided from two sources: (1) theindividual annulus fan MCC, and (2) the control powerbreaker #1 in Panel E. Breaker #1 supplies control power tocomponents in both the K2 Annulus Exhaust System and the K1Primary Exhaust System. Therefore, the control power (110V) had to be left on so that the K1 Primary Exhaust Systemwould continue to operate. The individual annulus fan MCCbreakers were turned off and lock & tagged. Theseconditions were specifically covered in the Pre-Job Safety Meeting.The Instrument Tech removed the electrically 'hot' leadsfrom the Differential Pressure Indicating Switches (DPIS) terminal strip and taped them with electrical tape. Theterminal strip is protected by a plexiglass cover that has ametal grommet-lined opening to allow wire insertion/removal.As the taped wires were being removed from inside theterminal strip housing, the 'hot' wire touched the metalgrommet, shorted, and tripped Breaker #1. Consequently, at1305 hours the K1 Primary Exhaust Fan shutdown, the HighPressure Alarm activated, and personnel exited the farm.The responsible Facility Manager for this report is W. E.Ross, (509) 373-4565. The name appearing on page one asFacility Manager is for data transmittal purposes only.

On 6/3/94 at 1320 hours, Operations and Health Physicspersonnel entered the farm in protective clothing and resetBreaker #1 in Panel E. The K1 Primary Exhaust Fan was thenrestarted.On 6/3/94 at 1350 hours, 241-AP Tank Farm wasradiologically surveyed and released. No contaminationwas found.On 6/3/94 at 1430 hours, a Critique meeting to determinecauses and corrective actions was held with all involvedparties.On 6/3/94 at 1530 hours, all notifications werecompleted.On 6/3/94 at 1545 hours, DPIS-18 and DPIS-20 werereplaced with new switches and the K2-5-1 AnnulusExhaust Fan was placed in service.

Complete Work Package #EE-91-00463, "K1-K2 AP ExhausterControl Power Revision". This will electrically separatethe K1 exhaust system from the K2 exhaust system.Action: W. E. Ross, Manager, 242-A/LERF/241-AP/AWOperations Org. 7C800 *26b#1 TARGETED ACTION COMPLETION DATE1995/04/28*26c#1 ACTUAL ACTION COMPLETION DATE 1994/12/07*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTIONDiscuss this event at TWRS Waste Tank Maintenance SafetyMeeting to ensure that appropriate personnel are aware ofthe proper actions for and implications of handling "hot"electrical leads.Action: K. W. Leliefeld, Manager, Waste Tank MaintenanceOrg: 7CB00 *26b#2 TARGETED ACTION COMPLETION DATE1994/09/01*26c#2 ACTUAL ACTION COMPLETION DATE 1994/10/24*26d#2 REVISED ACTION COMPLETION DATE

The direct cause of this event was a short in the system.When the Instrument Technician removed the taped "hot" leadfrom the terminal strip, it accidentally touched the metalgrommet-lined opening of the plexiglass cover, resulting ina short that tripped the control power breaker.A contributing cause of this event is inattention to detail.Several wraps of tape should have been used on the "hot"lead. It is accepted practice to use a sufficient amount oftape in order to prevent accidental shorting.The root cause of this event is a design problem. Severalcomponents of the K1 primary exhaust system and the K2annulus exhaust system are fed from the same breaker. Thismakes it impossible to electrically isolate these componentsfrom each other. The K1 system and the K2 system should befed from separate breakers, thus allowing for electricalisolation of one system from the other.

PLG EVALUATION

Failure_Effect	Potential Delay	This event could occur during Phase 1 operations with similar effects.
RAM_Applicability	Direct	
Safety Related	Yes	Based on ORPS report to replace switches and restore system to operation.
Intrusive	No	
Restoration_Time	2.5	

Comments None

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1994-0040	**_20_dir_cause code**	7B	**_10a_discovery date**	8/5/94
Component_Type	EF	**Failure Mode Code**	External - Loss of Power	**_07_sys/building**	Ventilation/East Area Tank Farms
_14_title of occurrence	LOSS OF VENTILATION TO EAST AREA TANK FARMS DUE TO SUB-CONTRACTORSEVERING A POWER LINE				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 8/05/94 at 1020 hours, shift operations received noticeconcerning a loss of electrical power to East Area TankFarms. Electric Utilities reported the severing of anelectrical cable by a sub-contractor performing excavationwork on the CO-18 project, outside the 200 East area. Thiscaused a power loss to the lines feeding the East Area TankFarms.The loss of electricity resulted in the loss of ventilationin 241-AN, AW, AP, C, 244-BX, and 244-CR. It also caused aloss of all remote tank monitoring capabilities.

Upon loss of ventilation all personnel were instructed toevacuate all the tank farms.On 8/05/94 at 1153 hours, Electric Utilities restored powerto East Tank Farms. Ventilation was restored to allfacilities. Health Physics performed surveys of affected farms which revealed no spread of contamination. Farms weresubsequently released.The 241-C Tank Farm exhauster, surface levels andtemperature indications were off-line for about two hours.The exhauster was restarted and the readings at theradiation survey touch points were stable. The temperatureand surface level indications returned to the pre-poweroutage readings.

Corrective actions beyond those listed in section #18 arenot required.*26b#1 TARGETED ACTION COMPLETION DATE 1994/08/05*26c#1 ACTUAL ACTION COMPLETION DATE1994/08/05*26d#1 REVISED ACTION COMPLETION DATE
The Corrective Action Evaluation Group (CAEG) hasestablished a Priority Planning Grid (PPG) value of 6.05 forthis event (see PPG Risk Evaluation Form #ORT-94-0040).Therefore, in accordance with current policy, an informalroot cause analysis using Simple Methodology was performed.The direct and root cause of this event is the loss ofelectrical power to East Tank Farm facilities. This was theresult of an electrical cable being damaged by asubcontractor performing excavation work outside the 200 East Area near the Liquid Effluent Retention Facility(LERF).

PLG EVALUATION

Failure_Effect	Potential Delay	Electic cable severed by sub-contractor performing excavation work. The loss of power resulted in loss of ventilation in 241-AN, AW, AP, C, 244-BX, and 244-CR.
RAM_Applicability	Direct	Also lost all remote tank monitoring capabilities
Safety Related	Yes	Power restored, ventilation restored to all facilities. HPT performed surveys of affected farms, no spread of contamination.
Intrusive	No	
Restoration_Time	1.5	
Comments	241-C Tank Farm exhauster, surface levels, and temperature indicators were off-line for about two hours.	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-199 4-0049	**_20_dir_cause code**	2A	**_10a_discovery date**	9/13/94		
Component_Type	Alarm by-pass switch	**Failure Mode Code**	Ventilation Loss	**_07_sys/building**	Ventilation/241-SY/K1-Exhauster		
_14_title of occurrence	LOSS OF PRIMARY VENTILATION AT 241-SY TANK FARM; DID NOT EXCEED OSR PRESSURIZATION LIMITS						

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 9/13/94 at 0913 hours, Instrument Technicians wereperforming monthly Component Based Recall System (CBRS) datasheet, Loop YSYS1, Seq 1, "Continuous Air Monitor (CAM)functional checks at 241-SY Tank Farm". A source was placedin the detector chamber in the CAM to test the highradiation level alarm. Prior to installing the source, thehigh alarm bypass switch was not engaged. The reason theswitch was not engaged was due to the CBRS data sheet notspecifying activating the bypass switch prior to performingthe check. The CAM high radiation alarm activated whichcaused the K-1 exhauster in SY-Farm to shut down. A tankpressurization alarm was received and all personnelevacuated the farm. While in the process of exiting the farm, a senior operator, understanding why the exhauster waslost, restarted the exhauster and the pressurization alarmcleared. The accountable Facility Manager for this report is James H.Wicks Jr., (509) 372-3919. The name appearing as FacilityManager on page one of this report is for data transmittalpurposes only.

On 9/13/94 at 0922 hours, shift operations verified hydrogenand ammonia levels in the Data Acquisition and ControlSystem (DACS) trailer (Hydrogen, 77 parts per million (PPM)and Ammonia, 57 PPM). Health Physics Technicians (HPT's)donned Self-contained breathing apparatus (SCBAs) to entertank farm for radiological survey.On 9/13/94 at 0940 hours, a Respiratory Technician (RT) andan operator were sent into SY farm to verify breathing zoneswhich were below limits for hydrogen, ammonia and organics.On 9/13/94 at 1000 hours, HPT's and RT's reported allsurveys were within limits.On 9/13/94 at 1010 hours, operations verified all steps ofthe Emergency Response Guide (ERG) were complete andreleased SY farm. Additionally, operators entered SY farmto verify proper operation of K1 exhauster and to take tanktemperatures.On 9/13/94 at 1130 hours, shift operations reviewed 101-SYtank temperatures and all were normal. The SY farm tankpressures were as follows: 101-SY - -0.1" water gauge (wg) 102-SY - -0.25" wg 103-SY - -0.2" wgOn 9/13/94 at 1150 hours, shift operations notified Technical Support to verify SY farm pressurization time. SYfarm has had 11 minutes of pressurization time over the pastyear. The 40 hour pressurization OSR limit has not beenexceeded.On 9/13/94 at 1330 hours, operations held a critique withall parties involved to review the event for lessons learnedand to discuss corrective actions necessary to preventrecurrence.

Revise CBRS data sheet to include a step, just prior to thehigh alarm test, to have personnel push the bypass switch,and to add a caution sign stressing that the bypass switchneeds to be pressed.Action: James M. Hay, West Tank Farms Instrumentation Maintenance ManagerOrg. Code: 7CB92*26b#1 TARGETED ACTION COMPLETION DATE1994/10/01*26c#1 ACTUAL ACTION COMPLETION DATE1994/10/01*26d#1 REVISED ACTION COMPLETION DATE*26a#2 CORRECTIVE ACTIONPerform a walkdown of all CBRS data sheets in tank farms.Ensure that any necessary revisions required to meet thatparticular Tank Farms unique test are incorporated into thedata sheets.Action: James M. Hay, West Tank Farms InstrumentationMaintenance ManagerOrg. Code:7CB92*26b#2 TARGETED ACTION COMPLETION DATE1994/10/01 *26c#2 ACTUAL ACTION COMPLETION DATE1994/10/01*26d#2 REVISED ACTION COMPLETION DATE*26a#3 CORRECTIVE ACTIONGenerate a J-3 to create a caution sign to be placed on theannunciator panels to stress pressing the bypass switchprior to the high alarm test.Action: James M. Hay, West Tank Farms InstrumentationMaintenance Manager Org. Code: 7CB92*26b#3 TARGETED ACTION COMPLETION DATE1994/09/30*26c#3 ACTUAL ACTION COMPLETION DATE1994/09/30*26d#3 REVISED ACTION COMPLETION DATE*26a#4 CORRECTIVE ACTION The following were stressed in a safety meeting. Theimportance for personnel while performing functionals, is toread each step and then to perform that step and sign it offbefore proceeding onto the next step. The importance ofevaluating and understanding the system response whenperforming any action was also stressed.Action: James J. Klos, West Tank Farm Operations ManagerOrg. Code: 7C900*26b#4 TARGETED ACTION COMPLETION DATE1994/10/21*26c#4 ACTUAL ACTION COMPLETION DATE1994/10/21*26d#4 REVISED ACTION COMPLETION DATE

On 9/22/94, the Corrective Action Evaluation Group (CAEG)convened and established a Priority Planning Grid (PPG)value of 5.0010 for this event. Therefore, in accordancewith current policy, a simple methodology root causeanalysis will be conducted. The direct and root cause is an inadequate procedure. Theprocedure did not specify activating the bypass switch priorto performing the high pressure alarm test.The contributing cause has been attributed to personnelerror/inattention to detail. The personnel performing thefunctional checks did not read, perform, and sign each stepon the CBRS data sheet before moving onto the next step.

PLG EVALUATION

Failure_Effect	Potential Delay	Farm evacuated following tank pressurization alarm. SCBAs required to enter , normal access restored and work allowed to continue after one hour
RAM_Applicability	Direct	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

Sheet 23 of 28

Safety Related	Yes	Alarm cleared while exiting facility. One hour wait period observed
Intrusive	Yes	
Restoration_Time	1	
Comments		

ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1994-0055		**_20_dir_cause code**	1A	**_10a_discovery date**		10/1/94
Component_Type	EF POWER	**Failure Mode Code**	MDF-FR-H		**_07_sys/building**	241-AW Tank Farm; primary tank ventilation	
_14_title of occurrence	LOSS OF PRIMARY TANK VENTILATION AT 241-AW TANK FARM						

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 10/01/94 at 2222, the primary ventilation system in241-AW Tank Farm shutdown, causing a loss of confinementventilation in the AW Tank Farm. The 242-A Evaporator,which was operating at the time, was shutdown toRecirculation with Vacuum. Several attempts were madeto restart the ventilation fans with no success.The responsible Facility Manager for this report is W. E.Ross, (509) 373-4565. The name appearing on page one ofthis report as Facility Manager is for data transmittalpurposes only.

Ventilation was verified to be secured by checkingpressure strip chart recorders.An Operator and Health Physics Technician (HPT) enteredfarm to attempt to restart the fans.The Evaporator was shutdown to Recirculation withVacuum. No other transfers were underway.On 10/1/94, at 2341, the fans would not restart, andCrafts personnel were called for troubleshooting andrepair.On 10/2/94, at approximately 0200, HPT's completedradiological surveys of the tank farm with no release of contamination being detected. The farm was then releasedfor normal operations.On 10/2/94, at 0227, Crafts personnel found the controlpower breaker for the primary exhaust fans in the trippedposition. The breaker was reset and the K1-5-2 fan restarted.

Develop a work package to electrically separate the K1exhaust system from the K2 exhaust system.Action: W. E. Ross, Mgr., 242-A/LERF/241-AP/AW Tank FarmOrg. 7C800*26b#1 TARGETED ACTION COMPLETION DATE1995/05/30*26c#1 ACTUAL ACTION COMPLETION DATE1996/04/23*26d#1 REVISED ACTION COMPLETION DATE

The loss of primary tank ventilation was the result of atripped control power breaker. The circuit breaker inquestion is a small 20 amp, molded case breaker very similarto ones that are used in a home. This breaker feeds controlpower to the primary (K1) exhaust fans control circuits.During troubleshooting efforts, it was noted that the loadthrough the breaker was 5.2 amps. This indicates that thenormal load through the breaker was not responsible for thebreaker tripping. It is possible that a voltage spike/transient occurred that caused the breaker to trip.Since this event occurred no other problems have occurredwith this breaker.The root cause is an inadequate design. Several componentsof the K1 primary exhaust system and the K2 annulus exhaustsystem are fed from the same power source. This makes itimpossible to electrically isolate these components fromeach other. The K1 system and the K2 system should bepowered from separate breakers, thus allowing for electricalisolation of one system from the other.

PLG EVALUATION

Failure_Effect	Potential Delay	Loss of control sysytem power, causes loss of ventilation, breaker tripped.
RAM_Applicability	Direct	
Safety Related	Yes?	Time for breaker to be identified and reset.
Intrusive	No	
Restoration_Time		
Comments	BRKR1 CA Done? Both primary and annulus components fed by same breaker.	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1994-0073	**_20_dir_cause code**	1A	**_10a_discovery date**	12/27/94
Component_Type		**Failure Mode Code**	EXTERNAL	**_07_sys/building**	SX-104/Liquid Observation Well
_14_title of occurrence	HIGH FLAMMABLE GAS AND AMMONIA LEVELS DISCOVERED IN SX-104 LIQUIDOBSERVATION WELL (LOW) DURING RISER LINER INSTALLATION ACTIVITIES				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 12/27/94 Work Package 2W-94-00737, "241-SX Install LOWProtective Sleeve in 104", was being performed. Thisconsisted of installing a 6 mil. thick tear resistant innerlining sleeve in the existing failed LOW. The linerfacilitated monitoring of the LOW to provide a liquid levelmeasurement of the tank.Per the work package instructions the LOW was allowed tobreathe through a HEPA filter glovebag for 30 minutes uponopening the riser. A WHC Respiratory Protection Technicianbegan monitoring the area as soon as the flange wasloosened. After the 30 minute time limit, the vapor levelswere still reading above the established limit. Personnelwere then instructed to proceed to step 7.15 of the workpackage. This consisted of reinstalling the flange andsealing the LOW. When this was completed, Draeger tubesamples were drawn confirming high ammonia levels. At 1230 hours, shift operations was notified by Surveillancethat 241-SX-104 LOW readings were 102% of the Lower Flammability Limit (LFL) and ammonia levels were at >700PPM. OSD-T-151-00030 requires the ceasing all workactivities if the vapor space flammable gas concentration isequal to or greater than 20% of the LFL. The recoveryaction is to stop all work and return the equipment to asafe configuration.Upon the initial opening of the riser, the LFL registered102%, ammonia at >700 PPM, and organics at 63 PPM.Local area readings outside the glovebag through-out theoperation were well below all limits.

All associated work was halted and the site was thenreturned to pre-job conditions.

A standing order was issued to ensure gas sampling isperformed prior to opening the LOW.*26b#1 TARGETED ACTION COMPLETION DATE1994/12/29*26c#1 ACTUAL ACTION COMPLETION DATE1994/12/29*26d#1 REVISED ACTION COMPLETION DATE
The LOW developed a leak, resulting in the accumulation oftank vapors inside the LOW.The LOW is used for determining interstitial liquid in thetank. Two work plans are being developed to resolve theinability to determine interstitial liquid level. Surfacelevels can be and are maintained using surface levelmonitoring equipment. Surface level indications remainnormal.

PLG EVALUATION

Failure_Effect	Potential Delay	High Flammable Gas generated USQ evaluation requirement prior to restart of workl
RAM_Applicability	Direct	
Safety Related	Yes	Unk but LONG USQ evaluation must be performed prior to any work being attempted.
Intrusive		
Restoration_Time		
Comments		

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--WHC-TANKFARM-1995-0007	**_20_dir_cause code**	1E	**_10a_discovery date**	1/18/95
Component_Type		**Failure Mode Code**	MDF-FR-H	**_07_sys/building**	K1-4-1/SY-Farm/P-28 Exhauster
_14_title of occurrence	LOSS OF PRIMARY TANK VENTILATION AT 241-SY TANKFARM DUE TO INADVERTENT SHUTDOWN OF THE P-28 EXHAUSTER				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 01/18/95 at 2230 hours, the ventilation system at 241-SYTank Farm was switched from the K1-4-1 exhauster to the P-28 exhauster. At approximately 2240 hours, a Health PhysicsTechnician (HPT) making scheduled continuous air monitor(CAM) checks, noted that there was no flow through thebeta/gamma CAM on the P-28 exhauster. The HPT toggled theCAM power control switch to "off", then back to "on"position and then noticed the record sampler flow indicationdropping off and the P-28 exhaust fan begin shutting down.The HPT then checked the three vacuum pumps but could notsee any problem.Operations is unsure of what caused the shut down. A spikemay have possibly been received on the beta/gamma CAM as itwas toggled off and on. The HPT doesn't believe any vacuumpump hoses were pinched off *at any time during this problem.The lowest the pressures* got on the SY tanks was -0.20".The accountable Facility Manager for this report is Dave P.Reber, (509) 372-3919. The name appearing as FacilityManager on page one of this report is for data transmittalpurposes only.

Operations personnel taking readings in the instrumentbuilding observed that the tank pressure in the SY farm wasdropping and shortly there-after, the tank farm highpressure alarm activated (2241 hours). The operatorsimmediately went to the P-28 exhauster and restarted it.All systems appeared to be normal.As a precaution, the cover blocks on the pits were checkedfor loose (smearable) radioactive contamination (none wasdetected) and the operational monitoring frequency wasincreased for the P-28 exhauster until stable operation wasassured.

Troubleshoot the exhauster to determine the cause of theequipment malfunction.*26b#1 *TARGETED ACTION COMPLETION* DATE1995/01/19*26c#1 ACTUAL ACTION COMPLETION DATE1995/01/19*26d#1 REVISED ACTION COMPLETION DATE
The cause of this event has not been determined.Operations, HPT's and maintenance craft personnel went intothe field and under controlled conditions, duplicated theactions taken by the HPT to determine if any of the causedthe unit to shut down. None of the actions caused theexhauster to shut down.

PLG EVALUATION

Failure_Effect	Potential Delay	A spurious signal to the various tank ventilation system components is possible and would create some delay in the transfer process.
RAM_Applicability	*Direct*	
Safety Related	Yes	The ORPS reprot did not indicate the time required to investigate the event restart the HVAC.
Intrusive	No	
Restoration_Time		
Comments	None	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--PHMC-TANKFARM-1997-0009	**_20_dir_cause code**	4B	**_10a_discovery date**	1/23/97
Component_Type		**Failure Mode Code**	See comments	**_07_sys/building**	241-SY P-28 EXHAUSTER
_14_title of occurrence	241-SY TANK FARM PRIMARY EXHAUSTER SHUTDOWN				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

At 1000 hrs, on January 23, 1997, it was reported to the on-duty shift operations manager (SOM) that the 241-SY P-28backup exhauster had shutdown, activating the pressurizationalarm. An operator, who was at the ventilation pad whenthis occurred, immediately restarted the exhauster. Stripcharts recording the tank vacuums indicate tank 102-SYmomentarily read +0.1" wg. It has been determined that theaccuracy of this gauge is + or - .4"wg. The exhauster wasrestarted within one minute of shutting down.

An operator at the exhauster pad taking field readings,realized that the exhauster was shutting down andimmediately pushed the restart button, successfully bringingthe exhauster back on line.The SOM, a Health Physics Technician and an Instrument technician entered the farm and acknowledged and cleared thepressurization alarm.Health Physics Technicians and an Industrial HealthTechnician and were sent to the farm to perform surveys ofthe area. Results of these surveys indicated that there wasno release to the atmosphere.The Double Shell Tank Farm Manager and the Team Coordinatorwent to the exhauster pad to determine the cause of theshutdown. (See section 23, Description of Cause)

The immediate actions taken by the personnel were adequate.No further corrective actions are necessary.*26b#1 TARGETED ACTION COMPLETION DATE1997/03/05*26c#1 ACTUAL ACTION COMPLETION DATE1997/03/05*26d#1 REVISED ACTION COMPLETION DATE

The direct and root cause of this event has been determinedto be an inadequate design. Static pressure gauge PS-2, inthe exhauster instrument cabinet, reads tank vacuum bycomparing the pressure in the vent header and atmosphericpressure. The high vacuum set point on this instrument is-4.0" wg. The reading on the gauge prior to shutting downwas at -2.8" wg. When the door to the cabinet was shut, thecabinet became slightly pressurized, raising the indicationon PS-2 past the high vacuum set point.

PLG EVALUATION

Failure_Effect	*Exhauster restarted within one minute of shutting down. Contamination surveys* results indicated that there were no release to the atmosphere. Event being considered an isolated incident
RAM_Applicability	
Safety Related	
Intrusive	
Restoration_Time	
Comments	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--PHMC-TANKFARM-19 97-0083	**_20_dir_cause code**	1E	**_10a_discovery date**	10/8/97
Component_Type	PDAH	**Failure Mode Code**	ALR-SO-I	**_07_sys/building**	241-SX, 296-S-15 "Sludge Cooler" exhauster
_14_title of occurrence	LOSS OF 241-SY 296-S-15 "SLUDGE COOLER" EXHASUTER				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On October 8, 1997 at 0546 hours, the West Tank Farm ShiftOperations Manager (SOM) was notified by the Computer Automated Surveillance System (CASS) operator that the 241-SXtank farm, 296-S-15 "Sludge Cooler" exhauster "shut down" alarm had been received. Loss of this exhauster requiredentry into Limiting Condition for Operation (LCO) 3.2.2 action statement.LCO 3.2.2 requires that Single Shell Tank (SST) ventilationsystem be operable. This requirement is specified to providea method to minimize the accumulation of flammable gas byproviding air flow through the tank vapor space. The LCO requirement for loss of SST ventilation is to restore theactive ventilation system to operable status immediately ANDverify concentration of flammable gas is less than 25 percentof the LFL in the affected tank once per 7 days.Upon notification of the sludge cooler shutting down, the SOMimmediately sent an operator and a Health Physics Technician(HPT) to attempt to restart the sludge cooler. At 0615 hours,the north fan of the sludge cooler was started. This fanoperated for approximately 5 minutes and then shut down. Thesouth fan was then started, which ran for approximately 2minutes before shutting down. Because both fans would notcontinue to run, the shift manager directed the operator andHPT not perform any further attempts to restart the exhausteruntil instrument technicians could determine the cause for theshutdown.Trouble shooting efforts by the instrument technicians couldnot determine the initial cause of the sludge cooler shutdown.At 1020 hours, instrument technicians determined that as aresult of the sludge cooler shutting down, the lowdifferential pressure (dp) switch DPS-11 activated and had notcleared. The low dp not clearing prevented the exhauster fromrestarting. Instrument technicians cleared the low dpinterlock and restarted the exhauster.

At 0546 hours, CASS notified the west area SOM that they hadreceived a 241-SX exhasuter shutdown alarm. Entered into LCO 3.2.2 action statement.At 0550 an operator and an HPT were dispatched to verify thealarm and attempt to restart the sludge cooler if necessary.The exhauster had shutdown and attempts to return the systemto operable were unsuccessful. The exhauster outage promptedentry into the LCO 3.2.2 action statement.The exhauster was restarted at 1020 hours. LCO 3.2.2condition "Active ventilation system is inoperable" no longerapplicable. (exit LCO 3.2.2 condition)This event was categorized as an off normal occurrence1.E.3.a.

Trouble shooting efforts by the instrument technicians couldnot determine the cause of the exhauster shutdown. Theexhauster was restarted and has continued to operate normally.No further corrective actions are necessary.*26b#1 TARGETED ACTION COMPLETION DATE1997/11/17*26c#1 ACTUAL ACTION COMPLETION DATE1997/11/17*26d#1 REVISED ACTION COMPLETION DATE

The direct and root causes of this event have been determinedto be electrical/instrument noise. Instrument technicianswere sent to the field to perform troubleshooting on theexhauster and to determine the cause of the shutdown. Thistroubleshooting activity did not identify any apparentproblems with the exhauster. The exhauster was restarted andcontinued to operate normally. Based on the results of thetroubleshooting, the shutdown has been attributed toelectrical/instrument noise.

PLG EVALUATION

Failure_Effect	Potential Delay	Similar pressure switches exist on Phase 1 systems. It is assumed that an equivalent priority on maintenance would be given during Phase 1 transfers.
RAM_Applicability	Direct	
Safety Related	Yes	Based on ORPS report to troubleshoot system, repair, and place back into operation.
Intrusive	No	
Restoration_Time	5	
Comments	None	

Table C-3. Sample Evaluations of ORPS Database for Applicability to WFDS Activities (Continued)

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ORPS INFORMATION

_01_orps_number	RL--PHMC-TANKFARM-1998-0009	**_20_dir_cause code**		**_10a_discovery date**	1/24/98
Component_Type	EF	**Failure Mode Code**	MDF-FR-H	**_07_sys/building**	241-SY Double-Shell Tank Primary Exhauster
_14_title of occurrence	UNPLANNED SHUTDOWN OF DOUBLE-SHELL TANK PRIMARY EXHAUSTER RESULTS IN PRESSURIZATION ALARM - NO OTHER ADVERSE IMPACTS ON THE FACILITY				

1) _16_description **2) _19_immediate cor actn** **3) _26_Corrective Action** **4) _23_cause narrative**

On 01/24/98, at approximately 1730 hours, a pressurizationalarm was received at the Computer Automated SurveillanceSystem (CASS) indicating the 241-SY Double-Shell Tank'sprimary exhauster had likely shutdown. The CASS Operatorinformed the shift manager who dispatched operators toinvestigate. Operators found the exhauster had shutdown, andrestarted it at 1806 hours.

At 1806 hours on 1/24/98, the exhauster was restarted.At 1816 hours, the tank's pressurization alarms cleared.Subsequent radiological surveys did not find any abnormalconditions.

*26b#1 TARGETED ACTION COMPLETION DATE*26c#1 ACTUAL ACTION COMPLETION DATE*26d#1 REVISED ACTION COMPLETION DATE

PLG EVALUATION

Failure_Effect	Potential Delay	Primary Exhauster fails, back-up did not startup
RAM_Applicability	Direct	
Safety Related	Yes	*Exhauster restarted without problems, alarms cleared, radiological surveys do not* find abnormal conditions
Intrusive	No	
Restoration_Time	1	
Comments		

Table C-4. Example of Information Available in JCS Database

Sheet 1 of 12

Work Package: 2W-93-00296 **ORIG DATE:** 3/30/93 **FIELD WORK COMPL DATE:** 6/28/93

WORK ITEM TITLE: 241-SY-101 SHMS-L SAMPLE PUMP REPLACEMENT

Work Description:

OBJECTIVE: REPLACE SAMPLE PUMP 241-SY-101 SHMS-J. QC HOLD *** QC VERIFY SC/IL 1, 2, AND 3 MATERIAL ON BOM SUPPLEMENT ZERO. INITIAL STAMP AND DATE BOM UPON VERIFICATION. *** ****************** SEE J4-A FOR RESOLUTION
****************** OBJECTIVE: REPLACE SAMPLE PUMP P-01LSY-1-1. PREQUISITES: 1) IS HAZARDOUS WASTE GENERATED
FROM OR BY THIS WORK? YES/NO/NA____________ PIC/SUP_________________DATE/TIME_______________
2) ARE APPROPRIATE WASTE CONTAINERS AVAILABLE TO PERFORM THIS WORK AND ARE THEY AT THE JOB SITE? YES/NO__________ PIC/SUP__________________DATE/TIME______________ ******NOTE****** DAILY THE PIC/SUPERVISOR SHALL RECORD ON THE J-5 THAT ALL WASTES HAVE BEEN PROPERLY DISPOSED OF PER WHC-IP-0842,
SECTION 16.1, CHAPTER 9 AND/OR TO-100-052. SIGN AND DATE THE J-5 DAILY. SCOPE: 1. OPEN CIRCUIT BREAKER CB-3L1/3L2 AND TAG WITH A DO NOT OPERATE TAG (REFER TO H-2-87278, SH. 1). PERFORM ZERO ENERGY CHECK AT PUMP J-BOX, LOCATED ON THE PUMP STAND, TO ENSURE NO POWER. 2. DISCONNECT TUBING AND WIRING AT THE PUMP.
3. REMOVE EXISTING PUMP AND INSTALL NEW PUMP. 4. CONNECT TUBING AND WIRING. 5. REQUEST OPERATOR REMOVE
TAGS. 6. TAG OLD PUMP WITH IDENTIFICATION/LOCATION, PLACE IN DOUBLE PLASTIC BAG AND STORE IN GMS-1 BUILDING. 7. PIC/SUPERVISOR VERIFY THAT JOB SITE HAS BEEN CLEANED UP AND THAT ALL WASTES HAVE BEEN DISPOSED OF PROPERLY. MAINT. PIC_________________DATE/TIME__________ OPERATIONS PIC_____________DATE/TIME__________ 8. OPERATIONS VERIFICATION PIC_________________________DATE/TIME__________ 9. PIC ENSURE HOUSEKEEPING IS PERFORMED. ________________________ _____________ SIGNATURE DATE . N/A QC INVOLVMENT - NONE
RETEST SATISFACTORY N/A QC VERIFY RETEST N/A J-8 FUNCTIONAL RETEST COMPLETE N/A

Work Package: 2W-93-00306 **ORIG DATE:** 4/5/93 **FIELD WORK COMPL DATE:** 5/4/93

WORK ITEM TITLE: 241-TX CALIBRATE 101-TX LIT

Work Description:

