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ENGINEERING CHANGE NOTICE

Page 1 of 2

1. ECN 657285

Proj. ECN

2. ECN Category (mark one)	3. Originator's Name, Organization, MSIN, and Telephone No.	4. USQ Required?	5. Date
Supplemental [] Direct Revision [X] Change ECN [] Temporary [] Standby [] Supersedure [X] Cancel/Void []	L. Jensen, Data Development and Interpretation, R2-12, 373-2779	Yes [X] No	04/13/00
	6. Project Title/No./Work Order No.	7. Bldg./Sys./Fac. No.	8. Approval Designator
	Sample Based Unit Liter Dose Estimates/Waste Management/DD&I/Process Engineering	NA	N/A
	9. Document Numbers Changed by this ECN (includes sheet no. and rev.)	10. Related ECN No(s).	11. Related PO No.
	HNF-4534, Rev. 1	ECNs:	N/A

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

13a. Description of Change

13b. Design Baseline Document? [] Yes [X] No

Complete revision of the document.

14a. Justification (mark one)

Criteria Change	[X]	Design Improvement	[]	Environmental	[]	Facility Deactivation	[]
As-Found	[]	Facilitate Const	[]	Const. Error/Omission	[]	Design Error/Omission	[]

14b. Justification Details

The dose conversion factors, uCi/g or uCi/L to Sv/L (sieverts per liter) have changed. Consequently, the ULDs given in Rev. 0 are no longer valid.

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

See attached distribution.

RELEASE STAMP

DATE: APR 13 2000

STA: 4

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ID: 2

A-7900-013-1

ENGINEERING CHANGE NOTICE

1. ECN (use no. from pg. 1)
ECN-657285

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

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

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

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

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

21. Approvals

	Signature	Date		Signature	Date
Design Authority			Design Agent		
Cog. Eng. L. Jensen	L Jensen	4/13/00	PE		
Cog. Mgr. J. G. Field	J G Field	4/13/00	QA		
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Other D. A. Reynolds	D A Reynolds	4/13/00	Design		
			Environ.		
Other			Other		

DEPARTMENT OF ENERGY

Signature or a Control Number that tracks the Approval Signature

ADDITIONAL

Sample Based Unit Liter Dose Estimates

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U.S. Department of Energy Contract 8023764-9-K001

EDT/ECN: ECN-657285 UC: 2070
Org Code: 74B20 CACN/COA: 101949/ES30
B&R Code: EW 3120074 Total Pages: 66

Key Words: Sample Based Unit Liter Dose Estimates, Dose Estimates, Unit Liter Dose Distributions

Abstract: N/A

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4/13/00
Release Approval Date

DATE: HANFORD RELEASE
STA: 4 ID: 2
APR 13 2000
Release Stamp

Approved for Public Release

RECORD OF REVISION

(1) Document Number: HNF-4534

Page 1

(2) Title: Sample Based Unit Liter Dose Estimates

Change Control Record

(3) Revision	(4) Description of Change - Replace, Add, and Delete Pages	Authorized for Release (5) Cog. Engr.	(6) Cog. Mgr. Date
	(7)		
1 RS	Incorporate per ECN-657285	L. Jensen	J. G. Field
		L. Jensen 4/13/00	J. G. Field 4/13/00

A-7320-005 (10/97)

HNF-4534
Revision 1

SAMPLE BASED UNIT LITER DOSE ESTIMATES

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Date Published
April 2000

Prepared for the U.S. Department of Energy
Office of River Protection

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Bq/µCi	Becquerel per microcurie
BIO	Basis for Interim Operation
DL	detection limit
DCF	dose conversion factor
DST	double-shell tank
FDH	Fluor Daniel Hanford, Inc.
FSAR	Final Safety Analysis Report
GA	Gross alpha
g/L	grams per liter
Num.Above DL	number of observations above detection limit
Num.Obs	number of observations
NS&L	Nuclear Safety and Licensing
TL	tolerance limit
µCi/g	microcuries per gram
µCi/L	microcuries per liter
µg/L	micrograms per liter
%	percent
SST	single-shell tank
Sv/Bq	sieverts per Becquerel
Sv/L	sieverts per liter
TCD	Tank Characterization Database
ULD	unit liter dose
WHC	Westinghouse Hanford Company

INTRODUCTION

The Tank Waste Characterization Program has taken many core samples, grab samples, and auger samples from the single-shell and double-shell tanks during the past 10 years. Consequently, the amount of sample data available has increased, both in terms of quantity of sample results and the number of tanks characterized. More and better data is available than when the current radiological and toxicological source terms used in the Basis for Interim Operation (BIO) (FDH 1999a) and the Final Safety Analysis Report (FSAR) (FDH 1999b) were developed.

The Nuclear Safety and Licensing (NS&L) organization wants to use the new data to upgrade the radiological and toxicological source terms used in the BIO and FSAR. The NS&L organization requested assistance in producing a statistically based process for developing the source terms. This report describes the statistical techniques used and the assumptions made to support the development of a new radiological source term for liquid and solid wastes stored in single-shell and double-shell tanks.

The results given in this report are a revision to similar results given in an earlier version of the document (Jensen and Wilmarth 1999). The main difference between the results in this document and the earlier version is that the dose conversion factors (DCF) for converting µCi/g or µCi/L to Sv/L (sieverts per liter) have changed. There are now two DCFs, one based on ICRP-68 and one based on ICRP-71 (Brevick 2000).

1.0 SUMMARY

Estimates of unit liter doses (ULDs) for waste in the single-shell tanks (SSTs) and double-shell tanks (DSTs) were computed based on recent sampling data from the tanks. The units for a ULD are sieverts per liter (Sv/L). The data was obtained from the Tank Characterization Database. There was sufficient data to estimate a ULD for 54 (57) SSTs with solid samples, 23 (26) SSTs with liquid samples, 15 (15) DSTs with solid samples, and 26 (27) DSTs with liquid samples. The numbers in parentheses refer to the number of tanks with a ULD if observations below detection limits are included.

If it is assumed that the tanks selected for characterization were selected at random, then the ULDs given in this document are unbiased estimates of the ULDs for all SSTs and DSTs. However, it may not be appropriate to assume that the characterized tanks were chosen at random. Many of the tanks that were selected were chosen because they were known to contain wastes that were of concern to Hanford's unresolved safety questions and safety issues. Consequently, if the data from the characterized tanks are an upper bound for all of the tanks then the ULDs are also an upper bound for all tanks.

The lognormal probability distribution was fit to the ULDs. ULD quantiles (Sv/L) corresponding to the 95th and 99th percentiles of the lognormal distribution were computed. The ULDs (Sv/L) corresponding to the 95/95 and 95/99 tolerance limits (TLs) were also computed (the interpretation of the TLs are, we are 95% confident that at least 95% (99%) of the population is less than the limit). The ULD quantiles and TLs are compared to the ULDs for the FSAR (FDH 1999b). In all but one cases, the ULD for the FSAR is greater than the 95th and 99th percentiles of the lognormal distribution. The exception is that the FSAR is less than the 99th for DST solid samples based on DCF ICRP-71. The FSAR is greater than the 95/95 TL except for ULDs based on DST liquid samples. They are less than the 95/99 TL except for ULDs based on SST solid samples.

2.0 AVAILABLE SAMPLE DATA

The TCD (Tank Characterization Database) contains the waste characterization data from tank samples obtained since 1989. This database was the source of data used to estimate the ULD for each waste storage tank.

From TCD, all of the data (available in January 2000) for the following five isotopes were obtained, ^{137}Cs, gross alpha, ^{241}Am, $^{89/90}$Sr, and ^{90}Sr. There were a total of 12,603 observations. There were 3,475 observations from liquid samples and 9,128 from solid samples. There were 141 observations on liquid samples with inconsistent units; e.g., 137 observations from liquid samples with units µCi/g, 3 with unit's µg/L, and one observation with no units. There were 115 observations with the "R" qualifier. The "R" denotes that the observation is unusable. All observations with the "R"qualifier and inconsistent units were deleted. The remaining 12,380 observations consisted of 3,357 on liquid samples and 9,023 on solid samples. There were 998 observations on liquid samples that were below the detection limits and 1,780 observation on solid samples below detection limits. The units are µCi/g or µCi/L. Not every tank had data from each of the five isotopes.

Estimates of the ULD were computed based on three methods for incorporating observations that were below detection limits. First, all observations below detection limits were deleted. In this case, the quantile estimates in the tables and figures apply to the proportion of the population with analyte concentrations above detection limits. Figures 1 through 8, which summarize the computations, are based on this method. Second, the below detection limit observations were replaced by the detection limit, and third, the below detection limit observations were replaced by zero. Note that these three methods each introduce a bias into the final results. A statistical comparison of the results given by each method indicates that the differences are small.

The ULDs were computed based only on the isotopes ^{137}Cs and ^{90}Sr and on alpha. The validity of this assumption is outlined in Sections 2.0 and 3.0 of Jensen et al. (1998) and in Table 3 of WHC-SD-WM-SARR-037 (WHC 1996).

2.1 TANK SPECIFIC RADIOISOTOPE CONCENTRATIONS

For each tank, the arithmetic mean (μCi/g or μCi/L) of the data for each of the five isotopes was computed. The data from the different analytical procedures were combined. That is, the data from the water, the acid and the fusion dissolution were combined.

The following methods were used to select the data used in the ULD calculations.

For ^{137}Cs: The mean of the ^{137}Cs data was used.

For alpha: If available, the mean for gross alpha was used. If there was no mean for gross alpha, the mean from ^{241}Am was used.

For ^{90}Sr: If available, the mean for $^{89/90}Sr$ was used. If there was no mean for $^{89/90}Sr$, the mean for ^{90}Sr was used. If there was a mean for both $^{89/90}Sr$ and ^{90}Sr, the mean of the combined data was used.

Tables A-1 to A-12 in Appendix A list the means for ^{137}Cs, for GA (gross alpha), and for ^{90}Sr. The tables are given by type of tank, SST and DST, and by type of waste, solid and liquid. The values in Table A-1 to A-12 are slightly different from the corresponding tables given in Rev. 0 of this document (Jensen and Wilmarth 1999). The reasons for the difference are that additional tank sample data has been added to TCD and that in Rev. 0, observations on total alpha (total alpha energy emitted from ^{238}Pu, ^{239}Pu, ^{240}Pu and ^{241}Pu) were combined with gross alpha. The observations on total alpha were not included in the results reported here. However, for most tanks, the means reported in Appendix A of this document and in Appendix A of Rev. 0 are identical. The tables in Appendix A also list the number of observations available by analyte and the number of observations above the detection limit (DL).

There are a total of 149 SSTs and 28 DSTs, and the ULDs can only be estimated for a subset of the total number of tanks. The estimates of the ULDs given in this document are unbiased estimates of the ULDs for all SSTs and DSTs if it is assumed that the tanks with a mean for ^{137}Cs, for alpha, and for ^{90}Sr (Tables A-1 through A-12) are a random sample of the tanks. Alternatively, if it is assumed that the tanks with a mean for ^{137}Cs, for alpha, and for ^{90}Sr are an upper bound to the means for all of the other tanks, then the ULDs based on the sampled tanks are an upper bound for the ULDs for all tanks.

There was insufficient data from TCD to compute a ULD for the two aging waste tanks 241-AZ-101 and 241-AZ-102. However, some preliminary laboratory data was available from recent tank samples. Table A-13 lists the summary means obtained from the TCD and the preliminary samples. For tank 241-AZ-101, a ULD could not be computed based on solid samples. For liquid samples, a ULD was computed using the laboratory detection limit (DL) for gross alpha as a quantitative value.

2.2 TANK SPECIFIC UNIT LITER DOSE

The units of the means in Tables A-1 to A-12 are μCi/g or μCi/L. The units for the ULD are Sv/L. The conversions factors used are given in Table 1. The fourth and sixth rows of this table are the dose conversion factors (DCF) for ^{137}Cs, alpha, and ^{90}Sr. There are two DCFs, the first is DCF based on ICRP-68 5μm AMAD (DCF ICRP-68) and the second is the DCF based on ICRP-71 adult (DCF ICRP-71). It is assumed that the concentration for ^{90}Y is the same as that for ^{90}Sr.

The dose conversion factors (DCF) given in Table 1 are different from the conversion factors used in Rev. 0 of this document (Jensen and Wilmarth 1999).

Table 1. Conversion Factors, μCi/g or μCi/L to Sv/L

Units	^{137}Cs	Alpha[2]	^{90}Sr	^{90}Y
Bq/μCi	3.70E+04	3.70E+04	3.70E+04	3.70E+04
g/L[3]	1.60E+03	1.60E+03	1.60E+03	1.60E+03
DCF ICRP-68				
Sv/Bq[1]	6.70E-09	2.89E-05	3.00E-08	1.70E-09
DCF ICRP-71				
Sv/Bq[1]	4.60E-09	4.50E-05	3.60E-08	1.50E-09

[1]The DCF for Sv/Bq are reported in the *Attachment to* (Brevick 2000).
[2]The DCF for alpha is the mean of four values: SST liquid and solid and DST liquid and solid.
[3]The conversion g/L from a weight basis to a liquid basis is given on page 7 of Brevick et al. (1996).

From Table 1, the conversion from μCi/g to Sv/L for solid samples is

$$Sv/L = (\mu Ci/g) \times (Bq/\mu Ci) \times (g/L) \times (Sv/Bq),$$

and for liquid sample the conversion from μCi/L to Sv/L is

$$Sv/L = (\mu Ci/L) \times (Bq/\mu Ci) \times (Sv/Bq).$$

Using the DCF ICRP-68, for solid samples, the equations used to convert μCi/g to Sv/L are

$$Sv/L(^{137}Cs) = mean(^{137}Cs) \times (3.70E+04) \times (1.60E+03) \times (6.70E-09)$$

$$Sv/L(alpha) = mean(alpha) \times (3.70E+04) \times (1.60E+03) \times (2.89E-05)$$

$$Sv/L(^{90}Sr + ^{90}Y) = mean(^{90}Sr) \times (3.70E+04) \times (1.60E+03) \times (3.00E-08 + 1.70E-09).$$

For liquid samples, the equations used to convert μCi/L to Sv/L are

$Sv/L(^{137}Cs) = mean(^{137}Cs) \times (3.70E+04) \times (6.70E-09)$

$Sv/L(alpha) = mean(alpha) \times (3.70E+04) \times (2.89E-05)$

$Sv/L(^{90}Sr + ^{90}Y) = mean(^{90}Sr) \times (3.70E+04) \times (3.00E-08 + 1.70E-09)$.

Using the DCF ICRP-71, for solid samples, the equations used to convert μCi/g to Sv/L are

$$Sv/L(^{137}Cs) = mean(^{137}Cs) \times (3.70E+04) \times (1.60E+03) \times (4.60E\text{-}09)$$

$$Sv/L(alpha) = mean(alpha) \times (3.70E+04) \times (1.60E+03) \times (4.50E\text{-}05)$$

$$Sv/L(^{90}Sr + {}^{90}Y) = mean(^{90}Sr) \times (3.70E+04) \times (1.60E+03) \times (3.60E\text{-}08 + 1.50E\text{-}09).$$

For liquid samples, the equations used to convert μCi/L to Sv/L are

$$Sv/L(^{137}Cs) = mean(^{137}Cs) \times (3.70E+04) \times (4.60E\text{-}09)$$

$$Sv/L(alpha) = mean(alpha) \times (3.70E+04) \times (4.50E\text{-}05)$$

$$Sv/L(^{90}Sr + {}^{90}Y) = mean(^{90}Sr) \times (3.70E+04) \times (3.60E\text{-}08 + 1.50E\text{-}09).$$

The ULD is defined to be the sum of the Sv/L for the four isotopes. The ULDs, for each tank and waste type, are given in Tables B-1, B-2, B-3, and B-4 in Appendix B. ULDs, for tanks 241-AY-101 and 241-AY-102, are included in Tables B-3 and B-4. These two tanks are "aging waste tanks." Tanks 241-AZ-101 and 241-AZ-102 are also "aging waste tanks." The ULDs for these two tanks were computed using the data in Table A-13.

All of the statistical computations were performed using the computer program S-PLUS (S-PLUS 2000). The S-PLUS functions written to convert μCi/g or μCi/L to Sv/L and to form the ULD are listed in Appendix D.

3.0 LOGNORMAL DISTRIBUTION

Three probability distributions can be fit to the ULD data: a lognormal, a gamma, and a Weibull. A goodness-of-fit test was used to test the appropriateness of the three distributions. Based on the goodness-of-fit test, the lognormal distribution cannot be rejected for SST solid samples and DST solid and liquid samples. At the 0.05 level of significance, the lognormal distribution is rejected for SST liquid samples. The gamma and Weibull distributions are also marginal for SST liquid samples.

These three distributions were also fit to ULDs used in the gas release event safety analysis tool (Jensen et al. 1998). For that project, and for Rev. 0 of this document (Jensen and Wilmarth 1999), the lognormal distribution was the recommended distribution. In addition, tolerance limits can be computed for the lognormal distribution, but not for the gamma or Weibull distribution (tolerance limits are discussed in Section 3.2). To be consistent with Jensen et al. (1998) and since the lognormal distribution cannot be totally rejected, a lognormal distribution is the recommended distribution for the ULDs. Even though the lognormal distribution for the SST liquid samples was rejected, the statistical results will be based on the lognormal distribution. Consequently, they should be used with caution.

The lognormal distribution is defined as follows. A random variable X has a lognormal distribution if Y= log(X) has a normal distribution. The lognormal density function has the form

$$f(x) = \frac{1}{x\sqrt{2\pi}\,\sigma} \exp\left\{ -\frac{(\log(x) - \mu)^2}{2\sigma^2} \right\}, x > 0$$
$$= 0, x \le 0$$

where μ is the mean of Y=log(X) and σ^2 is the variance of Y=log(X). The unbiased estimates of μ and σ^2 are the sample mean, $\hat{\mu}$, and sample variance, $\hat{\sigma}^2$, on the natural log scale. Table 2 gives the estimates of the means and variances for the four types of samples. The individual ULDs are given in Tables B-1 through B-8. The terms M1, M2, and M3 refer to the three models for using observations below detection limits; that is, they refer to deleting all observations below the detection limit, replacing the observations by the detection limit, and replacing them with zero. As can be seen from Table 2, there is little change in the estimates $\hat{\mu}$ and $\hat{\sigma}^2$ between the three models. This means that there is little difference in the lognormal distributions for the three sets of ULDs.

