PNL-10175
UC-721
Supplement 1

Ferrocyanide Safety Project: Comparison of Actual and Simulated Ferrocyanide Waste Properties

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October 1995

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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Summary

In 1995, available subsegment samples of wastes taken from the Hanford Site underground radioactive waste storage tanks 241-C-112 (C-112) and 241-C-109 (C-109) were reanalyzed to determine the nickel concentrations in the samples and to determine whether the use of a nickel crucible in the analytical sample preparation biased the reported nickel concentrations reported by Simpson and coworkers (1993a; 1993b) and in the original report (Scheele et al 1994) that this report supplements. The reanalysis strategy to determine nickel was to use a sodium peroxide flux in a zirconium crucible instead of the previously used potassium hydroxide flux in a nickel crucible. This supplemental report provides the results of the reanalyses and updates tables from the original report which reflect the new nickel analyses.

Nickel is important with respect to management of the potentially reactive ferrocyanide wastes as it is one of the key defining characteristics of the solids that resulted from scavenging radiocesium using ferrocyanides. In Hanford Site wastes, few other processes introduced nickel into the wastes other than radiocobalt scavenging, which was often coupled with the ferrocyanide-scavenging process. Thus the presence of nickel in a waste provides strong evidence that the original waste was or contained ferrocyanide waste at one time.

Given the potential import of nickel as a defining characteristic and marker for ferrocyanide wastes, the Pacific Northwest Laboratory's (PNL) Analytical Chemistry Laboratory (ACL) reanalyzed available samples from tanks C-112 and C-109 using inductively coupled argon plasma/atomic emission spectrometry (ICP/AES) and an alternative sample preparation method which precluded contamination of the analytical samples with nickel. The samples reanalyzed from C-112 were Core 34 quarter segment 2B (C34_2B), Core 34 quarter segment 2C (C34_2C), Core 34 quarter segment (C34_2D), Core 35 quarter segment 2D (C35_2D), Core 36 quarter segment 1C (C36_1C), Core 36 quarter segment 1D (C36_1D), Core 36 quarter segment 2D (C36_2D). The samples reanalyzed from 241-C-109 (C-109) were Core 47 quarter segment 1D (C47_1D), Core 49 quarter segment 1B (C49_1B), Core 49 quarter segment 1C (C49_1C), and Core 49 quarter segment (C49_1D).

The results of the reanalyses of available archived quarter-segment samples taken from C-112 by Cores 34, 35, and 36 and from C-109 by Cores 47, 48, and 49 to provide a more accurate nickel measurement indicate that based on a statistical paired T-Test, the nickel crucible contributed a significant (at the 95% confidence level) but variable amount of nickel to the originally reported nickel concentrations; the 1995 results ranged from 65 to 115% of the 1992 results with the results recently obtained typically less than those reported by Simpson et al. (1993a; 1993b). Based on the comparison of results obtained by the two different analyses, it is recommended that any future analyses of ferrocyanide wastes employ a non-nickel crucible for the sample preparation.

The alternative explanation that the mechanically mixed sludge samples were not homogeneous and sample inhomogeneity explains the observed differences in measured nickel concentrations is suggested by the documents of Simpson et al. (1993a; 1993b) that report the samples obtained from tanks C-112 and C-109 were difficult to homogenize successfully. Although inhomogeneity is a viable explanation for the dissimilarities in the nickel measurements, similarities in the other elemental waste components and typically lower comparative nickel concentrations in the 1995 analyses indicates that the nickel crucible contributed significant amounts of nickel to the 1992 analyses.

Although the nickel crucibles contributed significant amounts to the reported nickel concentrations for the different subsegment samples, the qualitative conclusions drawn and reported in the original report are changed little by the new nickel or other elemental analyses. These new ICP/AES analyses continue to indicate that the wastes stored in tanks C-112 and C-109 are aged ferrocyanide wastes mixed with the other waste types added to each tank with the amount of mixing dependent on the location within the tank.

Abbreviations and Initialisms

ACL	Analytical Chemistry Laboratory
AES	atomic emission spectrometer
CWP	aluminum cladding waste
1C	first cycle Bismuth Phosphate Process waste
GEA	gamma energy analysis
ICP	inductively coupled argon plasma
PNL	Pacific Northwest Laboratory
UR	uranium recovery wastes
WHC	Westinghouse Hanford Company

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1.0 Introduction

The wastes currently stored in the underground waste storage tanks 241-C-109 (C-109) and 241-C-112 (C-112) are predominantly ferrocyanide wastes that were generated using the IN-FARM scavenging flowsheet (Jeppson and Wong 1993) and other Hanford Site wastes including Bismuth Phosphate Process first cycle (1C) wastes, unscavenged uranium recovery wastes (UR), and PUREX aluminum cladding wastes (CWP) depending on the tank (Agnew 1993; Agnew et al. 1995; Brevick 1995; Simpson et al. 1993a; 1993b; and Dicenso et al. 1995). Brevick (1995), based on the work of Agnew and his coworkers (1995), reports that tank C-109 (in order of addition) contains 38 kL (12.0 cm) of 1C 160 kL (50 cm) of IN-FARM ferrocyanide waste, 26 kL (8.2 cm) of HS waste, 11 kL (3.5 cm) of an unknown waste, and 15.1 kL (4.7 cm) of supernate and that tank C-112 contains (in order of addition) 57 kL (16.6 cm) of 1C waste, 197 kL (57.3 cm) of IN-FARM waste, 57 kL (16.6 cm) of CWP, 11 kL (3.2 cm) of HS waste, and 19 kL (5.5 cm) of an unknown waste. The waste contents are slightly different than those previously reported by Simpson et al. (1993a; 1993b) who reported that tank C-109 contained CWP waste and that tank C-112 contained UR waste.

As described in the original report (Scheele et al. 1994), the original charter for the Ferrocyanide Safety Program's Comparison of Actual and Simulated Ferrocyanide Wastes Task was to provide a comparison of measured chemical and physical properties of simulated ferrocyanide wastes prepared by the Hanford Site operating contractor, Westinghouse Hanford Company (WHC), with samples of waste taken from two of the underground storage tanks identified as containing Hanford ferrocyanide wastes. The objective of this comparison was to determine whether properties of the ferrocyanide waste simulants characteristic of ferrocyanide wastes at the time of their creation were representative of or bounded the properties of wastes stored in the underground radioactive waste storage tanks 241-C-109 (C-109) and 241-C-112 (C-112). Included in our original work scope was remeasurement of nickel concentrations in available archived samples from tanks C-109 and C-112, using an analytical strategy that would preclude contamination of the sample with additional nickel. Unfortunately, operational difficulties in the facility housing the samples and analytical services organization prevented the remeasurement of nickel concentrations in these radioactive samples.

Remeasurement of nickel concentrations in these samples from tanks C-109 and C-112 using an alternate strategy was deemed necessary because of nickel's importance as a key characteristic and measure of the total amount of ferrocyanide wastes, coupled with the potential that the measured nickel concentrations reported by Simpson et al. (1993a; 1993b) were biased high. The possibility that the nickel concentrations might be biased high arose from using a nickel crucible while fusing the samples with potassium hydroxide for analysis by inductively coupled argon plasma (ICP) using an atomic emission spectrometer (AES). This remeasurement was deemed important even though nickel analyses of an analytical "blank" sample, a potassium-hydroxide fusion in a nickel crucible without any other added material, found that the crucible's contribution of nickel was less than one-tenth of the concentrations measured in the tank C-109 and tank C-112 samples, which indicated that the nickel crucible contributed no more than 10% to the final analytical result for nickel.

