AUG 25 1998 22
Sta 37

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT 621679

2. To: (Receiving Organization) Distribution	3. From: (Originating Organization) B. B. Peters, Process Development	4. Related EDT No.: NA
5. Proj./Prog./Dept./Div.: TWRS	6. Design Authority/ Design Agent/Cog. Engr.:	7. Purchase Order No.: NA
8. Originator Remarks: For approval and release.		9. Equip./Component No.: NA
		10. System/Bldg./Facility: NA
11. Receiver Remarks: 11A. Design Baseline Document? [] Yes [X] No		12. Major Assm. Dwg. No.: NA
		13. Permit/Permit Application No.: NA
		14. Required Response Date:

15. DATA TRANSMITTED

(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	(F) Approval Designator	(G) Reason for Transmittal	(H) Originator Disposition	(I) Receiver Disposition
1	HNF-2540	-	0	Low-Activity Waste Feed Delivery--Minimum Duration Between Successive Batches	NA	1,2	1	

16. KEY

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

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

(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN
		Design Authority									
		Design Agent									
1	1	Cog.Eng. B. B. Peters	BBPeters	8/19/98	~~H5-03~~ R3-73						
1	1	Cog. Mgr. J. S. Garfield	JSGarfield	8/20/98	H5-49						
		QA									
		Safety									
		Env.									

18.	19.	20.	21. DOE APPROVAL (if required)
B. B. Peters BBPeters 8/19/98 Signature of EDT Originator / Date	[signature] 8/20/98 Authorized Representative for Receiving Organization / Date	J. S. Garfield [signature] 8-20-98 Design Authority/ Cognizant Manager / Date	Ctrl. No. [] Approved [] Approved w/comments [] Disapproved w/comments

BD-7400-172-2 (05/96) GEF097

BD-7400-172-1

Low-Activity Waste Feed Delivery--Minimum Duration Between Successive Batches

B. B. Peters (MACTEC) and R. S. Wittman
Numatec Hanford Corporation, Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: EDT 621679 UC: 721
Org Code: 8C451 Charge Code: D2D28
B&R Code: EW3130010 Total Pages: 159

Key Words: low-activity waste, waste feed delivery

Abstract: The purpose of this study is to develop a defensible basis for establishing what "minimum duration" will provide acceptable risk mitigation for low-activity waste feed delivery to the privatization vendors. The study establishes a probabilistic-based duration for staging of low-activity waste feed batches. A comparison is made of the durations with current feed delivery plans and potential privatization vendor facility throughput rates.

AUG 25 1998
DATE: HANFORD RELEASE ID:
STA: 37 22

V. L. Birkland 8/25/98
Release Approval Date

Release Stamp

Approved for Public Release

HNF-2540
Revision 0

LOW-ACTIVITY WASTE FEED DELIVERY--MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES

August 1998

B. B. Peters
MACTEC
Richland, Washington

and

R. S. Wittman
Numatec Hanford Corporation
Richland, Washington

Prepared for
U.S. Department of Energy
Richland, Washington

This page intentionally left blank.

EXECUTIVE SUMMARY

The U.S. Department of Energy-Richland Operations Office (RL) is in the first stages of contracting with private companies for the treatment and immobilization of tank wastes. The tank waste retrieval, treatment, and immobilization mission has been conceived to occur in two phases. In Phase 1, the Project Hanford Management Contractor (PHMC) team will deliver tank waste to two private contractors on behalf of RL. The private contractors will demonstrate the capability to treat (separate and immobilize) the waste. Three envelopes of low-activity waste (LAW) (Envelopes A, B and C) will be processed during Phase 1. During Phase 2 the private contractors will retrieve, treat, and immobilize the waste.

One of the primary risks that the PHMC team has identified that must be managed to successfully meet the feed delivery requirements for the Phase 1 feed delivery is the following:

> The final contracts for Phase 1B with the private contractors may be for a higher feed rate than the Tank Waste Remediation System (TWRS) Project Contractor can initially deliver. In addition, private contractor contracts for Phase 1B may deviate from specifications in the Phase 1A contracts or from planning assumptions made by the TWRS Project Contractor.

A key recommendation to mitigate this risk and increase the robustness of the feed delivery system is to "impose a minimum time duration between the completion of the delivery of one feed batch and the waste transfer date for the following batch."

A study to develop a basis for establishing this minimum duration was completed which had the following key conclusions:

- *At a 95 percent probability, the minimum duration was determined to be 260 days for Envelope A and 190 days for Envelope's B and C. It was concluded that the Waste Feed Delivery system had a high probability of supporting delivery of waste* *feed for a privatization contractor processing rate of 2 MT Na/day per contractor.*

- *Even if all activities were completed within an optimistic time frame there would be only a small (approximately 20 percent) overall improvement in the total time required to retrieve, qualify, and deliver a batch of LAW.*

- *Waste feed adjustment to meet an envelope requirement can increase substantially the time required to retrieve, qualify, and deliver a batch of LAW. Chemical shimming can add 10 to 20 days, blending waste from another tank can add 50 to 90 days, and side-pocketing a feed batch and restaging the next feed batch can add 100 to 140 days.*

The purpose of this study is to develop a basis for establishing what "minimum duration" will provide acceptable risk mitigation for LAW feed delivery to the privatization vendors. The study establishes a probabilistic-based duration for staging of LAW feed batches. A comparison is made of the durations with current feed delivery plans and potential privatization vendor facility throughput rates. These durations are expressed in terms of the minimum duration between successive LAW batches. That is the time required to retrieve, transfer, adjust (if necessary), and qualify a LAW feed batch.

The study scope was the operational phase of waste retrieval, staging, and feed qualification only. It did not address risks from project delays or the ability to accelerate projects to support higher vendor processing rates. A key assumption is that all necessary equipment is in place and initially functional to support waste feed delivery.

Two retrieval and four waste feed adjustment scenarios were modeled. Laboratory sample analysis was identified as a key schedule risk element so a sensitivity analysis was completed to assess three alternative laboratory enabling assumptions. Detailed activity schedules were developed for each case based on the schedule developed in support of the Readiness-To-Proceed effort. Information regarding specific activity durations was obtained from knowledgeable individuals from the responsible organizations. The information obtained included what would make an activity take longer than expected or finish sooner than expected and three durations which describe the activity (optimistic, best estimate, pessimistic). These three values were used to establish a duration uncertainty (probability) curve for that particular activity (e.g., 50 percent of the time it can be completed in less than 10 days and 95 percent of the time in less than 20 days).

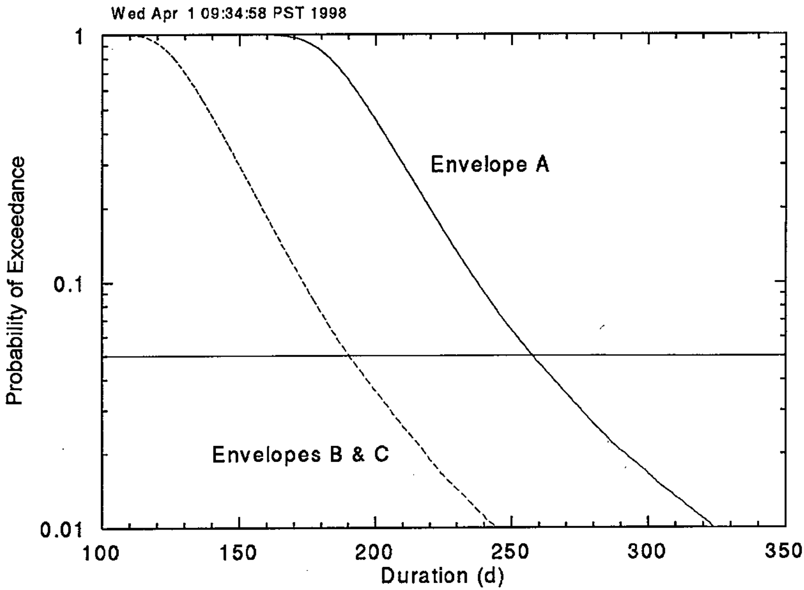
A Monte Carlo approach was adopted to calculate the probability of successfully delivering feed, given the quantified uncertainties in each of the feed staging activities. In this approach, the total time required to complete delivery of a waste feed batch is calculated many times (100,000). For each iteration, one point within the duration range of each individual task is selected randomly (based on the assigned probability curve) and the resulting overall duration for feed delivery is determined. Results from the multiple Monte Carlo runs are compiled to establish an overall duration probability curve for waste feed delivery.

Envelope A retrieval is more involved than that for Envelopes B and C (dissolution of precipitated salts). Therefore, it requires more time to retrieve, stage, and qualify. Envelopes B and C consist primarily of decant transfers without solids dissolution (sludges are left in the source tank). Therefore, the retrieval times are shorter. The times required to retrieve, stage and qualify a LAW feed batch as a function of probability are listed in Table ES-1 and shown graphically in Figure ES-1.

Table ES-1. Minimum Duration Between Successive Low-Activity Waste Batches If No Feed Adjustment is Required.

	Time required to retrieve, stage, and qualify a low-activity waste feed batch (days)		
	50% probability	80% probability	95% probability
Envelope A	<200	<220	<260
Envelopes B and C	<140	<160	<190

Figure ES-1. Cumulative Duration Probability--Waste Feed Delivery.



Comparing these durations with the currently planned waste feed batches, it can be concluded that Waste Feed Delivery (WFD) can successfully support privatization vendor processing rates of 2 MT Na/day per vendor but probably not 3 MT Na/day.

- *2 MT Na/day: WFD System has >90 percent Probability of Success except for Batches 4 and 9 (40 to 75 percent)*

- *3 MT Na/day: WFD System has >70 percent Probability of Success except for Batches 3, 4, and 9 which have little chance (<15 percent, assumes Projects can be accelerated to support).*

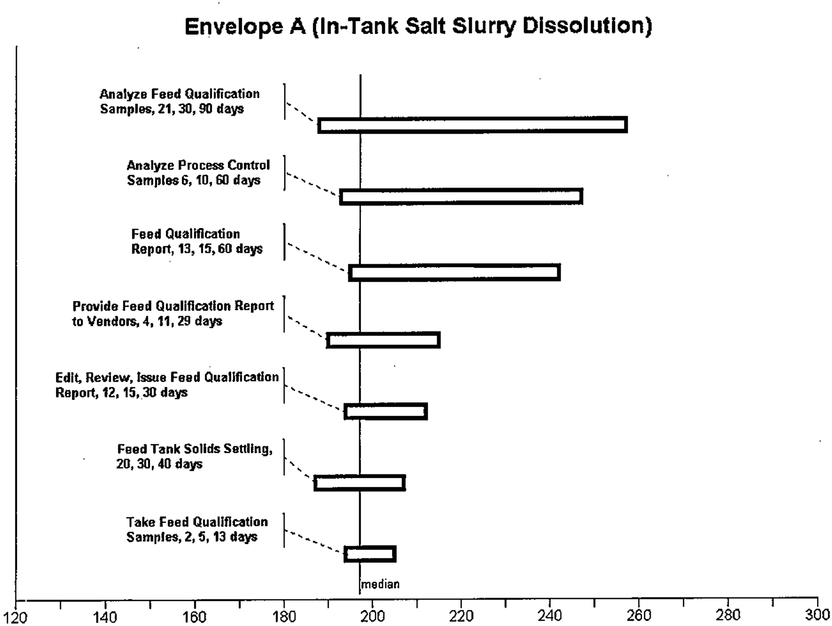
The three types of waste feed adjustments have different impacts to the feed delivery schedules. Shimming can extend the delivery schedule 10 to 20 days, blending waste from another tank can add 50 to 90 days, and side-pocketing the feed batch and staging the next batch (restaging) can add 100 to 140 days.

The relative impacts of the most significant activities are shown graphically as a tornado diagram in Figure ES-2. The vertical center line of the tornado is placed at the median duration for the full retrieval scenario modeled. Each of the bars represents a significant activity with the median duration for the activity aligned with that for the full retrieval. The left side of each bar represents the "optimistic" duration for the activity while the right side represents the "pessimistic" value. These three values are shown along with the title for each activity.

As can be seen, analysis of waste samples and issuing the Feed Qualification report are the primary contributors to the retrieval/staging/qualification time. The position of the bars also shows that even if all activities were completed within the optimistic time there would be a small improvement (approximately 20 percent) in the total time required. Alternatively, the pessimistic values, which represent various types of failures during the activity, can significantly extend the total time required. The key sample analysis risk is a laboratory shut-down resulting from audit/non-compliance findings. The other primary contributor to schedule risk is adjustment of the waste feed composition if it doesn't meet the envelope specification. The key risk associated with feed adjustment is developing options for completing the adjustment and getting a decision and approval to proceed.

Based on areas of risk identified by this study and previous ones, there are several changes to DOE guidance and to PHMC plans which could reduce the risks associated with supporting waste feed delivery to the privatization vendors. These include the following:

Figure ES-2. Tornado Diagram--Waste Feed Delivery.



1. *Contract terms require delivery of small batches of Envelopes B and C during proof-of-concept (to meet minimum order quantities). Refine contract terms to allow delivery of larger feed batches. This would allow the delivery of batches 7 and 8 in one transfer rather than as separate batches. This also provides more time for delivery of batch 9 which is at risk for meeting the delivery schedule (< 40 percent probability).*

2. *Negotiate a compensatory model which quantifies impacts to the privatization vendors (costs, waste loading, secondary waste, etc.) resulting from processing low-activity waste which does not meet the envelope specifications. This provides the basis for decisions regarding cost and schedule impacts of making adjustments to waste feed compositions.*

3. *Develop detailed plans for performing a range of feed adjustments prior to initiating retrieval of the applicable feed batch. Also, have procedures and plans in place for obtaining a DOE decision regarding feed adjustment. These are necessary to minimize the schedule impacts resulting from a feed batch being outside the contract specification.*

4. *Reverse the order for delivery of batches 3 and 4. Batch 3 is currently tank 241-AW-101 (856 MT Na) and batch 4 is tank 241-AN-103 (1170 MT Na). Reversing the order to deliver the larger batch first provides more time to deliver the tank 241-AW-101 feed batch. The current batch 4 is somewhat at risk for meeting the delivery schedule (approximately 75 percent probability). There should be no impact to batch 5 in either case.*

5. *Develop and maintain the capability for waste feed qualification at a backup laboratory or split the sample load between two labs. This reduces the risk that a single-point failure (laboratory shut-down) could halt waste feed delivery.*

6. *Change the current process control sampling approach. The current approach for tanks which require solids dissolution (batches 1-4, 11, 12) is to sample the source tank after solids dissolution and then to sample the staging tanks (241-AP-102/4) after the dissolved solids are mixed with the original supernatant. Changing the sample timing to take both samples at the same time will save at least 10 days. The two samples can be mixed in the laboratory to determine what the final composition will be in the staging tanks.*

In conclusion, a study was completed to determine the minimum duration between successive LAW feed batches that the baseline WFD system could support. At a 95 percent probability, this was determined to be 260 days for Envelope A and 190 days for Envelopes B and C. It was concluded that the baseline WFD system had a high probability of supporting delivery of waste feed for a privatization contractor processing rate of 2 MT Na/day per vendor. A number of key schedule risk areas were identified and opportunities to reduce these risks were listed.

CONTENTS

1.0 INTRODUCTION 1
1.1 BACKGROUND 1
1.2 STUDY PURPOSE 1

2.0 APPROACH 3
2.1 MODELING METHOD 3
2.2 CASES MODELED 4
2.2.1 Feed Retrieval Cases 6
2.2.2 Feed Adjustment Cases 7
2.2.3 Sample Analysis Sensitivity 8

3.0 RESULTS 11
3.1 WASTE RETRIEVAL 13
3.2 FEED ADJUSTMENT 14
3.3 SAMPLE ANALYSIS SENSITIVITY 16
3.4 COMPARISON TO PLANNED FEED BATCHES 16
3.5 SUMMARY OF STUDY ASSUMPTIONS/CAVEATS 20

4.0 QUALITY ASSURANCE 23

5.0 SUMMARY AND CONCLUSIONS 23

6.0 REFERENCES 27

APPENDIXES

A - CASES A-F: GANTT CHARTS A-1

B - ACTIVITY DATA SHEETS B-1

C - LABORATORY SAMPLE ANALYSIS SENSITIVITY BASES C-1

D - UNIQUE ACTIVITY PROBABILITY DISTRIBUTION SUMMARIES D-1

E - ACTIVITY CROSS-REFERENCE TABLE E-1

F - CASES A-F, S1-S3: DENSITY DISTRIBUTIONS AND ACTIVITY CORRELATIONS F-1

G - MONTE CARLO COMPUTER CODE (FORTRAN) G-1

LIST OF FIGURES

3-1. Failure Probability for Each Feed Delivery Case. 12

3-2. Tornado Diagram for Case A. 14

3-3. Tornado Diagram for Case E. 15

3-4. Low-Activity Waste Feed Delivery--2 MT Na/day 19

3-5. Low-Activity Waste Feed Delivery--3 MT Na/day. 19

3-6. Impacts of Increasing an Activity by 30 Days. 21

LIST OF TABLES

2-1. Feed Delivery Batch Cycle Time (Typical) 5

2-2. Sample Analysis Sensitivity Case S1 9

2-3. Sample Analysis Sensitivity Case S2 9

2-4. Sample Analysis Sensitivity Case S3. 10

3-1. Feed Delivery Duration at given Success Probability 11

3-2. Feed Adjustment Schedule Impacts. 14

3-3. Laboratory Options Schedule Impacts 16

3-4. Waste Feed Processing Times 17

3-5. Waste Feed Throughput Impacts 18

5-1. Minimum Duration Between Successive Low-Activity Waste Batches
If No Feed Adjustment is Required. 24

LIST OF TERMS

DOE	U.S. Department of Energy
DST	Double-shell tank
FDH	Fluor Daniel Hanford, Inc
FGWL	Flammable Gas Watch List.
ICD	Interface Control Document
IWFT	Intermediate waste feed tank
LAW	Low-activity waste
LMHC	Lockheed Martin Hanford Corporation
PHMC	Project Hanford Management Contractor
RL	U.S. Department of Energy-Richland Operations Office
RTP	Readiness to Proceed
TBR	Technical Baseline Report
TWRS	Tank Waste Remediation System
TWRSO&UP	Tank Waste Remediation System Operation and Utilization Plan
WFD	Waste Feed Delivery

This page intentionally left blank.

LOW-ACTIVITY WASTE FEED DELIVERY-- MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES

1.0 INTRODUCTION

1.1 BACKGROUND

The U.S. Department of Energy Richland Operations Office (RL) is in the first stages of contracting with private companies for the treatment and immobilization of tank wastes. The tank waste retrieval, treatment, and immobilization mission has been conceived to occur in two phases. In Phase 1, the Project Hanford Management Contractor (PHMC) team will deliver tank waste to two private contractors on behalf of RL. The private contractors will demonstrate the capability to treat (separate and immobilize) the waste. Three envelopes of low-activity waste (LAW) (Envelopes A, B, and C) will be processed during Phase 1. During Phase 2 the private contractors will retrieve, treat, and immobilize the waste.

To meet RL's anticipated contractual requirements, the Project Hanford Management Contractor (PHMC) team will be required to provide waste feeds to the private contractors. These will need to be consistent with waste envelopes that define the feeds in terms of quantity and concentration of both chemicals and radionuclides.

One of the primary risks that the PHMC team has identified (Payne et al. 1998) which must be managed to successfully meet the feed delivery requirements for the Phase 1 feed delivery is the following:

> *The final contracts for Phase 1B with the private contractors may be for a higher feed rate than the Tank Waste Remediation System (TWRS) Project Contractor can initially deliver. In addition, private contractor contracts for Phase 1B may deviate from specifications in the Phase 1A contracts or from planning assumptions made by the TWRS Project Contractor.*

A key recommendation (Payne et al. 1998) to mitigate this risk and increase the robustness of the feed delivery system is to "impose a minimum time duration between the completion of the delivery of one feed batch and the waste transfer date for the following batch."

1.2 STUDY PURPOSE

The purpose of this study is to develop a basis for establishing what "minimum duration" will provide acceptable risk mitigation for LAW feed delivery to the privatization vendors. The study establishes a probabilistic-based duration for staging of LAW feed batches. These durations are expressed in terms of the minimum duration between successive LAW batches. That is the time required to retrieve, transfer, adjust (if necessary), and qualify a LAW feed batch. It is assumed that all equipment is in place and functional and that the intermediate staging tanks (241-AP-102 and 241-AP-104) are empty. The probability for successfully delivering feed is compared with possible feed processing schedules of the private contractors. The processing rate of the private contractors, along with the size of the batch, sets the time between feed batches. Ideally, each successive batch should be delivered within this time. While the Readiness to Proceed (RTP) effort gives a best estimate for the time required for delivering feed to private contractors, it leaves open the question of a confidence for successfully achieving that best estimate. Furthermore, how does our confidence change if more or if less time is allowed for feed delivery? This "confidence" information is required to establish a feed delivery duration that is "as small as possible," but is still achievable at significant level of confidence.

2.0 APPROACH

The approach used to quantify a probability for successfully delivering feed in a given time is described in the following sections and is summarized below.

This approach builds on the RTP effort (Swita et al. 1998) by developing detailed schedules for different possible Waste Feed Delivery (WFD) scenarios. The baseline scenario (Case A) was primarily taken from the schedule given in the RTP work. Six distinct scenarios (Cases A-F) were developed to account for 10 of the 12 batches. Two batches (7 and 8) will be qualified in the source tank 241-AN-107. Therefore, the minimum duration is simply the time required to decant a total of approximately 5.7 ML (1.5 Mgal) to tanks 241-AP-102 and 241-AP-104 (approximately 10 days). The delivery of these two batches was not modeled. Each scenario is a schedule of linked activities that must occur for delivering feed. The schedule also allows the occurrence of off-normal events that can cause delays. The critical path through the schedule can be determined only after durations for individual activities and events are assigned. The schedule is evaluated many times with a Monte Carlo approach. Each evaluation of the schedule depends on summing activity durations which are selected randomly from an expected distribution assigned by the individual "activity expert." The raw result of the approach is the distribution of WFD durations for each scenario. The resulting distributions are then used to estimate the probability that feed can be delivered successfully within a given duration.

2.1 MODELING METHOD

A Monte Carlo approach (Press et al. 1992, Kalos and Whitlock 1986) was adopted to calculate the probability of successfully delivering feed, given the uncertainties in feed staging activities and events. In principle, Monte Carlo can be used for any problem that has a probabilistic interpretation, or formulation, or both. The huge number of applications will not be reviewed here, but include simulation of stochastic processes, radiation transport, solution of certain integral equations, performing sensitivity analysis and representing variable uncertainty. For these applications, Monte Carlo practically involves little more than a collection of random decision points and values with some simple arithmetic in between. This, of course, is its advantage. Normally, it is arranged so that each simulated result can be considered an independent observation or measurement in a numerical experiment. Therefore, convergence of the Monte Carlo approach is controlled by the central limit theorem--the uncertainty in the observables decreases as $1/\sqrt{N}$, where N is the number of independent observations.

The tools of the method are: (1) a good pseudo random number generator, and (2) a model that specifies how the random values combine to give one or more results. For this work, we use a long period ($>2\times10^{18}$) random number generator of L'Ecuyer with Bays-Durham shuffle (Press et al. 1992) to generate uniform deviates. The uniform deviates are then mapped to the desired probability distribution through the cumulative distribution function. The model for combining the random values is the Feed Delivery schedule.

For this analysis, the Monte Carlo approach can be understood by considering a Feed Delivery history (a realization of the schedule) to be a single experimental observation (i.e., a data point). The input distributions for individual activities should then be viewed as the probability that an activity duration falls within a prescribed range of values for any given history. The method of soliciting information from experts to construct the probability distributions was patterned after Zimmerman et al. (1997). While the process of capturing expert knowledge as a probability distribution involves some subjectivity on the part of the analyst, the important distributions were reviewed for final acceptance by the experts. Additionally, it was determined that the bulk shape of the distributions is unimportant. The important features of a distribution were found to be its central value (Median) and the extent to which the tail reaches beyond a set pessimistic value. This will be discussed further in results Section 3.0.

Once a random value is assigned to the duration of each activity according to its respective distribution, the total duration is calculated simply as the sum of durations along the critical path. The critical path will vary between different observations. The observables are the total duration, its variability, and the correlation of durations for individual activities with the total duration. The probability that the total duration for Feed Delivery falls in some specified range also can be determined. Furthermore, a success probability can be calculated for a given upper bound on the time allowed for Feed Delivery. This success probability for various delivery durations gives important guidance for establishing a minimum duration that the program can reasonably support.

In most cases, the results reported in Section 3 were calculated with 100,000 observations. Since the correlation observables are differences between expectation values, they were calculated with 100,000 observations and again with 20,000,000 observations to ensure convergence. The population size effects on the correlations between the two runs were only a few percent and would not be noticeable on the plotted results.

2.2 CASES MODELED

A prototypical schedule defined by the RTP effort (Swita et al. 1998) is summarized in Table 2-1. This schedule forms the bases for developing cases that represent feed staging alternatives to the baseline.

Table 2-1. Feed Delivery Batch Cycle Time (Typical).

RTP Activities	RTP
Mobilize and Retrieve LAW from Source Tank • Decant Supernate with In-Line Dilution • Add Dilution Water and Dissolved Solids In-Tank • Mix Tank and Take Process Control Samples • Decant Dissolved Solids	69 Days
Adjust Staged Feed As Required • Mix Tank and Take Process Control Samples • Select Feed Adjustment and Document • Add Chemical (Shim) Solution	28 Days
Feed Qualification • Mix Tank and Take Feed Qualification Samples (for PHMC, Private Contractor, And Archive) • Provide Samples to Private Contractor • Analyze Samples and Issue Sample Qualification Report • Provide Sample Qualification Report to Private Contractors	85 Days
TOTAL DURATION*	182 Days

*From when 241-AP-102 and 241-AP-104 are empty from previous batch to when the next batch is ready for delivery to the Private Contractors.

LAW = Low-activity waste

PHMC = Project Hanford Management Contractor

RTP = Readiness to Proceed.

Two retrieval and four waste feed adjustment scenarios were modeled (cases A-F). Waste sample laboratory analysis was identified as a key schedule risk element so a sensitivity analysis was completed to assess three alternative laboratory enabling assumptions (cases S1-S3). The schedules for these cases are provided in Appendix A as Gantt charts. Information regarding specific activity durations was obtained from knowledgeable individuals from the responsible organizations. The information obtained included what would make an activity take longer than expected or finish sooner than expected and three durations which describe the activity (optimistic, best estimate, pessimistic). This information was obtained for all of the unique activities and was recorded on activity-specific data sheets (Appendix B). A detailed description of the laboratory sample analysis sensitivity bases and assumptions is given in Appendix C.

There are a number of ways specific activities are identified and tracked. A total of 213 activities are shown in the full schedules in Appendix A. These schedules define all of the six cases studied. These activities are identified as ID in Appendix A and "Minimum Duration Study Activity ID" or "Activity ID" in the remaining appendices. Many of these activities are repeated a number of times in each case. Full sets of information for each of these "unique" activities were compiled as shown in Appendix B. Duration probability curves were established only for these unique activities.

A summary of the unique activities showing the activity ID number, the corresponding RTP activity ID, and the activity duration and density function is provided in Appendix D. Figures showing the distributions are also provided. They provide the analytic form of the density function (solid line) and the binned values for 100,000 observations. A cross-reference table is provided in Appendix E. This table lists all of the modeled activities and shows the corresponding unique activity.

The following sections describe the modeled cases in more detail.

2.2.1 Feed Retrieval Cases

Feed retrieval cases assume that the feed composition is well established; the delivery of the feed to the private vendors involves a direct transfer of Envelope A feed to an intermediate staging tank (241-AP-102 or 241-AP-104). Two general retrieval cases were evaluated. The baseline Case A assumed an in-tank dissolution of solids requiring multiple dissolution/decant transfer steps. Case F assumed in-line dilution during the decant transfer (Envelope A with in-line solids dissolution, Envelopes B and C).

2.2.1.1 Case A. Case A is comprised of 34 independent activities of which 23 were considered to be unique, and therefore have unique distributions. This case assumes no feed adjustments, in-tank solids dissolution, and multiple decant operations that transfer waste from the LAW Feed Tank to 241-AP-102 and 241-AP-104. The case begins with the addition of diluent to the transfer pump recirculation loop to prepare for decant transfers. After possible delays due to transfer line conflicts, each half of the LAW Feed Tank supernatant is decanted, sequentially, to 241-AP-102 and to 241-AP-104. Following the transfer, dilution water is added to the LAW Feed Tank and soluble solids are dissolved using mixer pumps.

After mixing, the remaining undissolved solids are allowed to settle. While solids are settling, processes control samples are taken from the LAW Feed Tank. The samples are analyzed and results are evaluated to indicated any variations from the expected feed composition. After evaluating the processes control samples and settling the solids, each half of the LAW Feed Tank supernatant is again decanted, sequentially, to 241-AP-102 and to 241-AP-104, with possible delays occurring due to transfer line conflicts. After running a mixer pump in the intermediate waste feed tank (e.g., 241-AP-104), additional process control samples are taken.

The samples are analyzed and evaluated to establish the feed composition prior to performing the feed qualification. Once again, the feed is mixed before taking the Feed Qualification and Private contractor samples. Samples are delivered to the Private contractor while the qualification samples are analyzed and the results are reported. The evaluation of sample results occurs concurrently with preparation and issuing of the draft report, but both are completed prior to the final editing review and issuing of the feed qualification report. The results are summarized in a transmittal letter; release approval is obtained from Lockheed Martin Hanford Corporation (LMHC). The necessary data are transmitted from Fluor Daniel Hanford, Inc. (FDH) to RL allowing the final conditions for feed processing to be agreed upon. With the successful completion of all previous activities, and when a transfer pathway to 241-AP-106 or 241-AP-108 has been setup, the feed is considered to be ready for delivery. Additionally, the small chance for delays due to independent failures of a transfer pump and/or a mixer pump is included in the schedule. This delay corresponds to the approximate time necessary for the major capital equipment replacement.