Table 2. Estimates of Means (log(Sv/L)) and Variances ((log(Sv/L))^2) for the Lognormal Distribution (2 sheets)

DCF ICRP-68	ULD.M1	ULD.M2	ULD.M3	ULD.M1	ULD.M2	ULD.M3
	SST Solid Samples			SST Liquid Samples		
Num. Tanks	54	57	57	23	26	26
$\hat{\mu}$	6.55E+00	6.49E+00	6.42E+00	4.26E+00	4.34E+00	4.12E+00
$\hat{\sigma}^2$	2.72E+00	2.62E+00	2.79E+00	3.35E+00	3.17E+00	2.89E+00
	DST Solid Samples			DST Liquid Samples		
Num. Tanks	15	15	15	26	27	27
$\hat{\mu}$	7.81E+00	7.77E+00	7.72E+00	3.90E+00	3.81E+00	3.72E+00
$\hat{\sigma}^2$	5.24E+00	5.34E+00	5.57E+00	2.86E+00	2.92E+00	2.99E+00
DCF ICRP-71	ULD.M1	ULD.M2	ULD.M3	ULD.M1	ULD.M2	ULD.M3
	SST Solid Samples			SST Liquid Samples		
Num. Tanks	54	57	57	23	26	26
$\hat{\mu}$	6.86E+00	6.80E+00	6.71E+00	4.15E+00	4.26E+00	3.93E+00
$\hat{\sigma}^2$	2.82E+00	2.72E+00	2.96E+00	3.13E+00	3.06E+00	2.62E+00

Table 2. Estimates of Means (log(Sv/L)) and Variances ((log(Sv/L))^2) for the Lognormal Distribution (2 sheets)

	ULD.M1	ULD.M2	ULD.M3	ULD.M1	ULD.M2	ULD.M3
ICRP-71	DST Solid Samples			DST Liquid Samples		
Num. Tanks	15	15	15	26	27	27
$\hat{\mu}$	8.09E+00	8.04E+00	7.96E+00	3.79E+00	3.69E+00	3.54E+00
$\hat{\sigma}^2$	5.71E+00	5.86E+00	6.25E+00	3.03E+00	3.10E+00	3.17E+00

The Kolmogorov-Smirnov goodness-of-fit test was used to determine the appropriateness of the lognormal distribution. If the level of significance is chosen to be 0.05, the lognormal distribution cannot be rejected for SST solid samples and DST solid and liquid samples.

The appropriateness of the lognormal distribution for SST liquid samples is questionable. However, for these samples, the gamma distribution is also questionable, and the Weibull distribution only fits marginally well. The gamma distribution is also rejected for the SST solid samples. The difficulty with fitting any probability distribution to the ULD SST liquid sample data is that it appears to be bimodal. For this waste type, based on DCF ICRP-68, most of the ULD values are around 100 Sv/L, and there are two extreme values around 1,000 Sv/L. Based on DCF ICRP-71, most of the ULD values are around 70 Sv/L, and there are two extreme values around 1,500 Sv/L. For the SST liquid sample, the statistical results will be based on the lognormal distribution. However, they should be used with caution.

Figures 1 through 8 are plots of the lognormal density functions for the four types of waste listed in Table 2 using ULD.M1. Figures 1 through 4 are based on DCF ICRP-68 and Figures 6 through 8 are based on DCF ICRP-71. These plots are for the case when observations below the detection limits are omitted. The plots for the other cases are similar. Superimposed on these plots are histograms of the corresponding ULDs.

A probability density function is non-negative and integrates to one. The lognormal density functions, Figures 1 through 8, do not integrate to one. They have been normalized so that they can be viewed when superimposed on the histograms.

3.1 QUANTILES AND PERCENTILES

The ULDs in the FSAR (FDH 1999b), for the four types of waste, need to be compared to the quantiles (Sv/L) corresponding to the 95th and 99th percentiles of the lognormal distributions based on ULD.M1. Table 3 lists these quantiles. The quantiles are the ULD.M1 values such that 95% or 99% of the "population" is to the left of the value. The quantiles are also given in Figures 1 through 8. Table 3 also lists the ULDs for the FSAR (FDH 1999b). Except for the 99th percentile for DST solid samples based on DCF ICRP-71, the FSAR ULD is greater than the quantile corresponding to the 95th and the 99th percentiles of the lognormal distribution for each of the four types of waste and DCFs. The 95th and 99th percentiles of the lognormal distribution using ULD.M2 and ULD.M3 are given in Table C-3 of Appendix C.

Table 3. Quantiles Corresponding to the 95th and 99th Percentiles of the Lognormal Distribution based on ULD.M1 and the FSAR ULD

	Num. Tanks	95th	99th	FSAR
	DCF ICRP-68 (Sv/L)			
SST Solid Samples	54	1.06E+04	3.26E+04	2.20E+05
SST Liquid Samples	23	1.44E+03	5.01E+03	1.10E+04
DST Solid Samples	15	1.07E+05	5.09E+05	5.30E+05
DST Liquid Samples	26	7.97E+02	2.53E+03	6.10E+03
	DCF ICRP-71 (Sv/L)			
SST Solid Samples	54	1.51E+04	4.77E+04	2.20E+05
SST Liquid Samples	23	1.16E+03	3.88E+03	1.10E+04
DST Solid Samples	15	1.67E+05	8.53E+05	5.30E+05
DST Liquid Samples	26	7.68E+02	2.51E+03	6.10E+03

These quantiles should be used with caution. The reason is that the lognormal density functions are bases on estimates of the means and variances. These estimates are subject to variability, and this variability is not incorporated into the estimates of the quantiles. It is difficult to compute confidence statements for the quantiles and for the density functions. However, tolerance limits are similar to quantiles, and they incorporate the uncertainty due to using estimates of the means and variances. Tolerance limits may be more appropriate than the quantiles. They are discussed in the next section.

3.2 TOLERANCE LIMITS

A one-sided tolerance interval is a confidence statement regarding the proportion of the population below a given limit. The advantage of using TLs is that a confidence statement is part of the TL; i.e., measures of uncertainty are in a TL and they are not in the quantiles. These limits are based on the normal distribution. The limits are of the form $\hat{\mu}+K\hat{\sigma}$ where $\hat{\mu}$ and $\hat{\sigma}$ are the sample mean and standard deviation on the log scale. The values of K are tabulated (e.g., Table A-7 in Natrella 1963), they are a function of the number of observations, the confidence level, and the proportion. The value $\exp(\hat{\mu}+K\hat{\sigma})$ is the tolerance limit for the lognormal distribution.

The notation for a 95% TL is 95/P were P is the proportion of the population. The interpretation of the tolerance interval is that we are 95% confident that at least P% of the population (distribution) is below the limit $\exp(\hat{\mu}+K\hat{\sigma})$. Table 4 gives the values of K used to compute the 95/95 and 95/99 TLs. The TLs (Sv/L) and the ULD for the FSAR (FDH 1999b) are given in Table 5. Figures 1 through 8 also plot the TLs and the ULD for the FSAR (FDH 1999b) for the specific type of waste.

Table 4. Values of K[1] for One-sided 95% Tolerance Limits

	Number of Tanks						
Proportion	15	23	24	26[2]	27[2]	54[2]	57[2]
P=0.95	2.566	2.329	2.309	2.278	2.263	2.048	2.035
P=0.99	3.520	3.206	3.181	3.139	3.120	2.841	2.824

[1]Natrella (1963), page T-15
[2]Estimated using linear interpolation

Table 5. One-Sided 95% Tolerance Limits for the Proportion P=0.95 and P=0.99 Based on the Lognormal Distribution for ULD.M1 and the FSAR ULD

	Num.Tanks	95/95 TL	95/99 TL	FSAR
	DCF ICRP-68 (Sv/L)			
SST Solid Samples	54	2.06E+04	7.63E+04	2.20E+05
SST Liquid Samples	23	5.04E+03	2.51E+04	1.10E+04
DST Solid Samples	15	8.82E+05	7.84E+06	5.30E+05
DST Liquid Samples	26	2.33E+03	1.00E+04	6.10E+03
	DCF ICRP-71 (Sv/L)			
SST Solid Samples	54	2.99E+04	1.14E+05	2.20E+05
SST Liquid Samples	23	3.89E+03	1.84E+04	1.10E+04
DST Solid Samples	15	1.51E+06	1.49E+07	5.30E+05
DST Liquid Samples	26	2.31E+03	1.03E+04	6.10E+03

The FSAR ULD is greater than the 95/95 TL for all of the waste types except for DST solid samples. The FSAR ULD is less than the 95/99 TL except for the ULDs based on SST solid samples. The 95th and 99th percentiles and the 95/95 TL and 95/99 TL using ULD.M2 and ULD.M3 are given in Table C-3 of Appendix C.

Figures 3, 4 and 7, 8 are the plots of the lognormal distributions for solid and liquid samples for DSTs including the aging waste tanks 241-AY-101, 241-AY-102, 241-AZ-101 (liquid samples) and 241-AZ-102 . A ULD could not be estimated for solid samples from 241-AZ-101.

All of the statistical computations and figures were completed using the statistical program S-PLUS (S-PLUS 2000).

4.0 VALIDITY OF ASSUMPTIONS

To compute a ULD for a tank, there had to be sample data for each of ^{137}Cs, alpha, and $^{89/90}$Sr. There were many tanks with sample data from at least one of ^{137}Cs, alpha, or $^{89/90}$Sr, but the data were not used to compute a ULD. In addition, three different models were used to incorporate observations below the detection limits. This section reports statistical results that compare ^{137}Cs, alpha, and $^{89/90}$Sr tank means based on the available data and the subset of the data used to compute the ULD. There is also a statistical comparison of the ULDs computed from the three models.

Tables A-1 through A-12 in Appendix A list the means for ^{137}Cs, alpha, and $^{89/90}$Sr for each of the four waste types, by tank and by the model for observations below the detection limits. Since all three of ^{137}Cs, alpha, and $^{89/90}$Sr are needed to compute the ULD for a tank, only a subset of the data in these twelve tables was used to compute the four tables in Appendix B. For a given analyte and waste type, all of the available data can be compared to the subset used to compute the ULD by comparing means, comparing variances, and by comparing distributions.

The computer program S-PLUS (S-PLUS 2000) was used to make the comparisons. The S-PLUS function t-test was used to compare the means, the function F-test was used to compare the variances, and the two-sample Kolmogorov-Smirnov test function was used to compare the distributions. For the two-sample Kolmogorov-Smirnov test, the distribution (e.g., normal, lognormal, gamma, etc.) is not specified. It is only specified that the two sets of data have the same distribution.

The results of the statistical comparisons are as follows. For each of the three radionuclide and each of the four waste types, there were no significant differences between the means, between the variances, and between the distributions (except in one case). The exceptional case is the comparison of the distributions of alpha in SST liquid samples. For this analyte, the distribution of alpha obtained by omitting all observations below the DL (model M1) is significantly different (0.05 level of significance) from the distribution of alpha obtained by replacing all observations below the DL by zero (model M3). The observed means and variances are given in Appendix C, Table C-1.

Figures 9, 10, and 11 are quantile plots of the two sets of data by radionuclide (using model M1) and by waste type. The number of points is the number of tanks with data. The x-axis represents the quantiles; i.e., the ordered values of the data. The y-axis represents the percentile points. That is, the point 0.50 corresponds to the median, the point 0.95 the quantile for the 95th percentile, etc. As these figures demonstrate, there is little evidence to show that the complete data set is different from the subset used in the ULD. The corresponding plots, based on the other two methods for incorporating observations below the DL, are similar.

Three models were used to incorporate observations below the detection limit. In the first model, the observations below the detection limits were omitted; in the second, the observations below the detection limits were replaced by the detection limit; and in the third model, the observations below the detection limits were replace by zero. For each of the four waste types, the means, variances and distributions of the ULDs obtained using the three modes were compared using S-PLUS. The results of these comparisons were that there were no significant differences (0.05 level of significance) between the means, between the variances, and between the distributions. The observed ULD means and variances are given in Appendix C, Table C-2.

Table C-3 lists the 95th, the 99th percentile points, and the 95/95 and 95/99 tolerance limits for the three models. These points are based on the lognormal distribution. For the different waste types, there is little difference in the percentile points and the tolerance limits given by the three models.

Based on the results of the statistical comparisons given above, there is no reason to believe that the ULDs computed from subsets of the radionuclide data would be different from those computed from a complete set of data, provided the complete set were available. In addition, the differences in percentile points and tolerance limits using the three models are small.