This supplemental report provides the results of the ICP/AES remeasurements of nickel concentrations in available tank C-109 and tank C-112 samples and corrects some errors in the elemental concentration tables. The report provides a comparison of the two sets of analyses for each sample to illustrate the similarities and differences between the two sets of ICP/AES elemental analyses, and provides revised tables from the original report incorporating the new nickel concentrations and the corrections.

2.0 Analytical Approach and Samples Analyzed

The nickel concentrations in samples taken from tank C-112 and tank C-109 reported by Simpson, Borsheim, and Jensen (1993a; 1993b) were measured by ICP/AES after preparing the sample for analysis by fusing the samples with potassium hydroxide in a nickel crucible. The use of a nickel crucible potentially raised the reported nickel contents in the tank C-112 and tank C-109 samples significantly above actual levels, even though analyses of blank samples indicated that the crucible should have contributed no more than 10% to the measured concentration.

To eliminate the potential that the nickel crucible contributed significant amounts of nickel to the measured nickel concentrations in the tank C-112 and tank C-109 samples, the Pacific Northwest Laboratory's (PNL)[(a)] Analytical Chemistry Laboratory (ACL) used an alternative analytical strategy employing a different flux and crucible to measure the nickel concentrations in available archived samples of tank C-112 and tank C-109 wastes. In this strategy the sample was prepared for reanalysis by ICP/AES by fusing the sample with sodium peroxide in a zirconium crucible. The use of this method rendered the sodium, zirconium, and phosphorous measurements either of little value or significantly biased the measurement; the measured phosphorous concentrations could be low due to formation of an insoluble zirconium phosphate.

Unfortunately, a few samples from tanks C-112 and C-109 were consumed by earlier characterization efforts (Bell 1993; Sprouse 1993), thus preventing reanalysis of all of the samples taken from these two radioactive waste storage tanks. The samples reanalyzed from tank C-112 were Core 34 quarter segment 2B (C34_2B), Core 34 quarter segment 2C (34_2C), Core 34 quarter segment (C34_2D), Core 35 quarter segment 2D (C35_2D), Core 36 quarter segment 1C (C36_1C), Core 36 quarter segment 1D (C36_1D), and Core 36 quarter segment 2D (C36_2D). The samples reanalyzed from tank 241-C-109 were Core 47 quarter segment 1D (C47_1D), Core 49 quarter segment 1B (C49_1B), Core 49 quarter segment 1C (C49_1C), and Core 49 quarter segment 1D (C49_1D).

Because of differences in the amount of stored waste in C-112 (115 cm) and C-109 (80 cm), the quarter segments with similar identifiers come from different depths in the two tanks. Tables 2.1 and 2.2 provide the quarter-segment sample locations taken from C-112 and C-109, respectively, based on the sampling information provided by Simpson et al. (1993a; 1993b).

(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

Table 2.1. Estimated Locations of Quarter-Segment Samples Taken by Cores 34, 35, and 36 taken from Tank C-112

Quarter Segment ID	Sampling Region Height, cm
1B	105-115
1C	93-105
1D	81-93
2A	69-81
2B	57-69
2C	45-57
2D	33-45

Table 2.2. Estimated Locations of Quarter-Segment Samples Taken by Cores 47, 48, and 49 from Tank C-109

Quarter Segment ID	Sampling Region Height, cm
1A	70-82
1B	58-70
1C	58-70
1D	34-46

3.0 Analytical Results

Tables 3.1 through 3.5 present the results in wt% of the reanalyses of the available tank C-112 and tank C-109 samples and, for comparison, the results of the earlier analyses (Bell 1993; Sprouse 1993; Simpson et al. 1993a; 1993b); these tables provide only those elements found in significant concentrations. The sodium and the zirconium concentrations measured in 1995 will be, or likely will be, biased high, because the sample preparation used a sodium peroxide flux in a zirconium crucible. In addition, the 1995 phosphate results are of questionable accuracy because of insoluble zirconium phosphate formation resulting from the use of a zirconium crucible.

In general, with the exception of nickel, the 1995 and 1992 measurements differ little. The nickel concentrations were typically lower for the reanalyses, after correcting for the blank, than those reported by Simpson et al. (1993a; 1993b); it is assumed that the earlier reported analyses corrected for the blank contribution, making the results directly comparable. A statistical paired T-Test, testing the hypothesis that the measured nickel concentrations were the same, indicated that the two sets of analyses were different at a > 95% confidence level.

The observed statistical differences between the 1995 and 1992 analyses is likely due to the differences in the two analytical strategies used; however, sample homogeneity may also be the cause for the observed differences. Prior to analysis, the samples are mechanically homogenized and aliquots of the homogenized sample taken from different locations are analyzed in duplicate by ICP/AES and by

Table 3.1. Comparison of Major Element Concentrations in Wt% as Measured by ICP/AES in 1995 for Available Archive Samples and in 1992 (Bell 1993) of Samples Taken by Core 34 from Tank C-112 (Dry Basis)

Element	1995 C34_2B, wt%	1992 C34_2B, wt%	1995 C34_2C, wt%	1992 C34_2C, wt%	1995 C34_2D, wt%	1992 C34_2D, wt%
Al	6.4e+00	6.9e+00	3.0e+00	4.1e+00	6.6e+00	5.6e+00
Ca	4.4e+00	4.6e+00	6.7e+00	7.1e+00	3.9e+00	5.0e+00
Fe	3.0e+00	3.1e+00	2.2e+00	2.4e+00	3.1e+00	4.1e+00
Na	(a)	1.9e+01	(a)	2.1e+01	(a)	1.6e+01
Ni	3.8e+00	4.7e+00	4.9e+00	6.7e+00	3.2e+00	4.9e+00
P	2.9e+00(b)	2.4e+00	2.8e+00(b)	4.7e+00	3.2e+00(b)	4.1e+00
Pb	8.7e-01	7.7e-01	3.0e-01	2.7e-01	5.4e-01	5.9e-01
Si	7.9e-01	6.8e-01	3.5e-01	3.4e-01	5.6e-01	6.0e-01
Sr	5.8e-02	5.8e-02	3.4e-02	3.6e-02	3.4e-02	3.9e-02
U	1.3e+00	6.3e-01	9.8e-01	1.3e+00	3.4e+00	4.2e+00

(a) Sodium peroxide fusion used for sample preparation rendering sodium analysis inaccurate.

(b) Zirconium crucible used for container during fusion rendering measurement inaccurate from possible zirconium phosphate precipitate formation.

Table 3.2. Comparison of Major Element Concentrations as Measured by ICP/AES in 1995 for Available Archive Samples and in 1992 (Bell 1993) of Samples Taken by Core 35 from Tank C-112 (Dry Basis)

Element	1995 C35_2D, wt%	1992 C35_2D, wt%
Al	7.0e+00	6.8e+00
Ca	2.5e+00	2.3e+00
Fe	6.5e+00	4.9e+00
Na	(a)	1.2e+01
Ni	2.5e+00	3.0e+00
P	(b)	3.2e+00
Pb	7.9e-01	7.1e-01
Si	1.5e+00	1.3e+00
Sr	7.0e-02	6.5e-02
U	1.5e+01	1.3e+01

(a) Sodium peroxide used as flux to dissolve sample rendering measurement inaccurate.

(b) Zirconium crucible used for container during fusion rendering measurement inaccurate from possible zirconium phosphate precipitate formation. .

