MAR 09 1998

ENGINEERING DATA TRANSMITTAL

Page 1 of 1

1. EDT

620801

2. To: (Receiving Organization) Distribution		3. From: (Originating Organization) SNF Characterization Project		4. Related EDT No.: N/A	
5. Proj./Prog./Dept./Div.: Spent Nuclear Fuel Project		6. Design Authority/ Design Agent/Cog. Engr.: A. L. Pitner		7. Purchase Order No.: N/A	
8. Originator Remarks: Approval and Release.				9. Equip./Component No.: N/A	
				10. System/Bldg./Facility: N/A	
11. Receiver Remarks: 11A. Design Baseline Document? ☐ Yes ☒ No				12. Major Assm. Dwg. No.: N/A	
				13. Permit/Permit Application No.: N/A	
				14. Required Response Date:	

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Design- nator	Reason for Trans- mittal	Origin- ator Dispo- sition	Receiv- er Dispo- sition
1	HNF-2314		0	STATISTICAL ANALYSIS OF THE K WEST FUEL ELEMENT VISUAL EXAMINATION RESULTS	N/A	2	1	

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

17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)										
(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp.	(J) Name	(K) Signature	(L) Date (M) MSIN
		Design Authority								
		Design Agent								
1	1	Cog.Eng. A. L. Pitner	<i>A. L. Pitner</i>	3/5/98	H0-40					
1	1	Cog. Mgr. R. P. Omberg	<i>R. P. Omberg</i>	3/5/98	H0-40					
		QA								

18. <i>A. L. Pitner</i> 3/5/98 Signature of EDT Originator Date		19. _____ Authorized Representative Date for Receiving Organization		20. <i>R. P. Omberg</i> 3/5/98 Design Authority/ Cognizant Manager Date		21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments	
--	--	--	--	--	--	---	--

STATISTICAL ANALYSIS OF THE K WEST FUEL ELEMENT VISUAL EXAMINATION RESULTS

T. L. Welsh

B&W Protec, Inc., Richland, WA 99352

U.S Department of Energy Contract DE-AC06-96RL13200

A. L. Pitner

Duke Engineering and Services Hanford, Inc., Richland, WA 99352

U.S. Department of Energy Contract DE-AC06-96RL13200

EDT/ECN: 620801

UC: 2070

Org Code: 2T960

Charge Code: LB072

B&R Code: EW7070000

Total Pages: 90

Key Words: K West Basin Fuel, Visual Examination, Statistical Analysis

Abstract: A statistical evaluation of K West fuel visual examination results was performed in an attempt to correlate observed fuel damage levels with parameters known from storage records and parameters obtained from in-basin measurements.

TRADEMARK DISCLAIMER. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors.

Printed in the United States of America. To obtain copies of this document, contact: WHC/BCS Document Control Services, P.O. Box 1970, Mailstop H6-08, Richland WA 99352, Phone (509) 372-2420; Fax (509) 376-4989.

James Aardal 3-9-98
Release Approval Date

Release Stamp

Approved for Public Release

CONTENTS

1.0	SUMMARY	7
2.0	INTRODUCTION	9
3.0	DAMAGE ASSESSMENT	11
3.1	INNERS--STORAGE PARAMETERS	11
3.2	OUTERS--STORAGE PARAMETERS	12
3.3	INNERS VERSUS OUTERS	13
3.4	MEASURED PARAMETERS	13
3.4.1	INNERS	14
3.4.2	OUTERS	15
3.5	STORAGE PARAMETERS VERSUS MEASURED PARAMETERS	15
3.5.1	Canister Type	16
3.5.2	Fuel Type	16
3.5.3	Key Date	16
3.5.4	Years Since Encapsulation	17
3.5.5	Plutonium-240 Isotopic Values	17
3.5.6	Gas Trap Readings	18
3.5.7	Cesium-137 Concentration	18
3.5.8	Potassium Concentration	18
3.5.9	Coating Code	18
3.5.10	Sludge Code	19
4.0	REFERENCES	21

LIST OF FIGURES

1. Histogram: INNERS--Percent Intact	39
2. Histogram: INNERS--Percent Breached	40
3. Histogram: INNERS--Percent Bad	41
4. Histogram: OUTERS--Percent Intact	42
5. Histogram: OUTERS--Percent Breached	43
6. Histogram: OUTERS--Percent Bad	44
7. Damage Versus Canister Type--INNERS	45
8. Damage Versus Fuel Type--INNERS	46
9. Damage Versus Key Date--INNERS	47
10. Damage Versus Years Encapsulated--INNERS	48
11. Damage Versus Plutonium-240--INNERS	49
12. INNERS Versus Canister Type	50
13. INNERS Versus Fuel Type	51
14. INNERS Versus Key Date	52
15. INNERS Versus Years Encapsulated	53
16. INNERS Versus Plutonium-240	54
17. Damage Versus Canister Type--OUTERS	55
18. Damage Versus Fuel Type--OUTERS	56
19. Damage Versus Key Date--OUTERS	57
20. Damage Versus Years Encapsulated--OUTERS	58
21. Damage Versus Plutonium-240--OUTERS	59
22. OUTERS Versus Canister Type	60
23. OUTERS Versus Fuel Type	61
24. OUTERS Versus Key Date	62
25. OUTERS Versus Years Encapsulated	63

LIST OF FIGURES (Continued)

26. OUTERS Versus Plutonium-240	64
27. INNERS-Intact Versus OUTERS-Intact	65
28. INNERS-Intact Versus OUTERS-Breached	65
29. INNERS-Intact Versus OUTERS-Bad	66
30. INNERS-Breached Versus OUTERS-Intact	66
31. INNERS-Breached Versus OUTERS-Breached	67
32. INNERS-Breached Versus OUTERS-Bad	67
33. INNERS-Bad Versus OUTERS-Intact	68
34. INNERS-Bad Versus OUTERS-Breached	68
35. INNERS-Bad Versus OUTERS-Bad	69
36. Sludge Code Versus INNERS-Percent Damage	70
37. Cesium-137 Versus OUTERS-Percent Damage	71
38. Sludge Code Versus OUTERS-Percent Damage	72
39. Canister Type Versus Years Since Encapsulated	73
40. Canister Type Versus Potassium	74
41. Canister Type Versus Coating Code	75
42. Fuel Type Versus Plutonium-240	76
43. Fuel Type Versus Cesium-137	77
44. Key Date Versus Years Since Encapsulation	78
45. Key Date Versus Coating Code	79
46. Key Date Versus Plutonium-240	80
47. Years Since Encapsulation Versus Plutonium-240	81
48. Years Since Encapsulation Versus Coating Code	82
49. Years Since Encapsulation Versus Potassium	83
50. Plutonium-240 Versus Gas Trap	84

LIST OF FIGURES (Continued)

51. Plutonium-240 Versus Coating Code	85
52. Plutonium-240 Versus Sludge Code	86
53. Gas Trap Versus Potassium	87
54. Cesium-137 Versus Sludge Code	88
55. Potassium Versus Coating Code	89

LIST OF TABLES

1. Canisters Selected for Visual Inspection--Storage Parameters	23
2. Visually Examined Barrels--Measured Parameters	25
3. Visual Inspection Results--INNERS	27
4. Visual Inspection Summary--INNERS	28
5. Correlation Coefficients--INNERS Damage Versus Storage Parameters	29
6. Visual Inspection Results--OUTERS	30
7. Visual Inspection Summary--OUTERS	31
8. Correlation Coefficients--OUTERS Damage Versus Storage Parameters	32
9. Correlation Coefficients--INNERS Versus OUTERS	32
10. Correlation Coefficients--INNERS Damage Versus Measured Parameters	33
11. Correlation Coefficients--OUTERS Damage Versus Measured Parameters.	33
12. Correlation Coefficients--Known Versus Measured Parameters	34

This page intentionally left blank.

STATISTICAL ANALYSIS OF THE K WEST FUEL ELEMENT VISUAL EXAMINATION RESULTS

1.0 SUMMARY

Over 250 fuel assemblies stored in 20 sealed canisters in the K West Basin were removed from their canisters and visually examined for damage. Prior measurements, ^{137}Cs concentrations from K West canister water samples, were used to identify canisters with the potential for extensive fuel element damage and high sludge levels for laboratory evaluations. As expected, extensive fuel element damage was found in the examinations.

Attempts were made to correlate fuel damage with (1) fuel storage conditions (canister type, fuel type, key date, years since encapsulation, ^{240}Pu content) and (2) measured parameters (gas trap readings, ^{137}Cs concentration, potassium concentration, fuel coating, and qualitative sludge level). The measured parameters were obtained from in-basin measurements and observations. Such correlations, if they could be demonstrated to exist, would aid in fuel handling and treatment process handling.

Correlation coefficients were determined comparing percent damage with functions of the storage parameters (canister type, fuel type, key date, years since encapsulation, and ^{240}Pu content) for the inner and outer fuel elements separately. Several correlation coefficients were significantly different from zero, but the magnitudes (absolute values) of the correlations were small (less than 0.5). Correlation coefficients also were determined for percent damage with functions of the measured parameters (gas trap readings, ^{137}Cs concentration, potassium concentration, fuel coating, and qualitative sludge level). Again, the comparisons considered the inner and outer fuel elements separately. Several of the correlation coefficients were significantly different from zero, but the magnitudes of the correlations were small (usually less than 0.5).