Figure 1. ULD Lognormal Density and Histogram
Single Shell Tanks, Solid Samples

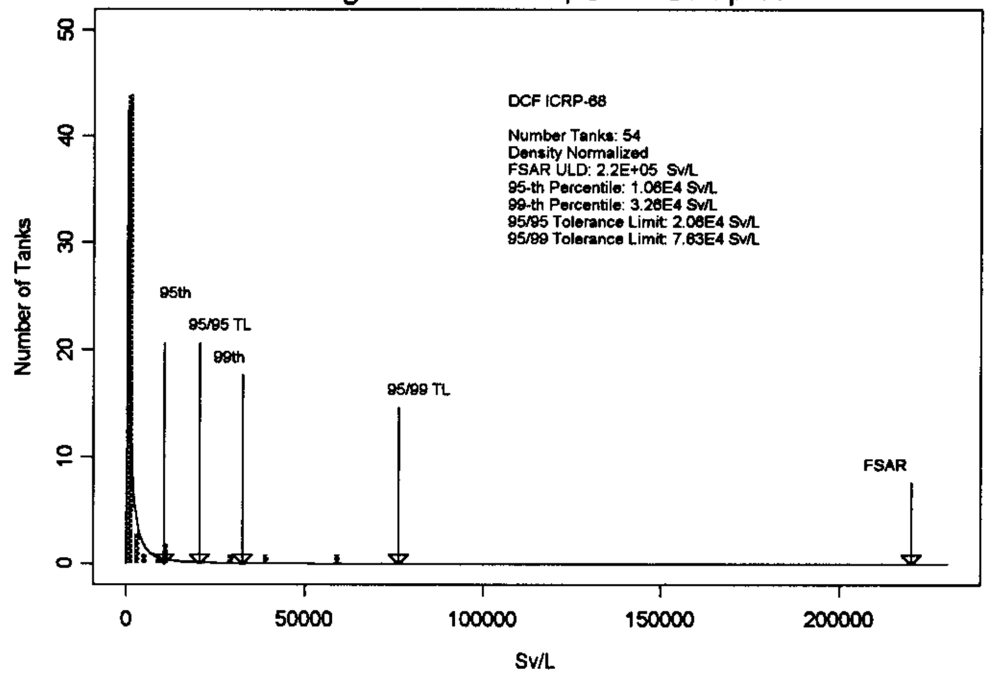


Figure 2. ULD Lognormal Density and Histogram
Single Shell Tanks, Liquid Samples

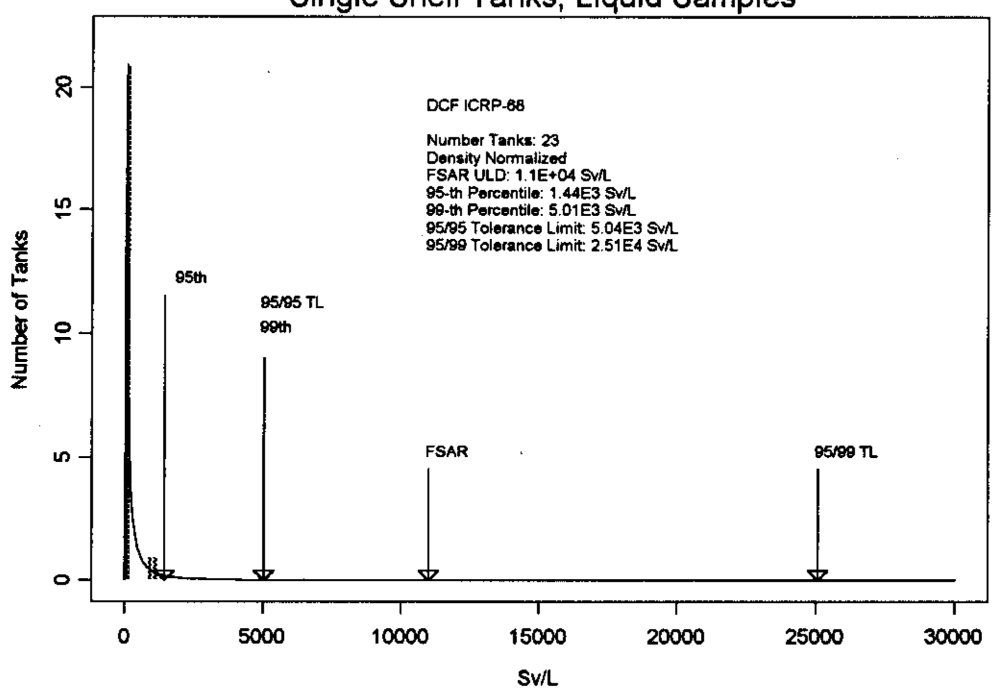


Figure 3. ULD Lognormal Density and Histogram
Double Shell Tanks, Solid Samples

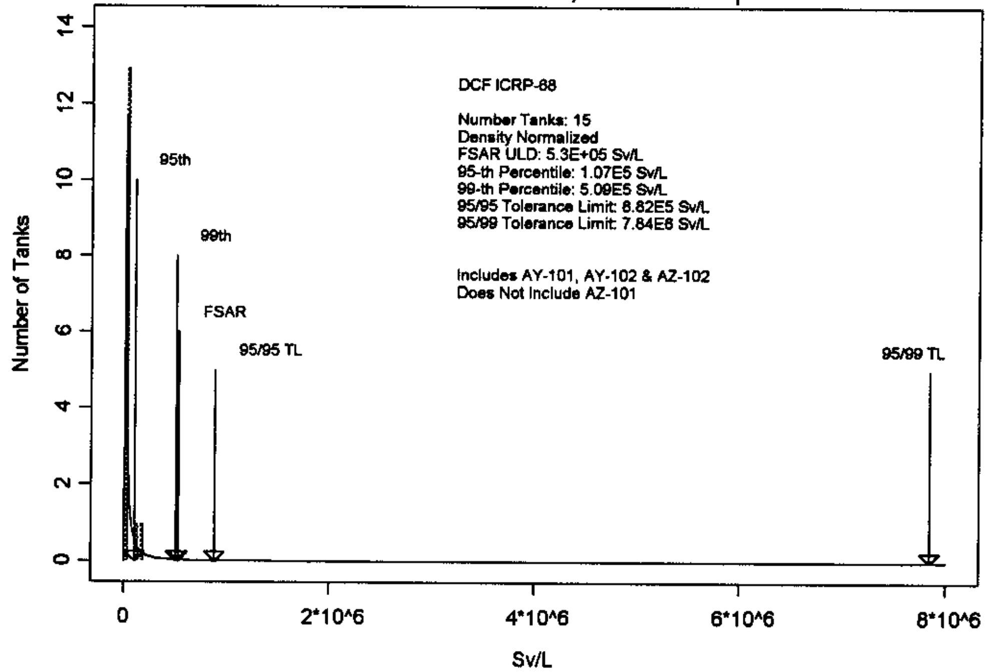


Figure 4. ULD Lognormal Density and Histogram
Double Shell Tanks, Liquid Samples

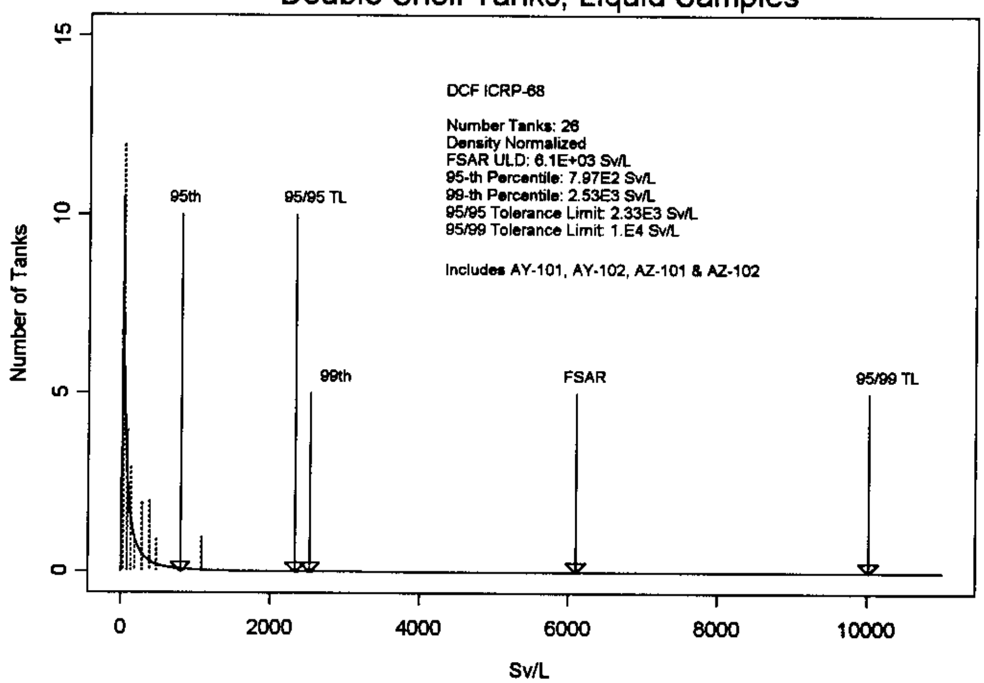


Figure 5. ULD Lognormal Density and Histogram
Single Shell Tanks, Solid Samples

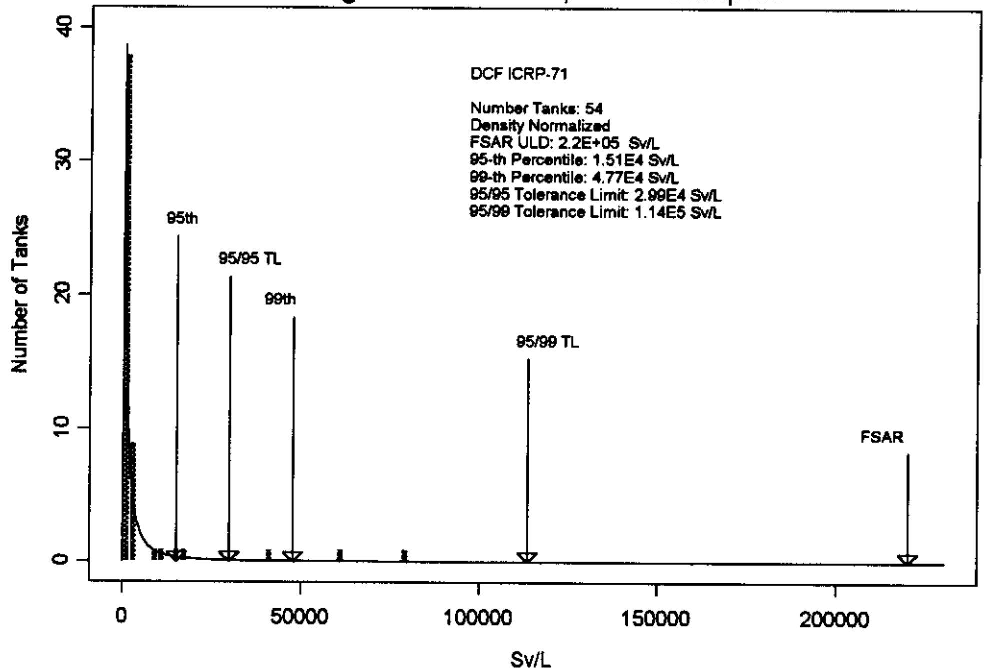


Figure 6. ULD Lognormal Density and Histogram
Single Shell Tanks, Liquid Samples

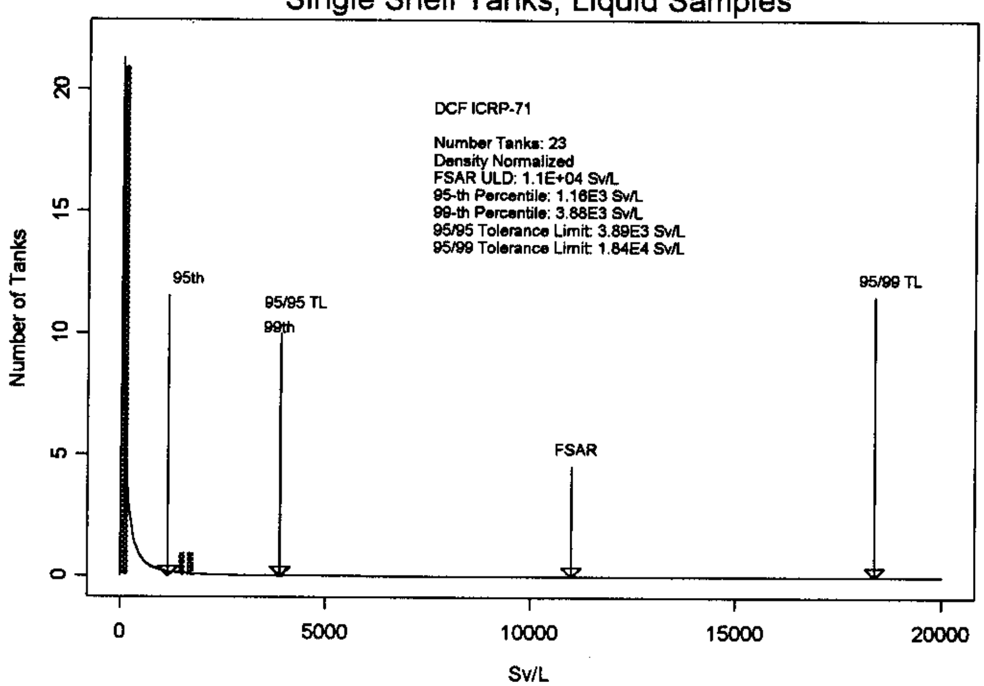


Figure 7. ULD Lognormal Density and Histogram
Double Shell Tanks, Solid Samples

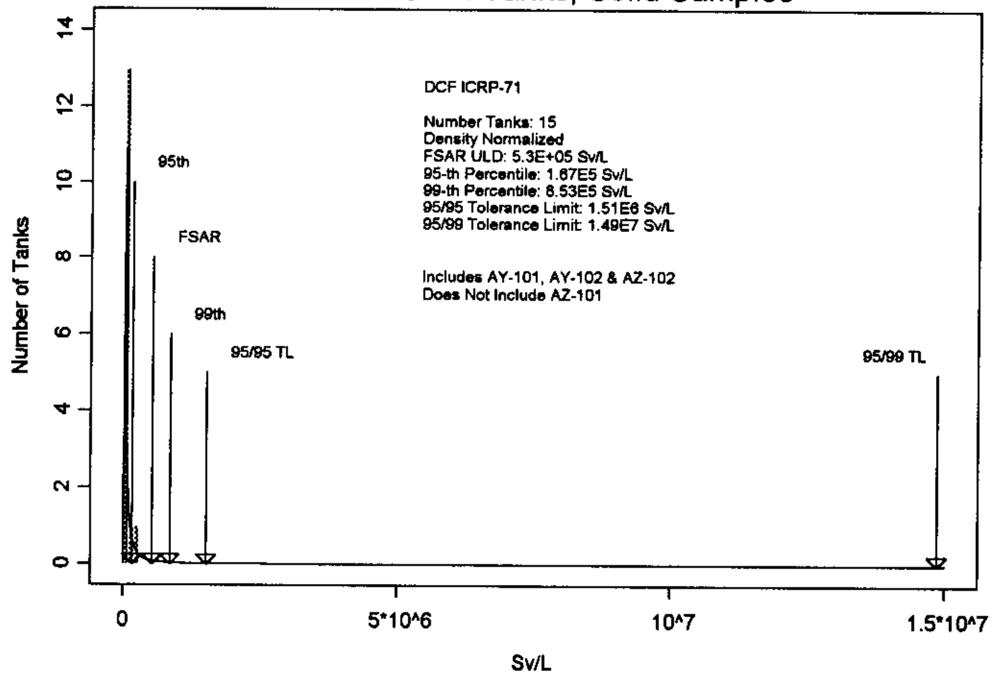
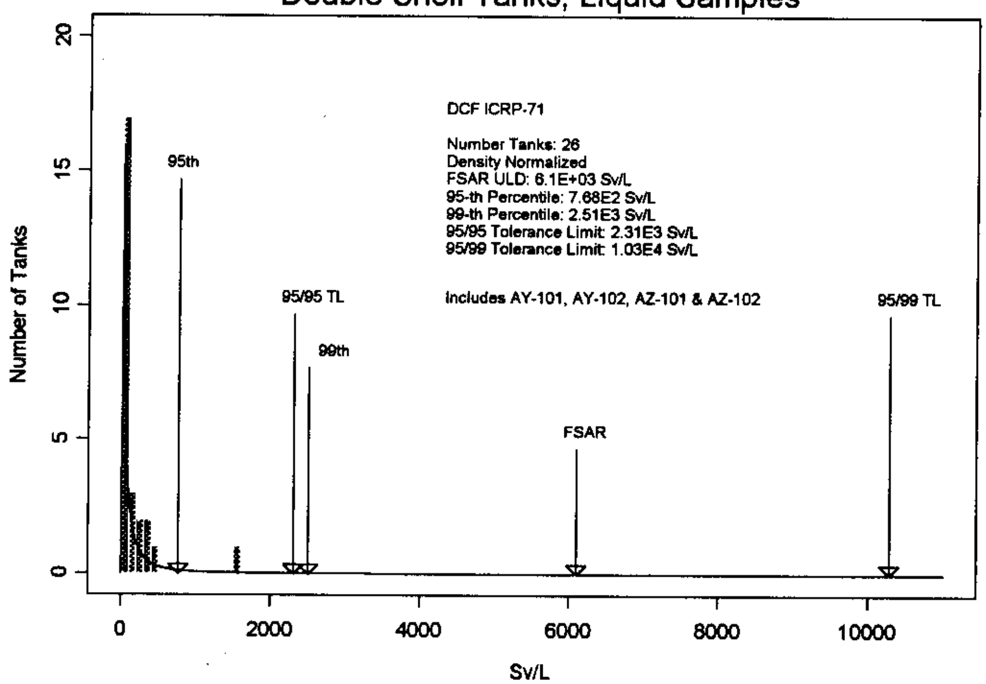