** WORK HAZARD IDENTIFICATION AND PRECAUTIONS 1. WORK WILL BE
DONE ON 120 VOLT AC ENERGIZED CIRCUIT. 2. BE AWARE THAT ELECTRIC SHOCK HAZARD EXISTS. 3. BE AWARE THAT
ELECTRIC ARC HAZARD EXISTS FROM SHORTING ENERGIZED WIRES TO GROUND. 4. USE GOOD ELECTRICAL WORK PRACTICES. 5. USE AC VOLTMETER/INDICATOR TO IDENTIFY ENERGIZED WIRES. 6. USE BUDDY SYSTEM.
** *OBJECTIVE: CALIBRATE/REPAIR UNIT AT 101-TX.*
****************************CAUTION****************************** HIGH RADIATION FIELD MAY BE PRESENT ANY TIME THE PLUMMET
IS RAISED INTO THE SIGHT GLASS. ** SCOPE: 1) WORK REQUIRES RAISING THE PLUMMET INTO THE SIGHT GLASS, OR IF THE PLUMMET IS ALREADY IN THE SIGHT GLASS; AN HPT. MUST BE
PRESENT TO DETERMINE DOSE RATES. 2) TROUBLESHOOT LIT PER 6TF-035 TO DETERMINE REQUIRED REPAIRS, IF NEEDED.
3) REPAIR LIT PER 6TF-035. 4) FOLLOWING REPAIRS, PERFORM FUNCTIONAL CHECK PER 6-TF-035. IF UNIT PASSES CHECK,
RECORD LIQUID LEVEL. ______________________ ___________ __________ SIGNATURE LIQUID LEVEL DATE 4.1) REMOVE DEFICIENCY TAG AND PUT IN PACKAGE. 5) IF CALIBRATION IS NEEDED PERFORM 6-TF-058 AND DOCUMENT FINDINGS ON PISCES JOB CARD TX101-1. 6) IF FLUSHING IS NEEDED, PERFORM FLUSH PER TO-020-420.
APPROVAL OF OPERATIONS WILL BE NEEDED PER PROCEDURE. 7) IF FURTHER REPAIR, PARTS NEEDED, OR IF CONTAINMENT IS TO BE BROKEN; RETURN THE PACKAGE TO PIC FOR A J-7 AND/OR A NEW RWP. 8) DOCUMENT ALL WORK
PERFORMED ON THE ENCLOSED CRAFT RESOURCE/USAGE LOG. 9) PIC ASSURE HOUSEKEEPING IS PERFORMED.
________________________ _____________ SIGNATURE DATE
~~~~~~ J-8 FUNCTIONAL RETEST COMPLETE N/A
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Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 2 of 12

Work Package: 2W-93-00427 **ORIG DATE:** 5/7/93 **FIELD WORK COMPL DATE:** 7/13/93

WORK ITEM TITLE: 241-S T/S AND REPAIR RAMP 1 FAILED TO RESPOND,

Work Description:

OBJECTIVE: REPAIR 241-S RAMP #1. NOTIFY SHIFT MANAGER OF WORK TO BE DONE. SEE COMMENTS SECTION FOR WORK HAZARD. SCOPE: 1. TROUBLE SHOOT AND REPAIR FAILED RAMP #1. 2. DOCUMENT ALL WORK PREFORMED AND MATERIAL USED ON J-5 CRAFT USAGE LOG. (IF PARTS ARE REQUIRED USE ONLY LIKE/ KIND). 3. IF PARTS ARE REQUIRED
FOR REPAIR PIC TO VERIFY PARTS USED. 4. RETEST: PREFORM PISCES S0078 #2. PISCES S0078-2 QC INVOLVMENT - NONE
RETEST SATISFACTORY FRANKLIN,FP 07/13/93 QC VERIFY RETEST N/A J-8 FUNCTIONAL RETEST COMPLETE AHRENS,JL
07/14/93

Work Package: 2W-93-00573 **ORIG DATE:** 6/9/93 **FIELD WORK COMPL DATE:**

WORK ITEM TITLE: 241-SY REPAIR 101-SY VIDEO CAM. PAN & TILT

Work Description:

PREREQUISITE: *NOTE* THE PIC/SUPERVISOR OF THE JOB OR TASK SHALL PERFORM THE FOLLOWING. 1.0 IS HAZARDOUS WASTE GENERATED FROM OR BY THIS WORK. YES/NO/NA_____/_____
PIC/SUP SIGN DATE/TIME 2.0 ARE THE APPROPRIATE WASTE CONTAINERS AVAILABLE TO PERFORM THIS TASK
AND ARE THEY AT THE JOB SITE YES/NO/NA_____/_____ PIC/SUP DATE/TIME
3.0 DAILY PIC/SUPERVISOR RECORD ON THE J-5 THAT ALL WASTE HAS BEEN PROPERLY DISPOSED OF. *SIGN AND DATE J-5* COMPLETION OF JOB: PIC/SUPERVISOR RECORD ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL
WASTE HAS BEEN PROPERLY DISPOSED OF: OPERATIONS VERIFY, SIGN AND DATE THE J-5
********** WORK SCOPE: 1.DECONTAMINATE PAN AND TILT ASSEMBLY PER OPERATIONS PIC INSTRUCTIONS. 2.HEALTH PHYSICS TECHNICIANS WILL SURVEY AND ESTABLISH ACCEPTABLE LEVELS
OF CONTAMINATION BEFORE REPAIRS ARE MADE TO THE PAN AND TILT ASSEMBLY. 3.WHEN DECONTAMINATION HAS BEEN COMPLETED CRAFTS WILL MAKE REPAIRS PER MAINTENANCE PROCEDURE 6-TF-069 PERFORM STEP 7.5.2 ONLY AS
DIRECTED BY THE SY-101 IN-TANK CAMERA COGNIZANT ENGINEER OR HIS DELEGATE. 4.CRAFTS WILL RECORD ALL ACTIONS TAKEN TO COMPLETE REPAIRS THE J-5 FORM. 5.PERFORM HOUSEKEEPING AT COMPLETION OF JOB. THISM,PACKAGE CANCELED WORK WILL BE PERFORMED UNDER PACKAGE 2W-93-00267/W J. E. PERHAM.

Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 3 of 12

Work Package: 2W-93-00750 **ORIG DATE:** 8/4/93 **FIELD WORK COMPL DATE:** 5/25/95

WORK ITEM TITLE: 241-SX REPLACE PIPING NORTH CAB. SLUDGE COOLER STEAM

Work Description:

SCOPE: REPAIR NORTH STEAM SUPPLY CABINET ON THE SX SLUDGE COOLER (296-S-15), WHICH SUPPLIES STEAM TO THE NORTH STEAM COIL AND TO THE SOUTH SIDE STEAM CABINET: 1. REMOVE PIPING, FITTINGS ETC. PER ECN'S 2. CLEAN UP CABINET 3. INSTALL INSULATION TO INSIDE OF CABINET WALLS 4. RE-INSTALL PIPING, CONTROL VALVES AND GAGE PER ECNS'. 5. SHEET/METAL WORKERS REPAIR CABINET 6. PERFORM LEAK TEST PER APPROVED MAINT WORK PROC. 7-GN-083. 7. DOCUMENT WORK SEE J4A FOR RESOLUTION:

SCOPE: REPAIR NORTH STEAM SUPPLY CABINET ON THE SX SLUDGE COOLER (296-S-15), WHICH SUPPLIES STEAM TO THE NORTH STEAM COIL AND TO THE SOUTH SIDE STEAM CABINET. 1. REMOVE PIPING ETC PER ECN'S. 2. CLEAN UP CABINET 3. INSTALL INSULATION TO INSIDE OF CABINET WALLS 4. RE-INSTALL PIPING, TEMP CONTROL VALVES AND GAGE PER ECNS'. 5. LABEL ALL VALVES PER ECN 162545 6. SHEET/METAL WORKERS REPAIR CABINET 7. PERFORM LEAK TEST PER APPROVED MAINT WORK PROC. 7-GN-083. 8. DOCUMENT WORK PREREQUISITE: *NOTE* THE PIC/SUPERVISOR OF THE JOB OR TASK SHALL PERFORM THE FOLLOWING: 1. A PRE-JOB SAFETY MEETING HAS BEEN CONDUCTED UTILIZING THE PRE-JOB SAFETY MEETING CHECKLIST AND THE JOB HAZARD ANALYSIS. _DONITHAN,MG_____ __11-4-93__ SIGNATURE DATE 2. PIC/CRAFT MANAGER SHALL BE IN ATTENDANCE DURING THE PERFORMANCE OF THIS WORK. 3. THE WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. DONITHAN,MG_____ _11-8-93____ PIC/CRAFT MANAGER SIGNATURE DATE SUGGESTED LOCK AND TAG: CLOSE STEAM SUPPLY VALVE LOCATED IN NORTH EAST CORNER OF 241-SX FARM (INSIDE FENCE) AND VALVES AT THE PRESSURE REDUCING STATION LOCATED BETWEEN 244-S AND 241-S-151 DIV BOX. INSTALL LOCK AND TAG. (QC) VERIFY 3Q MAT'L ON BOM SUPPL 1. STAMP AND DATE BOM FOR MAT'L ACCEPTANCE. _____WERNER,PA_____/_____11-8-93 QC DATE **SHOP WORK** 1. CALIBRATE PRESSURE GAGE (0-160) ECN162545 PER 06-TF-054. 2. MAKE UP TAGS FOR VALVE IDENTIFICATION, ECN 162545 AND 176882. LABEL VALVES PER HS-BS- 0015. TYPE 10, 1/8" HIGH CHARACTERS. TAGS: STM-V-1, STM-V-2, STM-V-3, STM-V-4, STM-V-5, STM-V-6, STM-V-7, STM-V-8 CND-V-1, CND-V-2, CND-V-3, CND-V-4, CND-V-5. TCV-1-1. **FIELD WORK:** 1. PRIOR TO STARTING WORK, VERIFY DOUBLE VALVE PROTECTION AND LOCK AND TAG ARE IN PLACE. __TUCKER,RP_____/_11-8-93_____ *LOCK AND TAG CUSTODIAN* *DATE* 2. AT THE NORTH STEAM CABINET, REMOVE ALL PIPING, VALVES AND GAGE, WHICH REQUIRE REPLACEMENT. CLEAN INSIDE OF CABINET AND PREP THE CABINET FOR INSTALLATION OF INSULATION. **NOTE** TAKE CARE NOT TO LOSE THE THE DEFIENCY TAG. THE TAG IS RE- QUIRED TO BE PLACED IN THE PACKAGE WHEN WORK IS COMPLETE. (INSULATOR) 3. INSULATE INSIDE OF CABINET AND DOORS WITH 1" ARMAFLEX, USING 520 GLUE AND FINISH WITH WHITE RUBATEX COATING. (MSDS NO. FOR 520 GLUE NO. 10034 AND FOR RUBATEX COATING NO. 19736) 3.A. AFTER GLUE ON SEAMS HAS DRIED PER MANUFACTURES RE- COMMENDATIONS, APPLY FINISH IN TWO COATS ALLOWING *FIRST COAT TO DRY PRIOR TO APPLICATION OF SECOND COAT. 4. INSTALL NEW PIPING, VALVES, TCV-1-1, GAGE,* TRAPS, STRAINERS AND TAGS AS SHOWN ON ECNS' 162545, 162550, 153934, 162547 604401 & 176882. (VALVE TAG NUMBERS SHOWN ON 176882) 5. REPLACE THE TI-1-1 (TEMPERATURE INDICATOR) PER ECN 162550 AND 604401. (SHEET/METAL) 6. SHEET/METAL CRAFTSMAN REPAIR CABINET. (FRONT CENTER SECTION HAS FALLEN OFF) (QC REQUIRED FOR MAINT. PROC. 7-GN-083) 7. WHEN STEAM BECOMES AVAILABLE: (STEAM MAY BE VALVED OUT AT PRESSURE REDUCING STATION DUE TO MAKING STEAM LEAK REPAIRS) REF WORK PACKAGE 91-1447 "PRES REDUCING STA. REPAIRS" REMOVE LOCK AND TAG. PERFORM LEAK TEST PER 7-GN-083 (STEAM IS PRESENTLY OFF UNTIL THE PRESSURE REDUCING STATION REPAIRS ARE COMPLETE) NORMAL OPERATING PRESSURE TO THE STEAM COILS IS 75 TO 90 PSI. **NOTE** DO NOT TURN STEAM ON TO SYSTEM UNTIL THE NORTH COIL HAS BEEN REPLACED. REF: 91-544, "REPLACE NORTH COIL" (QC HOLD) 7.A QC WITNESS INITIAL SERVICE LEAK TEST PER 7-GN-083. _____/_____/_____ QC STAMP DATE NCR# AFTER LEAK TEST IS COMPLETE, RETURN SYSTEM TO NORMAL OPER- ATION. (STEAM PRESSURE BETWEEN 75 TO 90 PSIG) REMOVE THE CALIBRATION STICKER FROM THE GAGE AND REPLACE IT WITH A "INDICATION ONLY" STICKER. _____ _____ PIC/MGR DATE 8. VERIFY THE DEFIENCY TAG IS REMOVED AND PLACED IN THE WORK PACKAGE. PIC_____DATE_____ 9. DOCUMENT ON THE J5, EACH DAY THIS WORK PACKAGE IS WORKED, ALL WORK PERFORMED, MATERIALS USED AND PROBLEMS ENCOUNTERED WHILE PERFORMING WORK. COMPLETION OF JOB: PIC/SUPERVISOR RECORD ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL WASTE HAS BEEN PROPERLY CONTAIN- ERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) /WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. OPERATIONS VERIFY AND SIGN AND DATE THE J-5. QCI REQUIRED WHILE

PERFORMING RETEST PER 7-GN-083 QC INVOLVMENT - VERIFY RETEST SATISFACTORY N/A QC VERIFY RETEST N/A J-8 FUNCTIONAL RETEST COMPLETE N/A

Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 4 of 12

Work Package: 2W-93-00882 **ORIG DATE:** 9/23/93 **FIELD WORK COMPL DATE:**

WORK ITEM TITLE: 242-S TRBSHT/REPR RAW WTR & STM HI RAD ALA G13

Work Description:

OBJECTIVE: TROUBLE/SHOOT ANN. G WINDOW #13 AT 242-S. (RAW WATER AND STEAM LINE RADIATION HI (RA-SP-1) SE
J4-A FOR RESOLUTION. PREREQUISITES: IF REQUIRED CONDUCT A PRE-JOB SAFETY MEETING USING THE PRE-JOB SAFETY MEETING FORM, INCLUDE A HANFORD JOB HAZARD ANALYSIS IF NEEDED. _____ _____ SIGNATURE DATE THE WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. _____ _____ PIC/CRAFT MANAGER DATE NOTE>> USE GUIDANCE FROM WHC-4-3, E-2 AS THIS WORK WILL REQUIRE WORKING NEAR ENERGIZED CIRCUITS. (120V) SCOPE: POST WORK REQUIREMENTS: 1. PIC/SUPERVISOR
RECORD ON THE J-5 THAT JOB SITE HAS BEEN CLEANED AND ALL WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) /WHC-IP-O842, SECT 16.1 (NON-RADIOACTIVE), AS APPLICABLE. QC INVOLVMENT - NONE

Work Package: 2W-94-00022 **ORIG DATE:** 1/4/94 **FIELD WORK COMPL DATE:**

WORK ITEM TITLE: 241-SY REWIRE LEAK DETECTORS

Work Description:

OBJECTIVE: REWIRE LEAK DETECTORS AT 241-SY VALVE PIT AND FLUSH PIT TO REFLECT DRAWING. SEE J-4A FOR RESOLUTION 1. PREREQUISITE: *NOTE* THE PIC/SUPERVISOR OF THE JOB OR TASK SHALL PERFORM THE FOLLOWING:
1.1 IF REQUIRED, CONDUCT A PRE-JOB SAFETY MEETING USING THE PRE-JOB SAFETY MEETING FORM. INCLUDE A *HANFORD JOB HAZARD ANALYSIS IF NEEDED. 1.2 THE WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE* CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. _____ _____ PIC/CRAFT MANAGER SIGNATURE DATE 1.3 USE GUIDANCE FROM WHC-4-3, E-2 AS THIS WORK WILL REQUIRE WORKING NEAR ENERGIZED CIRCUITS OF 220 VOLTS. SCOPE: 2. TROUBLESHOOT WIRING PROBLEMS WITH LEAK
DETECTOR FLUSH PITS A AND B, AND VALVE PITS A AND B. THE LEAK DETECTORS ARE NOT WIRED IN THE SEQUENCE
REFLECTED ON DRAWING H-2-37735 SHEET 2, REV. 8. 3. LOCK & TAG LEAK DETECTORS WHEN IDENTIFICATION IS COMPLETE OR AS NEEDED. 4. REWIRE LEAK DETECTORS AND LABLE CONDUCTORS AT SPLICES TO CONFORM WITH DRAWING. JUMPER WIRES MAY BE USED TO RELOCATE WIRES ON TERMINAL STRIPS IF NECESSARY WITH IDENTICAL TYPE
AND SIZE OF WIRE. (WIRE AND BUTT SPLICES FROM SHOP STOCK) QC VERIFY! 4.1 VERIFY DESIGN CONFIGURATION. VERIFY LEAK DETECTOR WIRING PER H-2-37735 SH.2, REV.8. _____ _____ QC SIGNATURE DATE 5. REMOVE LOCK & TAGS AND PERFORM FUNCTIONAL TEST USING CBRS CARDS SY054, SY055, SY036, AND SY037. QC WITNESS! 5.1 QC WITNESS FUNCTIONAL TEST. SIGN BLOCK NUMBER 20 OF J-4 UPON SATISFACTORY COMPLETION OF TEST. 6. POST WORK REQUIREMENTS: 6.1 PIC/SUPERVISOR RECORD ON THE J-5 THAT
THE JOB SITE HAS BEEN CLEANED AND ALL WASTE HAS BEEN PROPERLY CONTAIN- ERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) /WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. PERFORM FUNCTIONAL TEST USING CBRS CARDS SY054, SY055, SY036, AND SY037. QC WITNESS FUNTIONAL TEST OF CBRS. QC INVOLVMENT -
WITNESS

Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 5 of 12

Work Package: 2W-94-00473 **ORIG DATE:** 4/8/94 **FIELD WORK COMPL DATE:**

WORK ITEM TITLE: 242-S REPLACE 1C AND 2D BRKRS ON C8-S8 SWGR

Work Description:

RESOLUTION: SEE J4-A. 1 SCOPE: 1.1 INSTALL NEW BREAKERS IN COMPARTMENTS 1C AND 2D AT 242-S IN SWITCHEGEAR C8-S8. 2 DESCRIPTION: 2.1 REMOVE BREAKER FROM COMPARTMENT 1C (600A). 2.2 INSTALL NEW BREAKER IN COMPARTMENT 1C (600A). 2.3 INSTALL NEW BREAKER IN COMPARTMENT 2D (300A). 3 REFERENCED DOCUMENTS: 3.1 H-2-46424 SH 1 REV 8 3.2 H-2-46424 SH 2 REV 2 4 PERMITS AND SPECIAL PROCEDURES: 4.1 N/A 5

MATERIALS AND EQUIPMENT REQUIRED: 5.1 300A BREAKER 5.2 600A BREAKER 6 PREREQUISITES: 6.1 IS A PREJOB SAFETY MEETING REQUIRED? PIC INITAL APPROPRIATE BLOCK. YES_____ NO_____ IF PREJOB IS REQUIRED,
CONDUCT A PREJOB SAFETY MEETING UTILIZING PREJOB SAFETY MEETING CHECKLIST. 6.2 IS A JOB HAZARD ANALYSIS
CHECKLIST REQUIRED? PIC INITIAL APPROPRIATE BLOCK. YES_____ NO_____ IF JHA IS REQUIRED, FILL IT OUT COMPLETELY AND INSURE IT IS SIGNED BY INDUSTRIAL HYGIENE. 6.3 THE WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES.
_____ _____ PIC/CRAFT MANAGER DATE 7 SPECIFIC WORK INSTRUCTIONS:
7.1 OPEN CLOSED BREAKERS ON MCC-E-001 IN 242-S TO UNLOAD BREAKER "1C". RECORD CLOSED BREAKERS ON CRAFT USAGE LOG SHEET. _____ _____ PIC SIGNATURE DATE 7.2 IF NECESSARY, POSITION THE AUTO TRANSFER SWITCH, F8-ATSZ TO EMERGENCY POWER. THIS WILL PROVIDE POWER TO PANEL "D" AND KEEP
PANEL "C" (ALARMS) ACTIVE (THE TRANSFER SWITCH IS POWER SEEKING AND CANNOT BACKFEED C8-S8 BREAKER 2D,
AND IT'S DESIGNED TO WORK UNDER LOAD). 7.3 OPEN BREAKER "1C" AT C8-S8 AND REMOVE. 7.4 INSTALL NEW BREAKER (600A) IN COMPARTMENT "1C". 7.5 PIC TO VERIFY CORRECT BREAKER IS INSTALLED. _____ _____ PIC SIGNATURE DATE 7.6 INSTALL NEW BREAKER (300A) IN COMPARTMENT "2D". 7.7 PIC TO VERIFY
CORRECT BREAKER IS INSTALLED _____ _____ PIC SIGNATURE DATE 7.8 ENERGIZE BREAKER "1C", CLOSE ALL BREAKERS AT MCC THAT WERE OPENED IN STEP #1, DOCUMENT ON J5. 7.9 IF NECESSARY,
ENERGIZE BREAKER "2D" (AUTOMATIC TRANSFER SWITCH "F8-ATSZ" SHOULD SWITCH TO NORMAL POWER). 8 RESTORATION ACTIONS: 8.1 PIC/SUPERVISOR RECORD ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL
WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) / WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. 9 POST-MAINTENANCE TESTING: 9.1 DOCUMENT WORK PERFORMED AND ANY
PROBLEMS ENCOUNTERED ON J-5. 10 OPERATIONAL FUNCTIONAL TEST: 10.1 CHECK FOR PROPER VOLTAGE AT 242-S MCC-E-OO1 AND AT THE AUTOMATIC TRANSFER SWITCH "F8-ATSZ". SEE RETEST J4-A QC INVOLVMENT - NONE QC
VERIFY RETEST N/A

Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 6 of 12

Work Package: 2W-94-00749 **ORIG DATE:** 7/6/94 **FIELD WORK COMPL DATE:** 7/25/94

WORK ITEM TITLE: 241-SX 701SX #1 COMPRESSOR AIR LEAK

Work Description:
***** SEE J-4A FOR RESOLUTION **** 1 SCOPE: 1.1 Replace head gasket on middle cylinder of #1 Ingersoll-Rand Air Compressor. 1.1.1 The Head Gasket, second from the top, is leaking air. 1.1.2 Replace both head gaskets. New Gaskets are in the maint shop at 272-WA. 2 DESCRIPTION: 2.1 Lock and Tag Air Compressor #1 and #2 Elect. 2.2 Lock and Tag discharge from Receiver Tank. 2.3 Bleed air from Receiver tank. 2.4 Remove and Replace head gaskets. 2.5 Remove Locks and Tags. 2.6 Run unit for leak check. 2.7 Return System to Operations. 3 REFERENCED DOCUMENTS: 3.1 Refer to Parts List for Type 30 Model 10T3NLME15, Ingersoll-Rand for breakdown. 4 PERMITS AND SPECIAL PROCEDURES: 4.1 N/A 5 MATERIALS AND EQUIPMENT REQUIRED: 5.1 2-27 Part Number 30294193 Gasket, Airhead-Low Pressure. 5.2 2-32 Part Number 37007747 Gasket, Airhead- Top/Bottom 5.3 Portable Air Compressor. 5.3.1 CAUTION: Sludge Cooler will shut down if Portable Air Compressor is not utilized. 6 PREREQUISITES: 6.1 IF REQUIRED CONDUCT A PRE-JOB SAFETY MEETING USING THE PRE-JOB SAFETY MEETING FORM, INCLUDE A HANFORD JOB HAZARD ANALYSIS IF NEEDED. 6.2 THE WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. _DONITHAN,MG_____ __7/25/94_____ PIC/CRAFT MANAGER DATE 6.3 Station Portable Air Compressor outside of 241-SX-701 and hook into system. 6.4 Suggested Lock and Tag: 6.4.1 On control panel "CP-SX-001" in 241- SX-701 bld. Place disconnect Switch "DS-SX-001 for CMP-SX-001" to the "OFF" Position and Lock and Tag. 6.4.2 On control panel "CP-SX-002" in 241- SX-701 bld. Place disconnect Switch "DS-SX-002 for CMP-SX-002" to the "OFF" Position and Lock and Tag. 6.4.3 Place Discharge Valve "241-SX-701-V-1" temp tag #W-0194 to the "CLOSED" Position and Lock and Tag. 6.4.4 Bleed Air Pressure from Receiver Tank. 6.5 Refer to Pressure Gages. Pressure to be at "0" PSIG before taking lines loose or loosening bolts. 7 SPECIFIC WORK INSTRUCTIONS: 7.1 Disconnect air lines on top of Air-Head. 7.2 Remove bolts from Head. 7.3 Replace gaskets. 7.4 Reassemble Unit. 8 *RESTORATION ACTIONS: 8.1* PIC/SUPERVISOR RECORD ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) / WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. 9 POST-MAINTENANCE TESTING: 9.1 DOCUMENT WORK PERFORMED AND ANY PROBLEMS ENCOUNTERED ON J-5. 10 OPERATIONAL FUNCTIONAL TEST: 10.1 Remove Locks and Tags. 10.2 Disconnect Portable Air Compressor. 10.3 Return Electrical Disconnects and Discharge Valve on #1 and #2 241-SX-701 Air Compressors to Operational condition. 10.4 Start Compressor #1 "CMP-SX-001". 10.5 Perform Leak Check of Gasket Areas and Air Lines. *AFTER REPAIR, RUN COMPRESSOR AND CHECK FOR AIR AND OIL LEAKS. QC INVOLVMENT - NONE RETEST* SATISFACTORY DONITHAN,MG 07/25/94 QC VERIFY RETEST N/A J-8 FUNCTIONAL RETEST COMPLETE TUCKER,RP 07/28/94

Work Package: 2W-94-00808 **ORIG DATE:** 7/15/94 **FIELD WORK COMPL DATE:** 6/22/95

WORK ITEM TITLE: 242-T REPLACE LOW SIDE P/S ON A/C UNIT

Work Description:
SEE J4-A FOR RESOLUTION 1 SCOPE: 1.1 REPLACE LOW SIDE PRESSURE SWITCH FOR A/C CARRIER UNIT AT 242-T. 2 DESCRIPTION: 2.1 REMOVE DEFECTIVE LOW SIDE PRESSURE SWITCH FROM CONDENSING UNIT. 2.2 INSTALL NEW PRESSURE SWITCH IN CONDENSING UNIT. 3 REFERENCED DOCUMENTS: 3.1 H-2-74831 SHEETS 1 AND 2. 4 PERMITS AND SPECIAL PROCEDURES: 4.1 N/A 5 MATERIALS AND EQUIPMENT REQUIRED: 5.1 LOW SIDE PRESSURE SWITCH, 6 PREREQUISITES: 6.1 IS A PREJOB SAFETY MEETING REQUIRED? PIC INITIAL APPROPRIATE BLOCK. YES_____ NO_____ IF PREJOB IS REQUIRED, CONDUCT A PREJOB SAFETY MEETING UTILIZING PREJOB SAFETY MEETING CHECKLIST. 6.2 IS A JOB HAZARD ANALYSIS CHECKLIST REQUIRED? PIC INITIAL APPROPRIATE BLOCK. YES_____ NO_____ IF JHA IS REQUIRED, FILL IT OUT COMPLETELY AND INSURE IT IS SIGNED BY INDUSTRIAL HYGIENE. 6.3 LOCK AND TAG EQUIPMENT 7 SPECIFIC WORK INSTRUCTIONS: 7.1 VERIFY ZERO POWER IS PRESENT PRIOR TO STARTING WORK. 7.2 DISCONNECT WIRING FROM LOW SIDE PRESSURE SWITCH (ONE WIRE HAS ALREADY BEEN DISCONNECTED). 7.3 REMOVE DEFECTIVE LOW SIDE PRESSURE SWITCH. 7.4 INSTALL NEW LOW SIDE PRESSURE SWITCH. 7.5 RECONNECT WIRING TO LOW SIDE PRESSURE SWITCH. 7.6 REMOVE LOCK/TAG AND RETURN A/C UNIT TO NORMAL OPERATION. 8 RESTORATION ACTIONS: 8.1 PIC/SUPERVISOR RECORD ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) / WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. 9 POST-MAINTENANCE TESTING: 9.1 DOCUMENT WORK PERFORMED AND ANY PROBLEMS ENCOUNTERED ON J-5. 10 OPERATIONAL FUNCTIONAL TEST: 10.1 VERIFY A/C UNIT OPERATES PROPERLY. SEE J4-A QC INVOLVMENT - NONE RETEST SATISFACTORY BANCROFT,WD 06/22/95 QC VERIFY RETEST N/A J-8 FUNCTIONAL RETEST COMPLETE N/A

Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 7 of 12

Work Package: 2W-94-00829 **ORIG DATE:** 7/27/94 **FIELD WORK COMPL DATE:** 8/18/94

WORK ITEM TITLE: 244-TX REPLACE K-6 RELAY

Work Description:

SEE J4-A FOR RESOLUTION 1 SCOPE: 1.1 REPLACE DEFECTIVE ALARM RELAY K-6 AT 244-TX WITH REBUILT ALARM
RELAY FROM SHOP. 1.2 REPLACE RE-BUILT ALARM RELAY K-6 AT 244-TX WITH NEW RELAY WHEN RECEIVED. 2 DESCRIPTION: 2.1 RELAY WAS FOUND TO BE DEFECTIVE. REPLACE WITH REBUILT RELAY UNTIL NEW RELAY IS RECIEVED. 3 REFERENCED DOCUMENTS: 3.1 H-2-73818 SH 1 REV 10 H-2-73832 REV 3 H-2-85316 SH 2 REV 0 H-2-27280 REV 1 4 PERMITS AND SPECIAL PROCEDURES: 4.1 N/A 5 MATERIALS AND EQUIPMENT REQUIRED: 5.1
REBUILT RELAY/NEW RELAY 6 PREREQUISITES: 6.1 IF REQUIRED CONDUCT A PRE-JOB SAFETY MEETING USING THE
PRE-JOB SAFETY MEETING FORM, INCLUDE A HANFORD JOB HAZARD ANALYSIS IF NEEDED. 6.2 THE WASTE PLANNING
CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. _DRAKULICH,KE_____ _8-1-94_____ PIC/CRAFT MANAGER DATE 7 SPECIFIC WORK INSTRUCTIONS: 7.1 REMOVE DEFECTIVE K-6 RELAY. 7.2 INSTALL NEW K-6 RELAY. 7.3 REPEAT STEPS 7.1 AND 7.2 WHEN NEW K-6 RELAY IS RECEIVED 8 RESTORATION ACTIONS: 8.1 PIC/SUPERVISOR RECORD ON THE J-5 THAT
THE JOB SITE HAS BEEN CLEANED AND ALL WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) / WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. 9 POST-MAINTENANCE TESTING: 9.1 DOCUMENT WORK PERFORMED AND ANY PROBLEMS ENCOUNTERED ON J-5. 10 OPERATIONAL FUNCTIONAL TEST: 10.1 PERFORM CBRS # 4T039 TO VERIFY PROPER OPERATION OF K-6 RELAY AND ASSOCIATED EQUIPMENT. SEE J4-A FOR RETEST QC INVOLVMENT - NONE RETEST SATISFACTORY YOUNGERMAN,SP 08/18/94 QC VERIFY RETEST N/A J-8 FUNCTIONAL RETEST COMPLETE OWEN,PL 08/23/94

Work Package: 2W-94-00888 **ORIG DATE:** 8/16/94 **FIELD WORK COMPL DATE:**

WORK ITEM TITLE: 241-SY REPLACE LEAK DETECTOR LIGHTS

Work Description:

1 SCOPE: 1.1 241-SY FLUSH PIT A AND B REPAIR LEAK DETECTOR 2 DESCRIPTION: 2.1 REPLACE ZONE LIGHTS 3
REFERENCED DOCUMENTS: 3.1 CBRS: SY054-1 AND SY055-1 3.2 DWGS: H2-37735 SH 2 REV 8 4 PERMITS AND SPECIAL PROCEDURES: 4.1 RWP: TF-001 REV 9 4.2 PRE-APPROVED PROCEDURES: 6-6F-055 5 MATERIALS AND EQUIPMENT REQUIRED: 5.1 2-ZONE LIGHTS 6 PREREQUISITES: 6.1 IF REQUIRED CONDUCT A PRE-JOB SAFETY MEETING USING THE PRE-JOB SAFETY MEETING FORM, INCLUDE A HANFORD JOB HAZARD ANALYSIS IF NEEDED. 6.2 THE
WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. _____ _____ PIC/CRAFT MANAGER DATE 6.3 USE OF PERSONAL LOCKING DEVICES AUTHORIZED: YES_____ NO_____ _____ _____ PIC/SUPERVISOR DATE ISOLATION POINTS VERIFIED AND PERSONAL LOCKING DEVICES AUTHORIZED BY SHIFT OPERATION MANAGER: _____ _____ SOM DATE 7 SPECIFIC WORK INSTRUCTIONS:
7.1 REPLACE 241-SY FLUSH PITS A AND B ZONE LIGHTS PER PROCEDURE 6-6F-055 8 RESTORATION ACTIONS: 8.1 PIC/SUPERVISOR RECORD ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) / WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. 9 POST-MAINTENANCE TESTING: 9.1 DOCUMENT WORK PERFORMED AND ANY PROBLEMS ENCOUNTERED ON J-5. 10 OPERATIONAL FUNCTIONAL TEST: 10.1 PERFORM CBRS SY054-1 AND SY055-1

Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 8 of 12

Work Package: 2W-94-01137 **ORIG DATE:** 10/13/94 **FIELD WORK COMPL DATE:**

WORK ITEM TITLE: *241-SX REPAIR 101-SX THERMOCOUPLES*

Work Description:

SCOPE: REPAIR 101-SX THERMOCOUPLES **********SEE J-4A FOR RESOLUTION********** 1 SCOPE: 1.1
REPAIR 101-SX THERMOCOUPLES 2 DESCRIPTION: 2.1 N/A 3 REFERENCED DOCUMENTS: 3.1 6-TF-191, REV 0, CHG 0 4 PERMITS AND SPECIAL PROCEDURES: 4.1 TF-002, REV 8 5 MATERIALS AND EQUIPMENT REQUIRED: 5.1
SHOP SPARE PARTS 6 PREREQUISITES: 6.1 PRE-JOB SAFETY MEETING IS REQUIRED. CONDUCT PRE- JOB SAFETY
MEETING UTILIZING PRE-JOB SAFETY MEETING CHECKLIST AND JOB HAZARD ANALYSIS CHECKLIST (JHA), INSURE INDUSTRIAL HYGIENE SIGNS JHA. PRE-JOB SAFETY MEETING CONDUCTED. _____ PIC SIGNATURE 6.2 THE
WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. _____ _____ PIC/CRAFT MANAGER DATE 7
SPECIFIC WORK INSTRUCTIONS: 7.1 NOTIFY SHIFT OPERATIONS OF INTENT TO PERFORM TASK. 7.2 PERFORM 6-TF-191. 7.3 MAKE APPROPRIATE REPAIRS FROM DATA GATHERED PERFORMING 6-TF-191. SHOP SPARE PARTS WILL
BE USED FOR REPAIRS. 7.4 RETEST PER 6-TF-191. 7.5 NOTIFY SHIFT OPERATIONS OF COMPLETION OF TASK. 8 RESTORATION ACTIONS: 8.1 PIC/SUPERVISOR RECORD ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL
WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) / WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. 9 POST-MAINTENANCE TESTING: 9.1 DOCUMENT WORK PERFORMED AND ANY
PROBLEMS ENCOUNTERED ON J-5. 10 OPERATIONAL FUNCTIONAL TEST: 10.1 N/A . AS STATED IN 6-TF-191 QC INVOLVMENT - NONE QC VERIFY RETEST N/A

Table C-4. Example of Information Available in JCS Database (Continued)

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Work Package: 2W-95-00139 **ORIG DATE:** 2/21/95 **FIELD WORK COMPL DATE:** 4/28/95

WORK ITEM TITLE: *244-U REPLACE FAILED BREAKER AND RELAYS*

Work Description:

REPLACE FAILED 15A BREAKER FOR SUMP PUMP P-244-2 AND LUM RELAY FOR TRANSFER PUMP P-244. SEE J4-A FOR BALANCE OF RESOLUTION. 1 SCOPE: 1.1 REPLACE DEFECTIVE 15A BREAKER AND LAM RELAY FOR THE SUMP AND
TRANSFER PUMPS AND LAM METERS FOR BOTH PUMPS AT 244-U. 2 DESCRIPTION: 2.1 REPLACE 15A BREAKER FOR
PORTABLE SUMP PUMP P-244-U-2 AT 244-U. 2.2 REPLACE THE LAM RELAY FOR TRANSFER PUMP P-244-U-1 AT 244-U. 2.3 REPLACE LAM METERS FOR SUMP AND TRANFER PUMPS AT 244-U. 3 REFERENCED DOCUMENTS: TYPE: 3.1
H-2-73819 SH 1 REV 9 DWG 3.2 H-2-73820 SH 1 REV 6 DWG 3.3 6-TF-052 PROC 4 PERMITS AND SPECIAL PROCEDURES: 4.1 N/A 5 MATERIALS AND EQUIPMENT REQUIRED:
**********NOTES********** >
PARTS ARE BEING DETICATED FOR USE THROUGH THE FOLLOWING QC INSPECTIONS. > IF DAMAGE IS DETECTED ON ITEMS, QC SHALL IDENTIFY PROBLEMS ON AN NCR. ENGINEERING WILL RESOLVE ALL PROBLEMS PRIOR TO ITEM ACCEPTANCE. ********** *QC* 5.1 VERIFY TWO (2) AMP METERS, VISIPAK V508-5004, HOLD DC DIGITAL DISPLAY, 0-1 VDC INPUT. 5.1.1 METER PART # V508-5004 YES___ NO___ 5.1.2 DAMAGED:
YES___ NO___ NCR#_____ _____ _____ QC SIGNATURE DATE *QC* 5.2 VERIFY ONE (1) WESTINGHOUSE 600VAC, 3 POLE, 15 AMP, HOLD STYLE #2607D80G04, HMCP015EO, 15 AMP BREAKER. 5.2.1 15 AMP
BREAKER STYLE #2607D80G04, HMCP015EO. YES___ NO___ 5.2.2 DAMAGED: YES___ NO___
NCR#_____ _____ _____ QC SIGNATURE DATE *QC* 5.3 VERIFY FOUR (4) ACTION PAK MODEL 1624-6064,DUAL AC HOLD LIMIT-ALARM, 0-1VAC INPUT, 120 VAC POWER. INSTRUMENT. 5.3.1 MODEL #1624-6064 YES___ NO___ 5.3.2 DAMAGED YES___ NO___ NCR#_____ _____
_____ QC SIGNATURE DATE 6 PREREQUISITES: 6.1 IS A PRE-JOB SAFETY MEETING REQUIRED? PIC INITIAL
APPROPRIATE BLOCK. YES _____ NO _____ 6.1.1 IF PRE-JOB IS REQUIRED, CONDUCT A PRE-JOB SAFETY MEETING UTILIZING PRE-JOB SAFETY MEETING CHECKLIST. 6.2. IS A JOB HAZARD ANALYSIS CHECKLIST REQUIRED? PIC INITIAL
APPROPRIATE BLOCK. YES _____ NO _____ 6.2.1 IF JHA IS REQUIRED, FILL IT OUT COMPLETELY AND INSURE IT IS SIGNED BY INDUSTRIAL HYGIENE. 6.3 THE WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. _____
_____ PIC/CRAFT MANAGER DATE **********NOTE********** THE STATMENT OF "STATION
PERSONNEL TO MONITOR DISCONNECT " IN STEPS 7.2 AND 8.3 OF PROC 6-TF-052, DOES NOT APPLY BECAUSE A PERSONAL LOCKING DEVICE WILL BE INSTALLED. ********** 6.4 USE OF PERSONAL LOCKING
DEVICES AUTHORIZED: YES_____ NO_____ _____ _____ PIC/SUPERVISOR DATE
6.4.1 ISOLATION POINTS VERIFIED AND PERSONAL LOCKING DEVICES AUTHORIZED BY SHIFT OPERATION MANAGER:
_____ _____ SOM DATE 7 SPECIFIC WORK INSTRUCTIONS:
**********NOTE********** THE FOLLOWING STEPS MAY BE WORKED IN ANY ORDER
********** 7.1 VERIFY ZERO ENERGY IS PRESENT PRIOR TO STARTING WORK. 7.2 DISCONNECT WIRING FROM DEFECTIVE LIMIT ALARM METER FOR TRANSFER PUMP P-244-U-1 AT 244-U. 7.3 REMOVE DEFECTIVE LIMIT ALARM METER FOR TRANSFER PUMP P-244-U-1. 7.4 INSTALL NEW LIMIT ALARM METER FOR TRANSFER PUMP P-244-U-1. 7.5 RE-CONNECT WIRING TO NEW LIMIT ALARM METER FOR TRANSFER PUMP P-244-U-1. 7.6 DISCONNECT WIRING FROM DEFECTIVE LIMIT ALARM METER FOR PORTABLE SUMP PUMP P-244-U-2 AT 244-U. 7.7 REMOVE DEFECTIVE LIMIT ALARM METER FOR PORTABLE SUMP PUMP P-244-U-2. 7.8 INSTALL NEW LIMIT ALARM METER FOR PORTABLE SUMP PUMP P-244-U-2. 7.9 RE-CONNECT WIRING TO NEW LIMIT ALARM METER FOR PORTABLE SUMP PUMP P-244-U-2. 7.10 REMOVE DEFECTIVE LIMIT ALARM MODULE FROM TRANSFER PUMP P-244-U-1 AT 244-U. 7.11 INSTALL NEW LIMIT ALARM MODULE FOR TRANSFER PUMP P-244-U-1. 7.12 DISCONNECT REQUIRED WIRING FROM 15 AMP BREAKER FOR PORTABLE SUMP PUMP P-244-U-2, IN MCC COMPARTMENT A2, AT 244-U. 7.13 REMOVE DEFECTIVE 15 AMP BREAKER, FOR PORTABLE SUMP PUMP P-244-U-2, IN MCC COMPARTMENT A2. 7.14 INSTALL NEW 15 AMP BREAKER FOR PORTABLE SUMP PUMP P-244-U-2 IN MCC COMPARTMENT A2. 7.15 RE-CONNECT WIRING TO NEW 15 AMP BREAKER FOR PORTABLE SUMP PUMP P-244-U-2 IN MCC COMPARTMENT A2. 7.16 PIC/SUPERVISOR RECORD ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) / WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. 8 RESTORATION ACTIONS: 8.1 REMOVE LOCK AND TAG. 9 POST-MAINTENANCE TESTING: 9.1 PERFORM PROC 6-TF-052. 9.2 SUMP PUMP LAM RELAY SET POINTS: HI 10.6 AMPS & LO 4.0 AMPS. 9.3 TRANSFER PUMP RELAY SET POINTS: HI 38 AMPS & LO 14 AMPS. NOTE: ENGINEERING, RICH LARSON PROVIDED THE INFORMATION ON THE SET POINTS. 10 OPERATIONAL FUNCTIONAL TEST: 10.1 N/A PERFORM PROC 6-TF-052. QC INVOLVMENT - NONE RETEST SATISFACTORY DRAKULICH,KE 04/28/95 J-8 FUNCTIONAL RETEST COMPLETE N/A

Table C-4. Example of Information Available in JCS Database (Continued)

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Work Package: 2W-95-00229 **ORIG DATE:** 3/28/95 **FIELD WORK COMPL DATE:**

WORK ITEM TITLE: 241-SY REPAIR SERVICE PIT RADIATION MONITOR

Work Description:
1 SCOPE: 1.1 TROUBLESHOOT AND REPAIR SY SERVICE PIT RIAS. 2 DESCRIPTION: 2.1 TWO PROBLEMS; MONITOR FAILED AND DETECTOR UNDER WATER 3 REFERENCED DOCUMENTS: 3.1 WT-00660 PM/S DATA SHEET 3.2 SHOP CVI DATA 4 PERMITS AND SPECIAL PROCEDURES: 4.1 TF-002 REV 9 RWP 4.2 CONFINED SPACES ENTRY PERMIT 5 MATERIALS AND EQUIPMENT REQUIRED: 5.1 N/A 6 PREREQUISITES: 6.1 PRE-JOB SAFETY MEETING IS REQUIRED. CONDUCT PRE- JOB SAFETY MEETING UTILIZING PRE-JOB SAFETY MEETING CHECKLIST AND JOB HAZARD ANALYSIS CHECKLIST (JHA), INSURE INDUSTRIAL SAFETY SIGNS JHA. PRE-JOB SAFETY MEETING CONDUCTED.
_____ PIC SIGNATURE 6.2 THE WASTE PLANNING CHECKLIST HAS BEEN PROVIDED AND THE CORRECT WASTE CONTAINERS ARE AVAILABLE TO PERFORM THE WORK ACTIVITIES. _____
_____ PIC/CRAFT MANAGER DATE 6.3 LOCK AND TAG WATER SOURCE TO SERVICE PIT. 6.4 USE OF
PERSONAL LOCKING DEVICES AUTHORIZED: YES_____NO_____ _____
_____ PIC/SUPERVISOR DATE ISOLATION POINTS VERIFIED AND PERSONAL LOCKING DEVICES AUTHORIZED BY SHIFT MANAGER. _____ _____ SHIFT OPERATIONS MANAGER DATE
7 SPECIFIC WORK INSTRUCTIONS: 7.1 OPERATIONS ENSURE SERVICE PIT IS DRAINED OF WATER. PIC SIGNATURE_____ DATE_____ 7.2 NOTIFY SHIFT OPERATIONS AND CASS OF INTENT TO PERFORM TASK. 7.3 REMOVE COMPONENTS TO SHOP FOR TROUBLESHOOT/REPAIR 7.3.1 REMOVAL OF TECHNICAL ASSSOCIATES LOG RATEMETER AND PWR SUPPLY. 7.3.1.1 DEENERGIZE INSTRUMENT RACK (STANDARD POWER CORD ON REAR OF POWER SUPPLY MODULE) 7.3.1.2 REMOVE RATEMETER AND POWER SUPPLY FROM RACK. 7.3.2 REMOVAL OF DETECTOR AND PRE-AMP: 7.3.2.1 REMOVE ACCESS TO 241-SY SERVICE PIT 7.3.2.2 HI VOLTAGE TO THE DETECTOR HAS BEEN REMOVED BY REMOVING THE TECHNICAL ASSOCIATES POWER SUPPLY IN THE 271-SY INST.BLDG. PERFORM ZERO ENERGY CHECK TO ENSURE NO POWER TO THE DETECTOR. 7.3.2.3 AFTER THE SERVICE PIT ACCESS HAS BEEN OPEN FOR 30 MINUTES, HAVE A RESPRITORY PROTECTION TECHNICIAN SNIFF FOR AMMONIA AND OVM MONITORING AND SUFFICIENT OXYGEN IN THE PIT. 7.3.2.4 ONCE THE RESPIRATORY PROTECTION TECHNICIAN VERIFIES A BREATHABLE ATMOSPHERE, ENTER 241-SY SERVICE PIT, REMOVE THE GM TUBE AND ELECTRONICS FROM THE DETECTOR HOUSING BY REMOVING THE FOUR SCREWS AT THE REAR OF THE HOUSING. REMOVE THE PRE-AMP, LOCATED ON THE PIT WALL BEHIND THE DETECTOR. CAUTION: THE INTERNALS OF THE DETECTOR ARE HARD WIRED TO THE PLUG MOUNTED ON THE HOUSING END CAP. THE HOUSING END CAP IS A LEAD FILLED PLUG WHICH MUST REMAIN WITH THE INTERNAL
COMPONENTS 7.3.2.5 EXIT THE PIT AND REPLACE 241-SY SERVICE PIT ACCESS COVER. 7.4 TROUBLESHOOT AND REPAIR THE DETECTOR AND ELECTRONIC MODULES, AS REQUIRED, IN ACCORDANCE WITH THE SHOP CVI FILES AND STANDARD TROUBLESHOOTING PRACTICES 7.5 RETURNING SYSTEM TO SERVICE IN THE FIELD. 7.5.1 REPLACE DETECTOR: 7.5.1.1 REMOVE ACCESS TO 241-SY SERVICE PIT 7.5.1.2 AFTER THE SERVICE PIT ACCESS HAS BEEN OPEN
FOR 30 MINUTES, HAVE A RESPRITORY PROTECTION TECHNICIAN SNIFF FOR SUFFICIENT OXYGEN IN PIT. 7.5.1.3 ONCE
THE RESPIRATORY PROTECTION TECHNICIAN VERIFIES A BREATHABLE ATMOSPHERE, ENTER 241-SY SERVICE PIT, REINSTALL THE GM TUBE, ELECTRONICS AND THE END CAP. REINSTALL THE PRE-AMP ON PIT WALL. 7.5.1.4 EXIT THE PIT
AND REPLACE 241-SY SERVICE PIT ACCESS COVER. 7.5.2 REPLACE RATEMETER AND POWER SUPPLY IN THE INSTRUMENT RACK IN THE 271-SY INSTRUMENT BUILDING AND ENERGIZE EQUIPMENT. ALLOW APPROXIMATELY 30 MINUTE
WARMUP PERIOD. 7.6 NOTIFY SHIFT OPERATIONS AND CASS OF COMPLETION OF TASK 7.7 PIC/SUPERVISOR RECORD
ON THE J-5 THAT THE JOB SITE HAS BEEN CLEANED AND ALL WASTE PROPERLY CONTAINERIZED PER TO-100-052 (RADIOACTIVE/CONTAMINATED) / WHC-IP-0842, SEC. 16.1 (NON-RADIOACTIVE), AS APPLICABLE. 8 RESTORATION ACTIONS: 8.1 REMOVE LOCK AND TAG FROM WATER SOURCE TO SERVICE PIT 9 POST-MAINTENANCE TESTING: 9.1
PERFORM PM/S DATA SHEET, WT-00660. 10 OPERATIONAL FUNCTIONAL TEST: 10.1 N/A .

Work Package: 2W-96-00524 **ORIG DATE:** 5/22/96 **FIELD WORK COMPL DATE:** 7/8/96

WORK ITEM TITLE: 241-SY 101-SY FIC

Work Description:

Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 11 of 12

Work Package: 2W-96-00749 **ORIG DATE:** 7/16/96 **FIELD WORK COMPL DATE:** 7/19/96

WORK ITEM TITLE: 241-SY REPLACE EMPTY GMS-2 NITROGEN BOTTLE

Work Description:
REPLACE EMPTY PRE-PURIFIED, ULTRA-HIGH NITROGEN BOTTLE WITH SAME.

Work Package: 2W-96-01453 **ORIG DATE:** 12/17/96 **FIELD WORK COMPL DATE:** 12/20/96

WORK ITEM TITLE: 241-TX/TY TROUBLESHOOT AIR COMPRESSOR

Work Description:

Work Package: 2W-97-00126 **ORIG DATE:** 2/5/97 **FIELD WORK COMPL DATE:** 2/24/97

WORK ITEM TITLE: 241-TX REPAIR ELECTRICAL DIST. PANEL

Work Description:

Work Package: 2W-97-00178 **ORIG DATE:** 1/29/97 **FIELD WORK COMPL DATE:**

WORK ITEM TITLE: 241-UX-302A LEAK DETECTOR REPAIR

Work Description:
TROUBLESHOOT/REPAIR ALARM. IF PARTS ARE NEEDED, CONTACT PLANNING FOR BOM. IF LOCK AND TAG OR PLD IS
NEEDED, CONTACT PIC, PLANNING OR SHIFT MANAGER. 1. NOTIFY SHIFT OPERATIONS AND CASS OF INTENT TO PERFORM TASK. 2. TROUBLESHOOT AND REPAIR ALARM AS NEEDED. 3. NOTIFY SHIFT OPERATIONS AND CASS OF COMPELTION OF TASK.

Work Package: 2W-97-00182 **ORIG DATE:** 2/12/97 **FIELD WORK COMPL DATE:** 5/21/97

WORK ITEM TITLE: 241-SY REPLACE PAS-103-1

Work Description:
1. CALIBRATE NEW SWITCH PER PM/S DATA SHEET AND PROCEDURE. 2. NOTIFY SHIFT OPERATION AND CASS OF INTENT
TO PERFORM TASK. 3. VERIFY LOCK AND TAG INSTALLED AND PERFORM ZERO ENERGY CHECK ON WIRING FOR SWITCH. ********** USE OF LOCK & TAG WITHOUT CONTROLLING ORGANIZATION
LOCK & TAG AUTHORIZED: YES_____ NO_____ SINGLE POINT OF ISOLATION TO BE LOCKED OUT:
_____ _____ _____ PIC/SUPERVISOR
DATE ISOLATION POINT VERIFIED AND LOCK & TAG WITHOUT CONTROLLING ORGANIZATION LOCK & TAG AUTHORIZED BY SHIFT MANAGER. _____ _____ SHIFT OPERATIONS MANAGER
DATE JM HAY_____05-21-97_____ SAFETY CONDITION CHECK SATISFACTORY
********** 4. REMOVE FAILED SWITCH AND INSTALL NEW, CALIBRATED SWITCH.
5. REMOVE LOCK AND TAG AND PERFORM FUNCTION CHECK OF SWITCH. 6. NOTIFY SHIFT OPERATIONS AND CASS OF
COMPLETION OF TASK. .

Table C-4. Example of Information Available in JCS Database (Continued)

Sheet 12 of 12

Work Package: 2W-97-00323 **ORIG DATE:** 3/7/97 **FIELD WORK COMPL DATE:** 7/16/97

WORK ITEM TITLE: 272-WA FITTER SUPPORT FOR FEP DEFICIENCIES

Work Description:
FITTER REPAIRS LIST, BUT NOT LIMITED TO; 1. REPAIR LEAKING SHOWER HEADS IN MENS ROOM. 2. LUNCHROOM, FAUCET ON SINK (WHEN FACING SINK WALL IT ON THE RIGHT) DRIPS. REPLACE WASHERS ETC AS NEEDED. 3. REPLACE/REPAIR FAUCET ASSEMBLY ON THE LEFT HAND SINK. THE HANDLES WORK BACKWARDS. 4. REPAIR OLD WELD SHOP SINK. DOCUMENT REPAIRS ON J-5.

Work Package: 2W-97-00694 **ORIG DATE:** 6/3/97 **FIELD WORK COMPL DATE:** 6/4/97

WORK ITEM TITLE: 242-S TROUBLESHOOT/REPAIR PI-TK-1 FOR 244-S

Work Description:

Work Package: 2W-97-00739 **ORIG DATE:** 6/17/97 **FIELD WORK COMPL DATE:** 6/19/97

WORK ITEM TITLE: 244-TX REPLACE RAW WATER FILTER

Work Description:
1. NOTIFY SHIFT OPERATIONS OF INTENT TO PERFORM TASK. 2. VERIFY VALVE RW-7, LOCATED ON BACKSIDE OF F-1,
IS CLOSED. 3. CLOSE VALVE RW-6, LOCATED INLINE WITH F-1. 4. REPLACE F-1 FILTER WITH SHOP STOCK SPARE. 5. OPEN VALVE RW-6. 6. CHECK FOR ANY LEAKS AND TIGHTEN FITTINGS AS NEEDED. 7. LEAVE VALVE RW-7 CLOSED AS
FOUND. 8. NOTIFY SHIFT OPERATIONS OF COMPLETION OF TASK. .

Work Package: 2W-97-00920 **ORIG DATE:** 8/7/97 **FIELD WORK COMPL DATE:** 8/8/97

WORK ITEM TITLE: 241-SY TROUBLESHOOT GMS-2 AIR COMPRESSOR

Work Description:

Table C-5. Sample Evaluation of JCS Database for Applicability to WFDS Activities

Event ID	Origination Date	Complete Date	WORK PACKAGE TITLE	Failure/Error Mode Code	Failure Effect	Applicability of Evidence for RAM Quantification	Rationale	Comp Type	Safety Related Equipment?	Intrusive to Containment Barrier?	Restoration Time (hours)	Restoration Time Rationale
2W-93-00296	3/30/1993	6/28/1993	241-SY-101 SHMS-L SAMPLE PUMP REPLACEMENT	MDP-FS-C	Potential Delay	Indirect	A gas chromatograph system exists for hydrogen monitoring on Phase 1 systems. It is required that this equipment be operational for waste transfers.	P	Yes	Yes	2160	Based on time from identification to work package field work complete.
2W-93-00306	4/5/1993	5/4/1993	241-TX CALIBRATE 101-TX LIT	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2W-93-00427	5/7/1993	7/13/1993	241-S T/S AND REPAIR RAMP 1 FAILED TO RESPOND,	RST-FA-I	Insignificant	Indirect	Failure of area radiation monitors would not delay an ongoing waste transfer.	RM	Yes	No	1608	Based on time from identification to work package field work complete.
2W-93-00573	6/9/1993		241-SY REPAIR 101-SY VIDEO CAM. PAN & TILT	TFI-FA-E	Insignificant	Indirect	Similar equipment is also included in Phase 1 systems but is not germane to transfer operations.	TV	No	No	Unknown	No field work complete time in database.
2W-93-00750	8/4/1993	5/25/1995	241-SX REPLACE PIPING NORTH CAB. SLUDGE COOLER STEAM	PIP-LE-C	Insignificant	None	This equipment is not included in the Phase 1 design.	PIPE				

Table C-5. Sample Evaluation of JCS Database for Applicability to WFDS Activities (Continued)

Event ID	Origination Date	Complete Date	WORK PACKAGE TITLE	Failure/Error Mode Code	Failure Effect	Applicability of Evidence for RAM Quantification	Rationale	Comp Type	Safety Related Equipment?	Intrusive to Containment Barrier?	Restoration Time (hours)	Restoration Time Rationale
2W-93-00882	9/23/1993		242-S TRBSHT/REPR RAW WTR & STM HI RAD ALA G13	ALR-NR-I	Insignificant	None	This is evaporator equipment.	RA				
2W-94-00022	1/4/1994		241-SY REWIRE LEAK DETECTORS	UST-FA-I	Potential Delay	Indirect	Similar leak detector repairs could be necessary for Phase 1 systems.	LDE	Yes	Yes	Unknown	No field work complete time in database.
2W-94-00473	4/8/1994		242-S REPLACE 1C AND 2D BRKRS ON C8-S8 SWGR	ATS-NR-E	Potential Delay	Indirect	Although this is evaporator equipment, similar equipment exists for Phase 1 systems.	ES	No	No	Unknown	No field work complete time in database.
2W-94-00749	7/6/1994	7/25/1994	241-SX 701SX #1 COMPRESSOR AIR LEAK	CMP-FR-C	Potential Delay	Indirect	Although compressors are not listed as separate components in the Phase 1 design, they are incorporated as parts of larger systems whose failure could impact waste transfer operations.	CMP	No	No	456	Based on time from identification to work package fieldwork complete.

Table C-5. Sample Evaluation of JCS Database for Applicability to WFDS Activities (Continued)

Event ID	Origination Date	Complete Date	WORK PACKAGE TITLE	Failure/Error Mode Code	Failure Effect	Applicability of Evidence for RAM Quantification	Rationale	Comp Type	Safety Related Equipment?	Intrusive to Containment Barrier?	Restoration Time (hours)	Restoration Time Rationale
2W-94-00808	7/15/1994	6/22/1995	242-T REPLACE LOW SIDE P/S ON A/C UNIT	ACU-FR-H	Insignificant	Indirect	Air conditioning units exist for Phase 1 systems but are not crucial to continuing waste transfers.	ACU	No	No	8208	Based on time from identification to work package field work complete.
2W-94-00829	7/27/1994	8/18/1994	244-TX REPLACE K-6 RELAY	RLC-NR-E	Potential Delay	Indirect	Similar equipment exists for Phase 1 systems.	ES	No	No	528	Based on time from identification to work package field work complete.
2W-94-00888	8/16/1994		241-SY REPLACE LEAK DETECTOR LIGHTS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2W-94-01137	10/13/1994		241-SX REPAIR 101-SX THERMOCOUPLES	TST-FA-I	Insignificant	Indirect	It is not clear what the thermocouples pertained to for this effort.	TE	Unknown	Unknown	Unknown	No field work complete time in database.
2W-95-00139	2/21/1995	4/28/1995	244-U REPLACE FAILED BREAKER AND RELAYS	RLC-NR-E	Potential Delay	Indirect	Similar equipment exists for Phase 1 systems.	ES	No	No	1584	Based on time from identification to work package field work complete.

Table C-5. Sample Evaluation of JCS Database for Applicability to WFDS Activities (Continued)

Event ID	Origination Date	Complete Date	WORK PACKAGE TITLE	Failure/Error Mode Code	Failure Effect	Applicability of Evidence for RAM Quantification	Rationale	Comp Type	Safety Related Equipment?	Intrusive to Containment Barrier?	Restoration Time (hours)	Restoration Time Rationale
2W-95-00229	3/28/1995		241-SY REPAIR SERVICE PIT RADIATION MONITOR	RST-FA-I	Insignificant	Indirect	This equipment, if it exists for Phase 1 systems, is not crucial for waste transfers.	RM	No	No	Unknown	No field work complete time in database.
2W-96-00524	5/22/1996	7/8/1996	241-SY 101-SY FIC	TRM-FA-I	Potential Delay	Indirect	Similar equipment exists for Phase 1 systems.	LE	Yes	Yes	1128	Based on time from identification to work package field work complete.
2W-96-00749	7/16/1996	7/19/1996	241-SY REPLACE EMPTY GMS-2 NITROGEN BOTTLE	N2S-FA-F	Insignificant	Indirect	This type of gas monitoring equipment does not appear to be part of the Phase 1 system design. Other nitrogen support equipment is included and is usually duplicated.	N2	No	No	72	Based on time from identification to work package field work complete.

Table C-5. Sample Evaluation of JCS Database for Applicability to WFDS Activities (Continued)

Event ID	Origination Date	Complete Date	WORK PACKAGE TITLE	Failure/Error Mode Code	Failure Effect	Applicability of Evidence for RAM Quantification	Rationale	Comp Type	Safety Related Equipment?	Intrusive to Containment Barrier?	Restoration Time (hours)	Restoration Time Rationale
2W-96-01453	12/17/1996	12/20/1996	241-TX/TY TROUBLESHOOT AIR COMPRESSOR	CMP-FR-C	Potential Delay	Indirect	Although compressors are not listed as separate components in the Phase 1 design, they are incorporated as parts of larger systems whose failure could impact waste transfer operations.	CMP	No	No	72	Based on time from identification to work package field work complete.
2W-97-00126	2/5/1997	2/24/1997	241-TX REPAIR ELECTRICAL DIST. PANEL	TFI-FA-E	Potential Delay	Indirect	An electrical distribution failure of this magnitude would shutdown and delay waste transfer operations.	EY	No	No	456	Based on time from identification to work package field work complete.
2W-97-00178	1/29/1997		241-UX-302A LEAK DETECTOR REPAIR	UST-FA-I	Potential Delay	Indirect	Similar leak detector repairs could be necessary for Phase 1 systems.	LDE	Yes	Yes	Unknown	No field work complete time in database.

Table C-5. Sample Evaluation of JCS Database for Applicability to WFDS Activities (Continued)

Event ID	Origination Date	Complete Date	WORK PACKAGE TITLE	Failure/Error Mode Code	Failure Effect	Applicability of Evidence for RAM Quantification	Rationale	Comp Type	Safety Related Equipment?	Intrusive to Containment Barrier?	Restoration Time (hours)	Restoration Time Rationale
2W-97-00182	2/12/1997	5/21/1997	241-SY REPLACE PAS-103-1	PST-FA-I	Potential Delay	Indirect	Similar equipment exists for Phase 1 systems. If this item were tied into the master pump shutdown circuit, transfer could not occur.	PS	Yes	No	2376	Based on time from identification to work package field work complete.
2W-97-00323	3/7/1997	7/16/1997	272-WA FITTER SUPPORT FOR FEP DEFICIENCIES	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2W-97-00694	6/3/1997	6/4/1997	242-S TROUBLESHOOT/REPAIR PI-TK-1 FOR 244-S	IND-FA-I	Potential Delay	Indirect	Failure during transfer of a pressure indicator would be cause for delaying transfer operations if it were related to tank dome pressure or transfer line pressure.	PI	No	No	24	Based on time from identification to work package field work complete.
2W-97-00739	6/17/1997	6/19/1997	244-TX REPLACE RAW WATER FILTER	FLT-PG-H	Insignificant	Indirect	Failure of the raw water filter, even during use, would probably not incur a delay in transfer activities.	FLT	No	No	48	Based on time from identification to work package field work complete.

Table C-5. Sample Evaluation of JCS Database for Applicability to WFDS Activities (Continued)

Event ID	Origination Date	Complete Date	WORK PACKAGE TITLE	Failure/Error Mode Code	Failure Effect	Applicability of Evidence for RAM Quantification	Rationale	Comp Type	Safety Related Equipment?	Intrusive to Containment Barrier?	Restoration Time (hours)	Restoration Time Rationale
2W-97-00920	8/7/1997	8/8/1997	241-SY TROUBLESHOOT GMS-2 AIR COMPRESSOR	CMP-FR-C	Potential Delay	Indirect	Although compressors are not listed as separate components in the Phase 1 design, they are incorporated as parts of larger systems whose failure could impact waste transfer operations.	CMP		No	24	Based on time from identification to work package field work complete.

Table C-6a. Summary Input for Bayesian Update of Waste Transfer Pump Hanford Specific Failure Rates

Generic Pump Data

Failure Mode	Mean Failure Rate	Range Factor (95/50)	SRS Variable
Failure to Run	1.0E-04	10	MDP-FR-C
Fails to Start	1.0E-02	10	MDP-FS-C

Definition of Prior Distributions	Non Catastrophic Failures	Catastrophic Failures
Apportionment between Non-Catastrophic and Catastrophic Failures	80%	20%
Prior Median Failure to Run	3.0E-05	7.6E-06
Prior Median Failure to Start	3.0E-03	7.6E-04

Site-Specific Operating History

				RPP RAM Variable	
Waste Feed Pump Data	Experience	Non Catastrophic Failures	Catastrophic Failures	Non Catastrophic Failures	Catastrophic Failures
Total Transfers	61				
Starts (demands)	137	4	0	WFP-FR-1	WFP-FR-2
Run Time (hours)	2338	2	0	WFP-FS-1	WFP-FS-2

Table C-6b. Results of Bayesian Update of Waste Transfer Pump Hanford Specific Failure Rates

Name	Description	Events	Time/ Demands	Prior Mean	Mean	5th%ile...	Median	95th%ile..
PFPFR1	PRIOR - NON CATASTROPHIC FAILURE TO RUN			N/A	8.11E-05	3.10E-06	3.04E-05	2.99E-04
PFPFR2	PRIOR - CATASTROPHIC FAILURE TO RUN			N/A	2.02E-05	7.74E-07	7.59E-06	7.45E-05
PFPFS1	PRIOR - NON CATASTROPHIC FAILURE TO START			N/A	8.11E-03	3.10E-04	3.04E-03	2.99E-02
PFPFS2	PRIOR - CATASTROPHIC FAILURE TO START			N/A	2.02E-03	7.74E-05	7.59E-04	7.45E-03
WFPFR1	NON CATASTROPHIC FAILURE TO RUN	2.00E+00	2.34E+03	8.11E-05	3.79E-04	5.48E-05	2.84E-04	1.02E-03
WFPFR2	CATASTROPHIC FAILURE TO RUN	0.00E+00	2.34E+03	2.02E-05	1.68E-05	7.44E-07	7.14E-06	6.37E-05
WFPFS1	NON CATASTROPHIC FAILURE TO START	4.00E+00	1.37E+02	8.11E-03	2.23E-02	7.33E-03	2.03E-02	4.44E-02
WFPFS2	CATASTROPHIC FAILURE TO START	0.00E+00	1.37E+02	2.02E-03	1.13E-03	6.68E-05	5.85E-04	4.04E-03

Table C-6c. Transfer History Supporting Waste Transfer Pump Site Specific Evidence for Bayesian Update

Facility/ PIT #	Date Installed	Number of Transfers Since 1990	Number of Starts	Run Time (hrs)	Non-Cat. Failure to Start	Non-Cat. Failure to Run	Cat. Failure to Start	Cat. Failure to Run	Comments (See also general comments below)
AN-01A	9/10/1981	1	2	115		1			1 restart due to loss of level indication
AN-02A	8/3/1982	0	0	0					No logged transfers since 1990
AN-03A	12/27/1982	0	0	0					No logged transfers since 1990
AN-04A	8/4/1982	0	0	0					No logged transfers since 1990
AN-05A	5/21/1984	0	0	0					No logged transfers since 1990
AN-06A	3/19/1992	3	10	45	2	3			1 failure to start due to faulty valve pit valve position indication, one shutdown due to catch tank level increase, 2 MPSD signals, and one shutdown for unknown reasons. One transfer noted "numerous" aborted starts, we assumed five aborted starts.
AN-07A	Unknown	0	0	0					No logged transfers since 1990
AP-01A	7/6/1988	4	18	68					Two completed transfers and two aborted transfers. For two completed transfers there were four MPSD shutdowns, a line pluggage shutdown, and a shutdown due to conflict with other work. For aborted transfers there were 8 failed attempt to start the pump, two MPSD signals, and a management directed shutdown due to discovered calculation errors.
AP-02D	6/9/1988	0	0	0					No logged transfers since 1990
AP-03A	6/1/1986	1	2	22					1 MPSD signal received.
AP-04A	3/11/1988	1	1	99					No problems noted
AP-05A	6/1/1988	3	6	189					2 MPSD signals received and one mass balance calculation error. 1 transfer with no problems noted.
AP-06A	1/15/1989	2	3	128					One shutdown due to unknown reasons.
AP-07A	1994	5	8	215					Three transfers with no problems noted. One line high pressure signal, one MPSD signal and one mass balance discrepancy shutdown
AP-08A	1994	5	6	227					4 transfers with no problems noted, one MPSD signal received.
AW-01A	12/19/1984	0	0	0					No logged transfers since 1990
AW-02E	1/27/1989	0	0	0					No logged transfers since 1990
AW-03A	10/17/1984	0	0	0					No logged transfers since 1990
AW-04A	9/15/1982	0	0	0					No logged transfers since 1990

Table C-6c. Transfer History Supporting Waste Transfer Pump Site Specific Evidence for Bayesian Update (Continued)

Facility/ PIT #	Date Installed	Number of Transfers Since 1990	Number of Starts	Run Time (hrs)	Non-Cat. Failure to Start	Non-Cat. Failure to Run	Cat. Failure to Start	Cat. Failure to Run	Comments (See also general comments below)
AW-05A	10/19/1988	4	7	161					Two transfers with valve pit valve/jumper leakage and no restarts. Two transfer with two MBD discrepancy shutdowns each. One transfer with no problems noted.
AW-06A	7/28/1988	27	60	922					13 transfers with no problems noted. Other fourteen transfers restart for MPSD signals, mass balance deviations, motor problems, other alarms and unknown reasons.
AY-01D	Unknown	3	10	85					Assume all complete AY-101 transfers were with this pump. One transfer with 2 MPSD and 1 unknown shutdown, one transfer with level indicator shutdown, and one transfer with leak detector shutdown.
AY-02D	10/14/1986	2	4	62					One transfer with MPSD signal and one with other work conflict.
AZ-01C	3/27/1986	0	0	0					No logged transfers since 1990
AZ-02B	12/20/1985	0	0	0					No logged transfers since 1990
AZ-02C	10/21/1983	0	0	0					No logged transfers since 1990
SY-01A RISER 3A	Unknown	0	0	0					No logged transfers since 1990
SY-01A RISER 12A	Unknown	0	0	0					No logged transfers since 1990
SY-02A	12/30/1985	0	0	0					No logged transfers since 1990
SY-02E	8/8/1979	0	0	0					No logged transfers since 1990
SY-03A	7/16/1980	0	0	0					No logged transfers since 1990
Totals		61	137	2338	2	4	0	0	

NOTES:
For calculation purposes assume no "bumping" of pumps has occurred since 1990.
When interruptions occurred, assumed total gallons divided by 140 gallons per minute unless fewer hours are already indicated in transfer record.

Table C-6d. Available Waste Transfer Pump History

Facility/ PIT #	Pump #	Pump Type	Date Install	Date Remove	PROP. #	Assembly Drwg. #	Manuf.	P.O. #	HP	RPM	Length	Shft Dia.	Bearing Material	CBS Inch	STA	Rtd Flow GPM	Rtd Tdh ft	Dead Head ft	Curv Max gpm	Failure Reason Given
AN-01A	202P-TX1	vt	9/10/1981	active	F258557		Floway	26455	20	3500	48' 11"	1	Metallized graph	60	5	90	250	310	225	
AN-02A	65P-TX4	vt	8/3/1982	active	F258608		Wilkins	26503	30	3450	49' 0 1/2"	1	Ni-filled graphite		6	150	280			
AN-03A	211P-TX1	vt	12/27/1982	active	F258603		Wilkins	26503	22.5	3450	49' 0"	1	Ni-filled graphite		7	90	300	380	170	
AN-04A	64P-TX4	vt	8/4/1982	active	F258607		Wilkins	26503	30	3450	49' 0 1/2"	1	Ni-filled graphite		6	150	280			
AN-05A	84P-TX4/6P-TX6	vt	5/21/1984	active			Floway	294079	20	1760	49' 0 3/8"	1.25	Ni-filled graphite	45	27	100	281			
AN-06A	2P-TX1-XCF	vt	3/19/1992	active	F263783		Floway	419574	25	3500	49' 0 3/8"	1.25	Ni-filled graphite	29.5	7	100	300	360	190	
AN-07A	OPEN																			
AP-01A	1P-AP-4	vt, ff	7/6/1988	active	F263558		Goulds	325751	30	3500	33' 0"	1	Ni-impreg graphite		7	140	300	330	180	
AP-02A	1P-PSM-001	sub, mix	7/22/1987	failed			Hazleton		150				N/A	N/A	1					
AP-02D	1P-TX1-XCF	vt, sw	6/9/1988	active	F263782		Floway	419574	30	3500	44' 7"	1.25	Ni-filled graphite	29.5	7					
AP-03A	2P-AP-3	vt	6/1/1986	active	F263562		Goulds	325751	30	3500	49' 0 3/8"	1	Ni-impreg graphite		7	140	300	330	180	
AP-04A	4P-AP-3	vt	3/11/1988	active	F263564		Goulds	325751	30	3500	49' 0 3/8"	1	Ni-impreg graphite		7	140	300	330	180	
AP-05A	1P-AP-3	vt	6/1/1988	active	F263561		Goulds	325751	30	3500	49' 0 3/8"	1	Ni-impreg graphite		7	140	300	330	180	
AP-06A	2P-AP-4	vt, ff	1/15/1989	active	F263559		Goulds	325751	30	3500	33' 0"	1	Ni-impreg graphite		7	140	300	330	180	
AP-07A	2P-TX4-XCR-1	vt	1994	active	F266001		Floway	481394	30	3500	49' 0 3/8"	1.25	Chr-oxide coated	48 max	6	160	295	340	280	
AP-08A	1P-TX4-XCR-1	vt	1994	active	F266000		Floway	481394	30	3500	49' 0 3/8"	1.25	Chr-oxide coated	48 max	6	160	295	340	280	
AW-01A	205P-TX1	vt	10/14/1981	4/30/1984	F258597		Wilkins	26503	22.5	3450		1	Metal-impreg graph		7	100	300	380	170	shaft seizure, PE-017
AW-01A	70P-TX4	vt	5/1/1984	6/18/1984	F258613		Wilkins	26503	30	3450	45'	1	Metal-impreg graph		6	150	280			
AW-01A	101AW-S	sub, tan	6/30/1984	12/19/1984	none		Flygt 2060		3.7	3300	49'		N/A	N/A	2	58	134	154		rubber disch. hose severed, PE-023
AW-01A	85P-TX4/7P-TX6	vt	12/19/1984	active	F261994		Floway	294079	20	1750	49' 0 3/8"	1.25	Ni-filled graphite	45	27	100	281			
AW-02E	48P-TX4	vt	4/4/1980	11/21/1983	F258540		Floway	26455	25	3600	45'	1	Metallized graph	60	4	160	170	295	270	shaft seizure

Table C-6d. Available Waste Transfer Pump History (Continued)

Facility/ PIT #	Pump #	Pump Type	Date Install	Date Remove	PROP. #	Assembly Drwg. #	Manuf.	P.O. #	HP	RPM	Length	Shft Dia.	Bearing Material	CBS Inch	STA	Rtd Flow GPM	Rtd Tdh ft	Dead Head ft	Curv Max gpm	Failure Reason Given
AW-02E	102-1 (PTX-4)	vt	11/22/1983	7/26/1985	F262951	H-9-1021	Floway	212188	25	1750	45' 3 3/8"	1.25	Ethylene propylene		27	80	342	475	140	leak from top seal
AW-02E	71P-TX4	vt	7/26/1985	1/7/1986			Floway	294079	20	1760	45' 3 3/8"	1.25	Ni-filled graphite	45	26	100	277			shaft seizure
AW-02E	73P-TX4	vt	1/9/1986	3/6/1986	F262305		Floway	359040	20	1760	45' 3 3/8"	1.25	Ethylene propylene	45	26	95	330	470		shaft seizure
AW-02E	77P-TX4/4P-TX5	vt	3/12/1986	1/27/1989	F262301		Floway	359040	20	1760	45' 3 3/8"	1.25	Ni-filled graphite	45	26	100	280			leak from top seal
AW-02E	78P-TX4/5P-TX5	vt	1/27/1989	active	F261993		Floway	359040	20	1760	45' 3 3/8"	1.25	Ni-filled graphite	45	26	100	279	456		
AW-03A	206P-TX1	vt	12/3/1981	3/16/1983	F258598		Wilkins	26503	22.5	3450	48' 11"	1	Metal-impreg graph		7	100	300	380	170	shaft seizure
AW-03A	103AW-S	sub	9/23/1983	6/11/1984	none		Flygt		3.7	3300	47' 6"		N/A		1	50	70	80		
AW-03A	86P-TX4/8P-TX6	vt, ff	10/17/1984	active			Floway	294079	20	1760	33'	1.25	Ni-filled graphite	45	27	100	281			
AW-04A	80P-TX4	vt, oil, sw	9/15/1982	failed	F261984		Floway	212149	20	1760	49' 0 3/8"		Cast iron		27	100	281	460	120	broken shaft
AW-05A	120-P10	vt	4/4/1983	5/18/1984	F258210		Floway	83251	7.5	3500	49'	1	Ni-chrome alloy	60	2	75	115	130	218	shaft seizure
AW-05A	105AW-S	sub	6/4/1984	1/3/1985	N/A		Flygt		3.7	3300	49'		N/A	N/A	1					
AW-05A	75P-TX4/2P-TX5	vt, ff	4/30/1985	10/19/1988	F261999		Floway	359040	20	1760	47' 3 3/8"	1.25	Ethylene propylene	45	26	100	279			shaft seizure
AW-05A	1P-TX1	vt, ff	10/19/1988	active	F263871		Floway	423823	30	3500	33' 0 1/4"	1.25	Chr-oxide coated	48 max	7	100	300	360	190	
AW-06A	189P-TX1	vt	6/2/1980	1/15/1985	F258062		Doric		20		48'				6	90	245	320		shaft seizure
AW-06A	53P-TX4	vt	1/16/1985	8/1/1985	F258552		Floway	26455	25	3600	49'	1	Metallized graph	60	4	160	170	295	270	leak from top seal
AW-06A	12P-TX4	vt	8/1/1985	11/23/1985	F229816		Floway	31521	30		49'		Ethylene propylene			100	150			shaft seizure
AW-06A	81P-TX4/3P-TX6	vt	11/23/1985	2/26/1986			Floway	359040	20	1760	49' 0 3/8"	1.25	Ethylene propylene	45	27	100	281			shaft seizure
AW-06A	83P-TX4/5P-TX6	vt	2/26/1986	5/29/1987			Floway	359040	20	1760	49' 0 3/8"	1.25	Ni-filled graphite	45	26	100	360			leak from top seal
AW-06A	82P-TX4/4P-TX6	vt, oil	6/17/1987	7/28/1988	F261986		Floway	212149	20	1760	49' 0 3/8"		Cast iron							shaft seizure
AW-06A	1P-TX1-XCR-1	vt	7/28/1988	active	F263817		Floway	419574	30	3500	49' 0 3/8"	1.25	Chr-oxide coated	48 max	7	100	300	355	190	
AY-01B	F64GT																			
AY-01D	122P-10	vt	12/21/1979	active	F258418		Floway	83251	7.5	3500	45' 8 5/16"	1	Ni-chrome alloy	60	2	75	115	130	218	
AY-02B	8P-105-ATP	vt, mix	4/29/1986		F258072		Tait		20		47' 6"				6	350	140	204		

Table C-6d. Available Waste Transfer Pump History (Continued)

Facility/ PIT #	Pump #	Pump Type	Date Install	Date Remove	PROP. #	Assembly Drwg. #	Manuf.	P.O. #	HP	RPM	Length	Shft Dia.	Bearing Material	CBS Inch	STA	Rtd Flow GPM	Rtd Tdh ft	Dead Head ft	Curv Max gpm	Failure Reason Given
AY-02D	66P-TX4	vt	9/26/1980	4/18/1986	F258609		Wilkins	26503	30	3450	47' 3 3/8"	1	Metal-impreg graph	60	7	150	280	466		motor direct ground
AY-02D	79P-TX4/1P-TX6	vt, oil	5/2/1986	10/9/1986	F261991		Floway	212149	20	1760	47' 3 3/8"		Cast iron		27	100	281			
AY-02D	87P-TX4/9P-TX6 (OIL LUBE)	vt, oil	10/14/1986	active	F261996		Floway	294080	20	1760	47' 3 3/8"	1	Ni-filled graphite	45	27	100	281			motor freeze-up
AZ-01A	182P-TX1	vt	4/17/1980	11/23/1983			Doric		20		48' 11"				6	100	250	320		
AZ-01C	204P-TX1	vt	10/6/1980	11/29/1983	F258183		Doric		20		46' 2 1/2"				6	90	245			
AZ-01C	74P-TX4/1P-TX5	vt	3/27/1986	active	F261998		Floway	294079	20	1760	47' 3 3/8"	1.25	Ni-filled graphite	45	26	100	279			
AZ-02A	12P-102-A	agit	9/19/1983	10/21/1983			Tait	12480	75		49' 4 1/2"		Graphite		5	300	525	620		leaked on startup
AZ-02B	196P-TX1	vt	6/23/1981	12/20/1985	F258536		Floway	26455	20	3500	45' 6"	1	Metallized graph	60	5	100	250	310	225	motor failure
AZ-02B	74P-TX4/1P-TX5	vt	12/20/1985	3/27/1986	F261998		Floway	294079	20	1760	47' 3 3/8"	1.25	Ni-filled graphite		5	300	525	620		
AZ-02C	12P-102-A	agit	10/21/1983	10/14/1985			Tait	12480	75		49' 4 1/2"		Graphite		5	300	525	620		
SY-01A RISER 3A	OPEN																			
SY-01A RISER 12A	1PSM-002	mix																		
SY-02A	185P-TX1	vt	4/26/1978	8/5/1981	F258039		Doric		20		47' 6 1/4"				6	100	250	320		
SY-02A	68P-TX4	vt, wi	8/14/1981	10/29/1984			Wilkins	26503	30	3450	47'	1	Metal-impreg graph	60	6	150	280	467		
SY-02A	212P-TX1	vt, ff	10/29/1984				Wilkins	26503	30	3450	33'	1	Metal-impreg graph	60	6	90	360	380	170	
SY-02A	67P-TX4	vt, ff	11/22/84?	12/30/1985	F258610		Wilkins	26503	30	3450	33'	1	Metal-impreg graph	60	6	150	280	467		
SY-02A	SY-02A-3	vt, ff	12/30/1985	active	F262402		Floway	359040				1.25	Ethylene propylene	45						
SY-02E	37P-TX4	vt	3/28/1977	8/6/1977			Doric		25	3600			Graphite		6	160	200	375		
SY-02E	30P-TX4	vt	8/6/1977	1/24/1978			Floway		20		44' 11 3/4"				4	160	170	185		leak from top seal

Table C-6d. Available Waste Transfer Pump History (Continued)

Facility/ PIT #	Pump #	Pump Type	Date Install	Date Remove	PROP. #	Assembly Drwg. #	Manuf.	P.O. #	HP	RPM	Length	Shft Dia.	Bearing Material	CBS Inch	STA	Rtd Flow GPM	Rtd Tdh ft	Dead Head ft	Curv Max gpm	Failure Reason Given
SY-02E	60P-TX4	vt	1/24/1978	7/6/1978			Doric		25	3600	45'				6	160	200	375		pump shaft broken
SY-02E	38P-TX4	vt	7/6/1978	8/8/1979			Doric		25	3600	44' 0 1/2"		Graphite		6	160	200	375		pump "broke", 34' of column still in tank
SY-02E	49P-TX4	vt	8/8/1979		F258548		Floway	26455	25	3600	44' 0"	1	Metallized graph	60	4	100	170	295	270	
SY-03A	195P-TX1	vt	3/17/1980	7/16/1980			Floway	26455	20	3510		1	Metallized graph	60	5	100	250	310	225	
SY-03A	116P-10	vt	7/16/1980	active	F258206		Floway	83251	7.5	3500	47' 6 3/16"	1	Ni-chrome alloy	60	2	75	115	130	218	
244A	169P-TX1	vt	4/1/1976	10/18/1982			Tait		25		19' 11"									
244A	39P-TX4	vt	10/27/1982	4/26/1983	F258037		Doric		25	3600	19' 11 1/2"		Graphite		6	100	210	347		
244A	16P-TX1-002-2	vt	5/9/1983	9/7/1984	F258029		Doric				19' 11"					90	70			column failure?
244A	15P-TX1-002-2	vt	9/7/1984	7/7/1989	F256959		Layne?	89704	3		19' 11"					80	80	160		
244A	199P-TX1	vt	7/7/1989	active	F258554		Floway	26455	20	3500	19' 11 1/2"	1	Metallized graph	60	5	100	250	310	225	
244BX	208P-TX1	vt	2/11/1981	active	F258600		Wilkins	26503	22.5	3500	18' 4"	1	Metal-impreg graph	60	6	90	360	380	170	
244TX	207P-TX1	vt	11/23/1981	8/12/1982	F258599		Wilkins	26503	22.5	3500	18' 4"	1	Metal-impreg graph	60	6	90	360	380	170	
244TX	167P-TX1	vt	8/12/1982	1/1/1988	F256947		Tait				18' 4"									