Since no storage or measured parameter is strongly associated with the percent damage observed, the data were tabulated by the percent damage observed during the examination. The estimated proportion of the K West population for each class of damage is presented in the following table. Since the examination was performed on fuel assemblies with the potential for high fuel element damage, the estimated proportions of the populations are biased towards the damage side. A 95% confidence interval for the estimated proportion was computed and is also presented in the following table.

Population	Estimated Proportion of the Population	95% Confidence Limits for the Estimated Proportion *
INNERS - Intact	0.8929	(0.8547, 0.9311)
INNERS - Breached	0.0873	(0.0524, 0.1222)
INNERS - Bad	0.0198	(0.0026, 0.0370)
OUTERS - Intact	0.5475	(0.4873, 0.6077)
OUTERS - Breached	0.3460	(0.2885, 0.4035)
OUTERS - Bad	0.1065	(0.0692, 0.1438)

*Normal approximation to the binomial.

Correlation coefficients were determined for all storage parameters (canister type, fuel type, key date, years since encapsulation, and ^{240}Pu content) and all measured parameters (gas trap readings, ^{137}Cs concentration, potassium concentration, fuel coating, and qualitative sludge level). Several of the correlation coefficients were significantly different from zero, but the magnitudes of the correlations were small (usually less than 0.5). The correlation that was most obvious was the relationship between canister type and fuel coating; the heavy-white coating was observed on the fuel contained in the aluminum Mark I canisters. The higher potassium concentrations were also associated with this heavy-white coating.

2.0 INTRODUCTION

A campaign was conducted in the K West fuel storage basin in which selected canisters were opened and the fuel elements individually removed for visual examination (Pitner 1997). A total of 24 canisters in K West were opened, with 21 of the canisters containing fuel assemblies and 3 of the canisters containing known fragmented fuel pieces ("chip can"). None of the fragmented fuel pieces from the chip cans were extracted for examination. Fuel examination was not performed in one of the canisters (both barrels) because fuel elements were wedged laterally across the inside of the lid. The twenty canisters from which the fuel elements were removed and examined are listed in Table 1. Table 1 also contains the canister type, fuel type, key date, years since encapsulation, and ^{240}Pu concentration. These storage parameters are known, prior to any sampling, for the fuel contained in each canister.

Prior to the visual examinations, approximately 50 canisters in the basin were subjected to gas and liquid sampling (Trimble 1997). The water samples were analyzed for fission products, total uranium, corrosion inhibitor, and pH. The primary dissolved fission product was ^{137}Cs . It is assumed that the cesium curie content in the sample is an indication of the relative level of fuel damage in each canister barrel. The ^{137}Cs content, determined from nondestructive analyses (NDA) performed by Special Analysis Support (SAS)], ranged from 0.06 to 4046 mCi/barrel. A few samples were reported as nd (not determined/no data). A major objective of the visual examinations was to select candidate canisters containing fuel and sludge samples for detailed laboratory examination. Since damaged fuel elements and substantial sludge samples were desired for laboratory evaluations, the canisters with low cesium levels were not selected for the visual examinations. Except for one "nd" barrel, the ^{137}Cs content of the canister barrels selected for visual examination ranged from 77 to 4046 mCi/barrel. Only seven of the 51 canisters had both barrels with a ^{137}Cs content less than 77 mCi/barrel. These seven were excluded from the selection for the visual examination. Because of the exclusion of the low cesium canisters, a high "bias" for fuel damage is possible. The potassium (K) concentration was used as the indicator for the corrosion inhibitor in the water. The ^{137}Cs and K analytical results for those barrels selected for the visual examinations are listed in Table 2.

This page intentionally left blank.

3.0 DAMAGE ASSESSMENT

The procedure used to examine the K West fuel elements is described in (Pitner 1997). A canister was moved to the inspection station, the lid of one barrel was removed, ultrasonic measurements of sludge depths performed, the individual inner and outer fuel elements temporarily removed and examined. Each element was classified as intact, breached, or bad. The lid was then replaced. The other barrel of the canister was examined in like manner, and the canister was then returned to its basin storage location. A total of 252 inner elements and 263 outer elements were inspected. All steps of the examination process were recorded on videotape.

The results of the visual inspection are listed in Table 3 for the inner elements (INNERS). The results for the inner elements have been summarized in Table 4 and illustrated using histograms in Figures 1, 2, and 3. The results of the visual inspection are listed in Table 6 for the outer elements (OUTERS). The results for the outer elements have been summarized in Table 7 and illustrated using histograms in Figures 4, 5, and 6.

3.1 INNERS--STORAGE PARAMETERS

A total of 252 inner elements were inspected. Each element was classified as intact, breached, or bad. The results of visual inspection for the inner elements are listed in Table 3 along with the storage parameters. To illustrate the inspection data, the percent damage (intact, breached, bad) by barrel is shown with respect to the storage parameter data in Figures 7 through 11. Bar charts were generated (Figures 12 through 16) to see if there were any obvious correlations between K West fuel damage and any of the storage parameters associated with each canister that was examined. Figure 14 indicates a possible correlation between key date and percent INNERS intact (as the key date increases the percent INNERS intact decreases) and between key date and percent INNERS breached (as the key date increases the percent INNERS breached increases).

The sample correlation coefficient (assumes both variables are from a normal distribution) and the Spearman rank correlation coefficient (does not assume that either variable is from a normal distribution; nonparametric) were determined for percent damage (intact, breached, bad) and the storage parameters. Both the sample correlation coefficient and the Spearman rank correlation coefficient are measures of the closeness of a linear relationship between two variables (Snedecor 1980). A positive correlation coefficient indicates a tendency for the two variables to increase together while a negative correlation coefficient indicates that large values of one variable are associated with small values of the second variable. The correlation coefficient lies between -1 and 1. The closer the correlation coefficient is to ± 1 , the stronger the association between the two variables. The correlation coefficients for the INNERS percent damage variables and the storage parameters are listed in Table 5.

Hypothesis testing was used to determine the significance of the observed correlation coefficient. The null hypothesis is that the correlation coefficient is zero (no relationship between the two variables). The alternate hypothesis is that the correlation coefficient is not zero (a relationship does exist between the two variables). Statistical significance simply indicates that there is a linear relationship with nonzero slope. The tests were performed at the 0.05 level of significance (i.e., there is a 5% chance that the null hypothesis is rejected when it really is true). If the p-value (the observed significance level of the test; indicates whether the hypothesis of equality is rejected or not rejected) listed in Table 5 is less than or equal to 0.05, then the null hypothesis is rejected. If the p-value listed in Table 5 is greater than 0.05, then the null hypothesis (no relationship between the two variables) is not rejected.

- The correlation coefficient (sample or rank) for key date and INNERS-percent intact is statistically different from zero at the 0.05 level of significance (see Figure 14--as the key date increases the percent intact decreases). Note that the magnitude of the correlation (sample or rank) is less than 0.5.
- The correlation coefficient (sample or rank) for key date and INNERS-percent breached is statistically different from zero at the 0.05 level of significance (see Figure 14--as the key date increases the percent breached increases). Note that the magnitude of the correlation (sample or rank) is less than 0.5.

3.2 OUTERS--STORAGE PARAMETERS

A total of 263 outer elements were inspected. Each element was classified as intact, breached, or bad. The results of the inspection for the outer elements are listed in Table 6 along with the storage parameters. To illustrate the inspection data, the percent damage (intact, breached, and bad) by barrel is shown in Figures 17 through 21. Bar charts were generated (Figures 22 through 26) to see if there were any obvious correlations between K West fuel damage and any of the storage parameters associated with each canister that was examined. No obvious correlations are evident.

The sample correlation coefficient and the rank correlation coefficient were determined for the OUTERS percent damage variables (intact, breached, and bad) and the storage parameters. These correlation coefficients are listed in Table 8.

Hypothesis testing was used to determine the significance of the observed correlation coefficient. The null hypothesis is that the correlation coefficient is zero (no relationship between the two variables). The alternate hypothesis is that the correlation coefficient is not zero (a relationship does exist between the two variables). The tests were performed at the 0.05 level of significance (i.e., there is a 5% chance that the null

hypothesis is rejected when it really is true). If the p-value listed in Table 8 is less than or equal to 0.05, then the null hypothesis is rejected. If the p-value listed in Table 8 is greater than 0.05, then the null hypothesis (no relationship between the two variables) is not rejected.

- There were no correlation coefficients which were statistically different from zero at the 0.05 level of significance.

3.3 INNERS VERSUS OUTERS

The INNERS damage data (percent intact, percent breached, percent bad) were plotted (Figures 27 through 35) with respect to the OUTERS damage data (percent intact, percent breached, percent bad) to see if any correlations existed between the two variables. The sample correlation coefficient (assumes normal population) and the rank correlation coefficient (nonparametric; neither variable from a normal population) were determined for each combination of the two variables. The correlation coefficients are listed in Table 9.

Hypothesis testing was used to determine the significance of the observed correlation coefficient. The null hypothesis is that the correlation coefficient is zero (no relationship between the two variables). The alternate hypothesis is that the correlation coefficient is not zero (a relationship does exist between the two variables). The tests were performed at the 0.05 level of significance (i.e., there is a 5% chance that the null hypothesis is rejected when it really is true). If the p-value listed in Table 9 is less than or equal to 0.05, then the null hypothesis is rejected. If the p-value listed in Table 9 is greater than 0.05, then the null hypothesis (no relationship between the two variables) is not rejected.