2.2.1.2 Case F. Case F is comprised of 22 independent activities, all of which are specified in Case A. This case assumes no feed adjustments and a simple decant operation that transfers waste from the LAW Feed Tank to 241-AP-102 and 241-AP-104. A few activities that appear in Case A do not appear here. If solids dissolution is required, it is assumed that dissolution occurs in the trauster line. This eliminates the need to add dilution water to the tank and perform mixing. If necessary mixing of solids and dilution water occurs concurrently with the actual decant transfer of the waste to 241-AP-102 and to 241-AP-104. Additionally, the need for two processes control samples and their evaluation is eliminated. Only the samples from the intermediate waste feed tank are necessary.

2.2.2 Feed Adjustment Cases

The acceptance by the private vendor of any LAW batch is conditional on that feed meeting several composition requirements. Those requirements are related to the processability as well as the storability of the feed. The storability of the feed relates to its composition being within specs to minimize corrosion of the DST's carbon steel lining. The processability of the feed relates to its composition being within specs of the private vendor's vitrification process. Three feed envelopes have been defined to allow for feed variability. Each of the 12 batches to be delivered have been assigned to one of the three feed envelopes, yet; it is expected that some "feed adjustment" of the composition may be necessary for certain batches. Cases B, C and D are scenarios for which the necessary feed adjustment is performed during the staging. Two types of adjustments are considered:

1. Shimming-direct chemical additions of NaOH solution

2. Blending - the mixing of wastes from other DSTs with the staged LAW. Two blending cases are considered: directly adding the blend material to the intermediate waste feed tank (IWFT) (241-AP-102/104), and transfer of part of the staged waste out of the IWFT to make room for the blend material

Case E considers the possibility that restaging of the next LAW feed tank will be required.

2.2.2.1 Case B. Case B is comprised of 35 independent activities of which only two are unique. All others occur in Case A. This case assumes in-tank solids dissolution, the occurrence of a shimming feed adjustment, and multiple decant operations that transfer waste from the LAW Feed Tank to 241-AP-102 and 241-AP-104. The only difference from Case A is the chemical addition to the intermediate waste feed tank. This occurs after the second process control sample is evaluated and a process memo is written and issued.

2.2.2.2 Case C. Case C is comprised of 37 independent activities of which only two are unique. All others occur in Case A. This case assumes in-tank solids dissolution, multiple decant operations that transfer waste from the LAW Feed Tank to 241-AP-102 and 241-AP-104 and a blending feed adjustment. The only difference from Case A is the preparation of blending stock and its addition to the intermediate waste feed tank. This occurs after the second process control sample is evaluated a decision is made to blend, and a process memo is issued.

2.2.2.3 Case D. Case D is comprised of 40 independent activities of which only one is unique. All others occur in Case C. The complete schedule with a brief description of the schedule activities is given in Appendix A. This case assumes in-tank solids dissolution, multiple decant operations that transfer waste from the LAW Feed Tank to 241-AP-102 and 241-AP-104, and a blending feed adjustment. The only difference from Case C is the transfer of part of the staged waste out of the IWFT to make room for addition of the blending stock. This occurs after the second process control sample is evaluated, a decision is made to blend, and a process memo is issued.

2.2.2.4 Case E. Case E is comprised of 40 independent activities of which three are unique. All others occur in Case A. The complete schedule with a brief description of the schedule activities is given in Appendix A. This case assumes the full feed staging activities of Case A but with a determination after the second process control sample is analyzed, that the feed is too far out of specification to adjust. The decision is made that the staged feed needs to be transferred to an empty tank(s) and the next LAW feed tank is staged in its place.

2.2.3 Sample Analysis Sensitivity

The analysis of feed qualification samples has a key impact on the overall WFD schedule. This is because it can easily be one of the longest duration activities in the schedule. Even assuming a high priority of the laboratory's resources dedicated to WFD, a pessimistic duration of 90 days was assigned with a lognormal tail of 2 percent reaching beyond the 90 days. There are two general types of failures inherent in the pessimistic value. In general "management-type" failures can take 30 to 60 days to resolve. These include issues such as higher priority "safety-related" samples or implementation of recent changes in rules/regulations (such as Radcon). Failures related to lab regulatory/compliance issues (response to audit findings etc.) have in the past taken 120 to 180 days to resolve. Therefore, it is likely that mild changes to the sample analysis program can have a large impact on the success of the WFD system. Two variations on the baseline sample analysis assumptions are considered in this section.

2.2.3.1 Sample Analysis Basis. The sensitivity cases are selected to evaluate three scenarios for laboratory sample analysis. The three cases are the "best case" (S1), the current planning case (S2), and a business-as-usual case (S3). Case S1 assumes that we spend whatever is necessary to reduce the sample analysis time. Case S2 represents the assumptions used in the current RTP schedule. Case S3 represents what would be expected given the current situation of the 222-S laboratories. The laboratory activity durations will be adjusted for each case, but the shape of the distribution tails will be held fixed. Specifically, the sensitivity cases are characterized by the distributions assumed for three activities relating to sample Analysis and feed qualification. The activities titles are: Analyze Process Control Samples, Analyze Feed Qualification Samples, and Prepare Feed Qualification Sample Lab Report.

2.2.3.2 Case S1. This case assumes that lab equipment and personnel are dedicated for WFD. The modeled durations are shown in Table 2-2.

Table 2-2. Sample Analysis Sensitivity Case S1.

Activity	Duration (days)		
	Optimistic	Best estimate	Pessimistic
Analyze Process Control Samples	1	3	30
Analyze Feed Qualification Samples	14	20	60
Prepare Feed Qualification Sample Lab Report	10	14	21

2.2.3.3 Case S2. This is the RTP Baseline case (also Case A); it assumes that 222-S laboratories give Priority to WFD with Premium/Overtime. The modeled durations are shown in Table 2-3.

Table 2-3. Sample Analysis Sensitivity Case S2.

Activity	Duration (days)		
	Optimistic	Best estimate	Pessimistic
Analyze Process Control Samples	6	10	60
Analyze Feed Qualification Samples	21	30	90
Prepare Feed Qualification Sample Lab Report	14	21	28

2.2.3.4 Case S3. This case assumes that the current status of 222-S laboratories is unchanged. The modeled durations are shown in Table 2-4.

Table 2-4. Sample Analysis Sensitivity Case S3.

Activity	Duration (days)		
	Optimistic	Best estimate	Pessimistic
Analyze Process Control Samples	10	14	60
Analyze Feed Qualification Samples	30	60	120
Prepare Feed Qualification Sample Lab Report	21	28	35

3.0 RESULTS

The results from the Monte Carlo runs are given in following sections. Useful information from the typical cases described in Section 2.2 is discussed before preceding to specific tanks or batches in the conclusion Section 3.4. The tallied results for each of the typical cases are summarized in Table 3-1. The table shows the value for WFD duration at various percentiles of the distribution functions. Binned distribution functions are given in the figures of Appendix F. The interpretation of the Table 3-1 durations is straight forward. For each typical case, a given percentage of the simulated durations fall below the values shown in the table. For example, there is an 80 percent chance that a Case B feed delivery will be completed in less than 234 days. Notice that the performance is the best for Case F; this is because in-line dilution is assumed with no feed adjustments. At the other extreme, Case E assumes in tank solids dissolution and multiple transfer steps, the necessity of feed adjustment and the extra complications of restaging a new feed batch.

Table 3-1. Feed Delivery Duration at given Success Probability.

Case	Duration(days) at given success probability			
	50%	80%	90%	95%
A	197	220	237	258
B	209	234	253	276
C	250	284	311	340
D	258	291	317	346
E	298	339	367	396
F	138	158	173	190
S1	173	190	201	214
S2*	197	220	237	258
S3	238	262	279	297

*The baseline sensitivity case is the same as Case A.

The individual cases modeled were described in some detail in Section 2.0 and can be summarized as follows:

A — No Feed Adjustments, In-Tank Solids Dissolution, Multiple Decant Operations

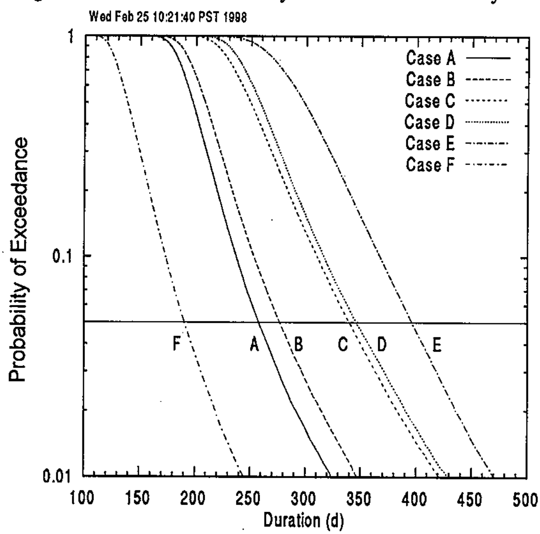
B — Shimming Feed Adjustment

C&D — Blending Feed Adjustment (2 cases)

E	Restaging New Feed Batch
F	No Feed Adjustments, No solids mixing, Simple Decant Operation
S1	Lab Sensitivity; Dedicated Lab Equipment and Personnel
S2	Lab Sensitivity; Priority to WFD with Premium/Overtime (RTP Baseline)
S3	Lab Sensitivity; Current Lab Status.

A continuous version of Table 3-1 is given in Figure 3-1. The compliments of the percentages (failure probabilities) are plotted on a logscale to stretch out the region of highest interest (i.e., small failure probabilities). This interpretation follows: with a minimum duration set at a value on the horizontal scale, the probability of failure (exceeding the duration) appears on the vertical scale. The failure probabilities are all <5 percent in the region below the horizontal line on the figure. Failure probabilities <1 percent can reach out to unacceptably long durations. The state of knowledge of the various staging activities is not good enough to make conclusions about the system at <1 percent. This requires much better characterization of the uncertainties, specifically the pessimistic region of the activitys' duration distribution functions.

Figure 3-1. Failure Probability for Each Feed Delivery Case.



The activities that have the greatest impact on the WFD duration were determined from the correlations of activity durations with total delivery duration. The correlations for all cases and for each activity are reported in the figures of Appendix F. In most cases, the correlations vary in the same way as the duration ranges (pessimistic - optimistic) of activities. The difference arise in the interpretation of the pessimistic value assigned by the experts. For each activity distribution, the expert defines a pessimistic duration and specifies that value as being either an ultimate upper bound or a given percentile (e.g., 95 percent) of a distribution tail that falls off at some prescribed rate. For this study, the tails were limited to normal and lognormal-in most cases the later. The parameters for each unique distribution are given in Appendix D. Therefore, an activity with a lognormal tail reaching out 5 percent past the pessimistic value can have a greater impact on the results than an activity with a larger pessimistic value that bounds the distribution.

Additional runs indicated that the detailed shape of the interior of the distribution is not important assuming that central values of the distributions remain fixed at their best estimate RTP values. The activities having the greatest impact were the sample analyses and the activities related to feed adjustment and restaging of waste.

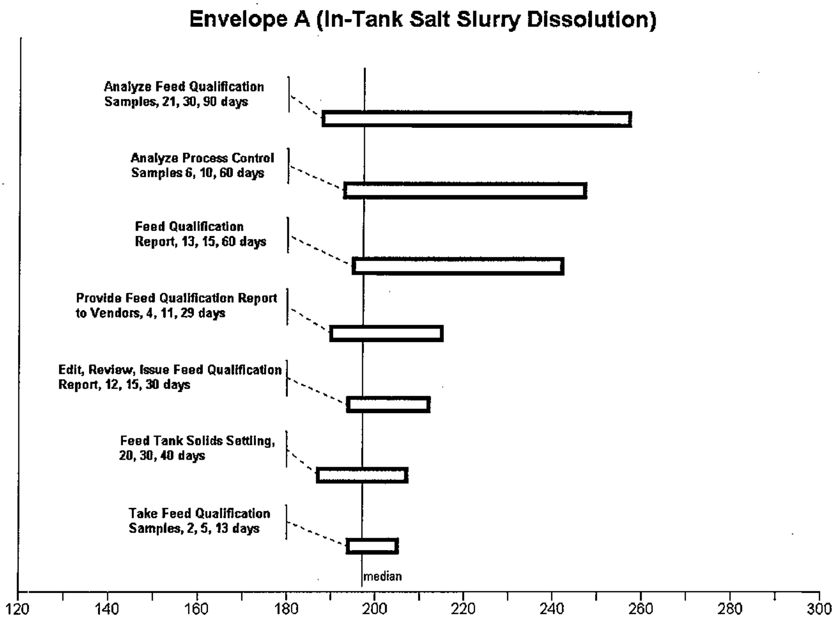
3.1 WASTE RETRIEVAL

The relative impacts of the most significant activities are shown graphically as a Tornado diagram in Figure 3-2. The vertical center line of the tornado is placed at the median duration for the full retrieval scenario modeled. Each of the bars represent a significant activity with the median duration for the activity aligned with that for the full retrieval. The left side of each bar represents the "optimistic" duration for the activity while the right side represent the "pessimistic" value. These three values are shown along with the title for each activity.

The primary reason the bars (distribution) are skewed with the pessimistic value much greater than the median, is that the pessimistic value, in general, includes the time required to respond to a failure and complete the activity.

As can be seen in Figure 3-2, the process of analyzing waste samples and issuing the Feed Qualification report are the primary contributors to the retrieval/staging/qualification time. The position of the bars also shows that even if all activities were completed within the optimistic time there would be little improvement in the total time required. Alternatively, the pessimistic values, which represent various types of failures during the activity, can significantly extend the total time required.

Figure 3-2. Tornado Diagram for Case A.



3.2 FEED ADJUSTMENT

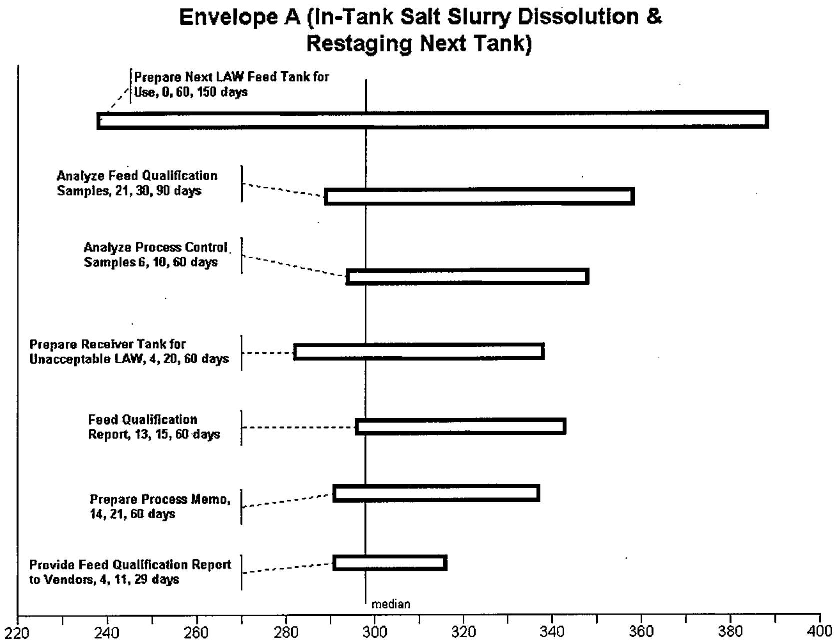
Comparison of the feed adjustment cases with baseline Case A is summarized in Table 3-2 as schedule impacts or delays. The mildest impact is for a chemical shimming of the feed directly in the intermediate staging tank. The greatest impact results from unplanned feed adjustment that requires restaging of the batch to another tank and staging of the next batch.

Table 3-2. Feed Adjustment Schedule Impacts.

Case	Run mode	Impact (days)
B	Shimming	10-20
C	Blending	50-90
D&E	Restaging	100-140

The relative impacts of the most significant activities associated with Case E are shown graphically as a Tornado diagram in Figure 3-3. As can be seen, the process of analyzing waste samples are still significant contributors to the total time. The activities required to restage the batch to another tank and prepare an alternate feed batch also contribute significantly to the total time.

Figure 3-3. Tornado Diagram for Case E.



3.3 SAMPLE ANALYSIS SENSITIVITY

As mentioned in Section 3.1, the laboratory analysis of the feed samples accounts for a significant fraction of the feed delivery duration. This analysis time is related to the staffing and dedication level of laboratory for WFD. The results of the sensitivity cases that represent the laboratory in three operating modes are shown in Table 3-3. Appendix C details the assumptions for the laboratory in each mode.

Table 3-3. Laboratory Options Schedule Impacts.*

Case	Run mode	Impact
S1	Dedicated	saves 25-45 Days
S2	High Priority to WFD	baseline
S3	Current Lab Mode	adds 40 days

WFD = Waste Feed Delivery
*Primary Laboratory risk is an extended shutdown resulting from Audit Findings/Non-Compliance.

The baseline Case S2 (Case A) assumes a high priority for WFD, while Case S1 makes the Laboratory completely dedicated to the WFD mission. For this ambitious case, the WFD duration can be reduced by as much as 45 days. Case S3 shows that by running the laboratory in its current mode, the schedule is likely to be lengthened by about 40 days.

3.4 COMPARISON TO PLANNED FEED BATCHES

The results from previous sections allow several conclusions to be drawn for actual batches planned for Phase 1 delivery. This is possible because batch sources and sizes as well as likely feed processing rates have been studied (Payne et al. 1998). Table 3-4 summarizes the planned batch sizes and the required processing time of the previous batch for three vendor processing rates. The processing time of a previous batch is considered the allowable staging time for the next batch.

The time required to process a given batch will vary depending on the total amount of Na delivered, the processing rate, and the heel left in the privatization contractor's feed tank when the next batch delivery occurs. The heel will vary batch to batch; batches which don't change feed envelopes will be made with a 30-day heel. That is enough feed that the privatization contractor can continue to process for 30 days. When switches are made between feed envelopes, it is assumed that the privatization contractor's feed tank is emptied to a 10-in. heel before starting the next feed batch transfer.

Table 3-4. Waste Feed Processing Times.

LAW feed batch	Na delivered per vendor (MT)	Processing time of previous LAW feed batch (days)		
		2.0 MT Na/day	2.5 MT Na/day	3.0 MT Na/day
1(a)	514	201-329	201-329	201-329
2(b)	535	227-355	176-304	141-269
3	428	268	214	178
4	585	214	171	143
5	575	293	234	195
6	118	318	260	222
7/8(c)	119/272	59/30	47/18	39/10
9	477	136	109	91
10	411	239	191	159
11	615	206	164	137
12	425	308	246	205

LAW = Low-activity waste

(a) Times shown are that available for 241-AN-105 retrieval assuming a retrieval start date of 7/7/2001 and initiation of processing on 6/1/2002. The lower value of 201 is the current baseline and is needed to allow retrieval of the second batch (241-AN-104) to start 1/24/2002.

(b) Times shown are the minimum available assuming that 241-AN-105 retrieval takes the full 329 days available. The upper value assumes 241-AN-105 retrieval takes the scheduled 201 days.

(c) Batch 7 is for ≈ 100 MT of Envelope C. Batch 8 is the remainder of the tank 241-AN-107 waste feed. The minimal retrieval time available (small batch 6) requires that the feed be qualified in the source tank prior to retrieval. This particular retrieval scenario was not modeled in this study.

The allowable delivery times (Table 3-4) can be compared with the results for the typical staging scenarios. Assuming a given staging scenario, how likely is the feed to be delivered within the processing time of the previous batch?

Using the Monte Carlo results, a success probability can be assigned to each of the batches for the various vendor processing rates (Table 3-5). At the 2 MT/day throughput rate and assuming no feed adjustment, the WFD System has high (>90 percent) probability of success for all batches except for 4 and 9 (40-75 percent). Batches 4 and 9 have preceding batches that have a relatively short processing duration. At the 3 MT/day throughput rate and assuming no feed adjustment, the WFD System has (>45 percent) probability of success for all batches except for 3, 4, and 9 which have a low chance (<5 percent) for success.

Table 3-5. Waste Feed Throughput Impacts.

LAW Feed Batch	Probability of delivering on time (with no feed adjustment)		
	2.0 MT Na/day	2.5 MT Na/day	3.0 MT Na/day
1[(a)]	55-60%	55-60%	55-60%
	(>95%)	(>95%)	(>95%)
2[(b)]	>95%	>95%	>95%
	(80-85%)	(<5%)	(<5%)
3	>95%	70-75%	10-15%
4	70-75%	<5%	<5%
5	>95%	>95%	>95%
6	>95%	>95%	>95%
7/8[(c)]	NA	NA	NA
9	40-45%	<5%	<5%
10	>95%	90-95%	80-85%
11	>95%	80-85%	45-50%
12	>95%	>95%	>95%

LAW = Low-activity waste

(a) The first set of probabilities is for meeting the baseline schedule of 201 days. The probabilities shown in parentheses assume that retrieval takes the full time available (241-AN-105 retrieval start date of 7/7/2001 and initiation of processing on 6/1/2002). The lower value of 201 is the current baseline and is needed to allow retrieval of the 2nd batch (241-AN-104) to start 1/24/2002.

(b) The first set of probabilities assumes that the baseline schedule for retrieval of the 1st batch (241-AN-105, 201 days) is met. The probabilities shown in parentheses assume that the first batch retrieval takes the full time available (241-AN-105 retrieval start date of 7/7/2001 and initiation of processing on 6/1/2002).

(c) NA-not evaluated. Batch 7 delivers ≈ 100 MT of Envelope C. Batch 8 is the remainder of the tank (241-AN-107) waste feed. The minimal retrieval time available (small batch 6) requires that the feed be qualified in the source tank prior to retrieval. This particular retrieval scenario was not modeled in this study.

Figure 3-4. Low-Activity Waste Feed Delivery--2 MT Na/day.

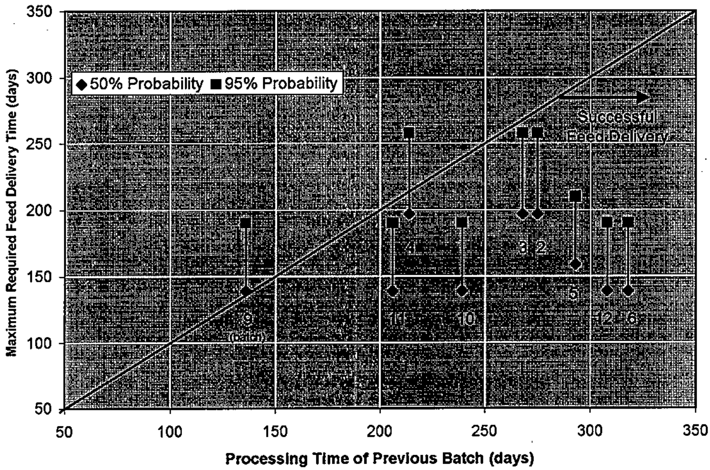
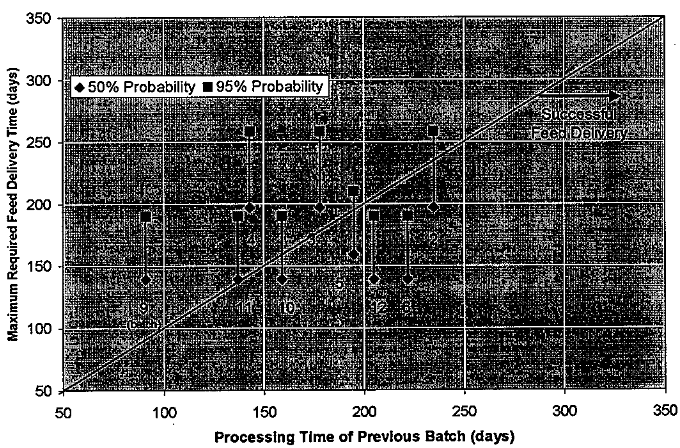


Figure 3-5. Low-Activity Waste Feed Delivery--3 MT Na/day.



Figures 3-4 and 3-5 show the time to deliver each LAW feed batch (at 50 percent and 95 percent probability) versus the processing time of the previous batch for processing rates of 2 MT Na/day and 3 MT Na/day, respectively. Points to the right of the line represent a successful retrieval and delivery of the feed batch. As can be seen in Figure 3-5, the baseline WFD system is unlikely to support a sustained 3 MT Na/day processing rate.

Figure 3-6 shows the impact of adding an additional 30 days to the time required to retrieve, qualify, and deliver a Case A (envelope A) feed batch. This shows how the probability of successfully delivering a feed batch would be impacted if, for example, additional analytical requirements added 30 days to feed qualification sample analysis. Two feed batches, 1 (500 MT Na) and 3 (420 MT Na), are shown in the figure. In this case, for batch 1 the probability of successfully delivering the feed batch decreases from 94 percent to 80 percent. In the case of batch 3, the probability of successfully delivering the feed batch decreases from 70 percent to 14 percent.

3.5 SUMMARY OF STUDY ASSUMPTIONS/CAVEATS

The following is a list of major enabling assumptions and/or caveats associated with this study. Changing these assumptions may alter the results and conclusions reached in this study.

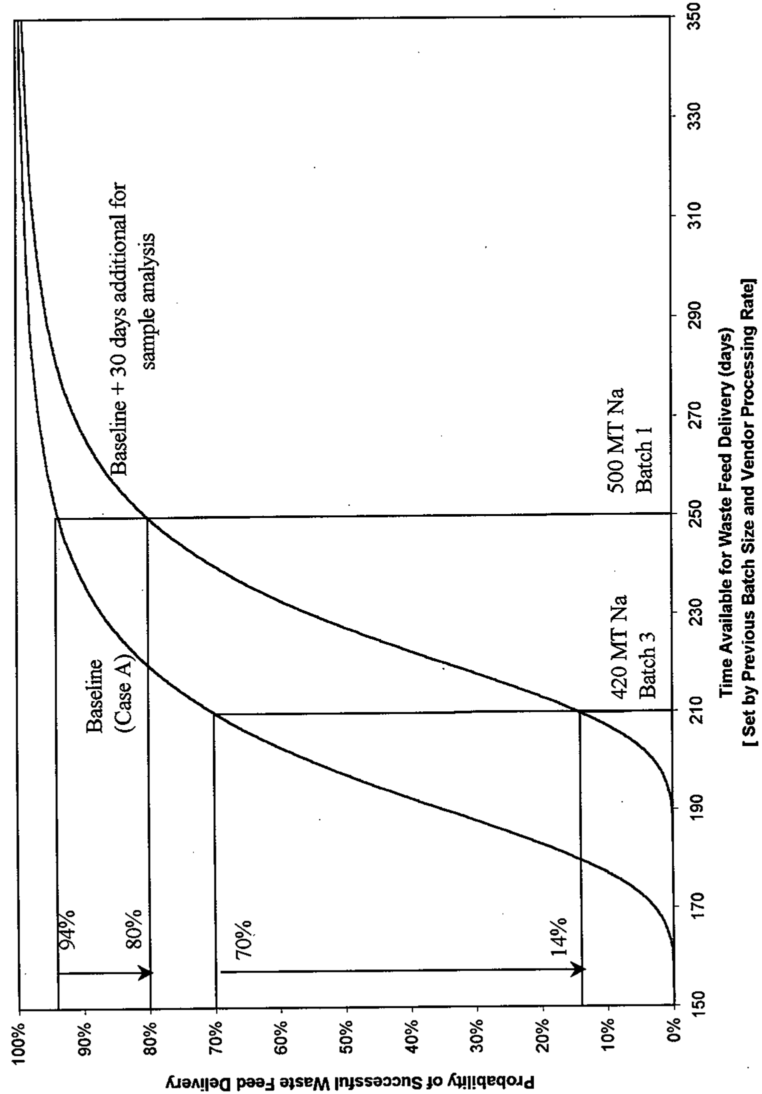
- All identified schedule activities are statistically independent. This assumption is believed to be generally true because the sequence of activities was developed such that the preceding activity must be successfully completed prior to starting the following activity. Areas in which the activities may not be independent are those administrative elements that are common to all or most activities within the TWRS such as training and equipment maintenance. No attempt was made to independently account for these elements. The dependency of the activities relative to these overarching administrative factors were considered too complex to include in this screening study. These dependencies will be addressed in subsequent Reliability, Availability, Maintainability (RAM) studies planned for FY 1998 and FY 1999.

- The laboratory analyses were assumed to be only those required to demonstrate that the contract envelope requirements were met.

- Tank space, transfer routes, equipment, and appropriate waste material are available for blending and/or restaging if the waste does not meet the envelope requirements.

- For replacement/repair of failed major equipment, it was assumed that all critical spare parts ere readily available and crews were trained and ready.

Figure 3-6. Impacts of Increasing an Activity by 30 Days.



- The study does not address potential for activities which are missing from the schedule.

- All equipment is installed and initially functional and, where appropriate, the waste has been degassed and settled prior to starting retrieval.

- The current state of knowledge of the various waste staging activities is not sufficient to make probability estimates about the system below 1 percent. This would require much better characterization of the uncertainties. Specifically, the pessimistic region of the activities' duration distribution functions.

4.0 QUALITY ASSURANCE

A combination of expert reviews and data quality checks were used to ensure that results of this study were defensible and met the needs of the Tank Waste Retrieval Program. The reviews included a review of the Monte Carlo statistical approach by Dr. Dan Goodman from Colorado State University and independent peer review of the code.

The data used to establish activity durations and distributions were obtained from subject matter experts and the data sources are identified in the appendices. The technical approach taken in this study was reviewed by waste feed delivery subject matter and Monte Carlo modeling experts and this report was reviewed by technical, systems engineering, and quality assurance personnel in the Tank Waste Retrieval Program.