244TX	213P-TX1	vt	1/1/1988	failed	F258605		Wilkins	26503	30	3450	18' 4"	1	Metal-impreg graph	60	7	100	355	380	170	
244TX AGITATOR	9P-102A	vt	4/8/1981	10/1/1983	F258023		Tait	12480	75	3550	18' 4"		Metallized graph		5	300	550	650		

Table C-6d. Available Waste Transfer Pump History (Continued)

Facility/ PIT #	Pump #	Pump Type	Date Install	Date Remove	PROP. #	Assembly Drwg. #	Manuf.	P.O. #	HP	RPM	Length	Shft Dia.	Bearing Material	CBS Inch	STA	Rtd Flow GPM	Rtd Tdh ft	Dead Head ft	Curv Max gpm	Failure Reason Given
244TX AGITATOR	11P-102A	vt	1/6/1984	6/6/1984	F258074		Tait	12480	75	3550	18' 4"		Metallized graph		5	300	550	650		
244TX AGITATOR	10P-TX3 (10P-102A)	vt, oil	6/6/1984	11/5/1984	F258024		Tait	12480	75	3550	18' 4"		Metallized graph		5	315	550	650		oil lube line partially blocked
244TX AGITATOR	16P-TX3	vt, oil	11/5/1984				Floway	280126	75		18' 4"			48 max	5	440	240			motor failure
244TX AGITATOR	17P-TX3	vt, oil		10/31/1985			Floway	280126	75		18' 4"			48 max	5	440	240			seal failure
244TX AGITATOR	244TX-01866		11/5/1985	8/31/1988			Floway	386130	75							400	300			
244TX AGITATOR	1P-TX3-XCR-1	vt	8/31/1988	active	F263815		Floway	419574	75	3550	18' 4"	1.25	Chr-oxide coated	48 max	4	400	300	460	675	
244S	112-P10	vt, wi	6/12/1980	7/26/1988	F258202		Floway	83251	7.5	3500	21' 9 1/8"	1	Ni-chrome alloy	60	2	75	115	130	218	
244S	99P-10	vt, wi	7/26/1988	active	F257698	H-2-71056	Doric	95543	10	3600	21' 9 1/8"				2	105	70	115		
244S SUMP	113-P10	vt	8/27/1980	active	F258203		Floway	83251	7.5	3500		1	Ni-chrome alloy	60	2	75	115	130	218	
244U	201P-TX1	vt					Floway	26455	20	3510		1	Metallized graph	60	5	100	250	327	225	
244-CR-003 AGITATOR	01A-002		3/11/1988						10		20' 3"									
244-CR-003	2-P-CR-003		12/6/1977	9/21/1987							20' 7/8"									
244-CR-003	P-CR-003		9/21/1987	3/11/1988					7.5		20'									
244-CR-003	216P-TX1	vt	3/11/1988	active	F262307		Floway	359040	10	1760	18' 4 3/8"	1.25	Ni-filled graphite	45						

NOTES:

Scope: DST's and DCRT's
Data compiled by GA Leshikar from the following sources:

1. "The Pump Report," WHC-SD-WM-RPT-025, Rev. 1, 1992, by BK Kemp
2. AW "Card-ex" logbook, thru 7/15/91, East Tank Farms, custodian Ron Wright
3. "WA Pump Book" logbook, West Tank Farms, custodians Judy Steen and Mike Sutey
4. Pump Installation History logbook, custodian GA Leshikar
5. Tank Farm Daily Operating Reports, 2750 library
6. Pump Letterbooks, custodian GA Leshikar
7. Property Records
8. Purchase Orders
9. Vendor data
10. Run-in test data sheets

DEFINITIONS:

Pump Type:

Vt - vertical turbine	sw - saltwell screen installed
Sub - submersible	agit-agitator
Mix - mixer	wi - water injection capability to suction
ff - flex float	tan - two submersible pumps in tandem (series)
oil - oil lubed	

Date Install: reference source is recorded to cell as an Excel NOTE

Date Removed: reference source is recorded to cell as an Excel NOTE

Active – if pump currently installed and believed operable

Failed – if pump currently installed and believed inoperable (not yet removed)

PROP.#: RL property number of equipment

P.O.#: purchase order number, given by last digits

CBS: column bearing spacing (inches)

STA: number of stages (impellers)

This document was too large to scan as a single document. It has been divided into smaller sections.

Section 2 of 2

Document Information			
Document #	**HNF-2863**	**Revision**	**2**
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Projects			
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Appendix D. Human Reliability Analysis

Tables

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Table D-3. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AZ-101 (Representative Class 2 Tank) D-8

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Table D-5. Definition of Human Error Rate Variables for Use in WFDS RAM Evaluations (Based on WSRC-TR-93-581) D-16

Table D-6. Events from ORPS That Have a Potential to Produce Delays in WFDS Schedule Activities D-21

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Table D-1. Definition of Human Action Failure Effects

Failure Effect	Definition	Examples
None	Not a failure associated with the waste transfer process. This event will not divert resources that would be used for process-related operations.	• Gasoline spills in parking lots. • Violation of an administrative requirement that is not associated with transfer.
Equipment Failure Cause	Actions that contribute to spurious alarms or other equipment failures once transfer activities commence. These failures do not directly result in a delay at the time of occurrence. They are revealed by the actual occurrence of the alarm or shutdown. Since the occurrences are being counted in the ORPS and JCS databases, including a separate error rate for the human contribution to the equipment failure would in effect double count the failure mode.	• Failure to verify that instruments and alarms are properly set. • Failure to accomplish pre-operational testing. • Errors during periodic reviews of equipment status.
Verification Activity	Actions that reveal previous failures. The presence of these activities tend to reduce the HEP associated with the previous actions. Errors in these activities would be reflected in a failure to check HEP, which is included in the previous activity.	• Independent checks. • Checks by a crew supervisor. • Periodic inspections of conditions other than equipment status.
Monitor Alarms	Refers to being prepared to act should an alarm occur. Generally, alarms result from equipment or control failures that are accounted for in other human actions.	• Operators fail to respond to alarms before transition to a shutdown state.
Consolidated Action	Actions that repeat or verify another operator action.	• Steps that require checking a previous action.
Insignificant Delay	The RPP can recover from the failure without delaying transfer activities, but the effort can require resources that would be used for process related activities.	• Errors that were detected and corrected before a transition to a failed state.
Potential Delay	The failure occurred under circumstances that would cause a delay if a transfers operation were underway.	• Operator actions lead directly to a state that will require additional time for recovery.

Table D-2. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-102 (Representative Class 1 Tank)

RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
Pretransfer A	Align Transfer Path	Perform Transfer Valving and Pit Cover Check - Steps 5.2.16 Through 5.2.19. Ensure the transfer cover check is or has been performed within 72 hours prior to removing an administrative lock from physically connected waste transfer pump. Notify HPT if a non-permanent, temporary cover is to be used. Isolate waste transfer paths connected to active waste transfer pumps not under administrative lock by two closed valves. Complete appropriate block on the TK-105-AN To TK-102-AP Valve Position Checklist. Perform valving per TK-105-AN To TK-102-AP Valve Position Checklist. Have valve positions Independently Verified and Checklist Initialed.	HAVLVEPC001	HAFACXXXL	5.E-04	RTHUMLRG02	392	0.2
Pretransfer A	Preheat Transfer Path	Perform Post Transfer Line Flushing - Steps 5.5.1.1 Through 5.5.1.7. Ensure diluent/flush system is operable and boiler exit temperature is 130F. Throttle flush water flow to 100 gpm using CHEMB-FCV-131. Align valves per TK-105-AN To TK-102-AP Flush Valve Position Checklist, "Pump Flush." Open main valve, Backflush pump for five min. with hot water and Close main valve. Align valves per TK-105-AN To TK-102-AP Flush Valve Position Checklist, "Transfer Line Flush." Open main valve, Flush transfer line with approximately 5000 gallons of hot water and Close main valve. Record actual flush volumes on TK-105-AN To TK-102-AP Transfer Data Sheet. Shift Manager will ensure that procedure TO-040-540, "Water Surveillance and Usage" requirements are followed. During line flushing, catch tank and interconnected tank readings, material balances, constant surveillance requirements, etc., still apply. When flush valving is completed, have an Independent Verification of valves' positions performed. Have Operator positioning the valves and the individual performing the independent verification Initial TK-105-AN To TK-102-AP Flush Valve Position Checklist.	HAPERFLS001	HAFACXXXL	5.E-04	RTHUMSML03	28	0.0

Table D-2. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-102 (Representative Class 1 Tank) (Continued)

RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
Transfer A to WTP	Startup Transfer Pump	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.14 Through 5.3.15. Align valves per TK-105-AN To TK-102-AP Flush Valve Position Checklist, "In-Line Dilution" and Open main flush valve. Flow rate must be maintained at 100 gpm. CHEMB-FCV-131 can be adjusted to accomplish this. From transfer pump control panel, Start pump and Set pump speed to one-third full speed. The setting assumes the transfer pump displaces 123 gpm.	HATRANSF016	HAFACXXXN	5.E-03	RTHUMSML03	28	0.1
Transfer A to WTP	Startup and Control In-line Dilution	Note - Procedure does not have an "add Diluent" step. Using Step 5.4, "Dissolve 105-AN Soluble Salts and Transfer To 102-AP." Steps 5.4.1.1 Through 5.4.1.5. Align valves per TK-105-AN To TK-102-AP Flush Value Position Checklist, "Tank Flush." Ensure diluent/flush system is operable. Open main flush valve. Throttle diluent flow to 100 gpm using CHEMB-FCV-131. When the amount of diluent has been transferred to TK-105-AN, Close main flush valve.	HAADDDIL001	HAFACXXXN	5.E-03	RTHUMSML03	28	0.1
Transfer A to WTP	Control Transfer Mission	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.22 Through 5.3.23. When the liquid level in TK-105-AN reaches the amount designated by the Shift Manager, shutdown transfer as follows: Reduce pump speed to one-third full speed and Increase flush water flow to 100 gpm. Continue transfer until 2000 gallons of flush water have been transferred, Stop the transfer pump. When another 500 gallons of flush water have been transferred, Close main flush valve. Record time and date when the transfer stopped and Initial TK-105-AN To TK-102-AP Transfer Data Sheet, the Interconnected Tank Liquid Level Monitoring Data Sheet, the Excavation Control Checklist, and the TK-102-AP Transfer Data Sheet.	HATRANSF022	HACADEXXN	3.E-03	RTHUMSML03	28	0.1

Table D-2. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-102 (Representative Class 1 Tank) (Continued)

RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
Pretransfer B	Align Transfer Path	Perform Transfer Valving and Pit Cover Check - Steps 5.2.16 Through 5.2.19. Ensure the transfer cover check is or has been performed within 72 hours prior to removing an administrative lock from physically connected waste transfer pump. Notify HPT if a non-permanent, temporary cover is to be used. Isolate waste transfer paths connected to active waste transfer pumps not under administrative lock by two closed valves. Complete appropriate block on the TK-105-AN To TK-102-AP Valve Position Checklist. Perform valving per TK-105-AN To TK-102-AP Valve Position Checklist. Have valve positions Independently Verified and Checklist Initialed.	HAVLVEPC001	HAFACXXXL	5.E-04	RTHUMLRG02	392	0.2
Pretransfer B	Preheat Transfer Path	Perform Post Transfer Line Flushing - Steps 5.5.1.1 Through 5.5.1.7. Ensure diluent/flush system is operable and boiler exit temperature is 130F. Throttle flush water flow to 100 gpm using CHEMB-FCV-131. Align valves per TK-105-AN To TK-102-AP Flush Valve Position Checklist, "Pump Flush." Open main valve, Backflush pump for five min. with hot water and Close main valve. Align valves per TK-105-AN To TK-102-AP Flush Valve Position Checklist, "Transfer Line Flush." Open main valve, Flush transfer line with approximately 5000 gallons of hot water and Close main valve. Record actual flush volumes on TK-105-AN To TK-102-AP Transfer Data Sheet. Shift Manager will ensure that procedure TO-040-540, "Water Surveillance and Usage" requirements are followed. During line flushing, catch tank and interconnected tank readings, material balances, constant surveillance requirements, etc., still apply. When flush valving is completed, have an Independent Verification of valves' positions performed. Have Operator positioning the valves and the individual performing the independent verification Initial TK-105-AN To TK-102-AP Flush Valve Position Checklist.	HAPERFLS001	HAFACXXXL	5.E-04	RTHUMSML03	28	0.0

Table D-2. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-102 (Representative Class 1 Tank) (Continued)

RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
Transfer B to WTP	Startup Transfer Pump	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.14 Through 5.3.15. Align valves per TK-105-AN To TK-102-AP Flush Valve Position Checklist, "In-Line Dilution" and Open main flush valve. Flow rate must be maintained at 100 gpm. CHEMB-FCV-131 can be adjusted to accomplish this. From transfer pump control panel, Start pump and Set pump speed to one-third full speed. The setting assumes the transfer pump displaces 123 gpm.	HATRANSF016	HAFACXXXN	5.E-03	RTHUMSML03	28	0.1
Transfer B to WTP	Startup and Control In-line Dilution	Note - Procedure does not have an "add Diluent" step. Using Step 5.4, "Dissolve 105-AN Soluble Salts and Transfer To 102-AP." Steps 5.4.1.1 Through 5.4.1.5. Align valves per TK-105-AN To TK-102-AP Flush Value Position Checklist, "Tank Flush." Ensure diluent/flush system is operable. Open main flush valve. Throttle diluent flow to 100 gpm using CHEMB-FCV-131. When the amount of diluent has been transferred to TK-105-AN, Close main flush valve.	HAADDDIL001	HAFACXXXN	5.E-03	RTHUMSML03	28	0.1
Transfer B to WTP	Control Transfer Mission	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.22 Through 5.3.23. When the liquid level in TK-105-AN reaches the amount designated by the Shift Manager, shutdown transfer as follows: Reduce pump speed to one-third full speed and Increase flush water flow to 100 gpm. Continue transfer until 2000 gallons of flush water have been transferred, Stop the transfer pump. When another 500 gallons of flush water have been transferred, Close main flush valve. Record time and date when the transfer stopped and Initial TK-105-AN To TK-102-AP Transfer Data Sheet, the Interconnected Tank Liquid Level Monitoring Data Sheet, the Excavation Control Checklist, and the TK-102-AP Transfer Data Sheet.	HATRANSF022	HACADEXXN	3.E-03	RTHUMSML03	28	0.1

Table D-3. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AZ-101 (Representative Class 2 Tank)

HLW HRA ID	Schedule Activity ID	RAM Model Activity	Old RAM Model Activity ID	Sub-Activity Task Title	Operational Activity	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
223	16A64B4	16010B2 Resuspend Solids	MX1, MX2	Startup and Control Mixer Pump A	Tank Sweep - Steps 5.1.2.1 Through 5.1.2.2. Set mixer pump speed. Place Mixer Pump (WST-P-AN105A) in manual mode and Orient it to 30 degrees ±2. Ensure pump rotation speed is set at minimum. Position start/stop toggle switch on console. Adjust pump rotation speed to 15 Hz (0.05 rpm). When pump has rotated to within 2 degrees of target, Toggle start/stop switch to stop pump rotation.	HATANKSW001	HAFACXXXN	5.E-03	RTHUMLRG02	392	2.0
231	16A64B5	16010B2 Resuspend Solids	MX1, MX2	Startup and Control Mixer Pump B	Tank Sweep - Steps 5.1.2.1 Through 5.1.2.2. Set mixer pump speed. Place Mixer Pump (WST-P-AN105A) in manual mode and Orient it to 30 degrees ±2. Ensure pump rotation speed is set at minimum. Position start/stop toggle switch on console. Adjust pump rotation speed to 15 Hz (0.05 rpm). When pump has rotated to within 2 degrees of target, Toggle start/stop switch to stop pump rotation.	HATANKSW001	HAFACXXXN	5.E-03	RTHUMLRG02	392	2.0

Table D-3. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AZ-101 (Representative Class 2 Tank) (Continued)

HLW HRA ID	Schedule Activity ID	RAM Model Activity	Old RAM Model Activity ID	Sub-Activity Task Title	Operational Activity	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
B - Batch Transfer HLW	B - Batch Transfer HLW	16010B2 Resuspend Solids	TR1	Align Transfer Path	Perform Transfer Valving and Pit Cover Check - Steps 5.2.16 Through 5.2.19. Ensure the transfer cover check is or has been performed within 72 hours prior to removing an administrative lock from physically connected waste transfer pump. Notify HPT if a non-permanent, temporary cover is to be used. Isolate waste transfer paths connected to active waste transfer pumps not under administrative lock by two closed valves. Complete appropriate block on the TK-105-AN To TK-102-AP Valve Position Checklist. Perform valving per TK-105-AN To TK-102-AP Valve Position Checklist. Have valve positions Independently Verified and Checklist Initialed.	HAVLVEPC001	HAFACXXXL	5.E-04	RTHUMLRG02	392	0.2
B - Batch Transfer HLW	B - Batch Transfer HLW	16010B3 Transfer HLW	TR1	Startup Transfer Pump	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.11 Through 5.3.12. Ensure service water and nitrogen are supplied to pump seals. Measure sludge level and Position transfer pump intake one foot above sludge level.	HATRANSF014	HAFACXXXN	5.E-03	RTHUMLRG02	392	2.0

Table D-3. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AZ-101 (Representative Class 2 Tank) (Continued)

HLW HRA ID	Schedule Activity ID	RAM Model Activity	Old RAM Model Activity ID	Sub-Activity Task Title	Operational Activity	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
272	16A78B	16010B3 Transfer HLW	FL1	Control Transfer Mission	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.22 Through 5.3.23. When the liquid level in TK-105-AN reaches the amount designated by the Shift Manager, shutdown transfer as follows: Reduce pump speed to one-third full speed and Increase flush water flow to 100 gpm. Continue transfer until 2000 gallons of flush water have been transferred, Stop the transfer pump. When another 500 gallons of flush water have been transferred, Close main flush valve. Record time and date when the transfer stopped and Initial TK-105-AN To TK-102-AP Transfer Data Sheet, the Interconnected Tank Liquid Level Monitoring Data Sheet, the Excavation Control Checklist, and the TK-102-AP Transfer Data Sheet.	HATRANSF022	HACADEXXN	3.E-03	RTHUMSML03	28	0.1

Table D-4. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-105 (Representative Class 3 Tank)

LAW HRA ID	Schedule Activity ID	RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
19	13E30B2	Prestage Supernate to AN-102	Align Transfer Path	Perform Transfer Valving and Pit Cover Check - Steps 5.2.16 Through 5.2.19. Ensure the transfer cover check is or has been performed within 72 hours prior to removing an administrative lock from physically connected waste transfer pump. Notify HPT if a non-permanent, temporary cover is to be used. Isolate waste transfer paths connected to active waste transfer pumps not under administrative lock by two closed valves. Complete appropriate block on the TK-105-AN To TK-102-AP Valve Position Checklist. Perform valving per TK-105-AN To TK-102-AP Valve Position Checklist. Have valve positions Independently Verified and Checklist Initialed.	HAVLVEPC001	HAFACXXXL	5.E-04	RTHUMLRG02	392	0.2
36	13E30B2	Stage Supernate to AN-102	Startup Transfer Pump	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.14 Through 5.3.15. Align valves per TK-105-AN To TK-102-AP Flush Valve Position Checklist, "In-Line Dilution" and Open main flush valve. Flow rate must be maintained at 100 gpm. CHEMB-FCV-131 can be adjusted to accomplish this. From transfer pump control panel, Start pump and Set pump speed to one-third full speed. The setting assumes the transfer pump displaces 123 gpm.	HATRANSF016	HAFACXXXN	5.E-03	RTHUMSML03	28	0.1
8	13E30A	Stage Supernate to AN-102	Startup and Control In-line Dilution	Note - Procedure does not have an "add Diluent" step. Using Step 5.4, "Dissolve 105-AN Soluble Salts and Transfer To 102-AP." Steps 5.4.1.1 Through 5.4.1.5. Align valves per TK-105-AN To TK-102-AP Flush Value Position Checklist, "Tank Flush." Ensure diluent/flush system is operable. Open main flush valve. Throttle diluent flow to 100 gpm using CHEMB-FCV-131. When the amount of diluent has been transferred to TK-105-AN, Close main flush valve.	HAADDDIL001	HAFACXXXN	5.E-03	RTHUMSML03	28	0.1

Table D-4. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-105 (Representative Class 3 Tank) (Continued)

LAW HRA ID	Schedule Activity ID	RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
42	13E30B2	Stage Supernate to AN-102	Control Transfer Mission	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.22 Through 5.3.23. When the liquid level in TK-105-AN reaches the amount designated by the Shift Manager, shutdown transfer as follows: Reduce pump speed to one-third full speed and Increase flush water flow to 100 gpm. Continue transfer until 2000 gallons of flush water have been transferred, Stop the transfer pump. When another 500 gallons of flush water have been transferred, Close main flush valve. Record time and date when the transfer stopped and Initial TK-105-AN To TK-102-AP Transfer Data Sheet, the Interconnected Tank Liquid Level Monitoring Data Sheet, the Excavation Control Checklist, and the TK-102-AP Transfer Data Sheet.	HATRANSF022	HACADEXXN	3.E-03	RTHUMSML03	28	0.1
106	13E30H	Pretransfer Supernate to WTP	Align Transfer Path	Perform Transfer Valving and Pit Cover Check - Steps 5.2.16 Through 5.2.19. Ensure the transfer cover check is or has been performed within 72 hours prior to removing an administrative lock from physically connected waste transfer pump. Notify HPT if a non-permanent, temporary cover is to be used. Isolate waste transfer paths connected to active waste transfer pumps not under administrative lock by two closed valves. Complete appropriate block on the TK-105-AN To TK-102-AP Valve Position Checklist. Perform valving per TK-105-AN To TK-102-AP Valve Position Checklist. Have valve positions Independently Verified and Checklist Initialed.	HAVLVEPC001	HAFACXXXL	5.E-04	RTHUMLRG02	392	0.2
121	13E30H	Transfer Supernate to WTP	Startup Transfer Pump	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.11 Through 5.3.12. Ensure service water and nitrogen are supplied to pump seals. Measure sludge level and Position transfer pump intake one foot above sludge level.	HATRANSF014	HAFACXXXN	5.E-03	RTHUMLRG02	392	2.0

Table D-4. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-105 (Representative Class 3 Tank) (Continued)

LAW HRA ID	Schedule Activity ID	RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
129	13E30H	Transfer Supernate to WTP	Control Transfer Mission	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.22 Through 5.3.23. When the liquid level in TK-105-AN reaches the amount designated by the Shift Manager, shutdown transfer as follows: Reduce pump speed to one-third full speed and Increase flush water flow to 100 gpm. Continue transfer until 2000 gallons of flush water have been transferred, Stop the transfer pump. When another 500 gallons of flush water have been transferred, Close main flush valve. Record time and date when the transfer stopped and Initial TK-105-AN To TK-102-AP Transfer Data Sheet, the Interconnected Tank Liquid Level Monitoring Data Sheet, the Excavation Control Checklist, and the TK-102-AP Transfer Data Sheet.	HATRANSF022	HACADEXXN	3.E-03	RTHUMSML03	28	0.1
86	13E30D	Add Diluent Water To AN-105	Control Diluent Addition	Note - Procedure does not have an "add Diluent" step. Using Step 5.4, "Dissolve 105-AN Soluble Salts and Transfer To 102-AP." Steps 5.4.1.1 Through 5.4.1.5. Align valves per TK-105-AN To TK-102-AP Flush Value Position Checklist, "Tank Flush." Ensure diluent/flush system is operable. Open main flush valve. Throttle diluent flow to 100 gpm using CHEMB-FCV-131. When the amount of diluent has been transferred to TK-105-AN, Close main flush valve.	HAADDDIL001	HAFACXXXN	5.E-03	RTHUMSML03	28	0.1

Table D-4. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-105 (Representative Class 3 Tank) (Continued)

LAW HRA ID	Schedule Activity ID	RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
242	15E30B	Mix Diluent with Salts in AN-105	Control Mixer Pump	Tank Sweep - Steps 5.1.2.1 Through 5.1.2.2. Set mixer pump speed. Place Mixer Pump (WST-P-AN105A) in manual mode and Orient it to 30 degrees ±2. Ensure pump rotation speed is set at minimum. Position start/stop toggle switch on console. Adjust pump rotation speed to 15 Hz (0.05 rpm). When pump has rotated to within 2 degrees of target, Toggle start/stop switch to stop pump rotation.	HATANKSW001	HAFACXXXN	5.E-03	RTHUMLRG02	392	2.0
59	13E30C2	Pretransfer Dissolved Salts to WTP	Align Transfer Path	Perform Transfer Valving and Pit Cover Check - Steps 5.2.16 Through 5.2.19. Ensure the transfer cover check is or has been performed within 72 hours prior to removing an administrative lock from physically connected waste transfer pump. Notify HPT if a non-permanent, temporary cover is to be used. Isolate waste transfer paths connected to active waste transfer pumps not under administrative lock by two closed valves. Complete appropriate block on the TK-105-AN To TK-102-AP Valve Position Checklist. Perform valving per TK-105-AN To TK-102-AP Valve Position Checklist. Have valve positions Independently Verified and Checklist Initialed.	HAVLVEPC001	HAFACXXXL	5.E-04	RTHUMLRG02	392	0.2
76	13E30C2	Transfer Dissolved Salts to WTP	Stratup Transfer Pump	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.14 Through 5.3.15. Align valves per TK-105-AN To TK-102-AP Flush Valve Position Checklist, "In-Line Dilution" and Open main flush valve. Flow rate must be maintained at 100 gpm. CHEMB-FCV-131 can be adjusted to accomplish this. From transfer pump control panel, Start pump and Set pump speed to one-third full speed. The setting assumes the transfer pump displaces 123 gpm.	HATRANSF016	HAFACXXXN	5.E-03	RTHUMSML03	28	0.1

Table D-4. Procedural Human Actions Quantified for Waste Feed Delivery from Tank 241-AN-105 (Representative Class 3 Tank) (Continued)

LAW HRA ID	Schedule Activity ID	RAM Model Activity	Sub-Activity Task Title	Operational Activity (Extracted from Readiness to Proceed Procedures)	Human Action Identifier	HEP Identifier	HEP per Operation	Recovery Identifier	MTTR (hours)	Expected Delay (hours)
82	13E30C2	Transfer Dissolved Salts to WTP	Control Transfer Mission	Transfer From TK-105-AN To TK-102-AP - Steps 5.3.22 Through 5.3.23. When the liquid level in TK-105-AN reaches the amount designated by the Shift Manager, shutdown transfer as follows: Reduce pump speed to one-third full speed and Increase flush water flow to 100 gpm. Continue transfer until 2000 gallons of flush water have been transferred, Stop the transfer pump. When another 500 gallons of flush water have been transferred, Close main flush valve. Record time and date when the transfer stopped and Initial TK-105-AN To TK-102-AP Transfer Data Sheet, the Interconnected Tank Liquid Level Monitoring Data Sheet, the Excavation Control Checklist, and the TK-102-AP Transfer Data Sheet.	HATRANSF022	HACADEXXN	3.E-03	RTHUMSML03	28	0.1

Table D-5. Definition of Human Error Rate Variables for Use in WFDS RAM Evaluations (Based on WSRC-TR-93-581)

HUMAN ERROR MODE ID	HUMAN ERROR MODE DESCRIPTION	PERFORMANCE DIFFICULTY DESIGNATOR	HEP ID	HEP	RF	HEP UNITS	SELECTION GUIDANCE
HACADEXX	Chemical addition or dilution error	LOW	HACADEXXL	3.E-04	10	per demand	Simple process
HACADEXX	Chemical addition or dilution error	NOMINAL	HACADEXXN	3.E-03	10	per demand	Typical process
HACADEXX	Chemical addition or dilution error	HIGH	HACADEXXH	3.E-02	5	per demand	Complex process
HACEXXXX	Communication error	LOW	HACEXXXXL	1.E-03	10	per demand	Simple information
HACEXXXX	Communication error	NOMINAL	HACEXXXXN	5.E-02	5	per demand	Moderate information
HACEXXXX	Communication error	HIGH	HACEXXXXH	5.E-01	2	per demand	Complex information
HACSSOXX	Crane/hoist strikes stationary object	LOW	HACSSOXXL	3.E-05	10	per operation	Spotter present
HACSSOXX	Crane/hoist strikes stationary object	NOMINAL	HACSSOXXN	3.E-04	10	per operation	Typical visibility
HACSSOXX	Crane/hoist strikes stationary object	HIGH	HACSSOXXH	3.E-03	10	per operation	No spotter, low visibility
HACVEXXX	Checker verification error	LOW	HACVEXXXL	1.E-02	5	per demand	Checking requires active participation
HACVEXXX	Checker verification error	NOMINAL	HACVEXXXN	1.E-01	3	per demand	Alerted, but not active participant
HACVEXXX	Checker verification error	HIGH	HACVEXXXH	3.E-01	3	per demand	Written materials not used
HADEXXXX	Diagnosis error	LOW	HADEXXXXL	1.E-03	10	per demand	Knowledge-based, greater than 120 minutes
HADEXXXX	Diagnosis error	NOMINAL	HADEXXXXN	1.E-02	5	per demand	Knowledge-based, 30 to 120 minutes
HADEXXXX	Diagnosis error	HIGH	HADEXXXXH	1.E-01	3	per demand	Knowledge-based, 10 to 30 minutes
HADLUCXX	Dropping of load when using crane/hoist	LOW	HADLUCXXL	3.E-05	10	per operation	Standardized load, spotter present
HADLUCXX	Dropping of load when using crane/hoist	NOMINAL	HADLUCXXN	1.E-04	10	per operation	Typical load
HADLUCXX	Dropping of load when using crane/hoist	HIGH	HADLUCXXH	1.E-03	10	per operation	Unusual, unevenly balanced load or remotely operated crane/hoists
HADLUFXX	Dropping of load when using forklift	LOW	HADLUFXXL	1.E-05	10	per operation	Standardized load, spotter present
HADLUFXX	Dropping of load when using forklift	NOMINAL	HADLUFXXN	5.E-05	10	per operation	Typical load
HADLUFXX	Dropping of load when using forklift	HIGH	HADLUFXXH	5.E-04	10	per operation	Unusual, unevenly balanced load
HAEDMXXX	Error during maintenance	LOW	HAEDMXXXL	3.E-04	10	per demand	Good external conditions, routine effort
HAEDMXXX	Error during maintenance	NOMINAL	HAEDMXXXN	3.E-02	5	per demand	Good external conditions, unique effort

Table D-5. Definition of Human Error Rate Variables for Use in WFDS RAM Evaluations (Based on WSRC-TR-93-581) (Continued)

HUMAN ERROR MODE ID	HUMAN ERROR MODE DESCRIPTION	PERFORMANCE DIFFICULTY DESIGNATOR	HEP ID	HEP	RF	HEP UNITS	SELECTION GUIDANCE
HAEDMXXX	Error during maintenance	HIGH	HAEDMXXXH	1.E-01	5	per demand	Challenging external conditions, unique effort
HAEEXXXX	Excavation error	LOW	HAEEXXXXL	1.E-03	10	per excavation	Excellent review of area (survey for underground objects)
HAEEXXXX	Excavation error	NOMINAL	HAEEXXXXN	1.E-02	5	per excavation	Good review of area
HAEEXXXX	Excavation error	HIGH	HAEEXXXXH	1.E-01	3	per excavation	Poor review of area
HAESCOCR	Error in selecting control outside control room	LOW	HAESCOCRL	3.E-03	10	per demand	Excellent layout, procedure-driven
HAESCOCR	Error in selecting control outside control room	NOMINAL	HAESCOCRN	1.E-02	5	per demand	Good layout, procedure-driven
HAESCOCR	Error in selecting control outside control room	HIGH	HAESCOCRH	5.E-02	5	per demand	Poor layout, scanning effort
HAESCWCR	Error in selecting control within control room	LOW	HAESCWCRL	1.E-03	10	per demand	Excellent layout, procedure-driven
HAESCWCR	Error in selecting control within control room	NOMINAL	HAESCWCRN	1.E-02	5	per demand	Good layout, procedure-driven
HAESCWCR	Error in selecting control within control room	HIGH	HAESCWCRH	3.E-02	5	per demand	Poor layout, scanning effort
HAFACXXX	Failure of administrative control	LOW	HAFACXXXL	5.E-04	10	per demand	Routine repetitive circumstances, includes checking within the team
HAFACXXX	Failure of administrative control	NOMINAL	HAFACXXXN	5.E-03	10	per demand	Typical circumstances
HAFACXXX	Failure of administrative control	HIGH	HAFACXXXH	5.E-02	5	per demand	Unusual circumstances
HAFLOXXX	Failure to lock out	NOMINAL	HAFLOXXXN	5.E-04	10	per demand	Typical lockout plan (5 to 10 lockouts)
HAFLOXXX	Failure to lock out	HIGH	HAFLOXXXH	5.E-03	10	per demand	Complex lockout plan (11 to 100 lockouts)
HAFLOXXX	Failure to lock out	LOW	HAFLOXXXL	5.E-02	10	per demand	Simple lockout plan (1 to 4 lockouts)
HAFLTAXX	Failure of long term accident recovery	LOW	HAFLTAXXL	3.E-05	10	per demand	3-7 days for recovery, simple recovery actions
HAFLTAXX	Failure of long term accident recovery	NOMINAL	HAFLTAXXN	3.E-03	10	per demand	24-48 hours for recovery, simple recovery actions
HAFLTAXX	Failure of long term accident recovery	HIGH	HAFLTAXXH	1.E-01	3	per demand	Less than 24 hours for recovery
HAFMFDXX	Failure of manual fire detection	LOW	HAFMFDXXL	1.E-02	5	per demand	Area occupied 100% of time
HAFMFDXX	Failure of manual fire detection	NOMINAL	HAFMFDXXN	1.E-01	3	per demand	Area occupied 80% of time
HAFMFDXX	Failure of manual fire detection	HIGH	HAFMFDXXH	5.E-01	2	per demand	Area unoccupied

Table D-5. Definition of Human Error Rate Variables for Use in WFDS RAM Evaluations (Based on WSRC-TR-93-581) (Continued)

HUMAN ERROR MODE ID	HUMAN ERROR MODE DESCRIPTION	PERFORMANCE DIFFICULTY DESIGNATOR	HEP ID	HEP	RF	HEP UNITS	SELECTION GUIDANCE
HAFMFSNX	Failure of manual fire suppression by non-occupant	LOW	HAFMFSNXL	3.E-02	5	per demand	Response less than 10 minutes, simple fire
HAFMFSNX	Failure of manual fire suppression by non-occupant	NOMINAL	HAFMFSNXN	1.E-01	3	per demand	Response by 10 minutes, typical fire
HAFMFSNX	Failure of manual fire suppression by non-occupant	HIGH	HAFMFSNXH	3.E-01	3	per demand	Response much longer than 10 minutes, simple fire
HAFMFSOX	Failure of manual fire suppression by occupant	LOW	HAFMFSOXL	1.E-01	3	per demand	Excellent fire extinguisher installation/maintenance
HAFMFSOX	Failure of manual fire suppression by occupant	NOMINAL	HAFMFSOXN	3.E-01	3	per demand	Typical fire extinguisher installation/maintenance
HAFMFSOX	Failure of manual fire suppression by occupant	HIGH	HAFMFSOXH	5.E-01	2	per demand	Poor fire extinguisher installation/maintenance
HAFRCSXX	Failure to respond to compelling signal	LOW	HAFRCSXXL	3.E-03	10	per demand	Few competing signals
HAFRCSXX	Failure to respond to compelling signal	NOMINAL	HAFRCSXXN	1.E-02	5	per demand	Several competing signals
HAFRCSXX	Failure to respond to compelling signal	HIGH	HAFRCSXXH	1.E-01	3	per demand	Many competing signals
HAFRFMXX	Failure to restore following maintenance	LOW	HAFRFMXXL	3.E-03	10	per demand	Two-person team, operator check
HAFRFMXX	Failure to restore following maintenance	NOMINAL	HAFRFMXXN	5.E-03	10	per demand	Single-person, operator check
HAFRFMXX	Failure to restore following maintenance	HIGH	HAFRFMXXH	5.E-02	5	per demand	Single-person, no checks
HAFRFTXX	Failure to restore following test	LOW	HAFRFTXXL	5.E-03	10	per demand	Two-person team, operator check
HAFRFTXX	Failure to restore following test	NOMINAL	HAFRFTXXN	1.E-02	5	per demand	Single-person, operator check
HAFRFTXX	Failure to restore following test	HIGH	HAFRFTXXH	3.E-02	5	per demand	Single-person, no checks
HAFVIXXX	Failure of visual inspection	LOW	HAFVIXXXL	1.E-02	5	per demand	Procedure followed, event easy to observe (damage very prominent)
HAFVIXXX	Failure of visual inspection	NOMINAL	HAFVIXXXN	1.E-01	3	per demand	Procedure usually followed, event easy to observe
HAFVIXXX	Failure of visual inspection	HIGH	HAFVIXXXH	5.E-01	2	per demand	Event difficult to observe
HAFVOCRX	Failure to verify outside control room	LOW	HAFVOCRXL	1.E-02	5	per demand	Excellent layout, procedure-driven
HAFVOCRX	Failure to verify outside control room	NOMINAL	HAFVOCRXN	3.E-02	5	per demand	Good layout, procedure-driven
HAFVOCRX	Failure to verify outside control room	HIGH	HAFVOCRXH	1.E-01	3	per demand	Poor layout, scanning effort
HAFVPCXX	Failure to verify parameter with calculation	LOW	HAFVPCXXL	5.E-03	10	per demand	Procedure almost always used, verification

Table D-5. Definition of Human Error Rate Variables for Use in WFDS RAM Evaluations (Based on WSRC-TR-93-581) (Continued)

HUMAN ERROR MODE ID	HUMAN ERROR MODE DESCRIPTION	PERFORMANCE DIFFICULTY DESIGNATOR	HEP ID	HEP	RF	HEP UNITS	SELECTION GUIDANCE
HAFVPCXX	Failure to verify parameter with calculation	NOMINAL	HAFVPCXXN	3.E-02	5	per demand	Procedure usually used, verification
HAFVPCXX	Failure to verify parameter with calculation	HIGH	HAFVPCXXH	1.E-01	3	per demand	No verification
HAFVWCRX	Failure to verify within control room	LOW	HAFVWCRXL	3.E-03	10	per demand	Excellent layout, procedure-driven
HAFVWCRX	Failure to verify within control room	NOMINAL	HAFVWCRXN	1.E-02	5	per demand	Good layout, procedure-driven
HAFVWCRX	Failure to verify within control room	HIGH	HAFVWCRXH	5.E-02	5	per demand	Poor layout, scanning effort
HAIASSXX	Inadvertent actuation/shutdown of system	LOW	HAIASSXXL	5.E-07	10	per hour	Almost no activities could affect system
HAIASSXX	Inadvertent actuation/shutdown of system	NOMINAL	HAIASSXXN	5.E-06	10	per hour	Some activities could affect system
HAIASSXX	Inadvertent actuation/shutdown of system	HIGH	HAIASSXXH	5.E-05	10	per hour	Many activities could affect system
HAILTXXX	Incorrect labeling or tagging	LOW	HAILTXXXL	1.E-03	10	per demand	Excellent administrative controls
HAILTXXX	Incorrect labeling or tagging	NOMINAL	HAILTXXXN	5.E-03	10	per demand	Normal administrative controls
HAILTXXX	Incorrect labeling or tagging	HIGH	HAILTXXXH	3.E-02	5	per demand	Poor administrative controls
HAIRDXX	Incorrect reading or recording of data	LOW	HAIRDXXL	3.E-03	10	per demand	Excellent display (digital readout, indicator lamp)
HAIRDXX	Incorrect reading or recording of data	NOMINAL	HAIRDXXN	1.E-02	5	per demand	Good display (graph)
HAIRDXX	Incorrect reading or recording of data	HIGH	HAIRDXXH	5.E-01	2	per demand	Poor display
HALAEXXX	Laboratory analysis error	LOW	HALAEXXXL	3.E-05	10	per demand	Zero dependence check
HALAEXXX	Laboratory analysis error	NOMINAL	HALAEXXXN	3.E-04	10	per demand	Low dependence check
HALAEXXX	Laboratory analysis error	HIGH	HALAEXXXH	1.E-03	10	per demand	No check
HAMCALXX	Miscalibration	LOW	HAMCALXXL	3.E-03	10	per demand	Two-person team, operator check
HAMCALXX	Miscalibration	NOMINAL	HAMCALXXN	5.E-03	10	per demand	Single-person, operator check
HAMCALXX	Miscalibration	HIGH	HAMCALXXH	3.E-02	5	per demand	Single-person, no checks
HAMPDXXX	Procedure development error	LOW	HAMPDXXXL	3.E-04	10	per demand	Simple procedure with adequate time
HAMPDXXX	Procedure development error	NOMINAL	HAMPDXXXN	3.E-02	5	per demand	Complex procedure with adequate time
HAMPDXXX	Procedure development error	HIGH	HAMPDXXXH	1.E-01	5	per demand	Complex procedure with limited time
HAOTXXXX	Overfilling of a tank	LOW	HAOTXXXXL	5.E-07	10	per tank-hour	Low activity (1 potential transfer/year)

Table D-5. Definition of Human Error Rate Variables for Use in WFDS RAM Evaluations (Based on WSRC-TR-93-581) (Continued)

HUMAN ERROR MODE ID	HUMAN ERROR MODE DESCRIPTION	PERFORMANCE DIFFICULTY DESIGNATOR	HEP ID	HEP	RF	HEP UNITS	SELECTION GUIDANCE
HAOTXXXX	Overfilling of a tank	NOMINAL	HAOTXXXXN	5.E-06	10	per tank-hour	Moderate activity (10 potential transfers/year)
HAOTXXXX	Overfilling of a tank	HIGH	HAOTXXXXH	5.E-05	10	per tank-hour	High activity (100 potential transfers/year)
HAPLUFXX	Puncturing of load when using forklift	LOW	HAPLUFXXL	5.E-06	10	per operation	Standardized load, spotter present
HAPLUFXX	Puncturing of load when using forklift	NOMINAL	HAPLUFXXN	3.E-05	10	per operation	Typical load
HAPLUFXX	Puncturing of load when using forklift	HIGH	HAPLUFXXH	3.E-04	10	per operation	Unusual, unevenly balanced load
HASVAXXX	Single vehicle accident	LOW	HASVAXXXL	1.E-07	10	per mile	Freeway environment
HASVAXXX	Single vehicle accident	NOMINAL	HASVAXXXN	1.E-06	10	per mile	Typical highway environment
HASVAXXX	Single vehicle accident	HIGH	HASVAXXXH	1.E-05	10	per mile	Congested road, bad weather
HASVEXXX	Supervisor verification error	LOW	HASVEXXXL	1.E-01	3	per demand	Check-off sheet, low dependence
HASVEXXX	Supervisor verification error	NOMINAL	HASVEXXXN	3.E-01	3	per demand	Check-off sheet, medium dependence
HASVEXXX	Supervisor verification error	HIGH	HASVEXXXH	5.E-01	2	per demand	Check-off sheet, high dependence, high stress
HATEXXXX	Transfer error	LOW	HATEXXXXL	3.E-07	10	per tank-hour	Low activity (1 potential transfer/year)
HATEXXXX	Transfer error	NOMINAL	HATEXXXXN	3.E-06	10	per tank-hour	Moderate activity (10 potential transfers/year)
HATEXXXX	Transfer error	HIGH	HATEXXXXH	3.E-05	10	per tank-hour	High activity (100 potential transfers/year)
HAVCMVXX	Vehicle collision with another moving vehicle	LOW	HAVCMVXXL	1.E-07	10	per mile	Freeway environment
HAVCMVXX	Vehicle collision with another moving vehicle	NOMINAL	HAVCMVXXN	1.E-06	10	per mile	Typical highway environment
HAVCMVXX	Vehicle collision with another moving vehicle	HIGH	HAVCMVXXH	1.E-05	10	per mile	Congested road, bad weather
HAVCSOXX	Vehicle collision with stationary object	LOW	HAVCSOXXL	1.E-07	10	per mile	Freeway environment
HAVCSOXX	Vehicle collision with stationary object	NOMINAL	HAVCSOXXN	1.E-06	10	per mile	Typical highway environment
HAVCSOXX	Vehicle collision with stationary object	HIGH	HAVCSOXXH	1.E-05	10	per mile	Congested road, bad weather

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL--WHC-TANKFAR M-1991-0207	03/14/91	272-AW	"Evacuation of 272-AW as a precautionary measure"	N/A	HA - Pouring bleach down drain	Potential Delay	Indirect	Building evacuated, sampling of air quality performed	272-AW	No	No	1	Time from initiation of event to building release	N/A	
CC 3	RL--WHC-TANKFAR M-1991-1019	06/18/91	241-BY	"Failure to continuously man control room during transfer per Procedure"	N/A	HA - Procedure violation	Potential Delay	Direct	Control room not manned during waste transfer	241-BY-254 Control Room	Yes	No		Control Room not manned for 30 min., radiation monitors were not alarming when the facility was re-manned	N/A	Procedure TO-305-004 requires Building 242-BY staffed at all times during pumping activities to monitor the area radiation alarms
CC 3	RL--WHC-TANKFAR M-1991-1036	08/26/91	241-AN-103	Non compliance to level monitoring requirements of double-shell tank 103-AN	N/A	HA - Failed to read tank daily surface level	Potential Delay	Direct	Surface level transmitter to CASS out of surface, field measurement was necessary to fulfill OSR requirement	241-AN-103 Tank	No	No		Failure to read level occurred three days before discovery. There was no adverse effect to facility	N/A	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL–WHC-TANKFAR M-1991-1045	09/19/91	244-CR vault/ TK-003	Daily liquid level measurement of TK-003-CR not obtained.	N/A	HA - Failed to read tank daily surface level	Potential Delay	Direct	OSD requires daily liquid level reading	244-CR Vault, TK-003	No	No		Violation detected next day, facility not in operation, no change in liquid level noted in follow-up reading	N/A	
CC 6	RL–WHC-TANKFAR M-1991-1054	10/22/91	Tank 244-CR-003	Tank 244-CR-003 Compositional Limit Nonconformance		HACADEX XN	Potential Delay	Indirect	A chemical addition or calculation error is a possible event for Phase 1 operations.		Yes	No	1248	Based on ORPS report data to provide retraining, correct procedures and determine effect of event on tank integrity.	None	None
CC 3	RL--WHC-TANKFAR M-1991-1067	11/26/91	241-T tank farm	241-T tank farm thermocouple riser broken off by front-end loader while spreading gravel	Thermocouple riser broken off	HA - Ran over thermocouple riser	Potential Delay	Direct	Broken off thermocouple riser, still functional. Tank integrity was not compromised	241-T Tank Farm	No	No	0	No apparent damage to wiring or instruments observed. Thermocouples were registering and transmitting recordable data.		

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL–WHC-TANKFARM-1991-1070	12/04/91	Tank 241-A-103	Single-shell tank 103-A lateral radiation detector data exceeds baseline	Lateral Radiation Detector	HA - Detector not positioned for proper reading	Potential Delay	Direct	Information analyzed for tank leak detection, reading indicated that a leak or migration occurred. Operation would be stopped to verify reading	SST 241-A-103	Yes	No	4	Time required to verify reading and to determine basis for high reading. Performing task per procedure would have prevented this event	N/A	
CC 3	RL–WHC-TANKFARM-1991-1074	12/07/91	241-AY tank farm	Raw water leak in the 241-AY-01A water service pit	Drain Valve	HA - Drain valve left open	Potential Delay	Direct	Breakdown of communication, personnel were not aware of the valving being opened the previous day	241-AY Water Service Pit	No	No	1	Response to possible leak was handled in a timely fashion. Actions necessary to bring system into safe condition was followed as directed	N/A	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL--WHC-TANKFAR M-1991-1082	12/26/91	241-AN tank farm	Discrepancies in data sheet recording at 241-AN tank farm	N/A	HA - Data copied from previous day, rather during current operation	Insignificant Impact	Direct	Review of corrupt data can lead to falsely believe that the facility is operating safely and thus preclude appropriate actions to rectify an adverse condition indicated by otherwise accurately recorded data sheets	241-AN Tank Farm	Yes	No		Significant discrepancies discovered 6 days after event. Serious misconduct by employee was basis, plant system was functioning as required	N/A	
CC 3	RL--WHC-TANKFAR M-1992-0018	02/23/92	Tank farm/ master key	Possible loss of tank farm 200 east and west facility access master keys.	N/A	HA - Loss of Access Master Keys	Potential Delay	Indirect	Disruption of activities due to verification of missing keys, re-keying of affected facilities, and training of personnel	200E and 200W Tank Farm Facilities	No	No			N/A	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL–WHC-TANKFARM-1992-0015	02/25/92	SX sludge cooler	Loss of SX tank farm exhauster due to loss of the portable air compressor	Portable Compressor	HA - Portable Compressor out of fuel	Potential Delay	Direct	Compressor necessary for the operation of the exhauster	SX Tank Farm	Yes	No		Compressor ran out of fuel, would not restart once re-fueled. ORPS Report does not indicated if replace compressor brought in	N/A	
CC 4	RL–WHC-TANKFARM-1992-0016	02/25/92	241-AZ tank farm	241-AZ tank farm evacuation due to high pressure horn activation	Panel 2	HA - Procedure Violation	Potential Delay	Direct	Engineer not authorized to open the electrical panels and trace individual circuits. Farm immediately evacuated.	271-A Instrument Building, 241-AZ Tank Farm	Yes	No	2	Contamination survey conducted and no contamination found. Panel was inspected b electrician and no wiring problem discovered	Not Listed	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 2	RL–WHC-TANKFARM-1992-0022	02/28/92	241-SY leak detector	Loss of configuration control in the 241-SY primary leak detection system due to an inaccurate procedure	LI	HA-EXT	Potential Delay	Direct	Conductivity probe set at wrong height, tank level error Unusual Occurrence declared. Conductivity probe provide one of two primary tank leak detection methods required by OSR	241-SY Leak Detector	Yes	Yes		Days - Procedure required modification , approval and issuance.	Not listed	
CC 3	RL–WHC-TANKFARM-1992-0054	07/15/92	A-302-A CT	OSD requirement exceeded when F18 transfer to 102-AN was routed through diversion box which drains into catch tank above liquid level limits	N/A	HA - Misrouting of waste	Potential Delay	Direct	OSD requirement exceeded, violation discovered 10 days after event	A-302-A CT	Yes	Yes		Violation discovered 10 days after transfer date. ORPS does not discuss corrective action to bring catch tank back into compliance	N/A	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL--WHC-TANKFARM-1992-0087	11/11/92	Tank 241-T-107	Procedure noncompliance at single-shell tank 241-T-107 results in less than adequate pre-job meeting and subsequent job performance	N/A	HA - Lack of attention to detail	Potential Delay	Indirect	All work which required a formal pre-job safety meeting was discontinued until job supervisors completed re-training	N/A	Maybe	No		ORPS Report did not specify when the Stop Work was lifted	N/A	
CC 3	RL--WHC-TANKFARM-1993-0011	01/21/93	AY/AZ farm vent fan	Temporary loss of 241-AY&AZ primary tank ventilation due to personnel error; no contamination spread or personnel injury resulted.	Magnetic motor starter for Exhaust Fan	HA - Inattention to details	Potential Delay	Direct	Tank Farm evacuated, personnel required to use respiratory protection to reenter the Farm	AY and AZ Farm Ventilation	Yes	No	1	Exhauster restarted and radiological surveys of the Farms conducted	N/A	
CC 1BF	RL--WHC-TANKFARM-1993-0040	04/21/93		Loss of chain of custody for 241-T-102 core sample; empty cask was inadvertently shipped to the lab while the sample was stored in a RMA		HAFACXXXN	Potential Delay	Direct	A similar incident could happen during Phase 1 sampling activities.		No	No	96	Based on information in ORPS report.	None	A similar incident during Phase 1 operations could potentially cause operations to resample tanks.

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL--WHC-TANKFAR M-1993-0041	04/28/93	204-AR	The HEPA filters for the EF-1 exhaust system at 204-AR were found to be delinquent for the annual efficiency test. No HAZ-MAT release.	EF-1 Exhaust System, HEPA filters	HA - Procedure violation	Potential Delay	Indirect	OSD violation. Work package not returned and considered lost. Test on HEPA filters was missed and went unnoticed until it came for recall a year later	204_AR	Yes	No	2.5	Efficiency test check completed on filters, all passed	2E-93-00626	
CC 3	RL--WHC-TANKFAR M-1993-0059	06/29/93	241-A-401 condenser cooling water system	Loss of control power to 241-A-401 condenser cooling water system resulted in OSR non-conformance	Condenser Cooling Water System	HA - Procedure violation	Potential Delay	Indirect	Control power removed from lift pumps, deep well pumps, recirculation fans and recirculation pumps. OSD violation, emergency power and backup capacity required to be provided for Emergency Cooling Water System	241-A-401	Yes	No	23	Loss of control power discovered 7 days after event. Once discovered corrected in 23 hrs.	2E-93-01169	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 6	RL–WHC-TANKFARM-1993-0069	08/04/93	Double shell waste tank 241-SY-101 mitigation pump	Loss of facility control results in an inadvertent start of waste tank 241-SY-101 hydrogen mitigation pump	P	HAFLOXXXL	Potential Delay	Indirect	A failure to lock out a system being tested or maintained would lead to at least an administrative hold on work to investigate.		Yes	Yes	864	Based on ORPS report to investigate and implement corrective actions.	None	None
CC 3	RL–WHC-TANKFARM-1993-0071	08/10/93	241-C-106	Inadequate work control results in personnel skin contamination at waste tank 241-C-106, PIT "B"	N/A	HA - Skin Contamination	Potential Delay	Direct	Declaration of an administrative hold of non-essential work at Tank Farms given. Resulting from combination of previous events within Tank Farms	241-C-106	No	No		Est days - ORPS Report did not specify when the Administrative Hold was lifted	N/A	
CC 6	RL–WHC-TANKFARM-1993-0083	09/06/93	241-AZ-801/241-AY-801	Failure to replace chart paper in 241-AY/AZ tank farm recorders results in an OSR non-conformance		HAEDMXXXL	Potential Delay	Indirect	A similar failure during maintenance could occur during Phase 1 operations with similar effects.		Yes	No	6	Based on ORPS report data to investigate and replace chart paper.	None	None

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 6	RL--WHC-TANKFAR M-1993-0090	10/08/93	241-SY-101 double-shell tank mixer pump operations	Waste tank 241-SY-101 safety analysis calculation error for ammonia release mechanism results in an unreviewed safety question		HAMPDXX XN	Potential Delay	Indirect	A similar error in FSAR/BIO calculations could be uncovered with similar effects.		Yes	No	0	Based on ORPS report to investigate and implement corrective actions.	None	The recovery time for this type of event could be large if it involved the generation of a Justification for Continued Operations report during the USQ investigation.
CC 3	RL--WHC-TANKFAR M-1993-0117	12/15/93	241-SX sludge cooler	Error in drawing interpretation causing work to be performed without appropriate precautions	Differential pressure switch	HA - Inattention to details	Potential Delay	Indirect	Violation of OSD "vapor space" requirements: did not use an electrical grounding strap not an explosive gas monitor	241-SX Tank Farm ventilation system	No	Yes	0	Violation discovered after work had been completed	2W-93-00078	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL–WHC-TANKFAR M-1994-0001	01/08/94	244-BX to 241-AN-101 transfer leak detection	Inadequate communications of operational information results in violation of alarm response procedure	N/A	HA - Procedure violation	Potential Delay	Direct	Transfer continued after receiving and alarm, procedure required transfer to have been terminated	244-BX DCRT to Tank 241-AN-101	No	No	0	Transfer essentially completed when it was finally shut down	N/A	
CC 3	RL--WHC-TANKFAR M-1994-0004	01/26/94	105-AN annulus continuous air monitor	Failure to initiate 4 hours operator surveillance of local annulus leak detection system results in OSR non-conformance	CAM	HA - Procedure Violation	Potential Delay	Direct	OSR requires that the annuli be equipped with at least one operable leak detection device. When continuous monitoring is interrupted, a 4 hr surveillance of the local leak detection alarm is required	241-AN - 105 Tank	No	No	0	Surveillance started once violation discovered. No active transfer was ongoing	N/A	
CC 1BF	RL--WHC-TANKFAR M-1994-0033	06/03/94		241-AP primary exhauster shutdown due to control power breaker trip		HAEDMXX XN	Potential Delay	Direct	This event could occur during Phase 1 operations with similar effects.		Yes	No	2.5	Based on ORPS report to replace switches and restore system to operation.	EE-94-580	None

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 6	RL–WHC-TANKFARM-1994-0046	08/19/94	200 east area waste tank hydroxide levels	Analysis of waste samples results in discovery of out-of-specification levels of hydroxide in 200 east area waste tanks	DST	HACADEX XN	Potential Delay	Direct	Improper chemical additions or dilution errors could occur during Phase 1 operations leading to similar effects.		Yes	No	888	Based on ORPS report to investigate and make proper chemical additions to bring the tank chemistry with OSD requirements.	Unknown	A similar event during Phase 1 operations would have a lesser impact because of the planned sampling and mixing operation built into the schedule.
CC 3	RL–WHC-TANKFARM-1994-0063	11/14/94	241-AW tank farm/242-A evaporator	Failure to properly implement double shell tank interim operational safety requirements results in missed surveillance requirements	Pit Covers	HA - Procedure Violation	Potential Delay	Direct	Violation of verification of covers once every 72 hrs once transfer begins for permanent covers and once per 12 hrs for temporary covers		No	No	0	Surveillance violation appears to have occurred over ~6 weeks, correction action (i.e., inspection of covers) was completed within 35 min. of discovery	N/A	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL--WHC-TANKFARM-1994-0064	11/16/94	241-BX-101	Inadequate communications lead to missed level surveillance in tank 101-BX	N/A	HA - Inattention to detail	Potential Delay	Direct	Violation of OSD, the level reading was taken within the 72 hrs grace period, however, written was not obtained	241-BX-101	No	No	0	ORPS Report did not specify what corrective actions were taken. There was not an active transfer ongoing at the time	N/A	
CC 6	RL--WHC-TANKFARM-1995-0050	05/30/95	102-AZ tank	Live electrical wire struck by worker during excavation		HAEDMXXXN	Potential Delay	Direct	A similar near miss event during Phase 1 operations could cause delays to implement corrective actions.		Yes	No	312	Based on ORPS report to investigate and implement corrective actions.	None	None
CC 3	RL--WHC-TANKFARM-1995-0082	10/03/95	241-SY/271-S-A/P-28 backup portable exhauster	Opening power supply breaker results in inadvertent shutdown of backup exhauster for 241-SY tank farm	EXT	HA	Potential delay		Violation occurred when establishing plant conditions for planned maintenance							

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 6	RL–WHC-TANKFAR M-1995-0091	10/19/95	241-S transfer system	Line fill resolves discrepancy in transfer line configuration	PIPE	HATEXXXX N	Potential Delay	Direct	A misrouting of water and or waste of similar proportions could occur during Phase 1 operations with similar effects.		Yes	No		Unknown based on ORPS report to investigate and recover.	None	Flush and recovery of proper routing appears to have taken less than one day. Water did leak through an open nozzle into a valve pit. If this had been waste, the delay would certainly have been longer.
CC 3	RL–WHC-TANKFAR M-1996-0003	01/05/96	Operator at AW tank farm	Personnel skin contamination at AW tank farm	N/A	HA - Inattention to details	Potential Delay	Direct	Pumping leak detection pits, crewmember became contaminated while removing tubing.	241-AW Leak Detection Pit	No	No		Pumping had been completed, contaminati on occur while exiting equipment from pit	N/A	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 1BF	RL--WHC-TANKFAR M-1996-0007	01/15/96	Double contained receiver tank 244-TX	Operating specifications document violation - liquid waste stored in tank 244-TX found to contain less hydroxide than required		HACADEX XN	Potential Delay	Indirect	Dilution errors and chemical addition errors are a possibility within the Phase 1 process. It may be possible to add too much or too little caustic to have to require recovery flushes which will then change the chemical specification of the delivery product.		No	No	0	Based on ORPS report that required no action to be taken.	None	None
CC 3	RL--WHC-TANKFAR M-1996-0017	02/14/96	AZ-101 thermocouple	Personnel potentially exceeded the administrative control level for extremity exposure	Thermocouple	HA - Inattention to details	Potential Delay	Direct	Work on project halted until completion of Type-C investigation.	AZ-101	No	No		Occurrence occurred while removing thermocouple tree. Work stopped to attend to personnel contamination, ORPS Report does not specify when work was resumed	N/A	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 6	RL--WHC-TANKFARM-1996-0050	07/15/96	Riser #14 on tank C-104	Tank C-104, Riser #14 was discovered to have no flange covering		HAFRFMXXN	Potential Delay	Direct	A similar event during Phase 1 operations would cause delay to prevent operator exposure.		Yes	Yes	672	Based on ORPS report to investigate and perform corrective maintenance.	ES-96-0468	None
CC 3	RL--WHC-TANKFARM-1996-0067	09/17/96	Tank C-106, pump pit, 06A, containment tent	97 gallons of water spilled into containment tent at tank C-106 pump pit	N/A	HA - Procedure Violation	Potential Delay	Direct	Water addition started without Shift Manager permission, without the Water Addition Authorization Sheet being signed by the Shift Manager, and without verifying the water addition line-up	C-106 Tank	No	No		Work stopped, area surveyed for contamination spread, and water removed from containment tent. Time necessary to complete water addition not specified in ORPS	N/A	
CC 6	RL--WHC-TANKFARM-1996-0072	09/24/96	AN-105 void viscometer	Non-sparking tools used for intrusive work		HAEDMXXXH	Potential Delay	Direct	Non-sparking tools are required for intrusive maintenance on Phase 1 systems. A similar stop work order would cause delay.		Yes	Yes		Many corrective actions were required to better train workers on flammable gas issues but it was not indicated when the maintenance work was completed.	Unknown	None

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 2	RL--PHMC-TANKFARM-1996-0001	10/04/96	Single shell tank 241-U-110/level indicating transmitter	Failure to obtain an intrusion detection reading per the operating specification document results in a procedure violation	LI	HA	Potential Delay	Direct	OSD-T-151-00031 violated	241-U-110	Yes	Yes		Temporary round sheet immediately implemente d once violation discovered.	N/A	After two weeks of baseline data, the frequent of readings was returned to quarterly per the round sheets
CC 3	RL--PHMC-TANKFARM-1996-0002	10/08/96	AN tank farm	Loss of ventilation in AN tank farm	EDS-DP-103 Distribution Panel	HA - Inattention to detail	Potential Delay	Direct	Loss of power, resulting in loss of primary and annulus stack CAM alarms, heat trace alarms, fan failure and HEPA low D/P alarms. The primary fan failure and HEPA low D/P alarms stayed locked in. AN Farm evacuated	AN Tank Farm	No	No	1	Ventilation was off for ~ 22 min.	N/A	