- There were no correlation coefficients which were statistically different from zero at the 0.05 level of significance.

3.4 MEASURED PARAMETERS

Prior to the visual examinations, approximately 50 canisters in the basin were subjected to liquid sampling (Trimble 1997). The results of liquid sampling are listed in Table 2.

During the visual examination it was found that nearly all of the fuel elements had some kind of coating on the exterior surface. The general coating observations for each canister barrel are given in Table 2. The level of coating (medium or heavy) is identified along with the observed coloration of the coating. Since the observed coating descriptions are qualitative, an indicator variable was established to identify the classes (coating descriptions). The indicator variable for fuel coating took on four values (1 represented the medium gray/white coating, 2 represented the medium orange coating, 3 represented the medium light green coating, and 4 represented the heavy white coating).

Attempts were made to measure sludge depth levels in the canister using an ultrasonic probe. The results for K West were inconclusive. Many measurements corresponded to the bottom of the canister. Significant non-zero depth measurements were actually believed to be from foreign material, such as grafoil pieces from the lid seal or other debris. Sludge rings (bottom level bands indicative of being buried in canister sludge) were not observed for most of the K West fuel examined. However, definite visual indications of sludge presence were noted in K West. Sludge clouds often were released when the lids were removed, and sludge frequently trailed the fuel elements as they were extracted from the canisters. A qualitative estimate of the sludge level in each canister barrel was made from these visual observations. Three categories were used to describe the sludge level: minimal, moderate, and maximum. An indicator variable was established for the sludge level. The indicator variable took on three values (1 represented the minimal level, 2 represented the moderate level, and 3 represented the maximum level). The sludge level indications for each canister barrel are also presented in Table 2.

The K West Basin fuel elements were loaded into canisters in the 105-N Basin, lids were installed, a nitrogen gas blanket was established, and corrosion inhibitor (potassium nitrite) was added to the water. The gas blanket (gas space) was obtained by forcing nitrogen gas through a lid valve while expelling water from the barrel and leaving a 64 mm gas space over the fuel (Trimble 1996). This also cleared most water from the gas trap. After loading, the canisters were shipped to the 105-K West Basin for storage. As a result of transferring the canisters from one water basin to another, a portion of the gas in the gas traps was replaced with water (Conn 1992). This encapsulation occurred at least twelve years ago. Fuel damage allows the metallic uranium fuel to be corroded by the canister water. The corrosion releases fission products and generates hydrogen gas. The hydrogen gas then passes through the gas trap into the basin water. The gas trap readings were a measure of the water level in the gas trap obtained using an ultrasonic probe positioned at the bottom of the gas trap. As hydrogen is generated it displaces water from the gas trap. Thus, low gas trap readings are indications of hydrogen generation and therefore fuel corrosion. The gas trap measurements (Trimble 1997) are included in Table 2.

3.4.1 INNERS

The sample correlation coefficient and the Spearman rank correlation coefficient were determined for percent damage (intact, breached, and bad) and the measured parameters. The correlation coefficients are listed in Table 10.

- The sample correlation coefficient for sludge code and INNERS-percent breached is statistically different from zero at the 0.05 level of significance (see Figure 36--as the sludge code goes from minimal to maximum the percent breached increases). Note that the magnitude of the sample correlation is less than 0.5.

- The sample correlation coefficient for sludge code and INNERS-percent intact is statistically different from zero at the 0.10 level of significance (see Figure 36--as the sludge code goes from minimal to maximum the percent intact decreases). Note that the magnitude of the sample correlation is less than 0.5.

3.4.2 OUTERS

The sample correlation coefficient and the Spearman rank correlation coefficient were determined for percent damage (intact, breached, and bad) and the measured parameters. The correlation coefficients are listed in Table 11.

- The sample correlation coefficient for ^{137}Cs and OUTERS-percent intact is statistically different from zero at the 0.05 level of significance (see Figure 37--the lowest level for ^{137}Cs is associated with the highest percentage of intact OUTERS). Note that the magnitude of the correlation (sample or rank) is less than 0.5.
- The sample correlation coefficient for ^{137}Cs and OUTERS-percent bad is statistically different from zero at the 0.05 level of significance (see Figure 37--as the ^{137}Cs increases the percent bad increases).
- The sample correlation coefficient for sludge code and OUTERS-percent bad is statistically different from zero at the 0.05 level of significance (see Figure 38--as the sludge code goes from minimal to maximum the percent bad increases).
- The sample correlation coefficient for sludge code and OUTERS-percent intact is statistically different from zero at the 0.10 level of significance (see Figure 38--the minimum sludge code is associated with the maximum percent intact). Note that the magnitude of the correlation (sample or rank) is less than 0.5.

3.5 STORAGE PARAMETERS VERSUS MEASURED PARAMETERS

The sample correlation coefficient and the Spearman rank correlation coefficient were determined for the storage parameters (canister type, fuel type, key date, years since encapsulation, and ^{240}Pu content) and the measured parameters (gas trap, ^{137}Cs , $[\text{K}]$, fuel coating, and qualitative sludge level). The correlation coefficients are listed in Table 12. Parameters within each group (storage or measured) were also evaluated against the other parameters in the same group.

3.5.1 Canister Type

The correlation coefficients (sample and rank) were significantly different from zero for canister type and years since encapsulation (Figure 39). The MK I aluminum canisters contained the fuel with the longest time (years since encapsulation), the MK II stainless steel canisters contained the fuel with the smallest time. Note that the magnitude of the correlation (sample and rank) is approximately 0.8.

The correlation coefficients (sample and rank) were significantly different from zero for canister type and potassium concentration (Figure 40). The highest potassium concentration was associated with samples from the MK I aluminum canisters. The smallest potassium concentration was associated with samples from the MK II stainless steel canisters. Note that the magnitudes of the correlations (sample and rank) are approximately 0.7 and 0.5 respectively.

The correlation coefficients (sample and rank) were significantly different from zero for canister type and coating code (Figure 41). The heavy white coating was associated with the MK I aluminum canisters. Note that the magnitudes of the correlations (sample and rank) are approximately 0.7 and 0.6 respectively.

The correlation coefficients (sample and rank) were equal to one and significantly different from zero for canister type and gas trap readings. This is a result of having gas trap readings for the MK II stainless steel canisters only.

3.5.2 Fuel Type

The sample correlation coefficient was significantly different from zero for fuel type and ^{240}Pu content (Figure 42). The higher ^{240}Pu concentrations are associated with the MIV fuel. Note that the magnitude of the correlation is less than 0.5.

The rank correlation coefficient was significantly different from zero for fuel type and ^{137}Cs concentration (Figure 43). The highest ^{137}Cs concentrations are associated with MIA fuel. Note that the magnitude of the correlation is less than 0.5.

3.5.3 Key Date

The sample correlation coefficient was significantly different from zero for key date and years since encapsulation (Figure 44). Most of the smaller key dates (older fuel) are associated with the smallest number of years since encapsulation. Note that the magnitude of the correlation is less than 0.5.

The rank correlation coefficient was significantly different from zero for key date and coating code (Figure 45). Coating Code 2 (medium-orange) is associated with the larger key date (newer fuel). Most of the smaller key dates (older fuel) are associated with coating Code 1 (medium-gray). Note that the magnitude of the correlation is less than 0.5.

The rank correlation coefficient was significantly different from zero for key date and ^{240}Pu content (Figure 46). The majority of the higher key dates are associated with the smaller ^{240}Pu isotopic values. Note that the magnitude of the correlation is less than 0.5.

3.5.4 Years Since Encapsulation

The correlation coefficients with respect to canister type and key date are discussed in sections 3.5.1 and 3.5.3 respectively.

The correlation coefficients (sample and rank) were significantly different from zero for years since encapsulation and ^{240}Pu content (Figure 47). The lowest number of years since encapsulation is associated with the lowest ^{240}Pu isotopic value. This single data point is enough to indicate a possible trend. Note that the magnitude of the correlation is less than 0.5.

The correlation coefficients (sample and rank) were significantly different from zero for years since encapsulation and coating code (Figure 48). The lower values for years since encapsulation are associated with coating Code 1 (medium-gray) and coating Code 4 (heavy white) is only associated with higher values for years since encapsulation. Note that the magnitude of the correlation is less than 0.5.

The correlation coefficients (sample and rank) were significantly different from zero for years since encapsulation and potassium concentration (Figure 49). The highest potassium concentrations are associated with the larger values for years since encapsulation. Note that the magnitude of the correlation is approximately 0.5.

3.5.5 Plutonium-240 Isotopic Values

The correlation coefficients with respect to fuel type, key date, and years since encapsulation are discussed in Sections 3.5.2, 3.5.3, and 3.5.4 respectively.

The sample correlation coefficient was significantly different from zero for ^{240}Pu content and gas trap readings (Figure 50). The high gas trap readings are associated with the larger ^{240}Pu concentration values. Note that the magnitude of the correlation is approximately 0.5.

The rank correlation coefficient was significantly different from zero for ^{240}Pu content and coating code (Figure 51). Coating Code 4 has only lower ^{240}Pu concentration values. Note that the magnitude of the correlation is less than 0.5.

The correlation coefficients (sample and rank) were significantly different from zero for ^{240}Pu content and sludge code (Figure 52). A line with nonzero slope can be fit to the data. The majority of the higher ^{240}Pu concentrations are associated with sludge Code 1 (minimal). Note that the magnitude of the correlation is less than 0.5.