Table 3.3. Comparison of Major Element Concentrations as Measured by ICP/AES in 1995 for Available Archive Samples and in 1992 (Bell 1993) of Samples Taken by Core 36 from Tank C-112 (Dry Basis)

Element	1995 C36_1C, wt%	1992 C36_1C, wt%	1995 C36_1D, wt%	1992 C36_1D, wt%	1995 C36_2D, wt%	1992 C36_2D, wt%
Al	3.0e+00	2.9e+00	1.1e+00	9.5e-01	6.6e-01	6.8e-01
Ca	6.4e+00	5.7e+00	7.3e+00	6.8e+00	5.7e-01	4.8e-01
Fe	6.8e+00	6.8e+00	2.1e+00	1.8e+00	7.4e+00	7.1e+00
Na	(b)	1.6e+01	(b)	1.9e+01	(b)	2.4e+01
Ni	4.9e+00	4.3e+00	5.1e+00	5.5e+00	2.4e-01	2.3e-01
P	(c)	ND	(c)	4.6e+00	(c)	6.8e+00
Pb	5.9e-01	5.7e-01	(9.1e-02)	ND	(2.6e-01)	1.8e-01
Si	8.4e-01[(d)]	3.1e-00	2.5e-01[(d)]	1.9e-01	3.3e-01[(d)]	3.2e-01
Sr	3.6e-02	2.8e-02	3.1e-02	2.8e-02	1.4e-01	1.4e-01
U	ND	5.6e-01	(9.6e-01)	7.4e-01	1.3e+01	1.3e+01

(a) A result reported in parentheses indicates results below matrix-adjusted detection limit but above instrument's detection limit for an optimum analytical matrix.

(b) Sodium peroxide used as flux to dissolve sample rendering measurement inaccurate.

(c) Zirconium crucible used for container during fusion rendering measurement inaccurate from possible zirconium phosphate precipitate formation.

(d) Quality control failure; results are for information only.

Table 3.4. Comparison of Major Element Concentrations as Measured by ICP/AES in 1995 for Available Archive Samples and in 1992 (Sprouse 1993) of Samples Taken by Core 47 from Tank C-109 (Dry Basis)

Element	1995 Ave C47_1D, wt%	1992 C47_1D, wt%
Al	2.1e+00	5.3e+00
Ca	3.5e+00	4.6e+00
Fe	4.8e+00	2.5e+00
Na	(b)	1.7e+01
Ni	4.6e+00	4.2e+00
P	(c)	5.0e+00
Pb	(1.7e-01)	2.4e+00
Si	5.3e-01[(d)]	3.7e+00
Sr	9.6e-02	ND
U	(2.6e+00)	9.6e-01

(a) A result reported in parentheses indicates results below matrix-adjusted detection limit but above instrument's detection limit for an optimum analytical matrix.

(b) Sodium peroxide used as flux to dissolve sample rendering measurement inaccurate.

(c) Zirconium crucible used for container during fusion rendering measurement inaccurate from possible zirconium phosphate precipitate formation.

(d) Quality control failure; results are for information only.

gamma energy analysis (GEA) to determine if the sample has been successfully homogenized. Simpson and coworkers (1993a) report that in the homogenization testing for tank C-112 samples, the aliquots of selected subsegments dissolved using acid indicated that 2 attempts at homogenizing the sample were not totally successful; as a result of this apparent failure to homogenize, Simpson et al. (1993a) recommend that future homogenization testing use a potassium hydroxide fusion to prepare the sample for analysis as it provides a more complete dissolution of the sample. As Simpson et al. report (1993b), even using a fusion dissolution preparation of the aliquots for homogenization testing, the differences observed between the top and bottom aliquots indicate that the subsegment samples were not fully homogenized. The results of the homogenization testing suggest that some of the differences observed between the 1995 and 1992 measured nickel content may be at least partially due to lack of homogeneity in the homogenized subsegment samples from tanks C-112 and C-109.

Table 3.5. Comparison of Major Element Concentrations as Measured by ICP/AES in 1995 for Available Archive Samples and in 1992 (Sprouse 1993) of Samples Taken by Core 49 from Tank C-109 (Dry Basis)

Element	1995 C49_1B, wt%	1992 C49_1B, wt%	1995 C49_1C, wt%	1992 C49_1C, wt%	1995 C49_1D, wt%	1992 C49_1D, wt%
Al	2.6e+01	2.3e+01	1.2e+01	1.3e+01	1.8e+01	1.2e+01
Ca	5.5e-01	5.3e-01	3.6e+00	2.6e+00	3.1e+00	3.7e+00
Fe	2.3e+00	1.9e+00	2.4e+00	6.4e-01	7.5e-01	2.5e+00
Na	(b)	5.3e+00	(b)	8.8e+00	(b)	1.5e+01
Ni	8.2e-01	1.3e+00	3.3e+00	4.5e+00	3.2e+00	5.1e+00
P	3.2e-01(c)	5.1e-01	3.3e+00(c)	1.6e+00	9.9e-01(c)	3.4e+00
Pb	2.9e-01	2.5e-01	(1.4e-01)	5.2e-02	(7.2e-02)	1.2e-01
Si	4.0e-01(d)	3.6e-01	2.9e-01(d)	1.2e-01	1.7e-01(d)	2.8e-01
Sr	1.4e-02	ND	6.9e-02	ND	1.3e-02	ND
U	ND	9.8e-01	(1.7e+00)	1.8e-01	ND	2.0e+00

(a) A result reported in parentheses indicates results below matrix-adjusted detection limit but above instrument's detection limit for an optimum analytical matrix.

(b) Sodium peroxide used as flux to dissolve sample rendering measurement inaccurate.

(c) Zirconium crucible used for container during fusion rendering measurement inaccurate from possible zirconium phosphate precipitate formation. For information only.

(d) Quality control failure; results are for information only.

It should be noted that this lack of homogeneity in the homogenized samples becomes more and more important as the sample size decreases. The chemical analyses typically use a 250 mg sample size and the DSC and TGA nominally use 10 mg or less sample sizes.

3.1 Results of Analyses of Samples Taken from Tank C-112

In review, the wastes stored in tank C-112, in order of their addition, are 1C waste (16.6 cm), In-Farm ferrocyanide waste (57 cm), CWP waste (16.6 cm), HS waste (3.2 cm), and an unknown waste (5.5 cm). The samples taken from tank C-112 that were reanalyzed using ICP/AES after fusing the sample with sodium peroxide in a zirconium crucible were C34_2B, C34_2C, C34_2D, C35_2D, C36_1C, C36_1D, and C36_2D.

As shown in Table 3.1, the elemental concentrations, with the exception of nickel, in the Core 34 samples as measured in 1995 and 1992 are similar. Some differences exist (particularly for uranium), however, none that will impact the discussion or conclusions made in the body of the original report. With respect to nickel, the 1995 analyses are lower than those in 1992; the amount found in the reanalyses ranges from 65 to 80%, indicating that the nickel crucibles contributed more than 10% to the previously reported concentrations.

Table 3.2 compares the results obtained in 1995 and 1992 for the Core 35 subsegment 2D analyses. Again the 1992 analysis of nickel is higher than that measured in 1995, 3.0 wt% compared to 2.5 wt% or about 80% of the previously reported value. Measured iron was higher in the 1995 analysis. Other elements, in general, had similar concentrations. Aluminum was found to be 6.8 wt% in 1992 and 7.0 wt% in 1995 and calcium was 2.2 and 2.5 wt%, respectively.