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL--PHMC-TANKFAR M-1996-0006	10/18/96	241-A-A valve pit leak detector	241-A-A intrinsically safe leak detector does not meet design requirements of the authorization basis	Leak Detector	HA - Inattention to detail	Potential Delay	Direct	Transfers that depend on the leak detector being operable were not allowed	241-A Valve Pit	Yes	No		ORPS did not specify how long it took to recover from this event	ES-96-371	
CC 6	RL--PHMC-TANKFAR M-1997-0029	03/17/97	241-SY	Electrical line severed during excavation		HAEEXXXX N	Potential Delay	Direct	A similar event during Phase 1 operations would cause delay if power were cut off to critical systems.		Yes	No	312	Based on ORPS report to investigate and complete required repairs to the severed cable.	Unknown	None
CC 6	RL--PHMC-TANKFAR M-1997-0040	04/28/97	241-S-108 SST, 241-S-110 SST, 244-S DCRT	Failure to perform preventative maintenance results in OSD violation		HAFACXXX L	Potential Delay	Direct	A failure to schedule and perform OSD related work on Phase 1 systems would create delay in transfer operations.		Yes	No	72	Based on ORPS report to investigate event and perform the missed maintenance evolution.	Unknown	None
CC 6	RL--PHMC-TANKFAR M-1997-0042	04/30/97	204-AR record sample	Operations safety requirement was found to be inconsistent with facility environmental requirements		HAFACXXX L	Potential Delay	Direct	A failure to schedule and perform OSD related work on Phase 1 systems would create delay in transfer operations.		Yes	No	840	Based on ORPS report to investigate event and perform the missed maintenance evolution.	Unknown	None

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
CC 3	RL–PHMC-TANKFARM-1997-0056	06/27/97	241-SY valve pits	Skin contamination discovered on person when exiting 241-SY tank farm	N/A	HA - Procedure Violation	Potential Delay	Direct	Decision to reinstall jumper with personnel in the pit instead of remotely was made without the RWP prepares, ALARA committee, or West Tank Farm management knowledge	241-SY Valve Pit	No	No	0	Construction activity, transfer no in progress	N/A	
CC 3	RL–PHMC-TANKFARM-1997-0092	11/17/97	Tank 101-AN, pits 01D and 01E drain seals	Non-intrinsically safe leak detectors were discovered to be not isolated from tank 101-AN	N/A	HA - Inattention to details	Potential Delay	Direct	SSCs required to be operational per BIO were not operating within approved requirements	AN-101 Tank, Pits 01D and 01E Drain Seals	Yes	Yes		ORPS Report was unclear when violation was discovered or any corrective taken	N/A	
Null	RL–PHMC-TANKFARM-1998-0005	01/13/98	Tank 102-AZ annulus leak detection system	Failure to perform required actions within the specified time frame for loss of primary tank leak detection per AZ-102, l.c.o. 3.2.6	Leak Detection	HA - Procedure Violation	Potential Delay	Direct	BIO/TSR related problem, flammable gas must be verified to be less than 25% of the LFL once per 12 hrs.	102-AZ	Yes	No	0	Flammable gas verified to be less than 25% LFL, manually checked every 6 hrs until system repaired		

Table D-6. Events from ORPS that Have a Potential to Produce Delays in WFDS Schedule Activities (Continued)

Direct Cause	ORPS ID	Discovery Date	System/ Building	Title	Component Type	Failure Mode Code	Failure Effect	RAM_ Applicability	Rationale	RAM Equip ID	Safety Related	Intrusive	Restoration Time	Time Rationale	JCS_Ref	Comments
Null	RL--PHMC-TANKFARM-1998-0011	02/03/98	244-A Continuous Air Monitor (CAM)	244-A continuous air monitor alarm setpoint was found to be out of range	CAM	HA - CAM set-point improperly set	Insignificant Impact	Direct	CAM alarm set-point incorrectly set. Found by personnel.	244-A Tank	Yes	No		Exhauster shutdown until analysis of sample paper is completed, ORPS Report did not define a restart time	N/A	
Null	RL--PHMC-TANKFARM-1998-0013	02/06/98	Ventilation System/242-S Evaporator	Loss of ventilation system at the 242-S evaporator (shutdown facility) has no adverse effects on personnel, the facility or environment	N/A	HA - Inattention to details	Potential Delay	Direct	Loss of ventilation to process facility serving a confinement function	242-S Evaporator	Yes	No	1	Power restored to facility, power restored to building's Motor Control Center and ventilation system, tag hung on defective breaker	Not listed	

Appendix E. Critical Items List and Supplemental Information Supporting RAM Analysis of Waste Feed Delivery Activities from Source Tank 241-AN-102

Figures

E-1 Simulation Results for Waste Transfer Activities from 241-AN-102 to the WTP (Note: This figure contains numerous pages of text and graphics generated by the Crystal Ball report generator.)

Tables

E-1 Waste Flowsheet Volume Summary for Waste Transfer Activities from 241-AN-102 to the WTP

E-2 Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by System Contribution to Schedule Delay

E-3 Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

E-4 Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure

E-5 Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay

E-6 Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Activity Contribution to Schedule Delay

E-7 Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

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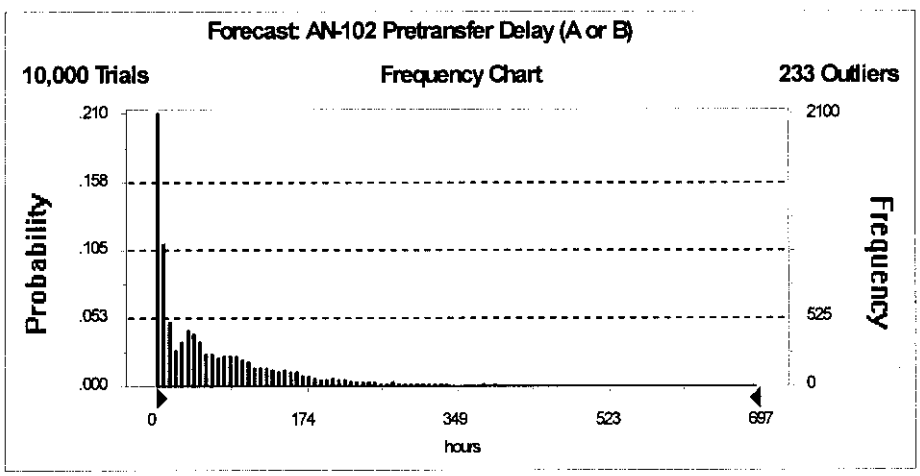
Crystal Ball Report
Simulation started on 9/4/00 at 10:18:36
Simulation stopped on 9/4/00 at 10:50:33

Forecast: AN-102 Pretransfer Delay (A or B) **Cell: E10**

Summary:
Display Range is from 0 to 697 hours
Entire Range is from 0 to 4251 hours
After 10,000 Trials, the Std. Error of the Mean is 2

Statistics:	Value
Trials	10000
Mean	109
Median	46
Mode	0
Standard Deviation	228
Variance	52062
Skewness	6.47
Kurtosis	65.72
Coeff. of Variability	2.10
Range Minimum	0
Range Maximum	4251
Range Width	4251
Mean Std. Error	2.28



Forecast: AN-102 Pretransfer Delay (A or B) (cont'd) **Cell: E10**

Percentiles:

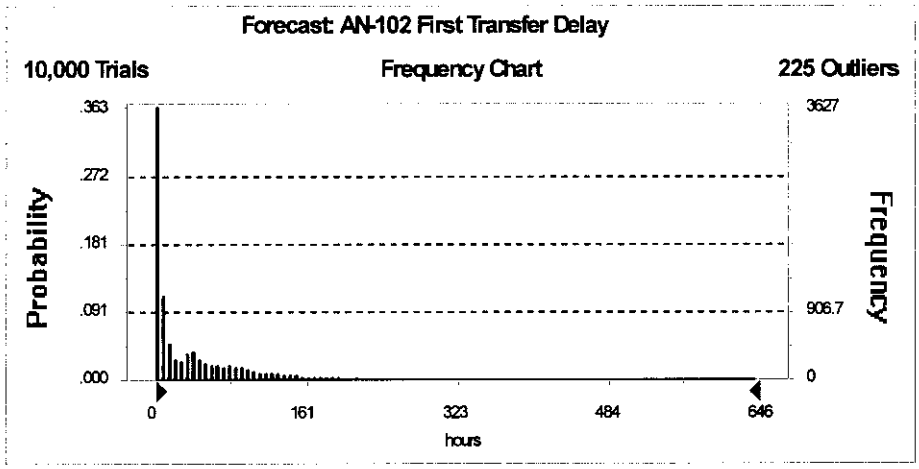
Percentile	hours
0%	0
5%	0
10%	2
15%	4
20%	6
25%	9
30%	12
35%	17
40%	29
45%	38
50%	46
55%	56
60%	69
65%	84
70%	99
75%	117
80%	142
85%	173
90%	232
95%	381
100%	4251

End of Forecast

Forecast: AN-102 First Transfer Delay **Cell: E12**

Summary:
Display Range is from 0 to 646 hours
Entire Range is from 0 to 4514 hours
After 10,000 Trials, the Std. Error of the Mean is 2

Statistics:	Value
Trials	10000
Mean	81
Median	15
Mode	0
Standard Deviation	226
Variance	51066
Skewness	7.48
Kurtosis	80.64
Coeff. of Variability	2.80
Range Minimum	0
Range Maximum	4514
Range Width	4514
Mean Std. Error	2.26



Forecast: AN-102 First Transfer Delay (cont'd) **Cell: E12**

Percentiles:

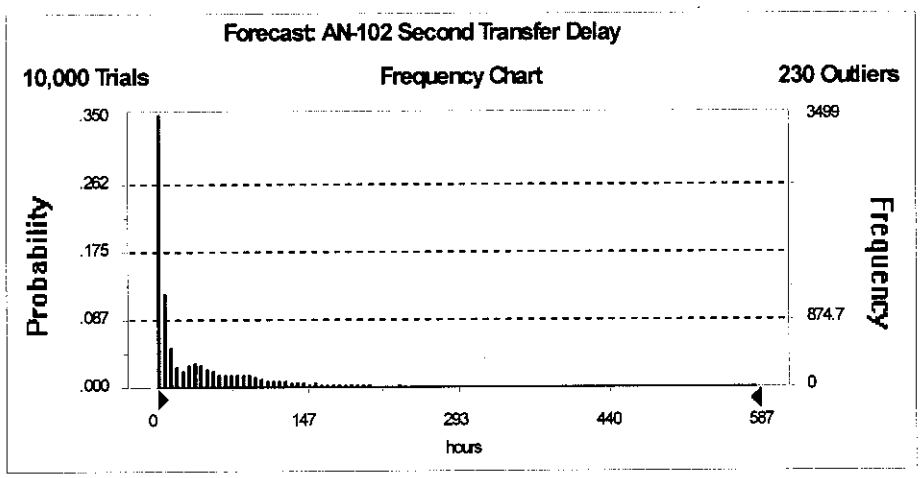
Percentile	hours
0%	0
5%	0
10%	0
15%	0
20%	2
25%	3
30%	4
35%	6
40%	8
45%	11
50%	15
55%	25
60%	36
65%	45
70%	57
75%	73
80%	92
85%	118
90%	165
95%	304
100%	4514

End of Forecast

Forecast: AN-102 Second Transfer Delay **Cell: E13**

Summary:
Display Range is from 0 to 587 hours
Entire Range is from 0 to 3123 hours
After 10,000 Trials, the Std. Error of the Mean is 2

Statistics:	Value
Trials	10000
Mean	74
Median	14
Mode	0
Standard Deviation	193
Variance	37367
Skewness	6.66
Kurtosis	60.59
Coeff. of Variability	2.62
Range Minimum	0
Range Maximum	3123
Range Width	3123
Mean Std. Error	1.93



Forecast: AN-102 Second Transfer Delay (cont'd) **Cell: E13**

Percentiles:

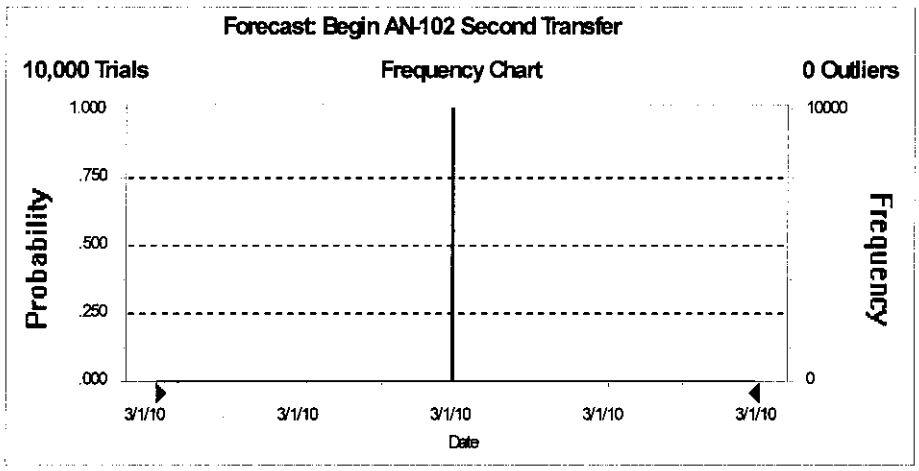
Percentile	hours
0%	0
5%	0
10%	0
15%	0
20%	2
25%	3
30%	4
35%	6
40%	8
45%	10
50%	14
55%	23
60%	35
65%	44
70%	56
75%	72
80%	90
85%	113
90%	157
95%	276
100%	3123

End of Forecast

Forecast: Begin AN-102 Second Transfer **Cell: C19**

Summary:
Display Range is from 3/1/10 to 3/1/10 Date
Entire Range is from 3/1/10 to 3/1/10 Date
After 10,000 Trials, the Std. Error of the Mean is 0/0/0

Statistics:	Value
Trials	10000
Mean	3/1/10
Median	3/1/10
Mode	3/1/10
Standard Deviation	0.00
Variance	0.00
Skewness	0.00
Kurtosis	+Infinity
Coeff. of Variability	0.00
Range Minimum	3/1/10
Range Maximum	3/1/10
Range Width	0.00
Mean Std. Error	0.00



Forecast: Begin AN-102 Second Transfer (cont'd) **Cell: C19**

Percentiles:

Percentile	Date
0%	3/1/10
5%	3/1/10
10%	3/1/10
15%	3/1/10
20%	3/1/10
25%	3/1/10
30%	3/1/10
35%	3/1/10
40%	3/1/10
45%	3/1/10
50%	3/1/10
55%	3/1/10
60%	3/1/10
65%	3/1/10
70%	3/1/10
75%	3/1/10
80%	3/1/10
85%	3/1/10
90%	3/1/10
95%	3/1/10
100%	3/1/10

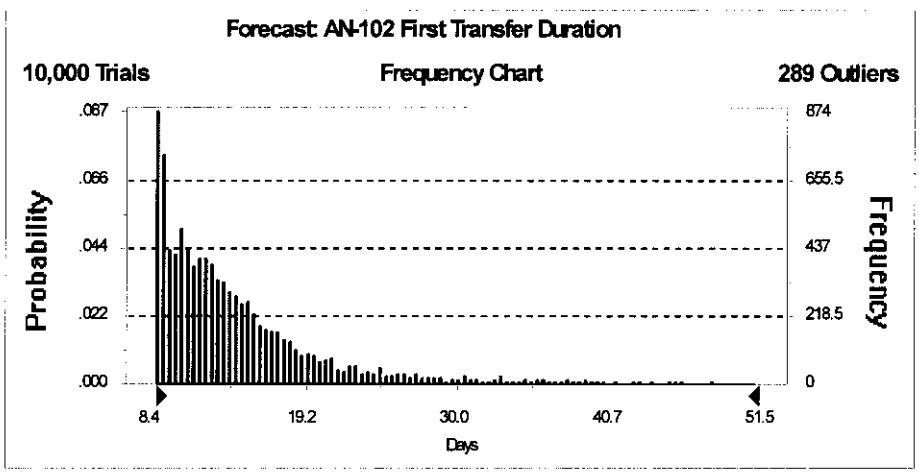
End of Forecast

Forecast: AN-102 First Transfer Duration **Cell: F18**

Summary:

Display Range is from 8.4 to 51.5 Days
Entire Range is from 8.4 to 197.3 Days
After 10,000 Trials, the Std. Error of the Mean is 0.1

Statistics:	Value
Trials	10000
Mean	16.5
Median	12.8
Mode	8.4
Standard Deviation	13.4
Variance	179.9
Skewness	4.84
Kurtosis	36.08
Coeff. of Variability	0.81
Range Minimum	8.4
Range Maximum	197.3
Range Width	188.9
Mean Std. Error	0.13



Forecast: AN-102 First Transfer Duration (cont'd) **Cell: F18**

Percentiles:

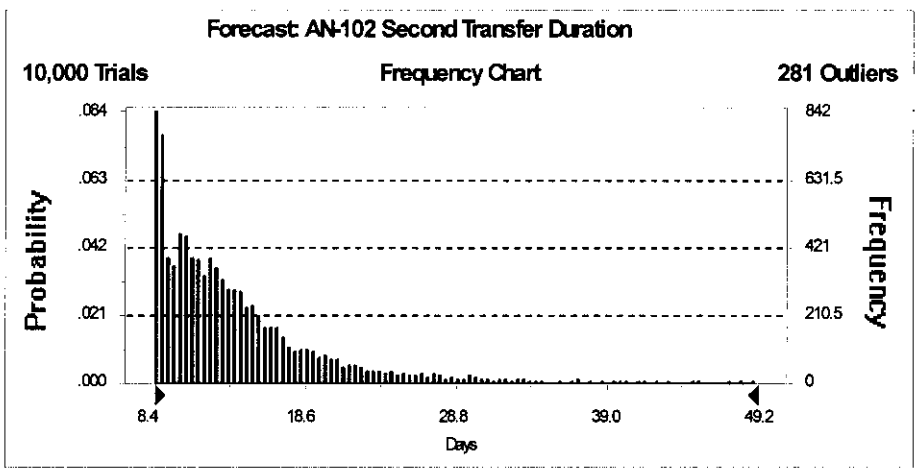
Percentile	Days
0%	8.4
5%	8.7
10%	8.9
15%	9.2
20%	9.7
25%	10.2
30%	10.6
35%	11.1
40%	11.7
45%	12.2
50%	12.8
55%	13.4
60%	14.1
65%	14.9
70%	15.8
75%	17.0
80%	18.5
85%	20.9
90%	25.3
95%	37.4
100%	197.3

End of Forecast

Forecast: AN-102 Second Transfer Duration **Cell: F19**

Summary:
Display Range is from 8.4 to 49.2 Days
Entire Range is from 8.4 to 204.3 Days
After 10,000 Trials, the Std. Error of the Mean is 0.1

Statistics:	Value
Trials	10000
Mean	16.2
Median	12.7
Mode	8.4
Standard Deviation	12.5
Variance	155.8
Skewness	4.65
Kurtosis	34.42
Coeff. of Variability	0.77
Range Minimum	8.4
Range Maximum	204.3
Range Width	195.9
Mean Std. Error	0.12



Forecast: AN-102 Second Transfer Duration (cont'd) **Cell: F19**

Percentiles:

Percentile	Days
0%	8.4
5%	8.6
10%	8.9
15%	9.1
20%	9.6
25%	10.1
30%	10.6
35%	11.0
40%	11.6
45%	12.1
50%	12.7
55%	13.3
60%	14.0
65%	14.7
70%	15.6
75%	16.8
80%	18.4
85%	20.6
90%	24.9
95%	36.6
100%	204.3

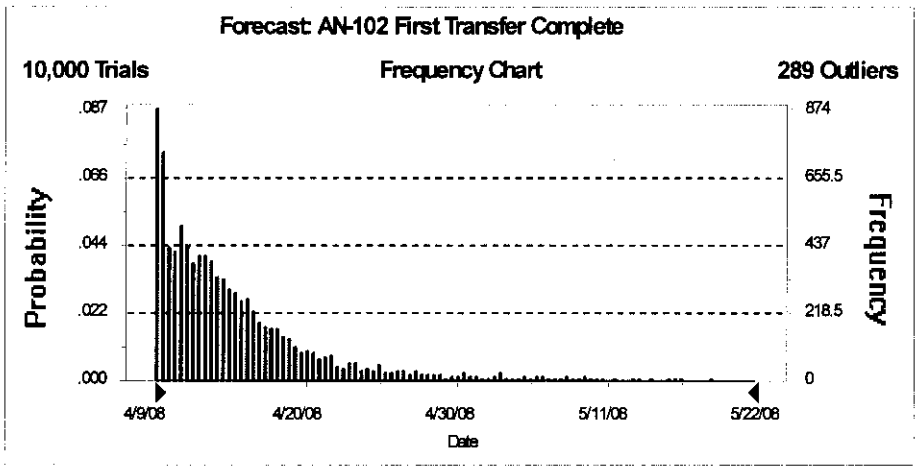
End of Forecast

Forecast: AN-102 First Transfer Complete **Cell: G18**

Summary:

Display Range is from 4/9/08 to 5/22/08 Date
Entire Range is from 4/9/08 to 10/15/08 Date
After 10,000 Trials, the Std. Error of the Mean is 1/0/00

Statistics:	Value
Trials	10000
Mean	4/17/08
Median	4/13/08
Mode	4/9/08
Standard Deviation	13.41
Variance	179.85
Skewness	4.84
Kurtosis	36.08
Coeff. of Variability	0.00
Range Minimum	4/9/08
Range Maximum	10/15/08
Range Width	188.92
Mean Std. Error	0.13



Forecast: AN-102 First Transfer Complete (cont'd) **Cell: G18**

Percentiles:

Percentile	Date
0%	4/9/08
5%	4/9/08
10%	4/9/08
15%	4/10/08
20%	4/10/08
25%	4/11/08
30%	4/11/08
35%	4/12/08
40%	4/12/08
45%	4/13/08
50%	4/13/08
55%	4/14/08
60%	4/15/08
65%	4/15/08
70%	4/16/08
75%	4/18/08
80%	4/19/08
85%	4/21/08
90%	4/26/08
95%	5/8/08
100%	10/15/08

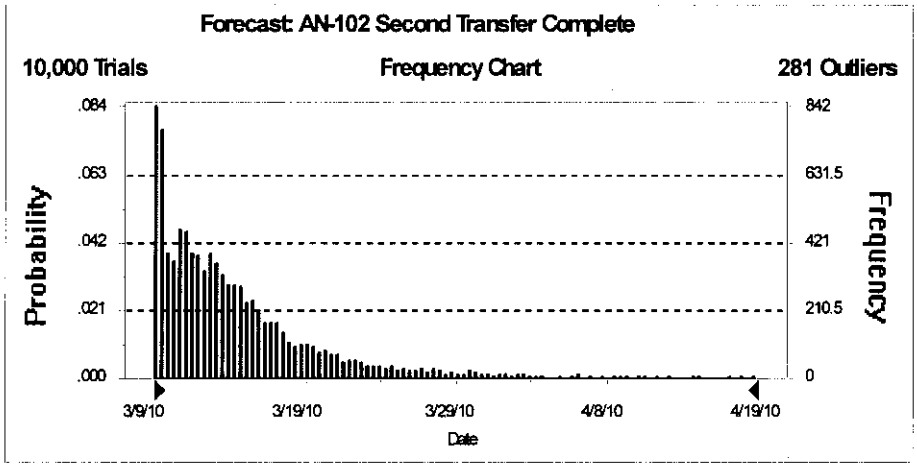
End of Forecast

Forecast: AN-102 Second Transfer Complete **Cell: G19**

Summary:

Display Range is from 3/9/10 to 4/19/10 Date
Entire Range is from 3/9/10 to 9/21/10 Date
After 10,000 Trials, the Std. Error of the Mean is 1/0/00

Statistics:	Value
Trials	10000
Mean	3/17/10
Median	3/13/10
Mode	3/9/10
Standard Deviation	12.48
Variance	155.82
Skewness	4.65
Kurtosis	34.42
Coeff. of Variability	0.00
Range Minimum	3/9/10
Range Maximum	9/21/10
Range Width	195.92
Mean Std. Error	0.12



Forecast: AN-102 Second Transfer Complete (cont'd) **Cell: G19**

Percentiles:

Percentile	Date
0%	3/9/10
5%	3/9/10
10%	3/9/10
15%	3/10/10
20%	3/10/10
25%	3/11/10
30%	3/11/10
35%	3/12/10
40%	3/12/10
45%	3/13/10
50%	3/13/10
55%	3/14/10
60%	3/14/10
65%	3/15/10
70%	3/16/10
75%	3/17/10
80%	3/19/10
85%	3/21/10
90%	3/25/10
95%	4/6/10
100%	9/21/10

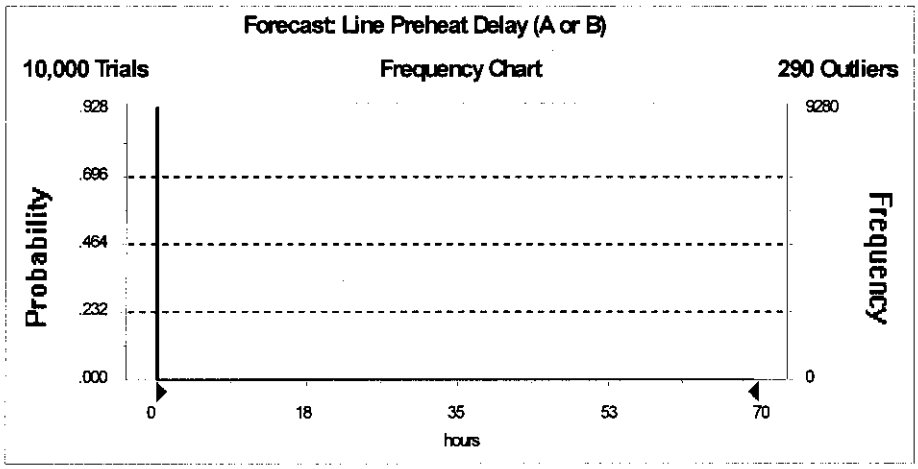
End of Forecast

Forecast: Line Preheat Delay (A or B) **Cell: E11**

Summary:

Display Range is from 0 to 70 hours
Entire Range is from 0 to 350 hours
After 10,000 Trials, the Std. Error of the Mean is 0

Statistics:	Value
Trials	10000
Mean	4
Median	0
Mode	0
Standard Deviation	22
Variance	503
Skewness	6.68
Kurtosis	58.82
Coeff. of Variability	5.03
Range Minimum	0
Range Maximum	350
Range Width	350
Mean Std. Error	0.22



Forecast: Line Preheat Delay (A or B) (cont'd) **Cell: E11**

Percentiles:

Percentile	hours
0%	0
5%	0
10%	0
15%	0
20%	0
25%	0
30%	0
35%	0
40%	0
45%	0
50%	0
55%	0
60%	0
65%	0
70%	0
75%	0
80%	0
85%	0
90%	0
95%	11
100%	350

End of Forecast

Assumptions

End of Assumptions

Table E-1. Waste Flowsheet Volume Summary for Waste Transfer Activities from 241-AN-102 to the WTP

Activity	Volume (m3)	Volume (gal)	Time (hrs)	Inches of Waste	Comment	Reference
Starting Waste Volume in AN-102	3480	919,312		322.6		AN-102 Flowsheet
Supernate Decanted to the WTP in First Transfer	1690	446,447		156.6	Based on transfer pump position	AN-102 Flowsheet
In-line dilution during AN-102 to WTP Transfer	880	232,470		81.6		AN-102 Flowsheet
Total first transfer to the WTP	2570	678,917	81	238.2		
Waste Volume in AN-102 After Decant	1790	472,864		165.9		
Starting Waste Volume in AN-102	1770	467,581		164.1	Includes other in leakages, line preheats and evaporation losses over the interim storage duration	
Supernate Decanted to the WTP in First Transfer	1660	438,522		153.9	Based on transfer pump position	AN-102 Flowsheet
In-line dilution during AN-102 to WTP Transfer	880	232,470		81.6		
Total second transfer to the WTP	2540	670,992	80	235.4		AN-102 Flowsheet
Heel Remaining in AP-104 after transfer	110	29,059		10.2	Heel required to maintain minimum level allowed by pump NPSH requirements	

Source: Orme, R.M., 1999, Waste Feed Delivery Technical Basis, HNF-1939-Vol. II, "Waste Feed Delivery Flowsheet for 241-AN-102" Appendix A, Rev.1, Numatec Hanford Corporation, Richland, Washington (Orme, 2000a)

Table E-2. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by System Contribution to Schedule Delay

System	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Total	**4.2**	**196.1**	**46.9**	**100%**	**100%**
Waste Transfer AN-102	3.0E-01	49.7	163.2	7.3%	25.3%
Diluent/Flush System	4.2E-01	34.9	84.0	9.9%	17.8%
Waste Transfer Routes	3.9E-02	29.5	763.4	0.9%	15.0%
Primary HVAC	2.7E-01	22.5	84.2	6.4%	11.5%
External Events	2.6E+00	19.7	7.5	63.2%	10.0%
Support/Utilities	2.1E-01	14.7	71.2	4.9%	7.5%
Annulus HVAC	1.3E-01	13.2	103.9	3.0%	6.7%
Confinement System	1.7E-01	9.6	57.1	4.0%	4.9%
Human Actions	1.4E-02	2.4	170.9	0.3%	1.2%

Table E-3. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
	Total	**4.2**	**196.1**	**46.9**	**100%**	**100%**
Waste Transfer AN-102	Transfer Pump	2.7E-01	46.1	170.8	6.5%	23.5%
Primary HVAC	Ventilation Tank Primary	2.7E-01	22.5	84.2	6.4%	11.5%
Diluent/Flush System	Diluent/Flush Delivery	2.1E-01	16.7	81.3	4.9%	8.5%
External Events	Weather	2.5E+00	16.3	6.6	59.4%	8.3%
Support/Utilities	Compressed Air	2.0E-01	14.3	70.7	4.8%	7.3%
Waste Transfer Route	Waste Transfer AN-105/AN-102	1.7E-02	13.5	776.1	0.4%	6.9%
Annulus HVAC	Ventilation Tank Annulus	1.3E-01	13.2	103.9	3.0%	6.7%
Diluent/Flush System	Diluent/Flush Preparation	1.9E-01	13.1	67.5	4.6%	6.7%
Waste Transfer Route	Waste Transfer AN-102/Stage	1.4E-02	11.1	776.1	0.3%	5.6%
Confinement System	Waste Storage Tank	9.7E-02	5.5	57.0	2.3%	2.8%
Waste Transfer Route	Diluent/Flush System	6.1E-03	4.7	776.1	0.1%	2.4%
Waste Transfer Route	Waste Transfer AN-105/AN-102/Stage	4.3E-03	3.3	776.1	0.1%	1.7%
Waste Transfer Route	Waste Transfer AN-102	1.9E-02	2.8	141.8	0.5%	1.4%
External Events	Hanford	6.0E-02	2.6	43.7	1.4%	1.3%
Confinement System	Primary Monitoring	3.1E-02	2.4	77.2	0.7%	1.2%
Human Actions	Transfer Pump	8.0E-03	2.0	255.3	0.2%	1.0%
Waste Transfer Route	Waste Transfer AN-105	2.5E-03	1.6	612.8	0.1%	0.8%
Confinement System	Leak Detection Pit	2.2E-02	0.9	43.9	0.5%	0.5%
Confinement System	Waste Tank AN-102	1.9E-02	0.8	40.7	0.5%	0.4%
Waste Transfer AN-102	Process Monitoring	7.4E-03	0.6	82.8	0.2%	0.3%
External Events	Electrical Distribution	9.1E-02	0.5	6.0	2.2%	0.3%
Diluent/Flush System	Diluent/Flush Storage	9.6E-03	0.4	38.8	0.2%	0.2%
Waste Transfer Route	Human Actions	6.0E-03	0.4	58.4		0.2%
Support/Utilities	Electrical Distribution	3.1E-03	0.3	102.3	0.1%	0.2%
Waste Transfer AN-102	Electrical Feed to Waste Transfer System	7.0E-03	0.2	32.5	0.2%	0.1%
External Events	Off Site	7.3E-03	0.2	24.0	0.2%	0.1%
Waste Transfer AN-102	Waste Transfer System	1.0E-03	0.04	35.6	0.02%	0.02%
Waste Transfer Route	Waste Transfer AN-105	1.3E-04	0.02	154.7	0.003%	0.01%
Confinement System	Tank Structure	1.7E-05	0.003	154.7	0.0004%	0.0014%
Waste Transfer Route	Waste Transfer AN-105/Stage	3.7E-06	0.003	691.7	0.0001%	0.0013%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
				Total	4.1	196.1	47.3	100%	100%
Annulus HVAC	Ventilation Tank Annulus	Air Inlet AN-102	Filter Bank	Filters	2.1E-03	0.2	76	5.0E-04	0.08%
Annulus HVAC	Ventilation Tank Annulus	Air Inlet AN-102	Isolation Valve	Isolation Valve	3.2E-04	0.0	155	7.8E-05	0.03%
Annulus HVAC	Ventilation Tank Annulus	Air Outlet AN-102	Isolation Valve	Isolation Valve	3.2E-04	0.0	155	7.8E-05	0.03%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train A	Demister	Demister	5.5E-04	0.0	76	1.3E-04	0.02%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train A	Exhaust Fan	Fan	7.0E-03	1.1	155	1.7E-03	0.55%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train A	Exhaust Fan	Instrumentation	9.0E-03	0.3	38	2.2E-03	0.17%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train A	Filter Bank	Filters	2.1E-03	0.2	76	5.0E-04	0.08%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train A	Filter Bank	Instrumentation	6.0E-04	0.1	158	1.4E-04	0.05%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train B	Exhaust Fan	Fan	9.9E-04	0.2	155	2.4E-04	0.08%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train B	Exhaust Fan	Instrumentation	5.4E-03	0.3	49	1.3E-03	0.14%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Trains A & B	Exhaust Trains Temperature Control	Exhaust Trains Temperature Control	2.1E-05	0.0	187	5.1E-06	0.002%
Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	6.9E-02	6.7	98	1.7E-02	3.43%
Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	Record Sampling	Record Sampling	3.0E-02	4.1	136	7.2E-03	2.07%
Confinement System	Leak Detection Pit	Leak Detection	Transmitter Enclosure	Alarm	2.0E-02	0.7	36	4.8E-03	0.36%
Confinement System	Leak Detection Pit	Leak Detection	Transmitter Enclosure	Switch	7.1E-04	0.1	158	1.7E-04	0.06%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Confinement System	Leak Detection Pit	Leak Detection	Transmitter Enclosure	Valve	7.5E-04	0.1	158	1.8E-04	0.06%
Confinement System	Primary Monitoring	Tank Monitoring	Dome Pressure	Tank Pressure Monitoring	1.8E-02	1.3	73	4.3E-03	0.66%
Confinement System	Primary Monitoring	Tank Monitoring	Dome Pressure	Tank Pressure Monitoring System	1.6E-03	0.1	36	3.8E-04	0.03%
Confinement System	Primary Monitoring	Waste Monitoring	Waste Level	Waste Level Monitor	6.6E-03	0.3	42	1.6E-03	0.14%
Confinement System	Primary Monitoring	Waste Monitoring	Waste Temperature	Waste Temperature Monitoring System	4.7E-03	0.7	158	1.1E-03	0.38%
Confinement System	Tank Structure	Tank Structure	Tank Structure	Tank Structure	1.7E-05	0.0	155	4.1E-06	0.001%
Confinement System	Waste Storage Tank	Flow	Flow Control	Valve	1.5E-03	0.2	158	3.6E-04	0.12%
Confinement System	Waste Storage Tank	Instrumentation	Instrumentation	Alarm		1.2	#DIV/0!	0.0E+00	0.62%
Confinement System	Waste Storage Tank	Instrumentation	Instrumentation	Computer	2.5E-02	1.0	40	6.0E-03	0.51%
Confinement System	Waste Storage Tank	Instrumentation	Instrumentation	Recorder	1.2E-02	0.4	36	3.0E-03	0.22%
Confinement System	Waste Storage Tank	Instrumentation	Instrumentation	Switch	6.6E-04	0.0	36	1.6E-04	0.01%
Confinement System	Waste Storage Tank	Instrumentation	Instrumentation	Valve	3.7E-03	0.5	130	9.0E-04	0.25%
Confinement System	Waste Storage Tank	Instrumentation	Pressure Monitoring	Indicator	9.5E-03	1.5	158	2.3E-03	0.76%
Confinement System	Waste Storage Tank	Instrumentation	Pressure Monitoring	Instrumentation	9.7E-04	0.2	175	2.3E-04	0.09%
Confinement System	Waste Storage Tank	Instrumentation	Pressure Monitoring	Transmitter	2.6E-03	0.2	68	6.2E-04	0.09%
Confinement System	Waste Storage Tank	Instrumentation	Pressure Monitoring	Valve	1.4E-03	0.1	90	3.4E-04	0.07%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Confinement System	Waste Storage Tank	Level	Level Control	Element	2.4E-04	0.0	158	5.7E-05	0.02%
Confinement System	Waste Storage Tank	Level	Level Control	Transmitter	1.3E-03	0.1	68	3.1E-04	0.04%
Confinement System	Waste Storage Tank	Monitoring	Monitoring	Sight Glass	6.3E-05	0.0	66	1.5E-05	0.00%
Confinement System	Waste Tank AN-102	Annulus Instrumentation System	Radiation Monitoring	Alarm	8.8E-03	0.3	37	2.1E-03	0.16%
Confinement System	Waste Tank AN-102	Annulus Instrumentation System	Radiation Monitoring	Computer	7.6E-03	0.3	40	1.8E-03	0.16%
Confinement System	Waste Tank AN-102	Annulus Instrumentation System	Radiation Monitoring	Monitor	1.4E-03	0.1	74	3.3E-04	0.05%
Confinement System	Waste Tank AN-102	Annulus Instrumentation System	Radiation Monitoring	Switch	1.3E-03	0.0	36	3.0E-04	0.02%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Delivery Line	Isolation Valves	4.3E-02	3.8	90	1.0E-02	1.95%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Delivery Line	Pipe	6.4E-04	0.1	90	1.5E-04	0.03%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Pump	Diluent/Flush Pump	1.4E-02	0.7	46	3.5E-03	0.33%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Pump	Sample Valve	3.9E-04	0.0	90	9.3E-05	0.02%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Tank Recirc Line	Diluent/Flush Tank Recirc Line	3.8E-02	3.4	90	9.2E-03	1.74%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Discharge Flow	Discharge Flow Control	1.4E-03	0.1	38	3.5E-04	0.03%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Process Instrumentation	Process Instrumentation	2.0E-02	0.8	40	4.8E-03	0.41%
Diluent/Flush System	Diluent/Flush Delivery	Storage to Transport Lines	Diluent/Flush Pump	Diluent/Flush Pump	8.8E-02	7.9	90	2.1E-02	4.01%
Diluent/Flush System	Diluent/Flush Preparation	Caustic Addition	Caustic Supply Truck to Storage Tank	Caustic Pump Enclosure	9.4E-03	0.6	61	2.3E-03	0.29%
Diluent/Flush System	Diluent/Flush Preparation	Caustic Addition	Caustic Supply Truck to Storage Tank	Process Line	6.4E-04	0.1	90	1.5E-04	0.03%
Diluent/Flush System	Diluent/Flush Preparation	Caustic/Hot Water Ratio Control	Caustic/Hot Water Ratio Control	Caustic/Hot Water Ratio Control	5.7E-02	4.1	72	1.4E-02	2.10%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Boiler	Boiler	2.7E-02	1.2	44	6.6E-03	0.62%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Boiler Blowdown Sump	Raw Water Feed Lines to Sump	5.4E-03	0.2	36	1.3E-03	0.10%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Enclosure Radiation Monitor	4.5E-03	0.5	106	1.1E-03	0.24%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Instrumentation	3.6E-03	0.6	158	8.8E-04	0.29%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Raw Water Supply Line	7.2E-04	0.1	90	1.7E-04	0.03%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Self Cleaning Strainer	4.3E-02	2.1	47	1.0E-02	1.05%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Valves	4.1E-02	3.7	89	9.9E-03	1.87%
Diluent/Flush System	Diluent/Flush Preparation	Safety Shower/Eyewash	Safety Shower Potable Water Feed	Water Heater	7.0E-04	0.1	90	1.7E-04	0.03%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Diluent/Flush System	Diluent/Flush Preparation	Safety Shower/Eyewash	Shower/Eyewash Flow	Drain Valve	3.1E-04	0.0	155	7.5E-05	0.02%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Diluent/Flush Analysis Instrumentation	Diluent/Flush Analysis Instrumentation	2.5E-03	0.1	37	6.0E-04	0.05%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Diluent/Flush Level Instruments	Diluent/Flush Level Instruments	2.9E-03	0.1	36	7.1E-04	0.05%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Diluent/Flush Temperature Control	Diluent/Flush Temperature Control	3.7E-03	0.1	37	9.0E-04	0.07%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Drain Valve	Drain Valve	3.9E-04	0.0	90	9.3E-05	0.02%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Tank Structure	Tank Structure	2.6E-05	0.0	90	6.2E-06	0.00%
Diluent/Flush System	Transfer Route	Piping	Piping	Jumper	2.7E-04	0.2	776	6.5E-05	0.11%
Diluent/Flush System	Transfer Route	Piping	Piping	Nozzle	7.7E-05	0.1	776	1.9E-05	0.03%
Diluent/Flush System	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	5.7E-03	4.5	776	1.4E-03	2.27%
External Events	Electrical Distribution	Electrical Distribution	Electrical Distribution	Electrical Distribution	9.1E-02	0.5	6	2.2E-02	0.28%
External Events	Hanford	Miscellaneous Events	Work Stoppage	Work Stoppage	4.5E-02	2.6	57	1.1E-02	1.31%
External Events	Hanford	Non Tank Farm Human Error	Non Tank Farm Human Error	Non Tank Farm Human Error	1.5E-02	0.1	4	3.6E-03	0.03%
External Events	Off Site	Miscellaneous Events	Work Stoppage	Work Stoppage	7.3E-03	0.2	24	1.8E-03	0.09%
External Events	Weather	Lighting	Lighting	Lighting	5.7E-01	1.7	3	1.4E-01	0.87%
External Events	Weather	Precipitation	Precipitation	Precipitation	4.7E-01	3.8	8	1.1E-01	1.92%
External Events	Weather	Temperature	Temperature High	Temperature High	2.4E-01	1.7	7	5.7E-02	0.85%
External Events	Weather	Temperature	Temperature Low	Temperature Low	3.1E-01	2.4	8	7.4E-02	1.24%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
External Events	Weather	Wind	Wind Gusts	Wind Gusts	9.0E-01	6.7	7	2.2E-01	3.44%
Human Actions	Transfer Pump	Transfer Pump	Transfer Pump	Transfer Pump	8.0E-03	2.0	255	1.9E-03	1.04%
Human Actions	Transfer Route	Transfer Route	Transfer Route	Transfer Route	6.0E-03	0.4	58	1.4E-03	0.18%
Primary HVAC	Ventilation Tank Primary	Air Inlet	Air Inlet	Air Inlet	1.0E-03	0.2	155	2.4E-04	0.08%
Primary HVAC	Ventilation Tank Primary	Air Inlet	HEPA Filter	Filter	1.0E-03	0.1	76	2.5E-04	0.04%
Primary HVAC	Ventilation Tank Primary	Air Inlet	HEPA Filter System	HEPA Filter System	1.8E-03	0.1	76	4.3E-04	0.07%
Primary HVAC	Ventilation Tank Primary	Air Inlet	Isolation Valve	Isolation Valve	7.7E-04	0.1	155	1.9E-04	0.06%
Primary HVAC	Ventilation Tank Primary	Condensate Collection	Seal Pot	Seal Pot 101	3.3E-05	0.0	155	7.9E-06	0.00%
Primary HVAC	Ventilation Tank Primary	Condensate Collection	Seal Pot	Seal Pot 102	3.3E-05	0.0	155	7.9E-06	0.00%
Primary HVAC	Ventilation Tank Primary	Continuous Air Monitor	Continuous Air Monitor	Radiation Detector	1.2E-01	7.5	63	2.9E-02	3.84%
Primary HVAC	Ventilation Tank Primary	Continuous Air Monitor	Continuous Air Monitor Flow Control	Radiation Detector	6.3E-02	7.9	127	1.5E-02	4.04%
Primary HVAC	Ventilation Tank Primary	Demister	Demister 1	Demister 1	9.5E-04	0.1	76	2.3E-04	0.04%
Primary HVAC	Ventilation Tank Primary	Demister	Demister 2	Demister 2	9.5E-04	0.1	76	2.3E-04	0.04%
Primary HVAC	Ventilation Tank Primary	Exhaust Ventilation	Exhaust Fans	Exhaust Fan Control	1.3E-02	0.5	41	3.0E-03	0.26%
Primary HVAC	Ventilation Tank Primary	Exhaust Ventilation	Exhaust Ventilation	Exhaust Ventilation	5.1E-04	0.1	155	1.2E-04	0.04%
Primary HVAC	Ventilation Tank Primary	Train A Exhaust	HEPA Filter	Line	6.3E-04	0.0	76	1.5E-04	0.02%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	Exhaust Fan	Exhaust Fan 2	1.6E-02	2.4	155	3.8E-03	1.25%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Damper	1.6E-03	0.1	76	3.8E-04	0.06%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Exhaust Filter	5.6E-03	0.4	76	1.4E-03	0.22%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Filter	2.8E-03	0.2	76	6.8E-04	0.11%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Pressure Monitoring	3.3E-02	1.6	49	8.0E-03	0.82%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Valve	6.3E-03	1.0	155	1.5E-03	0.50%
Support/Utilities	Compressed Air	Instrument Air	Air Dryer	Electrical Feed	3.3E-04	0.0	48	8.1E-05	0.01%
Support/Utilities	Compressed Air	Service Air	Compressor	Aftercooler	7.0E-04	0.1	90	1.7E-04	0.03%
Support/Utilities	Compressed Air	Service Air	Compressor	Air Filter and Intake	5.4E-03	0.2	40	1.3E-03	0.11%
Support/Utilities	Compressed Air	Service Air	Compressor	Compressor	3.1E-02	2.3	75	7.5E-03	1.20%
Support/Utilities	Compressed Air	Service Air	Compressor	Drain	8.5E-03	0.4	48	2.1E-03	0.21%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Coolant Pump #1 Electrical Feed	3.3E-04	0.0	48	8.1E-05	0.01%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Coolant Pump #2 Electrical Feed	3.3E-04	0.0	48	8.1E-05	0.01%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Cooling Fan #1 Electrical Feed	3.3E-04	0.0	48	8.1E-05	0.01%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Cooling Fan #2 Electrical Feed	3.3E-04	0.0	48	8.1E-05	0.01%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Cooling Fans	2.7E-02	2.4	90	6.5E-03	1.22%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Electrical Feed	2.0E-04	0.0	3	4.8E-05	0.00%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Heat Exchanger	1.1E-03	0.1	90	2.6E-04	0.05%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Holding Tank	3.6E-03	0.3	89	8.8E-04	0.16%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Inline Instrumentation	7.2E-04	0.1	90	1.7E-04	0.03%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Inline Valves	2.8E-03	0.3	90	6.8E-04	0.13%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Pump Train A	1.5E-04	0.0	90	3.6E-05	0.01%
Support/Utilities	Compressed Air	Service Air	Holding Tank	Drain	1.5E-03	0.1	90	3.7E-04	0.07%
Support/Utilities	Compressed Air	Service Air	Holding Tank	Holding Tank	1.5E-03	0.1	90	3.5E-04	0.07%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Accumulator	9.1E-03	0.6	65	2.2E-03	0.30%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Air Dryer	4.9E-02	2.3	46	1.2E-02	1.16%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Air Dryer Isolation Valves	2.2E-03	0.2	90	5.2E-04	0.10%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	In-Tank Instrument Air Supply	2.9E-02	3.5	120	7.0E-03	1.77%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Post Air Dryer Filter	1.3E-02	0.6	45	3.2E-03	0.30%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Pre Air Dryer Filter	8.3E-03	0.4	46	2.0E-03	0.20%
Support/Utilities	Compressed Air	Service Air	Service Air Compressor	Electrical Feed	3.3E-04	0.0	48	8.1E-05	0.01%
Support/Utilities	Compressed Air	Service Air	Service Air Supply	Service Air Supply	5.6E-03	0.3	49	1.3E-03	0.14%
Support/Utilities	Electrical Distribution	Change Trailer	Distribution Panelboard	Distribution Panelboard	1.1E-03	0.1	90	2.6E-04	0.05%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Support/Utilities	Electrical Distribution	Compressor Building Distribution	Electrical Feed	Electrical Feed	3.2E-04	0.0	7	7.7E-05	0.00%
Support/Utilities	Electrical Distribution	Distribution Panel 103	Distribution Panel 105	Distribution Panelboard	4.9E-04	0.1	187	1.2E-04	0.05%
Support/Utilities	Electrical Distribution	Distribution Panel 103	Electrical Feed	Electrical Feed	1.2E-04	0.0	14	2.9E-05	0.00%
Support/Utilities	Electrical Distribution	Distribution Panel 109	Electrical Feed	Electrical Feed	2.4E-04	0.0	24	5.9E-05	0.00%
Support/Utilities	Electrical Distribution	Motor Control Center 001	Electrical Feed	Electrical Feed	2.7E-04	0.0	109	6.5E-05	0.01%
Support/Utilities	Electrical Distribution	Motor Control Center 002	Electrical Feed	Electrical Feed	1.2E-04	0.0	14	2.9E-05	0.00%
Support/Utilities	Electrical Distribution	Station Service Equipment	Distribution Panelboard	Distribution Panelboard	4.9E-04	0.1	187	1.2E-04	0.05%
Waste Transfer AN-102	Electrical Feed to Waste Transfer System	Electrical Feed to Waste Transfer System	Electrical Feed to Waste Transfer System	Power Monitoring	7.0E-03	0.2	32	1.7E-03	0.12%
Waste Transfer AN-102	Process Monitoring	Waste Monitoring	Waste Density	Waste Characteristics Monitor	2.0E-03	0.1	36	4.8E-04	0.04%
Waste Transfer AN-102	Process Monitoring	Waste Monitoring	Waste Flow	Waste Characteristics Monitor	2.0E-03	0.1	36	4.8E-04	0.04%
Waste Transfer AN-102	Process Monitoring	Waste Monitoring	Waste Monitoring	Waste Characteristics Monitor	1.4E-03	0.4	285	3.4E-04	0.20%
Waste Transfer AN-102	Process Monitoring	Waste Monitoring	Waste Temperature	Waste Characteristics Monitor	2.0E-03	0.1	36	4.8E-04	0.04%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Flexible Suction	Cable Winch	1.0E-03	0.8	776	2.4E-04	0.40%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Flexible Suction	Cable Winch Instrumentation	4.0E-03	1.3	314	9.7E-04	0.64%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Nitrogen Feed	Nitrogen Supply Instrumentation	1.9E-02	1.2	64	4.5E-03	0.62%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Nitrogen Feed	Nitrogen Supply Line	3.4E-03	0.7	215	8.1E-04	0.37%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Nitrogen Feed	Purge Seal Gas	3.8E-03	0.6	155	9.1E-04	0.30%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Pump Instrumentation	Manual Transfer Switch	2.0E-03	0.1	36	4.8E-04	0.04%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Pump Instrumentation	Motor Temperature Monitor	2.2E-03	0.2	86	5.3E-04	0.10%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Pump Instrumentation	Pump Control	1.3E-02	0.5	38	3.1E-03	0.25%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Pump, Transfer	Cable Winch	2.0E-02	14.1	697	4.9E-03	7.19%
Waste Transfer AN-102	Transfer Pump	Transfer Pump	Pump, Transfer	Pump	2.0E-01	26.7	133	4.9E-02	13.61%
Waste Transfer AN-102	Transfer Route	Route Monitoring	Line Flow Monitoring	Flow Element	5.3E-03	0.5	103	1.3E-03	0.28%
Waste Transfer AN-102	Transfer Route	Route Monitoring	Line Pressure Monitoring	Pressure Monitor	4.8E-03	0.3	63	1.2E-03	0.15%
Waste Transfer AN-102	Transfer Route	Route Monitoring	Line Pressure Monitoring	Pressure Relief Valve	3.2E-04	0.2	776	7.6E-05	0.13%
Waste Transfer AN-102	Transfer Route	Route Monitoring	Pit Leak Detection	Pit Leak Detector	9.0E-03	1.7	184	2.2E-03	0.85%
Waste Transfer AN-102	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	1.2E-06	0.0	776	2.9E-07	0.00%
Waste Transfer AN-102	Waste Transfer System	Transfer System Control	Transfer System Control	Interlock	1.0E-03	0.0	36	2.4E-04	0.02%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer AN-102/Stage	Transfer Route	Piping	Piping	Nozzle	3.2E-05	0.0	776	7.7E-06	0.01%
Waste Transfer AN-102/Stage	Transfer Route	Piping	Piping	Transfer Line	8.0E-04	0.6	776	1.9E-04	0.32%
Waste Transfer AN-102/Stage	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	1.3E-02	10.4	776	3.2E-03	5.32%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Nitrogen Feed	Purge Seal Gas	1.3E-04	0.0	155	3.1E-05	0.01%
Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	8.5E-05	0.1	776	2.0E-05	0.03%
Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumpers	8.5E-05	0.1	776	2.1E-05	0.03%
Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	3.8E-05	0.0	776	9.3E-06	0.02%
Waste Transfer AN-105	Transfer Route	Route Monitoring	Pit Leak Detection	Pit Leak Detector	2.1E-03	1.2	576	5.0E-04	0.61%
Waste Transfer AN-105	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	2.6E-04	0.2	776	6.3E-05	0.10%
Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Jumper	2.1E-04	0.2	776	5.1E-05	0.08%
Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Nozzle	3.2E-05	0.0	776	7.7E-06	0.01%
Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Transfer Line	2.1E-03	1.6	776	5.1E-04	0.84%
Waste Transfer AN-105/AN-102	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	1.5E-02	11.7	776	3.6E-03	5.94%
Waste Transfer AN-105/AN-102/Stage	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	4.3E-03	3.3	776	1.0E-03	1.70%
Waste Transfer AN-105/Stage	Transfer Route	Piping	Piping	Jumper	3.1E-07	0.0	776	7.4E-08	0.00%
Waste Transfer AN-105/Stage	Transfer Route	Piping	Piping	Nozzle	8.0E-08	0.0	776	1.9E-08	0.00%

Table E-4. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Average Delay per Event (hours)	Expected Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer AN-105/Stage	Transfer Route	Piping	Piping	Transfer Line	8.0E-07	0.0	776	1.9E-07	0.00%
Waste Transfer AN-105/Stage	Transfer Route	Route Monitoring	Line Pressure Monitoring	Pressure Monitoring	5.0E-07	0.0	158	1.2E-07	0.00%
Waste Transfer AN-105/Stage	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	2.0E-06	0.0	776	4.8E-07	0.00%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
					Total	4.2	196.1	46.9	100%	100%
AN05A-WT-P-022-SUR	WTP	Transfer Pump	Tank AN-102	Waste Transfer AN-102	Transfer Pump	2.0E-01	26.7	132.5	4.82%	13.61%
AN05A-WT-Electric Clutch-SUR	CLUTCH	Transfer Pump Electric Clutch	Tank AN-102	Waste Transfer AN-102	Transfer Pump	2.0E-02	14.1	697.4	0.48%	7.19%
AN02A-WT-MOV-808	MOV	3-Way Motor Operated Ball Valve	Central Pump Pit AN-02A	Waste Transfer AN-102/Stage	Transfer Route	1.3E-02	10.4	776.1	0.32%	5.32%
AN241-CHEMB-P-002	P	Diluent/Flush Pump	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Delivery	8.8E-02	7.9	89.6	2.10%	4.01%
AN296-VTP-P-514	P	Pump	AN296-VTP-ENCL-500	Primary HVAC	Ventilation Tank Primary	4.8E-02	7.4	154.7	1.14%	3.78%
EXTWIND06	EXT	Wind Gusts 6 hr Delay	EXT	External Events	Weather	7.2E-01	4.3	6.0	17.25%	2.21%
EXTPRECIP	EXT	Precipitation Caused Delays	EXT	External Events	Weather	4.7E-01	3.8	8.0	11.28%	1.92%
AN241-RW-MOV-107	MOV	Motor Operated Ball Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	3.9E-02	3.5	89.4	0.92%	1.76%
AN241-CHEMB-V-109	V	Automatic Recirculating Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	3.8E-02	3.4	89.5	0.91%	1.74%
AN241-CHEMB-MOV-117	MOV	2-Way Motor Operated Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	3.8E-02	3.4	89.5	0.91%	1.74%
AN241-CHEMB-MOV-135	MOV	3-Way Motor Operated Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	3.8E-02	3.4	89.5	0.91%	1.74%
AN296-VTA-P-914	P	Pump	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	2.0E-02	3.1	154.7	0.48%	1.57%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN296-VTA-P-924	P	Pump	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	2.0E-02	3.1	154.7	0.48%	1.57%
AN296-VTP-RAH-510A	RAH	Radiation Alarm High	Pri Exh Stack Instr Encl AN296-VTP-ENCL-500 Local Alarm Box	Primary HVAC	Ventilation Tank Primary	1.7E-02	2.7	163.5	0.40%	1.40%
EXTLONG	EXT	Hanford Site work stoppage, long	EXT	External Events	Hanford	1.0E-02	2.4	242.0	0.24%	1.24%
AN241-VTP-EF-002	EF	Exhaust Fan	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.4E-02	2.2	154.7	0.34%	1.13%
AN273-SA-CMP-001	CMP	Compressor	AN Farm	Support/Utilities	Compressed Air	2.2E-02	2.0	89.6	0.53%	1.01%
HATRANSF014	HUMAN	Startup Transfer Pump	HUMAN	Human Actions	Transfer Pump	5.0E-03	2.0	391.6	0.12%	1.00%
EXTWIND12	EXT	Wind Gusts 12 hr Delay	EXT	External Events	Weather	1.6E-01	1.9	12.0	3.74%	0.96%
EXTLIGHT	EXT	Lightning Within 30 Miles	EXT	External Events	Weather	5.7E-01	1.7	3.0	13.55%	0.87%
AZNEW-WT-V-226	V	3-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	2.1E-03	1.7	776.1	0.05%	0.85%
AZNEW-WT-V-221	V	2-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	2.1E-03	1.7	776.1	0.05%	0.85%
AZNEW-WT-V-227	V	3-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102		2.1E-03	1.7	776.1	0.05%	0.85%
AZNEW-WT-V-228	V	3-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	2.1E-03	1.7	776.1	0.05%	0.85%
ANVPB-WT-V-214	V	3-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	2.1E-03	1.7	776.1	0.05%	0.85%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPB-WT-V-215	V	2-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	2.1E-03	1.7	776.1	0.05%	0.85%
ANVPB-WT-V-216	V	3-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/AN-102/Stage	Transfer Route	2.1E-03	1.7	776.1	0.05%	0.85%
AZNEW-WT-V-224	V	2-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	2.1E-03	1.7	776.1	0.05%	0.85%
ANVPB-WT-V-217	V	2-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/AN-102/Stage	Transfer Route	2.1E-03	1.7	776.1	0.05%	0.85%
AN296-VTA-RAH-910A	RAH	Radiation Alarm High	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	Annulus HVAC	Ventilation Tank Annulus	9.9E-03	1.6	163.5	0.24%	0.82%
EXTLTEMP06	EXT	Temperature Low 6 hr Delay	EXT	External Events	Weather	2.3E-01	1.4	6.0	5.44%	0.70%
EXTHTEMP06	EXT	Temperature High 6 hr Delay	EXT	External Events	Weather	2.1E-01	1.2	6.0	4.98%	0.64%
AN273-GLY-F-004	F	Heat Exchanger Fan	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	1.3E-02	1.2	89.6	0.32%	0.61%
AN273-GLY-F-003	F	Heat Exchanger Fan	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	1.3E-02	1.2	89.6	0.32%	0.61%
AN05A-WT-LDE-137-SUR	LDE	Leak Detector Element	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Route	2.0E-03	1.2	592.4	0.05%	0.60%
ANVPB-WT-LDE-231	LDE	AN-B Valve Pit Leak Detector Element	AN-B Valve Pit	Waste Transfer AN-105	Transfer Route	2.0E-03	1.2	592.4	0.05%	0.60%
AN05A-WT-ZE-158-SUR	ZE	Position Element	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Pump	2.0E-03	1.2	592.4	0.05%	0.60%
ANVPB-WT-V-803	V	2-Way Ball Valve	AN-B Valve Pit	Diluent/Flush System	Transfer Route	1.4E-03	1.1	776.1	0.03%	0.57%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPB-WT-V-205	V	3-Way Ball Valve	AN-B Valve Pit	Diluent/Flush System	Transfer Route	1.4E-03	1.1	776.1	0.03%	0.57%
ANVPB-WT-V-203	V	3-Way Ball Valve	AN-B Valve Pit	Diluent/Flush System	Transfer Route	1.4E-03	1.1	776.1	0.03%	0.57%
ANVPB-WT-V-206	V	2-Way Ball Valve	AN-B Valve Pit	Diluent/Flush System	Transfer Route	1.4E-03	1.1	776.1	0.03%	0.57%
AN296-VTP-FAL-512A	FAL	Flow Alarm Low	Pri Exh Stack Instr Encl AN296-VTP-ENCL-500 Local Alarm Box	Primary HVAC	Ventilation Tank Primary	1.5E-02	1.0	67.8	0.36%	0.52%
AN296-VTP-XA-510A	XA	Failure Alarm	Pri Exh Stack Instr Encl AN296-VTP-ENCL-500 Local Alarm Box	Primary HVAC	Ventilation Tank Primary	1.5E-02	1.0	67.8	0.36%	0.52%
AN241-VTA-EF-003	EF	Exhaust Fan	AN Farm A Train	Annulus HVAC	Ventilation Tank Annulus	6.0E-03	0.9	154.7	0.14%	0.47%
EXTLTEMP12	EXT	Temperature Low 12 hr Delay	EXT	External Events	Weather	6.8E-02	0.8	12.0	1.62%	0.41%
AN05A-WT-M-158-SUR	M	Pump Suction Motor	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Pump	1.0E-03	0.8	776.1	0.02%	0.40%
AN02C-WST-PI-112	PI	Pressure Indicator	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	4.8E-03	0.7	157.7	0.11%	0.38%
AN02C-IA-PI-112	PI	Pressure Indicator	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	4.8E-03	0.7	157.7	0.11%	0.38%
AN02C-WST-PI-122	PI	Pressure Indicator	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	4.8E-03	0.7	157.7	0.11%	0.38%
AN105-WST-TI-XX	TI	Temperature Indicator	Tank AN-105	Confinement System	Primary Monitoring	4.7E-03	0.7	157.7	0.11%	0.38%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN271-VTP-XA-510	RAL	Radiation Alarm Low	AN Farm	Primary HVAC	Ventilation Tank Primary	1.5E-02	0.6	38.7	0.35%	0.29%
AN296-VTA-XA-910A	XA	Failure Alarm	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	Annulus HVAC	Ventilation Tank Annulus	8.2E-03	0.6	67.8	0.20%	0.28%
EXTLOSP	EXT	Loss of Power to Tank Farms	EXT	External Events	Electrical Distribution	9.1E-02	0.5	6.0	2.18%	0.28%
AN05A-WT-V-107-SUR	V	2-Way Ball Valve	Tank AN-102	Waste Transfer AN-102	Transfer Pump	3.4E-03	0.5	154.7	0.08%	0.27%
EXTWIND24	EXT	Wind Gusts 24 hr Delay	EXT	External Events	Weather	2.2E-02	0.5	24.0	0.53%	0.27%
AN242A-VTP-RSH-AN-K1	RAH	Radiation Alarm High	AN Farm	Primary HVAC	Ventilation Tank Primary	1.5E-02	0.5	36.6	0.35%	0.27%
AN271-VTP-RAH-510	RAH	Radiation Alarm High	AN Farm	Primary HVAC	Ventilation Tank Primary	1.5E-02	0.5	36.6	0.35%	0.27%
AZ156-RW-YL-108	YL	Event/State Light	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	1.4E-02	0.5	35.6	0.35%	0.26%
AN271-WSTA-LDA-152	LDA	Leak Detected Alarm	AN Farm	Confinement System	Leak Detection Pit	1.4E-02	0.5	35.6	0.34%	0.26%
AN2750E-VTP-CASS-C-1365	CASS	Computer Automated Surveillance Station	AN Farm	Primary HVAC	Ventilation Tank Primary	1.2E-02	0.5	40.2	0.30%	0.26%
AN-WST-CASS-C-1223	CASS	Computer Automated Surveillance Station	Bldg 2750E	Confinement System	Waste Storage Tank	1.2E-02	0.5	40.2	0.30%	0.26%
AN241-VTP-CASS-C-1323	CASS	Computer Automated Surveillance Station	Bldg 2750E	Primary HVAC	Ventilation Tank Primary	1.2E-02	0.5	40.2	0.30%	0.26%
AN-WST-CASS-C-1224	CASS	Computer Automated Surveillance Station	Bldg 2750E	Confinement System	Waste Storage Tank	1.2E-02	0.5	40.2	0.30%	0.26%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPA-WT-SN-261-M25	PIPE	Valve Pit Discharge Pipe Segment	AN-A Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	6.4E-04	0.5	776.1	0.02%	0.25%
ANVPA-WT-SN-262-M25	PIPE	Valve Pit Discharge Pipe Segment	AN-A Valve Pit	Waste Transfer AN-102/Stage	Transfer Route	6.4E-04	0.5	776.1	0.02%	0.25%
ANVPA-WT-SN-634-M25	PIPE	Valve Pit Discharge Pipe Segment	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	6.4E-04	0.5	776.1	0.02%	0.25%
ANVPA-WT-SN-630-M25	PIPE	Valve Pit Discharge Pipe Segment	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	6.4E-04	0.5	776.1	0.02%	0.25%
AN273-IA-CP-101	CP	Air Dryer Control Panel	AN Farm	Support/Utilities	Compressed Air	1.2E-02	0.5	38.7	0.30%	0.25%
AN05A-WT-LDSTA-137-SUR	LDSTA	Leak Detector Station	Tank AN-102	Waste Transfer AN-102	Transfer Route	7.0E-03	0.5	67.8	0.17%	0.24%
AN271-VTP-PDAH-408	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AN-271	Primary HVAC	Ventilation Tank Primary	1.4E-02	0.5	32.6	0.35%	0.24%
AN271-VTP-PDAH-407	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AN-271	Primary HVAC	Ventilation Tank Primary	1.4E-02	0.5	32.6	0.35%	0.24%
AZ156-RW-PDAH-103	PDAH	Pressure Differential Alarm High	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	1.4E-02	0.5	32.6	0.35%	0.24%
AN242A-VTP-PSH-ANK11	XA	Failure Alarm	AN Farm	Primary HVAC	Ventilation Tank Primary	1.4E-02	0.5	32.6	0.35%	0.24%
AN242A-VTP-RXS-AN-K1	XA	Failure Alarm	AN Farm	Primary HVAC	Ventilation Tank Primary	1.4E-02	0.5	32.6	0.35%	0.24%
AN271-WST-LAH-132	LAH	Level Alarm High	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	1.4E-02	0.5	32.6	0.34%	0.24%
AN271-WST-PAH-112	PAH	Pressure Alarm High	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	1.4E-02	0.5	32.6	0.34%	0.24%
AN241-RW-FQI-101	FQI	Flow Totalizer Indicator	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	2.8E-03	0.4	157.7	0.07%	0.22%
AN271-WST-PR-112	PR	Pressure Recorder	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	1.2E-02	0.4	35.6	0.29%	0.22%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-RW-RIAS-126	RIAS	Radiation Indicating Alarm Switch	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	2.4E-03	0.4	163.5	0.06%	0.20%
AN241-CHEMB-V-113	V	2-Way Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.2E-03	0.4	89.6	0.10%	0.19%
AN296-VTA-FAL-922A	FAL	Flow Alarm Low	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	Annulus HVAC	Ventilation Tank Annulus	5.4E-03	0.4	67.8	0.13%	0.19%
AN296-VTA-FAL-912A	FAL	Flow Alarm Low	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	Annulus HVAC	Ventilation Tank Annulus	5.4E-03	0.4	67.8	0.13%	0.19%
AN05A-WT-UE-153-SUR	UE	Multivariable Element	Central Pump Pit AN-02A	Waste Transfer AN-102	Process Monitoring	6.0E-04	0.4	592.4	0.01%	0.18%
AN05A-WT-FE-155-SUR	FE	Flow Element	AN-02A Pump Pit	Waste Transfer AN-102	Transfer Route	6.0E-04	0.4	592.4	0.01%	0.18%
AN271-WSTA-RAH-102	RAH	Radiation Alarm High	AN Farm	Confinement System	Waste Tank AN-102	8.8E-03	0.3	36.6	0.21%	0.16%
AN05A-WT-FI-160-SUR	FI	Flow Indicator	Tank AN-102	Waste Transfer AN-102	Transfer Pump	2.0E-03	0.3	157.7	0.05%	0.16%
AN05A-WT-PI-161-SUR	PI	Pressure Indicator	Tank AN-102	Waste Transfer AN-102	Transfer Pump	2.0E-03	0.3	157.7	0.05%	0.16%
AN296-VTA-FI-920	FI	Flow Indicator	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	2.0E-03	0.3	157.7	0.05%	0.16%
AN2750E-WSTA-CASS-C-1363	CASS	Computer Automated Surveillance Station	AN Farm	Confinement System	Waste Tank AN-102	7.6E-03	0.3	40.2	0.18%	0.16%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN271-WST-PAL-112	PAL	Pressure Alarm Low	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	8.7E-03	0.3	32.6	0.21%	0.15%
EXTHTEMP12	EXT	Temperature High 12 hr Delay	EXT	External Events	Weather	2.4E-02	0.3	12.0	0.57%	0.14%
AN271-VTA-RAH-910	RAH	Radiation Alarm High	Instr Bldg 241-AN-271	Annulus HVAC	Ventilation Tank Annulus	7.6E-03	0.3	36.7	0.18%	0.14%
AZ156-CHEMB-YA-101	YA	Event/State Alarm	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	7.6E-03	0.3	35.6	0.18%	0.14%
AZ156-CHEMB-YL-101	YL	Event/State Alarm Low	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	7.6E-03	0.3	35.6	0.18%	0.14%
AZ156-CHEMB-YL-130	YL	Event/State Alarm Low	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	7.6E-03	0.3	35.6	0.18%	0.14%
AZ156-CHEMB-FIC-101	FIC	Flow Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	6.6E-03	0.3	40.2	0.16%	0.14%
AZ156-CHEMB-FIC-130	FIC	Flow Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	6.6E-03	0.3	40.2	0.16%	0.14%
AZ156-CHEMB-FQIC-130	FQIC	Flow Totalizer Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	6.6E-03	0.3	40.2	0.16%	0.14%
AN242A-VTA-CASS-C-1364	CASS	Computer Automated Surveillance Station	Bldg 2750E	Annulus HVAC	Ventilation Tank Annulus	6.6E-03	0.3	40.2	0.16%	0.14%
EXTLTEMP24	EXT	Temperature Low 24 hr Delay	EXT	External Events	Weather	1.1E-02	0.3	24.0	0.26%	0.13%
AN273-IA-ACC-001	ACC	Accumulator	AN Farm	Support/Utilities	Compressed Air	2.9E-03	0.3	89.6	0.07%	0.13%
AN241-RW-STR-101	STR	Strainer	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.9E-03	0.3	89.6	0.07%	0.13%
AN05A-WT-V-217-SUR	V	Check Valve	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Pump	3.3E-04	0.3	776.1	0.01%	0.13%
AN05C-IA-PI-115	PI	Pressure Indicator	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	1.6E-03	0.3	157.7	0.04%	0.13%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05C-WST-PI-125	PI	Pressure Indicator	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	1.6E-03	0.3	157.7	0.04%	0.13%
AN05C-WSTA-PI-115	PI	Pressure Indicator	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	1.6E-03	0.3	157.7	0.04%	0.13%
AZ156-WT-LDA-159-SUR	LDA	Leak Detected Alarm	Bldg AZ-156	Waste Transfer AN-102	Transfer Pump	7.0E-03	0.2	35.6	0.17%	0.13%
AZ156-CHEMB-LAHH-126	LAHH	Level Alarm High High	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	7.6E-03	0.2	32.6	0.18%	0.13%
AN271-VTA-XA-910	XA	Failure Alarm	Instr Bldg 241-AN-271	Annulus HVAC	Ventilation Tank Annulus	7.6E-03	0.2	32.6	0.18%	0.13%
AN05A-WT-PRV-102-SUR	PRV	Pressure Relief Valve	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Route	3.2E-04	0.2	776.1	0.01%	0.13%
AZ156-WT-VFD-122-SUR	VFD	Variable Frequency Drive	Bldg AZ-156	Waste Transfer AN-102	Transfer Pump	6.0E-03	0.2	40.2	0.14%	0.12%
AZ156-WT-PAL-161-SUR	PAL	Pressure Alarm Low	Bldg AZ-156	Waste Transfer AN-102	Transfer Pump	7.0E-03	0.2	32.5	0.17%	0.12%
AZ156-WT-XXA-101-SUR	XA	Failure Alarm	Bldg AZ-156	Waste Transfer AN-102	Electrical Feed to Waste Transfer System	7.0E-03	0.2	32.5	0.17%	0.12%
AZ156-WT-FAH-160-SUR	FAH	Flow Alarm High	Bldg AZ-156	Waste Transfer AN-102	Transfer Pump	7.0E-03	0.2	32.5	0.17%	0.12%
AN241-VTP-PDS-410	PDS	Pressure Differential Switch	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.4E-03	0.2	157.7	0.03%	0.11%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-VTP-PDIS-409	PDIS	Pressure Differential Indicating Switch (High/Low)	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.4E-03	0.2	157.7	0.03%	0.11%
AN241-VTP-PDIS-408	PDIS	Pressure Differential Indicating Switch (High/Low)	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.4E-03	0.2	157.7	0.03%	0.11%
AN241-VTP-PDIS-407	PDIS	Pressure Differential Indicating Switch (High/Low)	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.4E-03	0.2	157.7	0.03%	0.11%
AN241-VTP-FLT-401	FLT	Pre-Filter	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	2.8E-03	0.2	76.5	0.07%	0.11%
AN241-VTP-FLT-403	FLT	HEPA Filter	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	2.8E-03	0.2	76.5	0.07%	0.11%
AN241-VTP-FLT-402	FLT	HEPA Filter	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	2.8E-03	0.2	76.5	0.07%	0.11%
AN271-WSTA-LDA-155	LDA	Leak Detected Alarm	Instr Bldg 241-AN-271	Confinement System	Leak Detection Pit	5.7E-03	0.2	35.6	0.14%	0.10%
AN05A-WT-F-101-SUR	FLT	Filter	Tank AN-102	Waste Transfer AN-102	Transfer Pump	1.3E-03	0.2	154.7	0.03%	0.10%
AN241-RW-M-108	M	Strainer Motor	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.2E-03	0.2	89.6	0.05%	0.10%
HAVLVEPC001	HUMAN	Align Transfer Valving	HUMAN	Human Actions	Transfer Route	5.0E-04	0.2	391.6	0.01%	0.10%
AN241-CHEMB-V-100	V	Coupling Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	2.1E-03	0.2	89.6	0.05%	0.10%
AN271-WST-LAH-135	LAH	Level Alarm High	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	5.7E-03	0.2	32.5	0.14%	0.09%
AN271-WST-PAH-115	PAH	Pressure Alarm High	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	5.7E-03	0.2	32.5	0.14%	0.09%
EXTOTHER	EXT	Other Non-Hanford Events	EXT	External Events	Off Site	7.3E-03	0.2	24.0	0.17%	0.09%
AN271-WST-PR-115	PR	Pressure Recorder	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	4.9E-03	0.2	35.6	0.12%	0.09%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-VTA-PDAL-810	PDAL	Pressure Differential Alarm Low	Instr Bldg 241-AN-271	Annulus HVAC	Ventilation Tank Annulus	4.8E-03	0.2	35.6	0.12%	0.09%
AN241-VTA-PDAL-710	PDAL	Pressure Differential Alarm Low	Instr Bldg 241-AN-271	Annulus HVAC	Ventilation Tank Annulus	4.8E-03	0.2	35.6	0.12%	0.09%
AZ156-CHEMB-FC-118	FC	Flow Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.2E-03	0.2	40.2	0.10%	0.09%
AN241-VTA-CASS-C-1324	CASS	Computer Automated Surveillance Station	Bldg 2750E	Annulus HVAC	Ventilation Tank Annulus	4.2E-03	0.2	40.2	0.10%	0.09%
ANVPB-WT-R16,R15,R14(F)	JMP	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	2.1E-04	0.2	776.1	0.01%	0.08%
AN296-VTP-CAM-510	CAM	Continuous Air Monitor	AN296-VTP-ENCL-500	Primary HVAC	Ventilation Tank Primary	2.2E-03	0.2	74.3	0.05%	0.08%
AZ156-CHEMB-XA-100	XA	Failure Alarm	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.8E-03	0.2	32.7	0.11%	0.08%
AN241-VTA-M-004	M	Exhaust Fan Motor	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	9.9E-04	0.2	154.7	0.02%	0.08%
AN241-VTA-M-003	M	Exhaust Fan Motor	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	9.9E-04	0.2	154.7	0.02%	0.08%
AN273-SA-HM-101	HM	Hour Meter	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-IA-TI-102	TI	Temperature Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-IA-TI-101	TI	Temperature Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-SA-PI-102	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-IA-PI-104	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-IA-PI-105	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-IA-PI-102	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-IA-PI-101	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-IA-FI-101	FI	Flow Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN271-IA-PI-107	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AZ156-RW-PI-105	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.1E-03	0.1	35.6	0.10%	0.08%
AN241-RW-PI-104	PI	Pressure Indicator	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-IA-PI-106	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-SA-PI-103	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-IA-PI-103	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
AN273-SA-PI-105	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	4.1E-03	0.1	35.6	0.10%	0.08%
EXTHTEMP24	EXT	Temperature High 24 hr Delay	EXT	External Events	Weather	5.9E-03	0.1	24.0	0.14%	0.07%
AN241-VTP-MOV-401	MOV	Motor Operated Butterfly Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	9.1E-04	0.1	154.7	0.02%	0.07%
EXTSHORT	EXT	Hanford Site work stoppage, short	EXT	External Events	Hanford	3.5E-02	0.1	4.0	0.84%	0.07%
HAPERDIL001	HUMAN	Startup and Control Diluent Addition	HUMAN	Human Actions	Transfer Route	5.0E-03	0.1	28.1	0.12%	0.07%
AN102-VTP-FLT-204	FLT	HEPA Filter	Tank AN-102	Primary HVAC	Ventilation Tank Primary	1.8E-03	0.1	76.5	0.04%	0.07%
AN241-RW-FE-101	FE	Flow Element	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	8.4E-04	0.1	157.7	0.02%	0.07%
AN241-VTP-DMPR-401	DMPR	Damper	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.6E-03	0.1	76.5	0.04%	0.06%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN02C-WST-V-106	V	Globe Valve	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	7.7E-04	0.1	154.7	0.02%	0.06%
AN02C-WST-V-170	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.7E-04	0.1	154.7	0.02%	0.06%
AN241-VTP-V-402	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.7E-04	0.1	154.7	0.02%	0.06%
AN241-VTP-V-405	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.7E-04	0.1	154.7	0.02%	0.06%
AN241-VTP-V-407	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.7E-04	0.1	154.7	0.02%	0.06%
AN241-VTP-V-406	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.7E-04	0.1	154.7	0.02%	0.06%
AN02C-WST-V-168	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.7E-04	0.1	154.7	0.02%	0.06%
AN241-VTP-V-403	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.7E-04	0.1	154.7	0.02%	0.06%
AN02C-WST-V-101	V	Globe Valve	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	7.7E-04	0.1	154.7	0.02%	0.06%
AN02C-WST-V-167	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.7E-04	0.1	154.7	0.02%	0.06%
AN102-WST-V-159	V	Globe valve	AN-105	Support/Utilities	Compressed Air	7.7E-04	0.1	154.7	0.02%	0.06%
AN102-WST-V-163	V	Gate Valve	AN-105	Support/Utilities	Compressed Air	7.7E-04	0.1	154.7	0.02%	0.06%
AN02C-WST-V-102	V	Globe Valve	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	7.7E-04	0.1	154.7	0.02%	0.06%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-VTP-V-404	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.7E-04	0.1	154.7	0.02%	0.06%
AN02C-WST-V-164	V	Gate Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.7E-04	0.1	154.7	0.02%	0.06%
AN102-WST-V-160	V	Globe valve	AN-105	Support/Utilities	Compressed Air	7.7E-04	0.1	154.7	0.02%	0.06%
AN102-WST-V-162	V	Globe valve	AN-105	Support/Utilities	Compressed Air	7.7E-04	0.1	154.7	0.02%	0.06%
AN05A-WT-PE-154-SUR	PE	WT Pump Discharge Pressure Element	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Route	2.0E-04	0.1	592.4	0.00%	0.06%
AN05A-WT-TE-157-SUR	TE	Temperature Element	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Pump	2.0E-04	0.1	592.4	0.00%	0.06%
AN102-WST-FIV-104	FIV	Flow Indicator w/Flow Adjust Valve	Outside Tank AN-102	Confinement System	Waste Storage Tank	7.5E-04	0.1	157.7	0.02%	0.06%
AN02C-WST-FIV-102	FIV	Flow Indicator w/Flow Adjust Valve	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	7.5E-04	0.1	157.7	0.02%	0.06%
AN296-VTA-FCV-913	FCV	Flow Control Valve	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	7.1E-04	0.1	163.5	0.02%	0.06%
AN296-VTA-FCV-923	FCV	Flow Control Valve	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	7.1E-04	0.1	163.5	0.02%	0.06%
AN02C-IA-PRV-112	PRV	Pressure Relief Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.5E-04	0.1	154.7	0.02%	0.06%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-VTP-V-401	V	Butterfly Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.5E-04	0.1	154.7	0.02%	0.06%
AN02C-WST-PRV-112	PRV	Pressure Relief Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.5E-04	0.1	154.7	0.02%	0.06%
AN05A-WT-PCV-101-SUR	PCV	Pressure Control Valve	Tank AN-102	Waste Transfer AN-102	Transfer Pump	7.1E-04	0.1	154.7	0.02%	0.06%
AN273-IA-FLT-102	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.7E-03	0.1	40.2	0.06%	0.06%
AN273-SA-FLT-103	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.7E-03	0.1	40.2	0.06%	0.06%
AN273-IA-FLT-107	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.7E-03	0.1	40.2	0.06%	0.06%
AN273-IA-FLT-103	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.7E-03	0.1	40.2	0.06%	0.06%
AN273-SA-FLT-101	FLT	Air Filter	AN Farm	Support/Utilities	Compressed Air	2.7E-03	0.1	40.2	0.06%	0.06%
AN273-IA-FLT-101	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.7E-03	0.1	40.2	0.06%	0.06%
AN273-IA-FLT-106	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.7E-03	0.1	40.2	0.06%	0.06%
AN273-SA-FLT-102	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.7E-03	0.1	40.2	0.06%	0.06%
AN241-RW-BLR-101	BLR	Boiler	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	6.8E-04	0.1	154.7	0.02%	0.05%
AN05A-WT-V-806	V	Check Valve	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	1.3E-04	0.1	776.1	0.00%	0.05%
AN05A-WT-MOV-609	MOV	3-Way Ball Valve	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	1.3E-04	0.1	776.1	0.00%	0.05%
AN901-WSTA-CAM-102	CAM	Continuous Air Monitor	AN Farm	Confinement System	Waste Tank AN-102	1.4E-03	0.1	74.3	0.03%	0.05%
AN273-GLY-HX-001	HX	Heat Exchanger	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	1.1E-03	0.1	89.6	0.03%	0.05%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-STR-101	STR	Strainer	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.1E-03	0.1	89.6	0.03%	0.05%