3.5.6 Gas Trap Readings

The correlation coefficients with respect to canister type and ^{240}Pu content are discussed in Sections 3.5.1 and 3.5.5 respectively.

The sample correlation coefficient was significantly different from zero for gas trap readings and the potassium concentration (Figure 53). The majority of the small gas trap readings are associated with the small potassium concentrations. The largest potassium reading is associated with a larger gas trap reading. This single data point is enough to indicate a possible trend. Note that the magnitude of the correlation is 0.7.

3.5.7 Cesium-137 Concentration

The correlation coefficients with respect to fuel type are discussed in Section 3.5.2.

The correlation coefficients (sample and rank) were significantly different from zero for the ^{137}Cs concentration and sludge code (Figure 54). The largest ^{137}Cs concentrations are associated with sludge Code 3 (maximum). Note that the magnitude of the correlation is approximately 0.5.

3.5.8 Potassium Concentration

The correlation coefficients with respect to canister type, years since encapsulation, and gas trap readings are discussed in Sections 3.5.1, 3.5.4, and 3.5.6 respectively.

The correlation coefficients (sample and rank) were significantly different from zero for potassium concentration and coating code (Figure 55). The large potassium concentrations are associated with coating Code 4 (heavy-white). Note that the magnitudes of the correlations are 0.7 (sample) and 0.6 (rank).

3.5.9 Coating Code

The correlation coefficients with respect to canister type, key date, years since encapsulation, ^{240}Pu content, and potassium concentration are discussed in Sections 3.5.1, 3.5.3, 3.5.4, 3.5.5, and 3.5.8 respectively.

3.5.10 Sludge Code

The correlation coefficients with respect to ^{240}Pu content and ^{137}Cs concentration are discussed in sections 3.5.5 and 3.5.7 respectively.

This page intentionally left blank.

4.0 REFERENCES

- Pitner, A. L., 1997, *Visual Examinations of K West Fuel Elements*, HNF-SD-SNF-TI-046, Rev. 0, Duke Engineering & Services Hanford, Inc., Richland, Washington.
- Trimble, D. J., 1997, *Analysis of Water from K West Basin Canisters (Second Campaign)*, HNF-SD-SNF-TI-048, Rev. 0, Duke Engineering & Services Hanford, Inc., Richland, Washington.
- Trimble, D. J., 1996, *Data Analysis of Gas and Liquid from K West Basin Fuel Canisters*, WHC-SD-SNF-ANAL-008, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Conn, K. R., 1992, *Calculation of Water Level in Gas Traps on MK II Fuel Storage Canisters at 105-K West*, WHC-SD-NR-ANAL-009, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- Snedecor, G. W., and W. G. Cochran, 1980, *Statistical Methods*, 7th Edition, Iowa State University Press, Ames, Iowa.

This page intentionally left blank.

Table 1. Canisters Selected for Visual Inspection--Storage Parameters.

K West Fuel					
Location	Canister Type ¹	Fuel Type	Key Date ²	Years ³	Plutonium-240
0091M	MK II SS	MIV	13858	13.5	11.6
0091U	MK II SS	MIV	13858	13.5	11.6
0102M	MK I SS	MIA	11806	15.6	13.3
0102U	MK I SS	MIA	11806	15.6	13.3
0161M	MK I A1	MIA	10832	15.6	12.5
0161U	MK I A1	MIA	10832	15.6	12.5
0315M	MK I A1	MIV	12852	15.5	12.8
0315U	MK I A1	MIV	12852	15.5	12.8
1164M	MK I SS	MIA	12127	15.2	13.7
1164U	MK I SS	MIA	12127	15.2	13.7
1226M	MK I SS	MIA	11897	15.3	13.8
1226U	MK I SS	MIA	11897	15.3	13.8
1265M	MK II SS	MIA	12639	13.9	12.6
1265U	MK II SS	MIA	12639	13.9	12.6
1497M	MK I SS	MIA	11979	15.2	13.7
1497U	MK I SS	MIA	11979	15.2	13.7
1512M	MK II SS	MIV	13858	13.5	11.6
1512U	MK II SS	MIV	13858	13.5	11.6
1560M	MK I A1	MIV	12852	15.0	12.8
1560U	MK I A1	MIV	12852	15.0	12.8
1860M	MK I A1	Nat	13015	15.0	11.8
1860U	MK I A1	Nat	13015	15.0	11.8
2660M	MK I SS	MIA	13016	14.4	12.8
2660U	MK I SS	MIA	13016	14.4	12.8
2667M	MK I SS	MIA	13371	14.4	12.5
2667U	MK I SS	MIA	13371	14.4	12.5
5744M	MK II SS	MIA	11183	12.2	12.9

Table 1. Canisters Selected for Visual Inspection--Storage Parameters. (Continued)

K West Fuel					
Location	Canister Type ¹	Fuel Type	Key Date ²	Years ³	Plutonium-240
5744U	MK II SS	MIA	11183	12.2	12.9
6214M	MK II SS	MIV	11540	Unknown	16.9
6214U	MK II SS	MIV	11540	Unknown	16.9
6513M	MK II SS	MIA	11109	12.2	13.2
6513U	MK II SS	MIA	11109	12.2	13.2
6603M	MK II SS	MIV	11540	Unknown	17.0
6603U	MK II SS	MIV	11540	Unknown	17.0
6641M	MK II SS	MIV	12565	Unknown	15.4
6641U	MK II SS	MIV	12565	Unknown	15.4
6743M	MK II SS	MIA	10982	12.0	13.2
6743U	MK II SS	MIA	10982	12.0	13.2
7913M	MK II SS	MIA	10350	11.9	10.3
7913U	MK II SS	MIA	10350	11.9	10.3

¹SS: Stainless steel Al: Aluminum²Lowest key date is the oldest fuel.³Years since encapsulation (as of September 1996).

Table 2. Visually Examined Barrels--Measured Parameters.

K West Fuel Damage					
Location	Gas Trap Reading	Cesium-137 mCi/barrel	Potassium $\mu\text{g/ml}$	Fuel Coating	Qualitative Sludge Level
0091M	3.2	614	< 25	Medium-Light Green	Maximum
0091U	2.9	571	---	Medium-Gray/White	Maximum
0102M	---	623	230	Medium-Gray/White	Moderate
0102U	---	395	---	Medium-Gray/White	Moderate
0161M	---	999	296	Heavy-White	Moderate
0161U	---	486	280	Heavy-White	Moderate
0315M	---	119	334	Heavy-White	Minimal
0315U	---	142	---	Heavy-White	Moderate
1164M	---	1607	< 25	Medium-Gray/White	Moderate
1164U	---	538	---	Medium-Gray/White	Moderate
1226M	---	927	< 25	Medium-Gray/White	Moderate
1226U	---	152	< 25	Medium-Gray/White	Moderate
1265M	---	402	< 25	Medium-Gray/White	Minimal
1265U	---	703	< 25	Medium-Gray/White	Minimal
1497M	---	358	132	Medium-Gray/White	Minimal
1497U	---	4046	98	---	Maximum
1512M	1.9	765	< 25	Medium-Light Green	Maximum
1512U	2.2	246	---	Medium-Light Green	Maximum
1560M	---	179	38	Heavy-White	Moderate
1560U	---	1242	254	Heavy-White	Moderate
1860M	---	254	275	Heavy-White	Minimal
1860U	---	914	399	Heavy-White	Maximum
2660M	---	2801	< 25	Medium-Gray/White	Maximum
2660U	---	171	< 25	Medium-Gray/White	Maximum
2667M	---	3558	< 25	Medium-Gray/White	Maximum
2667U	---	804	---	Medium-Orange	Maximum
5744M	3.4	725	---	Medium-Gray/White	Maximum

Table 2. Visually Examined Barrels--Measured Parameters. (Continued)

K West Fuel Damage					
Location	Gas Trap Reading	Cesium-137 mCi/barrel	Potassium $\mu\text{g/ml}$	Fuel Coating	Qualitative Sludge Level
5744U	2.2	1051	72	Medium-Gray/White	Moderate
6214M	7.4	117	< 25	Medium-Gray/White	Minimal
6214U	15.8	120	84	Medium-Gray/White	Minimal
6513M	1.7	3546	26	Medium-Gray/White	Maximum
6513U	2.9	1444	< 25	Medium-Gray/White	Maximum
6603M	1.9	662	---	Medium-Gray/White	Maximum
6603U	16.6	195	106	Medium-Light Green	Minimal
6641M	16.2	77	242	Medium-Gray/White	Minimal
6641U	0.8	86	---	Medium-Gray/White	Minimal
6743M	3.1	807	< 25	Medium-Gray/White	Minimal
6743U	16.8	nd	---	Medium-Gray/White	Maximum
7913M	2.4	345	94	Medium-Gray/White	Minimal
7913U	0.9	989	< 25	Medium-Gray/White	Maximum

Table 3. Visual Inspection Results--INNERS.