The measured concentrations of the elements found in the Core 36 samples, presented in Table 3.3 are fairly consistent between the two analyses. Even the measured nickel concentrations are similar. The 1995 analysis is higher than the 1992 analysis; e.g. C36_1C with 1995 analysis was 4.9 wt% compared to 4.3 wt% for the 1992 analysis. The nickel concentrations measured in 1995 ranged from 115 to 93% of the 1992 results.

Because of the nickel remeasurements, revisions of Tables 4.7, 4.9, and 4.11 and Appendix C from the original report (Scheele et al. 1994) are provided to update the measured nickel concentrations; these revised tables supersede these same four tables in the original report. The remainder of the presented data is from the 1992 analyses. In addition to the changes due to the nickel remeasurement, the data originally reported in Tables 4.7 and 4.11 and Appendix C for C34_2C and C34_2D and C36_2A, C36_2C, and C36_2D have been corrected.

In general, comparison of the 1995 and 1992 analytical results indicates that the true nickel concentrations in the wastes are lower than reported in 1993 for the wastes stored in tank C-112. This conclusion must be tempered by the potential that the observed differences between the 1995 and 1992 measurements may be due to inhomogeneity in the mechanically homogenized subsegment samples; however, because the 1995 measured nickel concentrations are typically lower than the 1992 measured concentration indicates that the difference is due to the analytical strategy and the use of a nickel crucible in 1992.

With respect to the original report (Scheele et al. 1994), in general, the new nickel concentrations do not affect the discussion regarding the nature of waste from tank C-112. These analyses indicate that the waste stored in tank C-112 is predominantly aged ferrocyanide waste and that significant mixing of the different waste types has occurred within the tank. The mixing could have occurred as a result of waste-management operations, including introduction and removal of wastes (Simpson et al. 1993a; Agnew 1993) or via convective mixing as described by McGrail et al. (1993).

3.2 Results of Analyses of Samples Taken from Tank C-109

In review, the waste contained in tank C-109, in order of their addition, were 1C waste (12 cm), In-Farm ferrocyanide waste (50 cm), HS waste (8.2 cm), an unknown waste (3.5 cm), and supernatant (4.7 cm). The samples taken from tank C-109 that were reanalyzed using ICP/AES after fusing the sample with sodium peroxide in a zirconium crucible were C47_1D, C49_1B, C49_1C, and C49_1D. No archived samples remained for the Core 48 sampling from tank C-109.

The measured elemental concentrations for C47_1D given in Table 3.4 differ substantially from one another with the exception of nickel. The aluminum concentration measured in 1995 is half of that measured in 1992. The 1995 iron measurement is a factor of 2 greater than the 1992 measurement. No explanation is available for the differences in measured concentrations, given the lack of a definite

Table 4.7 (Revised). Comparison Element Concentrations on a Dry Basis in INFARM-2 Simulants **(Scheele et al. 1994)** and Waste from Core 34, Tank C-112 (Jeppson and Simpson 1994; Bell 1993)

Element	INFARM-2 Top Solids, mmol/g	INFARM-2 Bottom Solids, mmol/g	C34 Comp, mmol/g	C34_1D, mmol/g	C34_2B, mmol/g	C34_2C, mmol/g	C34_2D, mmol/g
Al	NA	NA	1.8e+00	1.2e+00	2.6e+00	1.5e+00	2.1e+00
Ba	NA	NA	<1.8e-04	<3.0e-04	<3.0e-04	4.1e-03	8.8e-04
Ca	NR	NR	1.2e+00	1.3e+00	1.2e+00	1.8e+00	1.2e+00
Cr	NA	NA	<6.8e-04	<1.1e-03	<1.1e-03	1.2e-02	9.1e-03
Cs	3.5e-02	3.8e-02	NM	NM	NM	NM	NM
Fe	6.8e-01	7.2e-01	6.6e-01	2.8e-01	5.6e-01	4.3e-01	7.3e-01
Mg	NA	NA	<3.9e-05	<6.3e-05	<6.3e-05	3.9e-02	3.7e-02
Mn	NA	NA	<5.7e-05	<9.3e-05	<9.3e-05	6.8e-03	8.5e-05
Na	9.6e+00	8.7e+00	8.1e+00	7.2e+00	8.2e+00	9.2e+00	7.1e+00
Ni	7.0e-01	7.7e-01	8.2e-01(a)	7.0e-01(a)	6.5e-01(b)	8.4e-01(b)	5.4e-01(b)
P	1.9e+00	2.5e+00	1.1e+00	7.5e-01	7.6e-01	1.5e-00	1.3e+00
Pb	NA	NA	1.1e-01	1.1e-01	3.7e-02	1.3e-02	2.8e-02
Si	NA	NA	9.1e-01	8.1e-01	2.4e-01	1.2e-01	2.2e-01
Sr	NA	NA	<1.4e-05	<2.3e-05	6.6e-03	4.1e-03	4.4e-03
Th	NA	NA	<9.9e-04	<1.6e-03	<1.6e-03	<4e-03	<3e-03
U (ICP)	NA	NA	9.8e-02	2.2e-02	2.6e-02	5.7e-02	1.8e-01
U (LF)	NA	NA	1.2e-01	NM	NM	NM	NM
Total	1.1e+01	1.0e+01	1.5e+01	1.2e+01	1.4e+01	1.6e+01	1.4e+01

NA = Not added.
NR = Not reported (Jeppson and Simpson 1994).
NM = Not measured.

(a) Sample prepared for analysis by fusion with potassium hydroxide in a nickel crucible; may be biased high.

(b) Sample prepared for analysis by fusion with sodium peroxide in a zirconium crucible (new, previously unreported analysis).

trend other than the potential for inhomogeneity in the sample that is suggested by the results of the homogeneity testing for samples from tank C-109 that indicated some inhomogeneity in these samples (Simpson et al. 1993b). Interestingly enough, the nickel concentrations are similar, with the 1995 result 10% greater than the 1992 result.

The comparison of the 1995 and 1992 measured concentrations of nickel found in the quarter segment samples taken by Core 49 from tank C-109 (presented in Table 3.5) shows significant differences between the two nickel analyses. The 1995 result was less than the 1992 result with the 1995 results ranging from 65 to 75% of the 1992 result. Assuming that the sample was homogeneous, this difference indicates that the nickel crucible contribution to the reported nickel concentration in the sample was greater than the expected 10% contribution, based on the blank analyses. It should be mentioned

Table 4.9 (Revised). Comparison of Element Concentrations on a Dry Basis in INFARM-2 and **(Scheele et al. 1994)** Waste from Core 35, Tank C-112 (Jeppson and Simpson 1994; Bell 1993)

Element	INFARM-2 Top Solids, mmol/g	INFARM-2 Bottom Solids, mmol/g	C35_Comp, mmol/g
Al	NA	NA	2.5e+00
Ba	NA	NA	<3.2e-04
Ca	NR	NR	5.7e-01
Cr	NA	NA	<1.2e-03
Cs	3.5e-02	3.8e-02	NM
Fe	6.8e-01	7.2e-01	8.8e-01
Mg	NA	NA	<6.8e-05
Mn	NA	NA	<1.0e-04
Na	9.6e+00	8.7e+00	5.4e+00
Ni	7.0e-01	7.7e-01	4.3e-01(a)
P	1.9e+00	2.5e+00	1.0e+00
Pb	NA	NA	<2.2e-03
Si	NA	NA	8.5e-01
Sr	NA	NA	<2.5e-05
Th	NA	NA	<1.7e-03
U (ICP)	NA	NA	5.7e-01
U (LF)	NA	NA	2.8e-01
Total	1.1e+01	1.0e+01	1.2e+01

NA = Not added.
NR = Not reported (Jeppson and Simpson 1994).
NM = Not measured.
(a) Sample prepared for analysis by fusion with sodium peroxide in a zirconium crucible (new, previously unreported analysis.

that the nickel concentrations for C49_1C and C49_1D are unaffected by the following discussion regarding the potential mix-up of these two samples, as the two analytical results are essentially the same, 3.3 and 3.2 wt%, respectively.