Figure 8. ULD Lognormal Density and Histogram
Double Shell Tanks, Liquid Samples



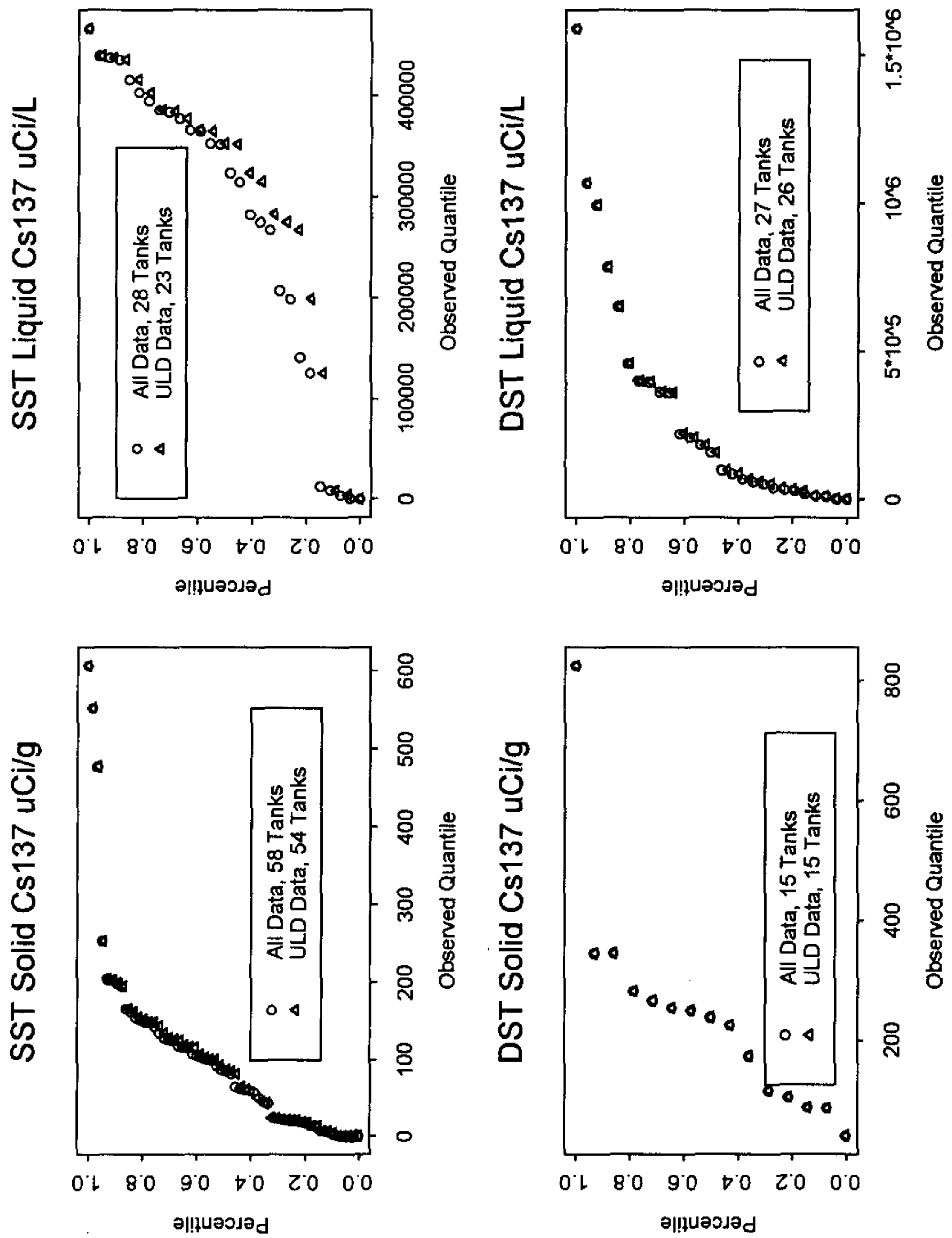


Figure 9: Quantile Plots for Cs-137

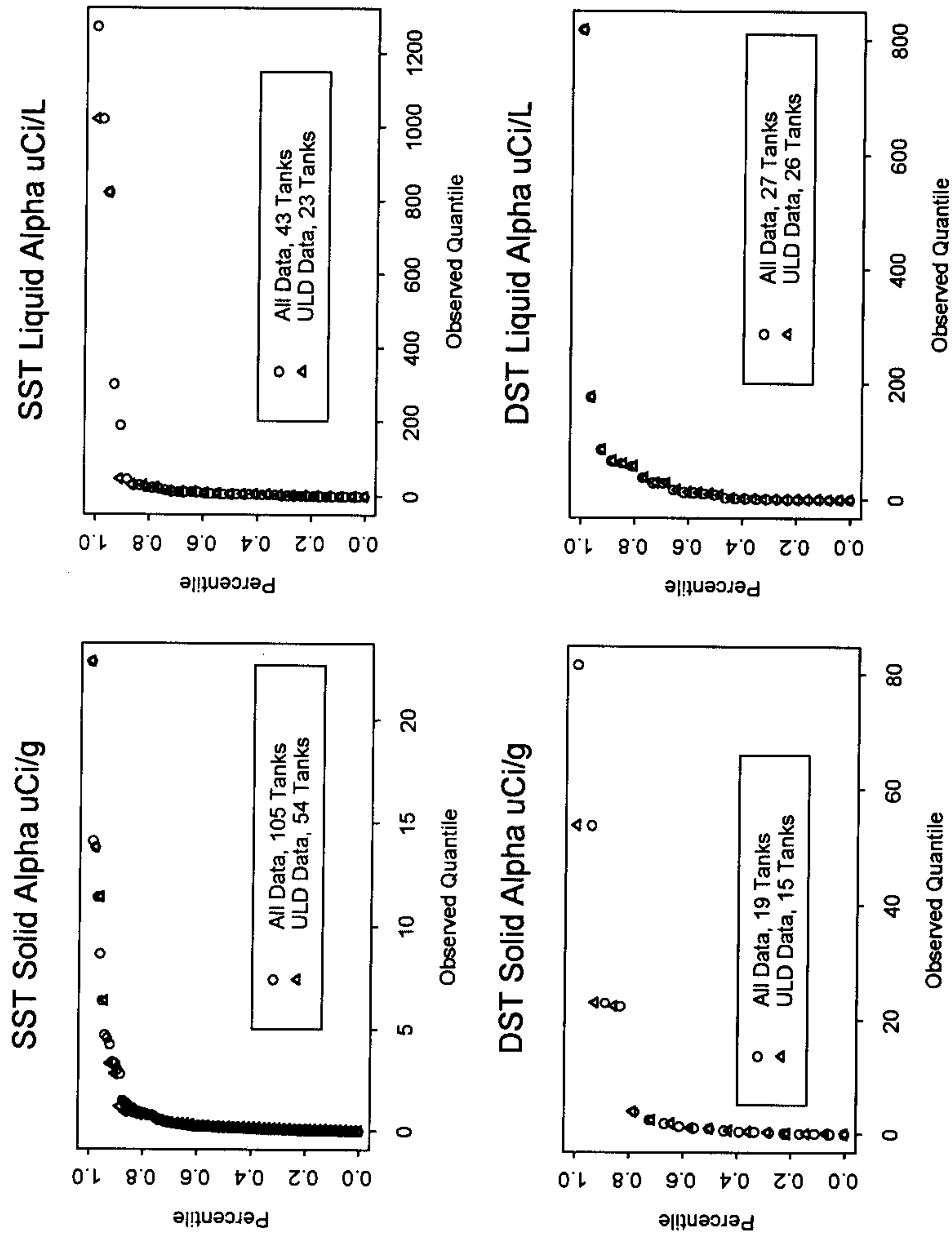


Figure 10: Quantile Plots for Alpha

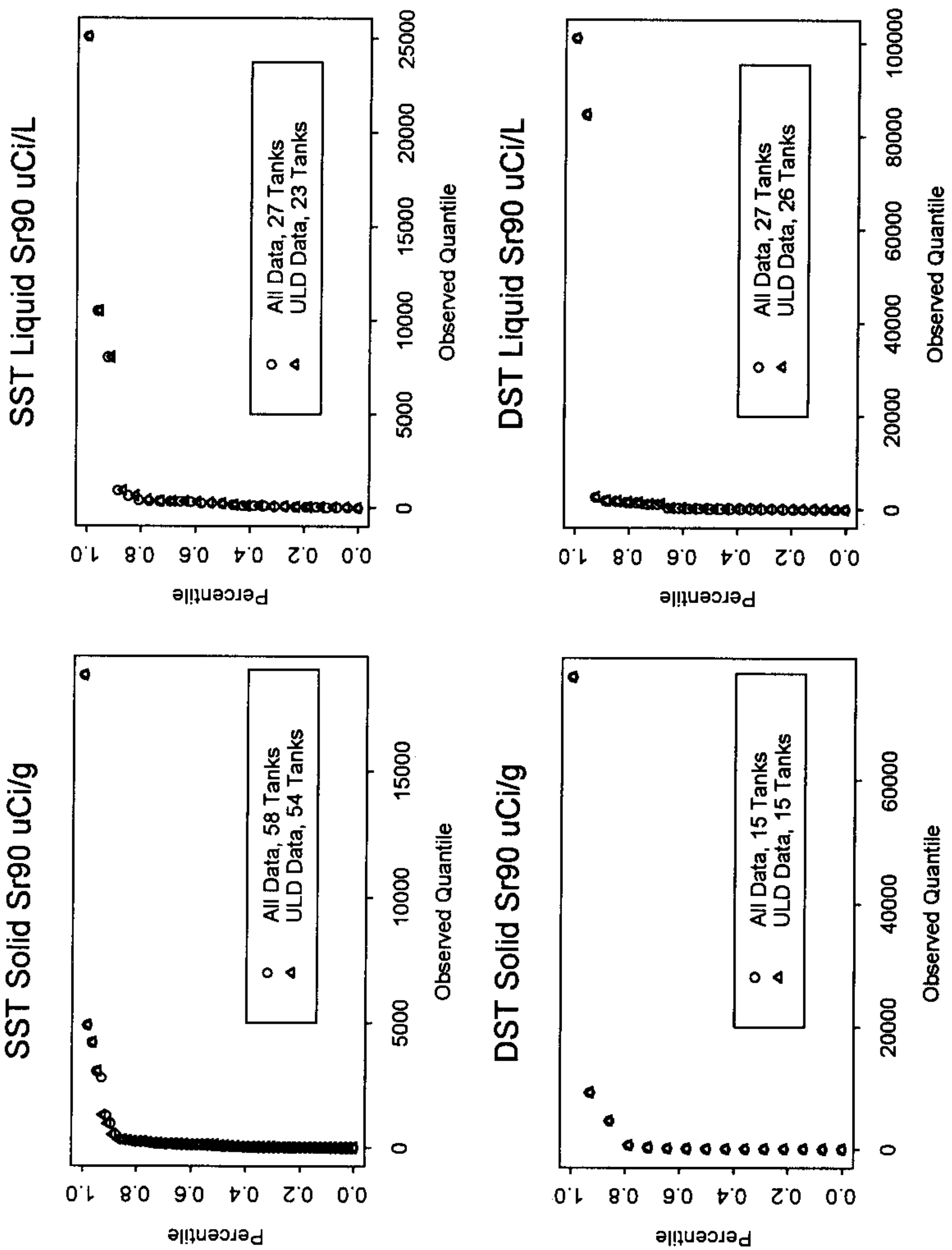


Figure 11. Quantile Plots for Sr-90

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APPENDIX A

A.0 ANALYTE MEANS TABLES

In Tables A-1 to A-13, the columns labeled "analyte" denote the type of data used to estimate the mean. That is, the symbol ^{137}Cs is used to indicate that the mean of all the ^{137}Cs data for the tank is reported. For alpha, GA indicates that the mean of the gross alpha data is reported; ^{241}Am, the mean of the ^{241}Am data. For strontium, $^{89/90}$Sr indicates that the mean of $^{89/90}$Sr is reported; ^{90}Sr, the mean of ^{90}Sr data; $^{89/90}$Sr&^{90}Sr, the mean of the combined $^{89/90}$Sr and ^{90}Sr data. The columns labeled M1, M2, and M3 are analyte concentration means when the below detection limit observations are omitted, replaced by the detection limit, and replaced by zero respectively. Num.Obs are the total number of observations and Num.Above DL are the number of observations above the detection limit. NA means not available.

Table A-1. Mean ^{137}Cs Concentration (μCi/g), SST Solid Samples (2 sheets)

Tank	Analyte	Num.Obs.	Num. Above DL	M1	M2	M3
241-A-101	^{137}Cs	90	90	2.03E+02	2.03E+02	2.03E+02
241-AX-101	^{137}Cs	96	96	1.99E+02	1.99E+02	1.99E+02
241-AX-104	^{137}Cs	10	10	6.07E+02	6.07E+02	6.07E+02
241-B-106	^{137}Cs	20	20	2.03E+01	2.03E+01	2.03E+01
241-B-108	^{137}Cs	16	16	1.72E+01	1.72E+01	1.72E+01
241-B-110	^{137}Cs	14	14	1.31E+01	1.31E+01	1.31E+01
241-B-111	^{137}Cs	20	20	1.49E+02	1.49E+02	1.49E+02
241-B-201	^{137}Cs	38	38	4.59E+00	4.59E+00	4.59E+00
241-B-202	^{137}Cs	8	6	1.26E-01	1.00E-01	9.44E-02
241-B-204	^{137}Cs	2	0	NA	3.14E-02	0.00E+00
241-BX-104	^{137}Cs	8	8	6.03E+01	6.03E+01	6.03E+01
241-BX-107	^{137}Cs	16	16	2.21E+01	2.21E+01	2.21E+01
241-BX-109	^{137}Cs	32	32	1.32E+01	1.32E+01	1.32E+01
241-BX-112	^{137}Cs	20	20	5.09E+01	5.09E+01	5.09E+01
241-BY-104	^{137}Cs	60	60	1.03E+02	1.03E+02	1.03E+02
241-BY-105	^{137}Cs	44	44	6.55E+01	6.55E+01	6.55E+01
241-BY-106	^{137}Cs	96	96	1.00E+02	1.00E+02	1.00E+02
241-BY-107	^{137}Cs	8	8	1.25E+02	1.25E+02	1.25E+02
241-BY-108	^{137}Cs	8	8	6.30E+01	6.30E+01	6.30E+01
241-BY-110	^{137}Cs	216	216	9.29E+01	9.29E+01	9.29E+01
241-C-103	^{137}Cs	10	10	1.35E+02	1.35E+02	1.35E+02

Table A-1. Mean ^{137}Cs Concentration (μCi/g), SST Solid Samples (2 sheets)

Tank	Analyte	Num.Obs.	Num. Above DL	M1	M2	M3
241-C-104	^{137}Cs	50	49	6.15E+01	6.49E+01	6.03E+01
241-C-106	^{137}Cs	22	22	5.53E+02	5.53E+02	5.53E+02
241-C-108	^{137}Cs	22	22	1.66E+02	1.66E+02	1.66E+02
241-C-109	^{137}Cs	40	40	4.77E+02	4.77E+02	4.77E+02
241-C-110	^{137}Cs	18	18	1.86E+01	1.86E+01	1.86E+01
241-C-111	^{137}Cs	4	4	4.32E+01	4.32E+01	4.32E+01
241-C-112	^{137}Cs	69	69	2.04E+02	2.04E+02	2.04E+02
241-S-101	^{137}Cs	58	58	1.29E+02	1.29E+02	1.29E+02
241-S-102	^{137}Cs	24	24	1.17E+02	1.17E+02	1.17E+02
241-S-104	^{137}Cs	24	24	5.84E+01	5.84E+01	5.84E+01
241-S-106	^{137}Cs	28	28	1.01E+02	1.01E+02	1.01E+02
241-S-107	^{137}Cs	92	92	8.22E+01	8.22E+01	8.22E+01
241-S-109	^{137}Cs	30	30	7.58E+00	7.58E+00	7.58E+00
241-S-110	^{137}Cs	68	68	8.78E+01	8.78E+01	8.78E+01
241-S-111	^{137}Cs	52	52	1.19E+02	1.19E+02	1.19E+02
241-SX-101	^{137}Cs	50	50	1.07E+02	1.07E+02	1.07E+02
241-SX-102	^{137}Cs	4	4	1.49E+02	1.49E+02	1.49E+02
241-SX-103	^{137}Cs	56	56	1.27E+02	1.27E+02	1.27E+02
241-SX-104	^{137}Cs	2	2	1.06E+02	1.06E+02	1.06E+02
241-SX-108	^{137}Cs	8	8	1.95E+02	1.95E+02	1.95E+02
241-T-102	^{137}Cs	6	6	2.09E+01	2.09E+01	2.09E+01
241-T-104	^{137}Cs	12	12	2.07E-01	2.07E-01	2.07E-01
241-T-105	^{137}Cs	12	12	4.57E+01	4.57E+01	4.57E+01
241-T-107	^{137}Cs	38	38	2.06E+01	2.06E+01	2.06E+01
241-T-108	^{137}Cs	4	4	2.00E+00	2.00E+00	2.00E+00
241-T-111	^{137}Cs	30	30	1.34E-01	1.34E-01	1.34E-01
241-T-201	^{137}Cs	4	3	3.46E-02	2.80E-02	2.59E-02
241-T-202	^{137}Cs	2	0	NA	2.82E-02	0.00E+00
241-T-203	^{137}Cs	2	0	NA	1.81E-02	0.00E+00
241-T-204	^{137}Cs	2	2	7.76E-03	7.76E-03	7.76E-03
241-TX-113	^{137}Cs	36	36	6.58E+00	6.58E+00	6.58E+00
241-TX-118	^{137}Cs	32	32	2.33E+01	2.33E+01	2.33E+01
241-U-102	^{137}Cs	56	56	1.62E+02	1.62E+02	1.62E+02
241-U-103	^{137}Cs	6	6	2.53E+02	2.53E+02	2.53E+02
241-U-105	^{137}Cs	74	74	1.55E+02	1.55E+02	1.55E+02
241-U-106	^{137}Cs	34	34	1.52E+02	1.52E+02	1.52E+02
241-U-107	^{137}Cs	16	16	8.55E+01	8.55E+01	8.55E+01
241-U-108	^{137}Cs	106	106	1.44E+02	1.44E+02	1.44E+02
241-U-109	^{137}Cs	110	110	1.16E+02	1.16E+02	1.16E+02
241-U-110	^{137}Cs	92	88	2.41E+01	2.30E+01	2.30E+01

Table A-2. Mean Alpha Concentration (µCi/g), SST Solid Samples (3 sheets)

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-A-101	GA	60	46	6.15E-02	4.83E-02	4.71E-02
241-A-102	GA	4	4	4.68E+00	4.68E+00	4.68E+00
241-AX-101	GA	60	44	5.17E-02	4.10E-02	3.79E-02
241-AX-102	GA	4	4	1.24E+00	1.24E+00	1.24E+00
241-AX-103	GA	6	6	4.48E-02	4.48E-02	4.48E-02
241-AX-104	GA	6	6	1.38E+01	1.38E+01	1.38E+01
241-B-101	GA	20	17	2.99E+00	2.57E+00	2.54E+00
241-B-102	GA	4	0	NA	3.56E-01	0.00E+00
241-B-103	GA	4	4	2.14E-01	2.14E-01	2.14E-01
241-B-104	GA	54	52	4.46E-02	5.45E-02	4.29E-02
241-B-106	GA	20	8	4.92E-02	4.66E-02	1.97E-02
241-B-107	GA	16	16	6.33E-02	6.33E-02	6.33E-02
241-B-108	GA	14	13	7.90E-03	8.22E-03	7.33E-03
241-B-109	GA	10	10	5.64E-02	5.64E-02	5.64E-02
241-B-110	GA	14	14	7.80E-02	7.80E-02	7.80E-02
241-B-111	GA	10	10	1.42E-01	1.42E-01	1.42E-01
241-B-112	GA	6	4	6.57E-03	4.64E-03	4.38E-03
241-B-201	GA	6	6	9.07E-01	9.07E-01	9.07E-01
241-B-202	GA	10	10	4.04E-01	4.04E-01	4.04E-01
241-B-203	GA	44	44	2.14E-01	2.14E-01	2.14E-01
241-B-204	GA	52	52	2.64E-01	2.64E-01	2.64E-01
241-BX-101	GA	10	10	9.75E-01	9.75E-01	9.75E-01
241-BX-103	GA	12	11	3.37E+00	3.13E+00	3.09E+00
241-BX-104	GA	8	8	8.22E-01	8.22E-01	8.22E-01
241-BX-105	GA	8	8	2.21E-01	2.21E-01	2.21E-01
241-BX-106	GA	4	4	5.90E-01	5.90E-01	5.90E-01
241-BX-107	GA	15	15	1.23E-01	1.23E-01	1.23E-01
241-BX-108	GA	8	8	8.16E-02	8.16E-02	8.16E-02
241-BX-109	GA	32	6	4.99E-02	5.91E-02	9.35E-03
241-BX-110	GA	16	10	1.18E-02	8.23E-03	7.38E-03
241-BX-111	GA	12	7	2.64E-03	2.28E-03	1.54E-03
241-BX-112	GA	24	24	1.90E-01	1.90E-01	1.90E-01
241-BY-101	GA	4	2	2.24E-03	2.32E-03	1.12E-03
241-BY-102	GA	20	17	1.10E-01	9.36E-02	9.32E-02
241-BY-103	GA	4	2	2.35E-02	1.35E-02	1.18E-02
241-BY-104	GA	30	24	1.13E-01	1.08E-01	9.01E-02
241-BY-105	GA	62	24	1.04E-01	1.68E-01	4.03E-02
241-BY-106	GA	38	32	2.59E-02	2.23E-02	2.18E-02
241-BY-107	GA	34	25	4.68E-02	3.80E-02	3.44E-02

Table A-2. Mean Alpha Concentration (μCi/g), SST Solid Samples (3 sheets)

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-BY-108	GA	56	40	8.66E-02	6.37E-02	6.19E-02
241-BY-109	GA	26	25	7.24E-02	7.11E-02	6.97E-02
241-BY-110	GA	110	101	5.38E-02	5.09E-02	4.94E-02
241-BY-111	GA	26	21	6.01E-02	1.06E-01	4.85E-02
241-BY-112	GA	24	24	7.46E-02	7.46E-02	7.46E-02
241-C-101	GA	6	6	1.09E+00	1.09E+00	1.09E+00
241-C-103	GA	14	14	1.14E+01	1.14E+01	1.14E+01
241-C-104	GA	28	28	6.37E+00	6.37E+00	6.37E+00
241-C-105	GA	16	16	1.33E+00	1.33E+00	1.33E+00
241-C-106	GA	22	22	2.77E+00	2.77E+00	2.77E+00
241-C-107	GA	40	37	4.22E+00	3.93E+00	3.91E+00
241-C-108	GA	22	2	7.81E-02	1.50E-01	7.10E-03
241-C-109	GA	8	8	1.72E-01	1.72E-01	1.72E-01
241-C-110	GA	18	18	1.25E-01	1.25E-01	1.25E-01
241-C-111	GA	10	10	8.21E-01	8.21E-01	8.21E-01
241-C-112	GA	11	11	3.35E-01	3.35E-01	3.35E-01
241-C-202	GA	4	4	8.64E+00	8.64E+00	8.64E+00
241-C-203	GA	12	12	1.44E+00	1.44E+00	1.44E+00
241-C-204	GA	6	6	2.66E-02	2.66E-02	2.66E-02
241-S-101	GA	34	34	3.49E-01	3.49E-01	3.49E-01
241-S-102	GA	90	89	1.78E-01	1.77E-01	1.76E-01
241-S-104	GA	24	21	5.52E-01	5.41E-01	4.83E-01
241-S-106	GA	20	18	3.09E-02	2.88E-02	2.78E-02
241-S-107	GA	92	92	9.24E-01	9.24E-01	9.24E-01
241-S-109	GA	30	27	7.74E-03	7.39E-03	6.97E-03
241-S-110	GA	46	42	3.12E-01	2.94E-01	2.85E-01
241-S-111	GA	34	28	3.46E-02	2.89E-02	2.85E-02
241-SX-101	GA	26	22	4.85E-01	4.37E-01	4.11E-01
241-SX-102	GA	38	34	2.13E-01	1.92E-01	1.91E-01
241-SX-103	GA	50	49	1.71E-01	1.68E-01	1.68E-01
241-SX-104	^{241}Am	4	0	NA	8.95E-02	0.00E+00
241-SX-105	GA	60	55	5.37E-01	5.00E-01	4.93E-01
241-SX-106	GA	30	19	4.35E-01	2.80E-01	2.75E-01
241-SX-108	GA	8	8	3.29E+00	3.29E+00	3.29E+00
241-SX-113	GA	8	5	1.42E-01	1.69E-01	8.85E-02
241-SX-115	^{241}Am	2	2	1.41E+01	1.41E+01	1.41E+01
241-T-102	GA	2	2	2.29E-01	2.29E-01	2.29E-01
241-T-104	GA	12	12	1.41E-01	1.41E-01	1.41E-01
241-T-105	GA	16	16	3.57E-01	3.57E-01	3.57E-01
241-T-106	GA	4	4	2.03E-01	2.03E-01	2.03E-01

Table A-2. Mean Alpha Concentration (μCi/g), SST Solid Samples (3 sheets)

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-T-107	GA	10	10	1.77E-01	1.77E-01	1.77E-01
241-T-108	GA	4	4	7.02E-02	7.02E-02	7.02E-02
241-T-109	GA	6	6	1.14E-02	1.14E-02	1.14E-02
241-T-110	GA	30	30	5.31E-02	5.31E-02	5.31E-02
241-T-111	GA	30	30	3.71E-01	3.71E-01	3.71E-01
241-T-112	GA	4	4	2.56E-01	2.56E-01	2.56E-01
241-T-201	GA	6	6	7.57E-01	7.57E-01	7.57E-01
241-T-202	GA	10	10	2.22E-01	2.22E-01	2.22E-01
241-T-203	GA	20	20	1.96E-01	1.96E-01	1.96E-01
241-T-204	GA	20	19	1.52E-01	1.44E-01	1.44E-01
241-TX-104	GA	12	12	3.09E-01	3.09E-01	3.09E-01
241-TX-107	GA	4	4	4.52E+00	4.52E+00	4.52E+00
241-TX-113	GA	38	35	1.30E-02	1.37E-02	1.20E-02
241-TX-118	GA	33	29	2.28E+01	2.00E+01	2.00E+01
241-TY-104	GA	4	4	1.45E-01	1.45E-01	1.45E-01
241-TY-106	GA	6	3	1.96E-02	1.83E-02	9.78E-03
241-U-101	GA	5	4	7.44E-02	7.27E-02	5.95E-02
241-U-102	GA	32	32	2.05E-01	2.05E-01	2.05E-01
241-U-103	GA	56	52	1.48E-01	1.40E-01	1.37E-01
241-U-105	GA	58	58	7.23E-01	7.23E-01	7.23E-01
241-U-106	GA	18	18	1.15E+00	1.15E+00	1.15E+00
241-U-107	GA	70	63	2.19E-01	2.12E-01	1.97E-01
241-U-108	GA	106	100	5.25E-02	5.31E-02	4.96E-02
241-U-109	GA	92	90	3.71E-02	4.07E-02	3.63E-02
241-U-110	GA	82	47	7.47E-01	5.96E-01	4.28E-01
241-U-112	GA	4	0	NA	3.29E-03	0.00E+00
241-U-201	GA	12	0	NA	1.69E-03	0.00E+00
241-U-202	GA	14	4	1.26E-03	1.73E-03	3.59E-04
241-U-203	GA	6	1	9.75E-04	1.27E-03	1.63E-04
241-U-204	GA	4	1	9.67E-02	6.17E-02	2.42E-02

Table A-3. Mean $^{89/90}Sr$ Concentration (μCi/g), SST Solid Samples (2 sheets)