5.0 SUMMARY AND CONCLUSIONS

The purpose of this study was to develop a basis for establishing what "minimum duration" between successive feed batches would provide acceptable risk mitigation for LAW feed delivery to the privatization vendors. The study established a probabilistic-based duration for staging of LAW feed batches. A comparison was made of the durations with current feed delivery plans and potential privatization vendor facility throughput rates. These durations are expressed in terms of the minimum duration between successive LAW batches. That is the time required to retrieve, transfer, adjust (if necessary), and qualify a LAW feed batch. It is assumed that all equipment is in place and functional and that the intermediate staging tanks (AP-102 and AP-104) are empty.

The cases evaluated included two baseline cases (Envelope A with in-tank dissolution of precipitated salts and Envelopes B and C with just supernate decant), four feed adjustment scenarios (shimming, blending (2 cases), and restaging next tank), and three analytical laboratory operation sensitivity cases.

As expected, the primary WFD schedule drivers were found to be waste sample analysis and waste feed adjustment. The key sample analysis risk is a laboratory shut-down resulting from audit/non-compliance findings. The key risk associated with feed adjustment is developing plans for completing the feed adjustment and getting a decision and approval to proceed.

Additional schedule impacts result from the different retrieval approach for each waste envelope. Envelope A retrieval is more involved than that for Envelopes B and C (dissolution of salts); therefore, it requires the most time to retrieve, stage, and qualify. Envelopes B and C consist primarily of decant transfers without solids dissolution (sludges are left in the source tank), therefore the retrieval times are shorter. The times required to retrieve, stage and qualify a LAW feed batch as a function of probability are shown in Table 4-1.

Table 5-1. Minimum Duration Between Successive Low-Activity Waste Batches If No Feed Adjustment is Required.

	Time Required to Retrieve, Stage and Qualify a LAW Feed Batch (days)		
	50% probability	80% probability	95% probability
Envelope A	<200	<220	<260
Envelopes B & C	<140	<160	<190

LAW = Low-activity waste.

Comparing these durations with the currently planned waste feed batches, it can be concluded that WFD can successfully support privatization vendor processing rates of 2 MT Na/day per vendor but probably not 3 MT Na/day.

- 2 MT Na/day: WFD System has >90 percent Probability of Success except for Batches 4 and 9 (40 to 75 percent)
- 3 MT Na/day: WFD System has >70 percent Probability of Success except for Batches 3, 4, and 9 which have little chance (<15 percent, assumes Projects can be accelerated to support)

The three types of waste feed adjustments have different impacts to the feed delivery schedules. Shimming can extend the delivery schedule 10 to 20 days, blending waste from another tank can add 50 to 90 days, and side-pocketing the feed batch and staging the next batch (restaging) can add 100 to 140 days.

Based on areas of risk identified by this study and previous ones, there are several changes to DOE guidance and to PHMC plans which could reduce the risks associated with supporting waste feed delivery to the privatization vendors. These include the following:

1. Current contract terms require delivery of small batches of Envelopes B and C during proof-of-concept processing (to meet minimum order quantities). Refine the contract terms to allow delivery of larger feed batches. This would allow the delivery of batches 7 and 8 in one transfer rather than as separate batches. This also provides more time for delivery of batch 9 which is at risk for meeting the delivery schedule (<40 percent probability).

2. Negotiate a compensatory model which quantifies impacts to the privatization vendors (costs, waste loading, secondary waste, etc.) resulting from processing low-activity waste which does not meet the envelope specifications. This provides the basis for decisions regarding cost and schedule impacts of making adjustments to waste feed compositions.

3. Develop detailed plans for performing a range of feed adjustments prior to initiating retrieval of the applicable feed batch. Also, have procedures and plans in place for obtaining a DOE decision regarding feed adjustment. These are necessary to minimize the schedule impacts resulting from a feed batch being outside the contract specification.

4. Reverse the order for delivery of batches 3 and 4. Batch 3 is currently tank 241-AW-101 (856 MT Na) and batch 4 is tank 241-AN-103 (1170 MT Na). Reversing the order to deliver the larger batch first provides more time to deliver the tank 241-AW-101 feed batch. The current batch 4 is somewhat at risk for meeting the delivery schedule (approximately 75 percent probability). There should be no impact to batch 5 in either case.

5. Develop and maintain the capability for waste feed qualification at a backup laboratory or split the sample load between two labs. This reduces the risk that a single-point failure (laboratory shut-down) could halt waste feed delivery.

6. Change the current process control sampling approach. The current approach for tanks which require solids dissolution (batches 1-4, 11, 12) is to sample the source tank after solids dissolution and then to sample the staging tanks (241-AP-102/4) after the dissolved solids are mixed with the original supernatant. Changing the sample timing to take both samples at the same time will save at least 10 days. The two samples can be mixed in the laboratory to determine what the final composition will be in the staging tanks.

This page intentionally left blank.

6.0 REFERENCES

Kalos, M. H., and P. A. Whitlock, 1986, *Monte Carlo Methods*, Wiley, New York.

Kirkbride, R. A., G. K. Allen, P. J. Certa, A. F. Manuel, R. M. Orme, L.W. Shelton, E. J. Slaathaug, R. S. Wittman, G.T. MacLean, and D. L. Penwell, 1997, *Tank Waste Remediation System Operation and Utilization Plan*, HNF-SD-WM-SP-012, Rev. 0, Numatec Hanford Corporation, Richland, Washington.

Payne, M. A., J. O. Honeyman, J. G. Kfistofzski, W. T. Thompson, and P. J. Certa, 1998, *Management Assessment of Tank Waste Remediation System Contractor Readiness to Proceed With Phase 1B Privatization*, HNF-2021, Rev. 1, prepared by Lockheed Martin Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

Press, W. H., S. A. Teukolsky, W. T. Vettering, and B. P. Flannery, 1992, *Numerical Recipes in FORTRAN, The Art of Scientific Computing*, 2nd Ed., Cambridge University Press, New York.

Swita, W. R., M. R. Lewis, and M. J. O'Neill, 1998, *Tank Waste Remediation System Retrieval and Disposal Mission Initial Updated Baseline Summary*, HNF-1946, Rev. 1, prepared by Lockheed Martin Hanford Corporation for Fluor Daniel Hanford, Inc., Richland, Washington.

Zimmerman, B. D., R. W. Harmsen, and C. N. Krohn, 1997, *Monte Carlo Risk Analysis of Phase I Feed Delivery*, FY 1997 Year End Report, Lockheed Martin Hanford Corporation, Richland, Washington.

This page intentionally left blank.

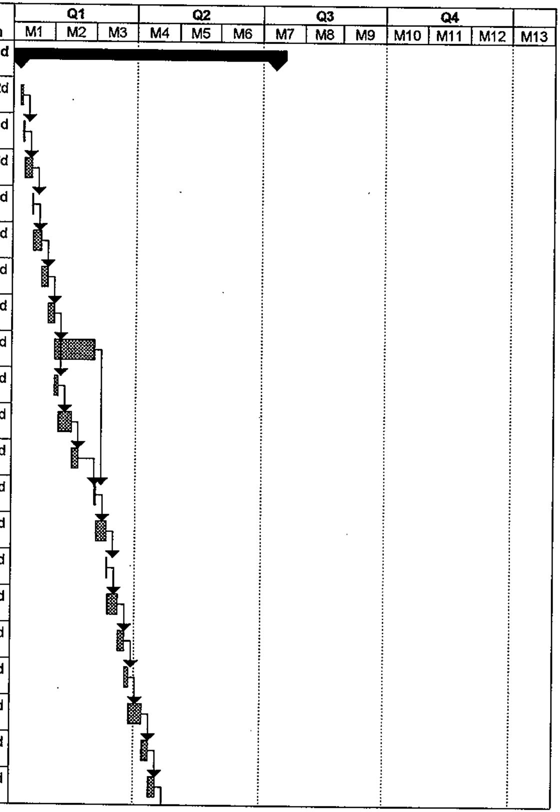
APPENDIX A

CASES A-F: GANTT CHARTS

This page intentionally left blank.

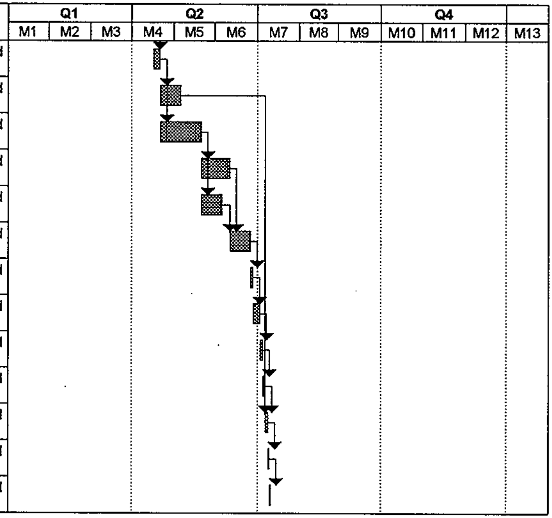
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
1	0	**CASE A: FEED DELIVERED AS STAGED [Envelope A w/ In Tank Salt Slurry Dissolution]**	188d
2	2	Add Diluent in Transfer Pump Recirc Loop	2d
3	3	Delay due to transfer line use conflict	1d
4	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	6d
5	3	Delay due to transfer line use conflict	1d
6	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	6d
7	7	Add Dilution Water to LAW Feed Tank	5d
8	8	Mix LAW Feed Tank using Mixer Pumps	5d
9	9	Allow Undissolved Solids to Settle	30d
10	10	Take Process Control Samples from LAW Feed Tank	3d
11	11	Analyze Process Control Samples from LAW Feed Tank	10d
12	12	Evaluate LAW Feed Tank Process Control Sample Data	5d
13	3	Delay due to transfer line use conflict	1d
14	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	8d
15	3	Delay due to transfer line use conflict	1d
16	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	8d
17	17	Mix 241-AP-104 with Mixer Pump	5d
18	10	Take Process Control Samples from 241-AP-104	3d
19	11	Analyze Process Control Samples from 241-AP-104	10d
20	12	Evaluate Process Control Sample Data	5d
21	17	Mix 241-AP-104 with Mixer Pump	5d



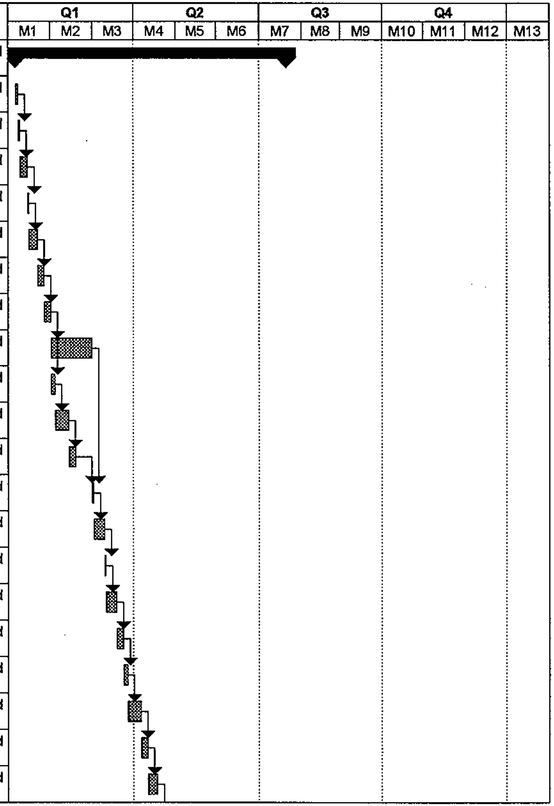
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
22	22	Take Feed Qualification and Private Contractor Samples	5d
23	23	Provide Samples to Private Contractors	15d
24	24	Analyze Feed Qualification Samples	30d
25	25	Prepare Feed Qualification Sample Lab Report	21d
26	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report	15d
27	27	Edit, Review, & Issue Feed Qualification Report	15d
28	28	Draft Transmittal Letter	2d
29	29	Obtain LMHC Approval	5d
30	30	FDH Transmit Data to DOE-RL	2d
31	31	DOE-RL Issue Transmittal Letter	2d
32	32	Setup Transfer to 241-AP-108	2d
33	33	Major Capital Equipment Replacement - Transfer Pump	1d
34	34	Major Capital Equipment Replacement - Mixer Pump	1d



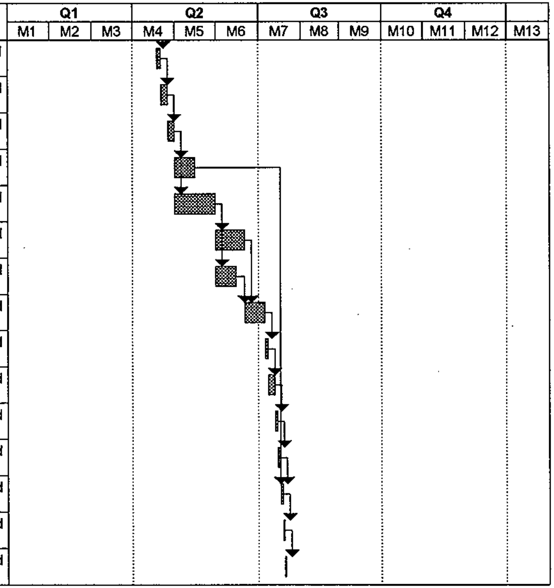
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
35	0	CASE B: SHIM FEED TO MEET SPECS [Envelope A]	198d
36	2	Add Diluent in Transfer Pump Recirc Loop	2d
37	3	Delay due to transfer line use conflict	1d
38	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	6d
39	3	Delay due to transfer line use conflict	1d
40	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	6d
41	7	Add Dilution Water to LAW Feed Tank	5d
42	8	Mix LAW Feed Tank using Mixer Pumps	5d
43	9	Allow Undissolved Solids to Settle	30d
44	10	Take Process Control Samples from LAW Feed Tank	3d
45	11	Analyze Process Control Samples from LAW Feed Tank	10d
46	12	Evaluate LAW Feed Tank Process Control Sample Data	5d
47	3	Delay due to transfer line use conflict	1d
48	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	8d
49	3	Delay due to transfer line use conflict	1d
50	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	8d
51	17	Mix 241-AP-104 with Mixer Pump	5d
52	10	Take Process Control Samples from 241-AP-104	3d
53	11	Analyze Process Control Samples from 241-AP-104	10d
54	12	Evaluate Process Control Sample Data	5d
55	55	Prepare Process Memo	7d



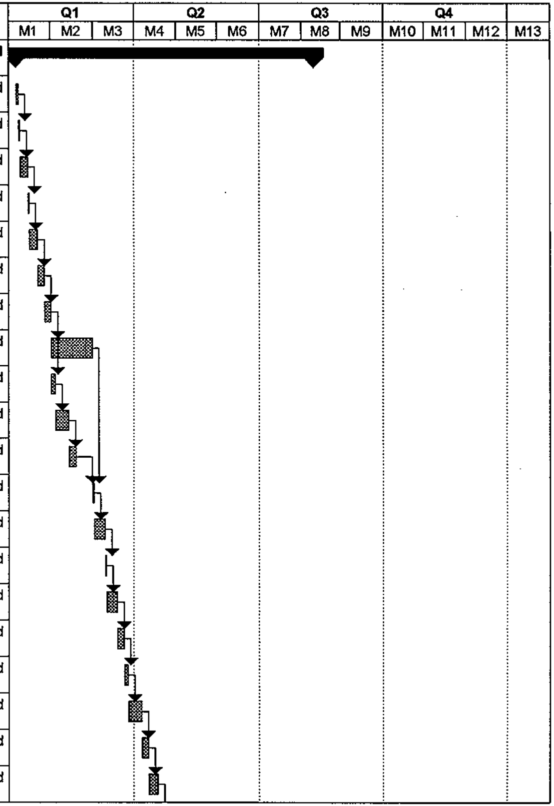
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
56	56	Add Chemical Solution (Shim) to 241-AP-104	3d
57	17	Mix 241-AP-104 with Mixer Pump	5d
58	22	Take Feed Qualification and Private Contractor Samples	5d
59	23	Provide Samples to Private Contractors	15d
60	24	Analyze Feed Qualification Samples	30d
61	25	Prepare Feed Qualification Sample Lab Report	21d
62	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report	15d
63	27	Edit, Review, & Issue Feed Qualification Report	15d
64	28	Draft Transmittal Letter	2d
65	29	Obtain LMHC Approval	5d
66	30	FDH Transmit Data to DOE-RL	2d
67	31	DOE-RL Issue Transmittal Letter	2d
68	32	Setup Transfer to 241-AP-108	2d
69	33	Major Capital Equipment Replacement - Transfer Pump	1d
70	34	Major Capital Equipment Replacement - Mixer Pump	1d



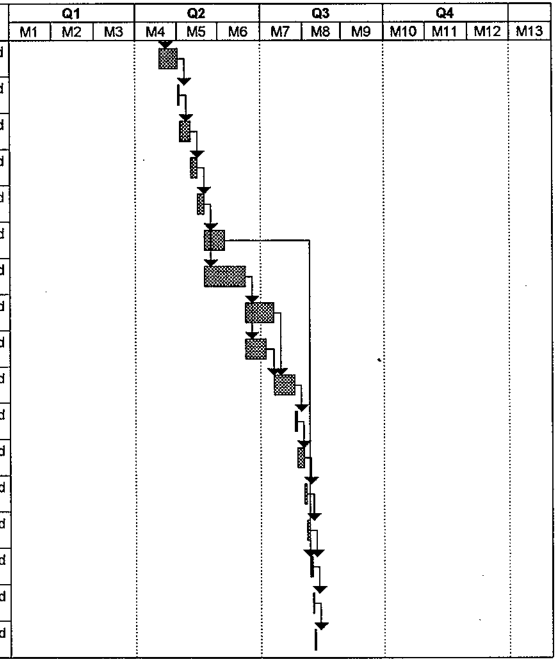
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
71	0	**CASE C: BLEND FEED TO MEET SPECS [Envelope A, assume AP-104 has enough capacity]**	218d
72	2	Add Diluent in Transfer Pump Recirc Loop	2d
73	3	Delay due to transfer line use conflict	1d
74	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	6d
75	3	Delay due to transfer line use conflict	1d
76	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	6d
77	7	Add Dilution Water to LAW Feed Tank	5d
78	8	Mix LAW Feed Tank using Mixer Pumps	5d
79	9	Allow Undissolved Solids to Settle	30d
80	10	Take Process Control Samples from LAW Feed Tank	3d
81	11	Analyze Process Control Samples from LAW Feed Tank	10d
82	12	Evaluate LAW Feed Tank Process Control Sample Data	5d
83	3	Delay due to transfer line use conflict	1d
84	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	8d
85	3	Delay due to transfer line use conflict	1d
86	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	8d
87	17	Mix 241-AP-104 with Mixer Pump	5d
88	10	Take Process Control Samples from 241-AP-104	3d
89	11	Analyze Process Control Samples from 241-AP-104	10d
90	12	Evaluate Process Control Sample Data	5d
91	91	Prepare Process Memo	7d



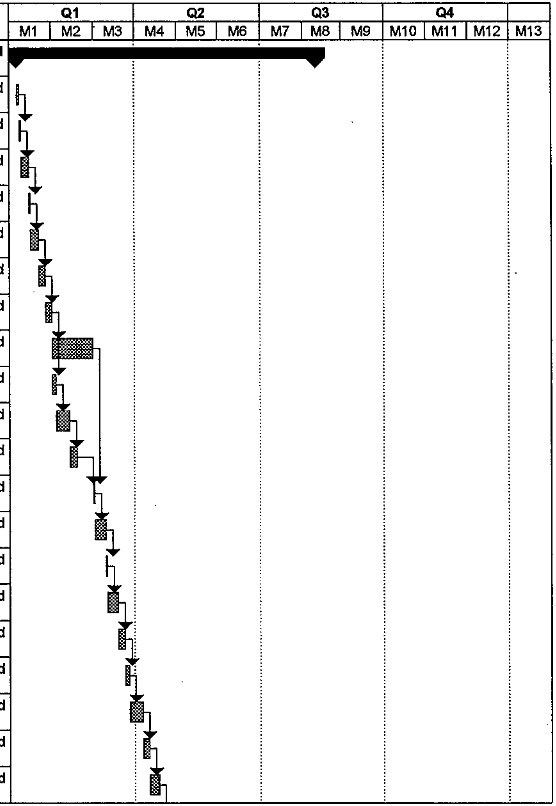
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
92	92	Prepare Selected LAW Blend Tank for Use	14d
93	3	Delay Due To Transfer Line Use Conflict	1d
94	4	Decant Supernate from LAW Blend Tank to 241-AP-104	8d
95	17	Mix 241-AP-104 with Mixer Pump	5d
96	22	Take Feed Qualification and Private Contractor Samples	5d
97	23	Provide Samples to Private Contractors	15d
98	24	Analyze Feed Qualification Samples	30d
99	25	Prepare Feed Qualification Sample Lab Report	21d
100	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report	15d
101	27	Edit, Review, & Issue Feed Qualification Report	15d
102	28	Draft Transmittal Letter	2d
103	29	Obtain LMHC Approval	5d
104	30	FDH Transmit Data to DOE-RL	2d
105	31	DOE-RL Issue Transmittal Letter	2d
106	32	Setup Transfer to 241-AP-108	2d
107	33	Major Capital Equipment Replacement - Transfer Pump	1d
108	34	Major Capital Equipment Replacement - Mixer Pump	1d



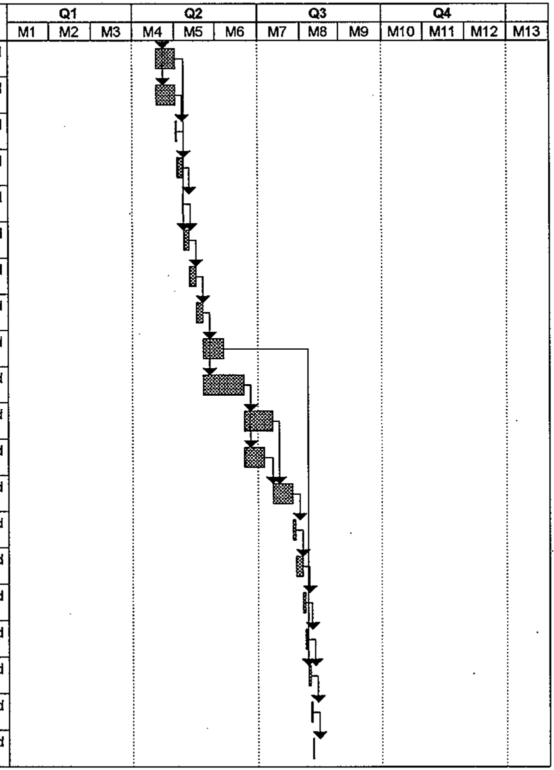
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
109	**0**	**CASE D: BLEND FEED TO MEET SPECS [Envelope A, assume need to blend after AP-104 is full]**	**219d**
110	2	Add Diluent in Transfer Pump Recirc Loop	2d
111	3	Delay due to transfer line use conflict	1d
112	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	6d
113	3	Delay due to transfer line use conflict	1d
114	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	6d
115	7	Add Dilution Water to LAW Feed Tank	5d
116	8	Mix LAW Feed Tank using Mixer Pumps	5d
117	9	Allow Undissolved Solids to Settle	30d
118	10	Take Process Control Samples from LAW Feed Tank	3d
119	11	Analyze Process Control Samples from LAW Feed Tank	10d
120	12	Evaluate LAW Feed Tank Process Control Sample Data	5d
121	3	Delay due to transfer line use conflict	1d
122	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	8d
123	3	Delay due to transfer line use conflict	1d
124	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	8d
125	17	Mix 241-AP-104 with Mixer Pump	5d
126	10	Take Process Control Samples from 241-AP-104	3d
127	11	Analyze Process Control Samples from 241-AP-104	10d
128	12	Evaluate Process Control Sample Data	5d
129	91	Prepare Process Memo	7d



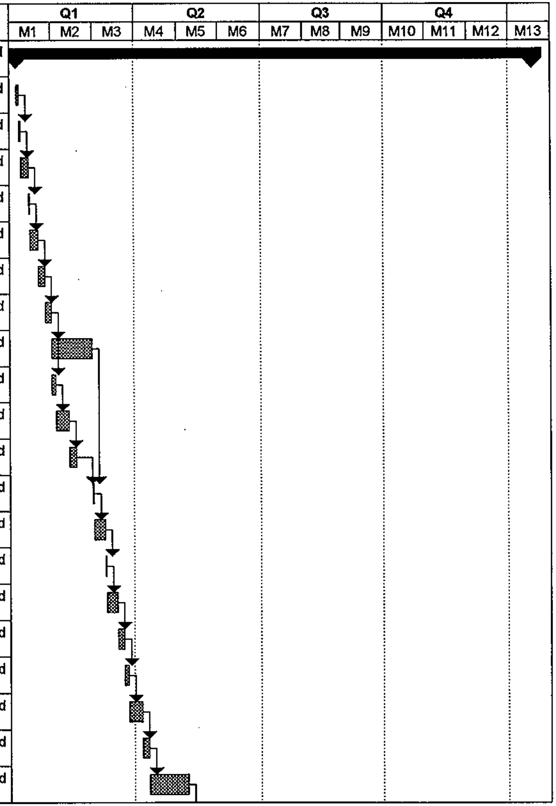
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
130	92	Prepare Selected LAW Blend Tank for Use	14d
131	131	Prepare Receiver Tank for Unacceptable LAW from 241-AP-104	14d
132	3	Delay Due To Transfer Line Use Conflict	1d
133	4	Decant Portion of Supernate from 241-AP-104 to Receiver Tank	4d
134	3	Delay Due To Transfer Line Use Conflict	1d
135	4	Decant Supernate from LAW Blend Tank to 241-AP-104	4d
136	17	Mix 241-AP-104 with Mixer Pump	5d
137	22	Take Feed Qualification and Private Contractor Samples	5d
138	23	Provide Samples to Private Contractors	15d
139	24	Analyze Feed Qualification Samples	30d
140	25	Prepare Feed Qualification Sample Lab Report	21d
141	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report	15d
142	27	Edit, Review, & Issue Feed Qualification Report	15d
143	28	Draft Transmittal Letter	2d
144	29	Obtain LMHC Approval	5d
145	30	FDH Transmit Data to DOE-RL	2d
146	31	DOE-RL Issue Transmittal Letter	2d
147	32	Setup Transfer to 241-AP-108	2d
148	33	Major Capital Equipment Replacement - Transfer Pump	1d
149	34	Major Capital Equipment Replacement - Mixer Pump	1d



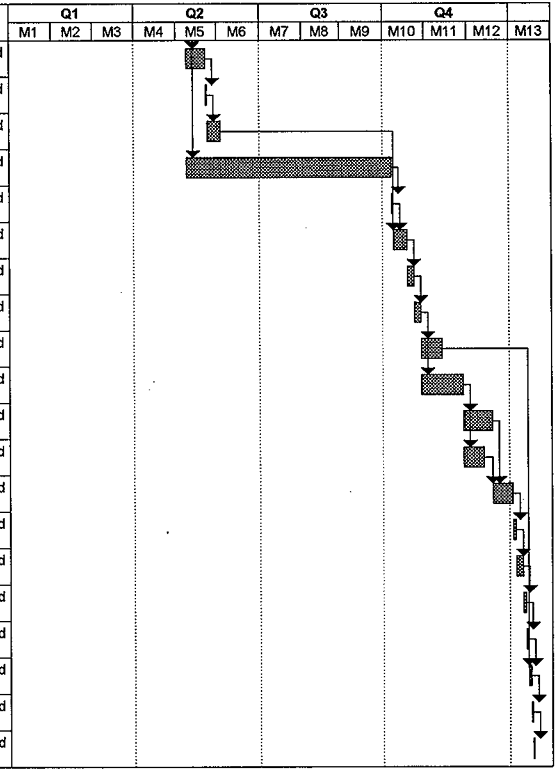
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
150	**0**	**CASE E: RESTAGE FEED TANK TO MEET SPECS [Envelope A]**	**377d**
151	2	Add Diluent in Transfer Pump Recirc Loop	2d
152	3	Delay due to transfer line use conflict	1d
153	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	6d
154	3	Delay due to transfer line use conflict	1d
155	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	6d
156	7	Add Dilution Water to LAW Feed Tank	5d
157	8	Mix LAW Feed Tank using Mixer Pumps	5d
158	9	Allow Undissolved Solids to Settle	30d
159	10	Take Process Control Samples from LAW Feed Tank	3d
160	11	Analyze Process Control Samples from LAW Feed Tank	10d
161	12	Evaluate LAW Feed Tank Process Control Sample Data	5d
162	3	Delay due to transfer line use conflict	1d
163	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	8d
164	3	Delay due to transfer line use conflict	1d
165	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	8d
166	17	Mix 241-AP-104 with Mixer Pump	5d
167	10	Take Process Control Samples from 241-AP-104	3d
168	11	Analyze Process Control Samples from 241-AP-104	10d
169	12	Evaluate Process Control Sample Data	5d
170	170	Prepare Process Memo	28d



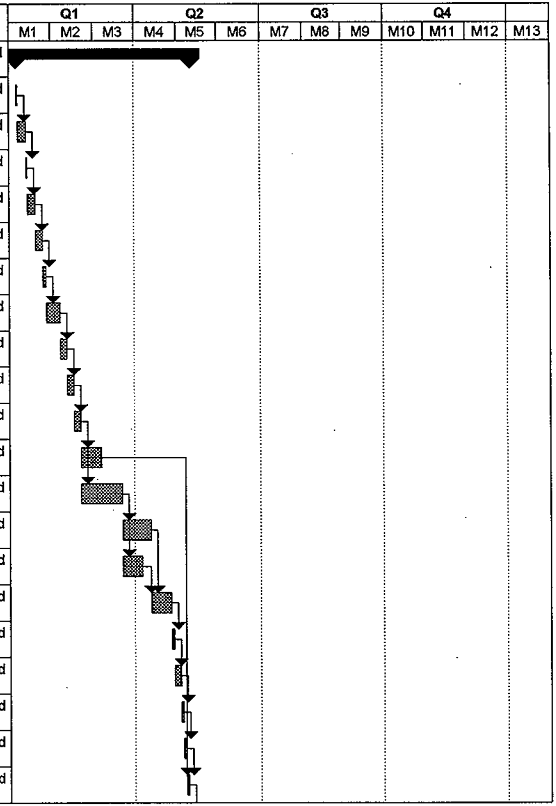
Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
171	171	Prepare Receiver Tank for Unacceptable LAW from 241-AP-104	14d
172	3	Delay Due To Transfer Line Use Conflict	1d
173	4	Decant Supernate from 241-AP-104 to Receiver Tank	10d
174	174	Prepare Next LAW Feed Tank for Use	150d
175	3	Delay Due To Transfer Line Use Conflict	1d
176	4	Decant Supernate from LAW Feed Tank to 241-AP-104	10d
177	17	Mix 241-AP-104 with Mixer Pump	5d
178	22	Take Feed Qualification and Private Contractor Samples	5d
179	23	Provide Samples to Private Contractors	15d
180	24	Analyze Feed Qualification Samples	30d
181	25	Prepare Feed Qualification Sample Lab Report	21d
182	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report	15d
183	27	Edit, Review, & Issue Feed Qualification Report	15d
184	28	Draft Transmittal Letter	2d
185	29	Obtain LMHC Approval	5d
186	30	FDH Transmit Data to DOE-RL	2d
187	31	DOE-RL Issue Transmittal Letter	2d
188	32	Setup Transfer to 241-AP-108	2d
189	33	Major Capital Equipment Replacement - Transfer Pump	1d
190	34	Major Capital Equipment Replacement - Mixer Pump	1d



Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration
191	**0**	**CASE F: FEED DELIVERED AS STAGED [Envelope A w/In-line Dissolution, Envelope B&C]**	**128d**
192	3	Delay due to transfer line use conflict	1d
193	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102	6d
194	3	Delay due to transfer line use conflict	1d
195	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104	6d
196	17	Mix 241-AP-104 with Mixer Pump	5d
197	10	Take Process Control Samples from 241-AP-104	3d
198	11	Analyze Process Control Samples from 241-AP-104	10d
199	12	Evaluate Process Control Sample Data	5d
200	17	Mix 241-AP-104 with Mixer Pump	5d
201	22	Take Feed Qualification and Private Contractor Samples	5d
202	23	Provide Samples to Private Contractors	15d
203	24	Analyze Feed Qualification Samples	30d
204	25	Prepare Feed Qualification Sample Lab Report	21d
205	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report	15d
206	27	Edit, Review, & Issue Feed Qualification Report	15d
207	28	Draft Transmittal Letter	2d
208	29	Obtain LMHC Approval	5d
209	30	FDH Transmit Data to DOE-RL	2d
210	31	DOE-RL Issue Transmittal Letter	2d
211	32	Setup Transfer to 241-AP-108	2d



Minimum Duration Between Successive LAW Batches

ID	Unique ID	Task Name	Duration	Q1			Q2			Q3			Q4			
				M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13
212	33	Major Capital Equipment Replacement - Transfer Pump	1d													
213	34	Major Capital Equipment Replacement - Mixer Pump	1d													

APPENDIX B

ACTIVITY DATA SHEETS

This page intentionally left blank.