The comparison presented in Table 3.5 has additional implications with respect to the accuracy of the reported results for quarter segments C49_1C and C49_1D. While the 1995 and 1992 results for C49_1B were similar, the results for the other two sets of analyses differ substantially from each other; however, similarities exist between the 1995 results for C49_1C and the 1992 results for C49_1D and vice versa. The differences observed between the 1995 and 1992 analyses for C49_1C and C49_1D suggest that in one analysis or the other the samples were mislabeled or switched. For example, differences exist between the 1995 measured iron concentration in C49_1C of 2.4 wt% and the 1992 measured 0.64 wt%; a similar disparity exists for calcium also. Comparable differences also exist between the 1995 and 1992 results for C49_1D with a 1995 measured iron concentration of 0.75 wt% compared to 2.5 wt% measured in 1992; again a similar disparity exists for calcium also. Comparison of the 1995 results for C49_1C with 1992 results for C49_1D; for iron 2.4 wt% in C49_1C in 1995

Table 4.11 (Revised). Comparison of Element Concentrations on a Dry Basis in INFARM-2 and Waste from Core 36, Tank C-112 (Jeppson and Simpson 1994; Bell 1993) **(Scheele et al. 1994)**

Element	INFARM-2 Top Solids, mmol/g	INFARM-2 Bottom Solids, mmol/g	C36_Comp, mmol/g	C36_1C, mmol/g	C36_1D, mmol/g	C36_2A, mmol/g	C36_2B, mmol/g	C36_2C, mmol/g	C36_2D, mmol/g
Al	NA	NA	4.3e-01	1.1e+00	3.5e-01	2.5e-01	1.9e-01	6.0e-01	5.7e-01
Ba	NA	NA	<1.3e-04	1.8e-03	<2.6e-04	(6.1e-04)	<1.2e-04	(1.8e-03)	<1.2e-04
Ca	NR	NR	9.3e-01	1.4e+00	1.7e+00	1.2e-00	3.8e-01	5.8e-01	2.7e-01
Cr	NA	NA	<4.8e-04	7.2e-03	<9.8e-04	8.7e-03	<4.5e-04	2.3e-02	<4.3e-04
Cs	3.5e-02	3.8e-02	NM	NM	NM	NM	NM	NM	NM
Fe	6.8e-01	7.2e-01	8.5e-01	1.3e+00	3.2e-01	4.7e-01	2.7e-01	2.1e-00	2.9e-01
Mg	NA	NA	<2.8e-05	4.6e-02	<5.5e-05	4.6e-02	<2.6e-05	8.2e-02	<2.5e-05
Mn	NA	NA	<4.1e-05	1.2e-02	<8.2e-05	2.9e-03	<3.8e-05	2.5e-02	<3.6e-05
Na	9.6e+00	8.7e+00	9.6e+00	6.9e+00	8.5e+00	9.3e+00	6.7e+00	3.6e+01	2.4e+01
Ni	7.0e-01	7.7e-01	4.0e-01(a)	8.3e-01(b)	8.7e-01(b)	4.4e-01(a)	1.4e-01(a)	1.3e-01(a)	4.1e-02(b)
P	1.9e+00	2.5e+00	2.2e+00	1.2e+00	1.5e+00	1.6e-00	1.4e+00	8.4e+00	5.0e+00
Pb	NA	NA	9.2e-01	2.7e-02	<1.8e-03	<9e-03	<8.3e-04	1.3e-02	2.0e-02
Si	NA	NA	1.0e+00	1.1e+00	6.6e-02	1.1e-01	7.7e-02	2.4e-01	2.6e-01
Sr	NA	NA	<1.0e-05	3.2e-03	3.2e-03	6.1e-03	3.2e-03	2.7e-02	3.5e-02
Th	NA	NA	<7.1e-04	<1.4e-03	<1.4e-03	<3.3e-03	<6.6e-04	<5e-03	<6.3e-04
U (ICP)	NA	NA	8.0e-01	2.3e-02	3.1e-02	3.9e-01	1.2e+00	3.6e+00	1.3e+00
U (LF)	NA	NA	7.2e-01	NM	NM	NM	NM	NM	NM
Total	1.1e+01	1.0e+01	1.7e+01	1.4e+01	7.1e+00	1.4e+01	1.0e+01	5.1e+01	3.4e+01

A result reported in parentheses indicates results below matrix-adjusted detection limit but above instrument's detection limit for an optimum analytical matrix.

NA = Not added.

NR = Not reported (Jeppson and Simpson 1994).

NM = Not measured.

(a) Sample prepared for analysis by fusion with potassium hydroxide in a nickel crucible; may be biased high.

(b) Sample prepared for analysis by fusion with sodium peroxide in a zirconium crucible (new, previously unreported analysis).

and 2.5 wt% in C49_1D in 1992. Likewise the 1992 results for C49_1C compare to the 1995 results for C49_1D; for iron 0.64 wt% in C49_1C in 1992 and 0.75 wt% in C49_1D in 1995. Similar relationships exist between the 1995 results for C49_1C and the 1992 results for C49_1D and vice versa for other elements such as calcium, silicon, and possibly aluminum. These relationships suggest that samples may have been switched or mislabeled; unfortunately, it is not possible to determine based on historical records or staff memories when the switch, if it occurred, did occur as all sample containers were labeled in 1992. Sample inhomogeneity may also explain the observed differences. Comparison of the ICP/AES results for C49_1B with the reported results for C49_1C and C49_1D provides few clues about which reported concentrations accurately represent the concentrations in these two quarter segments. Assuming that the iron concentration in C49_1C should be similar to C49_1B, then the 1995 C49_1C result and the 1992 C49_1D result should be assigned to the 1C quarter segment. In contrast, assuming that the aluminum concentration should be highest near the top (based on Simpson et al. (1993b) original report that the last waste added to tank C-109 was CWP) and decrease with increasing depth, the opposite conclusion can be drawn that the 1995 C49_1D results, and 1992 C49_1C results truly reflect the elemental concentrations for the 1C quarter segment. There is insufficient information provided by the analyses to make the proper assignment, assuming that the samples were switched.

Independent of whether analytical problems exist for two of the C49 samples, the conclusions presented in the original report change little. The reanalyses continue to indicate that the wastes stored in tank C-109 are predominately aged ferrocyanide wastes, that significant mixing has occurred between the 1C, IN-FARM ferrocyanide, HS, and unknown waste types that were added to tank C-109, and that the amount of mixing is dependent on location within the tank.

With respect to nickel concentrations, comparison of the 1995 and 1992 analyses, in general, indicate that the nickel crucible contributed significant amounts of nickel to the nickel concentrations reported by Simpson and coworkers (1993b). Alternatively, the reported sample inhomogeneity for the tank C-109 wastes (Simpson et al. 1993b) may explain the differences in measured nickel concentrations; however, that the 1995 measured nickel concentrations are typically lower than the 1992 measured concentration indicates that the difference is due to the analytical strategy.