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-A-101	$^{89/90}Sr$	8	8	1.55E+01	1.55E+01	1.55E+01
241-AX-101	$^{89/90}Sr$	22	22	1.82E+01	1.82E+01	1.82E+01
241-AX-104	$^{89/90}Sr$	20	20	1.88E+04	1.88E+04	1.88E+04
241-B-106	$^{89/90}Sr$	20	20	7.18E+01	7.18E+01	7.18E+01
241-B-108	$^{89/90}Sr$	8	8	2.87E+00	2.87E+00	2.87E+00
241-B-110	^{90}Sr	6	6	3.23E+01	3.23E+01	3.23E+01
241-B-111	^{90}Sr	8	8	2.48E+02	2.48E+02	2.48E+02
241-B-201	^{90}Sr	6	6	2.70E+00	2.70E+00	2.70E+00
241-B-202	^{90}Sr	*10*	*10*	*3.99E+00*	*3.99E+00*	*3.99E+00*
241-BX-107	^{90}Sr	8	8	9.87E+00	9.87E+00	9.87E+00
241-BX-109	$^{89/90}Sr$	6	6	1.62E+02	1.62E+02	1.62E+02
241-BX-112	^{90}Sr	12	12	6.17E+00	6.17E+00	6.17E+00
241-BY-104	$^{89/90}Sr$	48	48	1.84E+02	1.84E+02	1.84E+02
241-BY-105	$^{89/90}Sr$	44	44	1.26E+02	1.26E+02	1.26E+02
241-BY-106	$^{89/90}Sr$	68	68	2.67E+01	2.67E+01	2.67E+01
241-BY-107	$^{89/90}Sr$	8	8	2.21E+01	2.21E+01	2.21E+01
241-BY-110	$^{89/90}Sr$	216	216	1.08E+02	1.08E+02	1.08E+02
241-C-103	$^{89/90}Sr$	*10*	*10*	*4.90E+03*	*4.90E+03*	*4.90E+03*
241-C-104	$^{89/90}Sr$	4	4	3.23E+02	3.23E+02	3.23E+02
241-C-106	$^{89/90}Sr$	22	22	5.17E+02	5.17E+02	5.17E+02
241-C-107	$^{89/90}Sr$	12	12	2.81E+03	2.81E+03	2.81E+03
241-C-108	$^{89/90}Sr$	20	20	1.95E+02	1.95E+02	1.95E+02
241-C-109	^{90}Sr	11	11	9.58E+02	9.58E+02	9.58E+02
241-C-110	^{90}Sr	10	10	5.04E+00	5.04E+00	5.04E+00
241-C-111	^{90}Sr	4	4	4.21E+03	4.21E+03	4.21E+03
241-C-112	^{90}Sr	25	25	1.29E+03	1.29E+03	1.29E+03
241-S-101	$^{89/90}Sr$	4	4	2.52E+02	2.52E+02	2.52E+02
241-S-102	$^{89/90}Sr$	24	24	2.54E+01	2.54E+01	2.54E+01
241-S-104	^{90}Sr	12	12	3.10E+02	3.10E+02	3.10E+02
241-S-106	$^{89/90}Sr$	4	4	1.49E+01	1.49E+01	1.49E+01
241-S-107	$^{89/90}Sr$	92	92	1.60E+02	1.60E+02	1.60E+02
241-S-109	$^{89/90}Sr$	4	4	5.31E+00	5.31E+00	5.31E+00
241-S-110	$^{89/90}Sr$	62	62	1.22E+02	1.22E+02	1.22E+02
241-S-111	$^{89/90}Sr$	16	16	1.21E+02	1.21E+02	1.21E+02
241-SX-101	$^{89/90}Sr$	4	4	1.20E+02	1.20E+02	1.20E+02
241-SX-102	$^{89/90}Sr$	4	4	1.03E+02	1.03E+02	1.03E+02
241-SX-103	$^{89/90}Sr$	54	54	1.29E+02	1.29E+02	1.29E+02
241-SX-104	$^{89/90}Sr$	2	2	1.47E-01	1.47E-01	1.47E-01
241-SX-108	$^{89/90}Sr$	8	8	3.06E+03	3.06E+03	3.06E+03

Table A-3. Mean $^{89/90}Sr$ Concentration (μCi/g), SST Solid Samples (2 sheets)

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-T-102	^{90}Sr	2	2	2.38E+02	2.38E+02	2.38E+02
241-T-104	^{90}Sr	8	8	2.63E+00	2.63E+00	2.63E+00
241-T-105	^{90}Sr	4	4	2.80E+02	2.80E+02	2.80E+02
241-T-107	^{90}Sr	30	30	1.20E+02	1.20E+02	1.20E+02
241-T-111	^{90}Sr	8	8	5.41E+00	5.41E+00	5.41E+00
241-T-201	$^{89/90}Sr$	4	4	8.58E-02	8.58E-02	8.58E-02
241-T-202	$^{89/90}Sr$	2	2	2.49E-03	2.49E-03	2.49E-03
241-T-203	$^{89/90}Sr$	2	2	2.57E-03	2.57E-03	2.57E-03
241-T-204	$^{89/90}Sr$	2	2	4.60E-03	4.60E-03	4.60E-03
241-TX-113	$^{89/90}Sr$	16	16	1.07E+00	1.07E+00	1.07E+00
241-TX-118	$^{89/90}Sr$	10	10	1.83E+02	1.83E+02	1.83E+02
241-U-102	$^{89/90}Sr$	6	6	5.51E+01	5.51E+01	5.51E+01
241-U-103	$^{89/90}Sr$	6	6	1.01E+01	1.01E+01	1.01E+01
241-U-105	$^{89/90}Sr$	8	8	5.71E+01	5.71E+01	5.71E+01
241-U-106	$^{89/90}Sr$	4	4	7.72E+01	7.72E+01	7.72E+01
241-U-107	$^{89/90}Sr$	10	10	4.34E+00	4.34E+00	4.34E+00
241-U-108	$^{89/90}Sr$	106	106	1.03E+01	1.03E+01	1.03E+01
241-U-109	$^{89/90}Sr$	32	32	8.81E+00	8.81E+00	8.81E+00
241-U-110	$^{89/90}Sr$&^{90}Sr	30	28	1.57E+02	1.47E+02	1.47E+02

Table A-4. Mean ^{137}Cs Concentration (µCi/g), SST Liquid Samples

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-A-101	^{137}Cs	16	16	3.53E+05	3.53E+05	3.53E+05
241-AX-101	^{137}Cs	6	6	3.95E+05	3.95E+05	3.95E+05
241-BX-109	^{137}Cs	4	2	1.27E+04	6.33E+03	6.33E+03
241-BY-103	^{137}Cs	4	4	1.41E+05	1.41E+05	1.41E+05
241-BY-105	^{137}Cs	42	42	1.99E+05	1.99E+05	1.99E+05
241-BY-106	^{137}Cs	6	6	2.07E+05	2.07E+05	2.07E+05
241-C-106	^{137}Cs	18	18	1.25E+05	1.25E+05	1.25E+05
241-C-110	^{137}Cs	6	6	3.88E+03	3.88E+03	3.88E+03
241-S-102	^{137}Cs	6	6	3.24E+05	3.24E+05	3.24E+05
241-S-103	^{137}Cs	6	6	3.65E+05	3.65E+05	3.65E+05
241-S-106	^{137}Cs	16	16	2.67E+05	2.67E+05	2.67E+05
241-S-109	^{137}Cs	6	6	3.15E+05	3.15E+05	3.15E+05
241-S-111	^{137}Cs	16	16	2.75E+05	2.75E+05	2.75E+05
241-SX-101	^{137}Cs	20	20	4.03E+05	4.03E+05	4.03E+05
241-SX-102	^{137}Cs	2	2	4.38E+05	4.38E+05	4.38E+05
241-SX-103	^{137}Cs	6	6	4.40E+05	4.40E+05	4.40E+05
241-SX-104	^{137}Cs	2	2	2.83E+05	2.83E+05	2.83E+05
241-SX-105	^{137}Cs	28	28	3.84E+05	3.84E+05	3.84E+05
241-SX-106	^{137}Cs	16	16	3.77E+05	3.77E+05	3.77E+05
241-T-104	^{137}Cs	2	2	7.83E+01	7.83E+01	7.83E+01
241-T-107	^{137}Cs	6	6	8.43E+03	8.43E+03	8.43E+03
241-T-110	^{137}Cs	3	3	3.43E+00	3.43E+00	3.43E+00
241-U-102	^{137}Cs	10	10	4.36E+05	4.36E+05	4.36E+05
241-U-103	^{137}Cs	8	8	4.67E+05	4.67E+05	4.67E+05
241-U-105	^{137}Cs	6	6	3.86E+05	3.86E+05	3.86E+05
241-U-107	^{137}Cs	14	14	3.52E+05	3.52E+05	3.52E+05
241-U-108	^{137}Cs	2	2	4.16E+05	4.16E+05	4.16E+05
241-U-109	^{137}Cs	2	2	3.66E+05	3.66E+05	3.66E+05

Table A-5. Mean Alpha Concentration (μCi/g), SST Liquid Samples (2 sheets)

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-A-101	GA	32	3	5.68E+00	1.54E+01	5.32E-01
241-AX-101	GA	24	0	NA	2.16E+01	0.00E+00
241-B-107	GA	6	1	2.26E-01	2.05E-01	3.77E-02
241-B-108	GA	2	0	NA	3.95E+00	0.00E+00
241-B-203	GA	6	6	1.01E-01	1.01E-01	1.01E-01
241-B-204	GA	6	6	1.03E-01	1.03E-01	1.03E-01
241-BX-109	GA	4	3	4.40E-01	3.48E-01	3.30E-01
241-BX-110	GA	12	1	5.01E+00	5.51E+00	4.18E-01
241-BX-111	GA	2	1	3.93E+00	3.79E+00	1.97E+00
241-BY-102	GA	4	2	5.96E+00	4.78E+00	2.98E+00
241-BY-103	^{241}Am	4	0	NA	6.90E-01	0.00E+00
241-BY-105	GA	46	17	2.99E+01	1.76E+01	1.10E+01
241-BY-106	GA	2	0	NA	1.23E+01	0.00E+00
241-BY-107	GA	18	0	NA	8.94E+00	0.00E+00
241-BY-108	GA	2	1	3.65E+00	2.48E+00	1.83E+00
241-BY-109	GA	4	1	1.14E+01	1.49E+01	2.85E+00
241-BY-110	GA	14	0	NA	1.81E+00	0.00E+00
241-BY-111	GA	6	1	7.45E+00	7.30E+00	1.24E+00
241-BY-112	GA	4	0	NA	1.63E+01	0.00E+00
241-C-104	GA	4	0	NA	1.27E+00	0.00E+00
241-C-106	GA	4	4	1.02E+03	1.02E+03	1.02E+03
241-C-110	GA	6	2	2.07E+00	1.11E+00	6.90E-01
241-S-101	GA	10	2	1.17E+01	5.25E+00	2.33E+00
241-S-102	GA	10	1	1.21E+01	1.22E+01	1.21E+00
241-S-103	^{241}Am	6	6	1.19E+00	1.19E+00	1.19E+00
241-S-104	GA	1	1	1.88E+02	1.88E+02	1.88E+02
241-S-106	GA	18	7	2.20E+00	5.86E+00	8.54E-01
241-S-107	GA	8	1	2.08E+00	2.46E+00	2.60E-01
241-S-109	GA	8	3	6.12E+00	1.02E+01	2.29E+00
241-S-110	GA	8	0	NA	9.12E+00	0.00E+00
241-S-111	^{241}Am	18	10	1.76E-01	2.13E+02	9.76E-02
241-SX-101	GA	20	3	8.22E+02	1.36E+02	1.23E+02
241-SX-102	GA	14	6	5.87E+00	8.93E+00	2.51E+00
241-SX-103	GA	24	8	1.24E+01	1.66E+01	4.12E+00
241-SX-104	^{241}Am	4	1	2.62E-02	6.47E+02	6.55E-03
241-SX-105	GA	36	29	7.32E+00	5.89E+00	5.89E+00
241-SX-106	GA	10	3	4.11E+00	3.64E+00	1.23E+00
241-T-103	GA	4	4	2.00E+01	2.00E+01	2.00E+01
241-T-104	^{241}Am	2	0	NA	9.53E-01	0.00E+00

Table A-5. Mean Alpha Concentration (µCi/g), SST Liquid Samples (2 sheets)

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-T-105	GA	8	4	1.54E+01	9.02E+00	7.69E+00
241-T-107	GA	6	6	6.01E+00	6.01E+00	6.01E+00
241-T-110	GA	2	2	1.02E-01	1.02E-01	1.02E-01
241-T-112	GA	4	4	2.33E+01	2.33E+01	2.33E+01
241-T-201	GA	10	6	8.94E-03	2.83E-02	5.37E-03
241-T-203	GA	2	0	NA	6.99E-02	0.00E+00
241-TX-104	GA	10	10	1.27E+03	1.27E+03	1.27E+03
241-U-101	GA	8	8	1.75E+00	1.75E+00	1.75E+00
241-U-102	GA	10	10	2.20E+01	2.20E+01	2.20E+01
241-U-103	GA	18	14	2.92E+01	2.79E+01	2.27E+01
241-U-105	GA	8	8	4.58E+01	4.58E+01	4.58E+01
241-U-106	GA	8	8	2.99E+02	2.99E+02	2.99E+02
241-U-107	GA	40	12	1.12E+01	9.57E+00	3.36E+00
241-U-108	GA	6	1	8.88E+00	9.79E+00	1.48E+00
241-U-109	GA	4	1	1.07E+00	7.47E+00	2.68E-01

Table A-6. Mean $^{89/90}Sr$ Concentration (µCi/g), SST Liquid Samples

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-A-101	$^{89/90}Sr$	16	16	6.82E+01	6.82E+01	6.82E+01
241-AX-101	$^{89/90}Sr$	6	6	2.65E+02	2.65E+02	2.65E+02
241-BY-103	$^{89/90}Sr$	4	4	1.12E+02	1.12E+02	1.12E+02
241-BY-105	$^{89/90}Sr$	42	42	1.15E+02	1.15E+02	1.15E+02
241-BY-106	$^{89/90}Sr$	6	6	3.77E+01	3.77E+01	3.77E+01
241-C-106	$^{89/90}Sr$	14	14	6.55E+02	6.55E+02	6.55E+02
241-C-110	^{90}Sr	2	2	2.78E+01	2.78E+01	2.78E+01
241-S-102	$^{89/90}Sr$	6	6	3.11E+02	3.11E+02	3.11E+02
241-S-103	$^{89/90}Sr$	6	6	4.20E+02	4.20E+02	4.20E+02
241-S-106	$^{89/90}Sr$	16	16	5.67E+01	5.67E+01	5.67E+01
241-S-109	$^{89/90}Sr$	6	6	2.70E+02	2.70E+02	2.70E+02
241-S-111	$^{89/90}Sr$	16	16	2.26E+02	2.26E+02	2.26E+02
241-SX-101	$^{89/90}Sr$	20	20	8.03E+01	8.03E+01	8.03E+01
241-SX-102	$^{89/90}Sr$	2	2	2.34E+01	2.34E+01	2.34E+01
241-SX-103	$^{89/90}Sr$	6	6	1.15E+02	1.15E+02	1.15E+02
241-SX-104	$^{89/90}Sr$	2	2	6.33E+01	6.33E+01	6.33E+01
241-SX-105	$^{89/90}Sr$	28	28	1.60E+02	1.60E+02	1.60E+02
241-SX-106	$^{89/90}Sr$	16	16	3.40E+02	3.40E+02	3.40E+02
241-T-105	^{90}Sr	2	2	3.74E+02	3.74E+02	3.74E+02
241-T-107	^{90}Sr	6	6	5.94E+01	5.94E+01	5.94E+01
241-T-110	^{90}Sr	2	2	5.30E-01	5.30E-01	5.30E-01
241-U-102	$^{89/90}Sr$	10	10	8.04E+03	8.04E+03	8.04E+03
241-U-103	$^{89/90}Sr$	8	8	1.05E+04	1.05E+04	1.05E+04
241-U-105	$^{89/90}Sr$	6	6	2.51E+04	2.51E+04	2.51E+04
241-U-107	$^{89/90}Sr$	22	22	3.61E+02	3.61E+02	3.61E+02
241-U-108	$^{89/90}Sr$	2	2	3.45E+02	3.45E+02	3.45E+02
241-U-109	$^{89/90}Sr$	2	2	9.31E+02	9.31E+02	9.31E+02

Table A-7. Mean ^{137}Cs Concentration (µCi/g), DST Solid Samples

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-AN-102	^{137}Cs	12	12	2.39E+02	2.39E+02	2.39E+02
241-AN-103	^{137}Cs	5	5	2.51E+02	2.51E+02	2.51E+02
241-AN-104	^{137}Cs	5	5	3.46E+02	3.46E+02	3.46E+02
241-AN-105	^{137}Cs	7	7	2.67E+02	2.67E+02	2.67E+02
241-AN-107	^{137}Cs	5	5	1.74E+02	1.74E+02	1.74E+02
241-AW-101	^{137}Cs	11	11	2.55E+02	2.55E+02	2.55E+02
241-AW-102	^{137}Cs	4	4	8.64E+01	8.64E+01	8.64E+01
241-AW-105	^{137}Cs	69	69	3.82E+01	3.82E+01	3.82E+01
241-AW-106	^{137}Cs	10	10	1.15E+02	1.15E+02	1.15E+02
241-AY-101	^{137}Cs	2	2	8.56E+01	8.56E+01	8.56E+01
241-AY-102	^{137}Cs	2	2	2.83E+02	2.83E+02	2.83E+02
241-AZ-101	^{137}Cs			NA	NA	NA
241-AZ-102	^{137}Cs	2	2	8.25E+02	8.25E+02	8.25E+02
241-SY-101	^{137}Cs	218	218	3.46E+02	3.46E+02	3.46E+02
241-SY-102	^{137}Cs	2	2	1.04E+02	1.04E+02	1.04E+02
241-SY-103	^{137}Cs	16	16	2.26E+02	2.26E+02	2.26E+02

Table A-8. Mean Alpha Concentration (µCi/g), DST Solid Samples

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-AN-102	GA	18	18	5.52E-01	5.52E-01	5.52E-01
241-AN-103	GA	63	13	1.72E-02	1.78E-02	3.55E-03
241-AN-104	GA	35	21	4.07E-02	6.45E-02	2.44E-02
241-AN-105	GA	28	18	2.78E-02	2.43E-02	1.79E-02
241-AN-107	GA	17	17	1.00E+00	1.00E+00	1.00E+00
241-AP-105	GA	12	4	6.96E-03	1.01E-02	2.32E-03
241-AW-101	GA	89	38	7.97E-02	3.89E-02	3.40E-02
241-AW-102	GA	6	6	2.40E+00	2.40E+00	2.40E+00
241-AW-103	GA	28	28	3.83E-01	3.83E-01	3.83E-01
241-AW-104	GA	18	18	1.28E+00	1.28E+00	1.28E+00
241-AW-105	GA	41	41	1.75E+00	1.75E+00	1.75E+00
241-AW-106	GA	4	4	2.22E-01	2.22E-01	2.22E-01
241-AY-101	GA	6	6	3.80E+00	3.80E+00	3.80E+00
241-AY-102	^{241}Am	2	2	2.24E+01	2.24E+01	2.24E+01
241-AZ-101	GA	12	12	8.16E+01	8.16E+01	8.16E+01
241-AZ-102	GA	2	2	5.37E+01	5.37E+01	5.37E+01
241-SY-101	GA	134	122	3.99E-01	3.83E-01	3.63E-01
241-SY-102	GA	10	10	2.30E+01	2.30E+01	2.30E+01
241-SY-103	GA	44	22	8.93E-01	5.79E-01	4.47E-01