AN05A-WT-FSH-160-SUR	FSH	Flow Switch High	Tank AN-102	Waste Transfer AN-102	Transfer Pump	6.0E-04	0.1	157.7	0.01%	0.05%
AN296-VTA-FSL-912	FSL	Flow Switch Low	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.01%	0.05%
AN241-VTA-PDS-710	PDS	Pressure Differential Switch	AN Farm A Train	Annulus HVAC	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.01%	0.05%
AN241-VTA-PDS-810	PDS	Pressure Differential Switch	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.01%	0.05%
AN296-VTA-FSL-922	FSL	Flow Switch Low	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.01%	0.05%
AN241-EDS-XFMR-102	XFMR	Transformer	AN Farm	Support/Utilities	Electrical Distribution	4.9E-04	0.1	186.9	0.01%	0.05%
AN241-EDS-XFMR-100	XFMR	Transformer	AN Farm	Support/Utilities	Electrical Distribution	4.9E-04	0.1	186.9	0.01%	0.05%
AN02C-WST-PY-122	PY	Power Equipment	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	4.9E-04	0.1	186.9	0.01%	0.05%
AN241-CHEMB-MSTR-101	MSTR	Motor Starter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	7.7E-04	0.1	113.7	0.02%	0.04%
AN102-WST-LIT-104	LIT	Level Indicating Transmitter	Outside Tank AN-102	Confinement System	Waste Storage Tank	1.3E-03	0.1	67.8	0.03%	0.04%
AN02C-WST-PT-122	PT	Pressure Transmitter	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	1.3E-03	0.1	67.8	0.03%	0.04%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN02C-WST-PT-112	PT	Pressure Transmitter	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	1.3E-03	0.1	67.8	0.03%	0.04%
HATRANSF022	HUMAN	Control Transfer Mission	HUMAN	Human Actions	Transfer Pump	3.0E-03	0.1	28.1	0.07%	0.04%
AN273-IA-SOV-101	SOV	Solenoid Operated Valve	AN Farm	Support/Utilities	Compressed Air	9.4E-04	0.1	89.6	0.02%	0.04%
AN273-SA-SOV-101	SOV	Solenoid Operated Valve	AN Farm	Support/Utilities	Compressed Air	9.4E-04	0.1	89.6	0.02%	0.04%
AN273-IA-SOV-102	SOV	Solenoid Operated Valve	AN Farm	Support/Utilities	Compressed Air	9.4E-04	0.1	89.6	0.02%	0.04%
AN241-RW-RE-126	RE	Radiation Sensing element	AN Farm Retrieval Equipment Service Water Enclosure RW-PNL-101	Diluent/Flush System	Diluent/Flush Preparation	2.1E-03	0.1	40.2	0.05%	0.04%
AN105-VTP-FLT-210	FLT	HEPA Filter	Tank AN-105	Primary HVAC	Ventilation Tank Primary	1.0E-03	0.1	76.5	0.02%	0.04%
AN102-VTA-FLT-204	FLT	HEPA Filter	Tank AN-102	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	76.5	0.02%	0.04%
AN102-VTA-FLT-203	FLT	Pre-Filter	Tank AN-102	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	76.5	0.02%	0.04%
AN241-VTA-FLT-701	FLT	HEPA Filter	AN Farm A Train	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	76.5	0.02%	0.04%
AN241-VTA-FLT-702	FLT	HEPA Filter	AN Farm A Train	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	76.5	0.02%	0.04%
AN102-VTP-V-102	V	Butterfly Valve	AN Farm Vent Instr Pit 101	Primary HVAC	Ventilation Tank Primary	5.1E-04	0.1	154.7	0.01%	0.04%
AN102-VTP-V-202	V	Butterfly Valve	Tank AN-102	Primary HVAC	Ventilation Tank Primary	5.1E-04	0.1	154.7	0.01%	0.04%
AN102-VTP-V-262	V	Butterfly Valve	Tank AN-102	Primary HVAC	Ventilation Tank Primary	5.1E-04	0.1	154.7	0.01%	0.04%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN02C-WST-PY-112	PY	Pressure Equipment	Transmitter Enclosure AN02C-WSTA-ENCL-002	Confinement System	Waste Storage Tank	4.8E-04	0.1	163.5	0.01%	0.04%
AN241-CHEMB-PI-132	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	2.2E-03	0.1	35.6	0.05%	0.04%
AN241-CHEMB-PI-107	PI	Pressure Indicator	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.2E-03	0.1	35.6	0.05%	0.04%
AZ156-CHEMB-FI-116	FI	Flow Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	2.2E-03	0.1	35.6	0.05%	0.04%
AZ156-CHEMB-LIC-127	LI	Level Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Storage	2.2E-03	0.1	35.6	0.05%	0.04%
AZ156-CHEMB-PI-101	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	2.2E-03	0.1	35.6	0.05%	0.04%
AZ156-CHEMB-PI-131	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	2.2E-03	0.1	35.6	0.05%	0.04%
AZ156-CHEMB-TI-132	TI	Temperature Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	2.2E-03	0.1	35.6	0.05%	0.04%
AZ156-CHEMB-TI-115	TI	Temperature Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	2.2E-03	0.1	35.6	0.05%	0.04%
AZ156-CHEMB-LI-101	LI	Level Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	2.2E-03	0.1	35.6	0.05%	0.04%
AN296-VTA-FLT-920	FLT	Record Sample Filter	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	74.3	0.02%	0.04%
AN273-SA-ADV-101	ADV	Automatic Drain Valve	AN Farm	Support/Utilities	Compressed Air	8.3E-04	0.1	89.6	0.02%	0.04%
AN241-VTP-DMST-002	DMST	Demister	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	9.5E-04	0.1	76.5	0.02%	0.04%
AN241-VTP-DMST-001	DMST	Demister	AN Farm A Train	Primary HVAC	Ventilation Tank Primary	9.5E-04	0.1	76.5	0.02%	0.04%
AZ156-WT-FQI-155-SUR	FQI	Flow Totalizer Indicator	Bldg AZ-156	Waste Transfer AN-102	Transfer Route	2.0E-03	0.1	35.6	0.05%	0.04%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ156-WT-FI-155-SUR	FI	Flow Indicator	Bldg AZ-156	Waste Transfer AN-102	Transfer Route	2.0E-03	0.1	35.6	0.05%	0.04%
AZ156-WT-PI-154A-SUR	PI	Pressure Indicator	Bldg AZ-156	Waste Transfer AN-102	Transfer Route	2.0E-03	0.1	35.6	0.05%	0.04%
AN05A-WT-TI-153-SUR	TI	Temperature Indicator	Bldg AZ-156	Waste Transfer AN-102	Process Monitoring	2.0E-03	0.1	35.6	0.05%	0.04%
AZ156-WT-ZI-158-SUR	ZI	Position Indicator	Bldg AZ-156	Waste Transfer AN-102	Transfer Pump	2.0E-03	0.1	35.6	0.05%	0.04%
AN05A-WT-FI-153-SUR	FI	Flow Indicator	Bldg AZ-156	Waste Transfer AN-102	Process Monitoring	2.0E-03	0.1	35.6	0.05%	0.04%
AZ156-WT-TI-157-SUR	TI	Temperature Indicator	Bldg AZ-156	Waste Transfer AN-102	Transfer Pump	2.0E-03	0.1	35.6	0.05%	0.04%
AZ156-WT-ZI-106-SUR	ZI	Position Indicator	Bldg AZ-156	Waste Transfer AN-102	Transfer Pump	2.0E-03	0.1	35.6	0.05%	0.04%
AN05A-WT-DI-153-SUR	DI	Density Indicator	Bldg AZ-156	Waste Transfer AN-102	Process Monitoring	2.0E-03	0.1	35.6	0.05%	0.04%
AN105-WT-PI-154-SUR	PI	Pressure Indicator	Bldg AZ-156	Waste Transfer AN-102	Transfer Route	2.0E-03	0.1	35.6	0.05%	0.04%
AN241-RW-V-180	V	Gate Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	4.5E-04	0.1	154.7	0.01%	0.04%
AN241-CHEMB-V-111	V	Gate Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	4.5E-04	0.1	154.7	0.01%	0.04%
AN241-CHEMB-HTR-125	HTR	Heater	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	1.8E-03	0.1	38.7	0.04%	0.04%
AN241-CHEMB-V-119	V	2-Way Ball Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	4.4E-04	0.1	154.7	0.01%	0.03%
ANVPA-WT-L21,F,D	JMP	AN-A Valve Pit Jumper Assembly	AN-A Valve Pit	Diluent/Flush System	Transfer Route	8.5E-05	0.1	776.1	0.00%	0.03%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPA-WT-L3,A,B	JMP	AN-A Valve Pit Jumper Assembly	AN-A Valve Pit	Diluent/Flush System	Transfer Route	8.5E-05	0.1	776.1	0.00%	0.03%
AN05A-WT-B(9&10)	JMP	AN-05A Pump Pit Jumper Assembly	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	8.5E-05	0.1	776.1	0.00%	0.03%
AN05A-WT-(2,3&9)	JMP	AN-05A Pump Pit Jumper Assembly	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	8.5E-05	0.1	776.1	0.00%	0.03%
ANVPA-WT-B,L7	JMP	AN-A Valve Pit Jumper Assembly	AN-A Valve Pit	Diluent/Flush System	Transfer Route	8.5E-05	0.1	776.1	0.00%	0.03%
AN273-IA-V-101	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-171	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-104	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-105	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-106	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-107	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-108	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-105	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-110	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-SA-V-108	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-111	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-112	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-IA-V-113	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-114	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-115	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-116	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-133	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-109	V	Globe Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-125	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-106	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-104	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-132	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-131	V	Angle Globe Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-114	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-129	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-119	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-101	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-121	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-172	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-IA-V-118	V	Globe valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-SA-V-105	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN241-RW-BFP-102	BFP	Backflow Preventer	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.2E-04	0.1	89.6	0.02%	0.03%
AN273-SA-V-102	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-128	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	7.2E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-179	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.1E-04	0.1	89.6	0.02%	0.03%
AN271-WST-V-105	V	Globe Valve	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	7.1E-04	0.1	89.6	0.02%	0.03%
AN271-WST-V-108	V	Angle Globe Valve	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	7.1E-04	0.1	89.6	0.02%	0.03%
AN271-WST-V-107	V	Angle Globe Valve	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	7.1E-04	0.1	89.6	0.02%	0.03%
AN271-WST-V-106	V	Globe Valve	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	7.1E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-178	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.0E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-176	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.0E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-175	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.0E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-173	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.0E-04	0.1	89.6	0.02%	0.03%
AN241-POT-PRV-101	PRV	Pressure Relief Valve	Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.0E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-174	V	Globe Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.0E-04	0.1	89.6	0.02%	0.03%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-IA-PRV-103	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-102	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-103	V	Globe Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN271-IA-PRV-104	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-126	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-115	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-127	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-V-116	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-IA-PRV-102	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-GLY-PRV-101	PRV	Pressure Relief Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-SA-PRV-101	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-SA-PRV-102	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-SA-V-101	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-SA-V-104	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN271-IA-V-130	V	Globe valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-SA-V-107	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%
AN241-RW-V-177	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.0E-04	0.1	89.6	0.02%	0.03%
AN273-IA-PRV-101	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	7.0E-04	0.1	89.6	0.02%	0.03%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
EXTHUMAN	EXT	Hanford Site work stoppage, due to human	EXT	External Events	Hanford	1.5E-02	0.1	4.0	0.36%	0.03%
AN105-WT-V-105-SUR	V	Automatic Switch-Over Valve	Tank AN-102	Waste Transfer AN-102	Transfer Pump	3.9E-04	0.1	154.7	0.01%	0.03%
AN296-VTA-CAM-910	CAM	Continuous Air Monitor	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	7.9E-04	0.1	74.3	0.02%	0.03%
AN241-CHEMB-101-M9	PIPE	Pipe Segment	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	6.4E-04	0.1	89.6	0.02%	0.03%
AN241-CHEMB-106-M10	PIPE	Pipe Segment	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	6.4E-04	0.1	89.6	0.02%	0.03%
AN105-WST-PI-115A	PI	Pressure Indicator	Bldg AZ-156	Confinement System	Primary Monitoring	1.6E-03	0.1	35.6	0.04%	0.03%
AN820-EDS-XFMR-104	XFMR	Transformer	Change Trailer MO-820	Support/Utilities	Electrical Distribution	4.5E-04	0.1	113.7	0.01%	0.03%
AZ156-RW-JY-108	JY	Power Equipment	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.5E-04	0.1	113.7	0.01%	0.03%
AN05A-WT-V-106-SUR	V	Check Valve	Tank AN-102	Waste Transfer AN-102	Transfer Pump	3.3E-04	0.1	154.7	0.01%	0.03%
AN102-VTA-V-202	V	Butterfly Valve	Tank AN-102	Annulus HVAC	Ventilation Tank Annulus	3.2E-04	0.0	154.7	0.01%	0.03%
AN102-VTA-V-102	V	Butterfly Valve	Tank AN-102	Annulus HVAC	Ventilation Tank Annulus	3.2E-04	0.0	154.7	0.01%	0.03%
AZ156-CHEMB-TI-124	TI	Temperature Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Storage	1.4E-03	0.0	35.6	0.03%	0.02%
AZ156-CHEMB-AI-123	AI	Analysis Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Storage	1.4E-03	0.0	35.6	0.03%	0.02%
AN05A-WT-V-108-SUR (dupe)	V	3-Way Ball Valve	Tank AN-102	Waste Transfer AN-102	Transfer Pump	3.2E-04	0.0	154.7	0.01%	0.02%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05A-WT-PRV-101-SUR	PRV	Pressure Relief Valve	Tank AN-102	Waste Transfer AN-102	Transfer Pump	3.2E-04	0.0	154.7	0.01%	0.02%
AN241-VTP-EJ-401	EJ	Expansion Joint	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	6.3E-04	0.0	76.5	0.02%	0.02%
AN241-DR-V-110	V	2-Way Ball Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	3.1E-04	0.0	154.7	0.01%	0.02%
AN05C-WST-FIV-102	FIV	Flow Indicating Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	2.5E-04	0.0	186.9	0.01%	0.02%
AN241-EDS-DS-119	DS	Disconnect Switch	AN Farm	Support/Utilities	Electrical Distribution	2.4E-04	0.0	186.9	0.01%	0.02%
AN296-VTP-FCV-513	FCV	Flow Control Valve	AN296-VTP-ENCL-500	Primary HVAC	Ventilation Tank Primary	2.8E-04	0.0	163.5	0.01%	0.02%
AN242A-WSTA-RSH-AN102	RSH	Radiation Switch High	AN Farm	Confinement System	Waste Tank AN-102	1.3E-03	0.0	35.6	0.03%	0.02%
AN241-RW-PIT-105	PIT	Pressure Indicating Transmitter	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.2E-03	0.0	35.6	0.03%	0.02%
AN02C-IA-PCV-112	PCV	Pressure Control Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	2.7E-04	0.0	154.7	0.01%	0.02%
AN02C-WST-PCV-112	PCV	Pressure Control Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	2.7E-04	0.0	154.7	0.01%	0.02%
AN241-VTA-DMST-003	DMST	Demister	AN Farm A Train	Annulus HVAC	Ventilation Tank Annulus	5.5E-04	0.0	76.5	0.01%	0.02%
AN105-WT-FIT-155-SUR	FIT	Flow Indicating Transmitter	Tank AN-102	Waste Transfer AN-102	Transfer Route	6.0E-04	0.0	67.8	0.01%	0.02%
AN105-WT-PT-154-SUR	PIT	Pressure Indicating Transmitter	Tank AN-102	Waste Transfer AN-102	Transfer Route	6.0E-04	0.0	67.8	0.01%	0.02%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN105-WST-V-109	V	2-Way Ball Valve	Tank AN-105	Confinement System	Primary Monitoring	2.6E-04	0.0	154.7	0.01%	0.02%
AN105-VTP-V-205	V	Butterfly Valve	Tank AN-105	Primary HVAC	Ventilation Tank Primary	2.6E-04	0.0	154.7	0.01%	0.02%
AN105-IA-V-217	V	Globe valve	AN-105	Support/Utilities	Compressed Air	2.6E-04	0.0	154.7	0.01%	0.02%
AN105-VTP-V-105	V	Butterfly Valve	AN Farm Vent Instr Pit 103	Primary HVAC	Ventilation Tank Primary	2.6E-04	0.0	154.7	0.01%	0.02%
AN105-IA-V-219	V	Globe valve	AN-105	Support/Utilities	Compressed Air	2.6E-04	0.0	154.7	0.01%	0.02%
AN105-IA-V-218	V	2-Way Ball Valve	AN-105	Support/Utilities	Compressed Air	2.6E-04	0.0	154.7	0.01%	0.02%
AN105-WST-V-108	V	2-Way Ball Valve	Tank AN-105	Confinement System	Primary Monitoring	2.6E-04	0.0	154.7	0.01%	0.02%
AN05C-WST-V-227	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	2.6E-04	0.0	154.7	0.01%	0.02%
AN105-IA-V-216	V	Globe valve	AN-105	Support/Utilities	Compressed Air	2.6E-04	0.0	154.7	0.01%	0.02%
AN05C-WST-V-106	V	Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	2.6E-04	0.0	154.7	0.01%	0.02%
AN05C-WST-V-224	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	2.6E-04	0.0	154.7	0.01%	0.02%
AN05C-WST-V-225	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	2.6E-04	0.0	154.7	0.01%	0.02%
AN105-WSTA-FIV-106	FIV	Flow Indicator with Flow Adjust Valve	Tank AN-105	Confinement System	Leak Detection Pit	2.5E-04	0.0	157.7	0.01%	0.02%
AN105-WSTA-FIV-105	FIV	Flow Indicator with Flow Adjust Valve	Tank AN-105	Confinement System	Leak Detection Pit	2.5E-04	0.0	157.7	0.01%	0.02%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN105-WSTA-FIV-104	FIV	Flow Indicator with Flow Adjust Valve	Tank AN-105	Confinement System	Leak Detection Pit	2.5E-04	0.0	157.7	0.01%	0.02%
AN05C-IA-PRV-115	PRV	Pressure Relief Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	2.5E-04	0.0	154.7	0.01%	0.02%
AN05C-WST-V-101	V	Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	2.5E-04	0.0	154.7	0.01%	0.02%
AN05C-WST-V-102	V	Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	2.5E-04	0.0	154.7	0.01%	0.02%
AN105-VTP-V-265	V	Butterfly Valve	Tank AN-105	Primary HVAC	Ventilation Tank Primary	2.5E-04	0.0	154.7	0.01%	0.02%
AN102-WST-LE-132	LE	Level Element	Inside Tank AN-102	Confinement System	Waste Storage Tank	2.4E-04	0.0	157.7	0.01%	0.02%
AN102-WSTA-LIS-104	LIS	Level Indicating Switch	Tank AN-102	Confinement System	Leak Detection Pit	2.4E-04	0.0	157.7	0.01%	0.02%
AN102-WSTA-LIS-105	LIS	Level Indicating Switch	Tank AN-102	Confinement System	Leak Detection Pit	2.4E-04	0.0	157.7	0.01%	0.02%
AN241-CHEMB-V-106	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.0E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-117	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.0E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-108	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.0E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-110	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.0E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-107	V	Globe Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	3.9E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-112	V	2-Way Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	3.9E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-118	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	3.9E-04	0.0	89.6	0.01%	0.02%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-V-115	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	3.9E-04	0.0	89.6	0.01%	0.02%
AN05C-WST-PT-125	PT	Pressure Transmitter	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	4.8E-04	0.0	67.8	0.01%	0.02%
AN05C-WST-PT-115	PT	Pressure Transmitter	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	4.8E-04	0.0	67.8	0.01%	0.02%
AN105-WST-LIT-104	LIT	Level Indicating Transmitter	Tank AN-105	Confinement System	Primary Monitoring	4.8E-04	0.0	67.8	0.01%	0.02%
AN05A-WT-PS-161-SUR	PS	Pressure Switch	Tank AN-102	Waste Transfer AN-102	Transfer Pump	2.0E-04	0.0	157.7	0.00%	0.02%
AN241-CHEMB-AE-123	AE	Analysis element	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	7.0E-04	0.0	40.2	0.02%	0.01%
AN241-EDS-BKR-100	BKR	Breaker	AN Farm	Support/Utilities	Electrical Distribution	1.5E-04	0.0	186.9	0.00%	0.01%
AZ156-CHEMB-ZY-129	ZY	Position Equipment	PLC Instr Enclosure WT-ENCL-101	Diluent/Flush System	Diluent/Flush Delivery	6.6E-04	0.0	40.2	0.02%	0.01%
AN05C-WST-PY-115	PY	Pressure Equipment	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	1.6E-04	0.0	163.5	0.00%	0.01%
AN05C-WST-PY-125	PY	Pressure Equipment	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	1.6E-04	0.0	163.5	0.00%	0.01%
AZNEW-WT-E	NOZ	AZ Valve Pit Jumper Connection	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AN02A-WT-A	NOZ	AN-02A Central Pump Pit Jumper Connection	Central Pump Pit AN-02A	Waste Transfer AN-102/Stage	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZNEW-WT-L	NOZ	AZ Valve Pit Jumper Connection	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AZNEW-WT-J	NOZ	AZ Valve Pit Jumper Connection	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
ANVPB-WT-R15	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AN02A-WT-6	NOZ	AN-02A Central Pump Pit Jumper Connection	Central Pump Pit AN-02A	Waste Transfer AN-102/Stage	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AN02A-WT-5	NOZ	AN-02A Central Pump Pit Jumper Connection	Central Pump Pit AN-02A	Waste Transfer AN-102/Stage	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AZNEW-WT-A	NOZ	AZ Valve Pit Jumper Connection	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AN02A-WT-1	NOZ	AN-02A Central Pump Pit Jumper Connection	Central Pump Pit AN-02A	Waste Transfer AN-102/Stage	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AN01A-WT-D	NOZ	AN-01A Central Pump Pit Jumper Connection	AN-01A Central Pump Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AN01A-WT-A	NOZ	AN-01A Central Pump Pit Jumper Connection	AN-01A Central Pump Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AN02A-WT-8	NOZ	AN-02A Central Pump Pit Jumper Connection	Central Pump Pit AN-02A	Waste Transfer AN-102/Stage	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
ANVPB-WT-R16	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-102/Stage	Transfer Route	3.2E-05	0.0	776.1	0.00%	0.01%
AN242A-VTA-RSH-AN-K2	RSH	Radiation Switch High	Evaporator Bldg 242-A	Annulus HVAC	Ventilation Tank Annulus	6.9E-04	0.0	35.6	0.02%	0.01%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN242A-VTA-RXS-AN-K2	RXS	Radiation Failure Switch	Evaporator Bldg 242-A	Annulus HVAC	Ventilation Tank Annulus	6.9E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-V-103	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.7E-04	0.0	89.6	0.01%	0.01%
AN241-CHEMB-V-102	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.7E-04	0.0	89.6	0.01%	0.01%
AN271-WST-V-118	V	Angle Globe Valve	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	2.7E-04	0.0	89.6	0.01%	0.01%
AN271-WST-V-119	V	Globe Valve	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	2.7E-04	0.0	89.6	0.01%	0.01%
AN271-WST-V-117	V	Angle Globe Valve	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	2.7E-04	0.0	89.6	0.01%	0.01%
AN271-WST-V-120	V	Globe Valve	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	2.7E-04	0.0	89.6	0.01%	0.01%
AN241-CHEMB-V-105	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.6E-04	0.0	89.6	0.01%	0.01%
AN241-CHEMB-V-104	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.6E-04	0.0	89.6	0.01%	0.01%
AN241-CHEMB-V-101	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.6E-04	0.0	89.6	0.01%	0.01%
AN241-CHEMB-FIT-130	FIT	Flow Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	6.5E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-TIT-132	TIT	Temperature Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	6.5E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-FIT-116	FIT	Flow Indicating Transmitter	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	6.5E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-TIT-115	TIT	Temperature Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	6.5E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-ZT-129	ZT	Position Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	6.5E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-PIT-131	PIT	Pressure Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	6.5E-04	0.0	35.6	0.02%	0.01%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-LIT-127	LIT	Level Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	6.5E-04	0.0	35.6	0.02%	0.01%
AN273-IA-AOV-102	AOV	Air Operated Valve	AN Farm	Support/Utilities	Compressed Air	2.6E-04	0.0	89.6	0.01%	0.01%
AN241-RW-PCV-101	PCV	Pressure Control Valve	Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.6E-04	0.0	89.6	0.01%	0.01%
AN271-IA-PCV-101	PCV	Pressure Control Valve	AN Farm	Support/Utilities	Compressed Air	2.6E-04	0.0	89.6	0.01%	0.01%
AN273-IA-AOV-101	AOV	Air Operated Valve	AN Farm	Support/Utilities	Compressed Air	2.6E-04	0.0	89.6	0.01%	0.01%
AZ156-WT-SY-153-SUR	SY	Speed/Velocity Equipment	Bldg AZ-156	Waste Transfer AN-102	Process Monitoring	2.0E-04	0.0	113.7	0.00%	0.01%
AZ156-WT-UT-153-SUR	UT	Multivariable Transmitter	Bldg AZ-156	Waste Transfer AN-102	Process Monitoring	6.0E-04	0.0	35.6	0.01%	0.01%
AN241-RW-PRV-101	PRV	Pressure Reducing Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.3E-04	0.0	89.6	0.01%	0.01%
AN05A-WT-V-108 (dupe)	V	3-Way Ball Valve	Tank AN-102	Waste Transfer AN-105	Transfer Pump	1.3E-04	0.0	154.7	0.00%	0.01%
AN273-GLY-(P-001-ELEC)	ELEC	Coolant Pump Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.4E-04	0.0	113.7	0.00%	0.01%
AN273-GLY-(P-002-ELEC)	ELEC	Coolant Pump Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.4E-04	0.0	113.7	0.00%	0.01%
AN273-GLY-(F-003-ELEC)	ELEC	Cooling Fan Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.4E-04	0.0	113.7	0.00%	0.01%
AN273-GLY-(F-004-ELEC)	ELEC	Cooling Fan Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.4E-04	0.0	113.7	0.00%	0.01%
AN273-SA-(CMP-001-ELEC)	ELEC	Compressor Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.4E-04	0.0	113.7	0.00%	0.01%
AN273-IA-(DRY-101-ELEC)	ELEC	Dryer Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.4E-04	0.0	113.7	0.00%	0.01%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-RW-PDISH-103	PDISH	Pressure Differential Indicator Switch High	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.1E-04	0.0	35.6	0.01%	0.01%
AZ156-CHEMB-FFC-118	FFC	PLG added	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.1E-04	0.0	35.6	0.01%	0.01%
AN241-CHEMB-TIT-124	TIT	Temperature Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	4.1E-04	0.0	35.6	0.01%	0.01%
AN241-CHEMB-AIT-123	AIT	Analysis Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	4.1E-04	0.0	35.6	0.01%	0.01%
AN271-WST-PSH-112	PSH	Pressure Switch High	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	4.1E-04	0.0	35.6	0.01%	0.01%
AN05C-IA-PCV-115	PCV	Pressure Control Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	9.2E-05	0.0	154.7	0.00%	0.01%
HAPERFLS001	HUMAN	Flush Transfer Lines	HUMAN	Human Actions	Transfer Route	5.0E-04	0.0	28.1	0.01%	0.01%
AN273-GLY-P-001	P	Pump	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	1.5E-04	0.0	89.6	0.00%	0.01%
AN105-WSTA-LIS-105	LIS	Level Indicating Switch	Tank AN-105	Confinement System	Leak Detection Pit	7.9E-05	0.0	157.7	0.00%	0.01%
AN105-WST-LE-135	LE	Level Element	Tank AN-105	Confinement System	Primary Monitoring	7.9E-05	0.0	157.7	0.00%	0.01%
AN105-WSTA-LIS-104	LIS	Level Indicating Switch	Tank AN-105	Confinement System	Leak Detection Pit	7.9E-05	0.0	157.7	0.00%	0.01%
AN105-WSTA-LIS-106	LIS	Level Indicating Switch	Tank AN-105	Confinement System	Leak Detection Pit	7.9E-05	0.0	157.7	0.00%	0.01%
ANVPA-WT-L21	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Diluent/Flush System	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
ANVPB-WT-R20	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Diluent/Flush System	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPB-WT-B	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Diluent/Flush System	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
ANVPA-WT-B	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Diluent/Flush System	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
ANVPA-WT-A,B	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Diluent/Flush System	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
ANVPA-WT-L7	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Diluent/Flush System	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
ANVPB-WT-R7	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Diluent/Flush System	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
ANVPA-WT-D	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Waste Transfer AN-105	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
AN05A-WT-2	NOZ	AN-05A Pump Pit Jumper Connection	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
AN05A-WT-B	NOZ	AN-05A Pump Pit Jumper Connection	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	1.3E-05	0.0	776.1	0.00%	0.01%
AN241-VTP-EDS-MCC-002	MCC	Motor Control Center	AN-A & B Trains	Primary HVAC	Ventilation Tank Primary	4.9E-05	0.0	186.9	0.00%	0.00%
AN271-WST-PSL-112	PSL	Pressure Switch Low	Instr Bldg 241-AN-271	Confinement System	Waste Storage Tank	2.5E-04	0.0	35.6	0.01%	0.00%
AN241-CHEMB-PCV-122	PCV	Pressure Control Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	9.6E-05	0.0	89.6	0.00%	0.00%
AN241-CHEMB-PCV-123	PCV	Pressure Control Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	9.6E-05	0.0	89.6	0.00%	0.00%
AZ156-WT-I-2-SUR	I	Interlock	Bldg AZ-156	Waste Transfer AN-102	Waste Transfer System	2.0E-04	0.0	35.6	0.00%	0.00%
AZ156-WT-I-3-SUR	I	Interlock	Bldg AZ-156	Waste Transfer AN-102	Waste Transfer System	2.0E-04	0.0	35.6	0.00%	0.00%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ156-WT-I-8-SUR	I	Interlock	Bldg AZ-156	Waste Transfer AN-102	Waste Transfer System	2.0E-04	0.0	35.6	0.00%	0.00%
AZ156-WT-I-7-SUR	I	Interlock	Bldg AZ-156	Waste Transfer AN-102	Waste Transfer System	2.0E-04	0.0	35.6	0.00%	0.00%
AZ156-WT-I-1-SUR	I	Interlock	Bldg AZ-156	Waste Transfer AN-102	Waste Transfer System	2.0E-04	0.0	35.6	0.00%	0.00%
AN271-WST-PSL-115	PSL	Pressure Switch Low	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	1.6E-04	0.0	35.6	0.00%	0.00%
AN271-WST-PSH-115	PSH	Pressure Switch High	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	1.6E-04	0.0	35.6	0.00%	0.00%
AN274-WST-TBX-113	TBX	Terminal Box	Caustic Addition Control Room	Support/Utilities	Electrical Distribution	4.5E-05	0.0	113.7	0.00%	0.00%
AN241-CHEMB-FCV-129	FCV	Flow Control Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	1.3E-04	0.0	40.2	0.00%	0.00%
AN241-VTP-SP-102	SP	Seal Pot	AN Farm	Primary HVAC	Ventilation Tank Primary	3.3E-05	0.0	154.7	0.00%	0.00%
AN241-VTP-SP-101	SP	Seal Pot	AN Farm	Primary HVAC	Ventilation Tank Primary	3.3E-05	0.0	154.7	0.00%	0.00%
AN241-CHEMB-TE-125	TE	Temperature Element	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	1.4E-04	0.0	35.6	0.00%	0.00%
AN242A-VTA-PSH-ANK22	PSH	Pressure Switch High	Evaporator Bldg 242-A	Annulus HVAC	Ventilation Tank Annulus	1.4E-04	0.0	35.6	0.00%	0.00%
AN242A-VTA-PSH-ANK21	PSH	Pressure Switch High	Evaporator Bldg 242-A	Annulus HVAC	Ventilation Tank Annulus	1.4E-04	0.0	35.6	0.00%	0.00%
AN102-WST-SG-104	SG	Sight Glass	Outside Tank AN-102	Confinement System	Waste Storage Tank	6.3E-05	0.0	65.6	0.00%	0.00%
AN273-GLY-TK-001	TK	Tank	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	4.6E-05	0.0	89.6	0.00%	0.00%
AN273-SA-TK-001	TK	Tank	AN Farm	Support/Utilities	Compressed Air	4.6E-05	0.0	89.6	0.00%	0.00%
AN241-VTA-EDS-MCC-002	MCC	Motor Control Center	AN Farm	Annulus HVAC	Ventilation Tank Annulus	2.1E-05	0.0	186.9	0.00%	0.00%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-LE-127	LE	Level Element	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	1.1E-04	0.0	35.6	0.00%	0.00%
AN241-WST-105	DST	Double Shell Tank	Tank AN-105	Confinement System	Tank Structure	1.7E-05	0.0	154.7	0.00%	0.00%
AN273-GLY-LG-101	LG	Level Glass	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.3E-05	0.0	40.2	0.00%	0.00%
AZ156-CHEMB-YY-130	YY	Event Converter	PLC Instr Enclosure WT-ENCL-101	Diluent/Flush System	Diluent/Flush Delivery	6.5E-05	0.0	35.6	0.00%	0.00%
AN241-CHEMB-TK-001	TK	Diluent/Flush Tank	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	2.6E-05	0.0	89.6	0.00%	0.00%
AZ156-WT-YY-155-SUR	YY	Event Converter	Bldg AZ-156	Waste Transfer AN-102	Transfer Route	6.0E-05	0.0	35.6	0.00%	0.00%
AN271-EDS-BKR-129	BRK	Breaker	Motor Control Center AN271-EDS-MCC-001	Support/Utilities	Electrical Distribution	1.2E-04	0.0	14.0	0.00%	0.00%
AN271-EDS-BKR-106	BRK	Breaker	Motor Control Center AN271-EDS-MCC-001	Support/Utilities	Electrical Distribution	1.2E-04	0.0	14.0	0.00%	0.00%
AN271-EDS-BKR-104	BRK	Breaker	Motor Control Center AN271-EDS-MCC-001	Support/Utilities	Electrical Distribution	1.2E-04	0.0	14.0	0.00%	0.00%
AN271-EDS-BKR-101	BRK	Breaker	Motor Control Center AN271-EDS-MCC-001	Support/Utilities	Electrical Distribution	1.2E-04	0.0	14.0	0.00%	0.00%
AN105-WST-SG-104	SG	Sight Glass	Tank AN-105	Confinement System	Primary Monitoring	2.5E-05	0.0	65.6	0.00%	0.00%
ANVPA-WT-LDE-331	LDE	AN-A Valve Pit Leak Detector Element	AN-A Valve Pit	Waste Transfer AN-105	Transfer Route	2.5E-06	0.0	592.4	0.00%	0.00%
ANVPB-WT-LDK-231	LDK	AN-B Valve Pit Leak Detector Relay	AN Farm	Waste Transfer AN-105	Transfer Route	6.0E-05	0.0	18.9	0.00%	0.00%
ANVPA-WT-SN-268-M25	PIPE	Valve Pit Discharge Pipe Segment	AN-A Valve Pit to AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	8.0E-07	0.0	776.1	0.00%	0.00%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-GLY-DS-004	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	2.0E-04	0.0	3.0	0.00%	0.00%
AN273-GLY-DS-003	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	2.0E-04	0.0	3.0	0.00%	0.00%
AN273-GLY-DS-010	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	2.0E-04	0.0	3.0	0.00%	0.00%
AN273-GLY-DS-002	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	2.0E-04	0.0	3.0	0.00%	0.00%
AN273-GLY-DS-001	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	2.0E-04	0.0	3.0	0.00%	0.00%
AN820-EDS-DS-114	DS	Disconnect Switch	Change Trailer MO-820	Support/Utilities	Electrical Distribution	2.0E-04	0.0	3.0	0.00%	0.00%
AN273-EDS-DS-112	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Electrical Distribution	2.0E-04	0.0	3.0	0.00%	0.00%
AN273-EDS-DS-113	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Electrical Distribution	2.0E-04	0.0	3.0	0.00%	0.00%
AN271-EDS-DS-117	DS	Disconnect Switch	Instr Bldg 241-AN-271	Support/Utilities	Electrical Distribution	2.0E-04	0.0	3.0	0.00%	0.00%
AN273-SA-DS-001	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	2.0E-04	0.0	3.0	0.00%	0.00%
AN273-IA-DS-101	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	2.0E-04	0.0	3.0	0.00%	0.00%
AN05A-WT-V-806-SUR	V	Check Valve	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Route	4.1E-07	0.0	776.1	0.00%	0.00%
ANVPA-WT-V-320	V	2-Way Ball Valve	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	4.0E-07	0.0	776.1	0.00%	0.00%
AN05A-WT-MOV-609-SUR	MOV	3-Way Ball Valve	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Route	4.0E-07	0.0	776.1	0.00%	0.00%
AN05A-WT-MOV-611-SUR	MOV	3-Way Ball Valve	AN-02A Central Pump Pit	Waste Transfer AN-102	Transfer Route	4.0E-07	0.0	776.1	0.00%	0.00%
ANVPB-WT-V-219	V	2-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	4.0E-07	0.0	776.1	0.00%	0.00%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPA-WT-MOV-318	MOV	3-Way Ball Valve	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	4.0E-07	0.0	776.1	0.00%	0.00%
ANVPB-WT-V-218	V	3-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	4.0E-07	0.0	776.1	0.00%	0.00%
ANVPA-WT-V-319	V	3-Way Ball Valve	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	4.0E-07	0.0	776.1	0.00%	0.00%
ANVPB-WT-R19-(D&F)	JMP	AN-A Valve Pit Jumper Assembly	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	2.7E-07	0.0	776.1	0.00%	0.00%
AN05A-WT-A(8)	JMP	AN-05A Pump Pit Jumper Assembly	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	2.7E-07	0.0	776.1	0.00%	0.00%
AN273-GLY-V-108	V	Check Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	9.7E-07	0.0	89.6	0.00%	0.00%
AN273-GLY-V-109	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	9.7E-07	0.0	89.6	0.00%	0.00%
AN273-GLY-V-107	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	9.7E-07	0.0	89.6	0.00%	0.00%
ANVPA-WT-PSH-250	PSH	Pressure Switch High	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	2.5E-07	0.0	157.7	0.00%	0.00%
ANVPA-WT-PSH-251	PSH	Pressure Switch High	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	2.5E-07	0.0	157.7	0.00%	0.00%
ANVPB-WT-F	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	4.0E-08	0.0	776.1	0.00%	0.00%
ANVPA-WT-L19	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	4.0E-08	0.0	776.1	0.00%	0.00%
ANVPB-WT-R19	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	4.0E-08	0.0	776.1	0.00%	0.00%

Table E-5. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPA-WT-LDK-331	LDK	AN-A Valve Pit Leak Detector Relay	AN Farm	Waste Transfer AN-105	Transfer Route	7.5E-08	0.0	18.9	0.00%	0.00%

Table E-6. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Activity Contribution to Schedule Delay

Activity	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
	4.2	**196.1**	**46.9**	**100%**	**100%**
AN-102 Pre Transfer	2.5E+00	113.2	46	59.2%	57.7%
AN-102 Transfer B	1.6E+00	78.9	48	39.1%	40.2%
Line Preheat	7.3E-02	4.0	55	1.7%	2.1%

Table E-7. Critical Items List for Waste Transfer Activities from 241-AN-102 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

Component Type Category	Expected Number of Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Total	**4.2**	**196.1**	**46.9**	**100%**	**100%**
Pumps/Fans	2.7E-01	44.5	163	6.5%	22.7%
Instruments/Electrical	6.9E-01	40.4	58	16.6%	20.6%
Check and Manual Valves	1.0E-01	28.3	277	2.4%	14.5%
Power Operated Valves	1.9E-01	27.0	143	4.5%	13.8%
Transfer Pump	2.0E-01	26.7	133	4.8%	13.6%
External Events	2.6E+00	19.7	7	63.2%	10.0%
Pipes, Filters, Containers, Structure	5.4E-02	6.2	116	1.3%	3.2%
Human Actions	1.4E-02	2.4	171	0.3%	1.2%
Miscellaneous/Structural Components	1.3E-02	0.5	39	0.3%	0.2%
Miscellaneous/Other Non Active	1.4E-03	0.2	164	0.0%	0.1%
Electrical Heaters	1.8E-03	0.1	39	0.04%	0.04%

Appendix F. Critical Items List and Supplemental Information Supporting RAM Analysis of Waste Feed Delivery Activities from Source Tank 241-AZ-101

Figures

F-1 Simulation Results for Waste Transfer Activities from 241-AZ-101 to the WTP (Note: This figure contains numerous pages of text and graphics generated by the Crystal Ball report generator.)

Tables

F-1 Waste Flowsheet Volume Summary for Waste Transfer Activities from 241-AZ-101 to the WTP

F-2 Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by System Contribution to Schedule Delay

F-3 Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

F-4 Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure

F-5 Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay

F-6 Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Activity Contribution to Schedule Delay

F-7 Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

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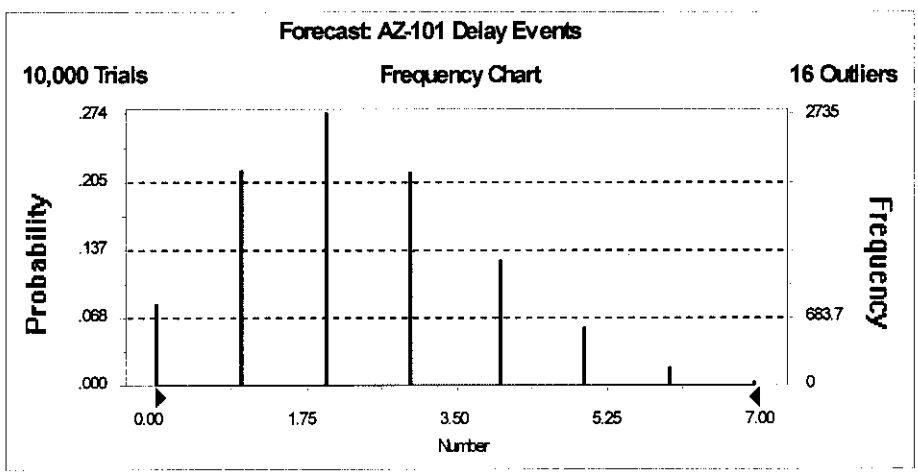
Crystal Ball Report
Simulation started on 9/4/00 at 13:23:29
Simulation stopped on 9/4/00 at 13:47:17

Forecast: AZ-101 Delay Events

Summary:
Display Range is from 0.00 to 7.00 Number
Entire Range is from 0.00 to 9.00 Number
After 10,000 Trials, the Std. Error of the Mean is 0.01

Statistics:	Value
Trials	10000
Mean	2.38
Median	2.00
Mode	2.00
Standard Deviation	1.48
Variance	2.18
Skewness	0.55
Kurtosis	3.17
Coeff. of Variability	0.62
Range Minimum	0.00
Range Maximum	9.00
Range Width	9.00
Mean Std. Error	0.01



Forecast: AZ-101 Delay Events (cont'd)

Percentiles:

Percentile	Number
0%	0.00
5%	0.00
10%	1.00
15%	1.00
20%	1.00
25%	1.00
30%	2.00
35%	2.00
40%	2.00
45%	2.00
50%	2.00
55%	2.00
60%	3.00
65%	3.00
70%	3.00
75%	3.00
80%	4.00
85%	4.00
90%	4.00
95%	5.00
100%	9.00

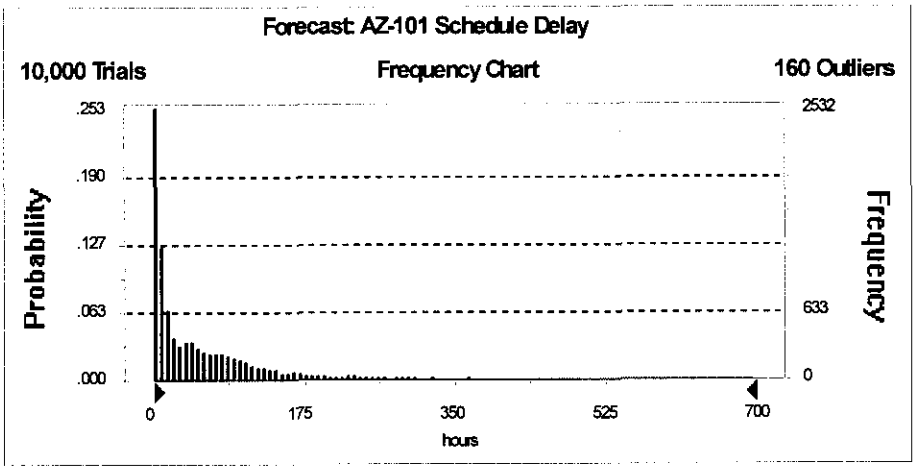
End of Forecast

Forecast: AZ-101 Schedule Delay

Summary:

Display Range is from 0 to 700 hours
Entire Range is from 0 to 3033 hours
After 10,000 Trials, the Std. Error of the Mean is 2

Statistics:	Value	Delay days
Trials	10000	
Mean	90	3.8
Median	32	1.3
Mode	0	
Standard Deviation	206	
Variance	42489	
Skewness	6.67	
Kurtosis	61.64	
Coeff. of Variability	2.29	
Range Minimum	0	
Range Maximum	3033	126.4
Range Width	3033	
Mean Std. Error	2.06	



Forecast: AZ-101 Schedule Delay (cont'd)

Percentiles:

Percentile	Delay hours	Delay days
0%	0	0.0
5%	0	0.0
10%	2	0.1
15%	3	0.1
20%	5	0.2
25%	7	0.3
30%	9	0.4
35%	12	0.5
40%	16	0.7
45%	22	0.9
50%	32	1.3
55%	42	1.7
60%	52	2.2
65%	64	2.7
70%	79	3.3
75%	93	3.9
80%	112	4.7
85%	140	5.8
90%	197	8.2
95%	340	14.2
100%	3033	126.4

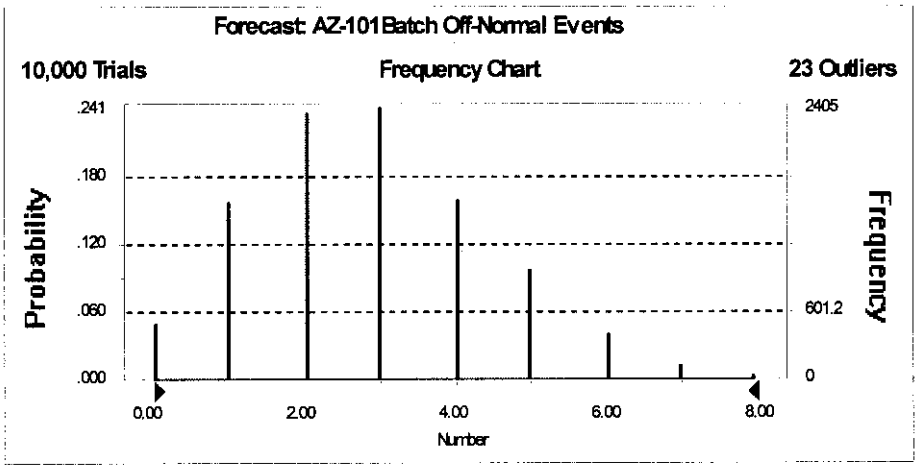
End of Forecast

Forecast: AZ-101Batch Off-Normal Events

Summary:

Display Range is from 0.00 to 8.00 Number
Entire Range is from 0.00 to 10.00 Number
After 10,000 Trials, the Std. Error of the Mean is 0.02

Statistics:	Value
Trials	10000
Mean	2.86
Median	3.00
Mode	3.00
Standard Deviation	1.61
Variance	2.61
Skewness	0.51
Kurtosis	3.22
Coeff. of Variability	0.56
Range Minimum	0.00
Range Maximum	10.00
Range Width	10.00
Mean Std. Error	0.02



Forecast: AZ-101Batch Off-Normal Events (cont'd)

Percentiles:

Percentile	Number
0%	0.00
5%	1.00
10%	1.00
15%	1.00
20%	1.00
25%	2.00
30%	2.00
35%	2.00
40%	2.00
45%	3.00
50%	3.00
55%	3.00
60%	3.00
65%	3.00
70%	4.00
75%	4.00
80%	4.00
85%	5.00
90%	5.00
95%	6.00
100%	10.00

End of Forecast

Assumptions

End of Assumptions

Table F-1. Waste Flowsheet Volume Summary for Waste Transfer Activities from 241-AZ-101 to the WTP

Activity	Volume (m3)	Volume (gal)	Time (hrs)	Inches of Waste	Comment	Reference
Starting Waste Volume in AZ-101	3200	845,344		296.6		241-AZ-101 Flowsheet
Transfer AZ-101 to BNFL - Batch 1	600	158,502	18.9	55.6		241-AZ-101 Flowsheet
Transfer AZ-101 to BNFL - Batch 2	600	158,502	18.9	55.6		241-AZ-101 Flowsheet
Transfer AZ-101 to BNFL - Batch 3	600	158,502	18.9	55.6		241-AZ-101 Flowsheet
Transfer AZ-101 to BNFL - Batch 4	600	158,502	18.9	55.6		241-AZ-101 Flowsheet
Transfer AZ-101 to BNFL - Batch 5	653	172,503	20.5	60.5		241-AZ-101 Flowsheet
Total Waste Transferred	3053	806,511	96	283.0		
Heel Remaining in AZ-101 after all transfers of Batch 1	147	38833		13.6	Does not include approximately 18 m3 of flush water drainback.	241-AZ-101 Flowsheet

Note: The deliveries from AZ-101 also have a very short duration flush at the end. These are modeled as one hour exposures for flush/dilution components

Note: Total waste transferred ignores small flush volumes.

Source: Orme, R.M., 1999, Waste Feed Delivery Technical Basis, HNF-1939-Vol. II, "Waste Feed Delivery Flowsheet for 241-AZ-101" Appendix B, Rev.1, Numatec Hanford Corporation, Richland, Washington (Orme, 2000b)

Table F-2. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by System Contribution to Schedule Delay

System	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Total	**2.4**	**88.0**	**36.9**	**100%**	**100%**
Waste Transfer System	2.2E-01	30.8	138.5	9.3%	35.1%
HVAC Primary	3.2E-01	25.3	78.2	13.5%	28.7%
External Events	1.7E+00	12.5	7.5	70.1%	14.2%
Diluent/Flush System	7.8E-02	7.3	93.6	3.3%	8.3%
Human Actions	1.9E-02	6.2	324.7	0.8%	7.0%
Confinement System	3.4E-02	3.1	90.4	1.4%	3.5%
HVAC Annulus	2.2E-02	2.3	104.1	0.9%	2.6%
Support/Utilities	1.6E-02	0.6	39.3	0.7%	0.7%

Table F-3. Critical Items List Waste Flowsheet Volume Summary for Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
	Total	**2.4**	**88.0**	**36.9**	**100%**	**100%**
HVAC Primary	Ventilation Tank Primary	2.6E-01	19.9	75.8	11.0%	22.6%
Waste Transfer System	Mixer Pumps	1.7E-01	19.9	118.3	7.0%	22.6%
External Events	Weather	1.6E+00	10.3	6.6	65.9%	11.8%
Waste Transfer System	Transfer Pump	4.8E-02	6.2	129.1	2.0%	7.0%
Waste Transfer System	Transfer Route	7.0E-03	4.8	690.6	0.3%	5.5%
HVAC Primary	Recirculation Condenser Cooling	4.4E-02	4.2	94.6	1.8%	4.7%
Diluent/Flush System	Diluent/Flush Delivery	3.9E-02	4.0	102.2	1.6%	4.5%
Human Actions	Mixer Pumps	1.0E-02	3.9	391.6	0.4%	4.5%
Diluent/Flush System	Diluent/Flush Preparation	3.8E-02	3.3	86.5	1.6%	3.7%
HVAC Annulus	Ventilation Tank Annulus	2.2E-02	2.3	104.1	0.9%	2.6%
Human Actions	Transfer Pump	8.0E-03	2.0	255.3	0.3%	2.3%
Confinement System	Ventilation Tank Annulus	1.5E-02	1.9	125.9	0.6%	2.1%
External Events	Hanford	3.8E-02	1.7	43.7	1.6%	1.9%
HVAC Primary	Exhaust Condenser Cooling	1.7E-02	1.2	72.7	0.7%	1.4%
Confinement System	Waste Tank	1.9E-02	1.2	63.0	0.8%	1.4%
Support/Utilities	Electrical Distribution	1.6E-02	0.6	39.3	0.7%	0.7%
External Events	Electrical Distribution	5.7E-02	0.3	6.0	2.4%	0.4%
Human Actions	Transfer Route	1.0E-03	0.2	209.9	0.0%	0.2%
External Events	Off Site	4.6E-03	0.1	24.0	0.2%	0.1%
Diluent/Flush System	Diluent/Flush Storage	1.2E-03	0.1	40.7	0.1%	0.1%
Waste Transfer System	Monitoring	1.3E-04	0.0	67.8	0.0%	0.0%

Table F-4. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
				Total	**2.4**	**88.0**	**36.9**	**100%**	**100%**
Confinement System	Ventilation Tank Annulus	Primary Containment Leak Detection	Leak Detector Trees	Leak Detector Trees	1.5E-02	1.9	126	0.62%	2.12%
Confinement System	Waste Tank	Instrument Air	Safe Storage Monitoring	Level Monitoring	2.3E-04	0.0	158	0.01%	0.04%
Confinement System	Waste Tank	Instrument Air	Safe Storage Monitoring	Tank Dome Pressure Monitor	1.6E-02	0.7	45	0.67%	0.83%
Confinement System	Waste Tank	Tank	Annulus Vent	Exhaust Fan Electrical Feed	2.0E-05	0.0	14	0.00%	0.00%
Confinement System	Waste Tank	Temperature Monitoring	Waste Temperature Sensors	Waste Temperature Sensors	2.8E-03	0.4	158	0.12%	0.50%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Delivery Line	Isolation Valves	3.4E-04	0.0	76	0.01%	0.03%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Delivery Line	Pipe	2.6E-05	0.0	90	0.001%	0.003%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Pump	Diluent/Flush Pump	3.7E-02	3.9	104	1.56%	4.40%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Pump	Sample Valve	8.3E-05	0.0	90	0.00%	0.01%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Tank Recirc Line	Diluent/Flush Tank Recirc Line	9.4E-05	0.0	85	0.00%	0.01%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Discharge Flow	Discharge Flow Control	5.0E-04	0.0	55	0.02%	0.03%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Process Instrumentation	Process Instrumentation	4.9E-04	0.0	47	0.02%	0.03%
Diluent/Flush System	Diluent/Flush Preparation	Caustic Addition	Caustic Supply Truck to Storage Tank	Caustic Pump Enclosure	3.5E-02	3.1	88	1.46%	3.48%
Diluent/Flush System	Diluent/Flush Preparation	Caustic Addition	Caustic Supply Truck to Storage Tank	Process Line	2.6E-05	0.0	90	0.001%	0.003%

Table F-4. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Diluent/Flush System	Diluent/Flush Preparation	Caustic/Hot Water Ratio Control	Caustic/Hot Water Ratio Control	Caustic/Hot Water Ratio Control	1.4E-03	0.1	38	0.06%	0.06%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Boiler	Boiler	3.1E-04	0.0	155	0.01%	0.05%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Boiler Blowdown Sump	Raw Water Feed Lines to Sump	7.7E-05	0.0	36	0.003%	0.003%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Raw Water Supply Line	5.9E-05	0.0	90	0.002%	0.01%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Self Cleaning Strainer	4.8E-04	0.0	81	0.02%	0.04%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Valves	2.9E-04	0.0	88	0.01%	0.03%
Diluent/Flush System	Diluent/Flush Preparation	Safety Shower/Eyewash	Shower/Eyewash Flow	Drain Valve	9.1E-05	0.0	155	0.004%	0.02%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Diluent/Flush Level Instruments	Diluent/Flush Level Instruments	3.5E-04	0.0	36	0.01%	0.01%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Diluent/Flush Temperature Control	Diluent/Flush Temperature Control	8.0E-04	0.0	37	0.03%	0.03%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Drain Valve	Drain Valve	8.3E-05	0.0	90	0.003%	0.01%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Tank Structure	Tank Structure	5.5E-06	0.0	90	0.0002%	0.001%
External Events	Electrical Distribution	Electrical Distribution	Electrical Distribution	Electrical Distribution	5.7E-02	0.3	6	2.40%	0.39%
External Events	Hanford	Miscellaneous Events	Work Stoppage	Work Stoppage	2.9E-02	1.6	57	1.20%	1.85%
External Events	Hanford	Non Tank Farm Human Error	Non Tank Farm Human Error	Non Tank Farm Human Error	9.5E-03	0.0	4	0.40%	0.04%
External Events	Off Site	Miscellaneous Events	Work Stoppage	Work Stoppage	4.6E-03	0.1	24	0.19%	0.12%
External Events	Weather	Lighting	Lighting	Lighting	3.6E-01	1.1	3	15.00%	1.22%
External Events	Weather	Precipitation	Precipitation	Precipitation	3.0E-01	2.4	8	12.55%	2.72%
External Events	Weather	Temperature	Temperature High	Temperature High	1.5E-01	1.1	7	6.31%	1.21%
External Events	Weather	Temperature	Temperature Low	Temperature Low	1.9E-01	1.5	8	8.12%	1.75%
External Events	Weather	Wind	Wind Gusts	Wind Gusts	5.7E-01	4.3	7	23.90%	4.85%
Human Actions	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Mixer Pump #1	5.0E-03	2.0	392	0.21%	2.23%
Human Actions	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Mixer Pump #2	5.0E-03	2.0	392	0.21%	2.23%
Human Actions	Transfer Pump	Transfer Pump	Transfer Pump	Transfer Pump	8.0E-03	2.0	255	0.34%	2.32%
Human Actions	Transfer Route	Transfer Route	Transfer Route	Transfer Route	1.0E-03	0.2	210	0.04%	0.24%

Table F-4. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
HVAC Annulus	Ventilation Tank Annulus	Air Inlet	Air Inlet Filter Bank	HEPA Filter	3.9E-04	0.1	155	0.02%	0.07%
HVAC Annulus	Ventilation Tank Annulus	Air Inlet	Air Inlet Filter Bank	Pre-filters	7.4E-04	0.1	82	0.03%	0.07%
HVAC Annulus	Ventilation Tank Annulus	Exhaust	Exhaust Fan	Exhaust Fan	1.6E-02	1.5	97	0.65%	1.72%
HVAC Annulus	Ventilation Tank Annulus	Exhaust	HEPA Filter Bank	Exhaust Inlet Pressure	2.8E-03	0.5	161	0.12%	0.51%
HVAC Annulus	Ventilation Tank Annulus	Exhaust	HEPA Filter Bank	Heater	2.0E-04	0.0	82	0.01%	0.02%
HVAC Annulus	Ventilation Tank Annulus	Exhaust	HEPA Filter Bank	HEPA Filter	2.0E-03	0.1	69	0.08%	0.15%
HVAC Annulus	Ventilation Tank Annulus	Exhaust	Radiation Detection	Exhaust CAM	3.0E-04	0.0	163	0.01%	0.06%
HVAC Primary	Exhaust Condenser Cooling	Air Cooled Chiller	Air Cooled Chiller	Chiller Electrical Feed	9.8E-05	0.0	16	0.00%	0.00%
HVAC Primary	Exhaust Condenser Cooling	Air Cooled Chiller	Packaged Chiller Unit	Chiller Housing	6.0E-03	0.5	90	0.25%	0.61%
HVAC Primary	Exhaust Condenser Cooling	Air Cooled Chiller	Packaged Chiller Unit	Control Instrumentation	1.3E-04	0.0	21	0.01%	0.003%
HVAC Primary	Exhaust Condenser Cooling	Expansion Tank	Expansion Tank	Expansion Tank	7.0E-04	0.1	155	0.03%	0.12%
HVAC Primary	Exhaust Condenser Cooling	Expansion Tank	Expansion Tank	Expansion Tank Instrumentation	1.2E-04	0.0	72	0.005%	0.01%
HVAC Primary	Exhaust Condenser Cooling	Expansion Tank	Thermal Storage Tank	Thermal Storage Tank	2.2E-06	0.0	39	0.0001%	0.0001%
HVAC Primary	Exhaust Condenser Cooling	Feed and Return Lines	Feed and Return Lines	Isolation Valves	2.0E-04	0.0	39	0.01%	0.01%
HVAC Primary	Exhaust Condenser Cooling	Feed and Return Lines	Feed and Return Lines	Process Instrumentation	7.3E-03	0.3	46	0.30%	0.38%
HVAC Primary	Exhaust Condenser Cooling	Feed and Return Lines	Feed and Return Lines	Process Valves	1.3E-03	0.1	102	0.05%	0.15%
HVAC Primary	Exhaust Condenser Cooling	Pump Train A	Pump Train A	Isolation Valves	6.4E-06	0.0	39	0.0003%	0.0003%
HVAC Primary	Exhaust Condenser Cooling	Pump Train A	Pump Train A	Pump	1.1E-03	0.1	90	0.05%	0.12%

Table F-4. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
HVAC Primary	Exhaust Condenser Cooling	Pump Train A	Pump Train A	Pump Electrical Feed	4.9E-11	0.0	14	0.00%	0.000%
HVAC Primary	Exhaust Condenser Cooling	Pump Train B	Pump Train B	Isolation Valves	5.6E-05	0.0	40	0.00%	0.003%
HVAC Primary	Recirculation Condenser Cooling	Condenser Cooling System	Recirc - Train A	Recirc Pump	4.4E-02	4.2	95	1.84%	4.72%
HVAC Primary	Recirculation Condenser Cooling	Evaporative Fluid Cooling Tower	Evaporative Fluid Cooling Tower	Tower Electrical Feed	4.9E-05	0.0	14	0.002%	0.001%
HVAC Primary	Recirculation Condenser Cooling	Recirc Loop	Recirc Loop	Recirc Loop Electrical Feed	4.9E-05	0.0	14	0.002%	0.001%
HVAC Primary	Ventilation Tank Primary	Air Inlet	HEPA Filter System	Filter	2.8E-03	0.3	117	0.12%	0.37%
HVAC Primary	Ventilation Tank Primary	Air Inlet	HEPA Filter System	Isolation Valve	2.7E-03	0.2	74	0.11%	0.23%
HVAC Primary	Ventilation Tank Primary	Exhaust Ventilation	Condensate Seal Pot	Condensate Seal Pot	5.0E-04	0.0	89	0.02%	0.05%
HVAC Primary	Ventilation Tank Primary	Exhaust Ventilation	Condensate Seal Pot	Level Monitoring	6.0E-03	0.2	33	0.25%	0.22%
HVAC Primary	Ventilation Tank Primary	Exhaust Ventilation	Condenser/HEME Bypass	Isolation Valves	3.7E-03	0.1	40	0.15%	0.17%
HVAC Primary	Ventilation Tank Primary	Exhaust Ventilation	Exhaust Condenser	Condenser	8.9E-03	0.3	35	0.37%	0.35%
HVAC Primary	Ventilation Tank Primary	Exhaust Ventilation	Exhaust Condenser	Isolation Valves	4.1E-03	0.3	65	0.17%	0.30%
HVAC Primary	Ventilation Tank Primary	Exhaust Ventilation	High Efficiency Mist Eliminator	HEME	4.0E-02	9.4	237	1.66%	10.65%
HVAC Primary	Ventilation Tank Primary	Exhaust Ventilation	High Efficiency Mist Eliminator	Isolation Valves	4.1E-03	0.3	65	0.17%	0.30%
HVAC Primary	Ventilation Tank Primary	Exhaust Ventilation	High Efficiency Mist Eliminator	Radiation Monitoring	2.1E-02	0.7	35	0.87%	0.83%
HVAC Primary	Ventilation Tank Primary	Primary Exhaust Radiation Monitoring	Continuous Air Monitor	CAM Pump 1	9.6E-04	0.1	89	0.04%	0.10%
HVAC Primary	Ventilation Tank Primary	Primary Exhaust Radiation Monitoring	Continuous Air Monitor	CAM Pump Control	5.4E-04	0.0	35	0.02%	0.02%
HVAC Primary	Ventilation Tank Primary	Primary Exhaust Radiation Monitoring	Continuous Air Monitor	CAM Pump Valves	9.3E-06	0.0	98	0.0004%	0.001%

Table F-4. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
HVAC Primary	Ventilation Tank Primary	Primary Exhaust Radiation Monitoring	High Radiation Detection	High Radiation Detector	4.1E-02	1.8	44	1.74%	2.05%
HVAC Primary	Ventilation Tank Primary	Primary Exhaust Radiation Monitoring	Radiation Monitor Flow Control	Radiation Monitor Flow Control	3.9E-02	1.6	40	1.65%	1.81%
HVAC Primary	Ventilation Tank Primary	Recirc Loop	Process	Condenser	2.7E-03	0.1	44	0.11%	0.13%
HVAC Primary	Ventilation Tank Primary	Recirc Loop	Process	Moisture Separator	2.9E-04	0.0	76	0.01%	0.03%
HVAC Primary	Ventilation Tank Primary	Recirc Loop	Process	Recirc Fan	4.1E-03	0.2	58	0.17%	0.27%
HVAC Primary	Ventilation Tank Primary	Recirc Loop	Process	Recirc Fan Electrical Feed	4.9E-05	0.0	14	0.00%	0.001%
HVAC Primary	Ventilation Tank Primary	Recirc Loop	Process	Recirc Isolation Valves	9.7E-05	0.0	88	0.004%	0.01%
HVAC Primary	Ventilation Tank Primary	Recirc/Exhaust Interface	Interface Lines	Instrumentation	1.3E-03	0.1	117	0.05%	0.17%
HVAC Primary	Ventilation Tank Primary	Recirc/Exhaust Interface	Interface Lines	Valves	1.7E-02	0.8	47	0.73%	0.94%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	Exhaust Fan	Fan	9.4E-04	0.0	40	0.04%	0.04%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	Exhaust Fan	Fan Electrical Feed	1.0E-05	0.0	14	0.0004%	0.0002%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	Exhaust Fan	Isolation Valves	1.9E-03	0.1	40	0.08%	0.09%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	HEPA Filter		2.9E-04	0.0	36	0.01%	0.01%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	HEPA Filter	Filter	3.0E-03	0.3	113	0.13%	0.38%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	HEPA Filter	Filter Instrumentation	3.4E-02	1.6	47	1.42%	1.82%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	HEPA Filter	Heater	2.7E-03	0.1	25	0.11%	0.08%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	HEPA Filter	Inlet Pressure Monitoring	1.1E-02	0.6	53	0.48%	0.68%
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	HEPA Filter	Isolation Valves	3.7E-03	0.3	69	0.15%	0.29%

Table F-4. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
HVAC Primary	Ventilation Tank Primary	Train A Exhaust	Train A/Train B Exhaust Crosstie	Crosstie Valves	1.0E-03	0.0	40	0.04%	0.05%
HVAC Primary	Ventilation Tank Primary	Train B Exhaust	Exhaust Fan	Fan	6.3E-04	0.1	90	0.03%	0.06%
HVAC Primary	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Isolation Valves	1.3E-03	0.1	63	0.06%	0.10%
Support/Utilities	Electrical Distribution	Distribution Panelboard	Panelboard	Panelboard Electrical Feed	1.5E-02	0.6	38	0.64%	0.66%
Support/Utilities	Electrical Distribution	Distribution Panelboard	Transformer	Transformer	2.1E-04	0.0	114	0.01%	0.03%
Support/Utilities	Electrical Distribution	Distribution Panelboard	UPS Panelboard	UPS Panelboard Electrical Feed	9.7E-05	0.0	14	0.004%	0.002%
Support/Utilities	Electrical Distribution	Distribution Transfer Switch	Distribution Transfer Switch	Distribution Transfer Switch	1.8E-04	0.0	39	0.01%	0.01%
Support/Utilities	Electrical Distribution	Motor Control Center	Motor Control Center	Motor Control Center	3.3E-04	0.0	44	0.01%	0.02%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Mixer Pump Electrical Feed	4.0E-03	0.2	39	0.17%	0.18%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Motor Temp Monitor	9.5E-04	0.0	47	0.04%	0.05%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Process Instrumentation	5.8E-03	0.3	45	0.25%	0.30%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Pump	6.7E-02	8.9	134	2.80%	10.17%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Pump Control	8.6E-05	0.0	3	0.004%	0.0003%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Pump Seals	4.8E-05	0.0	155	0.002%	0.01%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Rotation Motor	2.2E-04	0.0	155	0.01%	0.04%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Rotation Motor Control	9.5E-05	0.0	6	0.004%	0.001%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Rotation Motor Electrical Feed	3.9E-03	0.1	39	0.16%	0.17%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Mixer Pump #1	Seal Water/Flushing	7.0E-05	0.1	776	0.00%	0.06%
Waste Transfer System	Mixer Pumps	Mixer Pump #1	Raw Water Feed	Feed Line	1.3E-03	0.2	155	0.05%	0.23%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Mixer Pump Electrical Feed	4.0E-03	0.2	39	0.17%	0.18%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Motor Temp Monitor	9.5E-04	0.0	47	0.04%	0.05%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Process Instrumentation	5.5E-03	0.2	45	0.23%	0.28%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Pump	6.7E-02	8.9	134	2.80%	10.17%

Table F-4. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Pump Control	8.6E-05	0.0	3	0.004%	0.0003%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Pump Seals	4.8E-05	0.0	155	0.00%	0.01%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Rotation Motor	2.2E-04	0.0	155	0.01%	0.04%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Rotation Motor Control	7.1E-05	0.0	6	0.00%	0.00%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Rotation Motor Electrical Feed	3.9E-03	0.1	39	0.16%	0.17%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Mixer Pump #2	Seal Water/Flushing	7.0E-05	0.0	155	0.003%	0.01%
Waste Transfer System	Mixer Pumps	Mixer Pump #2	Raw Water Feed	Feed Line	1.2E-03	0.2	155	0.05%	0.21%
Waste Transfer System	Mixer Pumps	Mixer Pumps #1 & #2	Mixer Pumps #1 & #2	Emergency Stop	8.6E-05	0.0	40	0.004%	0.004%
Waste Transfer System	Mixer Pumps	Mixer Pumps #1 & #2	Mixer Pumps #1 & #2	Rotation Motor Electrical Feed	4.3E-05	0.0	185	0.002%	0.01%
Waste Transfer System	Mixer Pumps	Mixer Pumps #1 & #2	Raw Water Feed	Feed Preparation Diaphragm Tank	9.1E-05	0.0	155	0.004%	0.02%
Waste Transfer System	Mixer Pumps	Mixer Pumps #1 & #2	Raw Water Feed	Feed Preparation/Filtering Line	1.5E-03	0.2	135	0.06%	0.23%
Waste Transfer System	Monitoring	Tank Monitoring	Monitoring	Monitoring	1.3E-04	0.0	68	0.01%	0.01%
Waste Transfer System	Transfer Pump	Transfer Pump	Transfer Pump	Pump	4.5E-02	6.1	134	1.90%	6.90%
Waste Transfer System	Transfer Pump	Transfer Pump	Transfer Pump	Transfer Pump Electrical Feed	2.2E-03	0.1	39	0.09%	0.10%
Waste Transfer System	Transfer Route	Pump Pit AZ-01A	Monitoring	Leak Detector, Encasement	2.2E-05	0.0	592	0.001%	0.01%
Waste Transfer System	Transfer Route	Pump Pit AZ-01A	Monitoring	Leak Detector, Pit	3.4E-05	0.0	377	0.00%	0.01%
Waste Transfer System	Transfer Route	Pump Pit AZ-01A	Pump Pit AZ-01A	Jumpers	1.4E-04	0.1	701	0.01%	0.11%
Waste Transfer System	Transfer Route	Pump Pit AZ-01A	Pump Pit AZ-01A	Nozzle	9.1E-06	0.0	677	0.000%	0.01%
Waste Transfer System	Transfer Route	Pump Pit AZ-01A	Transfer Line	Instrument, Flow Characteristics	2.7E-04	0.2	612	0.01%	0.19%
Waste Transfer System	Transfer Route	Pump Pit AZ-01A	Transfer Line	Transfer Line	2.1E-03	1.2	556	0.09%	1.32%
Waste Transfer System	Transfer Route	Underground	Transfer Line	Underground Transfer Line	6.1E-05	0.0	298	0.003%	0.02%
Waste Transfer System	Transfer Route	Underground	Underground	Pipe	1.2E-04	0.0	338	0.01%	0.05%