Tables 4.1, 4.3, and 4.5 and Appendix A of the original report (Scheele et al. 1994) are updated to provide the 1995 measured nickel concentrations; these revised tables supersede these same three tables in the original report. The remainder of the data in these tables are from the 1992 analyses. Table 4.5 is also updated with a footnote describing the sample preparation method used for the reported nickel analysis and to provide a similar format to other tables.

The results of the ICP/AES reanalyses of the available tank C-109 quarter segment samples indicate that the nickel crucible contributed significant amounts of nickel to the measured nickel content determined in the original analyses. The reanalyses also suggest that samples or analytical results may have been switched.

Table 4.1 (Revised). Comparison of Element Concentrations on a Dry Basis (as Measured by ICP) of INFARM-2 Simulant with (Scheele et al. 1994) Waste from Tank C-109 (Core 47) (Jeppson and Simpson 1994; Sprouse 1993)

Element	INFARM-2 Top Solids, mmol/g	INFARM-2 Bottom Solids, mmol/g	C47 Comp, mmol/g	C47_1B, mmol/g	C47_1C, mmol/g	C47_1D, mmol/g
Al	NA	NA	5.5e+00	6.0e+00	6.2e+00	2.0e+00
Ba	NA	NA	<2.4e-04	<1.5e-04	<1.5e-05	<1.5e-06
Ca	NR	NR	7.9e-01	3.2e-01	6.3e-01	1.2e+00
Cr	NA	NA	6.6e-03	<5.7e-04	<5.7e-05	<5.7e-06
Cs	3.5e-02	3.8e-02	NM	NM	NM	NM
Fe	6.8e-01	7.2e-01	5.0e-01	1.4e+00	5.2e-01	4.5e-01
Mg	NA	NA	3.4e-02	<3.2e-05	<3.2e-06	<3.2e-07
Mn	NA	NA	3.7e-03	<4.7e-05	<4.7e-06	<4.7e-07
Na	9.6e+00	8.7e+00	4.8e+00	2.8e+00	3.8e+00	7.4e+00
Ni	7.0e-01	7.7e-01	6.9e-01(a)	4.1e-01(a)	5.4e-01(a)	7.8e-01(b)
P	1.9e+00	2.5e+00	8.2e-01	3.0e-01	5.6e-01	1.6e+00
Pb	NA	NA	4.5e-02	3.1e-02	2.0e-02	1.1e-01
Si	NA	NA	7.2e-01	8.3e-01	3.0e-01	1.3e+00
Sr	NA	NA	<1.9e-05	<1.2e-05	<1.2e-06	<1.2e-07
Th	NA	NA	1.1e-03	<8.2e-04	<8.2e-05	<8.2e-06
U(ICP)	NA	NA	4.9e-02	6.1e-02	3.6e-02	4.0e-02
U (LF)	NA	NA	6.4e-02	NM	NM	NM
Total	1.1e+01	1.0e+01	1.4e+01	1.2e+01	1.3e+01	1.5e+01

NA = Not added.
NR = Not reported (Jeppson and Simpson 1994).
NM = Not measured.
(a) Sample prepared for analysis by fusion with potassium hydroxide in a nickel crucible; may be biased high.
(b) Sample prepared for analysis by fusion with sodium peroxide in a zirconium crucible (new, previously unreported analysis).

Table 4.3 (Revised). (Scheele et al. 1994) Comparison of Element Concentrations on a Dry Basis (as Measured by ICP) of INFARM-2 Simulant with Waste from Core 49 Taken from Tank C-109 (Jeppson and Simpson 1994; Sprouse 1993)

Element	INFARM-2 Top Solids, mmol/g	INFARM-2 Bottom Solids, mmol/g	C49_Comp, mmol/g	C49_1B, mmol/g	C49_1C, mmol/g	C49_1D, mmol/g
Al	NA	NA	5.9e+00	8.5e+00	5.0e+00	4.3e+00
Ba	NA	NA	<1.5e-04	<1.2e-04	<1.2e-05	<1.2e-06
Ca	NR	NR	4.7e-01	1.3e-01	6.5e-01	9.3e-01
Cr	NA	NA	<5.6e-04	<4.6e-04	<4.6e-05	<4.6e-06
Cs	3.5e-02	3.8e-02	NM	NM	NM	NM
Fe	6.8e-01	7.2e-01	2.1e-01	3.5e-01	1.2e-01	4.6e-01
Mg	NA	NA	<3.2e-05	<2.6e-05	<2.6e-06	<2.6e-07
Mn	NA	NA	<4.7e-05	<3.9e-05	<3.9e-06	<3.9e-07
Na	9.6e+00	8.7e+00	4.2e+00	2.3e+00	3.8e+00	6.6e+00
Ni	7.0e-01	7.7e-01	5.0e-01(a)	1.4e-01(b)	5.6e-01(b)	5.4e-01(b)
P	1.9e+00	2.5e+00	6.0e-01	1.6e-01	5.2e-01	1.1e+00
Pb	NA	NA	5.0e-03	1.2e-02	2.5e-03	5.8e-03
Si	NA	NA	1.0e-01	1.3e-01	4.4e-02	9.9e-02
Sr	NA	NA	<1.2e-05	<9.7e-06	<9.7e-07	<9.7e-08
Th	NA	NA	<8.2e-04	<6.7e-04	<6.7e-05	<6.7e-06
U(ICP)	NA	NA	2.5e-02	4.1e-02	7.6e-03	8.6e-02
U (LF)	NA	NA	4.0e-02	NM	NM	NM
Total	1.1e+01	1.0e+01	1.2e+01	1.2e+01	1.1e+01	1.4e+01

NA = Not added.

NR = Not reported (Jeppson and Simpson 1994).

NM = Not measured.

(a) Sample prepared for analysis by fusion with potassium hydroxide in a nickel crucible; may be biased high.

(b) Sample prepared for analysis by fusion with sodium peroxide in a zirconium crucible (new, previously unreported analysis).

Table 4.5 (Revised). (Scheele et al. 1994) Comparison of Element Concentrations on a Dry Basis (as Measured by ICP) of INFARM-2 Simulant with Waste from Core 48 Taken from Tank C-109 (Jeppson and Simpson 1994; Sprouse 1993)

Element	INFARM-2 Top Solids, mmol/g	INFARM-2 Bottom Solids, mmol/g	C48_Comp, mmol/g	C48_1C, mmol/g	C48_1D, mmol/g
Al	NA	NA	4.1e-01	3.8e-01	6.0e-01
Ba	NA	NA	<1.5e-04	<1.2e-04	<1.2e-05
Ca	NR	NR	5.6e-01	1.0e+00	6.9e-01
Cr	NA	NA	<5.6e-04	<4.6e-04	<4.6e-05
Cs	3.5e-02	3.8e-02	NM	NM	NM
Fe	6.8e-01	7.2e-01	5.1e-01	5.0e-01	6.2e-01
Mg	NA	NA	<3.2e-05	<2.6e-05	<2.6e-06
Mn	NA	NA	<4.7e-05	<3.9e-05	<3.9e-06
Na	9.6e+00	8.7e+00	5.5e+00	7.0e+00	7.3e+00
Ni	7.0e-01	7.7e-01	7.2e-01[a]	1.1e+00[a]	6.7e-01[a]
P	1.9e+00	2.5e+00	8.3e-01	1.1e+00	1.1e+00
Pb	NA	NA	4.3e-03	3.7e-03	5.5e-03
Si	NA	NA	1.0e-01	1.4e-01	1.3e-01
Sr	NA	NA	<1.2e-05	<9.7e-06	<9.7e-07
Th	NA	NA	<8.2e-04	<6.7e-04	<6.7e-05
U (ICP)	NA	NA	1.3e-01	9.8e-02	1.0e-01
U (LF)	NA	NA	1.5e-01	NM	NM
Total	1.1e+01	1.0e+01	8.8e+00	1.1e+01	1.1e+01

NA = Not added.
NR = Not reported (Jeppson and Simpson).
NM = Not measured.
(a) Sample prepared for analysis by fusion with potassium hydroxide in a nickel crucible; may be biased high.