K West Fuel Damage--INNERS												
Location	Canister Type	Fuel Type	Key Date	Years ¹	²⁴⁰ Pu	Total	I ²	Br ³	B ⁴	I (%)	Br (%)	B (%)
0091M	MK II SS	MIV	13858	13.5	11.6	7	5	2	0	71.4	28.6	0.0
0091U	MK II SS	MIV	13858	13.5	11.6	7	3	4	0	42.9	57.1	0.0
0102M	MK I SS	MIA	11806	15.6	13.3	7	7	0	0	100.0	0.0	0.0
0102U	MK I SS	MIA	11806	15.6	13.3	6	6	0	0	100.0	0.0	0.0
0161M	MK I AL	MIA	10832	15.6	12.5	7	7	0	0	100.0	0.0	0.0
0161U	MK I AL	MIA	10832	15.6	12.5	7	7	0	0	100.0	0.0	0.0
0315M	MK I AL	MIV	12852	15.5	12.8	7	6	1	0	85.7	14.3	0.0
0315U	MK I AL	MIV	12852	15.5	12.8	7	6	1	0	85.7	14.3	0.0
1164M	MK I SS	MIA	12127	15.2	13.7	5	4	1	0	80.0	20.0	0.0
1164U	MK I SS	MIA	12127	15.2	13.7	7	7	0	0	100.0	0.0	0.0
1226M	MK I SS	MIA	11897	15.3	13.8	5	4	1	0	80.0	20.0	0.0
1226U	MK I SS	MIA	11897	15.3	13.8	7	7	0	0	100.0	0.0	0.0
1265M	MK II SS	MIA	12639	13.9	12.6	7	7	0	0	100.0	0.0	0.0
1265U	MK II SS	MIA	12639	13.9	12.6	7	6	0	1	85.7	0.0	14.3
1497M	MK I SS	MIA	11979	15.2	13.7	4	4	0	0	100.0	0.0	0.0
1497U	MK I SS	MIA	11979	15.2	13.7	0	0	0	0	---	---	---
1512M	MK II SS	MIV	13858	13.5	11.6	7	4	3	0	57.1	42.9	0.0
1512U	MK II SS	MIV	13858	13.5	11.6	7	7	0	0	100.0	0.0	0.0
1560M	MK I AL	MIV	12852	15.0	12.8	6	4	1	1	66.7	16.7	16.7
1560U	MK I AL	MIV	12852	15.0	12.8	7	7	0	0	100.0	0.0	0.0
1860M	MK I AL	Nat	13015	15.0	11.8	7	6	1	0	85.7	14.3	0.0
1860U	MK I AL	Nat	13015	15.0	11.8	6	3	2	1	50.0	33.3	16.7
2660M	MK I SS	MIA	13016	14.4	12.8	7	7	0	0	100.0	0.0	0.0
2660U	MK I SS	MIA	13016	14.4	12.8	7	7	0	0	100.0	0.0	0.0
2667M	MK I SS	MIA	13371	14.4	12.5	1	1	0	0	100.0	0.0	0.0
2667U	MK I SS	MIA	13371	14.4	12.5	6	6	0	0	100.0	0.0	0.0
5744M	MK II SS	MIA	11183	12.2	12.9	7	5	1	1	71.4	14.3	14.3
5744U	MK II SS	MIA	11183	12.2	12.9	7	6	1	0	85.7	14.3	0.0
6214M	MK II SS	MIV	11540	Unknown	16.9	7	7	0	0	100.0	0.0	0.0
6214U	MK II SS	MIV	11540	Unknown	16.9	7	6	0	1	85.7	0.0	14.3
6513M	MK II SS	MIA	11109	12.2	13.2	7	6	1	0	85.7	14.3	0.0
6513U	MK II SS	MIA	11109	12.2	13.2	5	5	0	0	100.0	0.0	0.0
6603M	MK II SS	MIV	11540	Unknown	17.0	7	6	1	0	85.7	14.3	0.0
6603U	MK II SS	MIV	11540	Unknown	17.0	7	7	0	0	100.0	0.0	0.0
6641M	MK II SS	MIV	12565	Unknown	15.4	7	6	1	0	85.7	14.3	0.0
6641U	MK II SS	MIV	12565	Unknown	15.4	7	7	0	0	100.0	0.0	0.0
6743M	MK II SS	MIA	10982	12.0	13.2	6	6	0	0	100.0	0.0	0.0
6743U	MK II SS	MIA	10982	12.0	13.2	6	6	0	0	100.0	0.0	0.0
7913M	MK II SS	MIA	10350	11.9	10.3	7	7	0	0	100.0	0.0	0.0
7913U	MK II SS	MIA	10350	11.9	10.3	7	7	0	0	100.0	0.0	0.0

¹Years since encapsulation (as of September 1996).²Intact.³Breached.⁴Bad.

Table 4. Visual Inspection Summary--INNERS.

INNERS - %Intact by Barrel			INNERS - %Breached by Barrel			INNERS - %Bad by Barrel		
Class	Midpoint of Class	Frequency	Class	Midpoint of Class	Frequency	Class	Midpoint of Class	Frequency
$X^1 \leq 40$	----	0	$X=0$	----	24	$X=0$	----	34
$40 < X \leq 45$	42.5	1	$0 < X \leq 5$	2.5	0	$0 < X \leq 5$	2.5	0
$45 < X \leq 50$	47.5	1	$5 < X \leq 10$	7.5	0	$5 < X \leq 10$	7.5	0
$50 < X \leq 55$	52.5	0	$10 < X \leq 15$	12.5	8	$10 < X \leq 15$	12.5	3
$55 < X \leq 60$	57.5	1	$15 < X \leq 20$	17.5	3	$15 < X \leq 20$	17.5	2
$60 < X \leq 65$	62.5	0	$20 < X \leq 25$	22.5	0		Total	39
$65 < X \leq 70$	67.5	1	$25 < X \leq 30$	27.5	1			
$70 < X \leq 75$	72.5	2	$30 < X \leq 35$	32.5	1			
$75 < X \leq 80$	77.5	2	$35 < X \leq 40$	37.5	0			
$80 < X \leq 85$	82.5	0	$40 < X \leq 45$	42.5	1			
$85 < X \leq 90$	87.5	9	$45 < X \leq 50$	47.5	0			
$90 < X \leq 95$	92.5	0	$50 < X \leq 55$	52.5	0			
$95 < X \leq 100$	97.5	22	$55 < X \leq 60$	57.5	1			
	Total	39		Total	39			

¹X=Percent damage.

Table 5. Correlation Coefficients--INNERS Damage Versus Storage Parameters.

Variable 1	Variable 2	Sample Correlation			Rank Correlation		
		N	Coefficient	p-value	N	Coefficient	p-value
INNERS-%Intact	Canister Type	39	0.0198	0.905	40	-0.0150	0.927
INNERS-%Intact	Fuel Type	39	0.1321	0.423	40	0.2027	0.212
INNERS-%Intact	Key Date	39	-0.4168	0.003	40	-0.3211	0.042
INNERS-%Intact	Years Encapsulated	33	0.0263	0.885	34	0.0586	0.741
INNERS-%Intact	²⁴⁰ Pu Concentration	39	0.1956	0.233	40	0.1300	0.423
INNERS-%Breached	Canister Type	39	0.0116	0.944	40	-0.0581	0.720
INNERS-%Breached	Fuel Type	39	-0.1800	0.273	40	-0.1877	0.247
INNERS-%Breached	Key Date	39	0.4509	0.004	40	0.3448	0.034
INNERS-%Breached	Years Encapsulated	33	-0.0286	0.874	34	-0.0196	0.912
INNERS-%Breached	²⁴⁰ Pu Concentration	39	-0.2308	0.157	40	-0.1551	0.339
INNERS-%Bad	Canister Type	39	-0.0887	0.591	40	-0.0472	0.771
INNERS-%Bad	Fuel Type	39	0.0818	0.621	40	0.0470	0.772
INNERS-%Bad	Key Date	39	0.0442	0.789	40	0.0448	0.782
INNERS-%Bad	Years Encapsulated	33	-0.0024	0.989	34	-0.0560	0.751
INNERS-%Bad	²⁴⁰ Pu Concentration	39	0.0291	0.861	40	-0.0358	0.825

Table 6. Visual Inspection Results--OUTERS.