Table A-9. Mean $^{89/90}Sr$ Concentration (μCi/g), DST Solid Samples

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-AN-102	$^{89/90}Sr$	12	12	1.17E+02	1.17E+02	1.17E+02
241-AN-103	$^{89/90}Sr$	2	2	2.66E+00	2.66E+00	2.66E+00
241-AN-104	$^{89/90}Sr$	5	5	3.36E+01	3.36E+01	3.36E+01
241-AN-105	$^{89/90}Sr$	7	7	1.87E+01	1.87E+01	1.87E+01
241-AN-107	$^{89/90}Sr$	5	5	2.53E+02	2.53E+02	2.53E+02
241-AW-101	$^{89/90}Sr$	11	11	3.43E+01	3.43E+01	3.43E+01
241-AW-102	$^{89/90}Sr$	4	4	6.64E+02	6.64E+02	6.64E+02
241-AW-105	$^{89/90}Sr$&^{90}Sr	60	60	6.22E+01	6.22E+01	6.22E+01
241-AW-106	$^{89/90}Sr$	10	10	2.26E+01	2.26E+01	2.26E+01
241-AY-101	$^{89/90}Sr$	2	2	4.61E+03	4.61E+03	4.61E+03
241-AY-102	$^{89/90}Sr$	2	2	7.67E+04	7.67E+04	7.67E+04
241-AZ-101	$^{89/90}Sr$			NA	NA	NA
241-AZ-102	$^{89/90}Sr$	2	2	9.30E+03	9.30E+03	9.30E+03
241-SY-101	$^{89/90}Sr$&^{90}Sr	61	61	2.65E+01	2.65E+01	2.65E+01
241-SY-102	$^{89/90}Sr$	2	2	2.49E+01	2.49E+01	2.49E+01
241-SY-103	$^{89/90}Sr$	16	16	9.64E+00	9.64E+00	9.64E+00

Table A-10. Mean ^{137}Cs Concentration (µCi/L), DST Liquid Samples

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-AN-101	^{137}Cs	12	12	1.01E+05	1.01E+05	1.01E+05
241-AN-102	^{137}Cs	19	19	3.66E+05	3.66E+05	3.66E+05
241-AN-103	^{137}Cs	8	8	7.86E+05	7.86E+05	7.86E+05
241-AN-104	^{137}Cs	8	8	6.54E+05	6.54E+05	6.54E+05
241-AN-105	^{137}Cs	8	8	4.02E+05	4.02E+05	4.02E+05
241-AN-107	^{137}Cs	8	8	3.63E+05	3.63E+05	3.63E+05
241-AP-101	^{137}Cs	14	14	1.61E+05	1.61E+05	1.61E+05
241-AP-102	^{137}Cs	52	52	2.25E+05	2.25E+05	2.25E+05
241-AP-103	^{137}Cs	26	26	6.24E+04	6.24E+04	6.24E+04
241-AP-104	^{137}Cs	4	4	4.97E+03	4.97E+03	4.97E+03
241-AP-105	^{137}Cs	32	32	2.10E+05	2.10E+05	2.10E+05
241-AP-106	^{137}Cs	36	36	3.98E+04	3.98E+04	3.98E+04
241-AP-107	^{137}Cs	24	21	3.03E+04	2.65E+04	2.65E+04
241-AP-108	^{137}Cs	22	22	7.07E+04	7.07E+04	7.07E+04
241-AW-101	^{137}Cs	7	7	4.62E+05	4.62E+05	4.62E+05
241-AW-102	^{137}Cs	18	18	3.48E+04	3.48E+04	3.48E+04
241-AW-103	^{137}Cs	2	2	2.06E+04	2.06E+04	2.06E+04
241-AW-104	^{137}Cs	12	12	1.32E+04	1.32E+04	1.32E+04
241-AW-105	^{137}Cs	37	37	1.41E+04	1.41E+04	1.41E+04
241-AW-106	^{137}Cs	11	11	1.86E+05	1.86E+05	1.86E+05
241-AY-101	^{137}Cs	20	20	8.81E+04	8.81E+04	8.81E+04
241-AY-102	^{137}Cs	32	32	3.59E+03	3.59E+03	3.59E+03
241-AZ-101	^{137}Cs	6	6	1.59E+06	1.59E+06	1.59E+06
241-AZ-102	^{137}Cs	8	8	1.07E+06	1.07E+06	1.07E+06
241-SY-101	^{137}Cs	62	62	9.96E+05	9.96E+05	9.96E+05
241-SY-102	^{137}Cs	34	34	5.49E+04	5.49E+04	5.49E+04
241-SY-103	^{137}Cs	4	4	3.99E+05	3.99E+05	3.99E+05

Table A-11. Mean Alpha Concentration (µCi/L), DST Liquid Samples

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-AN-101	GA	12	0	NA	1.03E+00	0.00E+00
241-AN-102	GA	31	31	1.76E+02	1.76E+02	1.76E+02
241-AN-103	GA	36	6	5.77E+01	3.73E+01	9.61E+00
241-AN-104	GA	56	8	1.23E+01	2.68E+01	1.75E+00
241-AN-105	GA	58	5	2.84E+01	2.93E+01	2.45E+00
241-AN-106	GA	18	4	1.01E+00	6.08E+00	2.25E-01
241-AN-107	GA	31	31	8.17E+02	8.17E+02	8.17E+02
241-AP-101	GA	14	2	5.95E-03	2.26E+00	8.49E-04
241-AP-102	^{241}Am	46	46	4.78E-01	4.78E-01	4.78E-01
241-AP-103	GA	6	6	1.68E+01	1.68E+01	1.68E+01
241-AP-104	GA	8	8	3.28E-01	3.28E-01	3.28E-01
241-AP-105	GA	16	2	1.01E+01	6.98E+00	1.26E+00
241-AP-106	GA	3	0	NA	2.11E+00	0.00E+00
241-AP-107	GA	15	2	7.77E-01	2.13E+00	1.04E-01
241-AP-108	GA	12	0	NA	3.46E+00	0.00E+00
241-AW-101	GA	57	8	8.27E+00	1.35E+01	1.16E+00
241-AW-102	GA	15	4	1.21E+00	1.47E+00	3.24E-01
241-AW-103	GA	4	0	NA	4.82E-01	0.00E+00
241-AW-104	GA	38	18	3.02E+00	3.74E+00	1.43E+00
241-AW-105	GA	29	15	1.83E+00	1.02E+00	9.48E-01
241-AW-106	GA	5	1	2.87E+01	1.36E+01	5.74E+00
241-AY-101	GA	28	25	6.62E+01	5.98E+01	5.91E+01
241-AY-102	^{241}Am	32	7	5.17E-01	1.94E-01	1.13E-01
241-AZ-101	GA	DL	DL	6.20E+01	6.20E+01	6.20E+01
241-AZ-102	GA	3	1	8.56E+01	6.99E+01	2.85E+01
241-SY-101	GA	10	10	3.72E+01	3.72E+01	3.72E+01
241-SY-102	GA	16	13	1.15E+01	1.60E+01	9.34E+00
241-SY-103	GA	4	0	NA	4.59E+01	0.00E+00

Table A-12. Mean $^{89/90}Sr$ Concentration (μCi/L), DST Liquid Samples

Tank	Analyte	Num.Obs	Num. Above DL	M1	M2	M3
241-AN-101	$^{89/90}Sr$	12	12	2.09E+02	2.09E+02	2.09E+02
241-AN-102	$^{89/90}Sr$	19	19	8.47E+04	8.47E+04	8.47E+04
241-AN-103	$^{89/90}Sr$	2	2	2.08E+01	2.08E+01	2.08E+01
241-AN-104	$^{89/90}Sr$	8	8	1.31E+02	1.31E+02	1.31E+02
241-AN-105	$^{89/90}Sr$	2	2	4.14E+01	4.14E+01	4.14E+01
241-AN-107	$^{89/90}Sr$	8	8	1.01E+05	1.01E+05	1.01E+05
241-AP-101	$^{89/90}Sr\&^{90}Sr$	14	14	1.33E+02	1.33E+02	1.33E+02
241-AP-102	^{90}Sr	50	50	1.45E+03	1.45E+03	1.45E+03
241-AP-103	$^{89/90}Sr\&^{90}Sr$	14	14	2.38E+02	2.38E+02	2.38E+02
241-AP-104	$^{89/90}Sr$	4	4	8.28E+01	8.28E+01	8.28E+01
241-AP-105	$^{89/90}Sr\&^{90}Sr$	33	33	2.13E+02	2.13E+02	2.13E+02
241-AP-106	$^{89/90}Sr\&^{90}Sr$	44	44	1.54E+02	1.54E+02	1.54E+02
241-AP-107	$^{89/90}Sr\&^{90}Sr$	19	18	4.05E+01	4.05E+01	4.05E+01
241-AP-108	$^{89/90}Sr$	22	22	1.74E+02	1.74E+02	1.74E+02
241-AW-101	$^{89/90}Sr$	7	7	3.12E+02	3.12E+02	3.12E+02
241-AW-102	$^{89/90}Sr\&^{90}Sr$	22	21	1.58E+02	1.58E+02	1.58E+02
241-AW-103	^{90}Sr	2	2	2.20E-01	2.20E-01	2.20E-01
241-AW-104	$^{89/90}Sr\&^{90}Sr$	12	12	1.60E+01	1.60E+01	1.60E+01
241-AW-105	$^{89/90}Sr\&^{90}Sr$	36	36	6.51E+01	6.51E+01	6.51E+01
241-AW-106	$^{89/90}Sr\&^{90}Sr$	13	13	3.82E+02	3.82E+02	3.82E+02
241-AY-101	$^{89/90}Sr$	16	16	1.89E+03	1.89E+03	1.89E+03
241-AY-102	$^{89/90}Sr\&^{90}Sr$	32	32	1.19E+03	1.19E+03	1.19E+03
241-AZ-101	$^{89/90}Sr$	6	6	1.20E+03	1.20E+03	1.20E+03
241-AZ-102	$^{89/90}Sr$	6	6	1.79E+03	1.79E+03	1.79E+03
241-SY-101	^{90}Sr	10	10	1.53E+03	1.53E+03	1.53E+03
241-SY-102	$^{89/90}Sr$	34	34	2.06E+02	2.06E+02	2.06E+02
241-SY-103	$^{89/90}Sr$	4	4	2.69E+03	2.69E+03	2.69E+03

Table A-13. Data from Tanks 241-AZ-101 and 241-AZ-102

Analyte	Num.Obs	Num. Above DL	M1	M2	M3	Source
241-AZ-101, Solid Samples, µCi/g						
^{137}Cs			NA	NA	NA	NA
GA	12	12	8.16E+01	8.16E+01	8.16E+01	Preliminary
$^{89/90}Sr$			NA	NA	NA	NA
241-AZ-101, Liquid Samples, µCi/L						
^{137}Cs	6	6	1.59E+06	1.59E+06	1.59E+06	TCD[1]
GA	DL	DL	6.20E+01	6.20E+01	6.20E+01	DL[2]
$^{89/90}Sr$	6	6	1.20E+03	1.20E+03	1.20E+03	TCD
241-AZ-102, Solid Samples, µCi/g						
^{137}Cs	2	2	8.25E+02	8.25E+02	8.25E+02	Preliminary
GA	2	2	5.37E+01	5.37E+01	5.37E+01	Preliminary
$^{89/90}Sr$	2	2	9.30E+03	9.30E+03	9.30E+03	Preliminary
241-AZ-102, Liquid Samples, µCi/L						
^{137}Cs	8	8	1.07E+06	1.07E+06	1.07E+06	Combined[3]
GA	3	1	8.56E+01	6.99E+01	2.85E+01	TCD
$^{89/90}Sr$	6	6	1.79E+03	1.79E+03	1.79E+03	TCD

[1]TCD: tank characterization database
[2]DL: detection limit
[3]Combined: combined TCD & preliminary data

APPENDIX B

B.0 UNIT LITER DOSE TABLES

Tables B-1, B-2, B-3, and B-4 list the ULD (Sv/L) for SST solid samples, SST liquid samples, DST solid samples, and DST liquid samples. The columns labeled ULD.M1, ULD.M2, and ULD.M3 are the ULD estimates when the below detection limit observations are omitted, replaced by the detection limit, and replaced by zero, respectively. NA means not available.

Table B-1. ULD SST Solid Samples (Sv/L) (2 sheets)

Tank	ICRP-68			ICRP-71		
	ULD.M1	ULD.M2	ULD.M3	ULD.M1	ULD.M2	ULD.M3
241-A-101	2.15E+02	1.92E+02	1.90E+02	2.54E+02	2.18E+02	2.15E+02
241-AX-101	2.02E+02	1.83E+02	1.78E+02	2.32E+02	2.04E+02	1.96E+02
241-AX-104	5.91E+04	5.91E+04	5.91E+04	7.87E+04	7.87E+04	7.87E+04
241-B-106	2.27E+02	2.23E+02	1.76E+02	2.96E+02	2.89E+02	2.17E+02
241-B-108	2.57E+01	2.63E+01	2.47E+01	3.21E+01	3.30E+01	3.06E+01
241-B-110	1.99E+02	1.99E+02	1.99E+02	2.83E+02	2.83E+02	2.83E+02
241-B-111	7.67E+02	7.67E+02	7.67E+02	9.69E+02	9.69E+02	9.69E+02
241-B-201	1.56E+03	1.56E+03	1.56E+03	2.42E+03	2.42E+03	2.42E+03
241-B-202	6.99E+02	6.99E+02	6.99E+02	1.09E+03	1.09E+03	1.09E+03
241-BX-107	2.38E+02	2.38E+02	2.38E+02	3.56E+02	3.56E+02	3.56E+02
241-BX-109	3.95E+02	4.10E+02	3.25E+02	4.96E+02	5.21E+02	3.88E+02
241-BX-112	3.57E+02	3.57E+02	3.57E+02	5.34E+02	5.34E+02	5.34E+02
241-BY-104	5.79E+02	5.71E+02	5.40E+02	7.38E+02	7.24E+02	6.77E+02
241-BY-105	4.40E+02	5.50E+02	3.31E+02	5.75E+02	7.45E+02	4.05E+02
241-BY-106	1.34E+02	1.28E+02	1.27E+02	1.56E+02	1.46E+02	1.45E+02
241-BY-107	1.71E+02	1.56E+02	1.50E+02	2.08E+02	1.84E+02	1.75E+02
241-BY-110	3.32E+02	3.27E+02	3.24E+02	4.08E+02	4.01E+02	3.97E+02
241-C-103	2.88E+04	2.88E+04	2.88E+04	4.13E+04	4.13E+04	4.13E+04
241-C-104	1.15E+04	1.15E+04	1.15E+04	1.77E+04	1.77E+04	1.77E+04
241-C-106	5.93E+03	5.93E+03	5.93E+03	8.68E+03	8.68E+03	8.68E+03
241-C-108	5.65E+02	6.88E+02	4.44E+02	6.86E+02	8.78E+02	4.97E+02
241-C-109	2.28E+03	2.28E+03	2.28E+03	2.71E+03	2.71E+03	2.71E+03
241-C-110	2.31E+02	2.31E+02	2.31E+02	3.49E+02	3.49E+02	3.49E+02
241-C-111	9.32E+03	9.32E+03	9.32E+03	1.15E+04	1.15E+04	1.15E+04
241-C-112	3.07E+03	3.07E+03	3.07E+03	3.81E+03	3.81E+03	3.81E+03
241-S-101	1.12E+03	1.12E+03	1.12E+03	1.52E+03	1.52E+03	1.52E+03
241-S-102	3.99E+02	3.97E+02	3.95E+02	5.62E+02	5.60E+02	5.57E+02
241-S-104	1.55E+03	1.53E+03	1.43E+03	2.17E+03	2.15E+03	1.99E+03

Table B-1. ULD SST Solid Samples (Sv/L) (2 sheets)

Tank	ICRP-68			ICRP-71		
	ULD.M1	ULD.M2	ULD.M3	ULD.M1	ULD.M2	ULD.M3
241-S-106	1.21E+02	1.17E+02	1.16E+02	1.43E+02	1.37E+02	1.35E+02
241-S-107	1.91E+03	1.91E+03	1.91E+03	2.84E+03	2.84E+03	2.84E+03
241-S-109	2.62E+01	2.56E+01	2.49E+01	3.45E+01	3.35E+01	3.24E+01
241-S-110	7.98E+02	7.67E+02	7.51E+02	1.13E+03	1.08E+03	1.05E+03
241-S-111	3.33E+02	3.24E+02	3.23E+02	3.93E+02	3.78E+02	3.77E+02
241-SX-101	1.10E+03	1.02E+03	9.71E+02	1.59E+03	1.46E+03	1.39E+03
241-SX-102	6.17E+02	5.81E+02	5.79E+02	8.37E+02	7.81E+02	7.78E+02
241-SX-103	5.85E+02	5.80E+02	5.80E+02	7.77E+02	7.69E+02	7.69E+02
241-SX-104	NA	1.95E+02	4.23E+01	NA	2.68E+02	2.92E+01
241-SX-108	1.14E+04	1.14E+04	1.14E+04	1.56E+04	1.56E+04	1.56E+04
241-T-102	8.47E+02	8.47E+02	8.47E+02	1.14E+03	1.14E+03	1.14E+03
241-T-104	2.46E+02	2.46E+02	2.46E+02	3.82E+02	3.82E+02	3.82E+02
241-T-105	1.15E+03	1.15E+03	1.15E+03	1.59E+03	1.59E+03	1.59E+03
241-T-107	5.36E+02	5.36E+02	5.36E+02	7.44E+02	7.44E+02	7.44E+02
241-T-111	6.45E+02	6.45E+02	6.45E+02	1.00E+03	1.00E+03	1.00E+03
241-T-201	1.30E+03	1.30E+03	1.30E+03	2.02E+03	2.02E+03	2.02E+03
241-T-202	NA	3.80E+02	3.80E+02	NA	5.91E+02	5.91E+02
241-T-203	NA	3.35E+02	3.35E+02	NA	5.22E+02	5.22E+02
241-T-204	2.60E+02	2.46E+02	2.46E+02	4.05E+02	3.84E+02	3.84E+02
241-TX-113	2.69E+01	2.81E+01	2.51E+01	3.88E+01	4.07E+01	3.61E+01
241-TX-118	3.94E+04	3.46E+04	3.46E+04	6.12E+04	5.37E+04	5.37E+04
241-U-102	5.18E+02	5.18E+02	5.18E+02	7.13E+02	7.13E+02	7.13E+02
241-U-103	3.73E+02	3.59E+02	3.54E+02	4.86E+02	4.64E+02	4.56E+02
241-U-105	1.41E+03	1.41E+03	1.41E+03	2.10E+03	2.10E+03	2.10E+03
241-U-106	2.17E+03	2.17E+03	2.17E+03	3.28E+03	3.28E+03	3.28E+03
241-U-107	4.17E+02	4.05E+02	3.79E+02	6.16E+02	5.98E+02	5.58E+02
241-U-108	1.66E+02	1.67E+02	1.61E+02	2.02E+02	2.04E+02	1.94E+02
241-U-109	1.26E+02	1.32E+02	1.25E+02	1.50E+02	1.60E+02	1.48E+02
241-U-110	1.58E+03	1.30E+03	1.02E+03	2.35E+03	1.92E+03	1.47E+03

Table B-2. ULD SST Liquid Samples (Sv/L)