4.0 Conclusions

The results of the reanalyses of available archived quarter segment samples taken from tank C-112 by Cores 34, 35, and 36 and from tank C-109 by Cores 47, 48, and 49 to provide a more accurate nickel measurement indicates that, in general, the nickel crucible contributed a significant although variable amount of nickel to the originally reported nickel concentrations. Based on the comparison of results obtained by the two different analyses, any future analyses of ferrocyanide wastes should employ a non-nickel crucible for the sample preparation.

Although the nickel crucibles contributed significant amounts to the reported nickel concentrations for the different subsegment samples, the qualitative conclusions drawn and reported in the original report (Scheele et al. 1994) are changed little by the new nickel or other elemental analyses. These new ICP/AES analyses continue to indicate that the wastes stored in tanks C-112 and C-109 are aged ferrocyanide wastes mixed with the other waste types added to each tank, with the amount of mixing dependent on the location within the tank.

5.0 References

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A.1. Comparison of Weight Percent Elemental Concentration on a Dry Basis in Simulated IN-FARM Waste and Waste from Tank 241-C-109 (Sprouse 1993)

Element	INFARM-2 Top Solids, wt%	INFARM-2 Bot Solids, wt%	C47_Comp, wt%	C47_1B, wt%	C47_1C, wt%	C47_1D, wt%
Al	NA	NA	1.5e+01	1.6e+01	1.7e+01	5.3e+00
Ba	NA	NA	<3.3E-03	<2.1E-03	<2.1E-04	<2.1E-05
Ca	NR	NR	3.1e+00	1.3e+00	2.5e+00	4.6e+00
Cr	NA	NA	3.4e-02	<2.9E-03	<2.9E-04	<2.9E-05
Cs	4.6e-01	5.0e-01	NM	NM	NM	NM
Fe	3.8e+00	4.0e+00	2.8e+00	7.9e+00	2.9e+00	2.5e+00
Mg	NA	NA	8.3e-02	<7.8E-05	<7.8E-06	<7.8E-07
Mn	NA	NA	2.1e-02	<2.6E-04	<2.6E-05	<2.6E-06
Na	2.2e+01	2.0e+01	1.1e+01	6.3e+00	8.8e+00	1.7e+01
Ni	4.1e+00	4.5e+00	4.1e+00(a)	2.4e+00(a)	3.2e+00(a)	4.6e+00(b)
P	5.9e+00	7.8e+00	2.5e+00	9.4e-01	1.7e+00	5.0e+00
Pb	NA	NA	9.3e-01	6.3e-01	4.1e-01	2.4e+00
Si	NA	NA	2.0e+00	2.3e+00	8.5e-01	3.7e+00
Sr	NA	NA	<1.7E-04	<1.0E-04	<1.0E-05	3.3e-02
Th	NA	NA	2.6e-02	<1.9E-02	<1.9E-03	<1.9E-04
U(ICP)	NA	NA	1.2e+00	1.5e+00	8.5e-01	9.6e-01
U (LF)	NA	NA	1.5e+00	NM	NM	NM
Total	3.0e+01	2.9e+01	4.3e+01	4.0e+01	3.8e+01	4.6e+01

A.1. (contd)

Element	INFARM-2 Top Solids, wt%	INFARM-2 Bot Solids, wt%	C48_Comp, wt%	C48_1C, wt%	C48_1D, wt%
Al	NA	NA	1.1e+00	1.0e+00	1.6e+00
Ba	NA	NA	<2.1E-03	<1.7E-03	<1.7E-04
Ca	NR	NR	2.3e+00	4.1e+00	2.8e+00
Cr	NA	NA	<2.9E-03	<2.4E-03	<2.4E-04
Cs	4.6e-01	5.0e-01	NM	NM	NM
Fe	3.8e+00	4.0e+00	2.8e+00	2.8e+00	3.5e+00
Mg	NA	NA	<7.8E-05	<6.4E-05	<6.4E-06
Mn	NA	NA	<2.6E-04	<2.1E-04	<2.1E-05
Na	2.2e+01	2.0e+01	1.3e+01	1.6e+01	1.7e+01
Ni	4.1e+00	4.5e+00	4.2e+00(a)	6.2e+00(a)	4.0e+00(a)
P	5.9e+00	7.8e+00	2.6e+00	3.3e+00	3.4e+00
Pb	NA	NA	8.9e-02	7.7e-02	1.1e-01
Si	NA	NA	2.8e-01	4.1e-01	3.6e-01
Sr	NA	NA	<1.0E-04	<8.5E-05	<8.5E-06
Th	NA	NA	<1.9E-02	<1.6E-02	<1.6E-03
U(ICP)	NA	NA	3.1e+00	2.3e+00	2.4e+00
U (LF)	NA	NA	3.5e+00	NM	NM
Total	3.0e+01	2.9e+01	2.9e+01	3.6e+01	3.5e+01

A.1. (contd)

Element	INFARM-2 Top Solids, wt%	INFARM-2 Bot Solids, wt%	C49_Comp, wt%	C49_1B, wt%	C49_1C, wt%	C49_1D, wt%
Al	NA	NA	1.6e+01	2.3e+01	1.3e+01	1.2e+01
Ba	NA	NA	<2.1E-03	<1.7E-03	<1.7E-04	<1.7E-05
Ca	NR	NR	1.9e+00	5.3e-01	2.6e+00	3.7e+00
Cr	NA	NA	<2.9E-03	<2.4E-03	<2.4E-04	<2.4E-05
Cs	4.6e-01	5.0e-01	NM	NM	NM	NM
Fe	3.8e+00	4.0e+00	1.2e+00	1.9e+00	6.4e-01	2.5e+00
Mg	NA	NA	<7.8E-05	<6.4E-05	<6.4E-06	<6.4E-07
Mn	NA	NA	<2.6E-04	<2.1E-04	<2.1E-05	<2.1E-06
Na	2.2e+01	2.0e+01	9.7e+00	5.3e+00	8.8e+00	1.5e+01
Ni	4.1e+00	4.5e+00	2.9e+00(a)	8.2e+01(a)	3.3e+00(b)	5.1e+00(b)
P	5.9e+00	7.8e+00	1.9e+00	5.1e-01	1.6e+00	3.4e+00
Pb	NA	NA	1.0e-01	2.5e-01	5.2e-02	1.2e-01
Si	NA	NA	2.9e-01	3.6e-01	1.2e-01	2.8e-01
Sr	NA	NA	<1.0E-04	<8.5E-05	<8.5E-06	<8.5E-07
Th	NA	NA	<1.9E-02	<1.6E-02	<1.6E-03	<1.6E-04
U(ICP)	NA	NA	6.0e-01	9.8e-01	1.8e-01	2.0e+00
U (LF)	NA	NA	9.6e-01	NM	NM	NM
Total	3.0e+01	2.9e+01	3.5e+01	3.4e+01	3.2e+01	4.4e+01

NA = Not added.
NR = Not reported.
(a) Sample prepared for analysis by fusing with potassium hydroxide in a nickel crucible; analysis could be biased high.
(b) Sample prepared for analysis by fusing with sodium peroxide in a zirconium crucible (new, previously unreported analysis).