APPENDIX B

ACTIVITY DATA SHEETS

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID:[1] 130B30A
Level 2 Schedule Activity Title: Add Diluent (~25KGal) Decant Pump Recirc AN-105
Min. Duration Study Activity ID:[2] 2
Activity Owner Interviewed: TBR
Date of Interview: NA

PURPOSE: To develop a curve that describes the probable duration for the identified activity.

DATA NEEDED:

1. List the major things that could cause the task to take longer than expected.

See TBR

2. List the major things that could cause the task to finish sooner than expected.

See TBR

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

See attached TBR Risk Assessment

Optimistic	1 day
Best Est.	2 days
Pessimistic	3 days

---

[1]Level 2 Schedule Activity ID and Title identify the corresponding activity as identified in *Tank Waste Retrieval and Disposal Mission Initial Updated Baseline Summary*, HNF-1946, Rev. 1, 1998.

[2]The Minimum Duration Study Activity ID is the corresponding ID number as shown in the Appendix A Gantt charts.

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **130B30B2**
Level 2 Schedule Activity Title: **Decant 250 kgal from AN-105 to AP-102**
Min. Duration Study Activity ID: **3 (delay due to transfer line use conflict)**
Activity Owner Interviewed: **Rick Wittman**
Date of Interview: **2/21/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   The major event which could cause transfer line conflicts for LAW feed staging was the staging of solids to the HLW contractor during Phase Ib.

2. **List the major things that could cause the task to finish sooner than expected.**

   Does not apply to this activity because the most favorable condition is that of "no conflict" which is the most likely condition in this case.

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   Occurrence probability for a transfer conflict was estimated at 2%. This corresponds to the fraction of time HLW transfers occur during Phase Ib. The delay impact from the conflict was assumed uniform over 1-7 days.

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **130B30B2**
Level 2 Schedule Activity Title: **Decant 250 kgal from AN-105 to AP-102**
Min. Duration Study Activity ID: **4 (decant supernate)**
Activity Owner Interviewed: **TBR**
Date of Interview: **NA**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. List the major things that could cause the task to take longer than expected.

Equipment not performing to rated level (<140 gpm)
Equipment failures
Instrument failures
Bad weather
Receipt tank not ready
All necessary procedures and authorizations not in place
Personnel not available

2. List the major things that could cause the task to finish sooner than expected.

No equipment failures
No instrument failures
Equipment operates to spec
Mass balances all are OK

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

See attached TBR risk assessment
See attached calculation sheets for algorithm (page B-45)
The activity duration is a function of the volume to be transferred

Optimistic	((volume to be transferred [gal]/180,000) + 3)
Best Est.	((volume to be transferred [gal]/167,000) + 3)*(1.25)
Pessimistic	((volume to be transferred [gal]/167,000) + 3)*(1.5)

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **130B30D**
Level 2 Schedule Activity Title: **Add Diluent Water to AN-105**
Min. Duration Study Activity ID: **7**
Activity Owner Interviewed: **TBR**
Date of Interview: **NA**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. List the major things that could cause the task to take longer than expected.

See TBR

2. List the major things that could cause the task to finish sooner than expected.

See TBR

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

See attached TBR Risk Assessment

Optimistic	4 days
Best Est	5 days
Pessimistic	6 days

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: **130B30E1**
Level 2 Schedule Activity Title: **Operate Mixer Pumps in AN-105**
Min. Duration Study Activity ID: **8**
Activity Owner Interviewed: **TBR**
Date of Interview: **NA**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. List the major things that could cause the task to take longer than expected.

See TBR

2. List the major things that could cause the task to finish sooner than expected.

See TBR

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

See attached TBR Risk Assessment (for 150B42B)

Optimistic	2 days
Best Est	5 days
Pessimistic	10 days

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **130B30G**
Level 2 Schedule Activity Title: **Settle Solids in AN-105**
Min. Duration Study Activity ID: **9**
Activity Owner Interviewed: **Brian Peters**
Date of Interview: **2/21/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. List the major things that could cause the task to take longer than expected.

   Solids settling rate slower than estimated
   Instrumentation not able to detect clear solid/liquid interface
   Fewer solids dissolve than expected

2. List the major things that could cause the task to finish sooner than expected.

   Solids settle faster than expected
   Settling step not required (total <2 wt% undissolved solids)

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

Optimistic	22 days (based on AN-105 dissolved solids tests HNF-SD-WM-DTR-046)
Best Est	30 days
Pessimistic	120 days (based on AN-105 whole tank composite (no dissolution) settling test HNF-SD-DTR-046)

Distribution is probably triangular

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID:	**130B30F**
Level 2 Schedule Activity Title:	**Perform Grab Sampling & Analysis of AN-105**
Min. Duration Study Activity ID:	**10 (Take Sample)**
Activity Owner Interviewed:	**George Stanton**
Date of Interview:	**1/20/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   WEATHER, bad weather can delay sampling from 1 - 7 days, most weather can be compensated for or waiting a day for the storm to pass usually works. During particularly windy periods the delays can be up to a week.

2. **List the major things that could cause the task to finish sooner than expected.**

   Changing the sampling technique may reduce the durations (in-line sampler rather than grab sampling)

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT 3-5 GRAB SAMPLES ARE REQUIRED

Optimistic	1.5 days
Best Est.	3 days
Pessimistic	10 days (3 days plus 7 day weather delay)

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **130B30F**
Level 2 Schedule Activity Title: **Perform Grab Sampling & Analysis of AN-105**
Min. Duration Study Activity ID: **11 (Analyze Process Control Sample)**
Activity Owner Interviewed: **Cary Seidel**
Date of Interview: **11/18/97 (revised 1/15/98 and 2/6/98)**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   FEB/DOE oversight
   Audit findings
   Other priority projects with safety issues
   Breakdowns in other projects such as solid waste and/or liquid waste
   Changes in rules/regulations (ie Radcon)
   Selection of analyses which require additional sample preparation or longer analysis
   Multiple reruns

2. **List the major things that could cause the task to finish sooner than expected.**

   new analytical techniques
   RUSH request (with required funding)

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT FOR THIS PROCESS CONTROL SAMPLE, A REPRESENTATIVE SET OF ANALYSES ARE ICP AND Pu.

Optimistic	ICP	36-48 hrs
	Pu	3 days
	Total	6 days (24 hrs if high RUSH)
Best Est	ICP	3 days (assumes 1 rerun)
	Pu	6 days
	Total	10 days
Pessimistic	Total	60 days

   Note: Total includes time to QA the data and issue brief lab report.

   Log Normal, unbounded, 98% curve

INTERVIEW TO REFINE ACTIVITY DURATION PROBABILITY CURVE

Activity Description: 11, 13B30F, Analyze Process Control Samples
Activity Owner Interviewed: C. Seidel

Durations:	optimistic	6
	best estimate	10
	pessimistic	60

Date: February 6, 1998

We have represented the activity durations you gave us as a lognormal distribution because the pessimistic value is considerably larger than the best estimate and likely represents the result of a system failure (be that management or equipment).

There are several key questions which will clarify our understanding of this activity:

1) Do the provided lognormal curves reasonably approximate your view of your activity duration? If not, how should we change them?

Lognormal curves are appropriate,

2) Can we assume that the Pessimistic value is a reasonable upper bound on the activity duration? Remember that the impacts of schedule delays are such that "considerable" management attention would be placed on resolving issues which will delay your activity.

No, issues involving audit findings and compliance can take longer than 60 days to resolve.

3) If this is not an upper bound, what is a reasonable frequency that the pessimistic value will be exceeded (1/20, 1/100, other) ? Is there an upper bound that we can assume?

Estimate 1-2 % of the time the duration will exceed the pessimistic value

Most management failures can take 30-60 days to resolve, regulatory/compliance issues can take 120-180 days to resolve.

4) What things could be done to reduce and/or bound the value of the Pessimistic duration?

Dedicated Personnel and dedicated analytical equipment

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: **130B30F**
Level 2 Schedule Activity Title: **Perform Grab Sampling & Analysis of AN-105**
Min. Duration Study Activity ID: **12 (Evaluate PC data)**
Activity Owner Interviewed: **Brian Peters**
Date of Interview: **2/21/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

Activity Description: The process control sample data is obtained from the laboratory. The analyses performed are limited to provide a quick lab turn-around but target key components which allow quantification of the degree of solids dissolution and the concentration of components which may be near a limit (may vary tank to tank). The data is evaluated to track solids dissolution and to make predictions regarding meeting of the envelope.

If everything is progressing as expected this activity is reasonably short duration. If the solids don't appear to be dissolving as expected an evaluation regarding additional mixing and/or adding more water is made. This should only add 1-2 days to the evaluation.

If it appears that an envelope limit may be exceeded, a more detailed evaluation of options will need to be performed and approval obtained from DOE to proceed. This can include shimming, blending additional waste from another tank, restaging another tank, or invoking the compensatory model. The cost impacts associated with shimming and the compensatory model should be readily available. Alternatives for blending or restaging should be developed in reasonable detail before the feed batch processing is begun.

DATA NEEDED:

1. List the major things that could cause the task to take longer than expected.

Additional laboratory reruns
Analyte concentrations outside expected range
No compensatory model
Insufficiently developed blending/restaging alternatives
Difficulties getting DOE decision

2. List the major things that could cause the task to finish sooner than expected.

No lab reruns needed
All analytes within expected range

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

Optimistic	3 days
Best Est.	5 days
Pessimistic	30 days

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: 150B32B
Level 2 Schedule Activity Title: Perform Batch Mixing Operations
Min. Duration Study Activity ID: 17
Activity Owner Interviewed: TBR
Date of Interview: NA

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   See TBR

2. **List the major things that could cause the task to finish sooner than expected.**

   See TBR

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   See attached TBR Risk Assessment (for 150B42B)

Optimistic	2 days
Best Est	5 days
Pessimistic	10 days

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **150B34A**
Level 2 Schedule Activity Title: **LAW AP-102 Feed Qual Grab Sample**
Min. Duration Study Activity ID: **22**
Activity Owner Interviewed: **George Stanton**
Date of Interview: **1/20/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   WEATHER, bad weather can delay sampling from 1 - 7 days, most weather can be compensated for or waiting a day for the storm to pass usually works. During particularly windy periods the delays can be up to a week.

2. **List the major things that could cause the task to finish sooner than expected.**

   Changing the sampling technique may reduce the durations (in-line sampler rather than grab sampling)

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT LARGE SAMPLE VOLUMES (1-3 liters) ARE REQUIRED

Optimistic	2 days
Best Est.	5 days
Pessimistic	13 days (5 days plus 7 day weather delay)

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: 150B36A
Level 2 Schedule Activity Title: LAW AP-102 Transfer Sample Material to Vendor
Min. Duration Study Activity ID: 23
Activity Owner Interviewed: Cary Seidel
Date of Interview: 1/15/98 (as modified 2/6/98)

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   Resource Conflicts
   If sample needs to be maintained at elevated temperature
   Higher than expected dose rates (500 ml per shipment is limit to meet DOT specs and limit dose to truck operator) This has potential to drive shipments from 2 to 20.
   Management of the hedgehog sample casks (80 on site). One component of the hedge hog is no longer available commerically
   An accident during shipment (down for months)

2. **List the major things that could cause the task to finish sooner than expected.**

   More sample shipment casks (hedgehogs)
   More formal container maangement program
   Different shipment containers (type B)

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME ONE 1-LITER SAMPLE, 200W TO 200E IN A HEDGEHOG

   Optimistic 9 days
   Best Est. 15 days
   Pessimistic 30 days
   Log Normal, unbounded, 98% curve

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **150B38A**
Level 2 Schedule Activity Title: **LAW AP-102 Analyze Feed Qual Sample**
Min. Duration Study Activity ID: **24 (Baseline Case - S1)**
Activity Owner Interviewed: **Cary Seidel**
Date of Interview: **11/18/97 (revised 1/15/98 & 2/06/98)**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   FEB/DOE oversight
   Audit findings
   Other priority projects with safety issues
   Breakdowns in other projects such as solid waste and/or liquid waste
   Changes in rules/regulations (ie Radcon)
   Multiple reruns
   Additional test requirements

2. **List the major things that could cause the task to finish sooner than expected.**

   new analytical techniques
   higher staffing

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT SAMPLES ARE GIVEN HIGH PRIORITY, PREMIUM AND OVERTIME CHARGES ARE AUTHORIZED, NECESSARY STAFFING IS MAINTAINED, ANALYTICAL TECHNIQUES ARE OPTIMIZED AND THAT ONLY CURRENT ENVELOPE ANALYSES ARE PERFORMED.

   Optimistic 21 days
   Best Est 30 days
   Pessimistic 90 days
   Log Normal, unbounded, 99% curve

INTERVIEW TO REFINE ACTIVITY DURATION PROBABILITY CURVE

Activity Description: 24, 150B38A, Analyze Feed Qualification Sample
Activity Owner Interviewed: C. Seidel

Durations:	optimistic	21
	best estimate	30
	pessimistic	90

Date: February 6, 1998

We have represented the activity durations you gave us as a lognormal distribution because the pessimistic value is considerably larger than the best estimate and likely represents the result of a system failure (be that management or equipment).

There are several key questions which will clarify our understanding of this activity:

1) Do the provided lognormal curves reasonably approximate your view of your activity duration? If not, how should we change them?

Lognormal curves are appropriate,

2) Can we assume that the Pessimistic value is a reasonable upper bound on the activity duration? Remember that the impacts of schedule delays are such that "considerable" management attention would be placed on resolving issues which will delay your activity.

No, issues involving audit findings and compliance can take longer than 90 days to resolve.

3) If this is not an upper bound, what is a reasonable frequency that the pessimistic value will be exceeded (1/20, 1/100, other) ? Is there an upper bound that we can assume?

Estimate 1-2 % of the time the duration will exceed the pessimistic value

Most management failures can take 30-60 days to resolve, regulatory/compliance issues can take 120-180 days to resolve.

4) What things could be done to reduce and/or bound the value of the Pessimistic duration?

Dedicated Personnel and dedicated analytical equipment

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: **150B38A**
Level 2 Schedule Activity Title: **LAW AP-102 Analyze Feed Qual Sample**
Min. Duration Study Activity ID: **24 (Low Priority/Funding Case)**
Activity Owner Interviewed: **Cary Seidel**
Date of Interview: **11/18/97 (revised 1/15/98 & 2/6/98)**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   FEB/DOE oversight
   Audits
   Other priority projects with safety issues
   Breakdowns in other projects such as solid waste and/or liquid waste
   Changes in rules/regulations (ie Radcon)
   Lower funding/lower sample priority
   Unexpected sample matrix interfences
   Additional test requirements

2. **List the major things that could cause the task to finish sooner than expected.**

   new analytical techniques
   higher staffing

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT THESE SAMPLES HAVE LOWER PRIORITY AND THAT FUNDING CONSTRAINTS LIMIT PREMIUM OR OVERTIME CHARGES AND THAT ONLY CURRENT ENVELOP ANALYSES ARE PERFORMED.

   Optimistic 30 days
   Best Est 60 days
   Pessimistic 120 days
   Log Normal, unbounded, 99% curve

INTERVIEW TO REFINE ACTIVITY DURATION PROBABILITY CURVE

Activity Description: 24, 150B38A, Analyze Feed Qualification Sample
Sensitivity Case S2
Activity Owner Interviewed: C. Seidel

Durations:	optimistic	30
	best estimate	60
	pessimistic	120

Date: February 6, 1998

We have represented the activity durations you gave us as a lognormal distribution because the pessimistic value is considerably larger than the best estimate and likely represents the result of a system failure (be that management or equipment).

There are several key questions which will clarify our understanding of this activity:

1) Do the provided lognormal curves reasonably approximate your view of your activity duration? If not, how should we change them?

The curve should be a skewed normal curve

2) Can we assume that the Pessimistic value is a reasonable upper bound on the activity duration? Remember that the impacts of schedule delays are such that "considerable" management attention would be placed on resolving issues which will delay your activity.

No, issues involving compliance can take up to 180 days to resolve.

3) If this is not an upper bound, what is a reasonable frequency that the pessimistic value will be exceeded (1/20, 1/100, other) ? Is there an upper bound that we can assume?

Estimate 1 % of the time the duration will exceed the pessimistic value

Most management failures can take 30-60 days to resolve, regulatory/compliance issues can take 120-180 days to resolve.

4) What things could be done to reduce and/or bound the value of the Pessimistic duration?

Dedicated Personnel and dedicated analytical equipment

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: 150B38C
Level 2 Schedule Activity Title: LAW AP-102 Prep Feed Qual Sample Lab Report
Min. Duration Study Activity ID: 25
Activity Owner Interviewed: Cary Seidel
Date of Interview: 1/15/98 (revised 2/6/98)

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   QA findings
   Documentation format changes
   Computer system problems
   Program Priority conflicts (esp. with program coordinators)

2. **List the major things that could cause the task to finish sooner than expected.**

   fast turn around from document control
   additional staffing
   automated report format

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   Optimistic 14 days
   Best Est 21 days
   Pessimistic 28 days
   Normal, unbounded, 99% curve

INTERVIEW TO REFINE ACTIVITY DURATION PROBABILITY CURVE

Activity Description: 25, 150B38C, Prepare Feed Qualification Sample Lab Report
Activity Owner Interviewed: C. Seidel

Durations:	optimistic	14
	best estimate	21
	pessimistic	28

Date: February 6, 1998

We have represented the activity durations you gave us as a triangle distribution because the duration ranges were symetrical.

There are several key questions which will clarify our understanding of this activity:

1) Does the provided triangular curve reasonably approximate your view of your activity duration? If not, how should we change them?

The curve should be a normal curve.

2) Can we assume that the Pessimistic value is a reasonable upper bound on the activity duration? Remember that the impacts of schedule delays are such that "considerable" management attention would be placed on resolving issues which will delay your activity.

No, computer problems or personnel shortages or other priority samples can extend the time required to write the lab report.

3) If this is not an upper bound, what is a reasonable frequency that the pessimistic value will be exceeded (1/20, 1/100, other) ? Is there an upper bound that we can assume?

Estimate 1-2 % of the time the duration will exceed the pessimistic value

4) What things could be done to reduce and/or bound the value of the Pessimistic duration?

Dedicated Personnel.

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **150B38B**
Level 2 Schedule Activity Title: **LAW AP-102 Write/Issue Qual Sample Report**
Min. Duration Study Activity ID: **26 (write draft report)**
Activity Owner Interviewed: **Kathleen Hall**
Date of Interview: **1/20/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   Sample lab report required as data source (assume can obtain directly from LabCore)
   Changes in report format and/or level of detail (assumed to be minimal)
   Higher priority activities

2. **List the major things that could cause the task to finish sooner than expected.**

   Analytical data is obtained directly from LabCore
   Minimal statistical evaluation is performed
   Minimal text discussion is provided

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT THIS IS A PRIORITY ACTIVITY

   Optimistic: 13 (calendar) days
   Best Est.: 15 (calendar) days
   Pessimistic: 60 (calendar) days
   Log Normal, bounded, 95% curve

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID:	**150B38B**
Level 2 Schedule Activity Title:	**LAW AP-102 Write/Issue Qual Sample Report**
Min. Duration Study Activity ID:	**27 (edit, review, issue report)**
Activity Owner Interviewed:	**Kathleen Hall**
Date of Interview:	**1/20/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   Higher priority activities
   Document review takes longer than expected
   Technical editing takes longer than expected

2. **List the major things that could cause the task to finish sooner than expected.**

   Minimal text discussion is provided
   Document review quicker than expected
   Technical editing quicker than expected

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT THIS IS A PRIORITY ACTIVITY

Optimistic:	12 (calendar) days
Best Est.:	15 (calendar) days
Pessimistic:	30 (calendar) days

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **150B40A**
Level 2 Schedule Activity Title: **Draft Transmit Ltr Data to PC#1 AN-105/AP-102**
Min. Duration Study Activity ID: **28**
Activity Owner Interviewed: **Kathleen Hall**
Date of Interview: **1/20/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   Other priority work

2. **List the major things that could cause the task to finish sooner than expected.**

   Prioritization

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT THIS IS A PRIORITY ACTIVITY

   Optimistic: 1 day
   Best Est.: 2 days
   Pessimistic: 7 days
   Triangle

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: 150B40B
Level 2 Schedule Activity Title: Obtain LMHC Appr for Transmit Ltr AN-105/AP-102

Min. Duration Study Activity ID: 29
Activity Owner Interviewed: Kathleen Hall
Date of Interview: 1/20/98

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   Last minute changes to required report format and/or content
   Other priority work

2. **List the major things that could cause the task to finish sooner than expected.**

   Prioritization of this task

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT THIS IS A PRIORITY ACTIVITY

   Optimistic: 1 day
   Best Est.: 5 days
   Pessimistic: 10 days
   Log Normal, bounded, 95% curve

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: 150B40C
Level 2 Schedule Activity Title: FDH Transmit Data to DOE-RL AN-105/AP-102
Min. Duration Study Activity ID: 30
Activity Owner Interviewed: Kathleen Hall
Date of Interview: 1/20/98

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   Lack of available staff
   other priority work

2. **List the major things that could cause the task to finish sooner than expected.**

   Prioritization of this task

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT THIS IS A PRIORITY ACTIVITY

   Optimistic: 1 day
   Best Est.: 2 days
   Pessimistic: 5 days
   Triangle

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: 150B40D
Level 2 Schedule Activity Title: DOE-RL iss trnsmt Ltr Data to PC#1 AN-105/AP-102
Min. Duration Study Activity ID: 31
Activity Owner Interviewed: Kathleen Hall
Date of Interview: 1/20/98

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   Last minute changes by RL to the report
   Other priority work

2. **List the major things that could cause the task to finish sooner than expected.**

   Prioritization

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   ASSUME THAT THIS IS A PRIORITY ACTIVITY

   Optimistic: 1 day
   Best Est.: 2 days
   Pessimistic: 7 days
   Triangle

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: 150B44A
Level 2 Schedule Activity Title: Prepare Transfer to PC#1 Feed Tank AN-105/AP-102
Min. Duration Study Activity ID: 32
Activity Owner Interviewed: TBR/CEIS (post 1/5/98)
Date of Interview: NA

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. List the major things that could cause the task to take longer than expected.

Equipment failures
Instrument failures
Bad weather
Receipt tank not ready
All necessary procedures and authorizations not in place
Personnel not available

2. List the major things that could cause the task to finish sooner than expected.

No equipment failures
No instrument failures

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

See attached TBR estimating input sheets
The best estimate duration is from the TBR at 2 days. Optimistically this may take 1 day or, if instruments fail and weather doesn't cooperate may take a week.

Optimistic	1
Best Est.	2
Pessimistic	7

Log Normal, unbounded, 99% curve

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: NEW
Min. Duration Activity Title: Major Capital Equipment Replacement - Transfer Pump
Min. Duration Study Activity ID: 33
Activity Owner Interviewed: Fred Jensen/Brian Peters
Date of Interview: 1/16/98

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   proper equipment burial container not available
   replacement spare not available
   crews not trained and ready for making a critical lift
   replacement activities not covered by current safety basis
   bad weather
   difficulties with old equipment removal
   spare equipment needs modification

2. **List the major things that could cause the task to finish sooner than expected.**

   Appropriate size burial containers available
   paperwork in place
   spare equipment available and ready for installation
   crews trained

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   An Operations assumption during the Baseline Enhancement was that the program would suffer at least one failure of a piece of major capital equipment during the program (Phase I) lifetime. It is assumed that the worst case would be the failure of a pump within a source or staging tank requiring removal of the pump. If everything is in place, replacement could take from 7 to 25 days depending on weather and the nature of the equipment failure.

Optimistic	7 days
Best Est.	16 days

Pessimistic 25 days
Triangle

The probability of failure is a function of equipment use. It is assumed that all of the critical equipment is fully tested and ready for operation so that initial "new equipment" failures are not experienced. The expected procurement specs will require that the pump, motor, and ancillary equipment shall be designed for a cumulative total of 5,000 hours of intermittent operation over 5 years. The nominal time of operation for a Phase I WFD transfer pump will be 200 hours (1.7 million gallons at 140 gpm). Assume that 4% of the time (200/5000*100%) a failure occurs. The remainder of the time this activity has a duration of 0 days.

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: NEW
Min. Duration Activity Title: Major Capital Equipment Replacement - Mixer Pump
Min. Duration Study Activity ID: 34
Activity Owner Interviewed: Fred Jensen/Brian Peters
Date of Interview: 1/16/98

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   proper equipment burial container not available
   replacement spare not available
   crews not trained and ready for making a critical lift
   replacement activities not covered by current safety basis
   bad weather
   difficulties with old equipment removal
   spare equipment needs modification

2. **List the major things that could cause the task to finish sooner than expected.**

   Appropriate size burial containers available
   paperwork in place
   spare equipment available and ready for installation
   crews trained

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   An Operations assumption during the Baseline Enhancement was that the program would suffer at least one failure of a piece of major capital equipment during the program (Phase I) lifetime. It is assumed that the worst case would be the failure of a pump within a source or staging tank requiring removal of the pump. If everything is in place, replacement could take from 7 to 25 days depending on weather and the nature of the equipment failure.

Optimistic	7 days
Best Est.	16 days
Pessimistic	25 days

The probability of failure is a function of equipment use. It is assumed that all of the critical equipment is fully tested and ready for operation so that initial "new equipment" failures are not experienced.

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: 150B42E1
Level 2 Schedule Activity Title: Blend & Shim to AP-102 Tank Chemistry
Min. Duration Study Activity ID: 55 (prepare process memo)
Activity Owner Interviewed: Brian Peters
Date of Interview: 2/13/98

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

ACTIVITY DESCRIPTION:
This activity ties the process control sampling activity to actions by operations to bring the waste feed into specification. This case assumes that the selected action is to shim the waste in the IWFT.

There are two approaches to defining this activity. The first is to assume that after analysis of the process control samples, the sample data are evaluated and found to indicate that the feed is likely to be out of specification, recommendations are made on methods for bringing the feed into specification, a decision is made (presumably by DOE), and a process memo is prepared by the cognizant engineer providing direction to operations. Alternatively, it can be assumed that applicable contingency plans were completed and approved prior to waste retrieval and the only action needed is to prepare the process memo.

This second method is implicit in the subject TBR (150.B42). Assumptions provided in the TBR are related only to preparation of the process memo and call for 40 MH for the cognizant engineer, 8 MH for engineering management review, 8 MH for shift management review, and 8 MH clerical support and gives an overall duration of 1 week.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**
   Preapproval to shim the feed is not obtained prior to getting the sample results.