Tank	ICRP-68			ICRP-71		
	ULD.M1	ULD.M2	ULD.M3	ULD.M1	ULD.M2	ULD.M3
241-A-101	9.37E+01	1.04E+02	8.82E+01	6.96E+01	8.58E+01	6.11E+01
241-AX-101	NA	1.21E+02	9.82E+01	NA	1.04E+02	6.76E+01
241-BY-103	NA	3.58E+01	3.51E+01	NA	2.53E+01	2.42E+01
241-BY-105	8.14E+01	6.83E+01	6.12E+01	8.38E+01	6.33E+01	5.23E+01
241-BY-106	NA	6.45E+01	5.14E+01	NA	5.58E+01	3.53E+01
241-C-106	1.12E+03	1.12E+03	1.12E+03	1.72E+03	1.72E+03	1.72E+03
241-C-110	3.21E+00	2.18E+00	1.73E+00	4.15E+00	2.55E+00	1.85E+00
241-S-102	9.36E+01	9.37E+01	8.20E+01	7.57E+01	7.59E+01	5.76E+01
241-S-103	9.22E+01	9.22E+01	9.22E+01	6.47E+01	6.47E+01	6.47E+01
241-S-106	6.86E+01	7.25E+01	6.72E+01	4.92E+01	5.53E+01	4.69E+01
241-S-109	8.49E+01	8.93E+01	8.09E+01	6.42E+01	7.10E+01	5.78E+01
241-S-111	6.86E+01	2.96E+02	6.85E+01	4.74E+01	4.02E+02	4.73E+01
241-SX-101	9.79E+02	2.45E+02	2.32E+02	1.44E+03	2.95E+02	2.73E+02
241-SX-102	1.15E+02	1.18E+02	1.11E+02	8.44E+01	8.94E+01	7.88E+01
241-SX-103	1.22E+02	1.27E+02	1.14E+02	9.57E+01	1.03E+02	8.19E+01
241-SX-104	7.03E+01	7.62E+02	7.02E+01	4.83E+01	1.13E+03	4.83E+01
241-SX-105	1.03E+02	1.02E+02	1.02E+02	7.78E+01	7.54E+01	7.54E+01
241-SX-106	9.83E+01	9.77E+01	9.52E+01	7.15E+01	7.07E+01	6.67E+01
241-T-107	8.59E+00	8.59E+00	8.59E+00	1.15E+01	1.15E+01	1.15E+01
241-T-110	1.11E-01	1.11E-01	1.11E-01	1.71E-01	1.71E-01	1.71E-01
241-U-102	1.41E+02	1.41E+02	1.41E+02	1.22E+02	1.22E+02	1.22E+02
241-U-103	1.59E+02	1.58E+02	1.52E+02	1.43E+02	1.41E+02	1.32E+02
241-U-105	1.74E+02	1.74E+02	1.74E+02	1.77E+02	1.77E+02	1.77E+02
241-U-107	9.97E+01	9.79E+01	9.13E+01	7.91E+01	7.63E+01	6.60E+01
241-U-108	1.13E+02	1.14E+02	1.05E+02	8.61E+01	8.76E+01	7.37E+01
241-U-109	9.30E+01	9.98E+01	9.21E+01	6.54E+01	7.60E+01	6.40E+01

Table B-3. ULD DST Solid Samples (Sv/L)

	ICRP-68			ICRP-71		
Tank	ULD.M1	ULD.M2	ULD.M3	ULD.M1	ULD.M2	ULD.M3
241-AN-102	1.26E+03	1.26E+03	1.26E+03	1.80E+03	1.80E+03	1.80E+03
241-AN-103	1.34E+02	1.35E+02	1.11E+02	1.20E+02	1.22E+02	8.37E+01
241-AN-104	2.70E+02	3.11E+02	2.42E+02	2.77E+02	3.41E+02	2.34E+02
241-AN-105	1.89E+02	1.83E+02	1.72E+02	1.88E+02	1.79E+02	1.62E+02
241-AN-107	2.25E+03	2.25E+03	2.25E+03	3.27E+03	3.27E+03	3.27E+03
241-AW-101	3.02E+02	2.32E+02	2.24E+02	3.58E+02	2.49E+02	2.36E+02
241-AW-102	5.39E+03	5.39E+03	5.39E+03	7.89E+03	7.89E+03	7.89E+03
241-AW-105	3.13E+03	3.13E+03	3.13E+03	4.81E+03	4.81E+03	4.81E+03
241-AW-106	4.68E+02	4.68E+02	4.68E+02	6.73E+02	6.73E+02	6.73E+02
241-AY-101	1.52E+04	1.52E+04	1.52E+04	2.04E+04	2.04E+04	2.04E+04
241-AY-102	1.82E+05	1.82E+05	1.82E+05	2.30E+05	2.30E+05	2.30E+05
241-AZ-102	1.10E+05	1.10E+05	1.10E+05	1.64E+05	1.64E+05	1.64E+05
241-SY-101	8.70E+02	8.42E+02	8.08E+02	1.22E+03	1.17E+03	1.12E+03
241-SY-102	3.94E+04	3.94E+04	3.94E+04	6.14E+04	6.14E+04	6.14E+04
241-SY-103	1.64E+03	1.10E+03	8.72E+02	2.46E+03	1.63E+03	1.27E+03

Table B-4. ULD DST Liquid Samples (Sv/L)

Tank	ICRP-68			ICRP-71		
	ULD.M1	ULD.M2	ULD.M3	ULD.M1	ULD.M2	ULD.M3
241-AN-101	2.53E+01	2.53E+01	2.53E+01	1.75E+01	1.75E+01	1.75E+01
241-AN-102	3.78E+02	3.78E+02	3.78E+02	4.73E+02	4.73E+02	4.73E+02
241-AN-103	2.57E+02	2.35E+02	2.05E+02	2.30E+02	1.96E+02	1.50E+02
241-AN-104	1.75E+02	1.91E+02	1.64E+02	1.32E+02	1.56E+02	1.14E+02
241-AN-105	1.30E+02	1.31E+02	1.02E+02	1.16E+02	1.17E+02	7.26E+01
241-AN-107	1.08E+03	1.08E+03	1.08E+03	1.56E+03	1.56E+03	1.56E+03
241-AP-101	4.01E+01	4.25E+01	4.01E+01	2.76E+01	3.13E+01	2.76E+01
241-AP-102	5.80E+01	5.80E+01	5.80E+01	4.11E+01	4.11E+01	4.11E+01
241-AP-103	3.37E+01	3.37E+01	3.37E+01	3.89E+01	3.89E+01	3.89E+01
241-AP-104	1.68E+00	1.68E+00	1.68E+00	1.51E+00	1.51E+00	1.51E+00
241-AP-105	6.31E+01	5.98E+01	5.37E+01	5.29E+01	4.77E+01	3.81E+01
241-AP-106	1.04E+01	1.03E+01	1.02E+01	7.60E+00	7.38E+00	7.26E+00
241-AP-107	8.39E+00	8.89E+00	6.73E+00	6.51E+00	8.11E+00	4.74E+00
241-AP-108	1.79E+01	1.79E+01	1.79E+01	1.25E+01	1.25E+01	1.25E+01
241-AW-101	1.24E+02	1.29E+02	1.16E+02	9.28E+01	1.02E+02	8.10E+01
241-AW-102	1.01E+01	1.04E+01	9.16E+00	8.16E+00	8.59E+00	6.68E+00
241-AW-103	NA	5.62E+00	5.11E+00	NA	4.31E+00	3.51E+00
241-AW-104	6.52E+00	7.29E+00	4.82E+00	7.30E+00	8.50E+00	4.65E+00
241-AW-105	5.53E+00	4.66E+00	4.59E+00	5.54E+00	4.19E+00	4.07E+00
241-AW-106	7.72E+01	6.11E+01	5.27E+01	8.00E+01	5.48E+01	4.17E+01
241-AY-101	9.48E+01	8.80E+01	8.73E+01	1.28E+02	1.17E+02	1.16E+02
241-AY-102	2.84E+00	2.49E+00	2.41E+00	3.12E+00	2.59E+00	2.45E+00
241-AZ-101	4.62E+02	4.62E+02	4.62E+02	3.76E+02	3.76E+02	3.76E+02
241-AZ-102	3.59E+02	3.42E+02	2.98E+02	3.27E+02	3.01E+02	2.32E+02
241-SY-101	2.88E+02	2.88E+02	2.88E+02	2.34E+02	2.34E+02	2.34E+02
241-SY-102	2.61E+01	3.10E+01	2.38E+01	2.88E+01	3.63E+01	2.52E+01
241-SY-103	1.04E+02	1.04E+02	1.04E+02	7.48E+01	7.48E+01	7.48E+01

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APPENDIX C

C.0 COMPARISON OF ANALYTE AND ULD MEANS AND VARIANCES

Tables C-1 and C-2 are a comparison of the means and variances of radionuclide activity (µCi/g or µCi/L) and the ULDs (Sv/L) for the three models (M1, M2, and M3) for using below detection limit observations. M1, M2, and M3 denote the models. They denote the cases when the below detection limit observations are omitted, replaced by the detection limit, and replaced by zero, respectively. Num.Tanks are the total number of tanks with a radionuclide mean or a ULD.

In Table C-1, for a given model, the first Num.Tanks value is the total number of tanks with an analyte mean. The second Num.Tanks value is the number of tanks with the radionuclide mean used in the ULD. For each model, the means and variances (by analyte and waste type) are not significantly different from each other.

In Table C-2, the Num.Tanks denotes the number of tanks with analyte means used to compute the ULD based on the three modes for using observations below the detection limit. For each waste type, the ULD means and variance for the three models are not significantly different from each other.

Table C-3 lists the quantiles corresponding to the 95th and 99th percentiles points and 95/95 and 95/99 tolerance limits based on the lognormal distribution for the three models for using observations below detection limits.

Table C-1. Comparison of Means (µCi/g) and Variances (µCi/g²) by Radionuclide and Waste Type for the Three Models (M1, M2, and M3) for Detection Limits (2 sheets)

Analyte	Model	Num. Tanks	Mean	Variance	Num. Tanks	Mean	Variance
DCF ICRP-68							
		SST Solid Samples, µCi/g			SST Liquid Samples, µCi/L		
^{137}Cs	M1	58	1.06E+02	1.51E+04	28	2.76E+05	2.41E+10
		54	1.10E+02	1.59E+04	23	3.04E+05	2.04E+10
	M2	61	1.01E+02	1.48E+04	28	2.76E+05	2.42E+10
		54	1.10E+02	1.59E+04	23	3.04E+05	2.04E+10
	M3	61	1.01E+02	1.49E+04	28	2.76E+05	2.42E+10
		54	1.10E+02	1.59E+04	23	3.04E+05	2.04E+10
GA	M1	105	1.21E+00	1.07E+01	43	9.13E+01	7.39E+04
		54	1.35E+00	1.52E+01	23	8.94E+01	6.99E+04
	M2	109	1.14E+00	9.29E+00	54	7.74E+01	5.56E+04
		54	1.30E+00	1.31E+01	23	9.75E+01	5.95E+04
	M3	109	1.12E+00	9.31E+00	54	5.74E+01	4.94E+04
		54	1.29E+00	1.31E+01	23	5.55E+01	4.49E+04
^{90}Sr	M1	58	7.01E+02	6.80E+06	27	1.82E+03	2.76E+07
		54	7.01E+02	7.20E+06	23	2.10E+03	3.21E+07
	M2	58	7.01E+02	6.80E+06	27	1.82E+03	2.76E+07
		54	7.01E+02	7.20E+06	23	2.10E+03	3.21E+07
	M3	58	7.01E+02	6.80E+06	27	1.82E+03	2.76E+07
		54	7.01E+02	7.20E+06	23	2.10E+03	3.21E+07
		DST Solid Samples, µCi/g			DST Liquid Samples, µCi/L		
^{137}Cs	M1	15	2.43E+02	3.53E+04	27	3.11E+05	1.57E+11
		15	2.43E+02	3.53E+04	26	3.23E+05	1.60E+11
	M2	15	2.43E+02	3.53E+04	27	3.11E+05	1.57E+11
		15	2.43E+02	3.53E+04	26	3.22E+05	1.60E+11
	M3	15	2.43E+02	3.53E+04	27	3.11E+05	1.57E+11
		15	2.43E+02	3.53E+04	26	3.22E+05	1.60E+11
GA	M1	19	1.02E+01	4.79E+02	27	5.29E+01	2.48E+04
		15	7.35E+00	2.24E+02	26	5.49E+01	2.57E+04
	M2	19	1.02E+01	4.80E+02	28	5.01E+01	2.39E+04
		15	7.33E+00	2.24E+02	26	5.37E+01	2.56E+04
	M3	19	1.02E+01	4.80E+02	28	4.41E+01	2.42E+04
		15	7.31E+00	2.24E+02	26	4.75E+01	2.60E+04
^{90}Sr	M1	15	6.13E+03	3.88E+08	27	7.41E+03	6.12E+08
		15	6.13E+03	3.88E+08	26	7.69E+03	6.34E+08
	M2	15	6.13E+03	3.88E+08	27	7.41E+03	6.12E+08
		15	6.13E+03	3.88E+08	26	7.69E+03	6.34E+08
	M3	15	6.13E+03	3.88E+08	27	7.41E+03	6.12E+08

Table C-1. Comparison of Means (μCi/g) and Variances (μCi/g²) by Radionuclide and Waste Type for the Three Models (M1, M2, and M3) for Detection Limits (2 sheets)

Analyte	Model	Num. Tanks	Mean	Variance	Num. Tanks	Mean	Variance
		15	6.13E+03	3.88E+08	26	7.69E+03	6.34E+08
DCF ICRP-71							
		SST Solid Samples, μCi/g			SST Liquid Samples, μCi/L		
^{137}Cs	M1	58	1.06E+02	1.51E+04	28	2.76E+05	2.41E+10
		54	1.10E+02	1.59E+04	23	3.04E+05	2.04E+10
	M2	61	1.01E+02	1.48E+04	28	2.76E+05	2.42E+10
		54	1.10E+02	1.59E+04	23	3.04E+05	2.04E+10
	M3	61	1.01E+02	1.49E+04	28	2.76E+05	2.42E+10
		54	1.10E+02	1.59E+04	23	3.04E+05	2.04E+10
GA	M1	105	1.21E+00	1.07E+01	43	9.13E+01	7.39E+04
		54	1.35E+00	1.52E+01	23	8.94E+01	6.99E+04
	M2	109	1.14E+00	9.29E+00	54	7.74E+01	5.56E+04
		54	1.30E+00	1.31E+01	23	9.75E+01	5.95E+04
	M3	109	1.12E+00	9.31E+00	54	5.74E+01	4.94E+04
		54	1.29E+00	1.31E+01	23	5.55E+01	4.49E+04
^{90}Sr	M1	58	7.01E+02	6.80E+06	27	1.82E+03	2.76E+07
		54	7.01E+02	7.20E+06	23	2.10E+03	3.21E+07
	M2	58	7.01E+02	6.80E+06	27	1.82E+03	2.76E+07
		54	7.01E+02	7.20E+06	23	2.10E+03	3.21E+07
	M3	58	7.01E+02	6.80E+06	27	1.82E+03	2.76E+07
		54	7.01E+02	7.20E+06	23	2.10E+03	3.21E+07
		DST Solid Samples, μCi/g			DST Liquid Samples, μCi/L		
^{137}Cs	M1	15	2.43E+02	3.53E+04	27	3.11E+05	1.57E+11
		15	2.43E+02	3.53E+04	26	3.23E+05	1.60E+11
	M2	15	2.43E+02	3.53E+04	27	3.11E+05	1.57E+11
		15	2.43E+02	3.53E+04	26	3.22E+05	1.60E+11
	M3	15	2.43E+02	3.53E+04	27	3.11E+05	1.57E+11
		15	2.43E+02	3.53E+04	26	3.22E+05	1.60E+11
GA	M1	19	1.02E+01	4.79E+02	27	5.29E+01	2.48E+04
		15	7.35E+00	2.24E+02	26	5.49E+01	2.57E+04
	M2	19	1.02E+01	4.80E+02	28	5.01E+01	2.39E+04
		15	7.33E+00	2.24E+02	26	5.37E+01	2.56E+04
	M3	19	1.02E+01	4.80E+02	28	4.41E+01	2.42E+04
		15	7.31E+00	2.24E+02	26	4.75E+01	2.60E+04
^{90}Sr	M1	15	6.13E+03	3.88E+08	27	7.41E+03	6.12E+08
		15	6.13E+03	3.88E+08	26	7.69E+03	6.34E+08
	M2	15	6.13E+03	3.88E+08	27	7.41E+03	6.12E+08
		15	6.13E+03	3.88E+08	26	7.69E+03	6.34E+08
	M3	15	6.13E+03	3.88E+08	27	7.41E+03	6.12E+08

Table C-1. Comparison of Means (μCi/g) and Variances (μCi/g²) by Radionuclide and Waste Type for the Three Models (M1, M2, and M3) for Detection Limits (2 sheets)

Analyte	Model	Num. Tanks	Mean	Variance	Num. Tanks	Mean	Variance
		15	6.13E+03	3.88E+08	26	7.69E+03	6.34E+08

Table C-2. Comparison of Means (Sv/L) and Variances (Sv/L^2) of ULDs by Waste Type for the Three Models (M1, M2, and M3) for Detection Limits

Model	Num. Tanks	Mean	Variance	Num. Tanks	Mean	Variance
DCF ICRP-68						
	ULD SST Solid Samples			ULD SST Liquid Samples		
M1	54	3.68E+03	1.05E+08	23	1.73E+02	7.90E+04
M2	57	3.41E+03	9.44E+07	26	1.70E+02	5.86E+04
M3	57	3.39E+03	9.45E+07	26	1.28E+02	4.37E+04
	ULD DST Solid Samples			ULD DST Liquid Samples		
M1	15	2.42E+04	2.74E+09	26	1.48E+02	5.35E+04
M2	15	2.41E+04	2.74E+09	27	1.41E+02	5.19E+04
M3	15	2.41E+04	2.74E+09	27	1.35E+02	5.13E+04
DCF ICRP-71						
	ULD SST Solid Samples			ULD SST Liquid Samples		
M1	54	5.19E+03	2.08E+08	23	2.03E+02	1.92E+05
M2	57	4.80E+03	1.84E+08	26	1.99E+02	1.44E+05
M3	**57**	**4.77E+03**	**1.84E+08**	**26**	1.35E+02	1.08E+05
	ULD DST Solid Samples			ULD DST Liquid Samples		
M1	15	3.33E+04	4.82E+09	26	1.57E+02	9.82E+04
M2	15	3.32E+04	4.82E+09	27	1.49E+02	9.48E+04
M3	15	3.31E+04	4.83E+09	27	1.39E+02	9.48E+04

Table C-3. Quantiles (Sv/L) Corresponding to the 95th and 99th Percentiles Points and 95/59 and 95/99 Tolerance Limits (Sv/L) for the Lognormal Distribution for the Three Models for Below Detection Limit Observations

Model	Num.Tanks	95th	99th	95/95 TL	95/99 TL
DCF ICRP-68	SST Solid Samples, Sv/L				
M1	54	1.06E+04	3.26E+04	2.06E+04	7.63E+04
M2	57	9.43E+03	2.84E+04	1.77E+04	6.35E+04
M3	57	9.53E+03	2.96E+04	1.82E+04	6.79E+04
	SST Liquid Samples, Sv/L				
M1	23	1.44E+03	5.01E+03	5.04E+03	2.51E+04
M2	26	1.43E+03	4.83E+03	4.43E+03	2.05E+04
M3	26	1.01E+03	3.21E+03	2.95E+03	1.28E+04
	DST Solid Samples, Sv/L				
M1	15	1.07E+05	5.09E+05	8.82E+05	7.84E+06
M2	15	1.06E+05	5.13E+05	8.91E+05	8.07E+06
M3	15	1.09E+05	5.44E+05	9.57E+05	9.08E+06
	DST Liquid Samples, Sv/L				
M1	26	7.97E+02	2.53E+03	2.33E+03	1.00E+04
M2	27	7.54E+02	2.43E+03	2.18E+03	9.79E+03
M3	27	7.12E+02	2.32E+03	2.08E+03	9.50E+03
DCF ICRP-71	SST Solid Samples, Sv/L				
M1	54	1.51E+04	4.77E+04	2.99E+04	1.14E+05
M2	57	1.35E+04	4.16E+04	2.57E+04	9.43E+04
M3	57	1.40E+04	4.51E+04	2.73E+04	1.06E+05
	SST Liquid Samples, Sv/L				
M1	23	1.16E+03	3.88E+03	3.89E+03	1.84E+04
M2	26	1.27E+03	4.18E+03	3.84E+03	1.74E+04
M3	26	7.32E+02	2.21E+03	2.05E+03	8.27E+03
	DST Solid Samples, Sv/L				
M1	15	1.67E+05	8.53E+05	1.51E+06	1.49E+07
M2	15	1.65E+05	8.57E+05	1.53E+06	1.53E+07
M3	15	1.75E+05	9.57E+05	1.74E+06	1.88E+07
	DST Liquid Samples, Sv/L				
M1	26	7.68E+02	2.51E+03	2.31E+03	1.03E+04
M2	27	7.24E+02	2.40E+03	2.15E+03	1.00E+04
M3	27	6.45E+02	2.18E+03	1.94E+03	9.29E+03

APPENDIX D

D.0 S-PLUS FUNCTIONS FOR COMPUTING THE ULD

Two S-PLUS functions were written to convert μCi/g or μCi/L to Sv/L and to the ULD. The functions are called SLD.ULD.fn, and LQD.ULD.fn. The first function is for solid samples, and the second is for liquid samples.