Waste Transfer System	Transfer Route	Valve Pits	241-AP-A New AP Valve Pit	2-way Gate Valve	1.3E-03	1.0	776	0.06%	1.19%
Waste Transfer System	Transfer Route	Valve Pits	241-AP-A New AP Valve Pit	Jumper	2.0E-05	0.0	701	0.001%	0.02%

Table F-4. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer System	Transfer Route	Valve Pits	241-AP-A New AP Valve Pit	Nozzle	3.8E-05	0.0	992	0.002%	0.04%
Waste Transfer System	Transfer Route	Valve Pits	AZ-241 Valve Pit	2-way Gate Valve	6.7E-04	0.5	776	0.03%	0.59%
Waste Transfer System	Transfer Route	Valve Pits	AZ-241 Valve Pit	3-way Gate Valve	2.0E-03	1.6	776	0.08%	1.78%
Waste Transfer System	Transfer Route	Valve Pits	AZ-241 Valve Pit	Jumper	6.0E-05	0.0	701	0.003%	0.05%
Waste Transfer System	Transfer Route	Valve Pits	AZ-241 Valve Pit	Nozzle	7.9E-05	0.1	980	0.003%	0.09%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
					Total	**2.4**	**88.0**	**36.9**	**100%**	**100%**
AZ702-VTP-HEME-AZ-K1-9-1	HEME	High Efficiency Mist Eliminator	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	3.0E-02	9.0	297.8	1.27%	10.29%
AZ101-WST-P-701A	WMP	Mixer Pump	Tank AZ-101	Waste Transfer System	Mixer Pumps	6.7E-02	8.9	133.2	2.80%	10.11%
AZ101-WST-P-702A	WMP	Mixer Pump	Tank AZ-101	Waste Transfer System	Mixer Pumps	6.7E-02	8.9	133.2	2.80%	10.11%
AZ01A-WT-WT-P-AZ101	WTP	Transfer Pump	AZ-01A VALVE PIT	Waste Transfer System	Transfer Pump	4.5E-02	6.1	133.6	1.90%	6.90%
AZ101-CW-AZ101-EW-P-1A	P	Pump	AZ-101	HVAC Primary	Recirculation Condenser Cooling	4.4E-02	4.2	94.8	1.84%	4.72%
AN241-CHEMB-P-002	P	Pump	Diluent/Flush	Diluent/Flush System	Diluent/Flush Delivery	3.6E-02	3.8	105.2	1.51%	4.31%
AN241-CHEMB-P-001	P	Pump	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	3.3E-02	2.9	89.6	1.37%	3.34%
EXTWIND06	EXT	Wind Gusts 6 hr Delay	EXT	External Events	Weather	4.6E-01	2.7	6.0	19.16%	3.12%
EXTPRECIP	EXT	Precipitation Caused Delays	EXT	External Events	Weather	3.0E-01	2.4	8.0	12.55%	2.72%
HATRANSF014	HUMAN	Human Action SWN	HUM	Human Actions	Transfer Pump	5.0E-03	2.0	391.6	0.21%	2.23%
HATANKSW001B	HUMAN	Human Action SMPS	HUM	Human Actions	Mixer Pumps	5.0E-03	2.0	391.6	0.21%	2.23%
HATANKSW001A	HUMAN	Human Action SMPS	HUM	Human Actions	Mixer Pumps	5.0E-03	2.0	391.6	0.21%	2.23%
EXTLONG	EXT	Hanford Site work stoppage, long	EXT	External Events	Hanford	6.4E-03	1.5	242.0	0.27%	1.75%
AZ241-VTA-(EF)-K1-3-2	EF	Exhaust Fan	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	1.6E-02	1.5	97.2	0.65%	1.72%
EXTWIND12	EXT	Wind Gusts 12 hr Delay	EXT	External Events	Weather	9.9E-02	1.2	12.0	4.15%	1.35%
EXTLIGHT	EXT	Lightning Within 30 Miles	EXT	External Events	Weather	3.6E-01	1.1	3.0	15.00%	1.22%
EXTLTEMP06	EXT	Temperature Low 6 hr Delay	EXT	External Events	Weather	1.4E-01	0.9	6.0	6.04%	0.98%
EXTHTEMP06	EXT	Temperature High 6 hr Delay	EXT	External Events	Weather	1.3E-01	0.8	6.0	5.53%	0.90%
A271-WST-LDA-101-1A	LDA	Leak Detector Alarm	Control Bldg 241-A-271	Confinement System	Ventilation Tank Annulus	7.2E-03	0.7	102.4	0.30%	0.83%
AZ241--PP-17	PB	Panelboard (Unfused Switch)	Standby Panelboard No. 1 & 2	Support/Utilities	Electrical Distribution	1.5E-02	0.6	38.6	0.63%	0.65%
AZ241-CW-AZ-CW-R-1	HX	Air Cooled Chiller	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	6.0E-03	0.5	89.6	0.25%	0.61%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
V-225	HV	2-Way Ball Valve	Transfer Route	Waste Transfer System	Transfer Route	6.7E-04	0.5	776.1	0.03%	0.59%
V-229	HV	3-Way Ball Valve	Transfer Route	Waste Transfer System	Transfer Route	6.7E-04	0.5	776.1	0.03%	0.59%
V-DE2 (PLG)	HV	2-Way Ball Valve	Transfer Route	Waste Transfer System	Transfer Route	6.7E-04	0.5	776.1	0.03%	0.59%
V-226	HV	3-Way Ball Valve	Transfer Route	Waste Transfer System	Transfer Route	6.7E-04	0.5	776.1	0.03%	0.59%
V-222	HV	3-Way Ball Valve	Transfer Route	Waste Transfer System	Transfer Route	6.7E-04	0.5	776.1	0.03%	0.59%
AZ101--VALVE 3 (TEMP)	V	3-Way Ball Valve	Tank AZ-101	Waste Transfer System	Transfer Route	6.7E-04	0.5	776.1	0.03%	0.59%
V-DE1 (PLG)	HV	2-Way Ball Valve	Transfer Route	Waste Transfer System	Transfer Route	6.7E-04	0.5	776.1	0.03%	0.59%
AZ101--VALVE 2 (TEMP)	V	3-Way Ball Valve	Tank AZ-101	Waste Transfer System	Transfer Route	6.7E-04	0.5	776.1	0.03%	0.59%
EXTLTEMP12	EXT	Temperature Low 12 hr Delay	EXT	External Events	Weather	4.3E-02	0.5	12.0	1.80%	0.58%
AZ101-WST-LDE-101-1A	LDE	Leak Detector Element	AZ-101	Confinement System	Ventilation Tank Annulus	2.3E-03	0.4	157.7	0.10%	0.42%
AZ101-WST-LDE-101-1B	LDE	Leak Detector Element	AZ-101	Confinement System	Ventilation Tank Annulus	2.3E-03	0.4	157.7	0.10%	0.42%
AZ101-WST-LDE-101-1C	LDE	Leak Detector Element	AZ-101	Confinement System	Ventilation Tank Annulus	2.3E-03	0.4	157.7	0.10%	0.42%
AZ271-VTP-PAXL-AZK1-1A	PAXL	Composite Pressure Alarm	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.9E-03	0.4	90.5	0.16%	0.40%
AZ271-VTP-TAHHH-AZK12-3A	TAHHH	Temperature Alarm High High High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.9E-03	0.4	90.5	0.16%	0.40%
AZ271-VTP-TAHH-AZK12-3A	TAHHH	Temperature Alarm High High High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.9E-03	0.4	90.5	0.16%	0.40%
EXTLOSP	EXT	Loss of Power to Tank Farms	EXT	External Events	Electrical Distribution	5.7E-02	0.3	6.0	2.40%	0.39%
A271-VTA-FA-AZ Annulus	FA	Flow Alarm	Instr Bldg 241-A-271	HVAC Annulus	Ventilation Tank Annulus	2.1E-03	0.3	162.2	0.09%	0.39%
EXTWIND24	EXT	Wind Gusts 24 hr Delay	EXT	External Events	Weather	1.4E-02	0.3	24.0	0.59%	0.38%
AZ702-VTP-RIAS-AZK1-1	RIAS	Radiation Indicating Alarm Switch	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	1.2E-03	0.2	186.9	0.05%	0.26%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ271-VTP-RAH-AZK19-1	RAH	Radiation Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.1E-03	0.2	36.7	0.25%	0.25%
AZ271-VTP-RAH-AZK1-1	RAH	Radiation Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.1E-03	0.2	36.7	0.25%	0.25%
AZ702-VTP-FAL-AZK1-2A	FAL	Flow Alarm Low	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
AZ702-VTP-RA-AZK1-1B	RA	Radiation Alarm (Horn)	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
AZ271-VTP-FAL-AZ1K1-2	FAL	Flow Alarm Low	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
A271-WST-PA-101-1	PA	Pressure Alarm	Control Bldg 241-A-271	Confinement System	Waste Tank	6.0E-03	0.2	35.3	0.25%	0.24%
A271-WST-PA-101-2	PA	Pressure Alarm	Control Bldg 241-A-271	Confinement System	Waste Tank	6.0E-03	0.2	35.3	0.25%	0.24%
AZ271-VTP-FAL-AZK1-1	FAL	Flow Alarm Low	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
AZ702-VTP-FAL-AZK1-1A	FAL	Flow Alarm Low	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
AZ271-VTP-RAX-AZK19-1	RAX	Radiation Alarm Failure	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
AZ271-VTP-FAL-AZK1-2	FAL	Flow Alarm Low	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
AZ702-VTP-RA-AZK1-1	RA	Radiation Alarm (Red Strobe Light)	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
AZ702-VTP-RA-AZK1-1A	RA	Radiation Alarm (Bell)	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%
AZ271-VTP-RAX-AZK1-1	RAX	Radiation Alarm Failure	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	35.3	0.25%	0.24%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ702-VTP-XA-AZK1-1	XA	Failure Alarm (Amber light)	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	34.0	0.25%	0.23%
AZ401-VTP-MK-AZ101K1-2	MK	Motor Operated Butterfly Valve	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	2.7E-03	0.2	75.0	0.11%	0.23%
AZ101-VTP-MK-AZ101K1-1	MK	Motor Operated Butterfly Valve	Air Inlet Station AZ101K1	HVAC Primary	Ventilation Tank Primary	2.7E-03	0.2	74.2	0.11%	0.23%
HAVLVEPC001	HUMAN	Human Action CVPC	HUM	Human Actions	Transfer Route	5.0E-04	0.2	391.6	0.02%	0.22%
AZ271-VTP-LAH-AZPCSP-1	LAH	Level Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	32.6	0.25%	0.22%
AZ271-VTP-FAH-AZ1K1-2	FAH	Flow Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	32.6	0.25%	0.22%
AZ271-VTP-PDAH-AZK19-1	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	32.6	0.25%	0.22%
AZ271-VTP-PDAH-AZK18-1	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	32.6	0.25%	0.22%
AZ702-VTP-RIAS-AZK109-1	RIA	Radiation Indicating Alarm	Vent Bldg 241-AZ-702, Cabinet CAB-AZK1-2	HVAC Primary	Ventilation Tank Primary	6.0E-03	0.2	32.6	0.25%	0.22%
AZ702-VTP-RY-AZK1-1	RY	Radiation Equipment	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	1.2E-03	0.2	163.5	0.05%	0.22%
AZ401-VTP-MK-AZ101K1-2A3	MK	Butterfly Valve	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	2.2E-03	0.2	87.6	0.09%	0.22%
AZ702-VTP-MK-AZK109-1A	MK	Butterfly Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.2E-03	0.2	87.6	0.09%	0.22%
AZ702-VTP-MK-AZ108-1A	MK	Butterfly Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.2E-03	0.2	87.6	0.09%	0.22%
EXTHTEMP12	EXT	Temperature High 12 hr Delay	EXT	External Events	Weather	1.5E-02	0.2	12.0	0.63%	0.20%
AZ101-VTP-AZ101-K1-4-1	FLT	HEPA Filter	Air Inlet Station AZ101K1	HVAC Primary	Ventilation Tank Primary	1.4E-03	0.2	122.4	0.06%	0.19%
EXTLTEMP24	EXT	Temperature Low 24 hr Delay	EXT	External Events	Weather	6.8E-03	0.2	24.0	0.29%	0.19%
AZ401-VTP-AZ101-K4-5-1	RF	Recirc Fan	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	1.8E-03	0.2	89.6	0.08%	0.19%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ101-VTP-AZ101-K1-3-1	FLT	Pre-Filter	Air Inlet Station AZ101K1	HVAC Primary	Ventilation Tank Primary	1.4E-03	0.2	111.7	0.06%	0.17%
AZ241-WST-(P-701A-ELEC)	ELEC	Breaker Unit w/VFD Controller	AZ Farm Switchgear MCC EDS-MCC-701	Waste Transfer System	Mixer Pumps	3.9E-03	0.1	38.6	0.16%	0.17%
AZ241-WST-(P-702A-ELEC)	ELEC	Breaker Unit w/VFD Controller	AZ Farm Switchgear MCC EDS-MCC-701	Waste Transfer System	Mixer Pumps	3.9E-03	0.1	38.6	0.16%	0.17%
AZ241-WST-(M-703A-ELEC)	ELEC	Breaker Unit w/VFD Controller	AZ Farm Switchgear MCC EDS-MCC-701	Waste Transfer System	Mixer Pumps	3.9E-03	0.1	38.6	0.16%	0.17%
AZ241-WST-(M-704A-ELEC)	ELEC	Breaker Unit w/VFD Controller	AZ Farm Switchgear MCC EDS-MCC-701	Waste Transfer System	Mixer Pumps	3.9E-03	0.1	38.6	0.16%	0.17%
AZ702-VTP-AZ-K1-10-1A	ABS	HEGA Filter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	8.5E-04	0.1	155.2	0.04%	0.15%
AZ271-VTP-PDAHH-AZK14-2A	PDAHH	Pressure Differential Alarm High High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.4E-03	0.1	35.3	0.14%	0.14%
AZ271-VTP-PDAHH-AZK14-1A	PDAHH	Pressure Differential Alarm High High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.4E-03	0.1	35.3	0.14%	0.14%
AZ702-VTP-MK-AZK1-2A	MK	Motor Operated Damper w/Limit Switches/Manual Handwheel	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.5E-03	0.1	77.7	0.06%	0.13%
AZ702-VTP-MK-AZK1-1A	MK	Motor Operated Damper w/Limit Manual/Manual Handwheel	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.5E-03	0.1	77.7	0.06%	0.13%
AZ101-VTP-PIC-AZ1K1-1	PIC	Pressure Indicating Controller	AZ-101	Confinement System	Waste Tank	7.1E-04	0.1	163.5	0.03%	0.13%
AZ101--VALVE 1 (TEMP)	V	3-Way Ball Valve	AZ-101	Waste Transfer System	Transfer Route	7.4E-04	0.1	154.7	0.03%	0.13%
AZ01A-WT-UE	UE	Multivariable Element	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	1.9E-04	0.1	592.4	0.01%	0.13%
AZ401-VTP-FE-AZ101K1-2	FE	Flow Element	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	7.0E-04	0.1	157.7	0.03%	0.13%
AZ702-VTP-FY-AZK1-2	FY	Flow Equipment	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	7.0E-04	0.1	157.7	0.03%	0.13%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ702-VTP-FY-AZK1-1	FY	Flow Equipment	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	7.0E-04	0.1	157.7	0.03%	0.13%
EXTOTHER	EXT	Other Non-Hanford Events	EXT	External Events	Off Site	4.6E-03	0.1	24.0	0.19%	0.12%
AZ271-VTP-PAH-AZK1-1A	PAH	Pressure Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.4E-03	0.1	32.6	0.14%	0.12%
AZ271-VTP-PDAH-AZK14-2A	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.4E-03	0.1	32.6	0.14%	0.12%
AZ271-VTP-TAH-AZK12-3A	TAH	Temperature Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.4E-03	0.1	32.6	0.14%	0.12%
AZ271-VTP-PDAH-AZK110-1A	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.4E-03	0.1	32.6	0.14%	0.12%
AZ271-VTP-PAL-AZK1-1A	PAL	Pressure Alarm Low	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.4E-03	0.1	32.6	0.14%	0.12%
AZ271-VTP-PDAH-AZK14-1A	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.4E-03	0.1	32.6	0.14%	0.12%
AZ241-CW-PCV-AZCWS-1	PCV	Pressure Control Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	7.0E-04	0.1	154.7	0.03%	0.12%
AZ241-CW-PCV-AZCWTK-1	PCV	Pressure Control Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	7.0E-04	0.1	154.7	0.03%	0.12%
AZ702-VTP-AZ-K1-4-1A	FLT	HEPA Filter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	7.8E-04	0.1	122.4	0.03%	0.11%
AZ702-VTP-AZ-K1-4-2A	FLT	HEPA Filter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	7.8E-04	0.1	122.4	0.03%	0.11%
AZ241-VTA-PI-K1-3-3	PI	Pressure Indicator	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.03%	0.11%
AZ241-CW-AZ-CW-P-1A	P	Pump	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	9.7E-04	0.1	94.8	0.04%	0.10%
EXTHTEMP24	EXT	Temperature High 24 hr Delay	EXT	External Events	Weather	3.7E-03	0.1	24.0	0.16%	0.10%
EXTSHORT	EXT	Hanford Site work stoppage, short	EXT	External Events	Hanford	2.2E-02	0.1	4.0	0.93%	0.10%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ702-VTP-AZ-K1-11-1	P	Pump	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	9.5E-04	0.1	89.6	0.04%	0.10%
HATRANSF022	HUMAN	Human Action RTPS	HUM	Human Actions	Transfer Pump	3.0E-03	0.1	28.1	0.13%	0.10%
AZ702-VTP-MK-AZK105-1A2	MK	Butterfly Damper Valve w/Limit Switches	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.9E-03	0.1	40.2	0.08%	0.09%
AZ702-VTP-MK-AZK109-1B	MK	Butterfly Valve w/Hand Wheel	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.9E-03	0.1	38.7	0.08%	0.08%
AZ702-VTP-MK-AZK108-1B	MK	Butterfly Valve w/Hand Wheel	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.9E-03	0.1	38.7	0.08%	0.08%
AZ702-VTP-MK-AZK108-1C	MK	Butterfly Valve w/Hand Wheel	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.8E-03	0.1	40.2	0.08%	0.08%
AZ702-VTP-MK-AZK109-1C	MK	Butterfly Valve w/Hand Wheel	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.8E-03	0.1	40.2	0.08%	0.08%
AZ801A-SW-PI-751	PI	Pressure Indicator	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.3E-04	0.1	157.7	0.02%	0.08%
AZ801A-SW-PI-750	PI	Pressure Indicator	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.3E-04	0.1	157.7	0.02%	0.08%
AZ801A-SW-FI-751	FI	Flow Indicator	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.3E-04	0.1	157.7	0.02%	0.08%
AZ801A-SW-FI-750	FI	Flow Indicator	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.3E-04	0.1	157.7	0.02%	0.08%
AZ702-VTP-MK-AZK1-1B	MK	Motor Operated Damper w/Limit Manual/Manual Handwheel	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	7.9E-04	0.1	78.9	0.03%	0.07%
AZ271-VTP-FQI-AZK1-2	FQI	Flow Totalizer Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-VTP-PDI-AZK18-1	PDI	Pressure Differential Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-VTP-RI-AZK1-1	RI	Radiation Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-CW-TI-AZCWS-1	IT	Temperature Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-VTP-FI-AZK1-1	FI	Flow Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-VTP-PDI-AZK19-1	PDI	Pressure Differential Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-VTP-FQI-AZK1-1	FQI	Flow Totalizer Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ271-CW-TI-AZCWR-1	TI	Temperature Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-VTP-RI-AZK19-1	RI	Radiation Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ702-VTP-FQI-AZK1-2	FQI	Flow Totalizer Indicator	Vent Bldg 241-AZ-702 CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ702-VTP-FQI-AZK1-1	FQI	Flow Totalizer Indicator	Vent Bldg 241-AZ-702 CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-VTP-FI-AZK1-2	FI	Flow Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.7E-03	0.1	35.6	0.07%	0.07%
AZ271-CW-FI-AZCWR-1	FI	Flow Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	1.7E-03	0.1	35.6	0.07%	0.07%
AZ241-VTA-K1-2-1	FLT	Filter	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	3.9E-04	0.1	154.7	0.02%	0.07%
AZ271-VTP-PDAH-AZ1K45-1	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.8E-03	0.1	32.6	0.08%	0.07%
AZ271-VTP-PDAH-AZ1K48-1	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.8E-03	0.1	32.6	0.08%	0.07%
AZ702-VTP-MK-AZ105-1B3	MK	Backdraft Damper	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	6.3E-04	0.1	89.6	0.03%	0.06%
AZ101-WST-V-701A-X3	V	2-Way Ball Valve	Tank AZ-101 Mixer Pump #2	Waste Transfer System	Mixer Pumps	7.0E-05	0.1	776.1	0.00%	0.06%
AZ101--VALVE 9 (TEMP)	V	Check Valve	Tank AZ-101	Waste Transfer System	Mixer Pumps	7.0E-05	0.1	776.1	0.00%	0.06%
AZ101-WST-V-702A-X3	V	2-Way Ball Valve	Tank AZ-101 Mixer Pump #1	Waste Transfer System	Mixer Pumps	7.0E-05	0.1	776.1	0.00%	0.06%
AZ156-WST-VFD-704A	VFD	Variable Frequency Drive	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	1.3E-03	0.1	40.2	0.05%	0.06%
AZ156-WST-VFD-703A	VFD	Variable Frequency Drive	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	1.3E-03	0.1	40.2	0.05%	0.06%
AZ156-WST-VFD-702A	VFD	Variable Frequency Drive	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	1.3E-03	0.1	40.2	0.05%	0.06%
AZ156-WST-VFD-701A	VFD	Variable Frequency Drive	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	1.3E-03	0.1	40.2	0.05%	0.06%
AZ241-VTA-CAM-101-AZ	CAM	Continuous Air Monitor	AZ Farm, Train A	HVAC Annulus	Ventilation Tank Annulus	3.0E-04	0.0	163.5	0.01%	0.06%
AZ241-VTA-K1-5-1	FLT	HEPA Filter	AZ Farm, Train A	HVAC Annulus	Ventilation Tank Annulus	3.9E-04	0.0	119.9	0.02%	0.05%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ241-VTA-K1-5-2	FLT	HEPA Filter	AZ Farm, Train A	HVAC Annulus	Ventilation Tank Annulus	3.9E-04	0.0	119.9	0.02%	0.05%
PLG-NEW-SP-1	PIPE	Pipe Segment	HVAC Primary	HVAC Primary	Ventilation Tank Primary	5.0E-04	0.0	89.6	0.02%	0.05%
AZ801A-ELEC-(P101-ELEC)	ELEC	Breaker Unit	Bldg 241-AZ-801A, EDS-MCC-704	Waste Transfer System	Transfer Pump	1.1E-03	0.0	38.5	0.05%	0.05%
AZ801A-WT-(P-101-ELEC)	ELEC	Breaker Unit	Bldg 241-AZ-801A, EDS-MCC-704	Waste Transfer System	Transfer Pump	1.1E-03	0.0	38.5	0.05%	0.05%
AZ801A-SW-FLT-751	FLT	Filter	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	2.8E-04	0.0	154.7	0.01%	0.05%
AZ702-VTP-MK-AZK1-3A	MK	Butterfly Damper Valve w/Limit Switches	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.0E-03	0.0	40.2	0.04%	0.05%
AZ101-VTP-PT-AZ101K1-1	PT	Pressure Transmitter	AZ-101	Confinement System	Waste Tank	5.7E-04	0.0	67.8	0.02%	0.04%
AZ401-VTP-FT-AZ101K1-2	FT	Flow Transmitter	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	5.7E-04	0.0	67.8	0.02%	0.04%
AZ101-VTP-PT-AZ101K1-2	PT	Pressure Transmitter	AZ-101	Confinement System	Waste Tank	5.7E-04	0.0	67.8	0.02%	0.04%
AZ241-CW-FT-AZCWR-1	FT	Flow Transmitter	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	5.7E-04	0.0	67.8	0.02%	0.04%
EXTHUMAN	EXT	Hanford Site work stoppage, due to human	EXT	External Events	Hanford	9.5E-03	0.0	4.0	0.40%	0.04%
AZ101-VTP-HV-AZ101K1-1	HV	2-Way Ball Valve	AZ-101	Confinement System	Waste Tank	2.5E-04	0.0	150.1	0.01%	0.04%
AZ241-CW-TE-AZCWR-1	TE	Temperature Element	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-72	TE	Temperature Element	Tank AZ-101, Riser 14C	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-65	TE	Temperature Element	Tank AZ-101, Riser 15I	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-71	TE	Temperature Element	Tank AZ-101, Riser 14B	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-66	TE	Temperature Element	Tank AZ-101, Riser 15I	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-69	TE	Temperature Element	Tank AZ-101, Riser 15B	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-70	TE	Temperature Element	Tank AZ-101, Riser 15B	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ101-WST-TE-101-AZ-68	TE	Temperature Element	Tank AZ-101, Riser 15B	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-73	TE	Temperature Element	Tank AZ-101, Riser 14A	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-103	TE	Temperature Element	Tank AZ-101, Riser 15C	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-67	TE	Temperature Element	Tank AZ-101, Riser 15I	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-104	TE	Temperature Element	Tank AZ-101, Riser 15C	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ101-WST-TE-101-AZ-102	TE	Temperature Element	Tank AZ-101, Riser 15C	Confinement System	Waste Tank	2.3E-04	0.0	157.7	0.01%	0.04%
AZ241-CW-TE-AZCWS-1	TE	Temperature Element	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.3E-04	0.0	157.7	0.01%	0.04%
AZ702-VTP-RE-AZK1-1	RE	Radiation Sensing Element	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	8.8E-04	0.0	40.2	0.04%	0.04%
AZ702-VTP-RE-AZK109-1	RE	Radiation Sensing Element	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	8.8E-04	0.0	40.2	0.04%	0.04%
AZ271-VTP-PDI-AZK110-1A	PDI	Pressure Differential Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	9.7E-04	0.0	35.6	0.04%	0.04%
AZ271-VTP-PDI-AZK14-1A	PDI	Pressure Differential Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	9.7E-04	0.0	35.6	0.04%	0.04%
AZ271-VTP-PDI-AZK14-2A	PDI	Pressure Differential Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	9.7E-04	0.0	35.6	0.04%	0.04%
AZ271-VTP-TI-AZK12-3A	TI	Temperature Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	9.7E-04	0.0	35.6	0.04%	0.04%
AZ702-VTP-AZ-K1-5-1A	EF	Exhaust Fan	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	8.4E-04	0.0	40.2	0.04%	0.04%
AZ01A-WT-FE	FE	Flow Element	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	5.7E-05	0.0	592.4	0.00%	0.04%
AZ101-WST-M-704A	M	Pump/Fan/Compressor Motor	Tank AZ-101, Mixer Pump #1	Waste Transfer System	Mixer Pumps	2.2E-04	0.0	155.2	0.01%	0.04%
AZ101-WST-M-703A	M	Pump/Fan/Compressor Motor	Tank AZ-101, Mixer Pump #2	Waste Transfer System	Mixer Pumps	2.2E-04	0.0	155.2	0.01%	0.04%
AZ-01A-WT-U6(2,C)	JMP	Jumper	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	4.6E-05	0.0	701.1	0.002%	0.04%
AZ-01A-WT-U12(A,B,C)	JMP	Jumper	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	4.6E-05	0.0	701.1	0.002%	0.04%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ-01A-WT-(A,1,5)	JMP	Jumper	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	4.6E-05	0.0	701.1	0.002%	0.04%
AN241-RW-STR-101	STR	Strainer	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	3.4E-04	0.0	89.6	0.01%	0.03%
AN241-CHEMB-STR-101	STR	Strainer	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	3.4E-04	0.0	89.6	0.01%	0.03%
AZ156-CHEMB-LAHH-126	LAHH	Level Alarm High High	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	8.5E-04	0.0	33.7	0.04%	0.03%
AZ156-CHEMB-XA-100	XA	Failure Alarm	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	8.5E-04	0.0	33.7	0.04%	0.03%
AZ801A-SW-STR-720	STR	Strainer	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	2.8E-04	0.0	89.6	0.01%	0.03%
AZ241-ELEC-XFMR-T-4	XFMR	Transformer	AZ Farm Mini Power Center	Support/Utilities	Electrical Distribution	2.1E-04	0.0	113.7	0.01%	0.03%
AZ241-VTA-MK-8501	MK	Louver	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	3.1E-04	0.0	76.5	0.01%	0.03%
AZ702-VTP-MK-AZK1-2B	MK	Butterfly Damper Valve w/Limit Switches	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	5.5E-04	0.0	40.2	0.02%	0.03%
AZ401-VTP-AZ101-K4-1-1	MOSE	Moisture Separator	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	76.5	0.01%	0.03%
AN241-CHEMB-MSTR-101	MSTR	Motor Starter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	1.9E-04	0.0	113.7	0.01%	0.03%
AZ801A-SW-FLT-750	FLT	Filter	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	1.4E-04	0.0	154.7	0.01%	0.02%
AZ241-VTA-PI-K1-4-1	PI	Pressure Indicator	AZ Farm, Train A	HVAC Annulus	Ventilation Tank Annulus	6.0E-04	0.0	35.6	0.03%	0.02%
AZ241-VTA-PI-K1-4-2	PI	Pressure Indicator	AZ Farm, Train A	HVAC Annulus	Ventilation Tank Annulus	6.0E-04	0.0	35.6	0.03%	0.02%
AZ702-VTP-MV-AZK1-1	MOV	Motor Operated Gate Valve	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	2.7E-04	0.0	77.8	0.01%	0.02%
AZ271-VTP-FIC-AZ1K1-2	FIC	Flow Indicating Controller	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	5.3E-04	0.0	40.2	0.02%	0.02%
AZ702-VTP-UC-AZK1-2	UC	Multivariable Controller	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.3E-04	0.0	40.2	0.02%	0.02%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
3INCH-SN-637A	PIPE	Pipe Segment	Transfer Route	Waste Transfer System	Transfer Route	6.1E-05	0.0	337.7	0.00%	0.02%
3INCH-SN-637	PIPE	Pipe Segment	Transfer Route	Waste Transfer System	Transfer Route	6.1E-05	0.0	337.7	0.00%	0.02%
AZ801A-WST-LDK-101-1	LDK	Leak Detector Relay	Instr Bldg 241-AZ-801A	Confinement System	Ventilation Tank Annulus	3.5E-04	0.0	58.9	0.01%	0.02%
AZ101-WST-ZS-702A-X2	ZS	Position Switch	AZ-101	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	157.7	0.01%	0.02%
AZ101-WST-ZS-703A-X2	ZS	Position Switch	AZ-101	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	157.7	0.01%	0.02%
AZ101-WST-ZS-702A-X1	ZS	Position Switch	AZ-101	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	157.7	0.01%	0.02%
AZ101-WST-ZS-703A-X1	ZS	Position Switch	AZ-101	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	157.7	0.01%	0.02%
AZ801A-SW-PCV-750	PCV	Pressure Control Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	154.7	0.01%	0.02%
E	NOZ	Nozzle	Transfer Route	Waste Transfer System	Transfer Route	1.9E-05	0.0	991.6	0.00%	0.02%
C	NOZ	Nozzle	Transfer Route	Waste Transfer System	Transfer Route	1.9E-05	0.0	991.6	0.00%	0.02%
J	NOZ	Nozzle	Transfer Route	Waste Transfer System	Transfer Route	1.9E-05	0.0	991.6	0.00%	0.02%
H	NOZ	Nozzle	Transfer Route	Waste Transfer System	Transfer Route	1.9E-05	0.0	991.6	0.00%	0.02%
D	NOZ	Nozzle	Transfer Route	Waste Transfer System	Transfer Route	1.9E-05	0.0	991.6	0.00%	0.02%
K	NOZ	Nozzle	Transfer Route	Waste Transfer System	Transfer Route	1.9E-05	0.0	991.6	0.00%	0.02%
AZ101A-WST-PT-101-1	PT	Pressure Transmitter	Transmitter Enclosure 241-AZ-101A	Confinement System	Waste Tank	5.2E-04	0.0	35.6	0.02%	0.02%
AZ271-VTP-PDI-AZ1K45-1	PDI	Pressure Differential Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ271-VTP-PDI-AZ1K48-1	PDI	Pressure Differential Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ271-CW-TT-AZCWS-1	TT	Temperature Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Exhaust Condenser Cooling	5.2E-04	0.0	35.6	0.02%	0.02%
AZ271-CW-TT-AZCWR-1	TT	Temperature Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Exhaust Condenser Cooling	5.2E-04	0.0	35.6	0.02%	0.02%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ101A-WST-PT-101-2	PT	Pressure Transmitter	Transmitter Enclosure 241-AZ-101A	Confinement System	Waste Tank	5.2E-04	0.0	35.6	0.02%	0.02%
AZ702-VTP-FE-AZK1-1	FE	Flow Element	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ271-VTP-PDT-AZK109-1	PDT	Pressure Differential Transmitter	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ702-VTP-FIT-AZK1-2	FIT	Flow Indicating Transmitter	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ702-VTP-FE-AZK1-2	FE	Flow Element	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ101-VTP-PI-AZ1K1-2	PIC	Pressure Indicating Controller	Vent Bldg 241-AZ-702	Confinement System	Waste Tank	5.2E-04	0.0	35.6	0.02%	0.02%
AZ702-VTP-PDT-AZK108-1	PDT	Pressure Differential Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ702-VTP-I-124	I	Interlock	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ702-VTP-FIT-AZK1-1	FIT	Flow Indicating Transmitter	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.2E-04	0.0	35.6	0.02%	0.02%
AZ101-IA-LLAS-101-1	LLAS	Liquid Level Alarm Switch	AZ-101	Confinement System	Waste Tank	1.2E-04	0.0	157.7	0.00%	0.02%
AZ101-IA-LLE-101-1	LLE	Liquid Level Element	AZ-101	Confinement System	Waste Tank	1.2E-04	0.0	157.7	0.00%	0.02%
AZ01A-WT-SN-632-M9	PIPE	Pipe Segment	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	6.1E-05	0.0	297.8	0.00%	0.02%
AZ156-WST-DS-2	SDS	PLG added	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	40.2	0.02%	0.02%
AZ01A-WT-PE	PE	Pressure Element	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	1.9E-05	0.0	865.3	0.00%	0.02%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ156-WST-ZI-DM8	ZI	Position Indicator	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-SI-DM9	SI	Current Indicator	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-SI-DM12	SI	Speed/Velocity Indicator	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-SI-DM6	SI	Speed/Velocity Indicator	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-SI-DM3	SI	Speed/Velocity Indicator	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-TI-701A-X2	TI	Temperature Indicator	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-TI-702A-X1	TI	Temperature Indicator	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-TI-702A-X2	TI	Temperature Indicator	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-II-DM4	II	Current Indicator	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-II-DM10	II	Current Indicator	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-ZI-DM2	ZI	Position Indicator	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-TI-701A-X1	TI	Temperature Indicator	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-EI-DM11	EI	Voltage Indicator	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ156-WST-EI-DM5	EI	Voltage Indicator	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-04	0.0	35.6	0.02%	0.02%
AZ241-VTA-K1-11-1	FLT	Pre-Filter	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	1.9E-04	0.0	76.5	0.01%	0.02%
AZ241-VTA-K1-1-1	FLT	Pre-Filter	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	1.9E-04	0.0	76.5	0.01%	0.02%
AN241-CHEMB-FCV-129	FCV	Flow Control Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	1.7E-04	0.0	85.4	0.01%	0.02%
AN241-CHEMB-V-119	V	2-Way Ball Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	9.5E-05	0.0	154.7	0.00%	0.02%
AN241-RW-V-180	V	Gate Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	9.5E-05	0.0	154.7	0.00%	0.02%
AN241-CHEMB-V-111	V	Gate Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	9.5E-05	0.0	154.7	0.00%	0.02%
H-A-J	JMP	Jumper	Transfer Route	Waste Transfer System	Transfer Route	2.0E-05	0.0	701.1	0.00%	0.02%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
J-L-K	JMP	Jumper	Transfer Route	Waste Transfer System	Transfer Route	2.0E-05	0.0	701.1	0.00%	0.02%
D-E	JMP	Jumper	Transfer Route	Waste Transfer System	Transfer Route	2.0E-05	0.0	701.1	0.00%	0.02%
K-C	JMP	Jumper	Transfer Route	Waste Transfer System	Transfer Route	2.0E-05	0.0	701.1	0.00%	0.02%
HAPERFLS001	HUMAN	Human Action FL	HUM	Human Actions	Transfer Route	5.0E-04	0.0	28.1	0.02%	0.02%
AN241-DR-V-110	V	2-Way Ball Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	9.1E-05	0.0	154.7	0.00%	0.02%
AN241-CHEMB-HTR-125	HTR	Heater	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	3.6E-04	0.0	38.7	0.01%	0.02%
AZ241-VTA-DTC-K1-1-1	DTC	Delta T Controller	AZ Farm, Train A, 101-AZ Heater Controller Encl	HVAC Annulus	Ventilation Tank Annulus	1.8E-04	0.0	74.3	0.01%	0.02%
AZ01A-WT-LDE	LDE	Level Detector Element (Encasement)	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	2.2E-05	0.0	592.4	0.00%	0.01%
AZ01A-WT-LDE-	LDE	Level Detector Element	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	2.2E-05	0.0	592.4	0.00%	0.01%
AZ801A-SW-PDIS-750	PDIS	Pressure Differential Indicating Switch	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	96.2	0.01%	0.01%
AZ241-EDS-MCC-701	MCC	Motor Control Center (Transformer)	AZ Farm	Support/Utilities	Electrical Distribution	1.9E-04	0.0	65.6	0.01%	0.01%
AZ702-VTP-HV-AZK1-1	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702 ENCL AZK1-1	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	41.9	0.01%	0.01%
AZ702-VTP-TIC-AZK102-1A	TIC	Temperature Indicating Controller	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	40.2	0.01%	0.01%
AZ401-VTP-HV-AZ101K408-1A2	HV	2-Way Ball Valve	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	7.6E-05	0.0	150.1	0.00%	0.01%
AZ101-VTP-HV-AZ101K408-1A1	HV	2-Way Ball Valve	AZ-101	HVAC Primary	Ventilation Tank Primary	7.6E-05	0.0	150.1	0.00%	0.01%
AZ101-VTP-HV-AZ101K408-1A	HV	2-Way Ball Valve	AZ-101	HVAC Primary	Ventilation Tank Primary	7.6E-05	0.0	150.1	0.00%	0.01%
AZ101--VALVE 10 (TEMP)	V	Check Valve	AZ-101	Waste Transfer System	Mixer Pumps	7.0E-05	0.0	154.7	0.00%	0.01%
AZ702-VTP-PDT-AZK110-1A	PDT	Pressure Differential Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ702-VTP-PDT-AZK104-1A	PDT	Pressure Differential Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ702-VTP-TT-AZK102-1A	TT	Temperature Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ702-VTP-TT-AZK102-3A	TT	Temperature Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ702-VTP-PT-AZK1-1A	PT	Pressure Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ702-VTP-PDT-AZK104-2A	PDT	Pressure Differential Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ271-VTP-PIC-AZK1-1A	PIC	Pressure Indicating Controller	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ271-VTP-I-107	I	Interlock	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ271-VTP-I-108	I	Interlock	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ702-VTP-I-103	I	Interlock	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ271-VTP-IT-AZK105-1A1	IT	Current Transmitter	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ271-VTP-I-101	I	Interlock	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ271-VTP-TDIC-AZK12-1A	TDIC	Temperature Differential Indicating Controller	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	2.9E-04	0.0	35.6	0.01%	0.01%
AZ241-VTA-PS-K1-1-2	PS	Pressure Switch	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	6.0E-05	0.0	157.7	0.00%	0.01%
AZ241-VTA-PS-K1-1-1	PS	Pressure Switch	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	6.0E-05	0.0	157.7	0.00%	0.01%
AN241-CHEMB-PI-107	PI	Pressure Indicator	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.6E-04	0.0	35.6	0.01%	0.01%
AZ156-CHEMB-LIC-127	LI	Level Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Storage	2.6E-04	0.0	35.6	0.01%	0.01%
AN241-CHEMB-PI-132	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	2.6E-04	0.0	35.6	0.01%	0.01%
AZ156-CHEMB-TI-124	TI	Temperature Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Storage	2.6E-04	0.0	35.6	0.01%	0.01%
AZ101-WST-ZT-703A-X1	ZT	Position Transmitter	AZ-101	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	67.8	0.01%	0.01%
AZ101-WST-ZT-702A-X1	ZT	Position Transmitter	AZ-101	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	67.8	0.01%	0.01%
AZ101-WST-JB101-101	JB	Digital Transmitter	AZ-101	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	67.8	0.01%	0.01%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ101-WST-JB101-100	JB	Digital Transmitter	AZ-101	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	67.8	0.01%	0.01%
AZ101--LIT-	LIT	Level Indicating Transmitter	AZ-101	Waste Transfer System	Monitoring	1.3E-04	0.0	67.8	0.01%	0.01%
AZ401-VTP-MK-AZ101K4-1	MK	Butterfly Valve	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	9.7E-05	0.0	88.3	0.00%	0.01%
AZ702-VTP-HV-AZK1-1A6	HV	2-Way Ball Valve	AZ Farm K1 Primary Vent Exhaust Radiation Monitoring	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ702-VTP-HV-AZK109-1E	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ702-VTP-HV-AZK109-1D	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ702-VTP-HV-AZK109-1A2	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ702-VTP-HV-AZK109-1A1	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ702-VTP-HV-AZK108-1A2	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ702-VTP-HV-AZK108-1A1	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ702-VTP-HV-AZK108-1	HV	2 3-Way Gate Valve Manifold	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ702-VTP-HV-AZK1-2	HV	2-Way Ball Valve	AZ Farm K1 Primary Vent Exhaust Radiation Monitoring	HVAC Primary	Ventilation Tank Primary	2.0E-04	0.0	42.7	0.01%	0.01%
AZ241-WST-XFMR-713A	XFMR	Transformer	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	186.9	0.002%	0.01%
AN241-CHEMB-V-109	V	Automatic Recirculating Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	9.4E-05	0.0	85.2	0.004%	0.01%
AN241-CHEMB-MOV-135	MOV	3-Way Motor Operated Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	9.1E-05	0.0	85.0	0.004%	0.01%
AN241-CHEMB-MOV-117	MOV	2-Way Motor Operated Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	9.1E-05	0.0	85.0	0.004%	0.01%
AN241-CHEMB-V-102	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	8.6E-05	0.0	89.6	0.004%	0.01%
AN241-CHEMB-V-117	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.6E-05	0.0	89.6	0.004%	0.01%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-V-108	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.6E-05	0.0	89.6	0.004%	0.01%
AN241-CHEMB-V-106	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.6E-05	0.0	89.6	0.004%	0.01%
AN241-CHEMB-V-105	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	8.6E-05	0.0	89.6	0.004%	0.01%
AN241-CHEMB-V-104	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	8.6E-05	0.0	89.6	0.004%	0.01%
AN241-CHEMB-V-103	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	8.6E-05	0.0	89.6	0.004%	0.01%
AN241-CHEMB-V-101	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	8.6E-05	0.0	89.6	0.004%	0.01%
AN241-CHEMB-V-100	V	Coupling Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	8.6E-05	0.0	89.6	0.004%	0.01%
AN241-CHEMB-V-110	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.6E-05	0.0	89.6	0.004%	0.01%
AZ241-CW-HV-AZCWS-1A1	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	1.9E-04	0.0	38.7	0.01%	0.01%
AZ241-CW-HV-AZCWR-1	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	1.9E-04	0.0	38.7	0.01%	0.01%
AZ241-CW-HV-AZCWR-1A1	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	1.9E-04	0.0	38.7	0.01%	0.01%
AZ241-CW-HV-AZCWS-1A2	HV	Globe Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	1.9E-04	0.0	38.7	0.01%	0.01%
AN241-CHEMB-V-107	V	Globe Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.3E-05	0.0	89.6	0.003%	0.01%
AN241-CHEMB-V-118	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.3E-05	0.0	89.6	0.003%	0.01%
AN241-CHEMB-V-112	V	2-Way Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.3E-05	0.0	89.6	0.003%	0.01%
AN241-CHEMB-V-113	V	2-Way Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.3E-05	0.0	89.6	0.003%	0.01%
AN241-CHEMB-V-115	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	8.3E-05	0.0	89.6	0.003%	0.01%
AZ702-VTP-HV-AZK109-1	HV	2 3-Way Gate Valve Manifold	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.9E-04	0.0	40.2	0.008%	0.01%
AZ801A-SW-V-771	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ801A-SW-V-790	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-791	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-766	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-752	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-756	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-757	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-758	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-760	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-764	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-761	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-759	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ101-SW-V-788	V	2-Way Ball Valve	Tank AZ-101, Mixer Pump #2	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-762	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-754	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-768	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-769	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-773	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-750	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ101-SW-V-789	V	2-Way Ball Valve	Tank AZ-101, Mixer Pump #1	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-767	V	Globe Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-765	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ801A-SW-V-763	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.8E-05	0.0	154.7	0.002%	0.01%
AZ241-VTA-K1-6-1	HTR	Heater	AZ Farm	HVAC Annulus	Ventilation Tank Annulus	3.9E-05	0.0	186.9	0.002%	0.01%
AZ801A-SW-V-721	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.6E-05	0.0	154.7	0.002%	0.01%
AZ801A-SW-V-720	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.6E-05	0.0	154.7	0.002%	0.01%
AZ101-WST-ODE-RTD-701A-X1	TE	Temperature Element	Tank AZ-101, Mixer Pump #2	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	157.7	0.002%	0.01%
AZ101-WST-ODE-RTD-702A-X1	TE	Temperature Element	Tank AZ-101, Mixer Pump #1	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	157.7	0.002%	0.01%
AZ801A-SW-PSL-751	PSL	Pressure Switch Low	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	157.7	0.002%	0.01%
AZ801A-SW-PSL-750	PSL	Pressure Switch Low	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	157.7	0.002%	0.01%
AZ101-WST-DE-RTD-702A-X1	TE	Temperature Element	AZ-101	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	157.7	0.002%	0.01%
AZ101-WST-DE-RTD-701A-X1	TE	Temperature Element	Tank AZ-101, Mixer Pump #2	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	157.7	0.002%	0.01%
AZ702-VTP-AZ-K1-8-1	COND	Condenser	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	5.3E-05	0.0	126.5	0.002%	0.01%
AZ241-ELEC-(ATS-3)	ATS	Auto Transfer Switch	AZ Farm	Support/Utilities	Electrical Distribution	1.7E-04	0.0	38.7	0.01%	0.01%
AZ801A-WST-PAS-101-1	PAS	Pressure Alarm Switch	Instr Bldg 241-AZ-801A	Confinement System	Waste Tank	1.7E-04	0.0	38.7	0.01%	0.01%
AZ241-ELEC-PP-6	PB	Panelboard (Transformer)	AZ Farm Chiller Pad, AZ-CW-R-1	Support/Utilities	Electrical Distribution	1.7E-04	0.0	38.7	0.007%	0.008%
AZ801A-WST-PAS-101-2	PAS	Pressure Alarm Switch	Instr Bldg 241-AZ-801A	Confinement System	Waste Tank	1.7E-04	0.0	38.7	0.007%	0.008%
AZ702-VTP-HV-AZK102-1A2	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.6E-04	0.0	41.9	0.007%	0.008%
AZ702-VTP-HV-AZK102-1A1	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.6E-04	0.0	41.9	0.007%	0.008%
AN241-CHEMB-PCV-122	PCV	Pressure Control Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.1E-04	0.0	52.5	0.005%	0.007%
AN241-CHEMB-PCV-123	PCV	Pressure Control Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.1E-04	0.0	52.5	0.005%	0.007%
AN241-CHEMB-M-102	M	Pump/Fan/Compressor Motor	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	1.4E-04	0.0	40.2	0.006%	0.006%
AN241-CHEMB-M-101	M	Pump/Fan/Compressor Motor	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.4E-04	0.0	40.2	0.006%	0.006%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ401-VTP-PDT-AZ101K408-1	PDT	Pressure Differential Transmitter	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	1.6E-04	0.0	35.6	0.007%	0.006%
AN241-RW-MOV-107	MOV	Motor Operated Ball Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	6.4E-05	0.0	83.1	0.003%	0.006%
AN241-RW-V-172	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	5.9E-05	0.0	89.6	0.002%	0.006%
AN241-RW-BFP-102	BFP	Backflow Preventer	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	5.9E-05	0.0	89.6	0.002%	0.006%
AN241-RW-V-171	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	5.9E-05	0.0	89.6	0.002%	0.006%
AZ156-WST-SC-703A-X1	SC	Speed Controller	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	40.2	0.005%	0.006%
AZ156-WST-SC-704A-X1	SC	Speed Controller	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	1.3E-04	0.0	40.2	0.005%	0.006%
AN241-RW-V-174	V	Globe Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	5.6E-05	0.0	89.6	0.002%	0.006%
AN241-RW-V-179	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	5.6E-05	0.0	89.6	0.002%	0.006%
AN241-RW-PRV-101	PRV	Pressure Reducing Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	5.6E-05	0.0	89.6	0.002%	0.006%
AZ702-VTP-AZ-K1-2-1A	HTR	Heater	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.3E-04	0.0	38.7	0.005%	0.006%
AZ702-VTP-HV-AZK104-1A	HV	2 3-Way Gate Valve Manifold	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.1E-04	0.0	42.7	0.005%	0.005%
AZ702-VTP-HV-AZK1-1A1	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.1E-04	0.0	42.7	0.005%	0.005%
AZ702-VTP-HV-AZK1-1A3	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.1E-04	0.0	42.7	0.005%	0.005%
AZ702-VTP-HV-AZK110-1A	HV	2 3-Way Gate Valve Manifold	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.1E-04	0.0	42.7	0.005%	0.005%
AZ702-VTP-HV-AZK1-1A4	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.1E-04	0.0	42.7	0.005%	0.005%
AZ702-VTP-HV-AZK104-2A	HV	2 3-Way Gate Valve Manifold	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.1E-04	0.0	42.7	0.005%	0.005%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ702-VTP-HV-AZK1-1A	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.1E-04	0.0	42.7	0.005%	0.005%
AZ702-VTP-HV-AZK1-1A2	HV	2-Way Ball Valve	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.1E-04	0.0	42.7	0.005%	0.005%
AZ801A-SW-SRV-750	SRV	Safety Relief Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.6E-05	0.0	89.6	0.002%	0.005%
AZ241-CW-LI-AZCWTK-1	LI	Level Indicator	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.6E-05	0.0	157.7	0.001%	0.005%
AZ241-CW-PI-AZCWP-1A1	PI	Pressure Indicator	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.6E-05	0.0	157.7	0.001%	0.005%
AZ241-CW-PI-AZCWP-1A2	PI	Pressure Indicator	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.6E-05	0.0	157.7	0.001%	0.005%
AZ801A-SW-FO-750	FO	Flow Orifice	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	89.6	0.002%	0.004%
AZ801A-SW-FO-751	FO	Flow Orifice	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	89.6	0.002%	0.004%
AZ801A-SW-V-751	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	154.7	0.001%	0.004%
AZ801A-SW-V-753	V	2-Way Ball Valve	Instr Bldg 241-AZ-801A	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	154.7	0.001%	0.004%
AZ156-WST-PB-ES-1	PLG Added	PLG added	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	8.6E-05	0.0	40.2	0.004%	0.004%
AZ702-VTP-TE-AZK102-3A	TE	Temperature Element	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	9.7E-05	0.0	35.6	0.004%	0.004%
AZ702-VTP-TE-AZK102-1A	TE	Temperature Element	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	9.7E-05	0.0	35.6	0.004%	0.004%
AZ702-VTP-TE-AZK102-1A1	TE	Temperature Element	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	9.7E-05	0.0	35.6	0.004%	0.004%
AN241-RW-PCV-101	PCV	Pressure Control Valve	Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	8.5E-05	0.0	40.5	0.004%	0.004%
AZ156-CHEMB-FC-118	FC	Flow Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	8.4E-05	0.0	40.2	0.004%	0.004%
AZ156-CHEMB-FIC-101	FIC	Flow Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	8.4E-05	0.0	40.2	0.004%	0.004%
AZ156-CHEMB-FQIC-130	FQIC	Flow Totalizer Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	8.4E-05	0.0	40.2	0.004%	0.004%
AN241-CHEMB-TC-125	TC	Temperature Controller	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	8.4E-05	0.0	40.2	0.004%	0.004%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	*Number of* Schedule Delay Events	*Expected* Schedule Delay (hours)	*Average Delay* per Event (hours)	*Percent of* Schedule Delay Events	*Percent of* Schedule Delay Hours
AZ156-CHEMB-ZC-117	ZC	Position Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	8.4E-05	0.0	40.2	0.004%	0.004%
AZ156-CHEMB-ZC-135	ZC	Position Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	8.4E-05	0.0	40.2	0.004%	0.004%
AZ156-CHEMB-ZIC-129	ZIC	Position Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	8.4E-05	0.0	40.2	0.004%	0.004%
AZ156-CHEMB-ZY-129	ZY	Position Equipment	PLC Instrument Enclosure WT-ENCL-101	Diluent/Flush System	Diluent/Flush Delivery	8.4E-05	0.0	40.2	0.004%	0.004%
AZ156-CHEMB-FIC-130	FIC	Flow Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	8.4E-05	0.0	40.2	0.004%	0.004%
AN241-RW-BLR-101	BLR	Boiler	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	2.1E-05	0.0	154.7	0.001%	0.004%
AZ241-VTA-CVT-K1-1-1	CVT	Converter	101-AZ Heater Controller Encl	HVAC Annulus	Ventilation Tank Annulus	1.8E-05	0.0	157.7	0.001%	0.003%
AZ241-WST-XFMR-701A	XFMR	Line Reactor Transformer	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	65.6	0.002%	0.003%
AZ241-EDS-DP-706	DP	Panelboard (Transformer)	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	65.6	0.002%	0.003%
AZ241-EDS-DP-707	DP	Panelboard (Transformer)	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	65.6	0.002%	0.003%
AZ241-WST-XFMR-702A	XFMR	Line Reactor Transformer	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	65.6	0.002%	0.003%
AZ156-CHEMB-FFC-118	FFC	PLG added	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	7.7E-05	0.0	35.6	0.003%	0.003%
AN241-RW-PIT-105	PIT	Pressure Indicating Transmitter	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.7E-05	0.0	35.6	0.003%	0.003%
AN241-CHEMB-ZT-129	ZT	Position Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	7.7E-05	0.0	35.6	0.003%	0.003%
AN241-CHEMB-ZS-129	ZS	Position Switch	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	7.7E-05	0.0	35.6	0.003%	0.003%
AN241-CHEMB-ZS-117	ZS	Position Switch	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	7.7E-05	0.0	35.6	0.003%	0.003%
AN241-CHEMB-TIT-132	TIT	Temperature Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	7.7E-05	0.0	35.6	0.003%	0.003%
AN241-CHEMB-TIT-124	TIT	Temperature Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	7.7E-05	0.0	35.6	0.003%	0.003%
AN241-CHEMB-PIT-131	PIT	Pressure Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	7.7E-05	0.0	35.6	0.003%	0.003%
AN241-CHEMB-LIT-127	LIT	Level Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	7.7E-05	0.0	35.6	0.003%	0.003%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-FIT-130	FIT	Flow Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	7.7E-05	0.0	35.6	0.003%	0.003%
AZ271-VTP-YS-AZK12-1A1	YS	Event/State Switch	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	8.8E-04	0.0	3.0	0.037%	0.003%
AZ241-CW-LAL-AZCWTK-1	LAL	Level Alarm Low	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	6.7E-05	0.0	35.3	0.003%	0.003%
AN241-CHEMB-106-M10	PIPE	Pipe Segment	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	2.6E-05	0.0	89.6	0.001%	0.003%
AN241-CHEMB-101-M9	PIPE	Pipe Segment	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.6E-05	0.0	89.6	0.001%	0.003%
AZ241-CW-CV-AZCWP-1B1	CV	Check Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	5.6E-05	0.0	40.2	0.002%	0.003%
AZ271-CW-XA-AZCWR-1	XA	Failure Alarm	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	6.6E-05	0.0	32.6	0.003%	0.002%
AZ-01A-WT-C	NOZ	Jumper	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	3.0E-06	0.0	677.2	0.000%	0.002%
AZ-01A-WT-A	NOZ	Jumper	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	3.0E-06	0.0	677.2	0.000%	0.002%
AZ-01A-WT-U12	NOZ	Jumper	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	3.0E-06	0.0	677.2	0.000%	0.002%
AZ-01A-WT-1	NOZ	Jumper	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	3.0E-06	0.0	677.2	0.000%	0.002%
AZ241-CW-(TK-1-TRAP)	TRAP	Air Separating Trap	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	1.4E-05	0.0	101.2	0.001%	0.002%
AZ401-VTP-AZ101-K4-8-1	COND	Condenser	Recirc/Cooling Module 241-AZ-401	HVAC Primary	Ventilation Tank Primary	1.5E-05	0.0	89.6	0.001%	0.001%
AZ271-VTP-IAH-AZK15-1A	IAH	Current Alarm High	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.7E-05	0.0	35.4	0.002%	0.001%
AZ-K1-5-1A-VSD1	VSD	Variable Speed Drive Controller	HVAC Primary	HVAC Primary	Ventilation Tank Primary	3.2E-05	0.0	40.2	0.001%	0.001%
AZ241-CW-(R-1-ELEC)	ELEC	Breaker Unit	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	4.9E-05	0.0	18.9	0.002%	0.001%
AZ241-EDS-MCC-702	MCC	Motor Control Center (Breaker Unit)	AZ Farm	Support/Utilities	Electrical Distribution	4.9E-05	0.0	18.9	0.002%	0.001%
AZ241-EDS-MCC-704	MCC	Motor Control Center (Breaker Unit)	AZ Farm	Support/Utilities	Electrical Distribution	4.9E-05	0.0	18.9	0.002%	0.001%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ241-ELEC-PP-1	PB	Panelboard (Breaker)	AZ Farm	Support/Utilities	Electrical Distribution	4.9E-05	0.0	18.9	0.002%	0.001%
AZ241-ELEC-PP-2	PB	Panelboard (Breaker)	AZ Farm	Support/Utilities	Electrical Distribution	4.9E-05	0.0	18.9	0.002%	0.001%
AN241-CHEMB-TE-125	TE	Temperature Element	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	2.6E-05	0.0	35.6	0.001%	0.001%
AZ702-VTP-FSL-AZK102-1A	FSL	Flow Switch Low	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	2.6E-04	0.0	3.0	0.011%	0.001%
AZ801A-WST-SS-101A	SS	Selector Switch	Instr Bldg 241-AZ-801A	Confinement System	Ventilation Tank Annulus	8.8E-05	0.0	8.6	0.004%	0.001%
AZ801A-WST-SS-101B	SS	Selector Switch	Instr Bldg 241-AZ-801A	Confinement System	Ventilation Tank Annulus	8.8E-05	0.0	8.6	0.004%	0.001%
AZ801A-WST-SS-101-C	SS	Selector Switch	Instr Bldg 241-AZ-801A	Confinement System	Ventilation Tank Annulus	8.8E-05	0.0	8.6	0.004%	0.001%
AZ241-ELEC-UPS-PP-14	ELEC	UPS Panelboard (Breaker)	Standby Panelboard No. 2	Support/Utilities	Electrical Distribution	4.9E-05	0.0	14.0	0.002%	0.001%
AZ241-ELEC-UPS-PP-15	ELEC	UPS Panelboard (Breaker)	Standby Panelboard No. 1 & 2	Support/Utilities	Electrical Distribution	4.9E-05	0.0	14.0	0.002%	0.001%
AZ801A-EDS-MCC-703	MCC	Motor Control Center (Breaker Unit)	AZ Farm	Support/Utilities	Electrical Distribution	4.9E-05	0.0	14.0	0.002%	0.0008%
AZ241-ELEC-PP-2-BKR-5	PB	Panelboard (Breaker)	PP	HVAC Primary	Exhaust Condenser Cooling	4.9E-05	0.0	14.0	0.002%	0.0008%
AZ101-ELEC-PP-11	PB	Panelboard (Breaker)	101AZ Tank Recirc Bldg 241-AZ-401	Support/Utilities	Electrical Distribution	4.9E-05	0.0	14.0	0.002%	0.0008%
AZ101-ELEC-2A (PP-2)	BKR	Circuit Breaker	Distribution Panelboard PP-2	HVAC Primary	Recirculation Condenser Cooling	4.9E-05	0.0	14.0	0.002%	0.0008%
AZ101-ELEC-1A (PP-2)	BKR	Circuit Breaker	Distribution Panelboard PP-2	HVAC Primary	Recirculation Condenser Cooling	4.9E-05	0.0	14.0	0.002%	0.0008%
AZ101-ELEC-(K4-5-1-ELEC)	ELEC	Breaker Unit	101AZ Tank Recirc Bldg 241-AZ-401	HVAC Primary	Ventilation Tank Primary	4.9E-05	0.0	14.0	0.002%	0.0008%
AZ271-CW-II-AZCWP-1A	II	Current Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	1.9E-05	0.0	35.6	0.0008%	0.0008%
AZ702-VTP-CAB-AZK1-1	CAB	Cabinet	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.7E-05	0.0	38.7	0.0007%	0.0008%
AN241-CHEMB-LS-126	LS	Level Switch	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	1.4E-05	0.0	38.7	0.0006%	0.0006%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ241-CW-UIC-AZCWR-1	CP	Control Panel	Air Cooled Chiller AZ-CW-R-1	HVAC Primary	Exhaust Condenser Cooling	1.0E-05	0.0	52.2	0.0004%	0.0006%
AN241-CHEMB-TK-001	TK	Tank	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	5.5E-06	0.0	89.6	0.0002%	0.0006%
AZ702-VTP-MK-AZK105-1A1	MK	Butterfly Damper Valve w/Limit Switches	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.2E-05	0.0	40.2	0.0005%	0.0005%
AN241-CHEMB-LE-127	LE	Level Element	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	1.3E-05	0.0	35.6	0.0005%	0.0005%
AZ702-VTP-MV-AZK1-5	MOV	3-Way Motor Operated Gate Valve	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	3.3E-06	0.0	134.1	0.0001%	0.0005%
AZ271-VTP-II-AZK15-1A	II	Current Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.0E-05	0.0	35.6	0.0004%	0.0004%
AZ271-VTP-KQI-AZK15-1A	KQI	Time Indicator	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	1.0E-05	0.0	35.6	0.0004%	0.0004%
AZ241-ELEC-(K1-3-2-ELEC)	ELEC	Breaker Unit	AZ Farm Annulus Vent Panel, EDS-MCC-703	Confinement System	Waste Tank	2.0E-05	0.0	14.0	0.0008%	0.0003%
AZ01A-WT-LDK-	LDK	Level Detector Relay	AZ-01A VALVE PIT	Waste Transfer System	Transfer Route	1.3E-05	0.0	18.9	0.0005%	0.0003%
AZ702-VTP-HS-AZK1-1B1	HS	2-Position Hand Switch	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	7.8E-05	0.0	3.0	0.0033%	0.0003%
AZ702-VTP-HS-AZK1-1A1	HS	2-Position Hand Switch	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	7.8E-05	0.0	3.0	0.0033%	0.0003%
AZ702-VTP-PCV-AZK111-1	PCV	Pressure Control Valve	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.8E-06	0.0	40.4	0.0002%	0.0003%
AZ702-VTP-MV-AZK1-4	MOV	Motor Operated Gate Valve	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	3.0E-06	0.0	77.8	0.0001%	0.0003%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ702-VTP-MV-AZK1-3	MOV	Motor Operated Gate Valve w/Filter	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	3.0E-06	0.0	77.8	0.0001%	0.0003%
AZ702-VTP-UC-AZK1-1	UC	Multivariable Controller	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.8E-06	0.0	40.2	0.0002%	0.0003%
AZ241-CW-I-301	I	Interlock	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	5.8E-06	0.0	38.7	0.0002%	0.0003%
AZ241-CW-IT-AZCWP-1A	IT	Current Equipment	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	5.7E-06	0.0	35.6	0.0002%	0.0002%
AZ241-CW-LSL-AZCWTK-1	LSL	Level Switch Low	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	1.3E-06	0.0	157.7	0.0001%	0.0002%
AZ702-VTP-I-123	I	Interlock	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.7E-06	0.0	35.6	0.0002%	0.0002%
AZ702-VTP-PIT-AZK1	PIT	Pressure Indicating Transmitter	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	5.7E-06	0.0	35.6	0.0002%	0.0002%
AZ271-CW-I-300	I	Programmable Logic Controller Field Mounted	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	5.2E-05	0.0	3.0	0.0022%	0.0002%
AZ271-CW-I-304	I	Programmable Logic Controller Field Mounted	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	5.2E-05	0.0	3.0	0.0022%	0.0002%
AZ156-WST-HS-704A-X3	HS	2-Position Hand Switch	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	6.3	0.0010%	0.0002%
AZ156-WST-HS-703A-X2	HS	2-Position Hand Switch	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	6.3	0.0010%	0.0002%
AZ156-WST-HS-704A-X4	HS	2-Position Hand Switch	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	6.3	0.0010%	0.0002%
AZ156-WST-HS-704A-X2	HS	2-Position Hand Switch	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	6.3	0.0010%	0.0002%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ156-WST-HS-703A-X3	HS	2-Position Hand Switch	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	6.3	0.0010%	0.0002%
AZ156-WST-HS-704A-X1	HS	2-Position Hand Switch	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	6.3	0.0010%	0.0002%
AZ156-WST-HS-703A-X4	HS	2-Position Hand Switch	Control Building 241-AZ-156	Waste Transfer System	Mixer Pumps	2.4E-05	0.0	6.3	0.0010%	0.0002%
AZ241-ELEC-(AZ-K1-5-1A-ELEC)	ELEC	Breaker Unit W/VFD Controller	Standby Panelboard No. 1	HVAC Primary	Ventilation Tank Primary	1.0E-05	0.0	14.0	0.0004%	0.0002%
AZ702-VTP-HS-AZK1-1A5	HS	3-Position Hand Switch	Vent Bldg 241-AZ-702, CAB-AZK1-1A	HVAC Primary	Ventilation Tank Primary	4.4E-05	0.0	3.0	0.0018%	0.0002%
AZ271-VTP-HS-AZK1-2A	HS	2-Position Hand Switch	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	4.4E-05	0.0	3.0	0.0018%	0.0002%
AZ271-VTP-HS-AZK12-1A	HS	3-Position Hand Switch	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	4.4E-05	0.0	3.0	0.0018%	0.0002%
AZ271-VTP-HS-AZK1-1A	HS	2-Position Hand Switch	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	4.4E-05	0.0	3.0	0.0018%	0.0002%
AZ156-WST-PB-S1	PB	Push Button	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	3.0	0.0018%	0.0001%
AZ156-WST-DS-1	DS	Disconnect Switch	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	3.0	0.0018%	0.0001%
AZ156-WST-DS-4	DS	Disconnect Switch	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	3.0	0.0018%	0.0001%
AZ156-WST-PB-S4	PB	Push Button	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	3.0	0.0018%	0.0001%
AZ156-WST-PB-S3	PB	Push Button	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	3.0	0.0018%	0.0001%
AZ156-WST-PB-S2	PB	Push Button	Control Console AZ-101 Pump #1	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	3.0	0.0018%	0.0001%
AZ156-WST-DS-3	DS	Disconnect Switch	Control Console AZ-101 Pump #2	Waste Transfer System	Mixer Pumps	4.3E-05	0.0	3.0	0.0018%	0.0001%
AZ702-VTP-SIT-AZK105-1A	SIT	Speed/Velocity Indicating Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	3.1E-06	0.0	35.6	0.0001%	0.0001%
AZ702-VTP-IT-AZK105-1A	IT	Current Transmitter	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	3.1E-06	0.0	35.6	0.0001%	0.0001%
AZ271-VTP-I-110	I	Interlock	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	3.1E-06	0.0	35.6	0.0001%	0.0001%