2. **List the major things that could cause the task to finish sooner than expected.**
   See TBR

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   Optimistic 2 days (assumes that similar process memo already exists)
   Best Est. 5 days
   Pessimistic 30 days (assumes that DOE approval not obtained ahead of time)
   Log Normal, unbounded, 95% curve

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **150B42D**
Level 2 Schedule Activity Title: **Blend & Shim to AP-102 Tank Chemistry**
Min. Duration Study Activity ID: **56 (shim)**
Activity Owner Interviewed: **TBR/CEIS (post 1/5/98)**
Date of Interview: **NA**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

   See TBR

2. **List the major things that could cause the task to finish sooner than expected.**

   See TBR

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

   See attached TBR Risk Assessment sheet

   Optimistic 2 days
   Best Est. 3 days
   Pessimistic 4 days
   Triangle

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **NEW**
Min. Duration Activity Title: **Prepare Process Memo**
Min. Duration Study Activity ID: **91**
Activity Definition By: **Brian Peters**
Date Completed: **2/21/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

ACTIVITY DESCRIPTION:
This activity ties the process control sampling activity to actions by operations to bring the waste feed into specification. This case assumes that the selected action is to blend waste from another tank into that in the IWFT and that there is enough tank head space for the transfer.

There are two approaches to defining this activity. The first is to assume that after analysis of the process control samples, the sample data are evaluated and found to indicate that the feed is likely to be out of specification, recommendations are made on methods for bringing the feed into specification, a decision is made (presumably by DOE), and a process memo is prepared by the cognizant engineer providing direction to operations. Alternatively, it can be assumed that applicable contingency plans were completed and approved prior to waste retrieval and the only action needed is to prepare the process memo.

To evaluate the impact of not having preapproved contingency plans, it will be assumed that an evaluation of options and approval from DOE for blending is required.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

- The waste components which are out of specification were not expected and no contingency plans were prepared
- Applicable compensatory model data are not available
- An appropriate blend material is not readily apparent
- Necessary routings are not readily apparent and/or are not RCRA compliant

2. **List the major things that could cause the task to finish sooner than expected.**

- Some contingency plans already developed
- Some options cost data available

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

Optimistic	14 days	(assumes that necessary compensatory data is available from the vendors, that an appropriate blend material is readily identified, that necessary routings are known and are RCRA compliant, estimates to complete blending are readily developed, 7 days to identify and cost options, 2 days to get DOE approval, 5 days to write & issue process memo)
Best Est.	21 days	(assumes that necessary compensatory data is available from the vendors, that an appropriate blend material is identified, that necessary routings are known and are RCRA compliant, approval from DOE is complicated, 10 days to identify and cost options, 6 days to get DOE approval, 5 days to write & issue process memo)
Pessimistic	60 days	(assumes that compensatory data is needed from the vendors, that an appropriate blend material is not readily identified, approval from DOE is difficult, 30 days to identify and cost options, 21 days to get DOE approval, 9 days to write & issue process memos)

Lognormal, upper unbounded, 95% at pessimistic

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: NEW
Min. Duration Activity Title: Prepare Selected LAW Blend Tank for Use
Min. Duration Study Activity ID: 92
Activity Definition By: Brian Peters
Date Completed: 2/21/98

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

ACTIVITY DESCRIPTION:
This activity includes all tasks needed to prepare a DST for transfer of a portion of the stored waste to the IWST. It is assumed that only waste supernatant would be transferred and no solids dissolution is needed. The tasks potentially include installing a pump and jumpers.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**
- Installation of a pump is necessary
- A new pump is needed but not readily available
- Installation of jumpers is needed to get the waste to the IWST
- Jumper fabrication is required

2. **List the major things that could cause the task to finish sooner than expected.**
- An appropriate pump is available in the tank and is functional

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

Optimistic	4 days	(assumes that only task is verification that the equipment and routings are ready)
Best Est.	14 days	(assumes that some pit work is required but nothing major)
Pessimistic	60 days	(assumes that an appropriate pump has to be located, shipped, tested, and installed)

Lognormal, upper unbounded, 95% at pessimistic value

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID:	**NEW**
Min. Duration Activity Title:	**Prepare Receiver Tank for Unacceptable LAW from 241-AP-104**
Min. Duration Study Activity ID:	**131**
Activity Definition By:	**Brian Peters**
Date Completed:	**2/21/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

ACTIVITY DESCRIPTION:
This activity includes all tasks needed to prepare a DST to receive out-of-specification waste from the IWFT for storage. It is assumed that the volume to be transferred is 350,000 gallons. This is the volume required (if the IWFT is nearly full) to blend a 10% over-spec waste with a 20% under-spec waste. It is assumed that a tank exists that can receive this waste volume and that the preparation activities consist of assessing waste compatibility and preparing the transfer route. The transfer route may require jumper changes.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**
- Data not readily available for waste compatibility assessment
- Installation of jumpers is needed to get the waste from the IWST to the storage DST
- Jumper fabrication is required

2. **List the major things that could cause the task to finish sooner than expected.**
- Transfer route is available and needs no maintenance or changes
- Compatibility assessment is simple

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

Optimistic	4 days	(assumes that only tasks are a simple waste compatibility assessment and verification that the equipment and routings are ready)
Best Est.	14 days	(assumes that some pit work is required but nothing major)
Pessimistic	30 days	(assumes that a sample of the receiving tank waste is needed for the compatibility assessment)

Lognormal, upper unbounded, 95% at pessimistic value

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: NEW
Min. Duration Activity Title: Prepare Process Memo
Min. Duration Study Activity ID: 170
Activity Definition By: Brian Peters
Date Completed: 2/21/98

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

ACTIVITY DESCRIPTION:
This activity ties the process control sampling activity to actions by operations to bring the waste feed into specification. This case assumes that the selected action is to transfer the staged feed to another tank and stage the next feed source tank instead.

There are two approaches to defining this activity. The first is to assume that after analysis of the process control samples, the sample data are evaluated and found to indicate that the feed is likely to be out of specification, recommendations are made on methods for bringing the feed into specification, a decision is made (presumably by DOE), and a process memo is prepared by the cognizant engineer providing direction to operations. Alternatively, it can be assumed that applicable contingency plans were completed and approved prior to waste retrieval and the only action needed is to prepare the process memo.

To evaluate the impact of not having preapproved contingency plans, it will be assumed that an evaluation of options and approval from DOE for restaging is required.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

- The waste components which are out of specification were not expected and no contingency plans were prepared
- Applicable compensatory model data are not available
- The next available feed source tank requires degassing prior to initiating waste retrieval
- The next available feed source tank requires Secretary of Energy approval to retrieve (FGWL)
- No feed source tank has all of the retrieval system installed.
- There is not enough DST space to contain the out-of-specification waste.

2. **List the major things that could cause the task to finish sooner than expected.**

- Contingency plans already developed
- The next feed source tank is ready for retrieval

3. Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).

Optimistic	14 days	(assumes that necessary compensatory data is available from the vendors, that the next feed source tank is ready for retrieval, estimates to complete staging the next tank are readily developed, 7 days to identify and cost options, 2 days to get DOE approval, 5 days to write & issue process memo)
Best Est.	21 days	(assumes that necessary compensatory data is available from the vendors, that the next feed source tank is ready for retrieval, estimates to complete staging the next tank are readily developed, approval from DOE is complicated, 10 days to identify and cost options, 6 days to get DOE approval, 5 days to write & issue process memo)
Pessimistic	60 days	(assumes that compensatory data is needed from the vendors, that the next feed source tank is not readily available so detailed planning is needed to accelerate it, approval from DOE is difficult, 30 days to identify and cost options, 21 days to get DOE approval, 9 days to write & issue process memos)

Lognormal, upper unbounded, 95% at pessimistic

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES ACTIVITY DURATION DISTRIBUTION

Level 2 Schedule Activity ID: **NEW**
Min. Duration Activity Title: **Prepare Receiver Tank for Unacceptable LAW from 241-AP-104**
Min. Duration Study Activity ID: **171**
Activity Definition By: **Brian Peters**
Date Completed: **2/21/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

ACTIVITY DESCRIPTION:
This activity includes all tasks needed to prepare a DST (or DSTs) to receive a full tank of out-of-specification waste from the IWFT for storage. It is assumed that the volume to be transferred is 1,000,000 gallons. It is assumed that a tank or tanks exists that can receive this waste volume and that the preparation activities consist of assessing waste compatibility and preparing the transfer route. The transfer routes may require jumper changes.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

- Data not readily available for waste compatibility assessment
- Installation of jumpers is needed to get the waste from the IWST to the storage DST
- Jumper fabrication is required
- Multiple DSTs required to receive full volume of the IWFT
- Both IWFTs must be restaged

2. **List the major things that could cause the task to finish sooner than expected.**

- Transfer route is available and needs no maintenance or changes
- Compatibility assessment is simple
- A single DST is available for receipt of the waste

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

Optimistic	4 days	(assumes that only tasks are a simple waste compatibility assessment and verification that the equipment and routings are ready)
Best Est.	20 days	(assumes that some pit work is required but nothing major)
Pessimistic	60 days	(assumes that multiple transfers are needed to make room for the waste, samples of each receiving tank waste are needed for the compatibility assessment and some pit work is required to set up the transfer routes)

Lognormal, upper unbounded, 95% at pessimistic value

**MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY DURATION DISTRIBUTION**

Level 2 Schedule Activity ID: **NEW**
Min. Duration Activity Title: **Prepare Next LAW Feed Tank for Use**
Min. Duration Study Activity ID: **174**
Activity Definition By: **Brian Peters**
Date Completed: **2/21/98**

PURPOSE: To develop a curve which describes the probable duration for the identified activity.

ACTIVITY DESCRIPTION:
This activity includes all tasks needed to prepare the next LAW feed tank for retrieval to the IWFT. This could range from almost no preparation needed if the next feed tank is the same feed envelope and doesn't require solids dissolution to extensive work if the retrieval systems aren't fully installed and operational or if the waste requires degassing.

DATA NEEDED:

1. **List the major things that could cause the task to take longer than expected.**

- The next available feed source tank requires degassing prior to initiating waste retrieval
- The next available feed source tank requires Secretary of Energy approval to retrieve (FGWL)
- The next feed source tank doesn't have an installed and/or operable retrieval system.

2. **List the major things that could cause the task to finish sooner than expected.**

- Contingency plans already developed
- The next feed source tank is ready for retrieval
- The next feed source tank doesn't require degassing
- The next feed source tank doesn't require in-tank solids dissolution

3. **Based on 1 and 2, estimate OPTIMISTIC, BEST ESTIMATE, AND PESSIMISTIC durations for the activity. Also suggest what type of distributions the durations might follow (triangular, flat, exponential, other).**

Optimistic	0 days	(assumes that the next feed source tank is ready for retrieval)
Best Est.	60 days	(assumes that the retrieval system is operable but waste degassing has not been started, degassing takes 60 days)
Pessimistic	150 days	(this is the planned duration between W-211 completion of each successive feed source tank retrieval system)

Lognormal, upper unbounded, 98% at pessimistic value

Determine algorithm for estimating transfer durations.

Activity	Volume transferred	Min	Med	Max
130B30B2	250,000	5	6	7
150B44B	700,000	7	9	11

Assume:

- Round <u>up</u> to nearest day
- All durations include 3 days for transfer setup and reset.

Want algorithm that expresses total duration as a function of :

- Volume transferred
- Pumping rate
- Efficiency factor (ϵf)

Min

$$[(\frac{Volume}{Rate}) + 3]\ [\epsilon f] \quad assume\ \epsilon f = 1.0$$

$$\frac{250000}{X} + 3 = 5 \Rightarrow X = \frac{125000\ gal}{day} = (87\ gpm)$$

$$\frac{700000}{X} + 3 = 7 \Rightarrow X = \frac{175000\ gal}{day} = (122\ gpm)$$

$$\Rightarrow Min = \frac{Volume}{180000} + 3$$ (rounded up to nearest day)

Median

$$((\frac{Volume}{Rate})+3)(\epsilon f) \quad assume\ \epsilon f\ =\ 1.25$$

$$(\frac{250000}{X}\ +\ 3\ )(1.25)\ =\ 6\ \Rightarrow\ =\ \frac{139000\ gal}{day}\ =\ 96.5\ gpm$$

$$(\frac{700000}{X}\ +\ 3\ )(1.25)\ =\ 9\ \Rightarrow\ =\ \frac{167000\ gal}{day}\ =\ 116\ gpm$$

$$\Rightarrow Median\ =\ (\frac{Volume}{167000}\ +\ 3)(1.25)$$

Max

$$((\frac{Volume}{Rate})+3)(\epsilon f) \quad assume\ rate\ =\ \frac{167000\ gal}{day}$$

$$(\frac{250000}{167000}\ +\ 3)(\epsilon f)\ =\ 7\quad \Rightarrow\ \epsilon f\ =\ 1.56$$

$$(\frac{700000}{167000}\ +\ 3)(\epsilon f)\ =\ 11\quad \Rightarrow\ \epsilon f\ =\ 1.53$$

$$\Rightarrow Max\ =\ (\frac{Volume}{167000}\ +\ 3)(1.5)$$

TBR Risk Assessment

TBR: 130.B30

Subactivity (WBS 8) Risk Assessment

WBS/ CEIS #	Summary Description	Activity Cost ($000)	Base Cost	Conting. (Yes/No)	Ri	Mi	ri	P(ri)
13B30A	Add Diluent (~25 KGal) Decant Pump Recirc AN-105	$ 5.6		No	1-3 Days	Price at 2 Days	50% over/under	10%
13B30B1	Write Procedure (Xfer) for AN-105 to AP-102	$ 8.5		No	N/A	N/A	0	0%
13B30B2	Decant 250kgal From AN-105 to AP-102	$ 15.7		No	5-7 Days	Price at 6 Days	16% over/under	10%
13B30C1	Write Procedure (Xfer) for AN-105 to AP-104	$ 8.5		No	N/A	N//A	0	0%
13B30C2	Perform Xfer from AN-105 to AP-104	$ 15.7		No	5-7 Days	Price at 6 Days	16% over/under	10%
13B30D	Add Diluent Water to AN-105	$ 49.2		No	4-6 Days	Price at 5	20% over/under	5%
13B30E	Prep Process Memo to Operate Mixer Pumps AN-105	$ 3.9		No	6-10 Days	Price at 8	25% over/under	10%
13B30E1	Operate Mixer Pumps in AN-105	$ 26.5		No	N/A	N//A	0	0%
13B30F	Perform Grab Sampling & Analysis of AN-105	$ 130.2		No	10-16 Days	Price at 13	21% over/under	20%
13B30G	Settle Solids in AN-105	$ -		No	20-40 Days	Say 30 Days	33% Schedule Risk	20%
13B30H	Decant Waste from AN-105 to AP-102	$ 23.7		No	7-10 Days	Price at 9	10% over/under	10%
13B30J	Decant Waste from AN-105 to AP-104	$ 23.7		No	7-10 Days	Price at 9	10% over/under	10%

Level I (WBS 7) Risk Assessment

Assumption	Basis	Baseline Risk	P(ri)
NONE	N/A	N/A	N/A

TBR Cost ($000):	Probability:	Low:	High:
$ 311.2	85%	273.2	350.1

130b30ra

Print Date: 1/10/98

APPENDIX C

LABORATORY SAMPLE ANALYSIS SENSITIVITY BASES

This page intentionally left blank.

APPENDIX C

LABORATORY SAMPLE ANALYSIS SENSITIVITY BASES

We will evaluate three scenarios for laboratory sample analysis. These will be a "best case" (S1), the current planning case (S2), and a business-as-usual case (S3). Case S1 will basically assume that we spend whatever is necessary to reduce the sample analysis time. Case S2 represents the assumptions used in the current RTP schedule and Case S3 represents what would be expected given the current situation of the 222-S laboratories. The laboratory activity durations will be adjusted for each case but the shape of the density curves won't be changed.

Case S1

Analyze Process Control Samples (Activity 11)

Optimistic 1 day
Best Estimate 3 days
Pessimistic 30 days (2% of the time duration will be >30 days)
Basis:

- There are two general types of failures inherent in the pessimistic value. In general "management-type" failures can take 30-60 days to resolve. These include issues such as higher priority "safety-related" samples or implementation of recent changes in rules/regulations (such as Radcon). Failures related to lab regulatory/compliance issues (response to audit findings etc.) have in the past taken 120-180 days to resolve.

- Analyses are those which require limited sample preparation (ie. supernatant ICP, GEA, Dionex, total alpha)

- Dedicated lab personnel (or a clearly defined priority for WFD samples)

- Dedicated analytical instrumentation and hotcell facilities (or a clearly defined priority for WFD samples)

- Data on Labcore is adequate for initial data report (results later documented in brief lab report)

- Premium and overtime charges are authorized

Analyze Feed Qualification Samples (Activity 24)

Optimistic 14 days
Best Estimate 20 days
Pessimistic 60 days (2% of the time duration will be >60 days)
Basis:

- There are two general types of failures inherent in the pessimistic value. In general "management-type" failures can take 30-60 days to resolve. These include issues such as higher priority "safety-related" samples or implementation of recent changes in rules/regulations (such as Radcon). Failures related to lab regulatory/compliance issues (response to audit findings etc.) have in the past taken 120-180 days to resolve.

- Analyses are limited to those necessary to qualify waste to the currently defined feed envelopes and to quantify Na concentrations.

- Dedicated lab personnel (or a clearly defined priority for WFD samples).

- Dedicated analytical instrumentation (or a clearly defined priority for WFD samples).

- Data on Labcore is adequate for drafting the Feed Qualification Report (activity 26). QA procedures are completed and a lab report issued (activity 25) prior to finalizing the Feed Qualification Report.

- Premium and overtime charges are authorized.

Prepare Feed Qualification Sample Lab Report (Activity 25)

Optimistic 10 days
Best Estimate 14 days
Pessimistic 21 days (2% of the time duration will be >21 days)
Basis:

- The primary failure which can cause delays in issuing the lab report are QA findings which require analysis reruns to resolve.

- Dedicated lab personnel, especially program coordinators (or a clearly defined priority for WFD samples).

- No laboratory computer system problems.

- Predefined (and partially automated) report format

- Premium and overtime charges are authorized.

Case S2

Analyze Process Control Samples (Activity 11)

Optimistic 6 days
Best Estimate 10 days
Pessimistic 60 days (2% of the time duration will be >60 days)
Basis:

- There are two general types of failures inherent in the pessimistic value. In general "management-type" failures can take 30-60 days to resolve. These include issues such as higher priority "safety-related" samples or implementation of recent changes in rules/regulations (such as Radcon). Failures related to lab regulatory/compliance issues (response to audit findings etc.) have in the past taken 120-180 days to resolve.

- Analyses are those which require limited sample preparation (ie. supernatant ICP, GEA, Dionex, total alpha)

- Adequate lab staffing is maintained and there is a clearly defined priority for WFD samples.

- Duration includes time to QA the data and issue a brief lab report.

- Premium and overtime charges are authorized

Analyze Feed Qualification Samples (Activity 24)

Optimistic 21 days
Best Estimate 30 days
Pessimistic 90 days (2% of the time duration will be >90 days)
Basis:

- There are two general types of failures inherent in the pessimistic value. In general "management-type" failures can take 30-60 days to resolve. These include issues such as higher priority "safety-related" samples or implementation of recent changes in rules/regulations (such as Radcon). Failures related to lab regulatory/compliance issues (response to audit findings etc.) have in the past taken 120-180 days to resolve.

- Analyses are limited to those necessary to qualify waste to the currently defined feed envelopes and to quantify Na concentrations.

- Adequate lab staffing is maintained and a clearly defined priority for WFD samples.

- Data on Labcore is adequate for drafting the Feed Qualification Report (activity 26). QA procedures are completed and a lab report issued (activity 25) prior to finalizing the Feed Qualification Report.

- Premium and overtime charges are authorized.

Prepare Feed Qualification Sample Lab Report (Activity 25)

Optimistic 14 days
Best Estimate 21 days
Pessimistic 28 days (2% of the time duration will be >28 days)

Basis:

- The primary failure which can cause delays in issuing the lab report are QA findings (such as RPD or RSD out of limits, poor spike recovery, etc.) which require analysis reruns to resolve.

- Adequate lab personnel, especially program coordinators.

- No laboratory computer system problems.

- Predefined report format

- Premium and overtime charges are authorized.

Case S3

Analyze Process Control Samples (Activity 11)

Optimistic 10 days
Best Estimate 14 days
Pessimistic 60 days (2% of the time duration will be >60 days)
Basis:

- There are two general types of failures inherent in the pessimistic value. In general "management-type" failures can take 30-60 days to resolve. These include issues such as higher priority "safety-related" samples or implementation of recent changes in rules/regulations (such as Radcon). Failures related to lab regulatory/compliance issues (response to audit findings etc.) have in the past taken 120-180 days to resolve.

- Analyses require sample preparation including digestion and/or preconcentration (solids analysis and/or trace analytes).

- Hotcell space at a premium.

- Minimal lab staffing is maintained with unclear priorities for WFD samples and those from other Hanford programs.

- Duration includes time to QA the data and issue a standard lab report.

- Premium and overtime charges not authorized

Analyze Feed Qualification Samples (Activity 24)

Optimistic 30 days
Best Estimate 60 days
Pessimistic 120 days (2% of the time duration will be >120 days)
Basis:

- There are two general types of failures inherent in the pessimistic value.

In general "management-type" failures can take 30-60 days to resolve. These include issues such as higher priority "safety-related" samples or implementation of recent changes in rules/regulations (such as Radcon). Failures related to lab regulatory/compliance issues (response to audit findings etc.) have in the past taken 120-180 days to resolve.

- Analyses are limited to those necessary to qualify waste to the currently defined feed envelopes and to quantify Na concentrations.

- Minimal lab staffing is maintained and no clear priority for WFD samples over other Hanford program samples.

- Data on Labcore is adequate for drafting the Feed Qualification Report (activity 26). QA procedures are completed and a lab report issued (activity 25) prior to finalizing the Feed Qualification Report.

- Frequent sample analysis reruns required.

- Premium and overtime charges not authorized.

Prepare Feed Qualification Sample Lab Report (Activity 25)

Optimistic 21 days
Best Estimate 28 days
Pessimistic 35 days (2% of the time duration will be >35 days)
Basis:

- The primary failure which can cause delays in issuing the lab report are QA findings which require analysis reruns to resolve.

- Minimal lab personnel, especially program coordinators.

- Laboratory computer system problems.

- Revised report formats

- Premium and overtime charges not authorized.

This page intentionally left blank.

APPENDIX D

UNIQUE ACTIVITY PROBABILITY DISTRIBUTION SUMMARIES

This page intentionally left blank.

APPENDIX D

UNIQUE ACTIVITY PROBABILITY DISTRIBUTION SUMMARIES

MINIMUM DURATION STUDY
UNIQUE ACTIVITIES (from 2/13/98 version of MINDUR4.MPP)

Study Sched ID	Level 2 P3 Sched ID	Optimistic	Best Estimate	Pessimistic	Duration Shape
2	13B30A	1	2	3	triangle
3	13B30B2	0	-	7	2-seg. uniform
4	13B30B2	(calculated)			triangle
7	13B30D	4	5	6	triangle
8	13B30E1	2	5	10	log normal, bounded, 95%
9	13B30G	20	30	40	uniform
10	13B30F	1.5	3	10	log normal, unbounded, 95%
11	13B30F	6	10	60	log normal, unbounded, 98%
12	13B30F	3	5	7	triangle
17	15B32B	2	5	10	log normal, bounded, 95%
22	15B34A	2	5	13	log normal, unbounded, 95%
23	15B36A	9	15	30	log normal, unbounded, 98%
24	15B38A	21	30	90	log normal, unbounded, 98% (upper bound is 180 days)
25	15B38C	14	21	28	normal, unbounded, 98%
26	15B38B	13	15	60	log normal, bounded, 95%
27	15B38B	12	15	30	log normal, bounded, 95%
28	15B40A	1	2	7	triangle
29	15B40B	1	5	10	log normal, bounded, 95%
30	15B40C	1	2	5	triangle
31	15B40D	1	2	7	triangle
32	15B44A	1	2	7	log normal, unbounded, 99%
33	new	7	16	25	2-seg. uniform/triangle
34	new	7	16	25	2-seg. uniform/triangle
55	15B42E1	2	5	30	log normal, unbounded, 95%
56	15B42D	2	3	4	triangle
91	new	14	21	60	log normal, unbounded, 95%
92	new	4	14	60	log normal, unbounded, 95%
131	new	4	14	30	log normal, unbounded, 95%
170	new	14	21	60	log normal, unbounded, 95%
171	new	4	20	60	log normal, unbounded, 95%
174	new	0	60	150	log normal, unbounded, 98%

MINIMUM DURATION STUDY
UNIQUE ACTIVITIES (from 2/13/98 version of MINDUR4.MPP)
(Cont.)

SENSITIVITY CASES

Case S1 (222-S Labs)

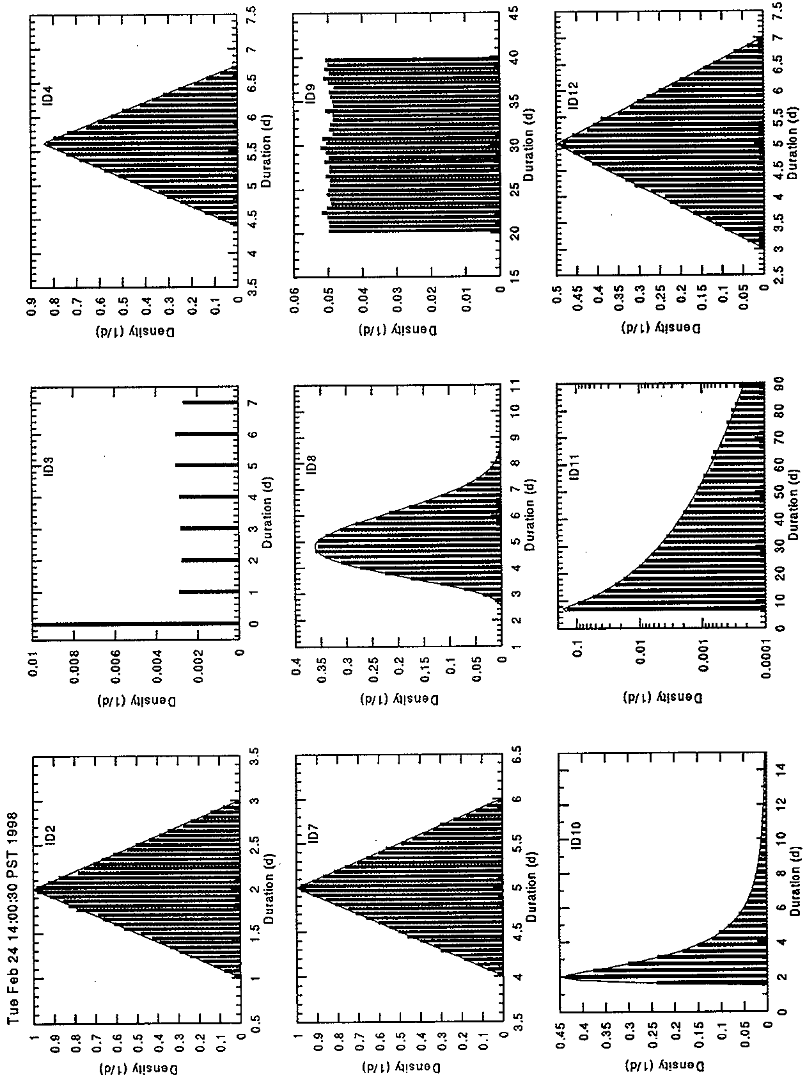
11	13B30F	1	3	30	log normal, unbounded, 98%
24	15B38A	14	20	60	log normal, unbounded, 98% (upper bound is 180 days)
25	15B38C	10	14	21	normal, unbounded, 98%

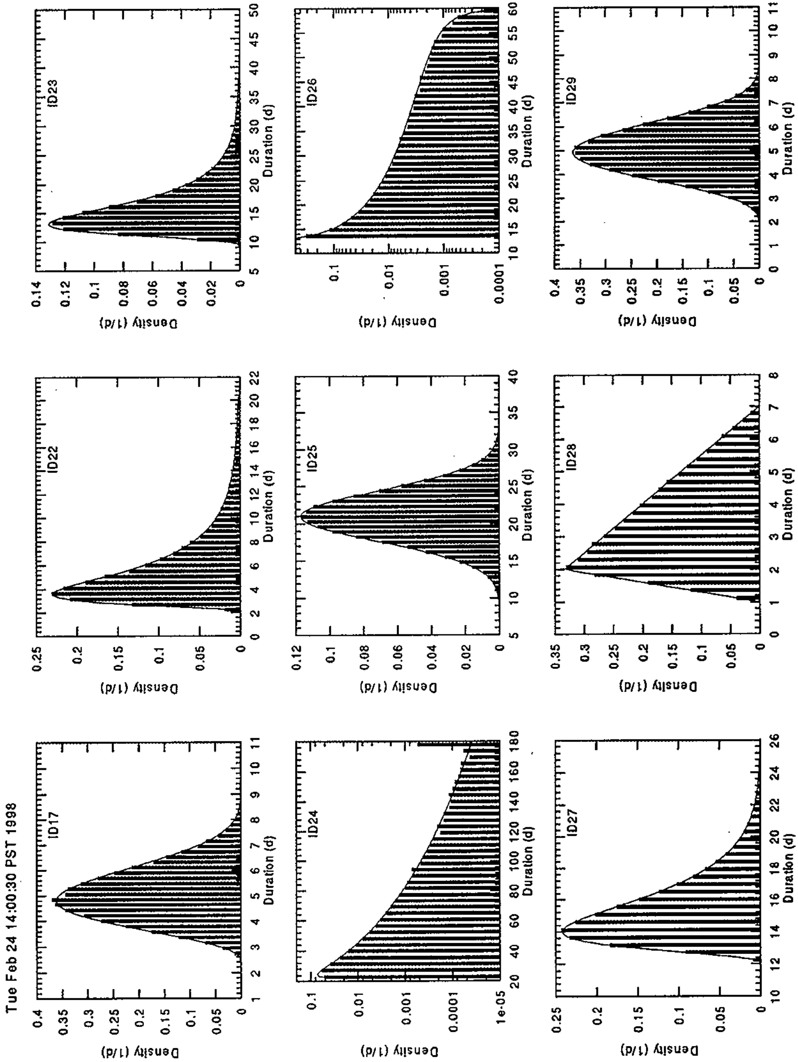
Case S2 (222-S Labs)