K West Fuel Damage												
Location	Canister Type	Fuel Type	Key Date	Years ¹	²⁴⁰ Pu	Total	I ²	Br ³	B ⁴	I (%)	Br (%)	B (%)
0091M	MK II SS	MIV	13858	13.5	11.6	7	2	5	0	28.6	71.4	0.0
0091U	MK II SS	MIV	13858	13.5	11.6	7	4	3	0	57.1	42.9	0.0
0102M	MK I SS	MIA	11806	15.6	13.3	7	3	4	0	42.9	57.1	0.0
0102U	MK I SS	MIA	11806	15.6	13.3	6	3	3	0	50.0	50.0	0.0
0161M	MK I Al	MIA	10832	15.6	12.5	7	1	4	2	14.3	57.1	28.6
0161U	MK I Al	MIA	10832	15.6	12.5	7	4	2	1	57.1	28.6	14.3
0315M	MK I Al	MIV	12852	15.5	12.8	7	5	2	0	71.4	28.6	0.0
0315U	MK I Al	MIV	12852	15.5	12.8	7	5	2	0	71.4	28.6	0.0
1164M	MK I SS	MIA	12127	15.2	13.7	6	0	4	2	0.0	66.7	33.3
1164U	MK I SS	MIA	12127	15.2	13.7	7	6	0	1	85.7	0.0	14.3
1226M	MK I SS	MIA	11897	15.3	13.8	7	5	2	0	71.4	28.6	0.0
1226U	MK I SS	MIA	11897	15.3	13.8	7	5	2	0	71.4	28.6	0.0
1265M	MK II SS	MIA	12639	13.9	12.6	7	4	3	0	57.1	42.9	0.0
1265U	MK II SS	MIA	12639	13.9	12.6	7	3	4	0	42.9	57.1	0.0
1497M	MK I SS	MIA	11979	15.2	13.7	7	5	2	0	71.4	28.6	0.0
1497U	MK I SS	MIA	11979	15.2	13.7	2	0	0	2	0.0	0.0	100.0
1512M	MK II SS	MIV	13858	13.5	11.6	7	4	2	1	57.1	28.6	14.3
1512U	MK II SS	MIV	13858	13.5	11.6	7	3	3	1	42.9	42.9	14.3
1560M	MK I Al	MIV	12852	15.0	12.8	6	2	3	1	33.3	50.0	16.7
1560U	MK I Al	MIV	12852	15.0	12.8	7	4	2	1	57.1	28.6	14.3
1860M	MK I Al	Nat	13015	15.0	11.8	7	6	0	1	85.7	0.0	14.3
1860U	MK I Al	Nat	13015	15.0	11.8	4	3	1	0	75.0	25.0	0.0
2660M	MK I SS	MIA	13016	14.4	12.8	7	5	1	1	71.4	14.3	14.3
2660U	MK I SS	MIA	13016	14.4	12.8	7	6	1	0	85.7	14.3	0.0
2667M	MK I SS	MIA	13371	14.4	12.5	3	0	1	2	0.0	33.3	66.7
2667U	MK I SS	MIA	13371	14.4	12.5	7	6	1	0	85.7	14.3	0.0
5744M	MK II SS	MIA	11183	12.2	12.9	6	1	4	1	16.7	66.7	16.7
5744U	MK II SS	MIA	11183	12.2	12.9	7	1	5	1	14.3	71.4	14.3
6214M	MK II SS	MIV	11540	Unknown	16.9	7	3	4	0	42.9	57.1	0.0
6214U	MK II SS	MIV	11540	Unknown	16.9	7	4	2	1	57.1	28.6	14.3
6513M	MK II SS	MIA	11109	12.2	13.2	7	4	2	1	57.1	28.6	14.3
6513U	MK II SS	MIA	11109	12.2	13.2	7	4	2	1	57.1	28.6	14.3
6603M	MK II SS	MIV	11540	Unknown	17.0	7	2	3	2	28.6	42.9	28.6
6603U	MK II SS	MIV	11540	Unknown	17.0	7	4	3	0	57.1	42.9	0.0
6641M	MK II SS	MIV	12565	Unknown	15.4	7	6	1	0	85.7	14.3	0.0
6641U	MK II SS	MIV	12565	Unknown	15.4	7	6	1	0	85.7	14.3	0.0
6743M	MK II SS	MIA	10982	12.0	13.2	6	3	3	0	50.0	50.0	0.0
6743U	MK II SS	MIA	10982	12.0	13.2	7	4	2	1	57.1	28.6	14.3
7913M	MK II SS	MIA	10350	11.9	10.3	7	5	1	1	71.4	14.3	14.3
7913U	MK II SS	MIA	10350	11.9	10.3	7	3	1	3	42.9	14.3	42.9

¹Years since encapsulation (as of September 1996).²Intact.³Breached.⁴Bad.

Table 7. Visual Inspection Summary--OUTERS.

OUTERS - %Intact by Barrel			OUTERS - %Breached by Barrel			OUTERS - %Bad by Barrel		
Class	Midpoint of Class	Frequency	Class	Midpoint of Class	Frequency	Class	Midpoint of Class	Frequency
X=0	----	3	X=0	----	3	X=0	----	19
0<X≤5	2.5	0	0<X≤5	2.5	0	0<X≤5	2.5	0
5<X≤10	7.5	0	5<X≤10	7.5	0	5<X≤10	7.5	0
10<X≤15	12.5	2	10<X≤15	12.5	7	10<X≤15	12.5	13
15<X≤20	17.5	1	15<X≤20	17.5	0	15<X≤20	17.5	2
20<X≤25	22.5	0	20<X≤25	22.5	1	20<X≤25	22.5	0
25<X≤30	27.5	2	25<X≤30	27.5	12	25<X≤30	27.5	2
30<X≤35	32.5	1	30<X≤35	32.5	1	30<X≤35	32.5	1
35<X≤40	37.5	0	35<X≤40	37.5	0	35<X≤40	37.5	0
40<X≤45	42.5	5	40<X≤45	42.5	5	40<X≤45	42.5	1
45<X≤50	47.5	2	45<X≤50	47.5	3	45<X≤50	47.5	0
50<X≤55	52.5	0	50<X≤55	52.5	0	50<X≤55	52.5	0
55<X≤60	57.5	10	55<X≤60	57.5	4	55<X≤60	57.5	0
60<X≤65	62.5	0	60<X≤65	62.5	0	60<X≤65	62.5	0
65<X≤70	67.5	0	65<X≤70	67.5	2	65<X≤70	67.5	1
70<X≤75	72.5	8	70<X≤75	72.5	2	70<X≤75	72.5	0
75<X≤80	77.5	0	75<X≤80	77.5	0	75<X≤80	77.5	0
80<X≤85	82.5	0	80<X≤85	82.5	0	80<X≤85	82.5	0
85<X≤90	87.5	6	85<X≤90	87.5	0	85<X≤90	87.5	0
90<X≤95	92.5	0	90<X≤95	92.5	0	90<X≤95	92.5	0
95<X≤100	97.5	0	95<X≤100	97.5	0	95<X≤100	97.5	1
	Total	40		Total	40		Total	40

¹Percent damage.

Table 8. Correlation Coefficients--OUTERS Damage Versus Storage Parameters.

Variable 1	Variable 2	Sample Correlation			Rank Correlation		
		N	Coefficient	p-value	N	Coefficient	p-value
OUTERS-%Intact	Canister Type	40	-0.1156	0.478	40	-0.1958	0.221
OUTERS-%Intact	Fuel Type	40	0.0324	0.843	40	0.0729	0.649
OUTERS-%Intact	Key Date	40	0.1767	0.275	40	0.2322	0.147
OUTERS-%Intact	Years Encapsulated	34	0.1193	0.502	34	0.1271	0.465
OUTERS-%Intact	²⁴⁰ Pu Concentration	40	0.0096	0.953	40	0.0329	0.837
OUTERS-%Breached	Canister Type	40	0.2171	0.178	40	0.2224	0.165
OUTERS-%Breached	Fuel Type	40	-0.1992	0.218	40	-0.1967	0.219
OUTERS-%Breached	Key Date	40	-0.0777	0.634	40	-0.1215	0.448
OUTERS-%Breached	Years Encapsulated	34	-0.1355	0.445	34	-0.0204	0.907
OUTERS-%Breached	²⁴⁰ Pu Concentration	40	0.0755	0.635	40	0.0519	0.746
OUTERS-%Bad	Canister Type	40	-0.0673	0.680	40	-0.0464	0.772
OUTERS-%Bad	Fuel Type	40	0.1542	0.342	40	0.1366	0.394
OUTERS-%Bad	Key Date	40	-0.1454	0.371	40	-0.2516	0.116
OUTERS-%Bad	Years Encapsulated	34	-0.0153	0.932	34	-0.1893	0.277
OUTERS-%Bad	²⁴⁰ Pu Concentration	40	-0.0879	0.590	40	-0.1442	0.368

Table 9. Correlation Coefficients--INNERS Versus OUTERS.

Variable 1	Variable 2	Sample Correlation			Rank Correlation		
		N	Coefficient	p-value	N	Coefficient	p-value
INNERS-%Intact	OUTERS-%Intact	39	0.1096	0.506	39	0.1317	0.417
INNERS-%Intact	OUTERS-%Breached	39	-0.2164	0.186	39	-0.2300	0.156
INNERS-%Intact	OUTERS-%Bad	39	0.1049	0.525	39	-0.0400	0.805
INNERS-%Breached	OUTERS-%Intact	39	0.0697	0.673	39	-0.0763	0.638
INNERS-%Breached	OUTERS-%Breached	39	0.1658	0.313	39	0.1703	0.294
INNERS-%Breached	OUTERS-%Bad	39	-0.1042	0.528	39	0.0280	0.863
INNERS-%Bad	OUTERS-%Intact	39	-0.1392	0.398	39	-0.1464	0.367
INNERS-%Bad	OUTERS-%Breached	39	0.2009	0.220	39	0.1743	0.283
INNERS-%Bad	OUTERS-%Bad	39	-0.0350	0.833	39	0.0944	0.561

Table 10. Correlation Coefficients--INNERS Damage Versus Measured Parameters.