For each type of sample, the means for ^{137}Cs, GA (gross alpha), and ^{90}Sr were stored in four S-PLUS data frames called SST.SLD.df, SST.LQD.df, DST.SLD.nu.AZ.df, and DST.LQD.nu.AZ.df. The first column of each data frame lists the name of the tank. Columns 2, 3, and 4 list the means for ^{137}Cs for each of the three models (M1, M2, and M2) for using observations below the detection limit. Likewise, columns 5, 6, and 7 list the three means for GA, and columns 8, 9, and 10 list the three means for ^{90}Sr. These are the means reported in Appendix A.

The two S-PLUS functions use the conversion factors Bq/μCi, g/L, and Sv/Bq given in Table 1 to convert μCi/g or μCi/L to Sv/L for each of ^{137}Cs, GA, and ^{90}Sr. Note that there are two conversion factors for Sv/Bq, one based on ICRP-68 and the other on ICRP-71. The Sv/L values are stored in columns 11, 12, and 13 for ^{137}Cs, in columns 14, 15, and 16 for GA, and in columns 17, 18, and 19 for ^{90}Sr. Note that ^{90}Y is included as a multiple of ^{90}Sr. Columns 20, 21, and 22 contain the ULD for each of the three models M1, M2, and M2. The ULD is the sum of the Sv/L for ^{137}Cs, GA, and ^{90}Sr. The last 16 columns are then named according to the units. That is columns 11 to 13 are called "Cs.SvPL.M1", "Cs.SvPL.M2", 'Cs.SvPL.M3", columns 14 to 16 are called GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3", columns 17 to 19 are called SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3", and columns 20 to 22 are called "ULD.M1", "ULD.M2", "ULD.M3".

These two S-PLUS functions generate eight new data frames. The data frames for SSTs are called ULD.SST.ICRP68.SLD.df, ULD.SST.ICRP71.SLD.df, ULD.SST.ICRP68.LQD.df, and ULD.SST.ICRP71.LQD.df. The data frames for DSTs are ULD.DST.ICRP68.SLD.df, ULD.DST.ICRP71.SLD.df, ULD.DST.ICRP68.LQD.df, and ULD.DST.ICRP71.LQD.df. The last three columns of each data frame, without most of the missing values, e.g., the NA's, are the ULD values given in Appendix B.

D1.0 THE S-PLUS FUNCTION SLD.ULD.FN

```
SLD.ULD.fn=
function(df1, df2)
{
#for SOLID samples, df1=SST.SLD.df, df2=DST.SLD.nu.AZ.df
	df1[, 11] <- df1[, 2] * (37000) * (1600) * (6.7e-009)
	df1[, 12] <- df1[, 3] * (37000) * (1600) * (6.7e-009)
	df1[, 13] <- df1[, 4] * (37000) * (1600) * (6.7e-009)
	df1[, 14] <- df1[, 5] * (37000) * (1600) * (2.89e-005)
	df1[, 15] <- df1[, 6] * (37000) * (1600) * (2.89e-005)
	df1[, 16] <- df1[, 7] * (37000) * (1600) * (2.89e-005)
	df1[, 17] <- df1[, 8] * (37000) * (1600) * (3e-008 + 1.7e-009)
	df1[, 18] <- df1[, 9] * (37000) * (1600) * (3e-008 + 1.7e-009)
	df1[, 19] <- df1[, 10] * (37000) * (1600) * (3e-008 + 1.7e-009)
	df1[, 20] <- df1[, 11] + df1[, 14] + df1[, 17]
	df1[, 21] <- df1[, 12] + df1[, 15] + df1[, 18]
	df1[, 22] <- df1[, 13] + df1[, 16] + df1[, 19]
	names(df1)[11:13] <- c("Cs.SvPL.M1", "Cs.SvPL.M2", "Cs.SvPL.M3")
	names(df1)[14:16] <- c("GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3")
	names(df1)[17:19] <- c("SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3")
	names(df1)[20:22] <- c("ULD.M1", "ULD.M2", "ULD.M3")
	ULD.SST.ICRP68.SLD.df <<- df1
	df2[, 11] <- df2[, 2] * (37000) * (1600) * (6.7e-009)
	df2[, 12] <- df2[, 3] * (37000) * (1600) * (6.7e-009)
	df2[, 13] <- df2[, 4] * (37000) * (1600) * (6.7e-009)
	df2[, 14] <- df2[, 5] * (37000) * (1600) * (2.89e-005)
	df2[, 15] <- df2[, 6] * (37000) * (1600) * (2.89e-005)
	df2[, 16] <- df2[, 7] * (37000) * (1600) * (2.89e-005)
	df2[, 17] <- df2[, 8] * (37000) * (1600) * (3e-008 + 1.7e-009)
	df2[, 18] <- df2[, 9] * (37000) * (1600) * (3e-008 + 1.7e-009)
	df2[, 19] <- df2[, 10] * (37000) * (1600) * (3e-008 + 1.7e-009)
	df2[, 20] <- df2[, 11] + df2[, 14] + df2[, 17]
	df2[, 21] <- df2[, 12] + df2[, 15] + df2[, 18]
	df2[, 22] <- df2[, 13] + df2[, 16] + df2[, 19]
	names(df2)[11:13] <- c("Cs.SvPL.M1", "Cs.SvPL.M2", "Cs.SvPL.M3")
	names(df2)[14:16] <- c("GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3")
	names(df2)[17:19] <- c("SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3")
	names(df2)[20:22] <- c("ULD.M1", "ULD.M2", "ULD.M3")
	ULD.DST.ICRP68.SLD.df <<- df2
	df1[, 11] <- df1[, 2] * (37000) * (1600) * (4.6e-009)
	df1[, 12] <- df1[, 3] * (37000) * (1600) * (4.6e-009)
```

```
        df1[, 13] <- df1[, 4] * (37000) * (1600) * (4.6e-009)
        df1[, 14] <- df1[, 5] * (37000) * (1600) * (4.5e-005)
        df1[, 15] <- df1[, 6] * (37000) * (1600) * (4.5e-005)
        df1[, 16] <- df1[, 7] * (37000) * (1600) * (4.5e-005)
        df1[, 17] <- df1[, 8] * (37000) * (1600) * (3.6e-008 + 1.5e-009)
        df1[, 18] <- df1[, 9] * (37000) * (1600) * (3.6e-008 + 1.5e-009)
        df1[, 19] <- df1[, 10] * (37000) * (1600) * (3.6e-008 + 1.5e-009)
        df1[, 20] <- df1[, 11] + df1[, 14] + df1[, 17]
        df1[, 21] <- df1[, 12] + df1[, 15] + df1[, 18]
        df1[, 22] <- df1[, 13] + df1[, 16] + df1[, 19]
        names(df1)[11:13] <- c("Cs.SvPL.M1", "Cs.SvPL.M2", "Cs.SvPL.M3")
        names(df1)[14:16] <- c("GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3")
        names(df1)[17:19] <- c("SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3")
        names(df1)[20:22] <- c("ULD.M1", "ULD.M2", "ULD.M3")
        ULD.SST.ICRP71.SLD.df <<- df1
        df2[, 11] <- df2[, 2] * (37000) * (1600) * (4.6e-009)
        df2[, 12] <- df2[, 3] * (37000) * (1600) * (4.6e-009)
        df2[, 13] <- df2[, 4] * (37000) * (1600) * (4.6e-009)
        df2[, 14] <- df2[, 5] * (37000) * (1600) * (4.5e-005)
        df2[, 15] <- df2[, 6] * (37000) * (1600) * (4.5e-005)
        df2[, 16] <- df2[, 7] * (37000) * (1600) * (4.5e-005)
        df2[, 17] <- df2[, 8] * (37000) * (1600) * (3.6e-008 + 1.5e-009)
        df2[, 18] <- df2[, 9] * (37000) * (1600) * (3.6e-008 + 1.5e-009)
        df2[, 19] <- df2[, 10] * (37000) * (1600) * (3.6e-008 + 1.5e-009)
        df2[, 20] <- df2[, 11] + df2[, 14] + df2[, 17]
        df2[, 21] <- df2[, 12] + df2[, 15] + df2[, 18]
        df2[, 22] <- df2[, 13] + df2[, 16] + df2[, 19]
        names(df2)[11:13] <- c("Cs.SvPL.M1", "Cs.SvPL.M2", "Cs.SvPL.M3")
        names(df2)[14:16] <- c("GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3")
        names(df2)[17:19] <- c("SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3")
        names(df2)[20:22] <- c("ULD.M1", "ULD.M2", "ULD.M3")
        ULD.DST.ICRP71.SLD.df <<- df2
}
```

D2.0 THE S-PLUS FUNCTION LQD.ULD.FN

```
LQD.ULD.fn=
function(df1, df2)
{
#for LIQUID samples, df1=SST.LQD.df, df2=DST.LQD.nu.AZ.df
        df1[, 11] <- df1[, 2] * (37000) * (6.7e-009)
        df1[, 12] <- df1[, 3] * (37000) * (6.7e-009)
```

```
df1[, 13] <- df1[, 4] * (37000) * (6.7e-009)
df1[, 14] <- df1[, 5] * (37000) * (2.89e-005)
df1[, 15] <- df1[, 6] * (37000) * (2.89e-005)
df1[, 16] <- df1[, 7] * (37000) * (2.89e-005)
df1[, 17] <- df1[, 8] * (37000) * (3e-008 + 1.7e-009)
df1[, 18] <- df1[, 9] * (37000) * (3e-008 + 1.7e-009)
df1[, 19] <- df1[, 10] * (37000) * (3e-008 + 1.7e-009)
df1[, 20] <- df1[, 11] + df1[, 14] + df1[, 17]
df1[, 21] <- df1[, 12] + df1[, 15] + df1[, 18]
df1[, 22] <- df1[, 13] + df1[, 16] + df1[, 19]
names(df1)[11:13] <- c("Cs.SvPL.M1", "Cs.SvPL.M2", "Cs.SvPL.M3")
names(df1)[14:16] <- c("GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3")
names(df1)[17:19] <- c("SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3")
names(df1)[20:22] <- c("ULD.M1", "ULD.M2", "ULD.M3")
ULD.SST.ICRP68.LQD.df <<- df1
df2[, 11] <- df2[, 2] * (37000) * (6.7e-009)
df2[, 12] <- df2[, 3] * (37000) * (6.7e-009)
df2[, 13] <- df2[, 4] * (37000) * (6.7e-009)
df2[, 14] <- df2[, 5] * (37000) * (2.89e-005)
df2[, 15] <- df2[, 6] * (37000) * (2.89e-005)
df2[, 16] <- df2[, 7] * (37000) * (2.89e-005)
df2[, 17] <- df2[, 8] * (37000) * (3e-008 + 1.7e-009)
df2[, 18] <- df2[, 9] * (37000) * (3e-008 + 1.7e-009)
df2[, 19] <- df2[, 10] * (37000) * (3e-008 + 1.7e-009)
df2[, 20] <- df2[, 11] + df2[, 14] + df2[, 17]
df2[, 21] <- df2[, 12] + df2[, 15] + df2[, 18]
df2[, 22] <- df2[, 13] + df2[, 16] + df2[, 19]
names(df2)[11:13] <- c("Cs.SvPL.M1", "Cs.SvPL.M2", "Cs.SvPL.M3")
names(df2)[14:16] <- c("GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3")
names(df2)[17:19] <- c("SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3")
names(df2)[20:22] <- c("ULD.M1", "ULD.M2", "ULD.M3")
ULD.DST.ICRP68.LQD.df <<- df2
df1[, 11] <- df1[, 2] * (37000) * (4.6e-009)
df1[, 12] <- df1[, 3] * (37000) * (4.6e-009)
df1[, 13] <- df1[, 4] * (37000) * (4.6e-009)
df1[, 14] <- df1[, 5] * (37000) * (4.5e-005)
df1[, 15] <- df1[, 6] * (37000) * (4.5e-005)
df1[, 16] <- df1[, 7] * (37000) * (4.5e-005)
df1[, 17] <- df1[, 8] * (37000) * (3.6e-008 + 1.5e-009)
df1[, 18] <- df1[, 9] * (37000) * (3.6e-008 + 1.5e-009)
df1[, 19] <- df1[, 10] * (37000) * (3.6e-008 + 1.5e-009)
df1[, 20] <- df1[, 11] + df1[, 14] + df1[, 17]
df1[, 21] <- df1[, 12] + df1[, 15] + df1[, 18]
df1[, 22] <- df1[, 13] + df1[, 16] + df1[, 19]
names(df1)[11:13] <- c("Cs.SvPL.M1", "Cs.SvPL.M2", "Cs.SvPL.M3")
```

```
    names(df1)[14:16] <- c("GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3")
    names(df1)[17:19] <- c("SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3")
    names(df1)[20:22] <- c("ULD.M1", "ULD.M2", "ULD.M3")
    ULD.SST.ICRP71.LQD.df <<- df1
    df2[, 11] <- df2[, 2] * (37000) * (4.6e-009)
    df2[, 12] <- df2[, 3] * (37000) * (4.6e-009)
    df2[, 13] <- df2[, 4] * (37000) * (4.6e-009)
    df2[, 14] <- df2[, 5] * (37000) * (4.5e-005)
    df2[, 15] <- df2[, 6] * (37000) * (4.5e-005)
    df2[, 16] <- df2[, 7] * (37000) * (4.5e-005)
    df2[, 17] <- df2[, 8] * (37000) * (3.6e-008 + 1.5e-009)
    df2[, 18] <- df2[, 9] * (37000) * (3.6e-008 + 1.5e-009)
    df2[, 19] <- df2[, 10] * (37000) * (3.6e-008 + 1.5e-009)
    df2[, 20] <- df2[, 11] + df2[, 14] + df2[, 17]
    df2[, 21] <- df2[, 12] + df2[, 15] + df2[, 18]
    df2[, 22] <- df2[, 13] + df2[, 16] + df2[, 19]
    names(df2)[11:13] <- c("Cs.SvPL.M1", "Cs.SvPL.M2", "Cs.SvPL.M3")
    names(df2)[14:16] <- c("GA.SvPL.M1", "GA.SvPL.M2", "GA.SvPL.M3")
    names(df2)[17:19] <- c("SrY.SvPL.M1", "SrY.SvPL.M2", "SrY.SvPL.M3")
    names(df2)[20:22] <- c("ULD.M1", "ULD.M2", "ULD.M3")
    ULD.DST.ICRP71.LQD.df <<- df2
}
```

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APPENDIX E

E.0 INDEPENDENT REVIEW

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REVIEW CHECKLIST

Document Reviewed:
Sample Based Unit Liter Dose Estimates
by L. Jensen and S.R. Wilmarth HNF-4534 Rev 1

Scope of Review:

Yes	No	NA		
⊗	○	○	*	Previous reviews complete and cover analysis, up to scope of this review, with no gaps.
⊗	○	○		Problem completely defined.
○	○	⊗		Accident scenarios developed in a clear and logical manner.
⊗	○	○		Necessary assumptions explicitly stated and supported.
⊗	○	○		Computer codes and data files documented.
⊗	○	○		Data used in calculations explicitly stated in document.
⊗	○	○		Data checked for consistency with original source information as applicable.
⊗	○	○		Mathematical derivation checked including dimensional consistency of results.
⊗	○	○		Models appropriate and used within range of validity or use outside range of established validity justified.
⊗	○	○		Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.
⊗	○	○		Software input correct and consistent with document reviewed.
⊗	○	○		Software output consistent with input and with results reported in document reviewed.
○	○	⊗		Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.
⊗	○	○		Safety margins consistent with good engineering practices.
⊗	○	○		Conclusions consistent with analytical results and applicable limits.
⊗	○	○		Results and conclusions address all points required in the problem statement.
○	○	⊗		Format consistent with appropriate NRC Regulatory Guide or other standards.
○	○	⊗	*	Review calculations, comments, and/or notes are attached.
⊗	○	○		**Document approved.**

Daniel A. Reynolds / DA Reynolds 04/12/00

Reviewer (Printed Name and Signature) Date

*Any calculations, comments, or notes generated as part of this review should be signed, dated and attached to this checklist. *Such material should be labeled and recorded in such a manner as to be intelligible to a technically qualified third party.*

A-6002-359 (02/98)

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Data Development and Interpretation	Date 04/13/00
Project Title/Work Order		EDT No. N/A
HNF-4534, Rev. 1, "Sample Based Unit Liter Dose Estimates"		ECN No. ECN-657285

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
Fluor Daniel Northwest					
B. E. Hey	B4-47		X		
G. W. Ryan	B4-47		X		
J. C. VanKeuren	B4-47		X		
CH2M Hill Hanford Group, Inc.					
R. J. Cash	R1-44		X		
W. L. Cowley	R1-49		5		
J. S. Davis	R1-49		X		
C. DeFigh-Price	R2-12		X		
J. G. Field	R2-12		X		
G. W. Gault	R1-44		X		
L. Jensen	R2-12		5		
C. E. Leach	R1-44		X		
J. E. Meacham	R1-49		X		
D. A. Reynolds	R2-11		X		
K. R. Sangren	R1-49		X		
S. R. Wilmarth	R2-12		5		
T.C.S.R.C.	R1-10		X		
Lockheed Martin Services, Inc.					
Central Files	B1-07		X		