AZ241-CW-HV-AZCWS-1	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ241-CW-HV-AZCWTK-1A4	HV	Angle Globe Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWP-1A4	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWP-1A5	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWP-1A2	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWTK-1A2	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWP-1A1	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWP-1A3	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWTK-1A3	HV	Angle Globe Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWTK-1A1	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-HV-AZCWTK-2	HV	Gate Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ241-CW-CV-AZCWP-1A1	CV	Check Valve	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.1E-06	0.0	38.7	0.0001%	0.0001%
AZ702-VTP-AZ-PC-SP-1	SP	Condensate Seal Pot	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.8E-06	0.0	40.2	0.0001%	0.0001%
AZ156-CHEMB-HS-130	HS	Hand Switch	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	6.1E-06	0.0	11.0	0.0003%	0.0001%
AZ156-CHEMB-HS-118	HS	2-Position Hand Switch	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	6.1E-06	0.0	11.0	0.0003%	0.0001%
AZ271-CW-YS-AZCWP-1A1	YS	Event/State Switch	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	1.7E-05	0.0	3.0	0.0007%	0.0001%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ241-ELEC-(ATS-1)	ATS	Auto Transfer Switch	AZ Farm	Support/Utilities	Electrical Distribution	1.1E-06	0.0	38.7	0.0000%	0.0000%
AZ702-VTP-SE-AZK105-1A	SE	Speed/Velocity Element	Vent Bldg 241-AZ-702	HVAC Primary	Ventilation Tank Primary	1.0E-06	0.0	35.6	0.0000%	0.0000%
AZ271-CW-FSL-AZCWR-1	FSL	Flow Switch Low	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	5.2E-06	0.0	3.0	0.0002%	0.0000%
AZ241-CW-(P-1A-MS)	MS	Motor Starter (Electric)	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	3.5E-06	0.0	4.3	0.0001%	0.0000%
AZ702-VTP-PS-AZK111-1	PS	Pressure Switch	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	1.7E-06	0.0	3.0	0.0001%	0.0000%
AZ241-CW-HS-AZCWP-1A1	HS	3-Position Hand Switch	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	8.7E-07	0.0	5.6	0.0000%	0.0000%
AZ271-CW-HS-AZCWP-1A	HS	3-Position Hand Switch	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	8.6E-07	0.0	3.0	0.0000%	0.0000%
AZ271-CW-HS-AZCWR-1	HS	Hand Switch	Instr Bldg 241-AZ-271	HVAC Primary	Exhaust Condenser Cooling	8.6E-07	0.0	3.0	0.0000%	0.0000%
AZ702-VTP-HS-AZK1-3	HS	Hand Switch	Vent Bldg 241-AZ-702 CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	8.6E-07	0.0	3.0	0.0000%	0.0000%
AZ702-VTP-HS-AZK111-1C	HS	2-Position Hand Switch	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	8.6E-07	0.0	3.0	0.0000%	0.0000%
AZ702-VTP-HS-AZK111-1B	HS	2-Position Hand Switch	K1 Primary Vent Exhaust Radiation Monitoring CAB-AZK1-1	HVAC Primary	Ventilation Tank Primary	8.6E-07	0.0	3.0	0.0000%	0.0000%
AZ702-VTP-HS-AZK111-1A	HS	2-Position Hand Switch	K1 Primary Vent Exhaust Radiation Monitoring ENCL-AZK1-1	HVAC Primary	Ventilation Tank Primary	8.6E-07	0.0	3.0	0.0000%	0.0000%
AZ241-WST-DS-703A	DS	Fused Switch	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-07	0.0	5.6	0.0000%	0.0000%

Table F-5. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ241-WST-DS-702A	DS	Fused Switch	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-07	0.0	5.6	0.0000%	0.0000%
AZ241-WST-DS-704A	DS	Fused Switch	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-07	0.0	5.6	0.0000%	0.0000%
AZ241-WST-DS-713A	DS	Fused Switch	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-07	0.0	5.6	0.0000%	0.0000%
AZ241-WST-DS-701A	DS	Fused Switch	AZ Farm	Waste Transfer System	Mixer Pumps	4.3E-07	0.0	5.6	0.0000%	0.0000%
AZ241-CW-AZ-CW-TK-1	TANK	Expansion Tank	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.4E-08	0.0	98.4	0.0000%	0.0000%
AZ241-CW-AZ-CW-TK-2	TANK	Thermal Storage Tank	AZ Farm	HVAC Primary	Exhaust Condenser Cooling	2.4E-08	0.0	98.4	0.0000%	0.0000%
AZ271-VTP-HS-AZK15-1A	HS	2-Position Hand Switch	Instr Bldg 241-AZ-271	HVAC Primary	Ventilation Tank Primary	4.7E-07	0.0	3.0	0.0000%	0.0000%
AZ241-CW-(P-1A-ELEC)	ELEC	Breaker Unit	AZ Farm Chiller Pad, AZ-CW-R-1	HVAC Primary	Exhaust Condenser Cooling	4.9E-11	0.0	14.0	0.0000%	0.0000%

Table F-6. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Activity Contribution to Schedule Delay

Activity	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
	2.4	**88.0**	**36.9**	**100%**	**100%**
16010B1	1.4E+00	35.8	26	56.8%	40.7%
16010B2	4.6E-01	22.3	48	19.3%	25.3%
16010B3	5.7E-01	29.9	52	23.9%	33.9%

Table F-7. Critical Items List For Waste Transfer Activities from 241-AZ-101 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

Component Type Category	Expected Number of Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Total	**2.4**	**88.0**	**36.9**	**100%**	**100%**
Pumps/Fans	3.2E-01	37.2	117	13.3%	42.3%
Instruments/Electrical	2.6E-01	13.0	51	10.7%	14.8%
External Events	1.7E+00	12.5	7	70.1%	14.2%
Miscellaneous/HEME/Moisture Separators	3.1E-02	9.1	296	1.3%	10.3%
Check and Manual Valves	3.3E-02	6.2	188	1.4%	7.1%
Human Actions	1.9E-02	6.2	325	0.8%	7.0%
Pipes, Filters, Containers, Structure	9.4E-03	1.4	147	0.4%	1.6%
Miscellaneous/Switches/Breakers	3.5E-02	1.3	37	1.5%	1.5%
Power Operated Valves	1.2E-02	1.0	86	0.5%	1.2%
Miscellaneous/Other Actively Powered	7.9E-04	0.1	79	0.0%	0.1%
Miscellaneous/Heaters	5.2E-04	0.0	50	0.0%	0.0%
Pressure Relief Valves	1.0E-04	0.0	90	0.0%	0.0%
Miscellaneous/Structural Components	1.7E-05	0.0	39	0.0%	0.0%

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Appendix G. Critical Items List and Supplemental Information Supporting RAM Analysis of Waste Feed Delivery Activities from Source Tank 241-AN-105

Figures

G-1 Simulation Results for Waste Transfer Activities from 241-AN-105 to the WTP

(Note: This figure contains numerous pages of text and graphics generated by the Crystal Ball report generator.)

Tables

G-1 Waste Flowsheet Volume Summary for Waste Transfer Activities from 241-AN-105 to the WTP

G-2 Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by System Contribution to Schedule Delay

G-3 Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

G-4 Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure

G-5 Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay

G-6 Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Activity Contribution to Schedule Delay

G-7 Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

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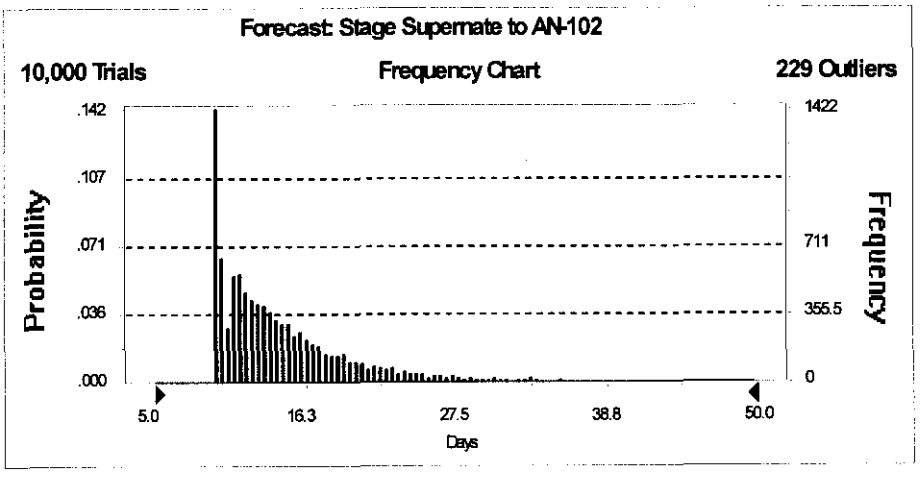
Crystal Ball Report
Simulation started on 9/4/00 at 14:28:16
Simulation stopped on 9/4/00 at 15:26:05

Forecast: Stage Supernate to AN-102 **Cell: F15**

Summary:
Display Range is from 5.0 to 50.0 Days
Entire Range is from 9.6 to 216.5 Days
After 10,000 Trials, the Std. Error of the Mean is 0.1

Statistics:	Value
Trials	10000
Mean	16.5
Median	13.3
Mode	9.6
Standard Deviation	11.7
Variance	137.4
Skewness	5.46
Kurtosis	48.07
Coeff. of Variability	0.71
Range Minimum	9.6
Range Maximum	216.5
Range Width	206.8
Mean Std. Error	0.12



Forecast: Stage Supernate to AN-102 (cont'd) **Cell: F15**

Percentiles:

Percentile	Days
0%	9.6
5%	9.6
10%	9.8
15%	10.0
20%	10.3
25%	11.0
30%	11.4
35%	11.8
40%	12.3
45%	12.8
50%	13.3
55%	13.9
60%	14.6
65%	15.3
70%	16.2
75%	17.3
80%	18.8
85%	20.6
90%	23.9
95%	32.4
100%	216.5

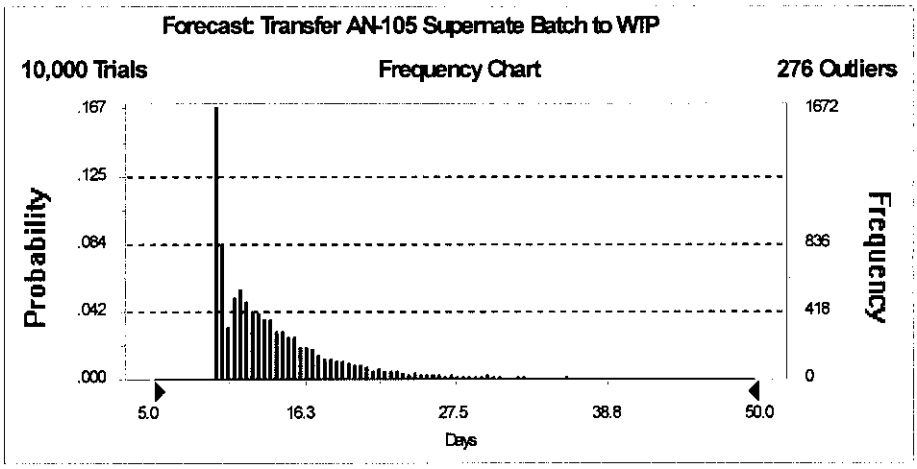
End of Forecast

Forecast: Transfer AN-105 Supernate Batch to WTP **Cell: F17**

Summary:

Display Range is from 5.0 to 50.0 Days
Entire Range is from 9.7 to 191.5 Days
After 10,000 Trials, the Std. Error of the Mean is 0.1

Statistics:	Value
Trials	10000
Mean	16.4
Median	12.9
Mode	9.7
Standard Deviation	12.5
Variance	156.8
Skewness	4.94
Kurtosis	36.25
Coeff. of Variability	0.76
Range Minimum	9.7
Range Maximum	191.5
Range Width	181.8
Mean Std. Error	0.13



Forecast: Transfer AN-105 Supernate Batch to WTP (cont'd) **Cell: F17**

Percentiles:

Percentile	Days
0%	9.7
5%	9.7
10%	9.8
15%	9.9
20%	10.1
25%	10.4
30%	11.0
35%	11.4
40%	11.8
45%	12.3
50%	12.9
55%	13.5
60%	14.1
65%	14.8
70%	15.6
75%	16.7
80%	18.3
85%	20.4
90%	24.3
95%	35.5
100%	191.5

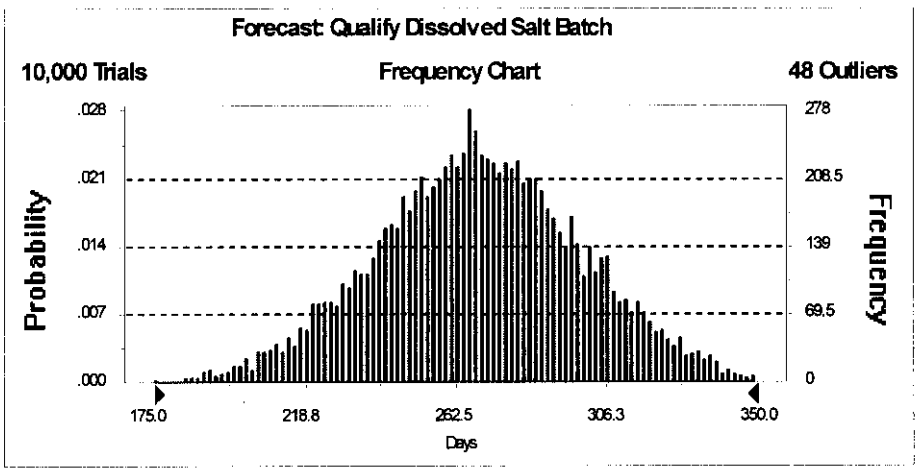
End of Forecast

Forecast: Qualify Dissolved Salt Batch **Cell: F19**

Summary:

Display Range is from 175.0 to 350.0 Days
Entire Range is from 156.6 to 404.7 Days
After 10,000 Trials, the Std. Error of the Mean is 0.3

Statistics:	Value
Trials	10000
Mean	269.8
Median	269.4
Mode	---
Standard Deviation	30.3
Variance	916.3
Skewness	0.02
Kurtosis	2.98
Coeff. of Variability	0.11
Range Minimum	156.6
Range Maximum	404.7
Range Width	248.1
Mean Std. Error	0.30



Forecast: Qualify Dissolved Salt Batch (cont'd) **Cell: F19**

Percentiles:

Percentile	Days
0%	156.6
5%	220.1
10%	230.6
15%	238.6
20%	244.5
25%	249.6
30%	254.1
35%	258.4
40%	262.3
45%	266.1
50%	269.4
55%	273.2
60%	277.2
65%	281.1
70%	285.4
75%	289.8
80%	295.4
85%	301.6
90%	308.7
95%	319.9
100%	404.7

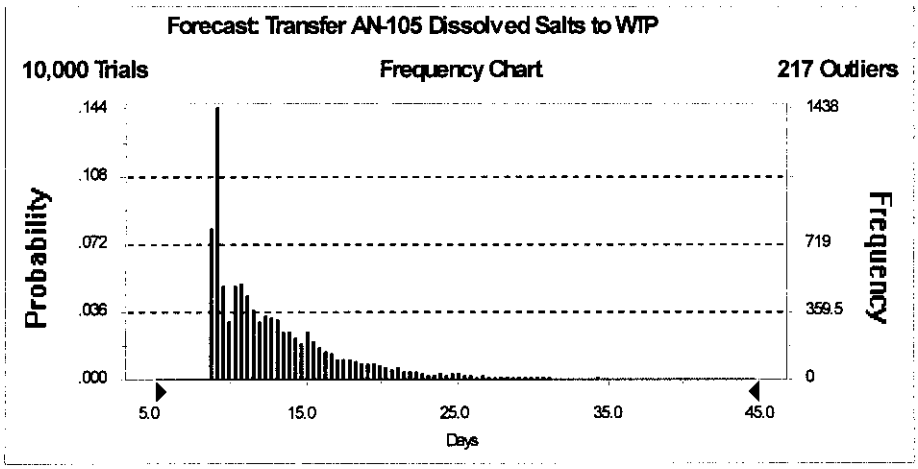
End of Forecast

Forecast: Transfer AN-105 Dissolved Salts to WTP **Cell: F20**

Summary:

Display Range is from 5.0 to 45.0 Days
Entire Range is from 9.0 to 172.5 Days
After 10,000 Trials, the Std. Error of the Mean is 0.1

Statistics:	Value
Trials	10000
Mean	14.9
Median	12.0
Mode	9.0
Standard Deviation	10.9
Variance	119.6
Skewness	5.74
Kurtosis	49.05
Coeff. of Variability	0.74
Range Minimum	9.0
Range Maximum	172.5
Range Width	163.5
Mean Std. Error	0.11



Forecast: Transfer AN-105 Dissolved Salts to WTP (cont'd) **Cell: F20**

Percentiles:

Percentile	Days
0%	9.0
5%	9.0
10%	9.1
15%	9.2
20%	9.3
25%	9.6
30%	10.2
35%	10.6
40%	11.0
45%	11.4
50%	12.0
55%	12.6
60%	13.2
65%	13.9
70%	14.7
75%	15.7
80%	16.9
85%	18.7
90%	21.5
95%	28.5
100%	172.5

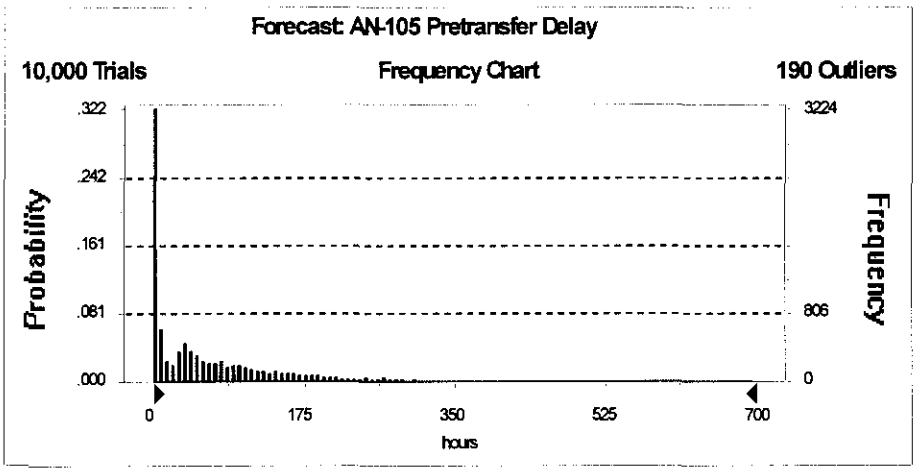
End of Forecast

Forecast: AN-105 Pretransfer Delay **Cell: G10**

Summary:

Display Range is from 0 to 700 hours
Entire Range is from 0 to 3,924 hours
After 10,000 Trials, the Std. Error of the Mean is 2

Statistics:	Value
Trials	10000
Mean	98
Median	40
Mode	0
Standard Deviation	220
Variance	48,259
Skewness	7.30
Kurtosis	79.45
Coeff. of Variability	2.23
Range Minimum	0
Range Maximum	3,924
Range Width	3,924
Mean Std. Error	2.20



Forecast: AN-105 Pretransfer Delay (cont'd) **Cell: G10**

Percentiles:

Percentile	hours
0%	0
5%	0
10%	0
15%	0
20%	2
25%	4
30%	6
35%	9
40%	18
45%	32
50%	40
55%	49
60%	61
65%	76
70%	93
75%	111
80%	136
85%	169
90%	220
95%	338
100%	3,924

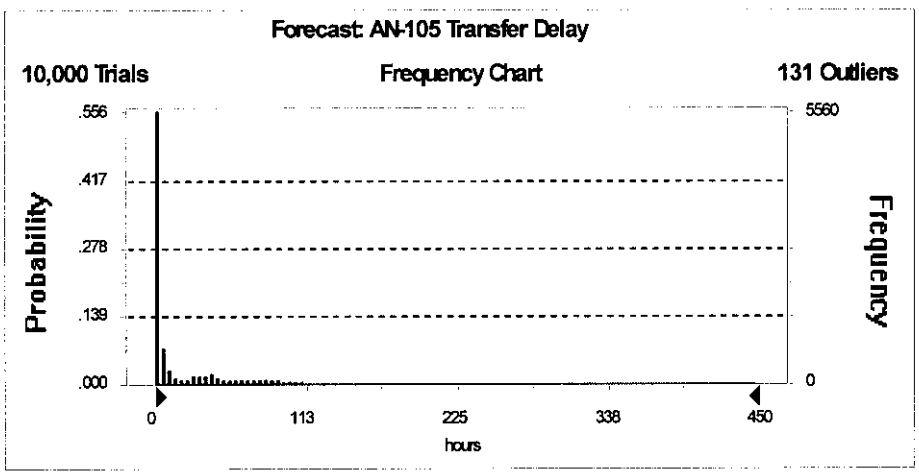
End of Forecast

Forecast: AN-105 Transfer Delay **Cell: G11**

Summary:

Display Range is from 0 to 450 hours
Entire Range is from 0 to 2,719 hours
After 10,000 Trials, the Std. Error of the Mean is 1

Statistics:	Value
Trials	10000
Mean	44
Median	3
Mode	0
Standard Deviation	145
Variance	20,984
Skewness	9.08
Kurtosis	109.67
Coeff. of Variability	3.32
Range Minimum	0
Range Maximum	2,719
Range Width	2,719
Mean Std. Error	1.45



Forecast: AN-105 Transfer Delay (cont'd) **Cell: G11**

Percentiles:

Percentile	hours
0%	0
5%	0
10%	0
15%	0
20%	0
25%	0
30%	0
35%	0
40%	0
45%	1
50%	3
55%	4
60%	6
65%	11
70%	27
75%	39
80%	53
85%	74
90%	103
95%	175
100%	2,719

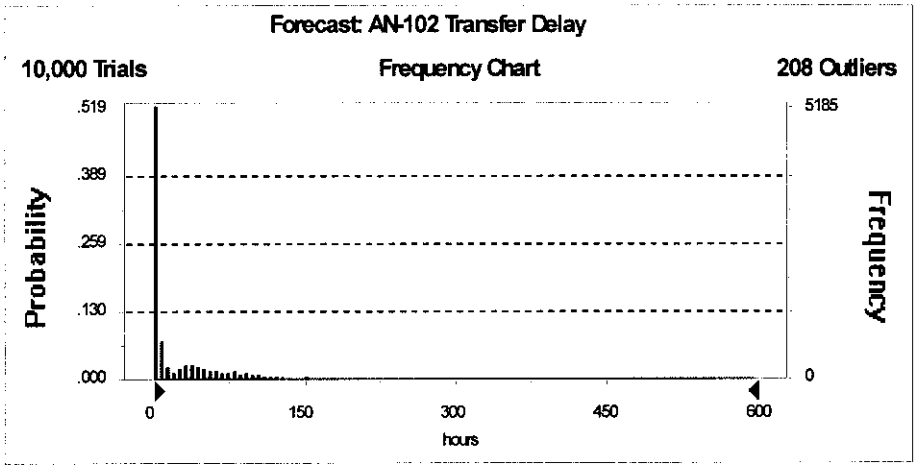
End of Forecast

Forecast: AN-102 Transfer Delay **Cell: G7**

Summary:

Display Range is from 0 to 600 hours
Entire Range is from 0 to 3,358 hours
After 10,000 Trials, the Std. Error of the Mean is 2

Statistics:	Value
Trials	10000
Mean	64
Median	5
Mode	0
Standard Deviation	200
Variance	39,958
Skewness	7.24
Kurtosis	71.40
Coeff. of Variability	3.10
Range Minimum	0
Range Maximum	3,358
Range Width	3,358
Mean Std. Error	2.00



Forecast: AN-102 Transfer Delay (cont'd) **Cell: G7**

Percentiles:

Percentile	hours
0%	0
5%	0
10%	0
15%	0
20%	0
25%	0
30%	0
35%	0
40%	2
45%	3
50%	5
55%	8
60%	13
65%	29
70%	40
75%	52
80%	70
85%	93
90%	131
95%	257
100%	3,358

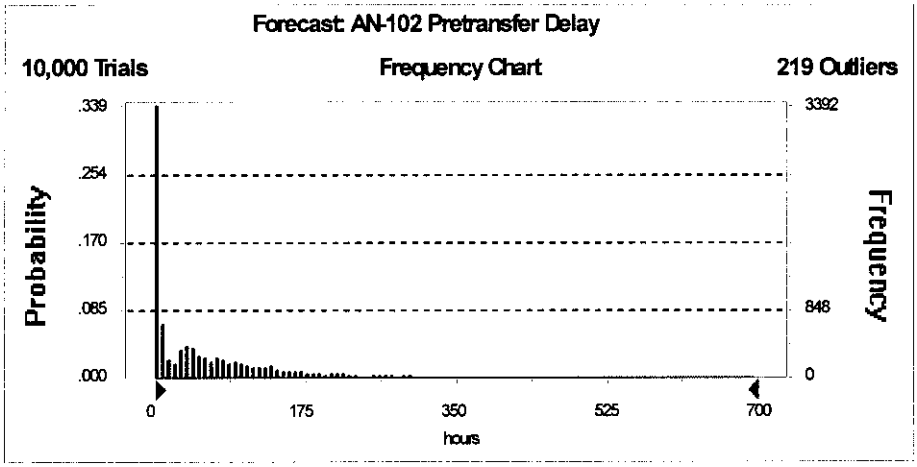
End of Forecast

Forecast: AN-102 Pretransfer Delay **Cell: G6**

Summary:

Display Range is from 0 to 700 hours
Entire Range is from 0 to 4,327 hours
After 10,000 Trials, the Std. Error of the Mean is 2

Statistics:	Value
Trials	10000
Mean	98
Median	37
Mode	0
Standard Deviation	224
Variance	50,269
Skewness	6.84
Kurtosis	70.64
Coeff. of Variability	2.29
Range Minimum	0
Range Maximum	4,327
Range Width	4,327
Mean Std. Error	2.24



Forecast: AN-102 Pretransfer Delay (cont'd) **Cell: G6**

Percentiles:

Percentile	hours
0%	0
5%	0
10%	0
15%	0
20%	1
25%	3
30%	5
35%	8
40%	13
45%	29
50%	37
55%	46
60%	58
65%	73
70%	88
75%	106
80%	131
85%	162
90%	214
95%	334
100%	4,327

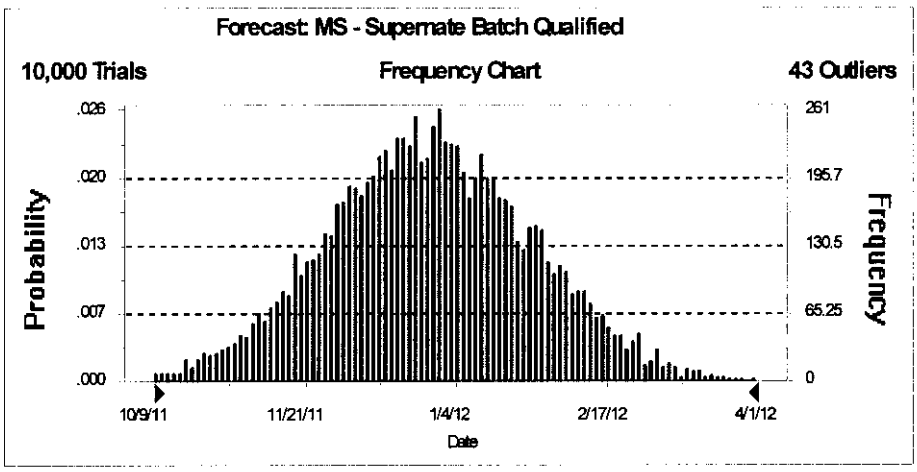
End of Forecast

Forecast: MS - Supernate Batch Qualified **Cell: G16**

Summary:

Display Range is from 10/9/11 to 4/1/12 Date
Entire Range is from 9/4/11 to 4/19/12 Date
After 10,000 Trials, the Std. Error of the Mean is 1/0/00

Statistics:	Value
Trials	10000
Mean	12/28/11
Median	12/27/11
Mode	---
Standard Deviation	30.09
Variance	905.31
Skewness	0.00
Kurtosis	2.96
Coeff. of Variability	0.00
Range Minimum	9/4/11
Range Maximum	4/19/12
Range Width	227.85
Mean Std. Error	0.30



Forecast: MS - Supernate Batch Qualified (cont'd) **Cell: G16**

Percentiles:

Percentile	Date
0%	9/4/11
5%	11/8/11
10%	11/19/11
15%	11/27/11
20%	12/2/11
25%	12/7/11
30%	12/12/11
35%	12/16/11
40%	12/20/11
45%	12/24/11
50%	12/27/11
55%	12/31/11
60%	1/4/12
65%	1/8/12
70%	1/12/12
75%	1/17/12
80%	1/22/12
85%	1/28/12
90%	2/5/12
95%	2/15/12
100%	4/19/12

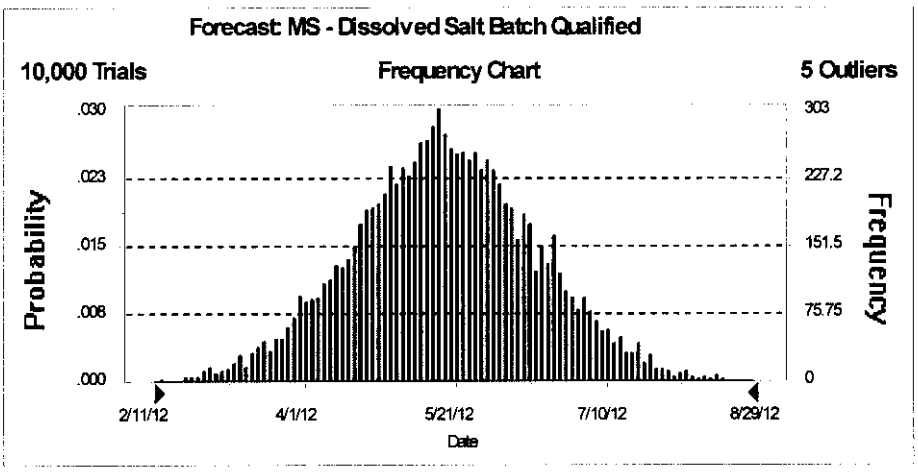
End of Forecast

Forecast: MS - Dissolved Salt Batch Qualified **Cell: G19**

Summary:

Display Range is from 2/11/12 to 8/29/12 Date
Entire Range is from 1/25/12 to 9/29/12 Date
After 10,000 Trials, the Std. Error of the Mean is 1/0/00

Statistics:	Value
Trials	10000
Mean	5/17/12
Median	5/17/12
Mode	---
Standard Deviation	30.27
Variance	916.27
Skewness	0.02
Kurtosis	2.98
Coeff. of Variability	0.00
Range Minimum	1/25/12
Range Maximum	9/29/12
Range Width	248.09
Mean Std. Error	0.30



Forecast: MS - Dissolved Salt Batch Qualified (cont'd) **Cell: G19**

Percentiles:

Percentile	Date
0%	1/25/12
5%	3/29/12
10%	4/8/12
15%	4/16/12
20%	4/22/12
25%	4/27/12
30%	5/2/12
35%	5/6/12
40%	5/10/12
45%	5/14/12
50%	5/17/12
55%	5/21/12
60%	5/25/12
65%	5/29/12
70%	6/2/12
75%	6/6/12
80%	6/12/12
85%	6/18/12
90%	6/25/12
95%	7/6/12
100%	9/29/12

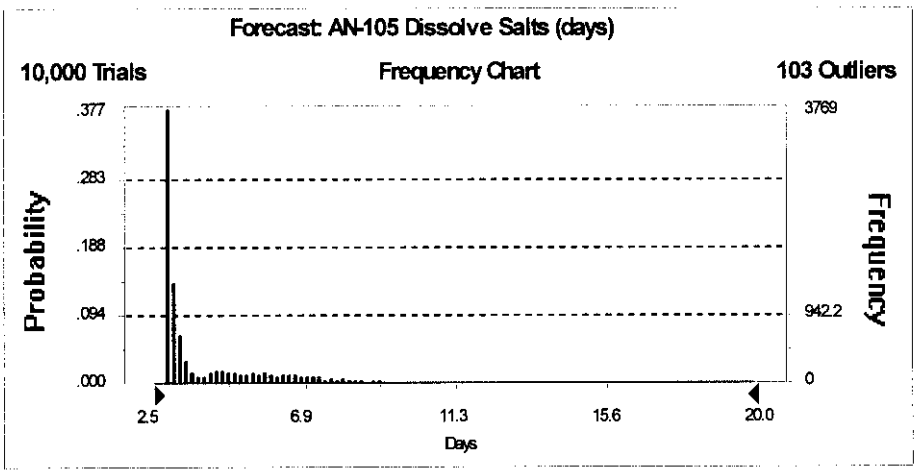
End of Forecast

Forecast: AN-105 Dissolve Salts (days) **Cell: F18**

Summary:

Display Range is from 2.5 to 20.0 Days
Entire Range is from 3.0 to 101.5 Days
After 10,000 Trials, the Std. Error of the Mean is 0.1

Statistics:	Value
Trials	10000
Mean	4.8
Median	3.2
Mode	3.0
Standard Deviation	5.7
Variance	32.7
Skewness	10.09
Kurtosis	130.69
Coeff. of Variability	1.18
Range Minimum	3.0
Range Maximum	101.5
Range Width	98.5
Mean Std. Error	0.06



Forecast: AN-105 Dissolve Salts (days) (cont'd) **Cell: F18**

Percentiles:

Percentile	Days
0%	3.0
5%	3.0
10%	3.0
15%	3.0
20%	3.0
25%	3.0
30%	3.0
35%	3.0
40%	3.1
45%	3.1
50%	3.2
55%	3.3
60%	3.5
65%	4.1
70%	4.6
75%	5.2
80%	5.9
85%	6.6
90%	7.5
95%	9.7
100%	101.5

End of Forecast

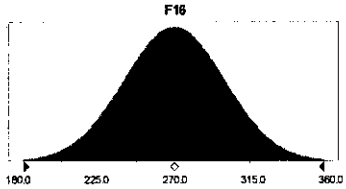
Assumptions

Assumption: F16 **Cell: F16**

Normal distribution with parameters:

Mean	270.0
Standard Dev.	30.0

Selected range is from -Infinity to +Infinity
Mean value in simulation was 270.1

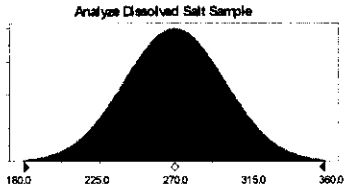


Assumption: Analyze Dissolved Salt Sample **Cell: F19**

Normal distribution with parameters:

Mean	270.0
Standard Dev.	30.0

Selected range is from -Infinity to +Infinity
Mean value in simulation was 269.8



End of Assumptions

Table G-1. Waste Flowsheet Volume Summary for Waste Transfer Activities from 241-AN-105 to the WTP

Activity	Volume (m3)	Volume (gal)	Time (hrs)	Inches of Waste	Comment	Reference
Starting Waste Volume in AN-105	4126	1,0189,965		382.4	Calculated expected volume after of existing waste after degassing 100 m3 of gas.	AN-105 Flowsheet
Supernate Decanted to AN-102	2266	598,609		210.0	Based on transfer pump position	AN-105 Flowsheet
In-line dilution during AN-105 to AN-102 Transfer	1265	334,175		117.3	AN-105 is too full for dilution prior to transfer	AN-105 Flowsheet
Total transfer to AN-102	3531	**932,784**	111	327.3		
Waste Volume in AN-105 After Decant	1860	491,356		172.4		
Diluent addition into AN-105	1489	393,349		138.0	Added to dissolve salts	
Total in AN-105 after dissolution of salts	3349	884,705		310.4		
Starting Waste Volume in AN-102	3711	980,335		344.0	Includes other inleakages and evaporation losses over the interim storage duration	
Transfer AN-102 to WTP	3573	**943,879**	112	331.2		AN-105 Flowsheet
Heel Remaining in AN-102 after transfer	138	36,455		12.8	Heel required to maintain minimum level allowed by pump NPSH requirements	
Starting Waste Volume in AN-105	3253	859,345		301.5	Includes other inleakages and evaporation losses over the interim storage duration	
Transfer AN-105 to WTP	3019	**797,529**	95	279.8		AN-105 Flowsheet
Heel Remaining in AP-104 after transfer	234	61,816		21.7	Heel required to maintain minimum level allowed by pump NPSH requirements	

Source: Orme, R.M., 1999, Waste Feed Delivery Technical Basis, HNF-1939-Vol. II, "Waste Feed Delivery Flowsheet for 241-AN-105" Appendix C, Rev.1, Numatec Hanford Corporation, Richland, Washington (Orme, 2000c)

Table G-2. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by System

System	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Total	**2.4**	**142.9**	**58.4**	**100%**	**100%**
Waste Transfer AN-105	2.8E-01	38.3	135.5	11.5%	26.8%
Waste Transfer Routes	3.1E-02	22.6	726.1	1.3%	15.8%
Primary HVAC	2.4E-01	20.3	84.9	9.8%	14.2%
Support/Utilities	2.6E-01	19.7	74.6	10.8%	13.8%
Annulus HVAC	1.3E-01	13.4	103.2	5.3%	9.3%
Diluent/Flush System	1.6E-01	10.4	63.7	6.7%	7.3%
External Events	1.2E+00	9.0	7.5	49.2%	6.3%
Confinement System	1.2E-01	6.9	55.9	5.1%	4.8%
Human Actions	8.5E-03	2.2	263.3	0.3%	1.6%

Table G-3. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay

System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
	Total	**2.4**	**142.9**	**58.4**	**100%**	**100%**
Waste Transfer AN-105	Transfer Pump	2.4E-01	30.9	129.2	9.8%	21.6%
Primary HVAC	Ventilation Tank Primary	2.4E-01	20.3	84.9	9.8%	14.2%
Support/Utilities	Compressed Air	2.6E-01	19.4	74.3	10.7%	13.6%
Annulus HVAC	Ventilation Tank Annulus	1.3E-01	13.4	103.2	5.3%	9.3%
Waste Transfer Route	Waste Transfer AN-105/AN-102	1.4E-02	11.0	776.1	0.6%	7.7%
Waste Transfer Route	Waste Transfer AN-105/Stage	1.4E-02	9.1	662.7	0.6%	6.4%
External Events	Weather	1.1E+00	7.4	6.6	46.3%	5.2%
Diluent/Flush System	Diluent/Flush Preparation	1.0E-01	6.5	63.3	4.2%	4.6%
Waste Transfer Route	Waste Transfer AN-105	2.7E-02	6.4	240.5	1.1%	4.5%
Confinement System	Primary Monitoring	9.9E-02	5.7	57.1	4.1%	4.0%
Diluent/Flush System	Diluent/Flush Delivery	5.2E-02	3.6	68.8	2.1%	2.5%
Waste Transfer Route	Waste Transfer AN-105/AN-102/Stage	3.3E-03	2.6	776.1	0.1%	1.8%
Human Actions	Transfer Pump	8.0E-03	2.0	255.3	0.3%	1.4%
External Events	Hanford	2.8E-02	1.2	43.7	1.1%	0.8%
Confinement System	Leak Detection Pit	1.6E-02	0.9	56.5	0.6%	0.6%
Waste Transfer AN-105	Process Monitoring	8.0E-03	0.7	82.8	0.3%	0.5%
Confinement System	Waste Tank AN-105	8.5E-03	0.3	39.2	0.3%	0.2%
Diluent/Flush System	Diluent/Flush Storage	8.4E-03	0.3	38.4	0.3%	0.2%

Table G-3. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by System and Major Element Contribution to Schedule Delay (Continued)

System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Support/Utilities	Electrical Distribution	2.9E-03	0.3	103.0	0.1%	0.2%
External Events	Electrical Distribution	4.2E-02	0.2	6.0	1.7%	0.2%
Waste Transfer AN-105	Electrical Feed to Waste Transfer System	7.5E-03	0.2	32.5	0.3%	0.2%
Human Actions	Waste Transfer Route	5.0E-04	0.2	391.6	0.02%	0.1%
External Events	Off Site	3.3E-03	0.1	24.0	0.1%	0.1%
Waste Transfer AN-105	Waste Transfer System	1.1E-03	0.0	35.6	0.04%	0.03%
Confinement System	Tank Structure	4.6E-05	0.0	154.7	0.002%	0.005%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
				Total	**2.4**	**142.9**	**58.4**	**100%**	**100%**
Annulus HVAC	Ventilation Tank Annulus	Air Inlet AN-105	Filter Bank	Filters	2.1E-03	0.2	76	8.4E-04	0.11%
Annulus HVAC	Ventilation Tank Annulus	Air Inlet AN-105	Isolation Valve	Isolation Valve	3.2E-04	0.0	155	1.3E-04	0.03%
Annulus HVAC	Ventilation Tank Annulus	Air Outlet AN-105	Isolation Valve	Isolation Valve	3.2E-04	0.0	155	1.3E-04	0.03%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train A	Exhaust Fan	Fan	9.9E-04	0.2	155	4.0E-04	0.11%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train A	Exhaust Fan	Instrumentation	4.8E-03	0.2	36	2.0E-03	0.12%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train A	Filter Bank	Instrumentation	6.0E-04	0.1	158	2.4E-04	0.07%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train B	Demister	Demister	5.5E-04	0.0	76	2.3E-04	0.03%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train B	Exhaust Fan	Fan	7.0E-03	1.1	155	2.8E-03	0.75%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train B	Exhaust Fan	Instrumentation	9.6E-03	0.4	45	3.9E-03	0.30%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Train B	Filter Bank	Filters	2.1E-03	0.2	76	8.4E-04	0.11%
Annulus HVAC	Ventilation Tank Annulus	Exhaust Trains A & B	Exhaust Trains Temperature Control	Exhaust Trains Temperature Control	2.1E-05	0.0	187	8.7E-06	0.003%

Table G-4. Critical Items for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	*Major Element*	*Subsystem 1*	*Subsystem 2*	*Super-component*	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	CAM	CAM	7.1E-02	6.9	97	2.9E-02	4.84%
Annulus HVAC	Ventilation Tank Annulus	Stack Monitoring	Record Sampling	Record Sampling	3.0E-02	4.1	136	1.2E-02	2.84%
Confinement System	Leak Detection Pit	Leak Detection	Transmitter Enclosure	Alarm	1.3E-02	0.5	36	5.4E-03	0.33%
Confinement System	Leak Detection Pit	Leak Detection	Transmitter Enclosure	Switch	6.6E-04	0.1	158	2.7E-04	0.07%
Confinement System	Leak Detection Pit	Leak Detection	Transmitter Enclosure	Valve	2.1E-03	0.3	158	8.5E-04	0.23%
Confinement System	Primary Monitoring	Tank Monitoring	Dome Pressure	Tank Pressure Monitoring	7.9E-02	4.7	59	3.2E-02	3.27%
Confinement System	Primary Monitoring	Tank Monitoring	Dome Pressure	Tank Pressure Monitoring System	3.8E-03	0.1	36	1.5E-03	0.09%
Confinement System	Primary Monitoring	Waste Monitoring	Waste Level	Waste Level Monitor	1.5E-02	0.7	43	6.2E-03	0.46%
Confinement System	Primary Monitoring	Waste Monitoring	Waste Temperature	Waste Temperature Monitoring System	1.4E-03	0.2	158	5.7E-04	0.15%
Confinement System	Tank Structure	Tank Structure	Tank Structure	Tank Structure	4.6E-05	0.0	155	1.9E-05	0.005%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Confinement System	Waste Tank AN-105	Annulus Instrumentation System	Flow Control	Valve	1.7E-04	0.0	163	7.1E-05	0.02%
Confinement System	Waste Tank AN-105	Annulus Instrumentation System	Radiation Monitoring	Alarm	8.3E-03	0.3	37	3.4E-03	0.21%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Delivery Line	Isolation Valves	1.5E-02	1.4	89	6.2E-03	0.95%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Delivery Line	Pipe	3.8E-04	0.0	90	1.6E-04	0.02%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Pump	Diluent/Flush Pump	9.2E-03	0.4	46	3.7E-03	0.30%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Pump	Sample Valve	2.6E-04	0.0	90	1.1E-04	0.02%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Diluent/Flush Tank Recirc Line	Diluent/Flush Tank Recirc Line	1.3E-02	1.2	89	5.5E-03	0.84%
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Discharge Flow	Discharge Flow Control	9.1E-04	0.0	38	3.7E-04	0.02%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Diluent/Flush System	Diluent/Flush Delivery	Diluent/Flush Storage to Transport Lines	Process Instrumentation	Process Instrumentation	1.3E-02	0.5	40	5.2E-03	0.35%
Diluent/Flush System	Diluent/Flush Preparation	Caustic Addition	Caustic Supply Truck to Storage Tank	Caustic Pump Enclosure	8.9E-03	0.5	59	3.6E-03	0.37%
Diluent/Flush System	Diluent/Flush Preparation	Caustic Addition	Caustic Supply Truck to Storage Tank	Process Line	3.8E-04	0.0	90	1.6E-04	0.02%
Diluent/Flush System	Diluent/Flush Preparation	Caustic/Hot Water Ratio Control	Caustic/Hot Water Ratio Control	Caustic/Hot Water Ratio Control	2.7E-02	1.7	63	1.1E-02	1.19%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Boiler	Boiler	1.7E-02	0.8	45	7.1E-03	0.55%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Boiler Blowdown Sump	Raw Water Feed Lines to Sump	3.1E-03	0.1	36	1.3E-03	0.08%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Enclosure Radiation Monitor	2.7E-03	0.3	109	1.1E-03	0.21%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Instrumentation	2.6E-03	0.4	158	1.1E-03	0.29%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Raw Water Supply Line	4.3E-04	0.0	90	1.8E-04	0.03%
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Self Cleaning Strainer	2.5E-02	1.2	48	1.0E-02	0.84%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	*Major Element*	*Subsystem 1*	*Subsystem 2*	*Super-component*	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Diluent/Flush System	Diluent/Flush Preparation	Hot Water for Caustic Addition	Raw Water Feed to Boiler	Valves	1.5E-02	1.4	89	6.2E-03	0.95%
Diluent/Flush System	Diluent/Flush Preparation	Safety Shower/Eyewash	Safety Shower Potable Water Feed	Water Heater	4.2E-04	0.0	90	1.7E-04	0.03%
Diluent/Flush System	Diluent/Flush Preparation	Safety Shower/Eyewash	Shower/Eyewash Flow	Drain Valve	3.1E-04	0.0	155	1.3E-04	0.03%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Diluent/Flush Analysis Instrumentation	Diluent/Flush Analysis Instrumentation	2.5E-03	0.1	37	1.0E-03	0.06%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Diluent/Flush Level Instruments	Diluent/Flush Level Instruments	1.9E-03	0.1	36	7.6E-04	0.05%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Diluent/Flush Temperature Control	Diluent/Flush Temperature Control	3.7E-03	0.1	37	1.5E-03	0.10%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Drain Valve	Drain Valve	2.6E-04	0.0	90	1.1E-04	0.02%
Diluent/Flush System	Diluent/Flush Storage	Diluent/Flush Tank	Tank Structure	Tank Structure	1.7E-05	0.0	90	7.1E-06	0.00%
External Events	Electrical Distribution	Electrical Distribution	Electrical Distribution	Electrical Distribution	4.2E-02	0.2	6	1.7E-02	0.17%
External Events	Hanford	Miscellaneous Events	Work Stoppage	Work Stoppage	2.1E-02	1.2	57	8.5E-03	0.82%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	*Major Element*	*Subsystem 1*	*Subsystem 2*	*Super-component*	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
External Events	Hanford	Non Tank Farm Human Error	Non Tank Farm Human Error	Non Tank Farm Human Error	6.9E-03	0.0	4	2.8E-03	0.02%
External Events	Off Site	Miscellaneous Events	Work Stoppage	Work Stoppage	3.3E-03	0.1	24	1.4E-03	0.06%
External Events	Weather	Lighting	Lighting	Lighting	2.6E-01	0.8	3	1.1E-01	0.54%
External Events	Weather	Precipitation	Precipitation	Precipitation	2.2E-01	1.7	8	8.8E-02	1.21%
External Events	Weather	Temperature	Temperature High	Temperature High	1.1E-01	0.8	7	4.4E-02	0.53%
External Events	Weather	Temperature	Temperature Low	Temperature Low	1.4E-01	1.1	8	5.7E-02	0.78%
External Events	Weather	Wind	Wind Gusts	Wind Gusts	4.1E-01	3.1	7	1.7E-01	2.15%
Human Actions	Transfer Pump	Transfer Pump	Transfer Pump	Transfer Pump	8.0E-03	2.0	255	3.3E-03	1.43%
Human Actions	Transfer Route	Transfer Route	Transfer Route	Transfer Route	5.0E-04	0.2	392	2.0E-04	0.14%
Primary HVAC	Ventilation Tank Primary	Air Inlet	HEPA Filter	Filter	2.6E-03	0.2	76	1.1E-03	0.14%
Primary HVAC	Ventilation Tank Primary	Air Inlet	Isolation Valve	Isolation Valve	2.1E-03	0.3	155	8.6E-04	0.23%
Primary HVAC	Ventilation Tank Primary	Condensate Collection	Seal Pot	Seal Pot 101	3.1E-05	0.0	155	1.3E-05	0.003%
Primary HVAC	Ventilation Tank Primary	Condensate Collection	Seal Pot	Seal Pot 102	3.1E-05	0.0	155	1.3E-05	0.003%
Primary HVAC	Ventilation Tank Primary	Continuous Air Monitor	Continuous Air Monitor	Radiation Detector	1.0E-01	6.5	63	4.2E-02	4.58%
Primary HVAC	Ventilation Tank Primary	Continuous Air Monitor	Continuous Air Monitor Flow Control	Radiation Detector	5.7E-02	7.3	127	2.3E-02	5.09%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Primary HVAC	Ventilation Tank Primary	Demister	Demister 1	Demister 1	9.0E-04	0.1	76	3.7E-04	0.05%
Primary HVAC	Ventilation Tank Primary	Demister	Demister 2	Demister 2	9.0E-04	0.1	76	3.7E-04	0.05%
Primary HVAC	Ventilation Tank Primary	Exhaust Ventilation	Exhaust Fans	Exhaust Fan Control	1.1E-02	0.5	41	4.7E-03	0.32%
Primary HVAC	Ventilation Tank Primary	Train A Exhaust	HEPA Filter	Line	5.7E-04	0.0	76	2.3E-04	0.03%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	Exhaust Fan	Exhaust Fan 2	1.5E-02	2.2	155	5.9E-03	1.57%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Damper	1.4E-03	0.1	76	5.8E-04	0.08%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Exhaust Filter	5.1E-03	0.4	76	2.1E-03	0.28%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Filter	2.6E-03	0.2	76	1.1E-03	0.14%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Pressure Monitoring	3.0E-02	1.5	49	1.2E-02	1.03%
Primary HVAC	Ventilation Tank Primary	Train B Exhaust	HEPA Filter	Valve	5.8E-03	0.9	155	2.4E-03	0.63%
Support/Utilities	Compressed Air	Instrument Air	Air Dryer	Electrical Feed	3.0E-04	0.0	48	1.2E-04	0.01%
Support/Utilities	Compressed Air	Service Air	Compressor	Aftercooler	6.4E-04	0.1	90	2.6E-04	0.04%
Support/Utilities	Compressed Air	Service Air	Compressor	Air Filter and Intake	4.9E-03	0.2	40	2.0E-03	0.14%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Support/Utilities	Compressed Air	Service Air	Compressor	Compressor	2.8E-02	2.1	75	1.2E-02	1.50%
Support/Utilities	Compressed Air	Service Air	Compressor	Drain	7.7E-03	0.4	48	3.2E-03	0.26%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Coolant Pump #1 Electrical Feed	3.0E-04	0.0	48	1.2E-04	0.01%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Coolant Pump #2 Electrical Feed	3.0E-04	0.0	48	1.2E-04	0.01%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Cooling Fan #1 Electrical Feed	3.0E-04	0.0	48	1.2E-04	0.01%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Cooling Fan #2 Electrical Feed	3.0E-04	0.0	48	1.2E-04	0.01%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Cooling Fans	2.4E-02	2.2	90	1.0E-02	1.53%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Electrical Feed	1.8E-04	0.0	3	7.3E-05	0.0004%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Heat Exchanger	9.9E-04	0.1	90	4.0E-04	0.06%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Holding Tank	3.3E-03	0.3	89	1.4E-03	0.21%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Inline Instrumentation	6.6E-04	0.1	90	2.7E-04	0.04%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Inline Valves	2.6E-03	0.2	90	1.1E-03	0.16%
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Pump Train A	5.8E-05	0.0	90	2.4E-05	0.00%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Support/Utilities	Compressed Air	Service Air	Glycol Cooling System	Pump Train B	8.2E-02	7.1	87	3.3E-02	5.00%
Support/Utilities	Compressed Air	Service Air	Holding Tank	Drain	1.4E-03	0.1	90	5.7E-04	0.09%
Support/Utilities	Compressed Air	Service Air	Holding Tank	Holding Tank	1.3E-03	0.1	90	5.5E-04	0.08%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Accumulator	8.3E-03	0.5	65	3.4E-03	0.38%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Air Dryer	4.5E-02	2.1	46	1.8E-02	1.44%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Air Dryer Isolation Valves	2.0E-03	0.2	90	8.0E-04	0.12%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	In-Tank Instrument Air Supply	2.1E-02	2.4	112	8.7E-03	1.68%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Post Air Dryer Filter	1.2E-02	0.5	45	4.9E-03	0.38%
Support/Utilities	Compressed Air	Service Air	In-Tank Instrument Air Supply	Pre Air Dryer Filter	7.5E-03	0.4	47	3.1E-03	0.24%
Support/Utilities	Compressed Air	Service Air	Service Air Compressor	Electrical Feed	3.0E-04	0.0	48	1.2E-04	0.010%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	*Major Element*	*Subsystem 1*	*Subsystem 2*	*Super-component*	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Support/Utilities	Compressed Air	Service Air	Service Air Supply	Service Air Supply	5.0E-03	0.2	49	2.1E-03	0.17%
Support/Utilities	Electrical Distribution	Change Trailer	Distribution Panelboard	Distribution Panelboard	1.0E-03	0.1	90	4.1E-04	0.06%
Support/Utilities	Electrical Distribution	Compressor Building Distribution	Electrical Feed	Electrical Feed	2.9E-04	0.0	7	1.2E-04	0.001%
Support/Utilities	Electrical Distribution	Distribution Panel 103	Distribution Panel 105	Distribution Panelboard	4.5E-04	0.1	187	1.8E-04	0.06%
Support/Utilities	Electrical Distribution	Distribution Panel 103	Electrical Feed	Electrical Feed	1.1E-04	0.0	14	4.5E-05	0.001%
Support/Utilities	Electrical Distribution	Distribution Panel 109	Electrical Feed	Electrical Feed	2.2E-04	0.0	24	9.0E-05	0.004%
Support/Utilities	Electrical Distribution	Motor Control Center 001	Electrical Feed	Electrical Feed	2.4E-04	0.0	110	1.0E-04	0.02%
Support/Utilities	Electrical Distribution	Motor Control Center 002	Electrical Feed	Electrical Feed	1.1E-04	0.0	14	4.5E-05	0.001%
Support/Utilities	Electrical Distribution	Station Service Equipment	Distribution Panelboard	Distribution Panelboard	4.5E-04	0.1	187	1.8E-04	0.06%
Waste Transfer AN-105	Electrical Feed to Waste Transfer System	Electrical Feed to Waste Transfer System	Electrical Feed to Waste Transfer System	Power Monitoring	7.5E-03	0.2	32	3.1E-03	0.17%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer AN-105	Process Monitoring	Waste Monitoring	Waste Density	Waste Characteristics Monitor	2.2E-03	0.1	36	8.8E-04	0.05%
Waste Transfer AN-105	Process Monitoring	Waste Monitoring	Waste Flow	Waste Characteristics Monitor	2.2E-03	0.1	36	8.8E-04	0.05%
Waste Transfer AN-105	Process Monitoring	Waste Monitoring	Waste Monitoring	Waste Characteristics Monitor	1.5E-03	0.4	285	6.1E-04	0.30%
Waste Transfer AN-105	Process Monitoring	Waste Monitoring	Waste Temperature	Waste Characteristics Monitor	2.2E-03	0.1	36	8.8E-04	0.05%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Flexible Suction	Cable Winch	1.1E-03	0.8	776	4.4E-04	0.58%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Flexible Suction	Cable Winch Instrumentation	4.3E-03	1.4	314	1.8E-03	0.94%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Nitrogen Feed	Nitrogen Supply Instrumentation	2.0E-02	1.3	64	8.3E-03	0.91%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Nitrogen Feed	Nitrogen Supply Line	3.6E-03	0.8	215	1.5E-03	0.54%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Nitrogen Feed	Purge Seal Gas	2.8E-03	0.4	155	1.1E-03	0.302%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Pump Instrumentation	Manual Transfer Switch	2.2E-03	0.1	36	8.8E-04	0.05%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Pump Instrumentation	Motor Temperature Monitor	2.4E-03	0.2	86	9.7E-04	0.14%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Pump Instrumentation	Pump Control	1.4E-02	0.5	38	5.7E-03	0.37%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Pump, Transfer	Cable Winch	2.2E-02	3.4	155	8.9E-03	2.35%
Waste Transfer AN-105	Transfer Pump	Transfer Pump	Pump, Transfer	Pump	1.7E-01	22.1	132	6.8E-02	15.44%
Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumper	6.8E-04	0.5	776	2.8E-04	0.37%
Waste Transfer AN-105	Transfer Route	Piping	Piping	Jumpers	2.3E-04	0.2	776	9.3E-05	0.12%
Waste Transfer AN-105	Transfer Route	Piping	Piping	Nozzle	2.1E-04	0.2	776	8.4E-05	0.11%
Waste Transfer AN-105	Transfer Route	Route Monitoring	Line Flow Monitoring	Flow Element	5.7E-03	0.6	103	2.3E-03	0.41%
Waste Transfer AN-105	Transfer Route	Route Monitoring	Line Pressure Monitoring	Pressure Monitor	5.2E-03	0.3	63	2.1E-03	0.23%
Waste Transfer AN-105	Transfer Route	Route Monitoring	Line Pressure Monitoring	Pressure Relief Valve	3.4E-04	0.1	155	1.4E-04	0.037%
Waste Transfer AN-105	Transfer Route	Route Monitoring	Pit Leak Detection	Pit Leak Detector	1.4E-02	4.3	307	5.8E-03	3.033%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer AN-105	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	3.4E-04	0.3	776	1.4E-04	0.19%
Waste Transfer AN-105	Waste Transfer System	Transfer System Control	Transfer System Control	Interlock	1.1E-03	0.0	36	4.4E-04	0.027%
Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Jumper	2.3E-04	0.2	776	9.3E-05	0.12%
Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Nozzle	3.4E-05	0.0	776	1.4E-05	0.019%
Waste Transfer AN-105/AN-102	Transfer Route	Piping	Piping	Transfer Line	2.3E-03	1.8	776	9.3E-04	1.233%
Waste Transfer AN-105/AN-102	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	1.2E-02	9.0	776	4.7E-03	6.29%
Waste Transfer AN-105/AN-102/Stage	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	3.3E-03	2.6	776	1.4E-03	1.80%
Waste Transfer AN-105/Stage	Transfer Route	Piping	Piping	Jumper	7.2E-04	0.6	776	2.9E-04	0.39%
Waste Transfer AN-105/Stage	Transfer Route	Piping	Piping	Nozzle	1.7E-04	0.1	776	7.0E-05	0.09%
Waste Transfer AN-105/Stage	Transfer Route	Piping	Piping	Transfer Line	1.4E-03	1.1	776	5.6E-04	0.75%
Waste Transfer AN-105/Stage	Transfer Route	Route Monitoring	Line Pressure Monitoring	Pressure Instrument Isolation Valves	1.4E-03	0.2	155	5.7E-04	0.15%

Table G-4. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Alphabetically Sorted by System Breakdown Structure (Continued)

System	Major Element	Subsystem 1	Subsystem 2	Super-component	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Waste Transfer AN-105/Stage	Transfer Route	Route Monitoring	Line Pressure Monitoring	Pressure Monitoring	4.3E-04	0.1	158	1.8E-04	0.05%
Waste Transfer AN-105/Stage	Transfer Route	Transfer Valving	In-line Valving	Waste Transfer Valve	9.0E-03	7.0	776	3.7E-03	4.87%
Waste Transfer AN-105/Stage	Transfer Route	Transfer Valving	Line Pressure Monitoring	Pressure Instrument Isolation Valves	6.9E-04	0.1	155	2.8E-04	0.07%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
					Total	**2.4**	**142.9**	**58.4**	**100%**	**100%**
AN05A-WT-P-022	WTP	Transfer Pump	AN-05A Central Pump Pit	Waste Transfer AN-105	Transfer Pump	1.7E-01	22.1	132.0	6.83%	15.44%
AN296-VTP-P-514	P	Pump	AN296-VTP-ENCL-500	Primary HVAC	Ventilation Tank Primary	4.4E-02	6.8	154.7	1.80%	4.76%
AN273-GLY-P-002	P	Pump	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	7.6E-02	6.8	89.6	3.09%	4.74%
AN05A-WT-Electric Clutch	CLUTCH	Transfer Pump Electric Clutch	Tank AN-105	Waste Transfer AN-105	Transfer Pump	2.2E-02	3.4	154.7	0.89%	2.35%
AN296-VTA-P-924	P	Pump	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	2.0E-02	3.1	154.7	0.81%	2.16%
AN296-VTA-P-914	P	Pump	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	2.0E-02	3.1	154.7	0.81%	2.16%
AN296-VTP-RAH-510A	RAH	Radiation Alarm High	Pri Exh Stack Instr Encl AN296-VTP-ENCL-500 Local Alarm Box	Primary HVAC	Ventilation Tank Primary	1.5E-02	2.5	163.5	0.63%	1.76%
AN241-VTP-EF-002	EF	Exhaust Fan	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.3E-02	2.0	154.7	0.54%	1.43%
EXTWIND06	EXT	Wind Gusts 6 hr Delay	EXT	External Events	Weather	3.3E-01	2.0	6.0	13.45%	1.38%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
HATRANSF014	HUMAN	Startup Transfer Pump	HUMAN	Human Actions	Transfer Pump	5.0E-03	2.0	391.6	0.20%	1.37%
AN273-SA-CMP-001	CMP	Compressor	AN Farm	Support/Utilities	Compressed Air	2.0E-02	1.8	89.6	0.83%	1.27%
EXTPRECIP	EXT	Precipitation Caused Delays	EXT	External Events	Weather	2.2E-01	1.7	8.0	8.79%	1.21%
AN296-VTA-RAH-910A	RAH	Radiation Alarm High	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	Annulus HVAC	Ventilation Tank Annulus	1.0E-02	1.7	163.5	0.42%	1.19%
ANVPA-WT-V-319	V	3-Way Ball Valve	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
AZNEW-WT-V-221	V	2-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
ANVPB-WT-V-215	V	2-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
AZNEW-WT-V-227	V	3-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
ANVPB-WT-V-217	V	2-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/AN-102/Stage	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
ANVPB-WT-V-218	V	3-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
ANVPB-WT-V-219	V	2-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPB-WT-V-214	V	3-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
ANVPB-WT-V-216	V	3-Way Ball Valve	AN-B Valve Pit	Waste Transfer AN-105/AN-102/Stage	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
AZNEW-WT-V-226	V	3-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
ANVPA-WT-V-320	V	2-Way Ball Valve	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
AZNEW-WT-V-228	V	3-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
ANVPA-WT-V-317	V	2-Way Ball Valve	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
AZNEW-WT-V-224	V	2-Way Ball Valve	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	1.7E-03	1.3	776.1	0.07%	0.90%
ANVPA-WT-LDE-331	LDE	AN-A Valve Pit Leak Detector Element	AN-A Valve Pit	Waste Transfer AN-105	Transfer Route	2.2E-03	1.3	592.4	0.09%	0.89%
AN05A-WT-ZE-158	ZE	Position Element	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Pump	2.2E-03	1.3	592.4	0.09%	0.89%
AN05A-WT-LDE-137	LDE	Leak Detector Element	AN-05A Central Pump Pit	Waste Transfer AN-105	Transfer Route	2.2E-03	1.3	592.4	0.09%	0.89%
ANVPB-WT-LDE-231	LDE	AN-B Valve Pit Leak Detector Element	AN-B Valve Pit	Waste Transfer AN-105	Transfer Route	2.2E-03	1.3	592.4	0.09%	0.89%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-RW-MOV-107	MOV	Motor Operated Ball Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.4E-02	1.2	89.3	0.55%	0.85%
AN241-CHEMB-V-109	V	Automatic Recirculating Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	1.3E-02	1.2	89.4	0.55%	0.84%
AN241-CHEMB-MOV-135	MOV	3-Way Motor Operated Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	1.3E-02	1.2	89.4	0.55%	0.84%
AN241-CHEMB-MOV-117	MOV	2-Way Motor Operated Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	1.3E-02	1.2	89.4	0.55%	0.84%
EXTLONG	EXT	Hanford Site work stoppage, long	EXT	External Events	Hanford	4.6E-03	1.1	242.0	0.19%	0.78%
AN273-GLY-F-004	F	Heat Exchanger Fan	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	1.2E-02	1.1	89.6	0.50%	0.77%
AN273-GLY-F-003	F	Heat Exchanger Fan	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	1.2E-02	1.1	89.6	0.50%	0.77%
AN296-VTP-XA-510A	XA	Failure Alarm	Pri Exh Stack Instr Encl AN296-VTP-ENCL-500 Local Alarm Box	Primary HVAC	Ventilation Tank Primary	1.4E-02	0.9	67.8	0.56%	0.65%
AN241-VTA-EF-004	EF	Exhaust Fan	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	6.0E-03	0.9	154.7	0.24%	0.65%
EXTWIND12	EXT	Wind Gusts 12 hr Delay	EXT	External Events	Weather	7.1E-02	0.9	12.0	2.92%	0.60%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05A-WT-M-158	M	Pump Suction Motor	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Pump	1.1E-03	0.8	776.1	0.04%	0.58%
EXTLIGHT	EXT	Lightning Within 30 Miles	EXT	External Events	Weather	2.6E-01	0.8	3.0	10.57%	0.54%
AN05C-WST-PI-125	PI	Pressure Indicator	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	4.4E-03	0.7	157.7	0.18%	0.48%
AN05C-IA-PI-115	PI	Pressure Indicator	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	4.4E-03	0.7	157.7	0.18%	0.48%
AN05C-WSTA-PI-115	PI	Pressure Indicator	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	4.4E-03	0.7	157.7	0.18%	0.48%
EXTLTEMP06	EXT	Temperature Low 6 hr Delay	EXT	External Events	Weather	1.0E-01	0.6	6.0	4.24%	0.44%
AN296-VTP-FAL-512A	FAL	Flow Alarm Low	Pri Exh Stack Instr Encl AN296-VTP-ENCL-500 Local Alarm Box	Primary HVAC	Ventilation Tank Primary	8.8E-03	0.6	67.8	0.36%	0.42%
AN296-VTA-XA-910A	XA	Failure Alarm	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	Annulus HVAC	Ventilation Tank Annulus	8.7E-03	0.6	67.8	0.36%	0.41%
EXTHTEMP06	EXT	Temperature High 6 hr Delay	EXT	External Events	Weather	9.5E-02	0.6	6.0	3.88%	0.40%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPA-WT-SN-261-M25	PIPE	Valve Pit Discharge Pipe Segment	AN-A Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	6.9E-04	0.5	776.1	0.03%	0.37%
ANVPA-WT-SN-265-M25	PIPE	Valve Pit Discharge Pipe Segment	AN-05A Pump Pit to AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	6.9E-04	0.5	776.1	0.03%	0.37%
ANVPA-WT-SN-268-M25	PIPE	Valve Pit Discharge Pipe Segment	AN-A Valve Pit to AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	6.9E-04	0.5	776.1	0.03%	0.37%
ANVPA-WT-SN-630-M25	PIPE	Valve Pit Discharge Pipe Segment	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	6.9E-04	0.5	776.1	0.03%	0.37%
ANVPA-WT-SN-634-M25	PIPE	Valve Pit Discharge Pipe Segment	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	6.9E-04	0.5	776.1	0.03%	0.37%
AN271-VTP-XA-510	RAL	Radiation Alarm Low	AN Farm	Primary HVAC	Ventilation Tank Primary	1.3E-02	0.5	38.7	0.54%	0.36%
AN05A-WT-LDSTA-137	LDSTA	Leak Detector Station	Tank AN-105	Waste Transfer AN-105	Transfer Route	7.5E-03	0.5	67.8	0.31%	0.36%
AN271-VTP-RAH-510	RAH	Radiation Alarm High	AN Farm	Primary HVAC	Ventilation Tank Primary	1.3E-02	0.5	36.6	0.54%	0.34%
AN242A-VTP-RSH-AN-K1	RAH	Radiation Alarm High	AN Farm	Primary HVAC	Ventilation Tank Primary	1.3E-02	0.5	36.6	0.54%	0.34%
AN271-WSTA-LDA-155	LDA	Leak Detected Alarm	Instr Bldg 241-AN-271	Confinement System	Leak Detection Pit	1.3E-02	0.5	35.6	0.54%	0.33%
AN2750E-WST-CASS-C-1267	CASS	Computer Automated Surveillance Station	Bldg 2750E	Confinement System	Primary Monitoring	1.1E-02	0.5	40.2	0.46%	0.32%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN2750E-VTP-CASS-C-1365	CASS	Computer Automated Surveillance Station	AN Farm	Primary HVAC	Ventilation Tank Primary	1.1E-02	0.5	40.2	0.46%	0.32%
AN241-VTP-CASS-C-1323	CASS	Computer Automated Surveillance Station	Bldg 2750E	Primary HVAC	Ventilation Tank Primary	1.1E-02	0.5	40.2	0.46%	0.32%
AN2750E-WST-CASS-C-1270	CASS	Computer Automated Surveillance Station	Bldg 2750E	Confinement System	Primary Monitoring	1.1E-02	0.5	40.2	0.46%	0.32%
AN273-IA-CP-101	CP	Air Dryer Control Panel	AN Farm	Support/Utilities	Compressed Air	1.1E-02	0.4	38.7	0.46%	0.31%
AN242A-VTP-RXS-AN-K1	XA	Failure Alarm	AN Farm	Primary HVAC	Ventilation Tank Primary	1.3E-02	0.4	32.6	0.53%	0.30%
AN271-WST-LAH-135	LAH	Level Alarm High	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	1.3E-02	0.4	32.6	0.53%	0.30%
AN242A-VTP-PSH-ANK11	XA	Failure Alarm	AN Farm	Primary HVAC	Ventilation Tank Primary	1.3E-02	0.4	32.6	0.53%	0.30%
AN271-VTP-PDAH-407	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AN-271	Primary HVAC	Ventilation Tank Primary	1.3E-02	0.4	32.6	0.53%	0.30%
AN271-VTP-PDAH-408	PDAH	Pressure Differential Alarm High	Instr Bldg 241-AN-271	Primary HVAC	Ventilation Tank Primary	1.3E-02	0.4	32.6	0.53%	0.30%
AN271-WST-PAH-115	PAH	Pressure Alarm High	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	1.3E-02	0.4	32.6	0.53%	0.30%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN271-WST-PAL-115	PAL	Pressure Alarm Low	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	1.3E-02	0.4	32.6	0.53%	0.30%
AN271-WST-PR-115	PR	Pressure Recorder	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	1.1E-02	0.4	35.6	0.46%	0.28%
AN05A-WT-UE-153	UE	Multivariable Element	AN-05A Central Pump Pit	Waste Transfer AN-105	Process Monitoring	6.5E-04	0.4	592.4	0.03%	0.27%
AN05A-WT-FE-155	FE	Flow Element	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	6.5E-04	0.4	592.4	0.03%	0.27%
AN05A-WT-V-107	V	2-Way Ball Valve	Tank AN-105	Waste Transfer AN-105	Transfer Pump	2.4E-03	0.4	154.7	0.10%	0.26%
EXTLTEMP12	EXT	Temperature Low 12 hr Delay	EXT	External Events	Weather	3.1E-02	0.4	12.0	1.26%	0.26%
AN296-VTA-FAL-912A	FAL	Flow Alarm Low	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	Annulus HVAC	Ventilation Tank Annulus	5.4E-03	0.4	67.8	0.22%	0.26%
AN296-VTA-FAL-922A	FAL	Flow Alarm Low	Annulus Exh Stack CAM Encl AN296-VTA-ENCL-900 Local Alarm box	Annulus HVAC	Ventilation Tank Annulus	5.4E-03	0.4	67.8	0.22%	0.26%
AN05A-WT-PI-161	PI	Pressure Indicator	Tank AN-105	Waste Transfer AN-105	Transfer Pump	2.2E-03	0.3	157.7	0.09%	0.24%
AN05A-WT-FI-160	FI	Flow Indicator	Tank AN-105	Waste Transfer AN-105	Transfer Pump	2.2E-03	0.3	157.7	0.09%	0.24%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN296-VTA-FI-920	FI	Flow Indicator	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	2.0E-03	0.3	157.7	0.08%	0.22%
AN241-RW-FQI-101	FQI	Flow Totalizer Indicator	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	2.0E-03	0.3	157.7	0.08%	0.22%
AN271-WSTA-RAH-105	RAH	Radiation Alarm High	Evaporator Bldg 242-A	Confinement System	Waste Tank AN-105	8.3E-03	0.3	36.6	0.34%	0.21%
AN271-VTA-RAH-910	RAH	Radiation Alarm High	Instr Bldg 241-AN-271	Annulus HVAC	Ventilation Tank Annulus	8.2E-03	0.3	36.6	0.33%	0.21%
AZ156-RW-YL-108	YL	Event/State Light	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	8.3E-03	0.3	35.6	0.34%	0.21%
AN242A-VTA-CASS-C-1364	CASS	Computer Automated Surveillance Station	Bldg 2750E	Annulus HVAC	Ventilation Tank Annulus	7.1E-03	0.3	40.2	0.29%	0.20%
ANVPA-WT-MOV-316	MOV	3-Way Ball Valve	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	3.5E-04	0.3	776.1	0.01%	0.19%
AN05A-WT-V-217	V	Check Valve	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Pump	3.5E-04	0.3	776.1	0.01%	0.19%
ANVPA-WT-MOV-318	MOV	3-Way Ball Valve	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	3.5E-04	0.3	776.1	0.01%	0.19%
AZ156-RW-PDAH-103	PDAH	Pressure Differential Alarm High	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	8.2E-03	0.3	32.6	0.34%	0.19%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AZ156-WT-LDA-159	LDA	Leak Detected Alarm	Bldg AZ-156	Waste Transfer AN-105	Transfer Pump	7.5E-03	0.3	35.6	0.31%	0.19%
AN05A-WT-MOV-608	MOV	3-Way Ball Valve	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	3.4E-04	0.3	776.1	0.01%	0.19%
AN271-VTA-XA-910	XA	Failure Alarm	Instr Bldg 241-AN-271	Annulus HVAC	Ventilation Tank Annulus	8.1E-03	0.3	32.6	0.33%	0.18%
AZ156-WT-VFD-122	VFD	Variable Frequency Drive	Bldg AZ-156	Waste Transfer AN-105	Transfer Pump	6.5E-03	0.3	40.2	0.26%	0.18%
EXTLOSP	EXT	Loss of Power to Tank Farms	EXT	External Events	Electrical Distribution	4.2E-02	0.2	6.0	1.70%	0.17%
AN241-RW-RIAS-126	RIAS	Radiation Indicating Alarm Switch	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	1.5E-03	0.2	163.5	0.06%	0.17%
AZ156-WT-FAH-160	FAH	Flow Alarm High	Bldg AZ-156	Waste Transfer AN-105	Transfer Pump	7.5E-03	0.2	32.5	0.31%	0.17%
AZ156-WT-PAL-161	PAL	Pressure Alarm Low	Bldg AZ-156	Waste Transfer AN-105	Transfer Pump	7.5E-03	0.2	32.5	0.31%	0.17%
AZ156-WT-XXA-101	XA	Failure Alarm	Bldg AZ-156	Waste Transfer AN-105	Electrical Feed to Waste Transfer System	7.5E-03	0.2	32.5	0.31%	0.17%
EXTWIND24	EXT	Wind Gusts 24 hr Delay	EXT	External Events	Weather	1.0E-02	0.2	24.0	0.41%	0.17%
AN273-IA-ACC-001	ACC	Accumulator	AN Farm	Support/Utilities	Compressed Air	2.6E-03	0.2	89.6	0.11%	0.16%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN105-WST-TI-XX	TI	Temperature Indicator	Tank AN-105	Confinement System	Primary Monitoring	1.4E-03	0.2	157.7	0.06%	0.15%
AN05A-WT-F-101	FLT	Filter	Tank AN-105	Waste Transfer AN-105	Transfer Pump	1.4E-03	0.2	154.7	0.06%	0.15%
AN241-VTP-PDIS-407	PDIS	Pressure Differential Indicating Switch (High/Low)	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.3E-03	0.2	157.7	0.05%	0.14%
AN241-VTP-PDS-410	PDS	Pressure Differential Switch	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.3E-03	0.2	157.7	0.05%	0.14%
AN241-VTP-PDIS-409	PDIS	Pressure Differential Indicating Switch (High/Low)	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.3E-03	0.2	157.7	0.05%	0.14%
AN241-VTP-PDIS-408	PDIS	Pressure Differential Indicating Switch (High/Low)	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.3E-03	0.2	157.7	0.05%	0.14%
AN105-VTP-FLT-210	FLT	HEPA Filter	Tank AN-105	Primary HVAC	Ventilation Tank Primary	2.6E-03	0.2	76.5	0.11%	0.14%
AN241-VTP-FLT-402	FLT	HEPA Filter	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	2.6E-03	0.2	76.5	0.11%	0.14%
AN241-VTP-FLT-401	FLT	Pre-Filter	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	2.6E-03	0.2	76.5	0.11%	0.14%
AN241-VTP-FLT-403	FLT	HEPA Filter	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	2.6E-03	0.2	76.5	0.11%	0.14%
HAVLVEPC001	HUMAN	Align Transfer Valving	HUMAN	Human Actions	Transfer Route	5.0E-04	0.2	391.6	0.02%	0.14%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05A-WT-(6,7&8)	JMP	AN-05A Valve Pit Jumper Assembly	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	2.3E-04	0.2	776.1	0.01%	0.12%
ANVPA-WT-L19-(E&F)	JMP	AN-A Valve Pit Jumper Assembly	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	2.3E-04	0.2	776.1	0.01%	0.12%
AN05A-WT-(5&6)	JMP	AN-05A Valve Pit Jumper Assembly	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	2.3E-04	0.2	776.1	0.01%	0.12%
ANVPB-WT-R16,R15,R14(F)	JMP	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	2.3E-04	0.2	776.1	0.01%	0.12%
ANVPB-WT-R19-(D&F)	JMP	AN-A Valve Pit Jumper Assembly	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	2.3E-04	0.2	776.1	0.01%	0.12%
ANVPA-WT-L14-L15-L16-(E)	JMP	AN-A Valve Pit Jumper Assembly	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	2.3E-04	0.2	776.1	0.01%	0.12%
AN05A-WT-A(8)	JMP	AN-05A Pump Pit Jumper Assembly	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	2.3E-04	0.2	776.1	0.01%	0.12%
AN05A-WT-(1,4&5)	JMP	AN-05A Pump Pit Jumper Assembly	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	2.3E-04	0.2	776.1	0.01%	0.12%
AZ156-CHEMB-YA-101	YA	Event/State Alarm	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.8E-03	0.2	35.6	0.20%	0.12%
AZ156-CHEMB-YL-101	YL	Event/State Alarm Low	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.8E-03	0.2	35.6	0.20%	0.12%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-VTA-PDAL-810	PDAL	Pressure Differential Alarm Low	Instr Bldg 241-AN-271	Annulus HVAC	Ventilation Tank Annulus	4.8E-03	0.2	35.6	0.20%	0.12%
AN241-VTA-PDAL-710	PDAL	Pressure Differential Alarm Low	Instr Bldg 241-AN-271	Annulus HVAC	Ventilation Tank Annulus	4.8E-03	0.2	35.6	0.20%	0.12%
AZ156-CHEMB-YL-130	YL	Event/State Alarm Low	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	4.8E-03	0.2	35.6	0.20%	0.12%
AZ156-CHEMB-FC-118	FC	Flow Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.2E-03	0.2	40.2	0.17%	0.12%
AN241-VTA-CASS-C-1325	CASS	Computer Automated Surveillance Station	Bldg 2750E	Annulus HVAC	Ventilation Tank Annulus	4.2E-03	0.2	40.2	0.17%	0.12%
AZ156-CHEMB-FIC-101	FIC	Flow Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.2E-03	0.2	40.2	0.17%	0.12%
AZ156-CHEMB-FQIC-130	FQIC	Flow Totalizer Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	4.2E-03	0.2	40.2	0.17%	0.12%
AZ156-CHEMB-FIC-130	FIC	Flow Indicating Controller	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	4.2E-03	0.2	40.2	0.17%	0.12%
AZ156-CHEMB-XA-100	XA	Failure Alarm	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.8E-03	0.2	32.7	0.19%	0.11%
AZ156-CHEMB-LAHH-126	LAHH	Level Alarm High High	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.8E-03	0.2	32.7	0.19%	0.11%
AN241-RW-STR-101	STR	Strainer	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.7E-03	0.2	89.6	0.07%	0.11%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-VTA-M-003	M	Exhaust Fan Motor	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	9.9E-04	0.2	154.7	0.04%	0.11%
AN241-VTA-M-004	M	Exhaust Fan Motor	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	9.9E-04	0.2	154.7	0.04%	0.11%
AN296-VTP-CAM-510	CAM	Continuous Air Monitor	AN296-VTP-ENCL-500	Primary HVAC	Ventilation Tank Primary	2.0E-03	0.1	74.3	0.08%	0.10%
AN241-CHEMB-V-113	V	2-Way Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	1.6E-03	0.1	89.6	0.06%	0.10%
AN241-CHEMB-V-100	V	Coupling Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	1.6E-03	0.1	89.6	0.06%	0.10%
AN273-SA-PI-102	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-TI-102	TI	Temperature Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-TI-101	TI	Temperature Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-GLY-PI-102	PI	Pressure Indicator	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-PI-102	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-PI-101	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-FI-101	FI	Flow Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-SA-HM-101	HM	Hour Meter	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-SA-PI-103	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-SA-PI-105	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-PI-106	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-PI-105	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN271-IA-PI-107	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-PI-104	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN273-IA-PI-103	PI	Pressure Indicator	AN Farm	Support/Utilities	Compressed Air	3.8E-03	0.1	35.6	0.15%	0.09%
AN105-WST-PI-115A	PI	Pressure Indicator	Bldg AZ-156	Confinement System	Primary Monitoring	3.8E-03	0.1	35.6	0.15%	0.09%
AN05C-WST-FIV-102	FIV	Flow Indicating Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	7.1E-04	0.1	186.9	0.03%	0.09%
AN241-VTP-MOV-401	MOV	Motor Operated Butterfly Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	8.4E-04	0.1	154.7	0.03%	0.09%
EXTHTEMP12	EXT	Temperature High 12 hr Delay	EXT	External Events	Weather	1.1E-02	0.1	12.0	0.44%	0.09%
AN05A-WT-PE-154	PE	WT Pump Discharge Pressure Element	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	2.2E-04	0.1	592.4	0.01%	0.09%
AN05A-WT-TE-157	TE	Temperature Element	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Pump	2.2E-04	0.1	592.4	0.01%	0.09%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
EXTLTEMP24	EXT	Temperature Low 24 hr Delay	EXT	External Events	Weather	4.9E-03	0.1	24.0	0.20%	0.08%
AN241-RW-M-108	M	Strainer Motor	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.3E-03	0.1	89.6	0.05%	0.08%
AN05A-WT-PCV-101	PCV	Pressure Control Valve	Tank AN-105	Waste Transfer AN-105	Transfer Pump	7.6E-04	0.1	154.7	0.03%	0.08%
AN296-VTA-FCV-923	FCV	Flow Control Valve	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	7.1E-04	0.1	163.5	0.03%	0.08%
AN296-VTA-FCV-913	FCV	Flow Control Valve	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	7.1E-04	0.1	163.5	0.03%	0.08%
AN105-IA-V-219	V	Globe valve	AN-105	Support/Utilities	Compressed Air	7.1E-04	0.1	154.7	0.03%	0.08%
AN105-VTP-V-205	V	Butterfly Valve	Tank AN-105	Primary HVAC	Ventilation Tank Primary	7.1E-04	0.1	154.7	0.03%	0.08%
AN105-IA-V-218	V	2-Way Ball Valve	AN-105	Support/Utilities	Compressed Air	7.1E-04	0.1	154.7	0.03%	0.08%
AN105-VTP-V-105	V	Butterfly Valve	AN Farm Vent Instr Pit 103	Primary HVAC	Ventilation Tank Primary	7.1E-04	0.1	154.7	0.03%	0.08%
AN05C-WST-V-225	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.1E-04	0.1	154.7	0.03%	0.08%
AN105-IA-V-217	V	Globe valve	AN-105	Support/Utilities	Compressed Air	7.1E-04	0.1	154.7	0.03%	0.08%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05C-WST-V-106	V	Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	7.1E-04	0.1	154.7	0.03%	0.08%
AN105-WST-V-109	V	2-Way Ball Valve	Tank AN-105	Confinement System	Primary Monitoring	7.1E-04	0.1	154.7	0.03%	0.08%
AN241-VTP-V-402	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.1E-04	0.1	154.7	0.03%	0.08%
AN05C-WST-V-227	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.1E-04	0.1	154.7	0.03%	0.08%
AN241-VTP-V-404	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.1E-04	0.1	154.7	0.03%	0.08%
AN241-VTP-V-405	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.1E-04	0.1	154.7	0.03%	0.08%
AN241-VTP-V-406	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.1E-04	0.1	154.7	0.03%	0.08%
AN241-VTP-V-407	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.1E-04	0.1	154.7	0.03%	0.08%
AN05C-WST-V-224	V	Angle Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	7.1E-04	0.1	154.7	0.03%	0.08%
AN105-IA-V-216	V	Globe valve	AN-105	Support/Utilities	Compressed Air	7.1E-04	0.1	154.7	0.03%	0.08%
AN105-WST-V-108	V	2-Way Ball Valve	Tank AN-105	Confinement System	Primary Monitoring	7.1E-04	0.1	154.7	0.03%	0.08%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-VTP-V-403	V	3-Way Ball Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	7.1E-04	0.1	154.7	0.03%	0.08%
AN241-VTP-DMPR-401	DMPR	Damper	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	1.4E-03	0.1	76.5	0.06%	0.08%
AN105-WSTA-FIV-106	FIV	Flow Indicator with Flow Adjust Valve	Tank AN-105	Confinement System	Leak Detection Pit	6.9E-04	0.1	157.7	0.03%	0.08%
AN105-WSTA-FIV-105	FIV	Flow Indicator with Flow Adjust Valve	Tank AN-105	Confinement System	Leak Detection Pit	6.9E-04	0.1	157.7	0.03%	0.08%
AN105-WSTA-FIV-104	FIV	Flow Indicator with Flow Adjust Valve	Tank AN-105	Confinement System	Leak Detection Pit	6.9E-04	0.1	157.7	0.03%	0.08%
AN05C-WST-V-101	V	Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	6.9E-04	0.1	154.7	0.03%	0.07%
AN05C-IA-PRV-115	PRV	Pressure Relief Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	6.9E-04	0.1	154.7	0.03%	0.07%