Variable 1	Variable 2	Sample Correlation			Spearman Rank Correlation		
		N	Coefficient	p-value	N	Coefficient	p-value
INNERS-%Intact	Gas Trap	18	0.1867	0.458	18	0.0324	0.894
INNERS-%Intact	¹³⁷ Cs	38	0.0391	0.816	40	-0.0858	0.597
INNERS-%Intact	K	29	-0.1391	0.472	30	-0.0669	0.723
INNERS-%Intact	Coating Code	39	-0.2407	0.140	39	-0.2070	0.202
INNERS-%Intact	Sludge Code	39	-0.2753	0.090	39	-0.1640	0.312
INNERS-%Breached	Gas Trap	18	-0.2549	0.307	18	-0.1494	0.538
INNERS-%Breached	¹³⁷ Cs	38	0.0013	0.994	40	0.1255	0.439
INNERS-%Breached	K	29	0.1128	0.560	30	0.0815	0.666
INNERS-%Breached	Coating Code	39	0.2156	0.188	39	0.2590	0.110
INNERS-%Breached	Sludge Code	39	0.3171	0.049	39	0.2429	0.134
INNERS-%Bad	Gas Trap	18	0.2362	0.345	18	0.3071	0.205
INNERS-%Bad	¹³⁷ Cs	39	-0.0544	0.742	40	-0.0396	0.807
INNERS-%Bad	K	29	0.1098	0.571	30	0.1498	0.428
INNERS-%Bad	Coating Code	39	0.1426	0.386	39	0.1214	0.454
INNERS-%Bad	Sludge Code	39	-0.0210	0.899	39	-0.0211	0.896

Table 11. Correlation Coefficients--OUTERS Damage Versus Measured Parameters.

Variable 1	Variable 2	Sample Correlation			Spearman Rank Correlation		
		N	Coefficient	p-value	N	Coefficient	p-value
OUTERS-%Intact	Gas Trap	18	0.3146	0.204	18	0.0689	0.776
OUTERS-%Intact	¹³⁷ Cs	40	-0.3999	0.031	40	-0.4349	0.007
OUTERS-%Intact	K	30	0.2534	0.177	30	0.2459	0.186
OUTERS-%Intact	Coating Code	39	0.0589	0.722	40	0.0786	0.628
OUTERS-%Intact	Sludge Code	40	-0.2766	0.084	40	-0.2391	0.136
OUTERS-%Breached	Gas Trap	18	-0.1522	0.547	18	0.2535	0.296
OUTERS-%Breached	¹³⁷ Cs	40	-0.0943	0.563	40	0.0988	0.537
OUTERS-%Breached	K	30	-0.1973	0.296	30	-0.2202	0.236
OUTERS-%Breached	Coating Code	39	-0.0377	0.820	40	-0.0434	0.789
OUTERS-%Breached	Sludge Code	40	-0.0298	0.855	40	-0.0594	0.711
OUTERS-%Bad	Gas Trap	18	-0.2900	0.243	18	-0.3699	0.127
OUTERS-%Bad	¹³⁷ Cs	40	0.5927	0.000	40	0.4782	0.003
OUTERS-%Bad	K	30	-0.1134	0.551	30	0.0118	0.950
OUTERS-%Bad	Coating Code	39	-0.0481	0.771	40	0.0293	0.857
OUTERS-%Bad	Sludge Code	40	0.3758	0.017	40	0.3948	0.014

Table 12. Correlation Coefficients--Known Versus Measured Parameters.

Variable 1	Variable 2	Sample Correlation			Spearman Rank Correlation		
		Coefficient	N	p-value	Coefficient	N	p-value
Can Type	Fuel Type	-0.2530	40	0.115	-0.2614	40	0.103
Can Type	Key Date	-0.1904	40	0.239	-0.2379	40	0.137
Can Type	Years	-0.8175	34	0.000	-0.8147	40	0.000
Can Type	²⁴⁰ Pu	0.2192	40	0.174	0.1323	40	0.409
Can Type	Gas Trap	1.0000	18	0.000	1.0000	40	0.000
Can Type	[¹³⁷ Cs]	-0.0134	39	0.936	-0.0446	40	0.783
Can Type	[K]	-0.6609	30	0.000	-0.5439	40	0.003
Can Type	Coating Code	-0.6788	39	0.000	-0.5852	40	0.000
Can Type	Sludge Code	0.0308	40	0.850	0.0288	40	0.858
Fuel Type	Can Type	-0.2530	40	0.115	-0.2614	40	0.103
Fuel Type	Key Date	-0.2761	40	0.085	-0.2611	40	0.103
Fuel Type	Years	-0.0067	34	0.970	0.0177	40	0.919
Fuel Type	²⁴⁰ Pu	-0.3916	40	0.012	-0.1820	40	0.256
Fuel Type	Gastrap	-0.2302	18	0.358	-0.1079	40	0.656
Fuel Type	[¹³⁷ Cs]	0.3011	39	0.063	0.4760	40	0.003
Fuel Type	[K]	0.1632	30	0.389	0.0213	40	0.909
Fuel Type	Coating Code	-0.1403	39	0.394	-0.2080	40	0.200
Fuel Type	Sludge Code	0.1189	40	0.465	0.1262	40	0.431
Key Date	Can Type	-0.1904	40	0.239	-0.2379	40	0.137
Key Date	Fuel Type	-0.2761	40	0.085	-0.2611	40	0.103
Key Date	Years	0.3449	34	0.046	0.0782	40	0.653
Key Date	²⁴⁰ Pu	-0.1977	40	0.222	-0.3398	40	0.034
Key Date	Gastrap	-0.1072	18	0.672	0.0063	40	0.979
Key Date	[¹³⁷ Cs]	-0.0405	39	0.807	-0.1072	40	0.509
Key Date	[K]	0.0385	30	0.840	-0.1161	40	0.532
Key Date	Coating Code	0.3110	39	0.054	0.3193	40	0.049
Key Date	Sludge Code	0.2008	40	0.214	0.2229	40	0.164

Table 12. Correlation Coefficients--Known Versus Measured Parameters. (Continued)

Variable 1	Variable 2	Sample Correlation			Spearman Rank Correlation		
		Coefficient	N	p-value	Coefficient	N	p-value
Years	Can Type	-0.8175	34	0.000	-0.8147	40	0.000
Years	Fuel Type	-0.0067	34	0.970	0.0177	40	0.919
Years	Key Date	0.3449	34	0.046	0.0782	40	0.653
Years	²⁴⁰ Pu	0.3959	34	0.021	0.3702	34	0.033
Years	Gastrap	-0.2120	12	0.508	0.0146	34	0.961
Years	[¹³⁷ Cs]	-0.1249	33	0.489	-0.2490	34	0.159
Years	[K]	0.5126	26	0.007	0.5013	34	0.012
Years	Coating Code	0.4344	33	0.012	0.3787	34	0.032
Years	Sludge Code	-0.2396	34	0.172	-0.3293	34	0.059
²⁴⁰ Pu	Can Type	0.2192	40	0.174	0.1323	40	0.409
²⁴⁰ Pu	Fuel Type	-0.3916	40	0.012	-0.1820	40	0.256
²⁴⁰ Pu	Key Date	-0.1977	40	0.222	-0.3398	40	0.034
²⁴⁰ Pu	Years	0.3959	34	0.021	0.3702	34	0.033
²⁴⁰ Pu	Gastrap	0.5422	18	0.020	0.3644	40	0.133
²⁴⁰ Pu	[¹³⁷ Cs]	-0.1355	39	0.411	-0.2197	40	0.176
²⁴⁰ Pu	[K]	-0.0836	30	0.661	-0.0434	40	0.815
²⁴⁰ Pu	Coating Code	-0.2576	39	0.113	-0.4303	40	0.008
²⁴⁰ Pu	Sludge Code	-0.3607	40	0.022	-0.3401	40	0.034
Gas Trap	Can Type	1.0000	18	0.000	1.0000	40	0.000
Gas Trap	Fuel Type	-0.2302	18	0.358	-0.1079	40	0.656
Gas Trap	Key Date	-0.1072	18	0.672	0.0063	40	0.979
Gas Trap	Years	-0.2120	12	0.508	0.0146	34	0.961
Gas Trap	²⁴⁰ Pu	0.5422	18	0.020	0.3644	40	0.133
Gas Trap	[¹³⁷ Cs]	-0.3942	17	0.117	-0.4408	18	0.078
Gas Trap	[K]	0.7093	12	0.010	0.4628	18	0.125
Gas Trap	Coating Code	0.0266	18	0.917	0.0516	18	0.832
Gas Trap	Sludge Code	-0.4113	18	0.090	-0.3076	18	0.205

Table 12. Correlation Coefficients--Known Versus Measured Parameters. (Continued)