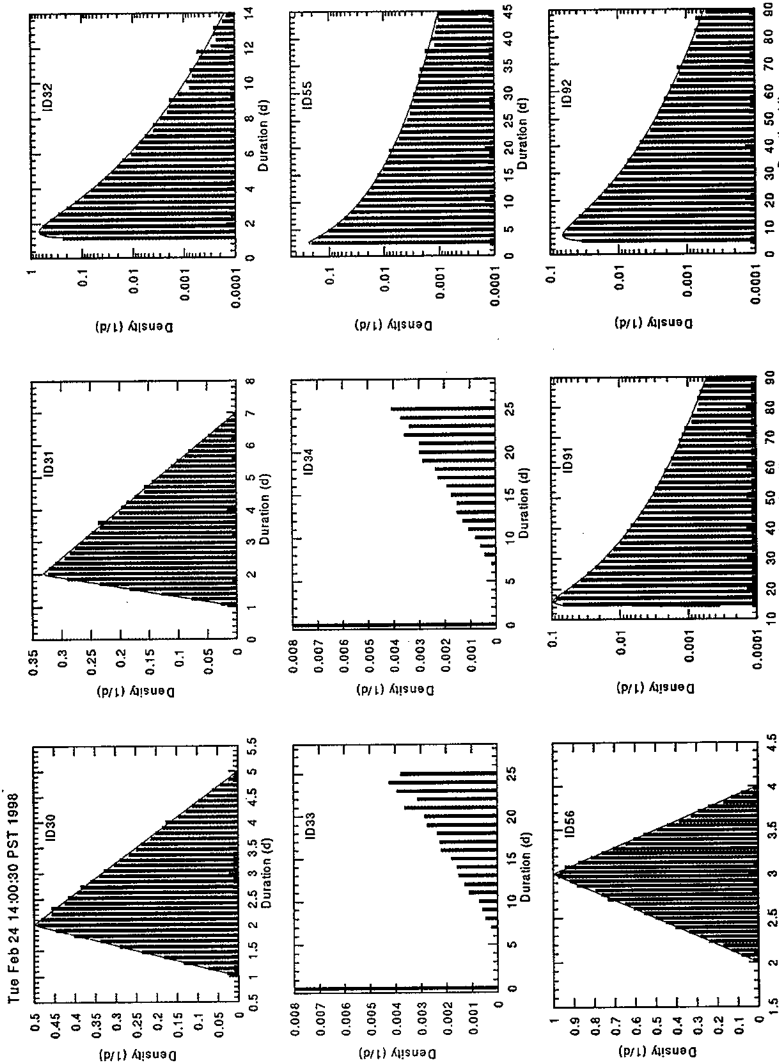
11	13B30F	6	10	60	log normal, unbounded, 98%
24	15B38A	21	30	90	log normal, unbounded, 98% (upper bound is 180 days)
25	15B38C	14	21	28	normal, unbounded, 98%

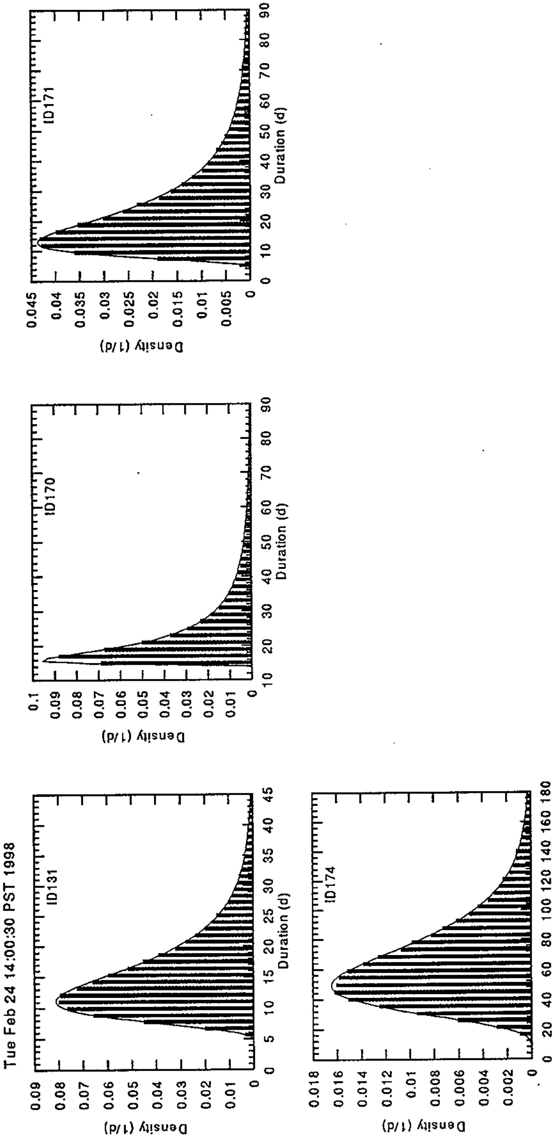
Case S3 (222-S Labs)

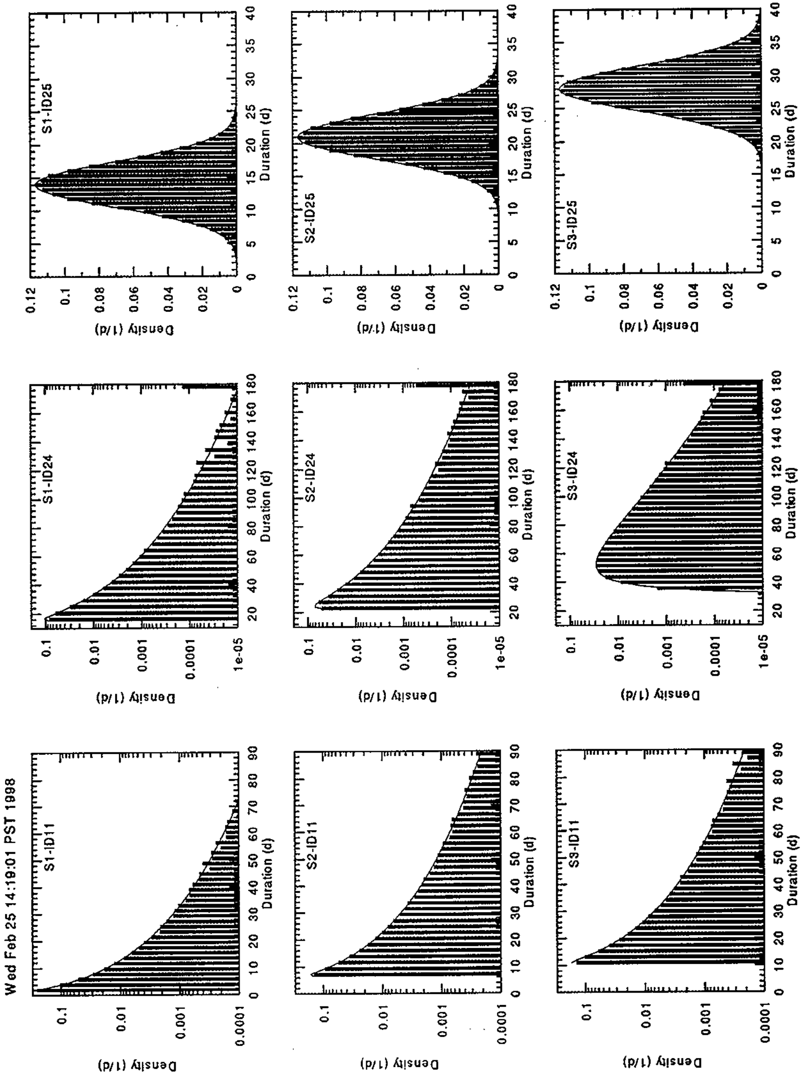
11	13B30F	10	14	60	log normal, unbounded, 98%
24	15B38A	30	60	120	log normal, unbounded, 98% (upper bound is 180 days)
25	15B38C	21	28	35	normal, unbounded, 98%


Tue Feb 24 14:00:30 PST 1998
ID2
ID3
ID4
ID7
ID8
ID9
ID10
ID11
ID12
Density (1/d)
Duration (d)


Tue Feb 24 14:00:30 PST 1998
ID17
ID22
ID23
ID24
ID25
ID26
ID27
ID28
ID29
Density (1/d)
Duration (d)


Tue Feb 24 14:00:30 PST 1998
ID30
ID31
ID32
ID33
ID34
ID55
ID56
ID91
ID92
Density (1/d)
Duration (d)


Tue Feb 24 14:00:30 PST 1998
ID131
ID170
ID171
ID174
Duration (d)
Density (1/d)


Wed Feb 25 14:19:01 PST 1998
S1-ID11
S2-ID11
S3-ID11
S1-ID24
S2-ID24
S3-ID24
S1-ID25
S2-ID25
S3-ID25
Density (1/d)
Duration (d)

This page intentionally left blank.

APPENDIX E

ACTIVITY CROSS-REFERENCE TABLE

This page intentionally left blank.

APPENDIX E

ACTIVITY CROSS-REFERENCE TABLE

MINIMUM DURATION BETWEEN SUCCESSIVE BATCHES
ACTIVITY CROSS-REFERENCE TABLE
(from 2/13/98 version of MINDUR4.MPP)

Activity ID	Unique ID	Activity Title
2	unique	Add Diluent in Transfer Pump Recirc Loop
3	unique	Delay due to transfer line use conflict
4	unique	Decant half of Supernate from LAW Feed Tank to 241-AP-102
5	3	Delay due to transfer line use conflict
6	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
7	unique	Add Dilution Water to LAW Feed Tank
8	unique	Mix LAW Feed Tank using Mixer Pumps
9	unique	Allow Undissolved Solids to Settle
10	unique	Take Process Control Samples from LAW Feed Tank
11	unique	Analyze Process Control Samples from LAW Feed Tank
12	unique	Evaluate LAW Feed Tank Process Control Sample Data
13	3	Delay due to transfer line use conflict
14	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
15	3	Delay due to transfer line use conflict
16	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
17	unique	Mix 241-AP-104 with Mixer Pump
18	10	Take Process Control Samples from 241-AP-104
19	11	Analyze Process Control Samples from 241-AP-104
20	12	Evaluate Process Control Sample Data
21	17	Mix 241-AP-104 with Mixer Pump
22	unique	Take Feed Qualification and Private Contractor Samples
23	unique	Provide Samples to Private Contractors
24	unique	Analyze Feed Qualification Samples
25	unique	Prepare Feed Qualification Sample Lab Report
26	unique	Interpret and Evaluate Sample Results and draft Feed Qualification Report
27	unique	Edit, Review, & Issue Feed Qualification Report
28	unique	Draft Transmittal Letter
29	unique	Obtain LHMC Approval
30	unique	FDH Transmit Data to DOE-RL
31	unique	DOE-RL Issue Transmittal Letter
32	unique	Setup Transfer to 241-AP-108
33	unique	Major Capital Equipment Replacement - Transfer Pump
34	unique	Major Capital Equipment Replacement - Mixer Pump

36	2	Add Diluent in Transfer Pump Recirc Loop
37	3	Delay due to transfer line use conflict
38	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
39	3	Delay due to transfer line use conflict
40	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
41	7	Add Dilution Water to LAW Feed Tank
42	8	Mix LAW Feed Tank using Mixer Pumps
43	9	Allow Undissolved Solids to Settle
44	10	Take Process Control Samples from LAW Feed Tank
45	11	Analyze Process Control Samples from LAW Feed Tank
46	12	Evaluate LAW Feed Tank Process Control Sample Data
47	3	Delay due to transfer line use conflict
48	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
49	3	Delay due to transfer line use conflict
50	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
51	17	Mix 241-AP-104 with Mixer Pump
52	10	Take Process Control Samples from 241-AP-104
53	11	Analyze Process Control Samples from 241-AP-104
54	12	Evaluate Process Control Sample Data
55	unique	Prepare Process Memo
56	unique	Add Chemical Solution (Shim) to 241-AP-104
57	17	Mix 241-AP-104 with Mixer Pump
58	22	Take Feed Qualification and Private Contractor Samples
59	23	Provide Samples to Private Contractors
60	24	Analyze Feed Qualification Samples
61	25	Prepare Feed Qualification Sample Lab Report
62	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report
63	27	Edit, Review, & Issue Feed Qualification Report
64	28	Draft Transmittal Letter
65	29	Obtain LHMC Approval
66	30	FDH Transmit Data to DOE-RL
67	31	DOE-RL Issue Transmittal Letter
68	32	Setup Transfer to 241-AP-108
69	33	Major Capital Equipment Replacement - Transfer Pump
70	34	Major Capital Equipment Replacement - Mixer Pump
72	2	Add Diluent in Transfer Pump Recirc Loop
73	3	Delay due to transfer line use conflict
74	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
75	3	Delay due to transfer line use conflict
76	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
77	7	Add Dilution Water to LAW Feed Tank
78	8	Mix LAW Feed Tank using Mixer Pumps
79	9	Allow Undissolved Solids to Settle
80	10	Take Process Control Samples from LAW Feed Tank

81	11	Analyze Process Control Samples from LAW Feed Tank
82	12	Evaluate LAW Feed Tank Process Control Sample Data
83	3	Delay due to transfer line use conflict
84	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
85	3	Delay due to transfer line use conflict
86	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
87	17	Mix 241-AP-104 with Mixer Pump
88	10	Take Process Control Samples from 241-AP-104
89	11	Analyze Process Control Samples from 241-AP-104
90	12	Evaluate Process Control Sample Data
91	unique	Prepare Process Memo
92	unique	Prepare Selected LAW Blend Tank for Use
93	3	Delay Due To Transfer Line Use Conflict
94	4	Decant Supernate from LAW Blend Tank to 241-AP-104
95	17	Mix 241-AP-104 with Mixer Pump
96	22	Take Feed Qualification and Private Contractor Samples
97	23	Provide Samples to Private Contractors
98	24	Analyze Feed Qualification Samples
99	25	Prepare Feed Qualification Sample Lab Report
100	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report
101	27	Edit, Review, & Issue Feed Qualification Report
102	28	Draft Transmittal Letter
103	29	Obtain LHMC Approval
104	30	FDH Transmit Data to DOE-RL
105	31	DOE-RL Issue Transmittal Letter
106	32	Setup Transfer to 241-AP-108
107	33	Major Capital Equipment Replacement - Transfer Pump
108	34	Major Capital Equipment Replacement - Mixer Pump
110	2	Add Diluent in Transfer Pump Recirc Loop
111	3	Delay due to transfer line use conflict
112	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
113	3	Delay due to transfer line use conflict
114	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
115	7	Add Dilution Water to LAW Feed Tank
116	8	Mix LAW Feed Tank using Mixer Pumps
117	9	Allow Undissolved Solids to Settle
118	10	Take Process Control Samples from LAW Feed Tank
119	11	Analyze Process Control Samples from LAW Feed Tank
120	12	Evaluate LAW Feed Tank Process Control Sample Data
121	3	Delay due to transfer line use conflict
122	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
123	3	Delay due to transfer line use conflict
124	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
125	17	Mix 241-AP-104 with Mixer Pump

126	10	Take Process Control Samples from 241-AP-104
127	11	Analyze Process Control Samples from 241-AP-104
128	12	Evaluate Process Control Sample Data
129	91	Prepare Process Memo
130	92	Prepare Selected LAW Blend Tank for Use
131	unique	Prepare Receiver Tank for Unacceptable LAW from 241-AP-104
132	3	Delay Due To Transfer Line Use Conflict
133	4	Decant Portion of Supernate from 241-AP-104 to Receiver Tank
134	3	Delay Due To Transfer Line Use Conflict
135	4	Decant Supernate from LAW Blend Tank to 241-AP-104
136	17	Mix 241-AP-104 with Mixer Pump
137	22	Take Feed Qualification and Private Contractor Samples
138	23	Provide Samples to Private Contractors
139	24	Analyze Feed Qualification Samples
140	25	Prepare Feed Qualification Sample Lab Report
141	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report
142	27	Edit, Review, & Issue Feed Qualification Report
143	28	Draft Transmittal Letter
144	29	Obtain LHMC Approval
145	30	FDH Transmit Data to DOE-RL
146	31	DOE-RL Issue Transmittal Letter
147	32	Setup Transfer to 241-AP-108
148	33	Major Capital Equipment Replacement - Transfer Pump
149	34	Major Capital Equipment Replacement - Mixer Pump
151	2	Add Diluent in Transfer Pump Recirc Loop
152	3	Delay due to transfer line use conflict
153	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
154	3	Delay due to transfer line use conflict
155	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
156	7	Add Dilution Water to LAW Feed Tank
157	8	Mix LAW Feed Tank using Mixer Pumps
158	9	Allow Undissolved Solids to Settle
159	10	Take Process Control Samples from LAW Feed Tank
160	11	Analyze Process Control Samples from LAW Feed Tank
161	12	Evaluate LAW Feed Tank Process Control Sample Data
162	3	Delay due to transfer line use conflict
163	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
164	3	Delay due to transfer line use conflict
165	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
166	17	Mix 241-AP-104 with Mixer Pump
167	10	Take Process Control Samples from 241-AP-104
168	11	Analyze Process Control Samples from 241-AP-104
169	12	Evaluate Process Control Sample Data
170	unique	Prepare Process Memo

171	unique	Prepare Receiver Tank for Unacceptable LAW from 241-AP-104
172	3	Delay Due To Transfer Line Use Conflict
173	4	Decant Supernate from 241-AP-104 to Receiver Tank
174	unique	Prepare Next LAW Feed Tank for Use
175	3	Delay Due To Transfer Line Use Conflict
176	4	Decant Supernate from LAW Feed Tank to 241-AP-104
177	17	Mix 241-AP-104 with Mixer Pump
178	22	Take Feed Qualification and Private Contractor Samples
179	23	Provide Samples to Private Contractors
180	24	Analyze Feed Qualification Samples
181	25	Prepare Feed Qualification Sample Lab Report
182	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report
183	27	Edit, Review, & Issue Feed Qualification Report
184	28	Draft Transmittal Letter
185	29	Obtain LHMC Approval
186	30	FDH Transmit Data to DOE-RL
187	31	DOE-RL Issue Transmittal Letter
188	32	Setup Transfer to 241-AP-108
189	33	Major Capital Equipment Replacement - Transfer Pump
190	34	Major Capital Equipment Replacement - Mixer Pump

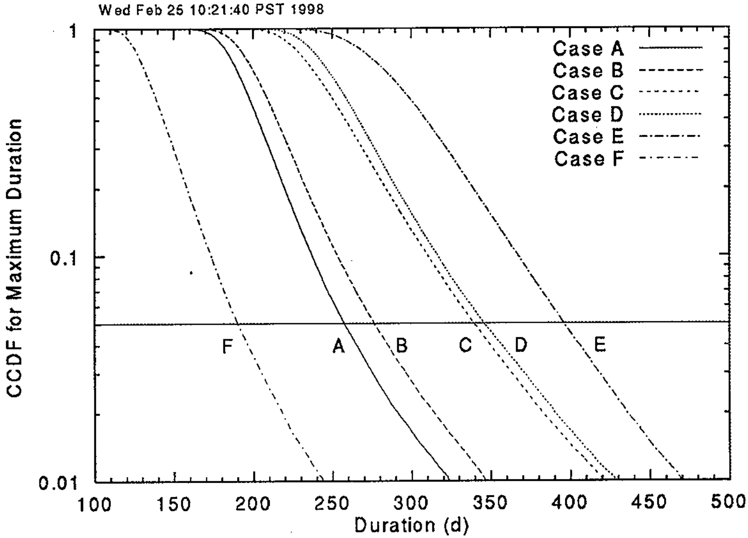
192	3	Delay due to transfer line use conflict
193	4	Decant half of Supernate from LAW Feed Tank to 241-AP-102
194	3	Delay due to transfer line use conflict
195	4	Decant half of Supernate from LAW Feed Tank to 241-AP-104
196	17	Mix 241-AP-104 with Mixer Pump
197	10	Take Process Control Samples from 241-AP-104
198	11	Analyze Process Control Samples from 241-AP-104
199	12	Evaluate Process Control Sample Data
200	17	Mix 241-AP-104 with Mixer Pump
201	22	Take Feed Qualification and Private Contractor Samples
202	23	Provide Samples to Private Contractors
203	24	Analyze Feed Qualification Samples
204	25	Prepare Feed Qualification Sample Lab Report
205	26	Interpret and Evaluate Sample Results and draft Feed Qualification Report
206	27	Edit, Review, & Issue Feed Qualification Report
207	28	Draft Transmittal Letter
208	29	Obtain LHMC Approval
209	30	FDH Transmit Data to DOE-RL
210	31	DOE-RL Issue Transmittal Letter
211	32	Setup Transfer to 241-AP-108
212	33	Major Capital Equipment Replacement - Transfer Pump
213	34	Major Capital Equipment Replacement - Mixer Pump

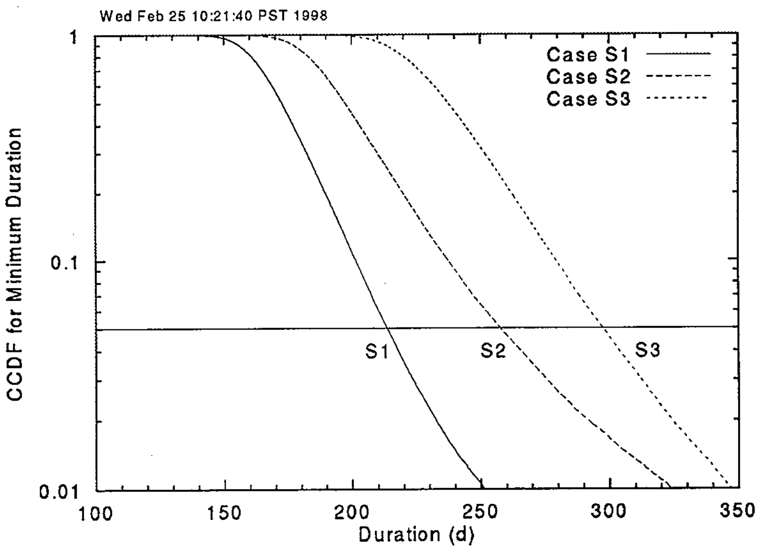
This page intentionally left blank.

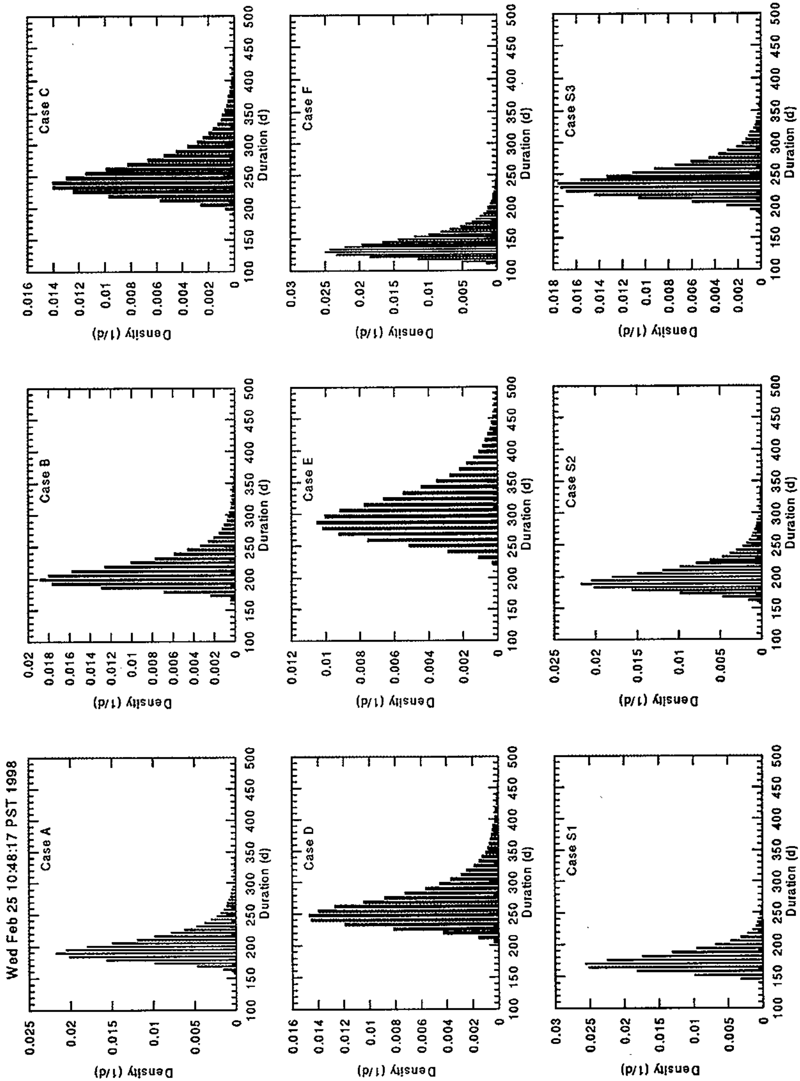
APPENDIX F

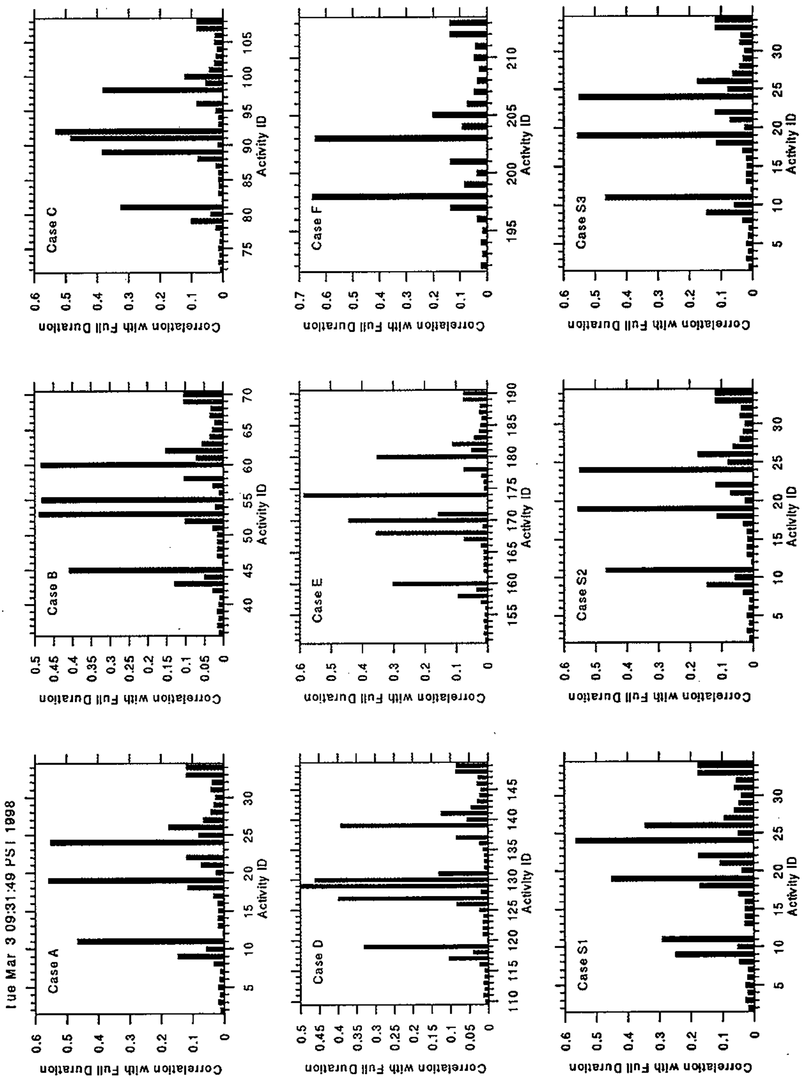
CASES A-F, S1-S3: DENSITY DISTRIBUTIONS AND ACTIVITY CORRELATIONS

This page intentionally left blank.


Wed Feb 25 10:21:40 PST 1998
Case A
Case B
Case C
Case D
Case E
Case F
F
A
B
C
D
E
CCDF for Maximum Duration
1
0.1
0.01
100
150
200
250
300
350
400
450
500
Duration (d)


Wed Feb 25 10:21:40 PST 1998
Case S1
Case S2
Case S3
S1
S2
S3
CCDF for Minimum Duration
1
0.1
0.01
100
150
200
250
300
350
Duration (d)


Wed Feb 25 10:48:17 PST 1998
Case A
Case B
Case C
Case D
Case E
Case F
Case S1
Case S2
Case S3
Density (1/d)
Duration (d)


Tue Mar 3 09:31:49 PST 1998
Case A
Case B
Case C
Case D
Case E
Case F
Case S1
Case S2
Case S3
Activity ID
Correlation with Full Duration

This page intentionally left blank.