AN241-VTP-V-401	V	Butterfly Valve	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	6.9E-04	0.1	154.7	0.03%	0.07%
AN105-VTP-V-265	V	Butterfly Valve	Tank AN-105	Primary HVAC	Ventilation Tank Primary	6.9E-04	0.1	154.7	0.03%	0.07%
AN05C-WST-V-102	V	Globe Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	6.9E-04	0.1	154.7	0.03%	0.07%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05A-WT-FSH-160	FSH	Flow Switch High	Tank AN-105	Waste Transfer AN-105	Transfer Pump	6.5E-04	0.1	157.7	0.03%	0.07%
AN273-IA-FLT-103	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.5E-03	0.1	40.2	0.10%	0.07%
AN273-SA-FLT-101	FLT	Air Filter	AN Farm	Support/Utilities	Compressed Air	2.5E-03	0.1	40.2	0.10%	0.07%
AN273-IA-FLT-102	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.5E-03	0.1	40.2	0.10%	0.07%
AN273-IA-FLT-106	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.5E-03	0.1	40.2	0.10%	0.07%
AN273-SA-FLT-103	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.5E-03	0.1	40.2	0.10%	0.07%
AN273-IA-FLT-107	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.5E-03	0.1	40.2	0.10%	0.07%
AN273-IA-FLT-101	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.5E-03	0.1	40.2	0.10%	0.07%
AN273-SA-FLT-102	FLT	Filter	AN Farm	Support/Utilities	Compressed Air	2.5E-03	0.1	40.2	0.10%	0.07%
AN241-CHEMB-STR-101	STR	Strainer	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.1E-03	0.1	89.6	0.04%	0.07%
AN241-VTA-PDS-810	PDS	Pressure Differential Switch	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.02%	0.07%
AN241-VTA-PDS-710	PDS	Pressure Differential Switch	AN Farm A Train	Annulus HVAC	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.02%	0.07%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN296-VTA-FSL-922	FSL	Flow Switch Low	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.02%	0.07%
AN241-RW-FE-101	FE	Flow Element	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	6.0E-04	0.1	157.7	0.02%	0.07%
AN296-VTA-FSL-912	FSL	Flow Switch Low	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	6.0E-04	0.1	157.7	0.02%	0.07%
AN273-GLY-HX-001	HX	Heat Exchanger	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	9.9E-04	0.1	89.6	0.04%	0.06%
HATRANSF022	HUMAN	Control Transfer Mission	HUMAN	Human Actions	Transfer Pump	3.0E-03	0.1	28.1	0.12%	0.06%
AN241-EDS-XFMR-100	XFMR	Transformer	AN Farm	Support/Utilities	Electrical Distribution	4.5E-04	0.1	186.9	0.02%	0.06%
AN241-EDS-XFMR-102	XFMR	Transformer	AN Farm	Support/Utilities	Electrical Distribution	4.5E-04	0.1	186.9	0.02%	0.06%
AN241-RW-PI-104	PI	Pressure Indicator	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.4E-03	0.1	35.6	0.10%	0.06%
AZ156-RW-PI-105	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	2.4E-03	0.1	35.6	0.10%	0.06%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05C-WST-PT-125	PT	Pressure Transmitter	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	1.2E-03	0.1	67.8	0.05%	0.06%
AN05C-WST-PT-115	PT	Pressure Transmitter	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	1.2E-03	0.1	67.8	0.05%	0.06%
AN105-WST-LIT-104	LIT	Level Indicating Transmitter	Tank AN-105	Confinement System	Primary Monitoring	1.2E-03	0.1	67.8	0.05%	0.06%
EXTOTHER	EXT	Other Non-Hanford Events	EXT	External Events	Off Site	3.3E-03	0.1	24.0	0.14%	0.06%
AN105-VTA-FLT-209	FLT	Pre-Filter	Tank AN-105	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	76.5	0.04%	0.06%
AN105-VTA-FLT-210	FLT	HEPA Filter	Tank AN-105	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	76.5	0.04%	0.06%
AN241-VTA-FLT-801	FLT	HEPA Filter	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	76.5	0.04%	0.06%
AN241-VTA-FLT-802	FLT	HEPA Filter	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	76.5	0.04%	0.06%
AN273-SA-SOV-101	SOV	Solenoid Operated Valve	AN Farm	Support/Utilities	Compressed Air	8.6E-04	0.1	89.6	0.04%	0.05%
AN273-IA-SOV-101	SOV	Solenoid Operated Valve	AN Farm	Support/Utilities	Compressed Air	8.6E-04	0.1	89.6	0.04%	0.05%
AN273-IA-SOV-102	SOV	Solenoid Operated Valve	AN Farm	Support/Utilities	Compressed Air	8.6E-04	0.1	89.6	0.04%	0.05%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05A-WT-FI-153	FI	Flow Indicator	Bldg AZ-156	Waste Transfer AN-105	Process Monitoring	2.2E-03	0.1	35.6	0.09%	0.05%
AZ156-WT-ZI-158	ZI	Position Indicator	Bldg AZ-156	Waste Transfer AN-105	Transfer Pump	2.2E-03	0.1	35.6	0.09%	0.05%
AN05A-WT-DI-153	DI	Density Indicator	Bldg AZ-156	Waste Transfer AN-105	Process Monitoring	2.2E-03	0.1	35.6	0.09%	0.05%
AZ156-WT-FI-155	FI	Flow Indicator	Bldg AZ-156	Waste Transfer AN-105	Transfer Route	2.2E-03	0.1	35.6	0.09%	0.05%
AZ156-WT-FQI-155	FQI	Flow Totalizer Indicator	Bldg AZ-156	Waste Transfer AN-105	Transfer Route	2.2E-03	0.1	35.6	0.09%	0.05%
AN05A-WT-TI-153	TI	Temperature Indicator	Bldg AZ-156	Waste Transfer AN-105	Process Monitoring	2.2E-03	0.1	35.6	0.09%	0.05%
AZ156-WT-TI-157	TI	Temperature Indicator	Bldg AZ-156	Waste Transfer AN-105	Transfer Pump	2.2E-03	0.1	35.6	0.09%	0.05%
AZ156-WT-PI-154A	PI	Pressure Indicator	Bldg AZ-156	Waste Transfer AN-105	Transfer Route	2.2E-03	0.1	35.6	0.09%	0.05%
AN105-WT-PI-154	PI	Pressure Indicator	Bldg AZ-156	Waste Transfer AN-105	Transfer Route	2.2E-03	0.1	35.6	0.09%	0.05%
AZ156-WT-ZI-106	ZI	Position Indicator	Bldg AZ-156	Waste Transfer AN-105	Transfer Pump	2.2E-03	0.1	35.6	0.09%	0.05%
AN296-VTA-FLT-920	FLT	Record Sample Filter	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	1.0E-03	0.1	74.3	0.04%	0.05%
AN241-RW-BLR-101	BLR	Boiler	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	4.8E-04	0.1	154.7	0.02%	0.05%

Table G-5. Critical Items List for Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05C-WST-PY-125	PY	Pressure Equipment	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	4.4E-04	0.1	163.5	0.02%	0.05%
AN05C-WST-PY-115	PY	Pressure Equipment	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Confinement System	Primary Monitoring	4.4E-04	0.1	163.5	0.02%	0.05%
AN241-CHEMB-HTR-125	HTR	Heater	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	1.8E-03	0.1	38.7	0.07%	0.05%
AN241-VTP-DMST-002	DMST	Demister	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	9.0E-04	0.1	76.5	0.04%	0.05%
AN241-VTP-DMST-001	DMST	Demister	AN Farm A Train	Primary HVAC	Ventilation Tank Primary	9.0E-04	0.1	76.5	0.04%	0.05%
AN273-SA-ADV-101	ADV	Automatic Drain Valve	AN Farm	Support/Utilities	Compressed Air	7.6E-04	0.1	89.6	0.03%	0.05%
EXTHTEMP24	EXT	Temperature High 24 hr Delay	EXT	External Events	Weather	2.7E-03	0.1	24.0	0.11%	0.05%
EXTSHORT	EXT	Hanford Site work stoppage, short	EXT	External Events	Hanford	1.6E-02	0.1	4.0	0.66%	0.05%
AN105-WT-V-105	V	Automatic Switch-Over Valve	Tank AN-105	Waste Transfer AN-105	Transfer Pump	4.1E-04	0.1	154.7	0.02%	0.04%
AN241-CHEMB-MSTR-101	MSTR	Motor Starter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	5.3E-04	0.1	113.7	0.02%	0.04%
AN273-GLY-V-104	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-IA-V-114	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-119	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-101	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-WST-V-118	V	Angle Globe Valve	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-132	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-129	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-125	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-128	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN241-RW-V-179	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-113	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-WST-V-120	V	Globe Valve	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-114	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-105	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-101	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-118	V	Globe valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-WST-V-119	V	Globe Valve	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	6.6E-04	0.1	89.6	0.03%	0.04%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-SA-V-105	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-106	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-112	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-111	V	Check Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-110	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-105	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-106	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-SA-V-108	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-121	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-110	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-116	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-133	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-115	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-131	V	Angle Globe Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-113	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-SA-V-102	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-112	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-104	V	Gate Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-IA-V-111	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-109	V	Globe Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-108	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN273-IA-V-107	V	Check Valve	AN Farm	Support/Utilities	Compressed Air	6.6E-04	0.1	89.6	0.03%	0.04%
AN271-WST-V-117	V	Angle Globe Valve	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	6.6E-04	0.1	89.6	0.03%	0.04%
AN296-VTA-CAM-910	CAM	Continuous Air Monitor	Annulus Exhaust Stack CAM Enclosure AN296-VTA-ENCL-900	Annulus HVAC	Ventilation Tank Annulus	7.9E-04	0.1	74.3	0.03%	0.04%
AN273-SA-V-101	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-IA-PRV-101	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-115	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-IA-PRV-102	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-IA-PRV-103	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-127	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-116	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-V-103	V	Globe Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-GLY-V-102	V	Gate Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-SA-V-107	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-130	V	Globe valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-GLY-PRV-101	PRV	Pressure Relief Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-SA-PRV-101	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN271-IA-V-126	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN271-IA-PRV-104	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-SA-PRV-102	PRV	Pressure Relief Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN273-SA-V-104	V	2-Way Ball Valve	AN Farm	Support/Utilities	Compressed Air	6.4E-04	0.1	89.6	0.03%	0.04%
AN05A-WT-V-106	V	Check Valve	Tank AN-105	Waste Transfer AN-105	Transfer Pump	3.5E-04	0.1	154.7	0.01%	0.04%
ANVPA-WT-V-208	V	2-Way Ball Valve	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	3.5E-04	0.1	154.7	0.01%	0.04%
ANVPA-WT-V-213	V	2-Way Ball Valve	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	3.5E-04	0.1	154.7	0.01%	0.04%
ANVPA-WT-V-210	V	2-Way Ball Valve	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	3.5E-04	0.1	154.7	0.01%	0.04%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPA-WT-V-211	V	2-Way Ball Valve	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	3.5E-04	0.1	154.7	0.01%	0.04%
ANVPA-WT-V-212	V	2-Way Ball Valve	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	3.4E-04	0.1	154.7	0.01%	0.04%
AN05A-WT-PRV-102	PRV	Pressure Relief Valve	Tank AN-105	Waste Transfer AN-105	Transfer Route	3.4E-04	0.1	154.7	0.01%	0.04%
AN05A-WT-PRV-101	PRV	Pressure Relief Valve	Tank AN-105	Waste Transfer AN-105	Transfer Pump	3.4E-04	0.1	154.7	0.01%	0.04%
AN05A-WT-V-108 (dupe)	V	3-Way Ball Valve	Tank AN-102	Waste Transfer AN-105	Transfer Pump	3.4E-04	0.1	154.7	0.01%	0.04%
ANVPA-WT-V-209	V	2-Way Ball Valve	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	3.4E-04	0.1	154.7	0.01%	0.04%
AN241-RW-V-180	V	Gate Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	3.2E-04	0.0	154.7	0.01%	0.03%
AN105-VTA-V-205	V	Butterfly Valve	Tank AN-105	Annulus HVAC	Ventilation Tank Annulus	3.2E-04	0.0	154.7	0.01%	0.03%
AN241-CHEMB-V-111	V	Gate Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	3.2E-04	0.0	154.7	0.01%	0.03%
AN105-VTA-V-105	V	Butterfly Valve	AN Farm Vent Instr Pit 3	Annulus HVAC	Ventilation Tank Annulus	3.2E-04	0.0	154.7	0.01%	0.03%
AZ156-CHEMB-LI-101	LI	Level Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	1.4E-03	0.0	35.6	0.06%	0.03%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-PI-107	PI	Pressure Indicator	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	1.4E-03	0.0	35.6	0.06%	0.03%
AN241-CHEMB-PI-132	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	1.4E-03	0.0	35.6	0.06%	0.03%
AZ156-CHEMB-LIC-127	LI	Level Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Storage	1.4E-03	0.0	35.6	0.06%	0.03%
AZ156-CHEMB-TI-132	TI	Temperature Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	1.4E-03	0.0	35.6	0.06%	0.03%
AZ156-CHEMB-FI-116	FI	Flow Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	1.4E-03	0.0	35.6	0.06%	0.03%
AZ156-CHEMB-PI-101	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	1.4E-03	0.0	35.6	0.06%	0.03%
AZ156-CHEMB-PI-131	PI	Pressure Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Delivery	1.4E-03	0.0	35.6	0.06%	0.03%
AZ156-CHEMB-AI-123	AI	Analysis Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Storage	1.4E-03	0.0	35.6	0.06%	0.03%
AZ156-CHEMB-TI-115	TI	Temperature Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	1.4E-03	0.0	35.6	0.06%	0.03%
AZ156-CHEMB-TI-124	TI	Temperature Indicator	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Storage	1.4E-03	0.0	35.6	0.06%	0.03%
AN241-CHEMB-V-119	V	2-Way Ball Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	3.1E-04	0.0	154.7	0.01%	0.03%
AN241-DR-V-110	V	2-Way Ball Valve	AN Farm	Diluent/Flush System	Diluent/Flush Preparation	3.1E-04	0.0	154.7	0.01%	0.03%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-RW-RE-126	RE	Radiation Sensing element	AN Farm Retrieval Equipment Service Water Enclosure RW-PNL-101	Diluent/Flush System	Diluent/Flush Preparation	1.2E-03	0.0	40.2	0.05%	0.03%
AN820-EDS-XFMR-104	XFMR	Transformer	Change Trailer MO-820	Support/Utilities	Electrical Distribution	4.1E-04	0.0	113.7	0.02%	0.03%
AN241-VTP-EJ-401	EJ	Expansion Joint	AN Farm B Train	Primary HVAC	Ventilation Tank Primary	5.7E-04	0.0	76.5	0.02%	0.03%
AN105-WT-FIT-155	FIT	Flow Indicating Transmitter	Tank AN-105	Waste Transfer AN-105	Transfer Route	6.5E-04	0.0	67.8	0.03%	0.03%
AN105-WT-PT-154	PIT	Pressure Indicating Transmitter	AN Farm WT-PNL-AN12 Pump and Valve Pit Instr Enclosure	Waste Transfer AN-105	Transfer Route	6.5E-04	0.0	67.8	0.03%	0.03%
AN241-VTA-DMST-004	DMST	Demister	AN Farm B Train	Annulus HVAC	Ventilation Tank Annulus	5.5E-04	0.0	76.5	0.02%	0.03%
AN241-EDS-DS-119	DS	Disconnect Switch	AN Farm	Support/Utilities	Electrical Distribution	2.3E-04	0.0	186.8	0.01%	0.03%
AN296-VTP-FCV-513	FCV	Flow Control Valve	AN296-VTP-ENCL-500	Primary HVAC	Ventilation Tank Primary	2.5E-04	0.0	163.5	0.01%	0.03%
AN05C-IA-PCV-115	PCV	Pressure Control Valve	Transmitter Enclosure AN-05C-WSTA-Enclosure-005	Support/Utilities	Compressed Air	2.5E-04	0.0	154.7	0.01%	0.03%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-RW-V-171	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.3E-04	0.0	89.6	0.02%	0.03%
AN241-RW-BFP-102	BFP	Backflow Preventer	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.3E-04	0.0	89.6	0.02%	0.03%
AN241-RW-V-172	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.3E-04	0.0	89.6	0.02%	0.03%
AN241-RW-V-178	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.2E-04	0.0	89.6	0.02%	0.03%
AN241-RW-V-173	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.2E-04	0.0	89.6	0.02%	0.03%
AN241-RW-V-174	V	Globe Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.2E-04	0.0	89.6	0.02%	0.03%
AN241-RW-V-175	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.2E-04	0.0	89.6	0.02%	0.03%
AN241-RW-V-176	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.2E-04	0.0	89.6	0.02%	0.03%
AN241-RW-V-177	V	Gate Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.2E-04	0.0	89.6	0.02%	0.03%
AN241-POT-PRV-101	PRV	Pressure Relief Valve	Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.2E-04	0.0	89.6	0.02%	0.03%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN105-WSTA-LIS-105	LIS	Level Indicating Switch	Tank AN-105	Confinement System	Leak Detection Pit	2.2E-04	0.0	157.7	0.01%	0.02%
AN105-WSTA-LIS-106	LIS	Level Indicating Switch	Tank AN-105	Confinement System	Leak Detection Pit	2.2E-04	0.0	157.7	0.01%	0.02%
AN105-WSTA-LIS-104	LIS	Level Indicating Switch	Tank AN-105	Confinement System	Leak Detection Pit	2.2E-04	0.0	157.7	0.01%	0.02%
AN105-WST-LE-135	LE	Level Element	Tank AN-105	Confinement System	Primary Monitoring	2.2E-04	0.0	157.7	0.01%	0.02%
AN241-CHEMB-106-M10	PIPE	Pipe Segment	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	3.8E-04	0.0	89.6	0.02%	0.02%
AN241-CHEMB-101-M9	PIPE	Pipe Segment	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	3.8E-04	0.0	89.6	0.02%	0.02%
ANVPA-WT-PSH-250	PSH	Pressure Switch High	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	2.2E-04	0.0	157.7	0.01%	0.02%
ANVPA-WT-PSH-251	PSH	Pressure Switch High	Pressure Switch Enclosure ENCL-102	Waste Transfer AN-105/Stage	Transfer Route	2.2E-04	0.0	157.7	0.01%	0.02%
AN05A-WT-PS-161	PS	Pressure Switch	Tank AN-105	Waste Transfer AN-105	Transfer Pump	2.2E-04	0.0	157.7	0.01%	0.02%
AZ156-RW-JY-108	JY	Power Equipment	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	2.8E-04	0.0	113.7	0.01%	0.02%
AN903-WSTA-FCV-105	FCV	Flow Control Valve	Annulus Tanks AN-105 & AN-106 CAM Instr Encl 241-AN-903	Confinement System	Waste Tank AN-105	1.7E-04	0.0	163.5	0.01%	0.02%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-AE-123	AE	Analysis element	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	7.0E-04	0.0	40.2	0.03%	0.02%
EXTHUMAN	EXT	Hanford Site work stoppage, due to human	EXT	External Events	Hanford	6.9E-03	0.0	4.0	0.28%	0.02%
AN01A-WT-A	NOZ	AN-01A Central Pump Pit Jumper Connection	AN-01A Central Pump Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AZNEW-WT-E	NOZ	AZ Valve Pit Jumper Connection	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AN05A-WT-1	NOZ	AN-05A Pump Pit Jumper Connection	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AZNEW-WT-L	NOZ	AZ Valve Pit Jumper Connection	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
ANVPB-WT-R15	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
ANVPA-WT-E	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AZNEW-WT-A	NOZ	AZ Valve Pit Jumper Connection	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
ANVPA-WT-F	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN05A-WT-A	NOZ	AN-05A Pump Pit Jumper Connection	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AN05A-WT-5	NOZ	AN-05A Pump Pit Jumper Connection	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AN05A-WT-6	NOZ	AN-05A Pump Pit Jumper Connection	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AN05A-WT-8	NOZ	AN-05A Pump Pit Jumper Connection	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
ANVPB-WT-R19	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
ANVPA-WT-L16	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
ANVPA-WT-L19	NOZ	AN-A Valve Pit Jumper Connection	AN-A Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AN05A-WT-7	NOZ	AN-05A Pump Pit Jumper Connection	AN-05A Pump Pit	Waste Transfer AN-105	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AZNEW-WT-J	NOZ	AZ Valve Pit Jumper Connection	AZ Valve Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AN01A-WT-D	NOZ	AN-01A Central Pump Pit Jumper Connection	AN-01A Central Pump Pit	Waste Transfer AN-105/AN-102	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
ANVPB-WT-F	NOZ	AN-B Valve Pit Jumper Connection	AN-B Valve Pit	Waste Transfer AN-105/Stage	Transfer Route	3.4E-05	0.0	776.1	0.00%	0.02%
AN241-EDS-BKR-100	BKR	Breaker	AN Farm	Support/Utilities	Electrical Distribution	1.4E-04	0.0	186.9	0.01%	0.02%
AN241-RW-PIT-105	PIT	Pressure Indicating Transmitter	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	7.1E-04	0.0	35.6	0.03%	0.02%
AN242A-VTA-RSH-AN-K2	RSH	Radiation Switch High	Evaporator Bldg 242-A	Annulus HVAC	Ventilation Tank Annulus	6.9E-04	0.0	35.6	0.03%	0.02%
AN242A-VTA-RXS-AN-K2	RXS	Radiation Failure Switch	Evaporator Bldg 242-A	Annulus HVAC	Ventilation Tank Annulus	6.9E-04	0.0	35.6	0.03%	0.02%
AZ156-WT-SY-153	SY	Speed/Velocity Equipment	Bldg AZ-156	Waste Transfer AN-105	Process Monitoring	2.2E-04	0.0	113.7	0.01%	0.02%
AN241-CHEMB-V-108	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.7E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-117	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.7E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-110	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.7E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-106	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.7E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-103	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.7E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-102	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.7E-04	0.0	89.6	0.01%	0.02%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-V-104	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.6E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-105	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.6E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-107	V	Globe Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.6E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-115	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	2.6E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-118	V	Gate Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.6E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-101	V	2-Way Ball Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.6E-04	0.0	89.6	0.01%	0.02%
AN241-CHEMB-V-112	V	2-Way Ball Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	2.6E-04	0.0	89.6	0.01%	0.02%
AZ156-WT-UT-153	UT	Multivariable Transmitter	Bldg AZ-156	Waste Transfer AN-105	Process Monitoring	6.5E-04	0.0	35.6	0.03%	0.02%
AN271-IA-PCV-101	PCV	Pressure Control Valve	AN Farm	Support/Utilities	Compressed Air	2.3E-04	0.0	89.6	0.01%	0.01%
AN273-IA-AOV-101	AOV	Air Operated Valve	AN Farm	Support/Utilities	Compressed Air	2.3E-04	0.0	89.6	0.01%	0.01%
AN273-IA-AOV-102	AOV	Air Operated Valve	AN Farm	Support/Utilities	Compressed Air	2.3E-04	0.0	89.6	0.01%	0.01%
AZ156-CHEMB-ZY-129	ZY	Position Equipment	PLC Instr Enclosure WT-ENCL-101	Diluent/Flush System	Diluent/Flush Delivery	4.2E-04	0.0	40.2	0.02%	0.01%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-CHEMB-FIT-116	FIT	Flow Indicating Transmitter	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	4.1E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-LIT-127	LIT	Level Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	4.1E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-ZT-129	ZT	Position Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.1E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-FIT-130	FIT	Flow Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.1E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-PIT-131	PIT	Pressure Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.1E-04	0.0	35.6	0.02%	0.01%
AZ156-CHEMB-FFC-118	FFC	PLG added	Bldg AZ-156	Diluent/Flush System	Diluent/Flush Preparation	4.1E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-TIT-115	TIT	Temperature Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Preparation	4.1E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-TIT-124	TIT	Temperature Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	4.1E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-TIT-132	TIT	Temperature Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	4.1E-04	0.0	35.6	0.02%	0.01%
AN241-CHEMB-AIT-123	AIT	Analysis Indicating Transmitter	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	4.1E-04	0.0	35.6	0.02%	0.01%
AN273-GLY-(F-003-ELEC)	ELEC	Cooling Fan Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.2E-04	0.0	113.7	0.01%	0.01%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-IA-(DRY-101-ELEC)	ELEC	Dryer Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.2E-04	0.0	113.7	0.01%	0.01%
AN273-GLY-(F-004-ELEC)	ELEC	Cooling Fan Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.2E-04	0.0	113.7	0.01%	0.01%
AN273-SA-(CMP-001-ELEC)	ELEC	Compressor Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.2E-04	0.0	113.7	0.01%	0.01%
AN273-GLY-(P-002-ELEC)	ELEC	Coolant Pump Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.2E-04	0.0	113.7	0.01%	0.01%
AN273-GLY-(P-001-ELEC)	ELEC	Coolant Pump Elec	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.2E-04	0.0	113.7	0.01%	0.01%
AN241-RW-PCV-101	PCV	Pressure Control Valve	Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.5E-04	0.0	89.6	0.01%	0.01%
AN271-WST-PSL-115	PSL	Pressure Switch Low	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	3.8E-04	0.0	35.6	0.02%	0.01%
AN271-WST-PSH-115	PSH	Pressure Switch High	Instr Bldg 241-AN-271	Confinement System	Primary Monitoring	3.8E-04	0.0	35.6	0.02%	0.01%
AN241-RW-PRV-101	PRV	Pressure Reducing Valve	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	1.4E-04	0.0	89.6	0.01%	0.01%
AN241-CHEMB-PCV-123	PCV	Pressure Control Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	9.6E-05	0.0	89.6	0.00%	0.01%
AN241-CHEMB-PCV-122	PCV	Pressure Control Valve	AN Caustic Pump Enclosure	Diluent/Flush System	Diluent/Flush Preparation	9.6E-05	0.0	89.6	0.00%	0.01%
AN241-VTP-EDS-MCC-002	MCC	Motor Control Center	AN-A & B Trains	Primary HVAC	Ventilation Tank Primary	4.5E-05	0.0	186.9	0.00%	0.01%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-RW-PDISH-103	PDISH	Pressure Differential Indicator Switch High	AN Farm Raw Water Treatment Enclosure	Diluent/Flush System	Diluent/Flush Preparation	2.4E-04	0.0	35.6	0.010%	0.006%
AZ156-WT-I-8	I	Interlock	Bldg AZ-156	Waste Transfer AN-105	Waste Transfer System	2.2E-04	0.0	35.6	0.009%	0.005%
AZ156-WT-I-1	I	Interlock	Bldg AZ-156	Waste Transfer AN-105	Waste Transfer System	2.2E-04	0.0	35.6	0.009%	0.005%
AZ156-WT-I-2	I	Interlock	Bldg AZ-156	Waste Transfer AN-105	Waste Transfer System	2.2E-04	0.0	35.6	0.009%	0.005%
AZ156-WT-I-3	I	Interlock	Bldg AZ-156	Waste Transfer AN-105	Waste Transfer System	2.2E-04	0.0	35.6	0.009%	0.005%
AZ156-WT-I-7	I	Interlock	Bldg AZ-156	Waste Transfer AN-105	Waste Transfer System	2.2E-04	0.0	35.6	0.009%	0.005%
AN241-WST-105	DST	Double Shell Tank	Tank AN-105	Confinement System	Tank Structure	4.6E-05	0.0	154.7	0.002%	0.005%
AN273-GLY-P-001	P	Pump	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	5.5E-05	0.0	89.6	0.002%	0.003%
AN242A-VTA-PSH-ANK21	PSH	Pressure Switch High	Evaporator Bldg 242-A	Annulus HVAC	Ventilation Tank Annulus	1.4E-04	0.0	35.6	0.006%	0.003%
AN242A-VTA-PSH-ANK22	PSH	Pressure Switch High	Evaporator Bldg 242-A	Annulus HVAC	Ventilation Tank Annulus	1.4E-04	0.0	35.6	0.006%	0.003%
AN241-CHEMB-TE-125	TE	Temperature Element	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	1.4E-04	0.0	35.6	0.006%	0.003%
AN241-VTP-SP-102	SP	Seal Pot	AN Farm	Primary HVAC	Ventilation Tank Primary	3.1E-05	0.0	154.7	0.001%	0.003%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN241-VTP-SP-101	SP	Seal Pot	AN Farm	Primary HVAC	Ventilation Tank Primary	3.1E-05	0.0	154.7	0.001%	0.003%
AN274-WST-TBX-113	TBX	Terminal Box	Caustic Addition Control Room	Support/Utilities	Electrical Distribution	4.1E-05	0.0	113.7	0.002%	0.003%
AN241-VTA-EDS-MCC-002	MCC	Motor Control Center	AN Farm	Annulus HVAC	Ventilation Tank Annulus	2.1E-05	0.0	186.9	0.001%	0.003%
AN273-SA-TK-001	TK	Tank	AN Farm	Support/Utilities	Compressed Air	4.2E-05	0.0	89.6	0.002%	0.003%
AN273-GLY-TK-001	TK	Tank	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	4.2E-05	0.0	89.6	0.002%	0.003%
AN105-WST-SG-104	SG	Sight Glass	Tank AN-105	Confinement System	Primary Monitoring	5.7E-05	0.0	65.6	0.002%	0.003%
AN241-CHEMB-FCV-129	FCV	Flow Control Valve	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Delivery	8.1E-05	0.0	40.2	0.003%	0.002%
AN241-CHEMB-LE-127	LE	Level Element	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	6.9E-05	0.0	35.6	0.003%	0.002%
AN273-GLY-LG-101	LG	Level Glass	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	5.7E-05	0.0	40.2	0.002%	0.002%
AZ156-WT-YY-155	YY	Event Converter	Bldg AZ-156	Waste Transfer AN-105	Transfer Route	6.5E-05	0.0	35.6	0.003%	0.002%
AN241-CHEMB-TK-001	TK	Diluent/Flush Tank	AN Dilution Pad	Diluent/Flush System	Diluent/Flush Storage	1.7E-05	0.0	89.6	0.001%	0.001%
AN271-EDS-BKR-104	BRK	Breaker	Motor Control Center AN271-EDS-MCC-001	Support/Utilities	Electrical Distribution	1.1E-04	0.0	14.0	0.004%	0.001%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN271-EDS-BKR-106	BRK	Breaker	Motor Control Center AN271-EDS-MCC-001	Support/Utilities	Electrical Distribution	1.1E-04	0.0	14.0	0.004%	0.001%
AN271-EDS-BKR-101	BRK	Breaker	Motor Control Center AN271-EDS-MCC-001	Support/Utilities	Electrical Distribution	1.1E-04	0.0	14.0	0.004%	0.001%
AN271-EDS-BKR-129	BRK	Breaker	Motor Control Center AN271-EDS-MCC-001	Support/Utilities	Electrical Distribution	1.1E-04	0.0	14.0	0.004%	0.001%
AZ156-CHEMB-YY-130	YY	Event Converter	PLC Instr Enclosure WT-ENCL-101	Diluent/Flush System	Diluent/Flush Delivery	4.1E-05	0.0	35.6	0.002%	0.0010%
ANVPA-WT-LDK-331	LDK	AN-A Valve Pit Leak Detector Relay	AN Farm	Waste Transfer AN-105	Transfer Route	6.5E-05	0.0	18.9	0.003%	0.0009%
ANVPB-WT-LDK-231	LDK	AN-B Valve Pit Leak Detector Relay	AN Farm	Waste Transfer AN-105	Transfer Route	6.5E-05	0.0	18.9	0.003%	0.0009%
AN820-EDS-DS-114	DS	Disconnect Switch	Change Trailer MO-820	Support/Utilities	Electrical Distribution	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-SA-DS-001	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-GLY-DS-001	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-IA-DS-101	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-GLY-DS-010	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.8E-04	0.0	3.0	0.007%	0.0004%

Table G-5. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Individual Component (EIN) Contribution to Schedule Delay (Continued)

EIN	Comp. Type	Component Description	Equipment Location	System	Major Element	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
AN273-GLY-DS-004	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-GLY-DS-002	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-EDS-DS-113	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Electrical Distribution	1.8E-04	0.0	3.0	0.007%	0.0004%
AN271-EDS-DS-117	DS	Disconnect Switch	Instr Bldg 241-AN-271	Support/Utilities	Electrical Distribution	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-EDS-DS-112	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Electrical Distribution	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-GLY-DS-003	DS	Disconnect Switch	Compressor Bldg 241-AN-273	Support/Utilities	Compressed Air	1.8E-04	0.0	3.0	0.007%	0.0004%
AN273-GLY-V-108	V	Check Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	8.9E-07	0.0	89.6	0.00004%	0.0001%
AN273-GLY-V-107	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	8.9E-07	0.0	89.6	0.00004%	0.0001%
AN273-GLY-V-109	V	2-Way Ball Valve	AN Farm Compressor Bldg	Support/Utilities	Compressed Air	8.9E-07	0.0	89.6	0.00004%	0.0001%

Table G-6. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Activity Contribution to Schedule Delay

Activity	Number of Schedule Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
	2.4	**142.9**	**58.4**	**100%**	**100%**
AN-105 Transfer	8.0E-01	44.2	55	32.8%	30.9%
AN-105 Pre Transfer	1.6E+00	98.7	60	67.2%	69.1%

Table G-7. Critical Items List For Waste Transfer Activities from 241-AN-105 to the WTP, Ranked by Component Type Category Contribution to Schedule Delay

Component Type Category	Expected Number of Delay Events	Expected Schedule Delay (hours)	Average Delay per Event (hours)	Percent of Schedule Delay Events	Percent of Schedule Delay Hours
Total	**2.4**	**142.9**	**58.4**	**100%**	**100%**
Instruments/Electrical	5.9E-01	36.3	62	24.0%	25.4%
Pumps/Fans	2.5E-01	31.5	125	10.3%	22.1%
Check and Manual Valves	8.9E-02	25.6	287	3.6%	17.9%
Transfer Pump	1.7E-01	22.1	132	6.8%	15.4%
External Events	1.2E+00	9.0	7	49.2%	6.3%
Power Operated Valves	7.4E-02	7.9	107	3.0%	5.5%
Pipes, Filters, Containers, Structure	5.1E-02	7.6	149	2.1%	5.3%
Human Actions	8.5E-03	2.2	263	0.3%	1.6%
Miscellaneous/Structural Components	1.1E-02	0.4	39	0.5%	0.3%
Miscellaneous/Other Non Active	1.3E-03	0.2	164	0.1%	0.2%
Electrical Heaters	1.8E-03	0.1	39	0.1%	0.0%

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Appendix H. Technical Peer Review of Waste Feed Delivery System Phase I Preliminary RAM Analysis

Technical Peer Review of Waste Feed Delivery System Phase I Preliminary RAM Analysis

An Independent Technical Review of the *Waste Feed Delivery System Phase I Preliminary RAM Analysis,* HNF-2863 Rev 2 document and related analyses was performed. A discussion of the scope of the review is provided in the following sections.

1. What was reviewed?

The following items of the document were covered in this review:

- Document *Waste Feed Delivery System Phase I Preliminary RAM Analysis*
- Excel Spreadsheet using the Crystal Ball software package (Version 4.0c) contained in the following files

File Name	Size	Date Generated	Time
AN-102 Quantification CILs, Rev 2 (AppE).xls	244,736	09/11/2000	14:57
AN-102 Quantification. Rev 2.xls1	666,048	09/11/2000	14:27
AN-102 Simulation Calcs. Rev 2.xls3	735,552	09/11/2000	15:01
AN-102 Simulation Results. Rev 2.xls6	106,112	09/11/2000	14:38
AN-105 Quantification CILs, Rev 2 (App G).xls	225,792	09/11/2000	16:00
AN-105 Quantification. Rev 2.xls2	897,408	09/11/2000	16:00
AN-105 Simulation Calcs. Rev 2.xls5	753,856	09/04/2000	15:57
AN-105 Simulation Results. Rev 2.xls	13,968,896	09/06/2000	14:00
AZ-101 Quantification CILs, Rev 2 (App F).xls	245,248	09/06/2000	08:54
AZ-101 Quantification. Rev 2.xls1	158,656	09/04/2000	13:23
AZ-101 Simulation. Rev 2.xls5	315,584	09/06/2000	13:33

- Access Database Files contained in the following files

File Name	Size	Date Generated	Time
AN-102 CILs Database, Rev 2.mdb	4,382,720	09/05/2000	18:03
AN-105 CILs Database, Rev 2.mdb	4,382,720	09/14/2000	16:26
AN-105 RAM Database, Rev 2.mdb6	477,824	09/14/2000	16:32
AZ-101 CILs Database. Rev 2.mdb	4,575,232	09/05/2000	08:38
AZ101 Quantification. Rev 2.mdb	6,621,184	08/31/2000	17:10

2. What was not reviewed?

Randomly selected and targeted (mixer and transfer pumps) components contained within the above spreadsheets and database files were selected for review. There are thousands of waste transfer components contained within these files making it impossible to review and verify each individual entry in the files within the time allotted.

A technical review of the document *Waste Feed Delivery System RAM Assessment,* HNF-2863 Rev2 was performed. The document was reviewed to determine if all of the key elements (as specified in the statement of

work for this review) had been addressed. An editorial review of the document was not performed of the document.

3. Details of the Reviewed Items

The review covered the following bulleted items. Each of these items was defined in a Statement of Work that was provided to Fluor Federal Services by CH2M Hanford Group at the start of the review process.

- **Problem statement completely defined?**

The *Statement of Purpose* of the analysis was clearly stated in Section 1.2 of the above document. In an abbreviated form the Statement of Purpose is defined as:

1) Support evaluating the ability of the FY 2000 baseline system design and O&M concept to meet the WFD schedule requirements for three representative Phase 1 source tanks:
   - Low Activity Waste in tank 241-AN-102
   - High Level Waste in tank 241-AZ-101
   - Low Activity Waste in tank 241-AN-105
2) Estimate the likelihood and magnitude of delivery delays associated with the tank farm O&M activities that can result in penalties to Hanford
3) Identify preliminary RAM-related design and O&M concept changes to enhance operating margins for meeting waste delivery schedules.

This adequately identifies the problem statement.

- **Is the methodology valid, including derivation of logic networks?**

Starting on page 2-1 Section 2.1, the RAM logic models are discussed. An FMEA was used to identify single component failures, which would result in the failure of the waste transfer system being analyzed. The RAM logic models used in the analysis are based on the FMEA results, which is a list of failure modes that can interrupt the process activity and produce schedule delay.

In the development of the RAM logic models the following items were addressed:

- Process Activities
- Mission-Related Off-Normal Events
- Backup Trains and Recovery Without Creating a Schedule Delay
- Generation of Quantification Tables
- Dynamic Calculation of Exposure and Shadowing Factor, and
- Generation of Critical Items Lists

Each of these items were covered for the following waste qualification and delivery processes:

- Class 1 Low Activity Waste Qualification and Delivery Process (241-AN-102)

  The RAM models for the AN-102 waste tank are contained in the Excel-Crystal Ball spreadsheets of AN-102 Quantification CILs, Rev 2 (App E).xls, AN-102 Quantification. Rev 2.xls1, AN-102 Simulation Calcs. Rev2.xls3, and AN-102 Simulation Results. Rev 2.xls6.

- Class 2 High Level Waste Qualification and Delivery Process (241-AZ-101)

  The RAM models for the AZ-101 waste tank are contained in the Excel-Crystal Ball spreadsheets of *AZ-101 Quantification CILs, Rev 2 (App F).xls, AZ-101 Quantification. Rev 2.xls1,* and *AZ-101 Simulation. Rev 2.xls5.*

- Class 3 Low Activity Waste Qualification and Delivery Process (241-AN-105)

  The RAM models for the AN-105 waste tank are contained in the Excel-Crystal Ball spreadsheets of *AN-105 Quantification CILs, Rev 2 (App G).xls, AN-105 Quantification. Rev 2.xls2, AN-105 Simulation Calcs. Rev2.xls5,* and *AN-105 Simulation Results. Rev 2.xls.*

The Crystal Ball simulation program is used in the development of the above simulation models. It is a program capable of handling probability distribution functions and failure rate frequencies for user identified variables. Monte Carlo simulations can be developed using these probability variables to determine a probability distribution functional result called a Forecast.

The forecast defined in the Excel-Crystal Ball model is the Delay Time associated with waste transfer system of Tank AN-105 and Tank AZ-101 due to system component failures and mean-time-to-repair. The total time needed for the delivery of the waste to the contractor's receiver tank is determined using the Delay Time and the nominal time to perform each of the qualification and delivery functions. This addresses the Figure of Merit as defined in Appendix B of the *Operations and Maintenance Concept for the Waste Feed Delivery System* Phase 1 document. The *Figure of Merit (FOM)* requires an estimate for the total time needed for the delivery of the waste to the contractor's receiver tank. This delivery time is then compared to the *Figure of Merit* requirement of 30 days.

Standard RAM assessment techniques were utilized in the assessment of the waste transfer activities evaluated in this RAM analysis. Component lists were developed for waste transfer activities and used as the logic network basis for the simulation runs.

- **Are calculations valid (spot checks)?**

The data sheet "Quantification All" from the file " AZ-101 Simulation. Rev 2.xls" was assessed. The following equations were evaluated for correctness and validity.

- Random Number
- Log Normal and Triangular Distributions
- Results of "If" statements
- Total Number of Off Norman Events

- Number of Delay Events
- Total Schedule Delay

A spot check was made for a number of components from this data sheet and is provided in Table1 and Table 2. All calculations were determined to be correct.

Spot checks were made on some of the failure rates used in this file going back toreference WSRC-TR-93-262 through the ACCESS database file*AZ101 Quantification. Rev 2.mdb*sub-file*Failure Rate.* The bases for mean-time-to-repair were spot-checked back to the ACCESS database file with sub-file*AZ101 Quantification. Rev 2.mdb* sub-file *Recovery Time*. There were no errors detected for the spot checks that were performed.

- **Are modeling assumptions valid and explicitly stated?**

All of the assumptions used in the RAM analysis are provided in Table 2-7,*Assumptions Used in the Preliminary RAM Analysis*. The assumptions used in the RAM analysis are explicitly stated and are valid for the analysis performed with the following exceptions.

A number of concerns exist about two of the assumptions listed in Table 2-7. Those assumptions are:

- Generic component failure rates are taken primarily from Savannah River Site data for chemical systems;

- Replacement and repair parts are assumed to be on hand to the extent that their availability does not dominate failure event restoration time. It is assumed that at least one spare of each repair/replacement part is on hand or is procurable during the normal job preparation time.

Using generic component failure rates from another DOE site has some drawbacks with respect to applicability. The Savannah River Site has a different waste composition from what is handled at Hanford, which could have a significant impact on failure rates of certain waste transfer system components (piping, pumps, and valves).

The availability of major waste-transfer-system components has a major impact on results of the analysis. The uncertainty associated with the recovery time distribution functions for these components would impact the overall complementary cumulative distribution functions for the waste transfer activity assessed. The waste tank transfer and mixer pumps have this type of impact. Catastrophic failure of one of these pumps may take from two to six months to repair or replace, if they are not on hand. These types of time delays could overwhelm any of the delay times calculated by the RAM model.

- **Are the models appropriate and used within their range of validity or is use outside the established validity range justified?**

Reference to Failure Modes and Effects Analysis (FMEA) is made in the report and the data files, as being the basis for the single component failure modes used in the RAM analysis. The FMEA results are contained within ACCESS database files.

The generic failure mode and effects for component types are provided in the *AN-105 RAM Database, Rev 2.mdb* and *AZ101 Quantification. Rev 2.mdb* database files in the *Activity* table for each of them. The components and the failure modes are combined with the specific failure rates via a query process. The resulting list of waste transfer system components was reviewed. The various types and categories of components expected in the list were found. Specific components (mixer and transfer pumps) were searched for and found in the list of components. Those components that result in the shutdown of the activity are designated via Delay columns in the ACCESS *Activity* database file.

The ACCESS datafiles provided for review contain extensive amounts of information on the system components, component failure rates, backup failure rates, exposure times for activities, recovery time, frequency of Off-Normal Events, and rad/recovery codes.

The ACCESS database files and EXCEL spreadsheet models for tanks AN-102, AN-105 and AZ-101 provide an extensive and in depth model for estimating the reliability of the transfer systems. The models are valid for estimating the Figure of Merit Delay Time. The validity of the models are appropriate based on the assumptions used in their development and are provided in Table 2-7 of the report.

- **Are raw data (input probability distributions) reasonable and checked for consistency with original source information as applicable? Is there a basis stated?**

The raw data for the component failure rate frequencies was spot checked and traced back to its original source. The component failure rate frequencies that were spot-checked are provided in Table 2. Some of the failure rates used in the analysis are based on PLG experience and are documented as so. The mean time to repairs for each waste transfer component identified is approximated in the RAM analysis via a lognormal or a triangular probability distribution function. For the triangular probability distribution a low value, mode, and high value mean time to repair are estimated for each of the component types (Table 1). A mean value and standard deviation are used for the lognormal probability distribution function. The basis used for these values is provided in an Access database file.

- **Does software appear to be working, with computer codes and data files documented, inputs correct and consistent with document reviewed, and output consistent with input and results documented in the report reviewed?**

The Access data files and Crystal Ball/Excel spreadsheets were accessed for AN-102, AN-105 and AZ-101 waste tanks. Data was reviewed on a spot basis. The Crystal Ball models were run to determine functionality of models for AZ-101 waste tank activities. They appear to provide results that are consistent with the results listed in the document and the spreadsheet itself. The calculational procedure was tracked from cell to cell of the spreadsheet to determine calculational process and correctness. No errors were detected. The movement from the ACCESS database to the EXCEL spreadsheet was traced to verify validity of data.

- **Do the numerical results support the reports' conclusions?**

The major conclusion of the report is that the risk delay time is dominated by Waste Transfer Systems. The mixing and transfer pumps for the Class I (AN-102), Class II (AZ-101), and Class III (AN-105) waste transfer activities are the major component contributors to batch delay times. This is supported by the Critical Items List (CIL) provided in Appendices G, E, and F.

Based on the delay time simulation results of the analysis for each of the waste tank activities, the conclusions expressed in Sections 5.1.6, 5.2.3, and 5.3.3 of the report are valid.

When reviewing Section 5 of the report, it was noticed that Figure 5-3 was misplaced in comparison to other figures within Section 5.0. Suggest moving the figures that are associated with a particular subsection of Section 5 to the end of that subsection (5.1, 5.2, 5.3). It makes the report more readable.

The information in the table on page 5-11 of the report could not be verified against the information provided in spreadsheet *AZ-101 Simulation. Rev 2.xls* page *Report*. The data in the table did not match the data in the simulation spreadsheet. The information provided in comparable tables in Sections 5.1 and 5.3 could be found in their related simulation spreadsheets.**[This error was corrected in the final report and verified by the reviewer.]**

- **Are limitations or caveats on the use of the numerical results and the conclusions clearly and accurately stated?**

The limitations in using the results of the RAM analysis are referred to in the recommendations specified in Section 5.7 of the report. Some discussion should be added to detail the limitations of the results of the report based on the generic component failure rates and mean time to repair probability distribution functions used in the analysis. There should be some discussion on the Uncertainty of the results of the analysis. The ordering of system components in the Critical Items List has an uncertainty associated with it based on the uncertainty range of the generic failure rates and the recovery distribution functions/values used in the analysis.

- **Does the report provide the answer for which equipment, process steps, and operational or maintenance activities drive the combined schedule duration and the probability of delivering feed on time (that is, critical path or critical resources/equipment)?**

The critical components of the waste transfer system are provided in Appendices E, F and G for the waste transfer activities for waste tanks AN-102, AZ-101, and AN-105 respectively. The maintenance activities for recovery from system component failures are included in the recovery time distributions for each of the particular components.

A table of human actions and process steps is provided for the major activities associated with the transfer of HLW and LLW in Table D-2, D-3, D-4. Probability of human error and mean time to recover are identified for each activity. Expected mean time to recover for each incident is also provided. Delay Timeare provided for several external events in Section 3.5 that could delay the transfer process.

Critical Items Lists are provided in appendices E, F, and G for Class I, II, and III waste feed batches. The

types of CILs provided are for Systems, System and Major Elements, System Breakdown, EIN (individual components), Activity, and Component Type Category. The report provides a discussion of each of these CILs and in doing so identifies the most critical system components, activities, and waste transfer paths.

The ranking of critical tank farm equipment is addressed in the Critical Items List provided in Appendices E, F, and G. The operational activities associated with waste transfer from AN-102, AN-105, and AZ-101 are explicitly defined in the report in Section 2. Critical maintenance activities are not explicitly listed in the report. However, by inspection, it could be determined which maintenance activities are critical to the waste transfer activity based on the Critical Items Lists provided in the appendices of the report. The probability of delivering feed on time is provided in complementary cumulative distribution functions in Section 5 of the report.

- **Does the report provide the cumulative probability curves for how long it takes to retrieve and qualify feed?**

Complementary cumulative probability distribution curves for how long it takes to retrieve and qualify feed for Class I, Class II, and Class III are provided in Sections 5.1, 5.2, and 5.3 respectively. Cumulative probability curves for Total Schedule Delay Times are not provided for each of the waste types and activities.

- **Does the report provide the cumulative probability curves for completion of the delivery transfer within the feed delivery window?**

The report provides complementary cumulative probability distribution curves for how long it takes to qualify feed and retrieve feed for Class I waste (Figure 5-1 and 5-2), Class II waste (Figures 5-3), and Class III waste (Figure 5-6 and 5-7). The feed delivery window is plotted in theabove figures. The report does not provide cumulative probability distribution curves per se.

These curves are plots of probability versus time or "Days After WTD." These plots are the result of simulation runs using Crystal Ball/Excel spreadsheet models and account for system component failures, external events, human errors and mean time to repair/recover. Based on the results provided in the report there is from 1.7% to 5.7% probability of performing the waste transfers going beyond the FOM of 30 days.

- **Is the report suitable for its intended purpose?**

Based on the objectives and scope provided in Section 1.2 the intended purpose of the analysis is:

- Support evaluating the ability of the FY 2000 baseline system design and O&M concept to meet the WFD schedule requirements for three representative Phase 1 source tanks;
- Estimate the likelihood and magnitude of delivery delays associated with the tank farm O&M activities that can result in penalties to Hanford; and
- Identify preliminary RAM-related designand O&M concept changes to enhance operating margins for meeting waste delivery schedules.

Each of the above items is adequately addressed in the Preliminary RAM Analysis for the Waste Feed Delivery Operations as provided in HNF-2863 Rev. 2.

4. Conclusions and Recommendations

The current version of the *Waste Feed Delivery System Preliminary RAM Analysis* Rev. 2 report has had some significant improvements over the Rev. 1 version. These improvements come in the following technical areas of:

- A more refined Failure Modes and Effects Analysis resulting in a substantial reduction in system component failures which would result in stoppage of waste transfers,
- Accounting for backup system recovery of operations in the event of front line systems failure to continue to operate,
- Calculation of exposure and shadowing factors, and
- More detailed definition of failure rates for various systems and components.

The results contained in the first table in Section 5.2.1 of the report could not be verified by the results provided in the spreadsheet *AZ-101 Simulation. Rev 2.xls*. The 95th percentile value was the only value that could be confirmed. The other values could not be found in the spreadsheet results. **[This error was corrected in the final report and verified by the reviewer.]**

Conclusion

The *Waste Feed Delivery System Preliminary RAM Analysis* Rev. 2 report meets the scope and objectives of the report as provided in Section 1.2. It is a technically sound report and the conclusions stated in the report are based on results derived from standard RAM calculational techniques.

Table 1. Data Spot Check

Equipment Identification Number (EIN)	Component Description	Failure Mode	Failure Rate	Unit	Increment Demand	Safety	Ep	Exposure	RECOVERY TIME ID	Recovery Time Distribution	Recovery Time
AZ801A-WST-SS-101-C	Selector Switch	Fails to open/close	5.00E-08	H	N/A	TRUE	FALSE	19	1NCNNA	cb.lognormal(35.56,8.9)	35.56
AZ241-CW-AZ-CW-P-1A	Pump	Fails to start/stop	3.00E-03	PD	1	TRUE	TRUE	24	5NCNEL	cb.lognormal(89.61,39.5)	90
AZ702-VTP-RE-AZK109-1	Radiation Sensing Element	Failure	5.00E-06	H	N/A	TRUE	FALSE	19	2NCNNA	cb.lognormal(40.2,10.06)	40.20
AZ271-VTP-RAH-AZK19-1	Radiation Alarm High	Failure	3.00E-05	H	N/A	TRUE	FALSE	19	2NCNNA	cb.lognormal(40.2,10.06)	40.20
AZ801A-WT-(P-101-ELEC)	Breaker Unit	Fails to open/close	5.00E-04	VD	2	FALSE	FALSE	1	3NCNNA	cb.lognormal(38.66,9.67)	39
AZ801A-ELEC-(P101-ELEC)	Breaker Unit	Fails to open/close	5.00E-04	VD	2	FALSE	FALSE	1	3NCNNA	cb.lognormal(38.66,9.67)	39
EXTWIND06	Wind Gusts 6 hr Delay	Stoppage	1.82E-03	H	N/A	TRUE	FALSE	24	EXTWIND06	cb.lognormal(6,4.4983)	6
EXTWIND12	Wind Gusts 12 hr Delay	Stoppage	3.95E-04	H	N/A	TRUE	FALSE	24	EXTWIND12	cb.lognormal(12,8.9967)	12
AZ241-WST-XFMR-713A	Transformer	Failure	1.00E-06	H	N/A	FALSE	FALSE	0	3TCNEL	cb.lognormal(186.85,112.7)	187
EXTPRECIP	Precipitation Caused Delays	Stoppage	1.19E-03	H	N/A	TRUE	FALSE	120	EXTPRECIP	cb.lognormal(4,3.5462)	8
EXTWIND06	Wind Gusts 6 hr Delay	Stoppage	1.82E-03	H	N/A	TRUE	FALSE	120	EXTWIND06	cb.lognormal(6,4.4983)	6
AZ241-WST-DS-704A	Fused Switch	Spurious operation	1.00E-08	H	N/A	FALSE	FALSE	0	RTFRMSML01	cb.triangular(2,6,48)	6
AZ241-EDS-DP-706	Panelboard (Transformer)	Failure	1.00E-06	H	N/A	FALSE	FALSE	0	3TCNSA	cb.lognormal(65.57,28.9)	66
AZ702-VTP-AZ-K1-5-1A	Exhaust Fan	Fails to start/stop	5.00E-03	PD	1	TRUE	TRUE	24	5NCNNA	cb.lognormal(40.2,10.06)	40
AZ702-VTP-AZ-K1-5-1A	Exhaust Fan	Leakage/Rupture (all)	3.10E-07	H	N/A	TRUE	TRUE	24	5NCNNA	cb.lognormal(40.2,10.06)	40
EXTLOSP	Loss of Power to Tank Farms	Stoppage	2.28E-04	H	N/A	TRUE	FALSE	24	EXTLOSP	cb.lognormal(1.9,1.4245)	6
AZ101-WST-P-702A	Mixer Pump	Fails to run (non-catastrophic)	3.79E-04	H	N/A	FALSE	FALSE	24	RTTMPSML01	cb.triangular(4,72,120)	65
AZ156-WST-EI-DM11	Voltage Indicator	Failure	1.00E-05	H	N/A	FALSE	FALSE	24	1NCNNA	cb.lognormal(35.56,8.9)	36
AZ271-VTP-RI-AZK19-1	Radiation Indicator	Failure	1.00E-05	H	N/A	TRUE	FALSE	24	1NCNNA	cb.lognormal(35.56,8.9)	36

Table 2. Simulation Sheet Spot Check

Equipment Identification Number (EIN)	Dynamic Exposure	Failure Frequency	Frequency of Delay	Expected Total Delay	Shadow Factor	Frequency of Schedule Delay	Expected Schedule Delay	RAND()	Recovery Time Distribution	Off-Normal Event?	Delay Time	Number of Off-Normal Events
AZ801A-WST-SS-101-C	48.85	2.44E-06	2.44E-06	0.00	100.0%	2.44E-06	0.00	1.8E-02	3.56E+01	Succeeds	No Delay	10
AZ241-CW-AZ-CW-P-1A	25.75	7.72E-02	8.53E-04	0.08	100.0%	8.53E-04	0.08	1.7E-02	8.96E+01	1	No Delay	
AZ702-VTP-RE-AZK109-1	48.85	2.44E-04	2.44E-04	0.01	100.0%	2.44E-04	0.01	3.4E-01	4.02E+01	Succeeds	No Delay	Number of Delay Events
AZ271-VTP-RAH-AZK19-1	48.85	1.47E-03	1.47E-03	0.06	100.0%	1.47E-03	0.06	6.2E-04	4.02E+01	1	40.2	8
AZ801A-WT-(P-101-ELEC)	2.24	1.12E-03	1.12E-03	0.04	100.0%	1.12E-03	0.04	7.6E-04	3.87E+01	1	38.7	
AZ801A-ELEC-(P101-ELEC)	2.24	1.12E-03	1.12E-03	0.04	100.0%	1.12E-03	0.04	1.0E+00	3.87E+01	Succeeds	No Delay	Total Schedule Delay (hours)
EXTWIND06	46.27	8.43E-02	8.43E-02	0.51	100.0%	8.43E-02	0.51	3.5E-03	6.00E+00	1	6.0	198
EXTWIND12	46.27	1.83E-02	1.83E-02	0.22	100.0%	1.83E-02	0.22	4.1E-01	1.20E+01	Succeeds	No Delay	
AZ241-WST-XFMR-713A	0.00	0.00E+00	0.00E+00	0.00	100.0%	0.00E+00	0.00	9.3E-02	1.87E+02	Succeeds	No Delay	
EXTPRECIP	155.84	1.86E-01	1.86E-01	1.49	100.0%	1.86E-01	1.49	4.2E-02	4.00E+00	1	4.0	
EXTWIND06	155.84	2.84E-01	2.84E-01	1.70	100.0%	2.84E-01	1.70	2.3E-01	6.00E+00	1	6.0	
AZ241-WST-DS-704A	0.00	0.00E+00	0.00E+00	0.00	100.0%	0.00E+00	0.00	1.5E-03	1.87E+01	Succeeds	No Delay	
AZ241-EDS-DP-706	0.00	0.00E+00	0.00E+00	0.00	100.0%	0.00E+00	0.00	9.5E-01	6.56E+01	Succeeds	No Delay	
AZ702-VTP-AZ-K1-5-1A	25.75	1.29E-01	7.79E-04	0.03	100.0%	7.79E-04	0.03	5.4E-02	4.02E+01	1	No Delay	
AZ702-VTP-AZ-K1-5-1A	79.94	2.48E-05	1.50E-07	0.00	100.0%	1.50E-07	0.00	7.7E-02	4.02E+01	Succeeds	No Delay	
EXTLOSP	46.27	1.06E-02	1.06E-02	0.06	100.0%	1.06E-02	0.06	8.8E-03	1.90E+00	1	1.9	
AZ101-WST-P-702A	24.00	9.10E-03	9.10E-03	0.59	100.0%	9.10E-03	0.59	7.1E-03	6.53E+01	1	65.3	
AZ156-WST-EI-DM11	24.00	2.40E-04	2.40E-04	0.01	100.0%	2.40E-04	0.01	5.4E-01	3.56E+01	Succeeds	No Delay	
AZ271-VTP-RI-AZK19-1	46.27	4.63E-04	4.63E-04	0.02	100.0%	4.63E-04	0.02	2.0E-04	3.56E+01	1	35.6	

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Attachment 02 - Sheet 1 of 1

FLUOR DANIEL NORTHWEST

TECHNICAL PEER REVIEWS

CHECKLIST FOR TECHNICAL PEER REVIEW

Document Reviewed: Waste Feed Delivery System Phase I
Title: Preliminary RAM Analysis HNF-2863 Rev 2
Author: EQE International Inc.
Date: September 28, 2000
Scope of Review: Document and related Spreadsheets

Yes	No*	NA	
[ ]	[ ]	[X] **	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
[X]	[ ]	[ ]	Problem completely defined.
[ ]	[ ]	[X]	Accident scenarios developed in a clear and logical manner.
[X]	[ ]	[ ]	Necessary assumptions explicitly stated and supported.
[X]	[ ]	[ ]	Computer codes and data files documented.
[X]	[ ]	[ ]	Data used in calculations explicitly stated in document.
[X]	[ ]	[ ]	Data checked for consistency with original source information as applicable.
[ ]	[ ]	[X]	Mathematical derivations checked including dimensional consistency of results.
[X]	[ ]	[ ]	Models appropriate and used within range of validity, or use outside range of established validity justified.
[X]	[ ]	[ ]	Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
[X]	[ ]	[ ]	Software input correct and consistent with document reviewed.
[X]	[ ]	[ ]	Software output consistent with input and with results reported in document reviewed.
[ ]	[ ]	[X]	Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
[ ]	[ ]	[X]	Safety margins consistent with good engineering practices.
[X]	[ ]	[ ]	Conclusions consistent with analytical results and applicable limits.
[X]	[ ]	[ ]	Results and conclusions address all points required in the problem statement.
[ ]	[ ]	[X]	Format consistent with applicable guides or other standards.
[ ]		[X] **	Review calculations, comments, and/or notes are attached.
[X]	[ ]	[ ]	Document approved (for example, the reviewer affirms the technical accuracy of the document).

David J. Braun David J. Braun 9-28-00
Reviewer (printed name and signature) Date

* All "no" responses must be explained below or on an additional sheet.

** Any calculations, comments, or notes generated as part of this review should be signed, dated, and attached to this checklist. The material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.

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