Variable 1	Variable 2	Sample Correlation			Spearman Rank Correlation		
		Coefficient	N	p-value	Coefficient	N	p-value
[¹³⁷ Cs]	Can Type	-0.0134	39	0.936	-0.0446	40	0.783
[¹³⁷ Cs]	Fuel Type	0.3011	39	0.063	0.4760	40	0.003
[¹³⁷ Cs]	Key Date	-0.0405	39	0.807	-0.1072	40	0.509
[¹³⁷ Cs]	Years	-0.1249	33	0.489	-0.2490	34	0.159
[¹³⁷ Cs]	²⁴⁰ Pu	-0.1355	39	0.411	-0.2197	40	0.176
[¹³⁷ Cs]	Gastrap	-0.3942	17	0.117	-0.4408	18	0.078
[¹³⁷ Cs]	[K]	-0.2238	30	0.234	-0.1880	39	0.311
[¹³⁷ Cs]	Coating Code	-0.2088	38	0.208	-0.1161	39	0.480
[¹³⁷ Cs]	Sludge Code	0.4979	39	0.001	0.5657	39	0.001
[K]	Can Type	-0.6609	30	0.000	-0.5439	40	0.003
[K]	Fuel Type	0.1632	30	0.389	0.0213	40	0.909
[K]	Key Date	0.0385	30	0.840	-0.1161	40	0.532
[K]	Years	0.5126	26	0.007	0.5013	34	0.012
[K]	²⁴⁰ Pu	-0.0836	30	0.661	-0.0434	40	0.815
[K]	Gastrap	0.7093	12	0.010	0.4628	18	0.125
[K]	[¹³⁷ Cs]	-0.2238	30	0.234	-0.1880	39	0.311
[K]	Coating Code	0.6661	29	0.000	0.6291	30	0.001
[K]	Sludge Code	-0.1945	30	0.303	-0.2696	30	0.147
Coating Code	Can Type	-0.6788	39	0.000	-0.5852	40	0.006
Coating Code	Fuel Type	-0.1403	39	0.394	-0.2080	40	0.200
Coating Code	Key Date	0.3110	39	0.054	0.3193	40	0.049
Coating Code	Years	0.4344	33	0.012	0.3787	34	0.032
Coating Code	²⁴⁰ Pu	-0.2576	39	0.113	-0.4303	40	0.008
Coating Code	Gastrap	0.0266	18	0.917	0.0516	18	0.832
Coating Code	[¹³⁷ Cs]	-0.2088	38	0.208	-0.1161	39	0.480
Coating Code	[K]	0.6661	29	0.000	0.6291	30	0.001
Coating Code	Sludge Code	-0.0133	39	0.936	0.0070	39	0.966

Table 12. Correlation Coefficients--Known Versus Measured Parameters. (Continued)

Variable 1	Variable 2	Sample Correlation			Spearman Rank Correlation		
		Coefficient	N	p-value	Coefficient	N	p-value
Sludge Code	Can Type	0.0308	40	0.850	0.0288	40	0.858
Sludge Code	Fuel Type	0.1189	40	0.465	0.1262	40	0.431
Sludge Code	Key Date	0.2008	40	0.214	0.2229	40	0.164
Sludge Code	Years	-0.2396	34	0.172	-0.3293	34	0.059
Sludge Code	²⁴⁰ Pu	-0.3607	40	0.022	-0.3401	40	0.034
Sludge Code	Gastrop	-0.4113	18	0.090	-0.3076	18	0.205
Sludge Code	[¹³⁷ Cs]	0.4979	39	0.001	0.5657	39	0.001
Sludge Code	[K]	-0.1945	30	0.303	-0.2696	30	0.147
Sludge Code	Coating Code	-0.0133	39	0.936	0.0070	39	0.966

This page intentionally left blank.

Figure 1. Histogram: INNERS--Percent Intact.

Figure 2. Histogram: INNERS--Percent Breached.

Figure 3. Histogram: INNERS--Percent Bad.

Figure 4. Histogram: OUTERS--Percent Intact.

Figure 5. Histogram: OUTERS--Percent Breached.

Figure 6. Histogram: OUTERS--Percent Bad.

Figure 7. Damage Versus Canister Type--INNERS.

Figure 8. Damage Versus Fuel Type--INNERS.

Figure 9. Damage Versus Key Date--INNERS.

Figure 10. Damage Versus Years Encapsulated--INNERS.

Figure 11. Damage Versus Plutonium-240--INNERS.

Figure 12. INNERS Versus Canister Type.

Figure 13. INNERS Versus Fuel Type.

Figure 14. INNERS Versus Key Date.

Figure 15. INNERS Versus Years Encapsulated.

Figure 16. INNERS Versus Plutonium-240.

Figure 17. Damage Versus Canister Type--OUTERS.

Figure 18. Damage Versus Fuel Type--OUTERS.

Figure 19. Damage Versus Key Date--OUTERS.

Figure 20. Damage Versus Years Encapsulated--OUTERS.

Figure 21. Damage Versus Plutonium-240--OUTERS.

Figure 22. OUTERS Versus Canister Type.

Figure 23. OUTERS Versus Fuel Type.

Figure 24. OUTERS Versus Key Date.

Figure 25. OUTERS Versus Years Encapsulated.

Figure 26. OUTERS Versus Plutonium-240.

Figure 27. INNERS-Intact Versus OUTERS-Intact.

Figure 28. INNERS-Intact Versus OUTERS-Breached.

Figure 29. INNERS-Intact Versus OUTERS-Bad.

Figure 30. INNERS-Breached Versus OUTERS-Intact.

Figure 31. INNERS-Breached Versus OUTERS-Breached.

Figure 32. INNERS-Breached Versus OUTERS-Bad.

Figure 33. INNERS-Bad Versus OUTERS-Intact.

Figure 34. INNERS-Bad Versus OUTERS-Breached.

Figure 35. INNERS-Bad Versus OUTERS-Bad.

Figure 36. Sludge Code Versus INNERS-Percent Damage.

Figure 37. Cesium-137 Versus OUTERS-Percent Damage.

Figure 38. Sludge Code Versus OUTERS-Percent Damage.

Figure 39. Canister Type Versus Years Since Encapsulated.

Figure 40. Canister Type Versus Potassium.

Figure 41. Canister Type Versus Coating Code.

Figure 42. Fuel Type Versus Plutonium-240.

Figure 43. Fuel Type Versus Cesium-137.

Figure 44. Key Date Versus Years Since Encapsulation.

Figure 45. Key Date Versus Coating Code.

Figure 46. Key Date Versus Plutonium-240.

Figure 47. Years Since Encapsulation Versus Plutonium-240.

Figure 48. Years Since Encapsulation Versus Coating Code.

Figure 49. Years Since Encapsulation Versus Potassium.

Figure 50. Plutonium-240 Versus Gas Trap.

Figure 51. Plutonium-240 Versus Coating Code.

Figure 52. Plutonium-240 Versus Sludge Code.

Figure 53. Gas Trap Versus Potassium.

Figure 54. Cesium-137 Versus Sludge Code.

Figure 55. Potassium Versus Coating Code.

DISTRIBUTION SHEET

To	From	Page 1 of 2
Distribution	SNF Characterization Project	Date 02/27/98
Project Title/Work Order	EDT No. 620801	
Spent Nuclear Fuel Project	ECN No.	

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
------	------	-----------------------------	-----------	------------------------------	-----------------

Fluor Daniel Hanford, Inc.

E. W. Gerber	R3-11	X			
N. H. Williams	R3-11	X			

Fluor Daniel Northwest

R. D. Crowe	R3-26	X			
L. J. Garvin	R3-26	X			

B & W Protec, Inc.

D. D. Scott	T4-40	X			
T. L. Welsh (5)	T4-40	X			

ICF Kaiser Hanford Company

G. Baston	R3-82	X			
R. P. Denise	R3-82	X			

Numatec Hanford Corporation

T. A. Flament	R3-86	X			
J. J. Irwin	R3-86	X			
C. R. Miska	R3-86	X			
J. P. Slougher	H5-49	X			

Pacific Northwest National Laboratory

J. Abrefah	P7-27	X			
A. B. Johnson	K8-34	X			
S. C. Marschman	P7-27	X			

SGN Eurisys Services Corp.

A. L. Pajunen	R3-86	X			
---------------	-------	---	--	--	--

XWest

R. P. Dipiazza	R3-15	X			
----------------	-------	---	--	--	--

Duke Engineering & Services
Hanford, Inc.

C. J. Alderman	X3-85	X			
R. B. Baker	H0-40	X			
D. W. Bergmann	X3-79	X			
K. H. Bergsman	X3-85	X			
L. D. Bruggeman	H0-40	X			
A. E. Bridges	H0-40	X			
S. A. Brisbin	R3-86	X			
S. A. Chastain	H0-40	X			

DISTRIBUTION SHEET

To	From	Page 2 of 2
Distribution	SNF Characterization Project	Date 02/27/98
Project Title/Work Order		EDT No. 620801
Spent Nuclear Fuel Project		ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
------	------	-----------------------------	-----------	------------------------------	-----------------

Duke Engineering & Services

Hanford, Inc. (Continued)

D. R. Duncan	R3-86	X
J. R. Frederickson	R3-86	X
W. M. Funderburke	R3-11	X
R. G. Gant	X3-79	X
L. H. Goldman	R3-86	X
J. J. Jernberg	X3-72	X
A. T. Kee	R3-86	X
L. A. Lawrence	H0-40	X
C. D. Lucas	X3-56	X
B. J. Makenas	H0-40	X
F. W. Moore	R3-86	X
R. P. Omberg	H0-40	X
M. J. Packer	X3-85	X
A. L. Pitner (5)	H0-40	X
A. N. Praga	R3-86	X
K. L. Pearce	R3-47	X
D. R. Precechtel	X3-85	X
R. W. Rasmussen	R3-86	X
A. M. Segrest	R3-11	X
E. J. Shen	X3-75	X
J. A. Swenson	R3-11	X
J. H. Wicks	R3-11	X
D. S. Takasumi	X3-85	X
D. J. Trimble	H0-40	X
D. J. Watson	X3-79	X
R. M. Yanocho	R3-86	X
SNF Project File	R3-11	X
Central Files	B1-07	X

U.S. Department of Energy

Richland Operations Office

J. M. Escamillio	S7-41	X
C. A. Hansen	S7-41	X
R. M. Hiegel	S7-41	X
O. M. Holgado	S7-41	X
P. G. Loscoe	S7-41	X
E. D. Sellers	S7-41	X
J. Shuen	S7-41	X