APPENDIX G

MONTE CARLO COMPUTER CODE (FORTRAN)

This page intentionally left blank.

```
      PROGRAM fstage
C Program to perform Monte Carlo analysis to determine the expected
C durations for feed staging of LAW.
C Rick Wittman, NHC (Fri Feb 20 09:04:01 PST 1998) Last Change
C
      REAL*8 TOL
      INTEGER MAXEV,NNODS,MAXIND,MAXCA,MAXPTH,MAXDIS,MPARAM,MAXUD,
     1        MPTSUD
      PARAMETER (MAXEV=250,NNODS=4,MAXIND=1000,MAXCA=20,MAXPTH=16,
     1    MAXDIS=11,MPARAM=20,MAXUD=100,MPTSUD=100,TOL=2.22D-14)
      CHARACTER card*160,evtitl(MAXEV)*90,case(MAXCA)*90,
     1    evdist(MAXEV)*2,chdist(MAXDIS)*2,udfile(MAXUD)*20,
     2    dfile*20,dwname*20
      INTEGER linkto(MAXEV,NNODS),nlinks(MAXEV),istore(MAXIND),
     1    ifirst(MAXCA),ilast(MAXCA),icolu(MPARAM),itcase(MAXCA),
     2    indxud(MAXEV),nptsud(MAXUD),iconvg,idflg,icrflg,idwfg(30),
     3    iact,nact
      REAL*8 evpdur(MAXEV),evdur(MAXEV),Tpath(MAXPTH),capdur(MAXCA),
     1       pparam(MAXEV,MPARAM),qparam(MPARAM),tcase(MAXCA),
     2       valud(MAXUD,MPTSUD),pud(MAXUD,MPTSUD)
      REAL*8  avt(MAXEV),avtt(MAXEV),avttot(MAXEV,MAXCA),
     1        avtot(MAXCA),avtot2(MAXCA)
      common /evdata/ evdur,linkto,nlinks,istore
      common /pathT/  Tpath
      common /prbdst/ pparam
      common /usrdst/ valud,pud,nptsud
      common /conflg/ iconvg
C
C  evtitl(MAXEV) -   Event Title (CHAR*90)
C  evpdur(MAXEV) -   Point Estimate of event duration (REAL*8)
C  linkto(MAXEV,NNODS) -
C  nlinks(MAXEV)
C  istore(MAXIND)
C
C  case(MAXCA)
C  capdur(MAXCA)
C  ifirst(MAXCA)
C  ilast(MAXCA)
C  Tpath(MAXPTH)
C
```



```
C USES blink, gettmx, ints, uqdev, expdev, gasdev, tridev,
C      usrdev, disdev, ebsdev, Blam, glndev, sigln, glbdev

      INTEGER iseed,icase,nevent,iread,istep,n,ncase,isam,ints,i,
     1        iev,ipath,it,itmax,nsam,nbnob,iqpts,nqpts,iparam,nud
      REAL*8  ran2,tsumin,tmax,uqdev,expdev,gasdev,tridev,usrdev,
     1        disdev,ebsdev,Blam,glndev,sigln,glbdev
      DATA chdist /'  ','U ','UQ','Ex','N ',
     1             'Tr','UD','DD','EB','GL','LB'/
C
C Sample CARD for each probability distribution type:
C DIST U      50.  100.
C DIST UQ 5    0. 14.0   .25 20.   .5 25.   .9 40.   1.0 50.
C DIST Ex     14.0
C DIST N     100. 5.
C DIST Tr     30. 50. 120.
C DIST UD     ud1.dist
C DIST DD 4    4.0 0.1   5.0 0.5   22.0 0.9   30.0 1.0
C DIST EB     30. 50. 120.
C DIST GL     30. 50. 120.  0.95
C DIST LB     30. 50. 120.  0.95
C
C Read Input Information -----------------------------------
C (Sanmple input control file ``mc-fstage.control'' follows:
C FDschedules.txt                ! Input Data File Name
C 100000                         ! Size of Random Sample Set
C -1127375                       ! Seed for RAN2
C 0                              ! Flag to write param convergence info (stout)
C 1                              ! Flag to write Tot Duration info (stout)
C 0                              ! Flag to write Correlations to unit 99
C 0                              ! Flag to write Activity ID Dist to flag
C
C ----------------------------------------------------------
      read(*,'(A)') dfile
      read(*,*) nsam
      read(*,*) iseed
      read(*,*) iconvg
      read(*,*) idflg
      read(*,*) icrflg
      nact = 1
```

```
      do 4 iact=1,30
          read(*,*,END=5) idwfg(nact)
          if(idwfg(nact).gt.0) nact = nact + 1
    4 continue
    5 continue
      nact = nact - 1
      if(nact.gt.0) then
        do 7 iact=1,nact
          if(idwfg(iact).gt.0) then
            if(idwfg(iact).lt.10) then
               write(dwname,"('activity.',i1,10x)") idwfg(iact)
            elseif(idwfg(iact).lt.100) then
               write(dwname,"('activity.',i2,9x)") idwfg(iact)
            else
               write(dwname,"('activity.',i3,8x)") idwfg(iact)
            endif
            open(10+iact,file=dwname,status='unknown')
          endif
    7   continue
      endif
      open(3,file=dfile,status='old')
c       nsam  = 100000
c       nsam  = 100000
C  WARNING! If nsam=1, then point estimate values are used for durations.
c        iseed = -1127775
        icase = 0
        nevent= 0
        nud = 0
        do 20 iread=1,1000
          read(3,'(a160)',end=25) card
          if(card(1:5).ne.'     ') then
            if(card(2:4).eq.'###') then
              icase = icase + 1
                   avtot(icase) = 0.d0
                   avtot2(icase)= 0.d0
              read(card(6:95),'(a90)')      case(icase)
              read(card(96:103),*) capdur(icase)
              read(card(104:160),*) ifirst(icase),ilast(icase)
            elseif(card(1:4).eq.'DIST') then
C Read info for any prob dist assigned to the event duration.
```



```
              call bnob(card,icolu,nbnob,1,160)
              read(card(icolu(1):icolu(1)+1),'(a2)') evdist(nevent)
              if(evdist(nevent).eq.chdist(3)) then
                read(card(icolu(2):160),*) nqpts
                read(card(icolu(3):160),*)
     1                      (pparam(nevent,iqpts),iqpts=1,2*nqpts)
              elseif(evdist(nevent).eq.chdist(2)) then
                read(card(icolu(2):160),*)
     1                      (pparam(nevent,iqpts),iqpts=1,2)
              elseif(evdist(nevent).eq.chdist(4)) then
                read(card(icolu(2):160),*)
     1                      (pparam(nevent,iqpts),iqpts=1,1)
              elseif(evdist(nevent).eq.chdist(5)) then
                read(card(icolu(2):160),*)
     1                      (pparam(nevent,iqpts),iqpts=1,2)
              elseif(evdist(nevent).eq.chdist(6)) then
                read(card(icolu(2):160),*)
     1                      (pparam(nevent,iqpts),iqpts=1,3)
              elseif(evdist(nevent).eq.chdist(7)) then
                nud = nud + 1
                indxud(nevent) = nud
                read(card(icolu(2):icolu(2)+19),'(a20)')
     1                      udfile(nud)
c                write(*,*) indxud(nevent),nevent,istep
c                write(*,*) udfile(nud)
                open(50,file=udfile(nud),status='OLD')
                do 10  i=1,MPTSUD
                   read(50,*,end=11) valud(nud,i),pud(nud,i)
c                    write(*,*) valud(nud,i),pud(nud,i)
   10           continue
   11           continue
                nptsud(nud) = i - 1
c                   write(*,*) nptsud(nud)
                close(50)
              elseif(evdist(nevent).eq.chdist(8)) then
                read(card(icolu(2):160),*) nqpts
                read(card(icolu(3):160),*)
     1                      (pparam(nevent,iqpts),iqpts=1,2*nqpts)
              elseif(evdist(nevent).eq.chdist(9)) then
                read(card(icolu(2):160),*)
```

```
     1                      (pparam(nevent,iqpts),iqpts=1,3)
              pparam(nevent,2) =
     1 Blam(pparam(nevent,1),pparam(nevent,2),pparam(nevent,3),TOL)
             elseif(evdist(nevent).eq.chdist(10)) then
               read(card(icolu(2):160),*)
     1                      (pparam(nevent,iqpts),iqpts=1,4)
              pparam(nevent,3) =
     1 sigln(pparam(nevent,1),pparam(nevent,2),pparam(nevent,3),
     2                        pparam(nevent,4),TOL)
             elseif(evdist(nevent).eq.chdist(11)) then
               read(card(icolu(2):160),*)
     1                      (pparam(nevent,iqpts),iqpts=1,4)
              pparam(nevent,4) =
     1 sigln(pparam(nevent,1),pparam(nevent,2),pparam(nevent,3),
     2                        pparam(nevent,4),TOL)
             endif
             avt(nevent)    =  0.d0
             avtt(nevent)   =  0.d0
           else
             nevent = nevent + 1
             read(card(1:5),*)    istep
             istore(istep) = nevent
             evdist(nevent) = chdist(1)
             read(card(6:95),'(a90)')  evtitl(nevent)
             read(card(96:103),*)      evpdur(nevent)
             nlinks(nevent) = ints(card,104,160)
             if(nlinks(nevent).ne.0) then
               read(card(104:160),*)
     1            (linkto(nevent,n),n=1,nlinks(nevent))
             endif
           endif
         endif
   20  continue
   25  continue
       ncase = icase
      close(3)
      do 29 icase=1,ncase
      do 29 iev=1,nevent
        avttot(iev,icase)= 0.d0
   29 continue
```



```
c -----------------------------------------------------------
      do 1000 isam=1,nsam
        do 40 iev=1,nevent
          if((evdist(iev).eq.chdist(1)).or.(nsam.eq.1)) then
            evdur(iev) = evpdur(iev)
          else
            if(evdist(iev).eq.chdist(2)) then
              evdur(iev) = (pparam(iev,2)-pparam(iev,1))*ran2(iseed)
     1                  +  pparam(iev,1)
            elseif(evdist(iev).eq.chdist(3)) then
              do 35 iparam=1,MPARAM
                qparam(iparam) = pparam(iev,iparam)
   35         continue
              evdur(iev) = uqdev(iseed,qparam)
            elseif(evdist(iev).eq.chdist(4)) then
              evdur(iev) = pparam(iev,1)*expdev(iseed)
            elseif(evdist(iev).eq.chdist(5)) then
              evdur(iev) = pparam(iev,2)*gasdev(iseed)+pparam(iev,1)
            elseif(evdist(iev).eq.chdist(6)) then
              evdur(iev) =
     1          tridev(iseed,pparam(iev,1),pparam(iev,2),pparam(iev,3))
            elseif(evdist(iev).eq.chdist(7)) then
              evdur(iev) =
     1          usrdev(iseed,indxud(iev))
            elseif(evdist(iev).eq.chdist(8)) then
              do 38 iparam=1,MPARAM
                qparam(iparam) = pparam(iev,iparam)
   38         continue
              evdur(iev) = disdev(iseed,qparam)
            elseif(evdist(iev).eq.chdist(9)) then
              evdur(iev) =
     1          ebsdev(iseed,pparam(iev,1),pparam(iev,2),pparam(iev,3))
            elseif(evdist(iev).eq.chdist(10)) then
              evdur(iev) =
     1          glndev(iseed,pparam(iev,1),pparam(iev,2),pparam(iev,3))
c     ------------------------------------------------------------
c     WARNING! Special Case  of  Hard wired U.B. of 180d
c              for event 34 which corresponds to iev = 23,58,95,135,175,197.
             if((iev.eq.23).or.(iev.eq.58).or.(iev.eq.95).or.
     1          (iev.eq.135).or.(iev.eq.175).or.(iev.eq.197)) then
```

```
              if(evdur(iev).gt.180.d0) evdur(iev) = 180.d0
           endif
C     I promise not to make a habit of this!!!!!!!!!
C     -----------------------------------------------------------
            elseif(evdist(iev).eq.chdist(11)) then
              evdur(iev) =
     1          glbdev(iseed,pparam(iev,1),pparam(iev,2),
     2                       pparam(iev,3),pparam(iev,4))
            else
              write(*,*) 'The requested distribution is UNKNOWN!'
              stop
            endif
              avt(iev)  =  avt(iev) + evdur(iev)
              avtt(iev) = avtt(iev) + evdur(iev)**2
          endif
   40   continue
        do 100 icase=1,ncase
        ipath  =  1
        tsumin = 0.d0
        do 50 it=1,16
          Tpath(it) = 0.d0
   50   continue
        call blink(ipath,ifirst(icase),ilast(icase),tsumin)
c        write(*,'(a90)') case(icase)
c        write(*,*) Tpath
        call gettmx(tmax,itmax)
        tcase(icase)  = tmax
        itcase(icase) = itmax
c        write(*,777) tmax,evdur(istore(165)),evdur(istore(185))
        avtot(icase) = avtot(icase)  + tcase(icase)
        avtot2(icase)= avtot2(icase) + tcase(icase)**2
        do 90 iev=1,nevent
         avttot(iev,icase)= avttot(iev,icase) + tcase(icase)*evdur(iev)
   90   continue
  100   continue
        if(idflg.ne.0)
     1      write(*,777) (tcase(icase),itcase(icase),icase=1,ncase)
C        write(31,*) evdur(istore(10))
C        write(32,*) evdur(istore(11))
C        write(33,*) evdur(istore(22))
```



```
C        write(25,*) evdur(istore(25))
        if(nact.gt.0) then
           do 997 iact=1,nact
             write(10+iact,*) evdur(istore(idwfg(iact)))
  997      continue
        endif
C        write(36,*) evdur(istore(27))
C        write(37,*) evdur(istore(29))
 1000 continue
      if(nact.gt.0) then
        do 1005 iact=1,nact
          close(30+iact)
 1005   continue
      endif
      if(icrflg.ne.0) then
      do 1100 iev=1,33
        write(99,*) iev+1,
     1     (avttot(iev,1)-avt(iev)*avtot(1)/dfloat(nsam))/
     1  dsqrt( ( avtt(iev)-avt(iev)**2/dfloat(nsam) )*
     2         ( avtot2(1)-avtot(1)**2/dfloat(nsam) )   )
 1100 continue
      endif
c  777 format(10(1pe11.3))
  777 format(20(1pe15.7,i5))
      stop
      END

      SUBROUTINE blink(ipath,istop,ilast,tsumin)
      INTEGER MAXEV,NNODS,MAXIND,MAXPTH
      PARAMETER (MAXEV=250,NNODS=4,MAXIND=1000,MAXPTH=16)
      INTEGER ipath,istop,ilast,linkto(MAXEV,NNODS),nlinks(MAXEV),
     1         istore(MAXIND)
      REAL*8  tsumin,evdur(MAXEV),Tpath(MAXPTH)
      common /evdata/ evdur,linkto,nlinks,istore
      common /pathT/ Tpath
C USES blink
C Routine to recursively follow the event links for all possible paths
C while summing the event durations for each path.  Recursion is
C performed from end to begining of feed staging history.
```

```
      INTEGER ibran
      REAL*8  tsum
      tsum = tsumin + evdur(istore(ilast))
      if(ilast.ne.istop) then
        do 11 ibran=1,nlinks(istore(ilast))
          if(ibran.gt.1) ipath=ipath+1
          call blink(ipath,istop,linkto(istore(ilast),ibran),tsum)
   11   continue
      else
        Tpath(ipath) = tsum
      endif
      return
      END

      FUNCTION ints(card,i1,i2)
      INTEGER ints,i1,i2
      CHARACTER card*160
C Return the nunber of blank-noblank pairs between i1 & i2
C positions of character string card.

      INTEGER i,ip1
      ints = 0
      do 11 i=i1,i2-1
        ip1 = i + 1
        if((card(ip1:ip1).eq.' ').and.(card(i:i).ne.' ')) then
            ints = ints + 1
        endif
   11 continue
      return
      END

      SUBROUTINE gettmx(tmax,itmax)
      INTEGER itmax,MAXPTH
      PARAMETER (MAXPTH=16)
      REAL*8  tmax,Tpath(MAXPTH)
      common /pathT/ Tpath
C Return the maximum value and position in the array Tpath.

      INTEGER it
      itmax = 1
```



```
      tmax  = Tpath(1)
      do 11 it=1,MAXPTH
        if(Tpath(it).gt.tmax) then
          tmax = Tpath(it)
          itmax = it
        endif
   11 continue
      return
      END

      SUBROUTINE bnob(card,icolu,nbnob,i1,i2)
      CHARACTER card*160
      INTEGER icolu,nbnob,i1,i2
      dimension icolu(*)
C Return the number and location of noblank-blank pairs between i1 & i2
C positions of character string card.

      INTEGER i,im1
      nbnob = 0
      do 20 i=i1-1,i2
        im1 = i - 1
        if((card(im1:im1).eq.' ').and.(card(i:i).ne.' ')) then
            nbnob = nbnob + 1
            icolu(nbnob) = i
        endif
   20 continue
      return
      END

      FUNCTION expdev(iseed)
      INTEGER iseed
      REAL*8 expdev
C USES ran2
C  FUNCTION gasdev from Numerical Recipes in FORTRAN, 1992, (p. 278)
C  W.H.Press, W.T.Vetterling, S.A.Teukolsky & B.P.Flannery
C  Returns a exponentially distributed, positive random deviate of unit
C  mean, using ran2(iseed) as the source of uniform deviates.
C
      REAL*8 dum,ran2
  1   dum=ran2(iseed)
```

```
      if(dum.eq.0.d0)goto 1
      expdev=-dlog(dum)
      return
      END

      FUNCTION gasdev(iseed)
      INTEGER iseed
      REAL*8 gasdev
C USES ran2
C  FUNCTION gasdev from Numerical Recipes in FORTRAN, 1992, (p. 280)
C  W.H.Press, W.T.Vetterling, S.A.Teukolsky & B.P.Flannery
C  Returns a normally distributed deviate with zero mean and unit
C  variance, using ran2(iseed) as the source of uniform deviates.
C
      INTEGER iset
      REAL*8 fac,gset,r,v1,v2,ran2
      SAVE iset, gset
      DATA iset /0/
      if (iset.eq.0) then
  1      v1=2.d0*ran2(iseed) - 1.d0
         v2=2.d0*ran2(iseed) - 1.d0
         r =v1**2 + v2**2
         if(r.gt.1.d0) goto 1
         fac=sqrt(-2.d0*dlog(r)/r)
         gset=v1*fac
         gasdev=v2*fac
         iset=1
      else
         gasdev=gset
         iset=0
      endif
      return
      END

      FUNCTION uqdev(iseed,qparam)
      INTEGER MPARAM
      PARAMETER (MPARAM=20)
      INTEGER iseed
      REAL*8 uqdev,qparam(MPARAM)
C USES ran2
```



```
C
      INTEGER i
      REAL*8 prob,ran2
      prob = ran2(iseed)
      i = 3
      do while (prob.gt.qparam(i))
        i = i + 2
        if(i.ge.MPARAM) then
          write(*,700)
          stop
        endif
      enddo
      uqdev=(qparam(i+1)-qparam(i-1))*ran2(iseed)+qparam(i-1)
  700 format(' End of array for UQ Dist params reached to Early!')
      return
      END

      FUNCTION tridev(iseed,A,B,C)
      INTEGER iseed
      REAL*8 tridev,A,B,C
C USES ran2
C  Returns a trinagular distributed deviate with A-min, B-mode, and
C  C-Max, using ran2(iseed) as the source of uniform deviates.
C
      REAL*8 prob,pvertx,ran2
      pvertx = (B-A)/(C-A)
      prob = ran2(iseed)
      if(prob.le.pvertx) then
          tridev = A + dsqrt((B-A)*(C-A)*prob)
      else
          tridev = C - dsqrt((C-B)*(C-A)*(1.d0-prob))
      endif
      return
      END

      FUNCTION glbdev(iseed,A,B,C,sig)
      INTEGER iseed
      REAL*8 glbdev,A,B,C,sig
C USES gasdev
C
```

```
      REAL*8 egas,fcomb,gasdev
      egas = exp(sig*gasdev(iseed))
      fcomb = (C-B)/(B-A)
      glbdev = (A*fcomb + C*egas)/(fcomb + egas)
      return
      END

      FUNCTION ebsdev(iseed,A,B,C)
      INTEGER iseed
      REAL*8 ebsdev,A,B,C
C USES ran2
C  Returns an exponetial distributed deviate with A-min, B-lambda, and
C  C-Max, using ran2(iseed) as the source of uniform deviates.
C
      REAL*8 elamA,elamC,ran2
      if(B.ne.0.d0) then
        elamA = exp(-B*A)
        elamC = exp(-B*C)
        ebsdev = -dlog(elamA - ran2(iseed)*(elamA-elamC))/B
      else
        ebsdev = A - ran2(iseed)*(A-C)
      endif
      return
      END

      FUNCTION usrdev(iseed,indxud)
      INTEGER MAXUD,MPTSUD
      PARAMETER (MAXUD=100,MPTSUD=100)
      INTEGER iseed,indxud,nptsud(MAXUD)
      REAL*8 usrdev,valud(MAXUD,MPTSUD),pud(MAXUD,MPTSUD)
      common /usrdst/ valud,pud,nptsud
C USES ran2
C  Returns a discrete distributed deviate based on user defined
C  values defined in COMMON BLOCK usrdst, using ran2(iseed) as
C  the source of uniform deviates.
C
      INTEGER ipts
      REAL*8 prob,ran2
      prob = ran2(iseed)
      ipts = 1
```



```
      do while (prob.gt.pud(indxud,ipts))
        ipts = ipts + 1
      enddo
      usrdev = valud(indxud,ipts)
      return
      END

      FUNCTION disdev(iseed,qparam)
      INTEGER MPARAM
      PARAMETER (MPARAM=20)
      INTEGER iseed
      REAL*8 disdev,qparam(MPARAM)
C USES ran2
C
      INTEGER i
      REAL*8 prob,ran2
      prob = ran2(iseed)
      i = 2
      do while (prob.gt.qparam(i))
        i = i + 2
        if(i.gt.MPARAM) then
          write(*,700)
          stop
        endif
      enddo
      disdev=qparam(i-1)
  700 format(' End of array for DDist params reached to Early!')
      return
      END

      FUNCTION Blam(A,xmean,C,TOL)
      REAL*8 xmean,A,Blam,C,TOL
C USES Bmean, dBmean
C  Returns the Blam parameter of an exponetially distributed deviate
C  on the finite inerval (A,C) givin A, C, and the mean (xmean).
C  The stopping tolerance is eps.
C  [ p(x) = N exp(-Blam*x) ]
C
      REAL*8 Bmean,dBmean,Blam1,Badd
      INTEGER iter,iconvg
```

```
      common /conflg/ iconvg
      Blam1 = 0.d0
      do 100 iter=1,100
        Badd = -(Bmean(A,Blam1,C)-xmean)/dBmean(A,Blam1,C)
        Blam = Blam1 + Badd
        if(abs(Badd).le.TOL) goto 200
        Blam1 = Blam
  100 continue
  200 continue
      if (iconvg.ne.0)
     1      write(*,*) iter,Badd
      return
      END

      FUNCTION Bmean(A,Blam,C)
      REAL*8 Bmean,A,Blam,C
C  Returns the mean of an exponetially distributed deviate on the
C  finite inerval (A,C) givin A, C, and the Blam parameter.
C  [ p(x) = N exp(-Blam*x) ]
C
      REAL*8 Ascal,Cscal,Blscal,Aexp,Cexp,Bmscal
      Ascal  = A/(C-A)
      Cscal  = C/(C-A)
      Blscal = Blam*(C-A)
      if(abs(Blscal).gt.0.1d0) then
        Aexp = exp(-Blscal*Ascal)
        Cexp = exp(-Blscal*Cscal)
        Bmscal = (Ascal*Aexp-Cscal*Cexp)/(Aexp-Cexp) + 1.d0/Blscal
      else
        Bmscal = (Ascal+Cscal)/2.d0 - Blscal/12.d0 +
     1          Blscal**3/720.d0 - Blscal**5/30240.d0
      endif
      Bmean = Bmscal*(C-A)
      return
      END

      FUNCTION dBmean(A,Blam,C)
      REAL*8 dBmean,A,Blam,C
C  Returns the derivative (with respect to Blam) of the mean of an
C  exponetially distributed deviate on the finite inerval (A,C)
```



```
C  givin A, C, and the Blam parameter.
C  [ p(x) = N exp(-Blam*x) ]
C
      REAL*8 Ascal,Cscal,Blscal,Aexp,Cexp,dBmscl
      Ascal  = A/(C-A)
      Cscal  = C/(C-A)
      Blscal = Blam*(C-A)
      if(abs(Blscal).gt.0.1d0) then
        Aexp = exp(-Blscal*Ascal)
        Cexp = exp(-Blscal*Cscal)
        dBmscl = ( (Ascal*Aexp-Cscal*Cexp)/(Aexp-Cexp) )**2 -
     1      (Ascal*Ascal*Aexp-Cscal*Cscal*Cexp)/(Aexp-Cexp)  -

     2                               1.d0/Blscal**2
      else
        dBmscl = - 1.d0/12.d0 + Blscal**2/240.d0 - Blscal**4/6048.d0
      endif
      dBmean = dBmscl*(C-A)**2
      return
      END

      FUNCTION glndev(iseed,A,B,sig)
      INTEGER iseed
      REAL*8 glndev,A,B,sig
C USES gasdev
C
      REAL*8 egas,gasdev
      egas = exp(sig*gasdev(iseed))
      glndev = A + (B-A)*egas
      return
      END

      FUNCTION sigln(A,B,C,P,TOL)
      REAL*8 sigln,A,B,C,P,TOL
C USES derf
C  Returns the sig parameter of lognormal distribution given
C  A, B, C, and P where:
C
C         1     1          1            C - A
C   P =   -  +  - erf[ ----------- ln[-------] ]
```

```
C         2      2        sig Sqrt[2]      B - A
C
C   Newton's method is used to solve for sig or 1/sig using the
C   analytical derivative.
C
      REAL*8 derf,sig1,sigadd,cnstln,sqpi
      INTEGER iter,iconvg
      common /conflg/ iconvg
      cnstln = dlog((C-A)/(B-A))/dsqrt(2.d0)
      sqpi   = dsqrt( 3.14159265358979323846264d0 )
      sig1 = 0.5d0
      if(cnstln.gt.2.5d0) then
C SOLVE FOR sig
        do 100 iter=1,1000
          sigadd = -( 0.5d0*(1.d0 + derf(cnstln/sig1)) - P )/
     1    (-cnstln*dexp(-(cnstln/sig1)**2)/(sqpi*sig1**2) )
          sigln = sig1 + sigadd
          if(abs(sigadd).le.TOL) goto 110
          sig1 = sigln
  100   continue
  110   continue
      else
C SOLVE FOR 1/sig
        do 200 iter=1,1000
          sigadd = -( 0.5d0*(1.d0 + derf(cnstln*sig1)) - P )/
     1    ( cnstln*dexp(-(cnstln*sig1)**2)/sqpi )
          sigln = sig1 + sigadd
          if(abs(sigadd).le.TOL) goto 210
          sig1 = sigln
  200   continue
  210   continue
        sigln = 1.d0/sigln
      endif
      if (iconvg.ne.0)
     1           write(*,*) iter,sigadd,sigln
      return
      END
```

Tue Apr 14 23:06:18 1998 **dran2.f** **Page 1**

```
      FUNCTION ran2(idum)
      IMPLICIT REAL*8 (A-H,O-Z)
      INTEGER idum,IM1,IM2,IMM1,IA1,IA2,IQ1,IQ2,IR1,IR2,NTAB,NDIV
      REAL*8 ran2,AM,EPS,RNMX
      PARAMETER (IM1=2147483563,IM2=2147483399,AM=1.d0/IM1,IMM1=IM1-1,
     *  IA1=40014,IA2=40692,IQ1=53668,IQ2=52774,IR1=12211,
     *  IR2=3791,NTAB=32,NDIV=1+IMM1/NTAB,EPS=2.23E-16,RNMX=1.d0-EPS)
C
C  FUNCTION ran2 from Numerical Recipes in FORTRAN, 1992, (p. 272)
C  W.H.Press, W.T.Vetterling, S.A.Teukolsky & B.P.Flannery
C  Long period (>2X10**18) random number generator of L'Ecuyer with
C  Bays-Durham shuffle and added safeguards.  Returns a uniform deviate
C  between 0.0 and 1.0 (exclusive of the endpoints values).  Call with
C  idum a negative integer to initialize; thereafter, do not alter idum
C  between successive deviates in a sequence.  RNMX should approximate
C  the largest floating value that is less than 1.
C
      INTEGER idum2,j,k,iv(NTAB),iy
      SAVE iv,iy,idum2
      DATA idum2/123456789/, iv/NTAB*0/, iy/0/
      if (idum.le.0) then
          idum=max(-idum,1)
          idum2=idum
          do 11 j=NTAB+8,1,-1
               k=idum/IQ1
               idum=IA1*(idum-k*IQ1)-k*IR1
               if (idum.lt.0) idum=idum+IM1
               if (j.le.NTAB) iv(j)=idum
   11     continue
          iy=iv(1)
      endif
      k=idum/IQ1
      idum=IA1*(idum-k*IQ1)-k*IR1
      if (idum.lt.0) idum=idum+IM1
      k=idum2/IQ2
      idum2=IA2*(idum2-k*IQ2)-k*IR2
      if (idum2.lt.0) idum2=idum2+IM2
      j=1+iy/NDIV
      iy=iv(j)-idum2
      iv(j)=idum
```