Appendix C (Scheele et al. 1994)
(Revised)

Comparison of Weight Percent Elemental Concentration on a Dry Basis in Simulated IN-FARM Waste and Waste from Tank 241-C-112

C.1. Comparison of Weight Percent Elemental Concentration on a Dry Basis in Simulated IN-FARM Waste and Waste from Tank 241-C-112 (Bell 1993)

Element	INFARM-2 Top Solids, wt%	INFARM-2 Bot Solids, wt%	C34_Comp, wt%	C34_1D, wt%	C34_2B, wt%	C34_2C, wt%	C34_2D, wt%
Al	NA	NA	4.8e+00	3.2e+00	6.9e+00	4.1e+00	5.6e+00
Ba	NA	NA	<2.5E-03	<4.1E-03	<4.1E-03	<4.1E-03	<4.1E-03
Ca	NR	NR	4.7e+00	5.1e+00	4.6e+00	7.1e+00	5.0e+00
Cr	NA	NA	<3.5E+03	<5.8E-03	<5.8E-03	<5.7E-03	<5.7E-03
Cs	4.6e-01	5.0e-01	NM	NM	NM	NM	NM
Fe	3.8e+00	4.0e+00	3.7e+00	1.5e+00	3.1e+00	2.4e+00	4.1e+00
Mg	NA	NA	<9.4E-05	<1.5E-04	<1.5E-04	<1.5E-04	<1.5E-04
Mn	NA	NA	<3.1E-04	<5.1E-04	<5.1E-04	<5.1E-04	<5.1E-04
Na	2.2e+01	2.0e+01	1.9e+01	1.7e+01	1.9e+01	2.1e+01	1.6e+01
Ni	4.1e+00	4.5e+00	4.8e+00(a)	4.1e+00(a)	3.8e+00(b)	4.9e+00(b)	3.2e+00(b)
P	5.9e+00	7.8e+00	3.5e+00	2.3e+00	2.4e+00	4.7e+00	4.1e+00
Pb	NA	NA	2.3e+00	2.3e+00	7.7e-01	2.7e-01	5.9e-01
Si	NA	NA	2.5e+00	2.3e+00	6.8e-01	3.4e-01	6.0e-01
Sr	NA	NA	<1.2E-04	<2.0E-04	5.8e-02	3.6e-02	3.9e-02
Th	NA	NA	<2.3E-02	<3.7E-02	<3.7E-02	<3.7E-02	<3.7E-02
U(ICP)	NA	NA	2.3e+00	5.1e+01	6.3e-01	1.3e+00	4.2e-00
U (LF)	NA	NA	2.9e+00	NM	NM	NM	NM
Total	3.0e+01	2.9e+01	4.7e+01	3.8e+01	4.3e+01	4.8e+01	4.5e+01

C.1. (contd)

Element	INFARM-2 Top Solids, wt%	INFARM-2 Bot Solids, wt%	C35_Comp, wt%
Al	NA	NA	6.8e+00
Ca	NR	NR	2.3e+00
Cr	NA	NA	3.9e-02
Cs	4.6e-01	5.0e-01	NM
Fe	3.8e+00	4.0e+00	4.9e+00
Mg	NA	NA	1.5e-01
Mn	NA	NA	6.2e-02
Na	2.2e+01	2.0e+01	1.2e+01
Ni	4.1e+00	4.5e+00	2.5e+00(b)
P	5.9e+00	7.8e+00	3.2e+00
Pb	NA	NA	7.1e-01
Si	NA	NA	1.3e+00
Sr	NA	NA	6.5e-02
U(ICP)	NA	NA	1.3e+01
U (LF)	NA	NA	6.7e+00
Total	3.0e+01	2.9e+01	6.2e+01

C.1. (contd)

Element	INFARM-2 Top Solids, wt%	INFARM-2 Bot Solids, wt%	C36_Comp, wt%	C36_1C, wt%	C36_1D, wt%	C36_2A, wt%	C36_2B, wt%	C36_2C, wt%	C36_2D, wt%
Al	NA	NA	1.2e+00	2.9e+00	9.5e-01	6.7e-01	5.3e-01	5.8e-01	6.8e-01
Ba	NA	NA	<1.8E-03	2.5e-02	<1.7E-04	<1.7E-05	<1.7E-03	<1.7E-04	<1.6E-03
Ca	NR	NR	3.7e+00	5.7e+00	6.8e+00	5.0e+00	1.5e+00	8.3e-01	4.8e-01
Cr	NA	NA	<2.5E-03	3.7e-02	<2.4E-04	<2.4E-05	<2.3E-03	<2.3E-04	<2.3E-03
Cs	4.6e-01	5.0e-01	NM	NM	NM	NM	NM	NM	NM
Fe	3.8e+00	4.0e+00	4.7e+00	7.1e+00	1.8e-00	2.6e+00	1.5e+00	4.2e+00	7.1e+00
Mg	NA	NA	<6.4E-05	1.1e-01	<6.4E-06	<6.4E-07	<6.2E-05	<6.2E-06	<6.0E-05
Mn	NA	NA	<2.2E-04	6.7e-02	<2.1E-05	<2.1E-06	<2.1E-04	<2.1E-05	<2.0E-04
Na	2.2e+01	2.0e+01	2.2e+01	1.6e+01	1.9e+01	2.1e+01	1.5e+01	2.9e+01	2.4e+01
Ni	4.1e+00	4.5e+00	2.3e+00(a)	2.2e+00(b)	5.1e+01(b)	2.6e+00(a)	8.1e-01(a)	2.8e-01(a)	2.4e-01(b)
P	5.9e+00	7.8e+00	6.7e+00	3.8e+00	4.6e+00	4.9e+00	4.3e+00	9.3e+00	6.8e+00
Pb	NA	NA	1.9e+01	5.7e-01	9.1e-02		<1.7E-02	<1.7E-03	1.8e-01
Si	NA	NA	2.9e+00	3.1e+00	1.9e-01	3.2e-01	2.2e-01	2.4e-01	3.2e-01
Sr	NA	NA	<8.9E-05	2.8e-02	2.8E-02	<8.5E-07	2.8e-02	8.6e-02	1.4e-01
Th	NA	NA	<1.6E-02	<3.3E-02	<1.6E-03	<1.6E-04	<1.5E-02	<1.5E-03	<1.5E-02
U(ICP)	NA	NA	1.9e+01	5.6e-01	7.4e-01	9.3e+00	3.0e+01	3.1e+01	1.3e+01
U (LF)	NA	NA	1.7e+01	NM	NM	NM	NM	NM	NM
Total	3.0e+01	2.9e+01	8.2e+01	4.4e+01	4.1e+01	4.7e+01	5.4e+01	7.6e+01	5.3e+01

A result reported in parentheses indicates results below matrix-adjusted detection limit but above instrument's detection limit for an optimum analytical matrix.
NA = Not added.
NR = Not reported.
LF = Analysis by Laser Fluorescence.
(a) Sample prepared for analysis by fusion with potassium hydroxide in a nickel crucible; may be biased high.
(b) Sample prepared for analysis by fusion with sodium peroxide in a zirconium crucible (new analysis).

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