Tue Apr 14 23:06:18 1998 **dran2.f** **Page 2**

```
      if(iy.lt.1)iy=iy+IMM1
      ran2=min(AM*iy,RNMX)
      return
      END
```

```
FDschedules.txt          !  Input Data File Name
100000                   !  Size of Random Sample Set
-1127375                 !  Seed for RAN2
0                        !  Flag to write param convergence info (stout)
1                        !  Flag to write Tot Duration info (stout)
0                        !  Flag to write Correlations to unit 99
0                        !  Flag to write Activity ID Dist to flag
```

```
 ### CASE 1: FEED MEETS SPECS AS RECEIVED  [ENVELOPE A]                                188.0    2  34
  2 Add Diluent in Transfer Pump Recirc Loop                                            2.0
DIST Tr    1.    2.    3.
  3 Delay due to transfer line use conflict                                             1.0    2
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
  4 Decant half of Supernate from LAW Feed Tank to 241-AP-102                           6.0    3
DIST Tr   4.39   5.62  6.75
  5 Delay due to transfer line use conflict                                             1.0    4
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
  6 Decant half of Supernate from LAW Feed Tank to 241-AP-104                           6.0    5
DIST Tr   4.39   5.62  6.75
  7 Add Dilution Water to LAW Feed Tank                                                 5.0    6
DIST Tr    4.    5.    6.
  8 Mix LAW Feed Tank using Mixer Pumps                                                 5.0    7
DIST LB    2.    5.    10.  0.95
  9 Allow Undissolved Solids to Settle                                                 30.0    8
DIST U     20.0   40.0
 10 Take Process Control Samples from LAW Feed Tank                                     3.0    8
DIST GL    1.5    3.    10.  0.95
 11 Analyze Process Control Samples from LAW Feed Tank                                 10.0   10
DIST GL    6.    10.    60.  0.98
 12 Evaluate LAW Feed Tank Process Control Sample Data                                  5.0   11
DIST Tr    3.    5.    7.
 13 Delay due to transfer line use conflict                                             1.0   12   9
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 14 Decant half of Supernate from LAW Feed Tank to 241-AP-102                           8.0   13
DIST Tr   5.5    7.12    8.54
 15 Delay due to transfer line use conflict                                             1.0   14
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 16 Decant half of Supernate from LAW Feed Tank to 241-AP-104                           8.0   15
DIST Tr   5.5    7.12    8.54
 17 Mix 241-AP-104 with Mixer Pump                                                      5.0   16
DIST LB    2.0    5.0    10.0  0.95
 18 Take Process Control Samples from 241-AP-104                                        3.0   17
DIST GL    1.5    3.    10.  0.95
 19 Analyze Process Control Samples from 241-AP-104                                    10.0   18
DIST GL    6.    10.    60.  0.98
 20 Evaluate Process Control Sample Data                                                5.0   19
DIST Tr    3.    5.    7.
 21 Mix 241-AP-104 with Mixer Pump                                                      5.0   20
```



```
DIST GL    2.0    5.0    10.0  0.95
 22 Take Feed Qualification and Private Contractor Samples                              5.0   21
DIST GL    2.0    5.    13.  0.95
 23 Provide Samples to Private Contractors                                             15.0   22
DIST GL    9.    15.    30.  0.98
 24 Analyze Feed Qualification Samples                                                 30.0   22
DIST GL    21.0    30.    90.  0.98
 25 Prepare Feed Qualification Sample Lab Report                                       21.0   24
DIST N     21.   3.408
 26 Interpret and Evaluate Sample Results and draft Feed Qualification Report          15.0   24
DIST LB    13.0    15.    60.  0.95
 27 Edit, Review, & Issue Feed Qualification Report                                    15.0   25  26
DIST LB    12.0    15.    30.  0.99
 28 Draft Transmittal Letter                                                            2.0   27
DIST Tr    1.0    2.    7.
 29 Obtain LMHC Approval                                                                5.0   28
DIST LB    1.0    5.    10.  0.95
 30 FDH Transmit Data to DOE-RL                                                         2.0   29
DIST Tr    1.0    2.    5.
 31 DOE-RL Issue Transmittal Letter                                                     2.0   30
DIST Tr    1.0    2.    7.
 32 Setup Transfer to 241-AP-108                                                        2.0   31  23
DIST GL   1.0   2.    7.  0.99
 33 Major Capital Equipment Replacement - Transfer Pump                                 1.0   32
DIST UD    MCER.dist
 34 Major Capital Equipment Replacement - Mixer Pump                                    1.0   33
DIST UD    MCER.dist

 ### CASE 2: SHIM FEED TO MEET SPECS  [ENVELOPE A]                                    186.0   36  70
 36 Add Diluent in Transfer Pump Recirc Loop                                            1.0
DIST Tr    1.    2.    3.
 37 Delay due to transfer line use conflict                                             1.0   36
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 38 Decant half of Supernate from LAW Feed Tank to 241-AP-102                           6.0   37
DIST Tr   4.39   5.62  6.75
 39 Delay due to transfer line use conflict                                             1.0   38
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 40 Decant half of Supernate from LAW Feed Tank to 241-AP-104                           6.0   39
DIST Tr   4.39   5.62  6.75
 41 Add Dilution Water to LAW Feed Tank                                                 5.0   40
```

Tue Apr 14 23:05:25 1998 **FDschedules.txt** **Page 3**

```
DIST Tr    4.    5.    6.
 42 Mix LAW Feed Tank using Mixer Pumps                                            5.0   41
DIST LB    2.    5.    10.  0.95
 43 Allow Undissolved Solids to Settle                                            30.0   42
DIST U     20.0  40.0
 44 Take Process Control Samples from LAW Feed Tank                                1.0   42
DIST GL    1.5    3.    10.  0.95
 45 Analyze Process Control Samples from LAW Feed Tank                             7.0   44
DIST GL    6.    10.    60.  0.98
 46 Evaluate LAW Feed Tank Process Control Sample Data                             5.0   45
DIST Tr    3.    5.    7.
 47 Delay due to transfer line use conflict                                        1.0   46  43
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 48 Decant half of Supernate from LAW Feed Tank to 241-AP-102                      8.0   47
DIST Tr   5.5   7.12    8.54
 49 Delay due to transfer line use conflict                                        1.0   48
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 50 Decant half of Supernate from LAW Feed Tank to 241-AP-104                      8.0   49
DIST Tr   5.5   7.12    8.54
 51 Mix 241-AP-104 with Mixer Pump                                                 5.0   50
DIST LB    2.0    5.0    10.0  0.95
 52 Take Process Control Samples from 241-AP-104                                   3.0   51
DIST GL    1.5    3.    10.  0.95
 53 Analyze Process Control Samples from 241-AP-104                                7.0   52
DIST GL    6.    10.    60.  0.98
 54 Evaluate Process Control Sample Data                                           3.0   53
DIST Tr    3.    5.    7.
 55 Prepare Process Memo                                                           5.0   54
DIST GL    2.    5.   30.0  0.95
 56 Add Chemical Solution (Shim) to 241-AP-104                                     3.0   55
DIST Tr    2.    3.    4.
 57 Mix 241-AP-104 with Mixer Pump                                                 5.0   56
DIST LB    2.0    5.0    10.0  0.95
 58 Take Feed Qualification and Private Contractor Samples                         7.0   57
DIST GL    2.0    5.    13.  0.95
 59 Provide Samples to Private Contractors                                         9.0   58
DIST GL    9.    15.    30.  0.98
 60 Analyze Feed Qualification Samples                                            22.0   58
DIST GL    21.0    30.    90.  0.98
 61 Prepare Feed Qualification Sample Lab Report                                  15.0   60
```

Tue Apr 14 23:05:25 1998 **FDschedules.txt** **Page 4**

```
DIST N     21.   3.408
 62 Interpret and Evaluate Sample Results and draft Feed Qualification Report     15.0   60
DIST LB    13.0    15.    60.  0.95
 63 Edit, Review, & Issue Feed Qualification Report                               15.0   62  61
DIST LB    12.0    15.    30.  0.99
 64 Draft Transmittal Letter                                                       2.0   63
DIST Tr    1.0    2.    7.
 65 Obtain LMHC Approval                                                           7.0   64
DIST LB    1.0    5.    10.  0.95
 66 FDH Transmit Data to DOE-RL                                                    4.0   65
DIST Tr    1.0    2.    5.
 67 DOE-RL Issue Transmittal Letter                                                2.0   66
DIST Tr    1.0    2.    7.
 68 Setup Transfer to 241-AP-108                                                   2.0   67  59
DIST GL   1.0   2.    7.  0.99
 69 Major Capital Equipment Replacement - Transfer Pump                            2.0   68
DIST UD    MCER.dist
 70 Major Capital Equipment Replacement - Mixer Pump                               2.0   69
DIST UD    MCER.dist

 ### CASE 3: BLEND FEED TO MEET SPECS  [ENVELOPE A] (assume AP-104 has enough capacity)   188.0   72 108
 72 Add Diluent in Transfer Pump Recirc Loop                                       1.0
DIST Tr    1.    2.    3.
 73 Delay due to transfer line use conflict                                        1.0   72
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 74 Decant half of Supernate from LAW Feed Tank to 241-AP-102                      2.0   73
DIST Tr   4.39   5.62  6.75
 75 Delay due to transfer line use conflict                                        1.0   74
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 76 Decant half of Supernate from LAW Feed Tank to 241-AP-104                      2.0   75
DIST Tr   4.39   5.62  6.75
 77 Add Dilution Water to LAW Feed Tank                                            5.0   76
DIST Tr    4.    5.    6.
 78 Mix LAW Feed Tank using Mixer Pumps                                            5.0   77
DIST LB    2.    5.    10.  0.95
 79 Allow Undissolved Solids to Settle                                            30.0   78
DIST U     20.0   40.0
 80 Take Process Control Samples from LAW Feed Tank                                1.0   78
DIST GL    1.5    3.    10.  0.95
 81 Analyze Process Control Samples from LAW Feed Tank                             7.0   80
```

```
DIST GL    6.    10.    60.  0.98
  82 Evaluate LAW Feed Tank Process Control Sample Data                                  5.0   81
DIST Tr    3.    5.    7.
  83 Delay due to transfer line use conflict                                             1.0   82  79
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
  84 Decant half of Supernate from LAW Feed Tank to 241-AP-102                           3.0   83
DIST Tr   5.5   7.12   8.54
  85 Delay due to transfer line use conflict                                             1.0   84
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
  86 Decant half of Supernate from LAW Feed Tank to 241-AP-104                           3.0   85
DIST Tr   5.5   7.12   8.54
  87 Mix 241-AP-104 with Mixer Pump                                                      5.0   86
DIST LB    2.0   5.0   10.0  0.95
  88 Take Process Control Samples from 241-AP-104                                        3.0   87
DIST GL    1.5    3.    10.  0.95
  89 Analyze Process Control Samples from 241-AP-104                                     7.0   88
DIST GL    6.    10.    60.  0.98
  90 Evaluate Process Control Sample Data                                                3.0   89
DIST Tr    3.    5.    7.
  91 Prepare Process Memo                                                                7.0   90
DIST GL   14.    21.   60.0  0.95
  92 Prepare Selected LAW Blend Tank for Use                                            14.0   91
DIST GL    4.    14.   60.0  0.95
  93 Delay Due To Transfer Line Use Conflict                                             1.0   92
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
  94 Decant Supernate from LAW Blend Tank to 241-AP-104                                  8.0   93
DIST Tr   5.5   7.12   8.54
  95 Mix 241-AP-104 with Mixer Pump                                                      5.0   94
DIST LB    2.0   5.0   10.0  0.95
  96 Take Feed Qualification and Private Contractor Samples                              7.0   95
DIST GL    2.0    5.    13.  0.95
  97 Provide Samples to Private Contractors                                              9.0   96
DIST GL    9.    15.    30.  0.98
  98 Analyze Feed Qualification Samples                                                 22.0   96
DIST GL   21.0    30.    90.  0.98
  99 Prepare Feed Qualification Sample Lab Report                                       15.0   98
DIST N    21.   3.408
 100 Interpret and Evaluate Sample Results and draft Feed Qualification Report          15.0   98
DIST LB   13.0    15.    60.  0.95
 101 Edit, Review, & Issue Feed Qualification Report                                    15.0  100  99
```



```
DIST LB   12.0    15.    30.  0.99
 102 Draft Transmittal Letter                                                            2.0  101
DIST Tr    1.0    2.    7.
 103 Obtain LMHC Approval                                                                7.0  102
DIST LB    1.0    5.    10.  0.95
 104 FDH Transmit Data to DOE-RL                                                         4.0  103
DIST Tr    1.0    2.    5.
 105 DOE-RL Issue Transmittal Letter                                                     2.0  104
DIST Tr    1.0    2.    7.
 106 Setup Transfer to 241-AP-108                                                        2.0  105  97
DIST GL   1.0    2.    7.  0.99
 107 Major Capital Equipment Replacement - Transfer Pump                                 2.0  106
DIST UD    MCER.dist
 108 Major Capital Equipment Replacement - Mixer Pump                                    2.0  107
DIST UD    MCER.dist

 ### CASE 4: BLEND FEED TO MEET SPECS  [ENVELOPE A] (assume need to blend after AP-104 is full)   189.0  110 149
 110 Add Diluent in Transfer Pump Recirc Loop                                            1.0
DIST Tr    1.    2.    3.
 111 Delay due to transfer line use conflict                                             1.0  110
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 112 Decant half of Supernate from LAW Feed Tank to 241-AP-102                           2.0  111
DIST Tr   4.39   5.62  6.75
 113 Delay due to transfer line use conflict                                             1.0  112
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 114 Decant half of Supernate from LAW Feed Tank to 241-AP-104                           2.0  113
DIST Tr   4.39   5.62  6.75
 115 Add Dilution Water to LAW Feed Tank                                                 5.0  114
DIST Tr    4.    5.    6.
 116 Mix LAW Feed Tank using Mixer Pumps                                                 5.0  115
DIST LB    2.    5.    10.  0.95
 117 Allow Undissolved Solids to Settle                                                 30.0  116
DIST U    20.0   40.0
 118 Take Process Control Samples from LAW Feed Tank                                     1.0  116
DIST GL    1.5    3.    10.  0.95
 119 Analyze Process Control Samples from LAW Feed Tank                                  7.0  118
DIST GL    6.    10.    60.  0.98
 120 Evaluate LAW Feed Tank Process Control Sample Data                                  5.0  119
DIST Tr    3.    5.    7.
 121 Delay due to transfer line use conflict                                             1.0  120 117
```

```
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 122 Decant half of Supernate from LAW Feed Tank to 241-AP-102                    3.0  121
DIST Tr    5.5    7.12     8.54
 123 Delay due to transfer line use conflict                                      1.0  122
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 124 Decant half of Supernate from LAW Feed Tank to 241-AP-104                    3.0  123
DIST Tr    5.5    7.12     8.54
 125 Mix 241-AP-104 with Mixer Pump                                               5.0  124
DIST LB    2.0    5.0     10.0  0.95
 126 Take Process Control Samples from 241-AP-104                                 3.0  125
DIST GL    1.5    3.     10.  0.95
 127 Analyze Process Control Samples from 241-AP-104                              7.0  126
DIST GL    6.     10.    60.  0.98
 128 Evaluate Process Control Sample Data                                         3.0  127
DIST Tr    3.     5.     7.
 129 Prepare Process Memo                                                         7.0  128
DIST GL    14.    21.    60.0  0.95
 130 Prepare Selected LAW Blend Tank for Use                                     14.0  129
DIST GL    4.     14.    60.0  0.95
 131 Prepare Receiver Tank for Unacceptable LAW from 241-AP-104                  14.0  129
DIST GL    4.     14.    30.0  0.95
 132 Delay Due To Transfer Line Use Conflict                                      1.0  131
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 133 Decant Portion of Supernate from 241-AP-104 to Receiver Tank                 4.0  132
DIST Tr    5.5    7.12     8.54
 134 Delay Due To Transfer Line Use Conflict                                      1.0  133
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 135 Decant Supernate from LAW Blend Tank to 241-AP-104                           4.0  134 130
DIST Tr    5.5    7.12     8.54
 136 Mix 241-AP-104 with Mixer Pump                                               5.0  135
DIST LB    2.0    5.0     10.0  0.95
 137 Take Feed Qualification and Private Contractor Samples                       7.0  136
DIST GL    2.0    5.     13.  0.95
 138 Provide Samples to Private Contractors                                       9.0  137
DIST GL    9.     15.    30.  0.98
 139 Analyze Feed Qualification Samples                                          22.0  137
DIST GL    21.0   30.    90.  0.98
 140 Prepare Feed Qualification Sample Lab Report                                15.0  139
DIST N     21.    3.408
 141 Interpret and Evaluate Sample Results and draft Feed Qualification Report   15.0  139
```



```
DIST LB    13.0   15.    60.  0.95
 142 Edit, Review, & Issue Feed Qualification Report                             15.0  141 140
DIST LB    12.0   15.    30.  0.99
 143 Draft Transmittal Letter                                                     2.0  142
DIST Tr    1.0    2.     7.
 144 Obtain LMHC Approval                                                         7.0  143
DIST LB    1.0    5.     10.  0.95
 145 FDH Transmit Data to DOE-RL                                                  4.0  144
DIST Tr    1.0    2.     5.
 146 DOE-RL Issue Transmittal Letter                                              2.0  145
DIST Tr    1.0    2.     7.
 147 Setup Transfer to 241-AP-108                                                 2.0  146 138
DIST GL    1.0    2.     7.  0.99
 148 Major Capital Equipment Replacement - Transfer Pump                          2.0  147
DIST UD    MCER.dist
 149 Major Capital Equipment Replacement - Mixer Pump                             2.0  148
DIST UD    MCER.dist

 ### CASE 5: RESTAGE FEED TANK TO MEET SPECS  [ENVELOPE A]                      340.0  151 190
 151 Add Diluent in Transfer Pump Recirc Loop                                     1.0
DIST Tr    1.     2.     3.
 152 Delay due to transfer line use conflict                                      1.0  151
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 153 Decant half of Supernate from LAW Feed Tank to 241-AP-102                    2.0  152
DIST Tr    4.39   5.62  6.75
 154 Delay due to transfer line use conflict                                      1.0  153
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 155 Decant half of Supernate from LAW Feed Tank to 241-AP-104                    2.0  154
DIST Tr    4.39   5.62  6.75
 156 Add Dilution Water to LAW Feed Tank                                          5.0  155
DIST Tr    4.     5.     6.
 157 Mix LAW Feed Tank using Mixer Pumps                                          5.0  156
DIST LB    2.     5.     10.  0.95
 158 Allow Undissolved Solids to Settle                                          30.0  157
DIST U     20.0   40.0
 159 Take Process Control Samples from LAW Feed Tank                              1.0  157
DIST GL    1.5    3.     10.  0.95
 160 Analyze Process Control Samples from LAW Feed Tank                           7.0  159
DIST GL    6.     10.    60.  0.98
 161 Evaluate LAW Feed Tank Process Control Sample Data                           5.0  160
```

```
DIST Tr    3.    5.    7.
 162 Delay due to transfer line use conflict                                        1.0  161 158
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 163 Decant half of Supernate from LAW Feed Tank to 241-AP-102                      3.0  162
DIST Tr   5.5   7.12    8.54
 164 Delay due to transfer line use conflict                                        1.0  163
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 165 Decant half of Supernate from LAW Feed Tank to 241-AP-104                      3.0  164
DIST Tr   5.5   7.12    8.54
 166 Mix 241-AP-104 with Mixer Pump                                                 5.0  165
DIST LB    2.0    5.0    10.0  0.95
 167 Take Process Control Samples from 241-AP-104                                   3.0  166
DIST GL    1.5    3.    10.  0.95
 168 Analyze Process Control Samples from 241-AP-104                                7.0  167
DIST GL    6.    10.    60.  0.98
 169 Evaluate Process Control Sample Data                                           3.0  168
DIST Tr    3.    5.    7.
 170 Prepare Process Memo                                                          28.0  169
DIST GL   14.   21.   60.0  0.95
 171 Prepare Receiver Tank for Unacceptable LAW from 241-AP-104                    14.0  170
DIST GL    4.   20.   60.0  0.95
 172 Delay Due To Transfer Line Use Conflict                                        1.0  171
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 173 Decant Supernate from 241-AP-104 to Receiver Tank                              4.0  172
DIST Tr   5.5   7.12    8.54
 174 Prepare Next LAW Feed Tank for Use                                           150.0  170
DIST GL    0.   60.  150.0  0.98
 175 Delay Due To Transfer Line Use Conflict                                        1.0  174
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 176 Decant Supernate from LAW Feed Tank to 241-AP-104                              3.0  175 173
DIST Tr   5.5   7.12    8.54
 177 Mix 241-AP-104 with Mixer Pump                                                 5.0  176
DIST LB    2.0    5.0    10.0  0.95
 178 Take Feed Qualification and Private Contractor Samples                         7.0  177
DIST GL    2.0    5.    13.  0.95
 179 Provide Samples to Private Contractors                                         9.0  178
DIST GL    9.    15.    30.  0.98
 180 Analyze Feed Qualification Samples                                            22.0  178
DIST GL    21.0    30.    90.  0.98
 181 Prepare Feed Qualification Sample Lab Report                                  15.0  180
```



```
DIST N     21.   3.408
 182 Interpret and Evaluate Sample Results and draft Feed Qualification Report     15.0  180
DIST LB    13.0    15.    60.  0.95
 183 Edit, Review, & Issue Feed Qualification Report                               15.0  182 181
DIST LB    12.0    15.    30.  0.99
 184 Draft Transmittal Letter                                                       2.0  183
DIST Tr    1.0    2.    7.
 185 Obtain LMHC Approval                                                           7.0  184
DIST LB    1.0    5.    10.  0.95
 186 FDH Transmit Data to DOE-RL                                                    4.0  185
DIST Tr    1.0    2.    5.
 187 DOE-RL Issue Transmittal Letter                                                2.0  186
DIST Tr    1.0    2.    7.
 188 Setup Transfer to 241-AP-108                                                   2.0  187 179
DIST GL   1.0    2.    7.  0.99
 189 Major Capital Equipment Replacement - Transfer Pump                            2.0  188
DIST UD    MCER.dist
 190 Major Capital Equipment Replacement - Mixer Pump                               2.0  189
DIST UD    MCER.dist

 ### CASE 6: FEED MEETS SPECS AS RECEIVED: [Envelope A w/In-line Dissolution, Envelope B&C]   128.0  192 213
 192 Delay due to transfer line use conflict                                        1.0
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 193 Decant half of Supernate from LAW Feed Tank to 241-AP-102                      6.0  192
DIST Tr   4.39   5.62  6.75
 194 Delay due to transfer line use conflict                                        1.0  193
DIST DD 8  0. .98 1. .98286 2. .98571 3. .98857 4. .99143 5. .99429 6. .99741 7. 1.
 195 Decant half of Supernate from LAW Feed Tank to 241-AP-104                      6.0  194
DIST Tr   4.39   5.62  6.75
 196 Mix 241-AP-104 with Mixer Pump                                                 5.0  195
DIST LB    2.0    5.0    10.0  0.95
 197 Take Process Control Samples from 241-AP-104                                   3.0  196
DIST GL    1.5    3.    10.  0.95
 198 Analyze Process Control Samples from 241-AP-104                               10.0  197
DIST GL    6.    10.    60.  0.98
 199 Evaluate Process Control Sample Data                                           5.0  198
DIST GL    2.0    5.0    10.0  0.95
 200 Mix 241-AP-104 with Mixer Pump                                                 5.0  199
DIST LB    2.0    5.0    10.0  0.95
 201 Take Feed Qualification and Private Contractor Samples                         5.0  200
```

```
DIST GL    2.0    5.    13.  0.95
 202 Provide Samples to Private Contractors                                                  15.0  201
DIST GL    9.    15.    30.  0.98
 203 Analyze Feed Qualification Samples                                                      30.0  201
DIST GL    21.0    30.    90.  0.98
 204 Prepare Feed Qualification Sample Lab Report                                            21.0  203
DIST N     21.   3.408
 205 Interpret and Evaluate Sample Results and draft Feed Qualification Report               15.0  203
DIST LB    13.0    15.    60.  0.95
 206 Edit, Review, & Issue Feed Qualification Report                                         15.0  204 205
DIST LB    12.0    15.    30.  0.99
 207 Draft Transmittal Letter                                                                 2.0  206
DIST Tr    1.0    2.    7.
 208 Obtain LMHC Approval                                                                     5.0  207
DIST LB    1.0    5.    10.  0.95
 209 FDH Transmit Data to DOE-RL                                                              2.0  208
DIST Tr    1.0    2.    5.
 210 DOE-RL Issue Transmittal Letter                                                          2.0  209
DIST Tr    1.0    2.    7.
 211 Setup Transfer to 241-AP-108                                                             2.0  210 202
DIST GL   1.0   2.    7.  0.99
 212 Major Capital Equipment Replacement - Transfer Pump                                      1.0  211
DIST UD    MCER.dist
 213 Major Capital Equipment Replacement - Mixer Pump                                         1.0  212
DIST UD    MCER.dist
```

Tue Apr 14 23:05:25 1998	MCER.dist	Page 1

0.0	0.96000000
7.0	0.96021053
8.0	0.96063158
9.0	0.96126316
10.0	0.96210526
11.0	0.96315789
12.0	0.96442105
13.0	0.96589474
14.0	0.96757895
15.0	0.96947368
16.0	0.97157895
17.0	0.97389474
18.0	0.97642105
19.0	0.97915789
20.0	0.98210526
21.0	0.98526316
22.0	0.98863158
23.0	0.99221053
24.0	0.99600000
25.0	1.00000000

```
      IMPLICIT REAL*8 (A-H,O-Z)
      dimension val(100000),vbin(41),nbin(41),nva(100000)
      common /binval/ val
      npath1 = 0
      npath2 = 0
      npath3 = 0
      npath4 = 0
      eval = 0.d0
      do 20 ival=1,100000
c        read(*,*,end=50) du1,du2,du3,du4,du5,val(ival)
c        read(*,*,end=50) du1,val(ival)
c        read(*,*,end=50) du1,nu1,du2,nu2,du3,nu3,du4,nu4,
c     1                    val(ival),ipath
c        read(*,*,end=50) du1,nu1,du2,nu2,du3,nu3,du4,nu4,
c     1                    val(ival),ipath
c        read(*,*,end=50)  val(ival),ipath,du2,nu2,du3,nu3,du4,nu4,
c     1                    du5,nu5
        if(ndum.eq.0) then
          read(*,*,end=50)  val(ival),ipath
        else
          read(*,*,end=50)  (vbin(idum),nbin(idum),idum=1,ndum),
     1                    val(ival),ipath
        endif
c        read(*,*,end=50)  val(ival)
        if(ipath.eq.1) npath1 = npath1 + 1
        if(ipath.eq.2) npath2 = npath2 + 1
        if(ipath.eq.3) npath3 = npath3 + 1
        if(ipath.eq.4) npath4 = npath4 + 1
        eval = eval + val(ival)
   20 continue
   50 continue
      write(*,*) npath1,npath2,npath3,npath4
      call RSORT(val,nva,100000)
      write(*,*) val(nva(50001)),val(nva(95001))
         write(8,*) val(nva(1)),dfloat(1)/100000.d0
c      dn = 19.d0
      do 100 iw=10,100000,10
c          xsum  = 0.d0
c          xxsum = 0.d0
c          ysum  = 0.d0
```



```
c          xysum = 0.d0
c          do 90 id=0,18
c            xsum  =  xsum + val(nva(iw-9+id))
c            xxsum = xxsum + val(nva(iw-9+id))**2
c            ysum  =  ysum + dfloat(iw-9+id)
c            xysum = xysum + val(nva(iw-9+id))*dfloat(iw-9+id)
c   90     continue
c          slope = (dn*xysum-xsum*ysum)/(dn*xxsum-xsum**2)
         write(8,*) val(nva(iw)),dfloat(iw)/100000.d0
c     1   slope/100000.d0
  100 continue
      nval = ival-1
C      call getbnd(vmax,ivmax,vmin,ivmin,nval)
      vmin = .5d0
      vmax = 7.5d0
      vdiff = (vmax-vmin + 2.22d-13)/38.d0
c      vmax =200.d0
c      vdiff = vmax-vmin + 2.22d-13
c      vmax = vmax + vdiff/20.d0
c      vmin = vmin - vdiff/20.d0
      do 150 iv=1,41
        vbin(iv) = vmin + vdiff*dfloat(iv-2)
        nbin(iv) = 0
  150 continue
      do 200 ival=1,nval
      do 200 iv=1,40
        if((val(ival).ge.vbin(iv)).and.(val(ival).lt.vbin(iv+1))) then
c        if(val(ival).lt.vbin(iv+1)) then
          nbin(iv) = nbin(iv) + 1
        endif
  200 continue
      do 300 iv=1,40
        vwrite = (vbin(iv)+vbin(iv+1))/2.d0
        dwrite = dfloat(nbin(iv))/(dfloat(nval)*vdiff)
        write(*,*) vwrite,dwrite
  300 continue
      write(*,*) eval/dfloat(nval)
      stop
      END
```

```
      SUBROUTINE getbnd(vmax,ivmax,vmin,ivmin,nval)
      IMPLICIT REAL*8 (A-H,O-Z)
      dimension val(100000)
      common /binval/ val
      ivmax = 1
      vmax  = val(1)
      ivmin = 1
      vmin  = val(1)
      do 11 iv=1,nval
        if(val(iv).gt.vmax) then
          vmax = val(iv)
          vtmax = iv
        endif
        if(val(iv).lt.vmin) then
          vmin = val(iv)
          vtmin = iv
        endif
   11 continue
      return
      END

      SUBROUTINE RSORT(VAR,IVAR,N)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION VAR(*),IVAR(*)
      DO 5 I=1,N
        IVAR(I)  = I
    5 CONTINUE
      JUMP = N
   10 IF(JUMP.GT.1) THEN
        JUMP = JUMP/2
        DO 30 J=1,N-JUMP
          I = J
   20     JN = I + JUMP
          IF(VAR(IVAR(I)).GT.VAR(IVAR(JN))) THEN
            ITEMP      = IVAR(I)
            IVAR(I)    = IVAR(JN)
            IVAR(JN)   = ITEMP
            I = I - JUMP
            IF(I.GT.0) GOTO 20
          ENDIF
```



```
   30   CONTINUE
        GOTO 10
      ENDIF
      RETURN
      END
```

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	B. B. Peters	Date 8/20/98
Project Title/Work Order Low-Activity Waste Feed Delivery--Minimum Duration Between Successive Batches, Rev. 0		EDT No. 621679 ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
Central Files	B1-07	X			
DOE Reading Room	H2-53	X			
DIMC	R1-41	X			
S. K. Baker	R3-73	X			
J. F. Bores	R2-89	X			
P. J. Certa	R3-73	X			
R. D. Claghorn	R3-73	X			
T. W. Crawford	R3-73	X			
J. S. Garfield	R3-73	X			
F. A. Jensen	R3-75	X			
R. A. Kirkbride	R3-73	X			
B. K. Olson	H6-06	X			
S. M. O'Toole	R2-89	X			
I. G. Papp	R3-73	X			
B. B. Peters (5 copies)	R3-73	X			
R. W. Powell	R3-75	X			
E. J. Slaathaug	R3-73	X			
R. L. Treat	R3-75	X			
R. S. Wittman	R3-73	X			
R. D. Wojtasek	R2-53	X			
B. D. Zimmerman	H6-35	X			